Essays on International Environmental Agreements: Political Economy Aspects of the Post-Negotiation Period

A thesis submitted to the School of Economics of the University of East Anglia for the Degree of Doctor of Philosophy

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December 2022

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Abstract

This thesis aims to investigate and study the main stages in the post-negotiation period in international treaties that deal with the provision of public goods. In particular, we look into the stages of signature and ratification. The thesis includes three chapters. The first chapter examines the interaction between the Executive and the Legislature as domestic institutions involved in a treaty-making process. Their interaction is crucial for the transformation of the international treaty terms to domestic policy and largely defines the success of the treaty. Our work is the first one that provides the theoretical and empirical analyses of this interaction and the factors that affect it.

The second empirical chapter looks deeper into the understanding of the role of signature on the ratification decision. Using a duration model in which time is measured on a daily basis, we test the hypothesis that the probability of ratifying an international treaty is greater if it is preceded by signature. Furthermore, we assess the magnitude of that effect depending on the type of the Executive who has signed the treaty: the Executive who has negotiated a treaty, and the Executive who has not taken part in the negotiations.

Finally, the third empirical chapter turns to the interdependent ratification behaviour of countries in the post-negotiation period. We propose a novel empirical approach to the estimation of the factors that affect the decisions of countries to ratify an international treaty (the ratification timing) in the presence of interdependencies between states by estimating a fixed effect model that takes into account heterogeneity among countries and treaties.

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Acknowledgment

My appreciation and gratitude go primarily to my supervisors: Dr. Emiliya Lazarova and Dr. Corrado Di Maria for their continued support, guidance, motivation and immense knowledge, from the initial to the final stage of this thesis.

I am grateful to the School of Economics of the University of East Anglia for providing a full PhD scholarship.

I am appreciative to the academic staff and PhD students of the UEA School of Economics for their valuable feedback, comments and advice during the internal seminars, and communications which helped me to improve my work in various aspects.

I would like to dedicate this thesis to my mother who continuously supported me throughout my PhD journey and to the loving memory of my grandmother, who will stay forever in my heart.

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1 Introduction.

1.1 Motivation.

Despite significant advancements in science and technology, countries still struggle to adequately address international problems that require their coordinated efforts. This is particularly important in the domain of public good provision, where the presence of externalities, and the absence of supra-national authorities make countries reluctant to cooperate fully towards common goals. Moreover, different national interests, cultural values, economic, political and social factors, make the task even more challenging.

Although our analysis can be applied to different areas of public good provision, the main focus of this work is on environmental protection. Nowadays we observe that international collaboration in the area of environmental protection often fails to reach their objectives. Furthermore, if these environmental challenges are not addressed promptly, they may result in threatening certain industries, such as agriculture or tourism, affect human health and well-being, deplete resources and create irreversible damage.

While international treaties are a very important formal mechanism that allows countries to address global and regional problems, and promote sustainable development, their effectiveness and success still remain a challenging task for society, mostly due to their self-enforcing nature, when countries decide voluntarily to join a treaty or not. Moreover, from an economist's point of view, such cooperative agreements are still puzzling. A straightforward game-theoretic analysis predicts that in equilibrium, cooperation among countries in managing global public goods may give a larger pay-off to each member than noncooperation. Any individual country, however, may appropriate the benefits from cooperation without assuming commitments of their own: this is the well-known free-rider problem. This behaviour is driven by the positive externalities that the provision of public goods generates and the individual rationality of countries: given the level of provision, every country is better off by not incurring the costs while benefiting from the actions of others.

International treaty-making process is a complex topic for discussion. The main focus of our work is the post-negotiation period in international treaty-making process, and we begin with introducing its main stages.

As a result of a negotiation process, a final treaty text is formulated, which is ready for adoption and signature. After an authorized representative signs a treaty at the international level, the treaty has to be approved at the domestic level through the process of ratification, thus expressing the consent of a state to be bound by a treaty. The negotiated agreement has to go through the approval of domestic stakeholders, who have an interest in agreement is-

sues. Their pulling in different directions can cause such negotiations over implementation to slow down and possibly halt. When a minimum number of countries ratify an international treaty, it enters into force. In the domain of public good provision, implementation of the agreements, which may have reached success in negotiations, is particularly problematic. Ratification of the agreements by a minimum number of countries can often take many years. Because of the ratification delay and the time criticality of the problems addressed by environmental agreements, successfully negotiated outcomes are often not enough and arriving too late to resolve or save a situation. Therefore, the post-negotiation process needs to get more attention. The treaty-making process requires a lot of time and effort, and can be tiresome. One such example is the Kyoto protocol. It was adopted in 1997, but only entered into force after 8 years.

All the steps along the treaty-making process require decisions from various levels of power. What decision - in favour or against - will be taken at each step depends on numerous factors: economic, political, social, legal. The post-negotiation period includes two steps that are central to our work as they may be crucial for the success of the treaty: signature and ratification.

1.2 The view of political scientists on signature.

The role and value of signature in a treaty-making process is widely discussed among political scientists, while economists in their analysis usually pay more attention to the ratification process. By and large, economists treat signature as a formality, and say it means no more than that state representatives have agreed upon an acceptable text (Shaw, 2017). However, in our work we show that the signature is an important step in a treaty-making process. There are two types of signatures: a 'definitive' signature that indicates consent to be bound, and a signature subject to ratification, acceptance or approval (or 'simple' signature). (Hollis, 2012).

Shaw (2017) argues that the definitive signature is appropriate for the more routine and less politicised of treaties, while a signature subject to ratification, acceptance or approval is more common for multilateral conventions (including environmental ones), which often have a very long and complicated period of negotiations, mediating interests of many countries. These features of the negotiations are observed in many international environmental agreements, in particular in multilateral environmental conventions and protocols. Hollis (2012) defines one of the reasons why nowadays states prefer simple over definitive signature: this is to better accommodate domestic treaty-making requirements in the presence of executive and legislative branches of power. In our analysis we look into the role of the

signature subject to ratification, acceptance or approval.

It is important to outline the legal obligations, which signature imposes on countries. These obligations are provided in the Article 18 of the Vienna Convention on the Law of Treaties (1969): A State is obliged to refrain from acts which would defeat the object and purpose of a treaty when:

(a) It has signed the treaty or has exchanged instruments constituting the treaty subject to ratification, acceptance or approval, until it shall have made its intention clear not to become a party to the treaty; or

(b) It has expressed its consent to be bound by the treaty, pending the entry into force of the treaty and provided that such entry into force is not unduly delayed.

The part (a) of Article 18 specifies the role of signature in the treaty-making process. Article 18 does impose an obligation of conduct. If a state breaches this obligation, it will incur international responsibility.[1] This fact is underpinned with a number of court cases, where signature is regarded as a legal rather than a formal act. However, 'vagueness and ineffectiveness' are often indicated as the two major shortcomings affecting the obligation laid down in Article 18. The Article is considered to be 'vague' in determining when a signatory state may be regarded as defeating the object and purpose of the treaty. (Palchetti, 2011). [2]

Ongoing discussions among the political scientists about the legal obligations of signature demonstrate that signature is important for international treaties. Although it does not make a treaty effective, it may have an impact on country's decisions during the post-negotiation period and, in particular, on its ratification decision. In our work we aim to study signature from the economists' perspective, the analysis is done in conjunction with the potential raification.

We examine whether signature is an important step in the treaty-making process and in what context it is important. The methodology of this thesis is both theoretical and empirical. We use game-theoretic analysis and several econometric models to study different aspects of post-negotiation period. In all studies in this thesis a panel data set is employed.

[1] Political science researchers are mostly united in their view that the state must not do anything which would prevent it being able fully to comply with the treaty once it has entered into force. Thus, if the treaty obligations are premised on the status quo at the time of signature, doing something before entry into force which alters the status quo in a way which would prevent the state from performing the treaty would be a breach of the Article 18. (Aust, 2007).

Rogoff (1990) specifies a purpose of the Article 18 to prevent a signatory from claiming the benefits to which it is entitled under the treaty while at the same time engaging in acts that would materially reduce the benefits to which the other signatories are entitled.

[2] Recently there have been a number of cases before domestic and international courts, when judgements are based on Article 18, and courts have accorded legal relevance to signed but unratified treaties. Further examples see Palchetti (2011)).

1.3 Dataset.

For the empirical analysis, we use our novel dataset of International Environmental Agreements (IEAs). IEAs as an instrument of international cooperation represent an interesting case for research. The existence of IEAs in practice raises interest among the researchers, mostly due to the market failure caused by the nature of environmental quality as a public good: in the presence of externalities, the incentives to free-ride, the absence of supranational authority, countries are reluctant to join IEAs, thus, reducing the efficiency in regulating environmental quality issues. The situation is aggravated by the fact that IEAs often do not include effective enforcement or monitoring mechanisms (Battaglini and Harstad, 2020). So, the effect of political, and economic factors, may appear to be more pronounced.

The dataset of IEAs consists of 52 treaties. It is collected from the United Nations Treaty collection database, from primary sources - open access texts of IEAs, and the data from two other sources. Firstly, institutional and electoral results data are taken from the Database of Political Institutions (2017) (DPI) of Inter-American Development Bank (Cruz et al., 2018). The current version of the database covers about 180 countries for 40 years, 1975-2017.

Secondly, the Polity V Project of the Center for Systemic Peace (2020) provides information about indicators of democracy and autocracy, authority characteristics and polity regime transitions. It contains data for the period from 1800 to 2018.

Economic indicators are taken from the Open Data Project of World Bank (2023). Due to the limitation of the DPI (2017) data, our analysis is restricted to the period 1975-2017. For each 'treaty-country' observation, the dataset provides information about variables at three different points in time: the year of treaty adoption, the year of signing, and the year of ratification. Each pair 'treaty-country' is unique, as each country can sign (in case it signs) and ratify/accede to a treaty only once, while during one year a country can ratify/accede to more than one treaty. The full description of variables and descriptive statistics are presented in each chapter. We use different models and different dependent variables in each chapter, therefore, we describe them in more detail along the way.

IEAs in our dataset are differentiated according to the membership in negotiations: open or restricted. We assume that the essence of the environmental problem underlies a dissimilarity in the process of treaty negotiations, and thus affects the following treaty-making process. We conjecture that IEAs with open membership aim to solve global environmental problems without borders, thus, they are open for signing by every country. No country can gain by restricting membership, so all countries are invited to negotiateBarrett (2005). Examples of agreements with open membership are the Convention on the Conservation of Migratory Species of Wild Animals (1979), or the Vienna Convention for the Protection of

the Ozon Layer (1985). Historically, a 'newly-recognised' global environmental problem is framed into a Convention, which establishes the general principles for the problem identification and the ways to solve it. Protocols under the Convention usually deal with specific issues and are signed later. In the Convention - Protocol model with open membership, a country can sign a Protocol only after it becomes a Party to the associated Convention. For our analysis, we consider such protocols as treaties with open membership.

We conjecture that the restricted participation in the negotiations is usually defined by the local geo-referenced nature of the environmental problem to be solved. It could be pollution of a local area, or a river. Comparing agreements with open and restricted membership, we point out the following: it is easier to combine resources and efforts to solve the particular problem through 'neighbouring' links (if it is a local problem). Often countries that are located in the same area have historically established relations and ways of cooperation, also they might have already signed bilateral agreements (trade agreements, environmental treaties, etc.). It is easier to provide stronger cooperation through well-defined logistics between several countries than with the whole world. In the treaties with restricted membership excluded parties do not have an opportunity to act, and have no interest in the externalities (Barrett, 2005).

These dissimilarities are not widely studied in the literature. Usually the analysis is conducted on a single IEA case study, or using only IEAs with open membership. It is questionable whether such samples are representative for the whole population. Our research demonstrates that political and economic factors have different effects depending on the type of participation in the negotiations.

1.4 Literature.

In this introduction, we only highlight the seminal papers, that are pivotal to our research topic, and we provide a more extensive literature review in each chapter. One of the comprehensive studies on international environmental agreements is Barrett (2005), who develops a theory on cooperation between states in their intention to protect their shared environmental resources. The book presents treaties as effective tools to do it, and the author takes both conceptual and practical approaches to describe the role of each stage in a treaty-making process. It is done by using game theory, international law concepts and political economy approaches. One of the book's chapters includes a list of multilateral environmental agreements, which inspired us to compile our own database of treaties with up-to-date information.

We begin our analysis with the examination of the interaction between the Executive and the

Legislature as domestic institutions that are involved in a treaty-making process. Putnam (1988) describes this relationship between a national political leader and domestic stakeholders as a two-level game. While Putnam (1988)'s emphasis is on the negotiation stage, the concept of a two-level game sheds light on the interaction between the Executive and the Legislature in the post-negotiation period as well. Putnam (1988) describes a negotiator as a player who is involved in a bargain between international and domestic politics. On the one hand, a negotiator takes part in the negotiations that connect various interests of different countries and their leaders in order to achieve a trade-off on debating points and to tailor an agreement to the needs of the negotiators; on the other hand, the Legislature may provide certain conditions to be met for ratification, and the negotiator has to find the optimal terms to present at the negotiations. By signing a treaty after the negotiations, in which the Executive has taken part, she may signal to the ratifiers that their conditions for ratification are met. The existing literature often leaves the stage of signature out of the analysis. Our work aims to fill this gap and examines the transformation of the international treaty terms to domestic policy through the interaction of domestic institutions in both stages - signature and ratification. We do this by offering both a conceptual framework and an empirically relevant case study.

The idea that signature may serve as a signal to other states or domestic actors about the leader's intentions is not novel. One of the recent papers that studies the signature as a signal is a paper by Hugh-Jones et al. (2018). They introduce a model where executives, having access to information, form their summed expertise during negotiations. This expertise is revealed to domestic actors through the signature as a signalling device. The greater the weight of international opinion signalled by initial signatures, the greater the likelihood of a legislature ratifying a treaty. Their model takes into account the international factors (the pooled expertise of states initially signing environmental treaties) that may affect the decision of the domestic veto players, while our work focuses on the Executive's reelection concern as a domestic factor that has an impact on the decisions made by both the Executive and the Legislature, and, eventually, on the success of a treaty.

Our analysis looks into how electoral incentives of the Executive affect the decisions made by both key players: whether they act in accordance or in discordance with each other. We analyse their behaviour within the political cycle. Here, we would like to highlight two papers that study the effect of the domestic reelection concern on international cooperation. This is a paper by Battaglini and Harstad (2020), who develop a theoretical model to study how the electoral incentives of the incumbent shape the type, size and scope of an international agreement. They show that in the presence of strong reelection concerns, an incumbent tends to negotiate treaties whose compliance will depend on the preferences of

the next policy maker, and the treaty may or may not be complied with.

However, the authors simplify the process of translating the terms of an international agreement into domestic policy. They assume, for example, that once signed, a treaty is always ratified. This assumption neglects the interactions between the international and domestic levels that are crucial for the success of international cooperation. Clearly, the stages of signature and ratification differ in their agency: international negotiations and the following decision on signing a treaty are headed by political leaders, who care about their reelection prospects, while the ratification of a treaty often passes through multiple domestic groups and veto players. We contribute to their model by including the ratification stage in the analysis, thus taking into account the complexity of policy-making.

The other paper is by Cazals and Sauquet (2015) who examine when leaders are more likely to ratify IEAs: for developed countries, leaders have incentives to delay ratification to the post-electoral period. Cazals and Sauquet (2015) argue that in this case participation in an environmental agreement is seen as a constraint for domestic economic agents, similar to the adoption of a new tax. In contrast, in developing countries, politicians tend to use ratification as a pre-electoral tool to boost their chances of staying in office, due to the benefits of participation for the country (for example, access to financial support or green technologies). Cazals and Sauquet (2015) focus on the ratification stage, which is certainly important for the treaty-making process. Their empirical model, however, does not include a signature stage, which may also be influenced by domestic reelection concerns. In our work, we provide a more complete theoretical and empirical analysis of the translation of an international treaty into domestic policy, including both stages - signature and ratification. Our third chapter is inspired by the theoretical contributions of the second chapter that treat signature as a signalling device and revisits the empirical evidence on the role of treaty signing in determining the timing of the ratification decision. We use the Cox proportional hazard model with time-change covariates which Cazals and Sauquet (2015) also employ in their paper.

The recent case studies of international treaties provide evidence of the influence that countries have on each other's decisions at the international level (see, for example, Campbell et al. (2019), Wagner (2016)). One country or a group of countries may put pressure on others to join the treaty. It increases the likelihood that other countries ratify or may accelerate the ratification decision. On the contrary, joining the international agreement by one country may have a negative effect on the decisions of others, causing delays in ratification and even discouraging the other countries from joining the treaty. Such negative effect may be a result of the free-riding incentives, arising from the positive externalities that the provision of public goods generates. Assessing the role of international factors that imply state-to-state

influence has proven difficult in the literature. Meanwhile, the interdependent behaviour of countries may become a contributing factor to ratification delay. Moreover, understanding the role of interdependencies addresses the more general topic of the existence of international treaties dealing with the provision of pure public goods in the presence of free-rider problems and the self-enforcing nature of the treaties.

The fourth chapter draws from the paper by Wagner (2016) that studies the interdependencies between countries in their decisions to ratify an international treaty. Wagner (2016) considers ratification to be a strategic substitute or strategic complement, depending on whether the relative payoff to cooperation decreases or increases with the number of treaty members. As a relative payoff to cooperation, he employs the timing of the ratification decisions. Strategic complementarity accelerates participation by reinforcing the incentive to cooperate: treaty ratification by one country triggers ratification by others. In contrast, if ratification becomes less desirable as treaty membership grows, it is a strategic substitute. In order to estimate the spillover parameter that determines the strategic interaction effect, Wagner (2016) employs the method of simulated moments. The results demonstrate that ratification decisions are strategic complements in the case of the Montreal Protocol.

We develop the ideas presented in Wagner (2016) and introduce an approach for the econometric estimation of the model, which we apply to our panel dataset of treaties. We aim to empirically estimate the factors that affect the decisions of countries to ratify an international treaty in the presence of interdependencies between states, and estimate a panel data model that takes into account heterogeneity among countries and treaties. In order to estimate the sign and magnitude of the strategic interaction effect, we introduce three indexes that capture economic and political sources of interdependencies between countries.

1.5 Thesis structure.

Chapter 2 begins with the examination of the interaction between the Executive and the Legislature as domestic institutions that are involved in a treaty-making process. The existing literature so far has paid limited attention to this interaction. Instead, it has mostly focused on the results of policy implementation, or the ratification stage only, thus often leaving the stage of signature out of the analysis. Our work aims to fill this gap and examines the transformation of the international treaty terms to domestic policy through the interaction of domestic institutions in both stages - signature and ratification. We do this by offering both a conceptual framework and an empirically relevant case study. Our analysis looks into how electoral incentives of the Executive affect the decisions made by both key players: whether they act in accordance or in discordance with each other.

In our model, the Executive who cares about her political status sends a signal to the Legislature by signing or not signing a treaty. The Legislature observes the message sent by the Executive, and then chooses an action according to his conditional beliefs. The Executive's motivation changes within the electoral cycle: the Executive is more office-motivated at the end of the electoral cycle, and more ideology-motivated at the beginning of it. The Executive's office motivation is captured in our analysis through the weight, which she places on political capital.

The theoretical model demonstrates that in the extreme case with the maximum weight, which the Executive places on political capital, the action of the Legislature is likely to be accordant to the Executive's message. The Executive, who is facing an election, in an attempt to accumulate political capital, tends to act in accordance with the Legislature's preferences.

The analysis of the theoretical model demonstrates that the dynamics of the Executive's political motivation may affect the Executive's decision at the stage of signature, the Legislature's action based on his conditional beliefs, and, eventually, the outcome in the treaty-making process. The Executive, who is facing an election, experiences strong reelection concerns and tends to act in accordance with the Legislature's preferences.

In order to test the main hypothesis and look into the correlation between the level of the Executive's motivation and the behaviour of agents in a treaty-making process, we use the logistic regression. Our independent variable of interest is the time within the electoral cycle, which is used as a proxy for the level of the Executive's office motivation that changes within the electoral cycle. Our findings demonstrate that the electoral incentives of the Executive affect the decisions made by both key players, and the outcome in the treaty-making process. The results deepen the understanding of the post-negotiation period and the factors that lead to delay in the ratification of the treaty, or the failure of it in case of being not ratified by the required number of countries.

In the third chapter, we further look into the role of signature in the post-negotiation period and study its effect on the ratification decision. We are doing that by analysing signature as a step that connects two milestones: the negotiations and ratification. Estimating a duration model with time-varying covariates, namely, the Cox proportional hazards model, we estimate the overall effect that signature has on the subsequent ratification. Then we assess the magnitude of that effect depending on the type of Executive who has signed the treaty: the Executive who has negotiated a treaty, and the Executive who has not taken part in the negotiations and signed the treaty later. All empirical models include political and economic variables that are referred to in the literature as important factors that affect international environmental cooperation. First, IEAs exist within the framework of international law and

political institutions, which determine the importance of political factors; second, international commitments are likely to generate both short-term and long-term costs and benefits for states and economic factors are likely to affect their behaviour as rational actors.

The analyses presented in the second and third chapters focus on the domestic factors. In Chapter 4, we turn our consideration to the role of international factors in the post-negotiation period. We propose a novel empirical approach to the estimation of the factors that affect the decisions of countries to ratify an international treaty (the ratification timing) in the presence of interdependencies between states. We estimate a fixed effect model for panel data that takes into account heterogeneity among countries and treaties. Our analysis looks into how the country's incentives to join an international treaty are affected by the decisions made by other countries, and, eventually, what is the role of interdependencies between countries in overcoming the collective action problem. In order to estimate the sign and magnitude of the strategic interaction effect, we introduce three indexes. They are constructed in a way that captures three types of spillovers: spillovers between two countries (pairwise spillovers); between a country and a group of ratifiers as a formed coalition; and between a country within a group of ratifiers and a set of all countries to which the treaty is open for ratification including non-ratifiers. The indexes estimate the group-effect rather than pairwise links between countries traditionally used in the literature. It allows us see, for example, whether geopolitical and economic pressure may overcome free-riding incentives.

2 Signing as a signal to domestic ratifiers.

2.1 Introduction to Chapter 2.

International treaties are the most important formal mechanism, through which countries coordinate efforts in solving international problems. However, the success of an international treaty is a challenging task for society: in the presence of externalities, the opportunities to free-ride, countries are reluctant to join a treaty, thus, reducing the efficiency in regulating international issues, moreover, in the absence of supra-national authority, treaties are voluntary commitments in the sense that states cannot be bound by an agreement without their consent. International treaties become effective through their transformation/translation into the domestic policies of countries: most treaties enter into force only after a minimum number of countries have expressed the consent of a state to be bound by a treaty. It happens through the following procedures: after an authorized representative (the Executive) negotiates and signs a treaty at the international level, the treaty normally has to

be approved at the domestic level by the Legislature through the process of ratification. In the case of not signing a treaty by the Executive, a country still may join a treaty through the process of accession.[3]

The interaction between the Executive and the Legislature thus impacts the efficacy of the treaty. It is instrumental for the global success of the treaty and locally for domestic policy. Indeed, the treaty-making process requires a lot of time and effort. If a country does not sign a treaty, it may take a long time before a country accedes to it, if it accedes at all.[4] Conversely, a country may hamper entering a treaty into force if it has signed a treaty but has not ratified it. Obviously, the coherence in the actions of the Executive and the Legislature is crucial for the success of a treaty. The existing literature so far has paid limited attention to this interaction. Instead, it has mostly focused on the results of policy implementation, or the ratification stage only, thus often leaving the stage of signature out of the analysis. Our work aims to fill this gap and examines the transformation of the international treaty terms to domestic policy through the interaction of domestic institutions in both stages - signature and ratification. We do this by offering both a conceptual framework and an empirically relevant case study. Our analysis looks into how electoral incentives of the Executive affect the decisions made by both key players: whether they act in accordance or in discordance with each other.

We illustrate the importance of the interaction between the Executive and the Legislature with the following example: the Final Act of the Conference on International Cooperation on Oil Pollution Preparedness and Response (1990) states that the representatives of 90 states participated in the Conference. One of the results of the Conference was the adoption and signature of the International Convention on Oil Pollution Preparedness, Response and Co-operation. However, only 21 countries signed it on the date of its adoption, 8 countries signed the Convention later, and 84 countries joined the Convention after the period of signature ended. As a result, the Convention has entered into force only in 1995 after the required minimum of 15 ratifications has been reached. Even though all the signatories to the Convention have ratified it later, it took 5 years for the treaty to enter into force. This happened because the domestic institutions failed to demonstrate the accordance in their actions within a reasonable period (for example, one electoral cycle). Furthermore, about half of the accession cases (the countries have acceded to the Convention without signing it) have taken place only after 10 years since the Convention adoption, demonstrating the

[3] According to Articles 2 (1) (b) and 15 of Vienna Convention on the Law of Treaties 1969, "accession" is the act whereby a state accepts the offer or the opportunity to become a party to a treaty already negotiated and signed by other states. It has the same legal effect as ratification.

[4] The descriptive statistics for our dataset demonstrate, that around 50% of accession cases have occurred after seven years since the treaty adoption, while the same proportion of ratification cases has taken place within three years after the treaty adoption.

reluctance of the countries to join the unsigned treaty, and as a consequence providing a slow pace of effective rendering. This example demonstrates that the conclusion of the negotiations and a treaty adoption do not automatically lead to the success of a treaty, while the coherence in the actions of the Executive and the Legislature after the negotiations can do it.

Our theoretical model captures the transfer of the international treaty's provisions into the domestic environmental policy. On this pathway the Executive and the Legislature interact with each other: the Executive sends a signal to the Legislature by signing or not signing a treaty. The Legislature observes the message sent by the Executive, and then chooses an action according to his conditional beliefs. During their interaction, the agents act in accordance or in discordance with each other.

We assume that an Executive cares about her political status, what is known in the literature as an office-motivated politician. The payoff of the Executive depends on the degree of her office motivation, which reaches its maximum when the Executive is facing election. We take the Legislature's preferences as representing the preferences of the median voter in the country. We consider the Legislature to be fully ideology-motivated and inspired only by policy outcomes.[5]

The analysis of the theoretical model demonstrates that the dynamics of the Executive's political motivation may affect the Executive's decision at the stage of signature, the Legislature's action based on his conditional beliefs, and, eventually, the outcome in the treaty-making process. The Executive, who is facing an election, experiences strong reelection concerns and tends to act in accordance with the Legislature's preferences.

The closest work to ours that studies the effect of the domestic reelection concern on international cooperation is Battaglini and Harstad (2020). They develop a theoretical model to study how the electoral incentives of the incumbent shape the type, size and scope of an international agreement. In the first period the incumbent governments of two countries negotiate a treaty and define the sanction for non-compliance. In the second period, an election determines whether the incumbent remains in power or is replaced by a different government (the preferences of the opponent may differ from the preferences of the incumbent). Finally, the winner of the election decides whether to comply with the treaty or face the sanction. By comparing the sanction and the cost, the second-period incumbent finds it optimal to comply if the sanction is larger than the cost. Battaglini and Harstad (2020)

[5]Our assumptions are consistent with the literature arguing that the Executives who are responsible for heading the negotiations and signing a treaty may be subject to electoral concerns, while the process of ratification involving multiply domestic groups and veto players includes diverse preferences and views of voters. (see, for example, Hugh-Jones et al. (2018), Battaglini and Harstad (2020).

show that in the presence of strong reelection concerns, an incumbent tends to negotiate treaties whose compliance will depend on the preferences of the next policy maker, and the treaty may or may not be complied with. The paper establishes the link between domestic electoral incentives and international cooperation. However, the authors simplify the process of translating the terms of an international agreement into domestic policy. They assume, for example, that once signed, a treaty is always ratified. This assumption neglects the interactions between the international and domestic levels that are crucial for the success of international cooperation. Clearly, the stages of signature and ratification differ in their agency: international negotiations and the following decision on signing a treaty are headed by political leaders, who care about their reelection prospects, while the ratification of a treaty often passes through multiple domestic groups and veto players. As a result, the reelection concern have distinctive impacts on the decisions taken at these two stages. Similarly to the approach of Battaglini and Harstad (2020), we allow the Executive to be at least partly office-motivated. We contribute to their model by including the ratification stage into the analysis, thus taking into account the complexity of policy-making.

While their contribution is mostly theoretical, Battaglini and Harstad (2020) provide a preliminary quantitative evaluation of their model, where they link the strength of the electoral concerns with the level of democracy. We find their approach problematic as the level of democracy typically does not vary much from year to year and cannot be taken as a representative measure of personal concerns. In our work we offer wider empirical analysis, using the time within the electoral cycle as a proxy for the level of the Executive's reelection concerns, while still controlling for the level of democracy.

In our empirical analysis, we take International Environmental Agreements (IEAs) as our case study. The existence of environmental agreements in practice rises interest among the researchers, mostly due to the market failure caused by the nature of environmental quality as a public good: in the presence of externalities, the incentives to free-ride, the absence of supra-national authority, countries are reluctant to join IEAs, thus, reducing the efficiency in regulating environmental quality issues. The situation is aggravated by the fact that IEAs often do not include effective enforcement or monitoring mechanisms (Battaglini and Harstad, 2020). As a result, many IEAs fail to reach their targets, even after the long negotiation process and agreeing on the terms of a treaty. In this sense, the interaction after negotiations is important for the efficacy of IEA.

The political economy literature does not pay much attention to the role of reelection concerns in secondary policy decisions, focusing on the frontline policy issues, which are traditionally considered to be more politicized. Regarding environmental policy issues, List and Sturm (2006) develop two-dimensional political agency model, where politicians, who

face periodic elections, decide on the level of public spending and on environmental policy. The model suggests that politicians may use environmental policy to attract either environmental or anti-environmental voters. The model predicts that environmental policy varies systematically between the years in which the incumbent can and cannot be reelected. These predictions were tested by analyzing the behaviour of U.S. governors over the 1970 –2000 period. The findings show that environmental spending differs between US governors who face a binding term limit and those who can instead be reelected, thus implying that in anticipation of elections, the secondary policy may become important.

In this context, the IEAs form a representative dataset of the agreements, which on the one hand are not highly politicized, but on the other hand may be influenced by the reelection concern of the Executive, whose decision on signing a treaty will be noted by the voters to her advantage.

With regard to the case of IEAs, very few papers look into the role of domestic reelection concerns in particular stages of the treaty-making process. Cazals and Sauquet (2015), for example, examine when leaders are more likely to ratify IEAs: for developed countries, leaders have incentives to delay ratification to the post-electoral period. Cazals and Sauquet (2015) argue that in these cases participation in an environmental agreement is seen as a constraint for domestic economic agents, similar to the adoption of a new tax. In contrast, in developing countries politicians tend to use ratification as a pre-electoral tool to boost their chances of staying in office, due to the benefits of participation for the country (for example, access to financial support or green technologies). Cazals and Sauquet (2015) focus on the ratification stage, which is certainly important for the treaty-making process. Their empirical model, however, does not include a signature stage, which may also be influenced by the domestic reelection concerns. In our work, we provide a more complete analysis - both theoretically and empirically - of the translation of an international treaty into domestic policy, including both stages - signature and ratification.

Köke and Lange (2017) investigate the impact of ratification constraints and ratification uncertainty on the optimal terms of an IEA. Their theoretical model demonstrates the importance of the interaction between domestic and international levels for the success of the treaty. Similarly to their approach, we consider countries not as unitary actors, but as consisting of a plurality of players, who may have different preferences. In particular, Köke and Lange (2017) show that the difference in the preferences of domestic ratifiers and negotiators affects the IEA commitment level and a minimum participation requirement. Our theoretical model takes into account the difference in preferences of the Executive and the Legislature, moreover, we allow the preferences of the Executive to be subject to her reelection concerns and to change with time within the electoral cycle.

Our work also contributes to the literature on political business cycles (PBC). The earliest formal analytical framework of PBC is associated with Nordhaus (1975), whose theory demonstrates that the course of macroeconomic variables is influenced by political considerations and is subject to cyclical fluctuations linked to the rhythm of elections. These findings have been followed by a considerable number of empirical works, many of which provide supportive empirical evidence that incumbent politicians tend to increase public spending or change its composition before elections to improve the chances that they (or their party) will be reelected (see, for example, Rogoff (1990), Tabellini and Alesina (1987), Drazen and Eslava (2010)). While the literature on PBC focuses mostly on the domestic policy indicators such as growth, unemployment, inflation, fiscal policy etc, little attention has been paid to the effect which elections have on international cooperation. Elections are widely believed to be the one of the most prominent political factors affecting the leader's domestic policies. In our work we show that electoral concerns may also have an impact on the politician's decisions in the international arena. Focusing on what happens after an IEA has been negotiated, we investigate whether the behaviour of the Executive, who is subject to the domestic reelection concern, exhibits electoral cycles.

Our research contributes to the existing literature in the following points: first, we focus on international treaties after they have been negotiated, thus emphasizing the importance of interaction between domestic institutions within a treaty-making process. Our analysis focuses on the path of translation of the international agreement provisions into domestic policy. Along this path, the coherence in the actions of the Executive and the Legislature plays a crucial role for the success of the treaty. Second, our theoretical findings predict the existence of an electoral cycle for the Executive's behaviour. We argue that a political leader, who decides on signing an international treaty may be affected by the domestic reelection concern, and chooses to act in her best interest according to the timing of elections.

In this chapter, for our empirical analysis we use the subset of our full dataset, which include 113 countries with presidential and semi-presidential systems that assume executive-legislature separation. The subset includes 52 international environmental treaties signed between 1975 and 2017. We attempted to include all the IEAs, for which the information about the time of signature is available. The timing of signature is traditionally overlooked in the literature, however, we show that it plays an important role in the treaty-making process. Our empirical model looks into the impact of the domestic reelection concerns on the interaction between the political institutions within the treaty-making process, and eventually on the success of international cooperation, - the analysis that has been previously done only theoretically. The time within the electoral cycle is used as a proxy for the level of the Executive's office motivation. We use a logistic regression in order to examine the correla-

tion between the Executive's office motivation and the behaviour of the agents. We find that the number of years left in the current term for the Executive, positively affects the probability that the Executive and the Legislature act discordantly. We control for a number of other economic and political factors that have been identified in the literature as important determinants of environmental policy (such as the level of economic development, the level of democratization, etc).

The second chapter is organized as follows. We begin by presenting the theoretical model and solve for the equilibria in Section 2.2. In Section 2.3 we discuss relevant empirical evidence for the dataset of IEAs. Section 2.4 concludes the second chapter.

2.2 Theoretical Model.

2.2.1 An Introduction to the Model.

The process of becoming a party to a treaty for a country is described as a two-stage game.

We look at the case of one country, where, in the first stage, an executive (E) decides whether to sign an IEA after the negotiations, or not. Then, in the second stage, a legislature (L) considers if a consent to be bound by a treaty will be established through the act of ratification, or, in the case of not signing a treaty, through the act of accession; a Legislature may also decide for a country not to establish a consent to be bound by a treaty.

For ease of reading, we refer to the Executive as 'she', and the Legislature as 'he'.

We construct our model as a signaling model, where E sends a signal to L by signing or not signing a treaty. The idea that signature may serve as a signal to other states or domestic actors about the leader's intentions is not novel. One of the recent papers that studies the signature as a signal is a paper by Hugh-Jones et al. (2018). They introduce a model where executives, having access to information, form their summed expertise during negotiations. This expertise is revealed to domestic actors through the signature as a signaling device. The greater the weight of international opinion signaled by initial signatures, the greater the likelihood of a legislature ratifying a treaty.

Their model takes into account the international factors (the pooled expertise of states initially signing environmental treaties) that may affect the decision of the domestic veto players, while our work focuses on the E's reelection concern as a domestic factor that has an impact on the decisions made by both E and L, and, eventually, on the success of a treaty.

We begin by describing the game tree, which represents the main agents, the sequence of their moves, what actions each player can take, players' knowledge in the decision nodes,

and payoffs from each possible outcome of the actions taken by the players.

We distinguish the types of treaties according to their overall value for the country. The intuition behind this is that a country makes its commitment to an international agreement if it expects that it is possible to comply at a reasonable cost (Simmons, 2009).

There are two types of treaties from a set of states $\Theta = \{\theta_1, \theta_2\}$:

θ_1 is a treaty, which is beneficial for a country. θ_2 is a treaty, which is not beneficial for a country.

We consider a treaty to be beneficial for a country, when it has a positive discounted utility of net benefits. This discounted utility is total benefits, which a country gains after becoming a party to a treaty, after deduction of the costs that a country faces after joining a treaty.[6]

If a treaty has a negative discounted utility of net benefits, we consider it to be a non-beneficial for a country.

The approach to define the outcome of joining a treaty as a discounted utility is determined by the fact that international commitments are likely to generate both short-term and long-term costs and benefits for countries.

In our model Nature draws a type θ_1 with the probability z, and a type θ_2 with the probability 1-z.

The Sender (E) observes the type of a treaty from the set of states Θ. Within the period, when a treaty is opened for signature, E has to decide if she signs a treaty, or not. This decision is a message from a set of feasible messages $M = \{sign, not\ sign\}$, where E sends a message $'sign'$ if she signs an agreement within the period when it is opened for signature, and E sends a message 'not sign' if otherwise.

The probability that E sends $'sign'$ when she observes θ_1 is denoted by s; and the probability that E sends $'sign'$ when she observes θ_2 is denoted by k.

The Receiver (L) does not know the true state Θ, but knows the probability distribution, with which Nature draws the states θ_1 and θ_2.

The Receiver (L) observes the message sent by E, and then chooses an action from a set of feasible actions $A = \{ratify, not\ ratify, accede, not\ accede\}$.

The probability that L chooses $'ratify'$ if he observes $'sign'$ is denoted by r; and the probability that L chooses $'accede'$ if he observes *'not sign'* is denoted by a.

After receiving the message, L forms a belief about which type of the agreement is observed

[6]This is done taking all other countries' decisions as given. So at this stage we do not take into account the impact that this country's decision has on others.

by E. We use $(p, 1-p)$ and $(q, 1-q)$ to denote L's conditional beliefs at his two information sets, where p denotes L's belief after seeing 'sign' that E observes θ_1, and $1-p$ denotes L's belief after seeing 'sign' that E observes θ_2. Correspondingly, q denotes L's conditional belief after seeing 'not sign' that E observes θ_1, and $1-q$ denotes L's belief after seeing 'not sign' that E observes θ_2. L's beliefs are derived using Bayes' rule.

For each message, the action of L must maximise L's expected payoff, given his belief.

For each θ in Θ, E's message must maximize E's payoff, given L's strategy.

Agents perceive utilities of net benefits and net costs for a given treaty differently. Due to this assumption we distinguish the utilities of net benefits and net costs for L and E. For example, Hugh-Jones et al. (2018) point out that E often possesses more policy expertise than domestic veto players, due to better access to policy experts. Furthermore, the legislature and the executive might have different attitudes towards environmental issues, because of their political preferences and ideological commitments.

A treaty becomes effective through two paths: E signs and L ratifies a treaty; or E does not sign and L accedes to a treaty.[7]

In order to define the payoffs of agents, we specify the key parameters, which are b_{1j}, b_{2j}, c_{1j}, c_{2j} with $j \in \{E, L\}$, where

b_{1j} - discounted utility of j, which j gets if a treaty becomes effective, given the state of the world is θ_1 (a beneficial treaty), and implements a policy on the domestic level.

b_{2j} - discounted utility of j, which j gets if a treaty does not become effective, given the state of the world is θ_2 (a non-beneficial treaty).

c_{1j} - discounted utility of j, which j gets if a treaty does not become effective, given the state of the world is θ_1 (a beneficial treaty).

c_{2j} - discounted utility of j, which j gets if a treaty becomes effective , given the state of the world is θ_2 (a non-beneficial treaty).

E's payoff consists of two components: the potential net benefits (or net costs) for the country to join (or not to join) a treaty, and the amount of political capital, which E can get by signing or not signing an agreement.

The definitions of political capital originate from political science literature and are mostly intuitive. However, recently there has been a growing number of papers, which investigate various political capital parameters, in order to deepen the understanding of it. We assume

[7] In our model we assume that a treaty becomes effective after its ratification/accession. With this assumption we abstract away from international dynamics and a 'minimum participation clause' that sets a minimum number of ratifiers necessary for entering a treaty into force.

that an Executive cares about her political status, what is known in the literature as office-motivated politician (Callander, 2008). This characteristic is included in our model through the concept of political capital, which is captured by the parameter μ. μ is a weight, which E places on gaining political capital, where $\mu_i \in [0, 1]$.

For our theoretical model two characteristics of political capital are important: first, political capital can be built by a politician using particular actions to create 'impressions among citizens' (French, 2011), which allow E to be credited with the approval of voters and supporters and contribute to candidate's potential political influence and winning the election (Yun, 2020). In our model such action is E's decision to sign or not to sign an international agreement. Second, political capital has a cyclical nature. The literature often describes the time before the election as a period of gaining political capital, while newly elected politicians enjoy a 'honeymoon period' when they can spend their accumulated political capital (Casey, 2005). During a tranquil phase at the beginning of the electoral cycle political capital is spent on promoting topical policies. At this time a politician is inspired by policy outcomes rather than seeking the perquisites of office (Callander, 2008). As early as a few months after the new executive enters office, her popularity begins to erode, mainly due to the electorate's unrealistically high initial expectations (Nordhaus et al., 1989). It implies that politician's concern about political capital is subject to changes during the electoral cycle.

The parameter μ defines the extent to which E values political capital in addition to policy outcomes. At one extreme, if $\mu = 0$, E is fully policy-motivated and thus puts zero weight on political capital. Her decision to sign or not to sign a treaty provides the policy-relevant payoff, which is not linked with her intention to accumulate political capital.

As μ is rising, the focus of E's decision moves from the policy-motivated action to the office-motivated one. E places more weight on accumulating political capital, and less weight on the policy-relevant payoff.

At the other extreme, if $\mu = 1$, E is an office-motivated politician, whose decision is only induced by her purpose to build political capital. In this case E places a maximum weight on political capital.

We consider L to be fully policy-motivated and inspired only by policy outcomes.

E possesses the information about the type of a treaty. This information becomes available after the negotiations, where E has taken part. L does not know the type of a treaty, but he can form his conditional beliefs, which are based on E's message ('sign' or 'not sign'). L's beliefs determine his actions, and the payoffs of both agents.

In our model we assume that E can gain political capital on the domestic market if the action

of L is accordant to E's message. It is captured by the following cases:

1) L's action is in accord with E's message. E gains political capital if E signs, L ratifies, or E does not sign, L does not accede.

2) L's action is in contrast to E's message. E gains no political capital if E signs, L does not ratify, or E does not sign, L accedes.

These cases are formally represented by the indicator variable I_E :

$$I_E = \begin{cases} 1 & \text{if E's message is in accord with L's action} \\ 0 & \text{otherwise} \end{cases}$$

We assume that:

$$b_{1j} > b_{2j} > 0 > c_{2j} > c_{1j}, \tag{1}$$

This assumption is based on the following intuition: in a wide sense, joining an international treaty generates positive effects for the countries with respect to improving the existing situation (it might be solving local environmental problems or dealing with global issues).

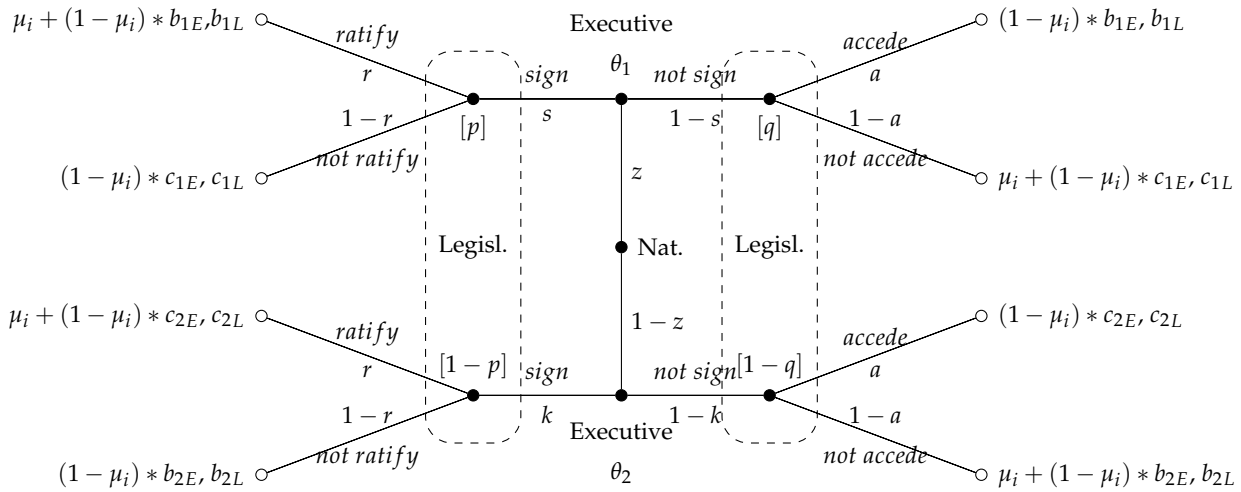
In order to compare the level of c_{1j} and c_{2j}, we look into two cases. If a country does not join a beneficial treaty, it means that it does not obtain all the potential benefits from a treaty, including a positive effect from resolving the issue under consideration. At the same time, ratifying a non-beneficial treaty may require considerable investments, however, a country gains from changing the situation for the better. For that reason, our assumption is $0 > c_{2j} > c_{1j}$.

In order to compare the level of b_{1j} and b_{2j}, we again look at two cases. If a country ratifies a beneficial treaty, it gets all the benefits from it, including a positive effect from resolving the issue under consideration , while not joining a non-beneficial treaty does save funds, but the country's existing situation continues to deteriorate, causing negative consequences. For that reason, our assumption is $b_{1j} > b_{2j} > 0$.[8]

The game tree below summarises the above information about the game and payoffs.[9]

[8] As an example, we provide a payoff calculation for the outcome, when E signs an agreement, and L ratifies it, given $\theta = \theta_1$ (the upper-left outcome in the game tree). In this case $I_E = 1$, and the payoff for E is:
$\mu I_E + (1-\mu)(b_{1E}) = \mu * 1 + (1-\mu)(b_{1E}) = \mu + (1-\mu)(b_{1E})$
L's payoff: $rb_{1L} + (1-r)c_{1L} = 1 * b_{1L} + (1-1) * c_{1L} = b_{1L}$
For the type of a treaty θ_2, we replace b_{1j} with c_{2j} and c_{1j} with b_{2j} correspondingly. For instance, for the outcome, when E signs, L ratifies, given $\theta = \theta_2$, the payoff for E is:
$\mu I_E + (1-\mu)(c_{2E}) = \mu * 1 + (1-\mu)(c_{2E}) = \mu + (1-\mu)(c_{2E})$
L's payoff: $rc_{2L} + (1-r)b_{2L} = 1 * c_{2L} + (1-1) * b_{2L} = c_{2L}$.
Similarly, the other payoffs are calculated.

[9] In our model we use the same level of discounted utility for agents for each θ, if L takes similar actions (to



The payoff for the Executive is:

$$\pi_E = z\{s\left(r(\mu+(1-\mu)b_{1E})+(1-r)(1-\mu)c_{1E}\right)+(1-s)\left(a(1-\mu)b_{1E}+(1-a)(\mu+(1-\mu)c_{1E})\right\}$$
$$+(1-z)\{k\left(r(\mu+(1-\mu)c_{2E})+(1-r)(1-\mu)b_{2E}\right)+(1-k)\left(a(1-\mu)c_{2E}+(1-a)(\mu+(1-\mu)b_{2E})\right\},$$

L's beliefs are derived using Bayes rule. For the purpose of these notes we let $z = \frac{1}{2}$:

$$p(\theta_1|sign) = \frac{sz}{sz+k(1-z)} = \frac{s}{s+k}$$

$$q(\theta_1|notsign) = \frac{(1-s)z}{(1-s)z+(1-k)(1-z)} = \frac{1-s}{2-s-k}$$

The payoff for the Legislature:

$$\pi_L = (sz+k(1-z))\left\{\frac{s}{s+k}\left(rb_{1L}+(1-r)c_{1L}\right)+\left(\frac{k}{s+k}\right)\left(rc_{2L}+(1-r)b_{2L}\right)\right\}$$
$$+((1-s)z+(1-k)(1-z))\left\{\frac{1-s}{2-s-k}\left(ab_{1L}+(1-a)c_{1L}\right)+\left(\frac{1-k}{2-s-k}\right)\left(ac_{2L}+(1-a)b_{2L}\right)\right\}.$$

After solving the associated maximization problems $\max_{s,k} \pi_E$ and $\max_{r,a} \pi_L$ we have equations that we use to characterize equilibria for the game[10]:

The first-order condition for $\max_{s,k} \pi_E$ gives us the following equations:

join a treaty, or not), even in different paths. In practice, the utilities from the signed and ratified treaty are not necessarily the same as from the treaty that was acceded without signing. The signature imposes the obligation in maintaining the status quo. It implies that in the end of the treaty-making process a country may face higher costs by signing and ratifying a treaty, than a country that has not signed, and acceded it later. It is the same procedure with unratified treaties: after signing a treaty, a country has to maintain the status quo, while in case of not signing and not acceding a treaty, a country does not face any costs.

[10]Two extreme models are presented in Appendix 1: in Model 1 the Executive places a maximum weight on political capital, in Model 2 the Executive places zero weight on political capital.

We call the equilibria in Model 1 'political capital equilibria', in Model 2 'ideology equilibria'. Note, that outcomes with E and L acting in discordance with each other are not observed in Model 1.

$$\frac{\partial \pi_E}{\partial s} : \; r\mu + r(1-\mu)(b_{1E} - c_{1E}) \gtreqless (1-a)\mu + a(1-\mu)(b_{1E} - c_{1E}); \tag{2}$$

$$\frac{\partial \pi_E}{\partial k} : r\mu + r(1-\mu)(c_{2E} - b_{2E}) \gtreqless (1-a)\mu + a(1-\mu)(c_{2E} - b_{2E}). \tag{3}$$

We note that $b_{1E} - c_{1E} > 0$, while $c_{2E} - b_{2E} < 0$, which is derived from (1). We analyse the above relationships for each equilibrium.

The first-order condition for $\max_{r,a} \pi_L$ gives us the following equations:

$$\frac{\partial \pi_L}{\partial r} \gtreqless 0 \iff \frac{s}{k} \gtreqless \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}}; \tag{4}$$

$$\frac{\partial \pi_L}{\partial a} \gtreqless 0 \iff \frac{1-s}{1-k} \gtreqless \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}}. \tag{5}$$

Equation (4) implies that if the $>$ relationship holds then $r = 1$, if $<$ holds, $r = 0$, whereas any r solves the problem for FOC=0. The second equation implies that if the $>$ relationship holds then $a = 1$, if $<$ holds, $a = 0$, whereas any a solves the problem for FOC=0.

We note that from (1) the ratio $0 < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} < 1$.

We can now use these four equations to characterize possible equilibria for this game.

I

We consider now the first possible equilibrium, when:

$$\begin{cases} \dfrac{s}{k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

When both these conditions hold, $r = 1$ and $a = 1$.

In this case, expressions (2) and (3) are reduced to:

$$\frac{\partial \pi_E}{\partial s} : \; \mu + (1-\mu)(b_{1E} - c_{1E}) \gtreqless (1-\mu)(b_{1E} - c_{1E});$$

$$\frac{\partial \pi_E}{\partial k} : \mu + (1-\mu)(c_{2E} - b_{2E}) \gtreqless (1-\mu)(c_{2E} - b_{2E}).$$

The first equation implies that for any $\mu > 0$ E chooses 'sign' with the probability $s = 1$ after observing θ_1, and chooses 'sign' with the probability $k = 1$ after observing θ_2.

Equilibrium (Ia):

For any $\mu > 0$, E chooses 'sign' after observing θ_1 with the probability $s = 1$, and chooses 'sign' after observing θ_2 with the probability $k = 1$ such that

$$\begin{cases} \dfrac{s}{k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} - \textit{off the equilibrium path} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 1$, L chooses 'accede' after observing 'not sign' with the probability $a = 1$.

The equilibrium (Ia) is a pooling equilibrium, in which E chooses 'sign' for both states θ_1 and θ_2. In this case she gains political capital.

E's message 'sign' does not transfer any information for L about the state Θ. In this equilibrium E always signs an agreement, having a goal to gain political capital, even if the agreement is not beneficial for the country.

For $\mu = 0$, the expressions (2) and (3) are reduced to:

$$\begin{aligned} &\frac{\partial \pi_E}{\partial s} : \; b_{1E} - c_{1E} = b_{1E} - c_{1E}; \\ &\frac{\partial \pi_E}{\partial k} : c_{2E} - b_{2E} = c_{2E} - b_{2E}, \end{aligned}$$

implying that E may choose any combination of strategies s and k.

We consider two pooling pure-strategy equilibria, and two separating pure-strategy equilibria. However, after checking, we found that separating pure-strategy equilibria cannot exist, still we get two potential pooling pure-strategy equilibria:

Equilibrium (Ib):

For $\mu = 0$, E chooses 'sign' after observing θ_1 with the probability $s = 1$, and chooses 'sign' after observing θ_2 with the probability $k = 1$ such that

$$\begin{cases} \frac{s}{k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \frac{1-s}{1-k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} - \textit{off the equilibrium path} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 1$, L chooses 'accede' after observing 'not sign' with the probability $a = 1$.

Equilibrium (Ic):

For $\mu = 0$, E chooses 'sign' after observing θ_1 with the probability $s = 0$, and chooses 'not sign' after observing θ_2 with the probability $k = 0$ such that

$$\begin{cases} \frac{s}{k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} - \textit{off the equilibrium path} \\ \frac{1-s}{1-k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 1$, L chooses 'accede' after observing 'not sign' with the probability $a = 1$.

Equilibria (Ia) and (Ib) coincide. At the same time, the final goals of E in these equilibria differ: in the Equilibrium (Ia) E gets political capital in the combination E 'signs' - L 'ratifies'. However, E will not choose 'not sign' given that L plays 'accede', because E does not get political capital.

In the Equilibrium (Ib), E does not care about political capital. She gets the same payoff after playing 'sign' or 'not sign', given L's playing 'ratify'. It means that E may not sign a treaty, if she knows that L will accede it later.

The next equilibria are derived using the same steps.

$$Equilibrium(II):$$

For any $\mu > 0$, E chooses 'not sign' after observing θ_1 with the probability $s = 0$, and chooses 'not sign' after observing θ_2 with the probability $k = 0$ such that

$$\begin{cases} \frac{s}{k} < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} - \textit{off the equilibrium path} \\ \frac{1-s}{1-k} < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

L chooses 'not ratify' after observing 'sign' with the probability $r = 0$, L chooses 'not accede'

after observing 'not sign' with the probability $a = 0$.

The equilibrium (II) is a pooling equilibrium, in which E chooses 'not sign' for both states θ_1 and θ_2. In this case she gets her political capital.

E's message 'not sign' does not transfer any information for L about the state Θ. In this equilibrium E never signs an agreement, having a goal to gain political capital, even if the agreement is beneficial for the country.

For $\mu = 0$, we have the same situation, as in Model 2, Equilibrium (II), which does not exist (see Appendix 1).

$$Equilibrium(III):$$

For any $0 \leq \mu < 1$,

E chooses 'sign' after observing θ_1 with the probability $s = 0$, and chooses 'sign' after observing θ_2 with the probability $k = 1$ such that

$$\begin{cases} \frac{s}{k} < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \frac{1-s}{1-k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 0$, L chooses 'accede' after observing 'not sign' with the probability $a = 1$.

If $\mu = 1$, then

$$\frac{\partial \pi_E}{\partial s} : 0 = 0, \text{ and}$$
$$\frac{\partial \pi_E}{\partial k} : 0 = 0,$$

E does not get political capital. We are not expecting this equilibrium to have an empirical relevance.

$$Equilibria(IV):$$

Equilibrium (IVa):

For any $0 \leq \mu < 1$, E chooses 'sign' after observing θ_1 with the probability $s = 1$, and chooses 'sign' after observing θ_2 with the probability $k = 0$ such that

$$\begin{cases} \dfrac{s}{k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 1$, L chooses 'accede' after observing 'not sign' with the probability $a = 0$.[11]

If $\mu = 1$,

$$\begin{aligned} &\frac{\partial \pi_E}{\partial s} : \mu = \mu, \text{ and} \\ &\frac{\partial \pi_E}{\partial k} : \mu = \mu. \end{aligned}$$

then we have the situation, when E gets political capital choosing any combination of strategies s and k. The payoff of E does not depend on the choice of her strategies.

As a particular case, we consider a separating pure-strategy equilibrium: E chooses 'sign' after observing θ_1 with the probability $s = 1$, and chooses 'sign' after observing θ_2 with the probability $k = 0$.

Equilibrium (IVb):

If $\mu = 1$, E chooses 'sign' after observing θ_1 with the probability $s = 1$, and chooses 'sign' after observing θ_2 with the probability $k = 0$ such that

$$\begin{cases} \dfrac{s}{k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 1$, L chooses ' accede' after observing 'not sign' with the probability $a = 0$.

Equilibria (IVa) and (IVb) coincide. However, the message of E, who puts the maximum weight on political capital ($\mu = 1$), is driven by her office motivation.

[11] the Equilibrium (IVa) provides the same payoff as the Equilibrium (III). In both equilibria, E coordinates the L's action without gaining political capital.

2.2.2 Analysis of the theoretical model and hypotheses.

The analysis of the theoretical model demonstrates that the political motivation of E may affect the behaviour of agents in the treaty-making process. In particular, the results show that:

1) in the extreme case with the maximum weight, which E places on political capital, the action of L is likely to be accordant to E's message. (there are no equilibria with E and L acting in discordance with each other if $\mu = 1$).

2) if the weight, which E places on political capital, is strictly lower than 1, E and L may act in accordance or in discordance with each other irrespective of the level of μ.

If $\mu < 1$ the result will depend on the preferences of E and L concerning the issue under consideration, in particular, on the parameters b and c.

As an example we consider Equilibrium III where E and L act discordantly under condition that

$$\begin{cases} \dfrac{s}{k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

The probability of Equilibrium III is rising if the ratio $\dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}}$ tends to 1, and reaches its maximum at

$$\frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} = 1 \tag{6}$$

This condition holds, for example, in the situation when net benefits from signing a beneficial treaty and net costs from not signing a beneficial treaty are not large. It may happen if a 'non-monetary' positive effect from resolving the issue under consideration is negligible. In this case the ratio (6) tends to 1.

In our empirical analysis we further investigate the relationship between the E's political motivation and behaviour of agents. The choice of the dependent variable is determined by the characteristics of our dataset: each treaty-country observation is included in our dataset only if a country has signed a treaty or has acceded to it later - the information which is available for treaties. A treaty-country observation is not included in the dataset if a country has not signed and has not acceded to it.

Given the availability of data, we estimate the model with a dependent variable, which

captures the outcomes, when E and L act discordantly.[12]

During the introduction of the political capital concept in section 2.2.1, we pointed out that E's concern about her political capital is subject to changes during the electoral cycle: we posit that at the beginning of the electoral cycle, E places zero weight on gaining political capital; similarly, we posit that when E faces reelection, she puts a maximum weight on political capital.

Following the discussion, we use the time within the electoral cycle as a proxy for the level of E's office motivation, in other words, for the weight E places on political capital.

The general connections between the point in time within the electoral cycle, the weight, which E places on political capital, and the behaviour of E and L in the treaty-making process allow us to draw our main hypothesis on the effect, which the number of years left in the current term for E has on agents' behaviour. [13]

We posit our main hypothesis: Given the level of benefits of an agreement, the probability of ideology equilibrium is higher at the beginning of the electoral cycle, all other factors being equal.

2.3 Empirical evidence.

2.3.1 Data and empirical model.

The description of our full dataset is presented in Section 1.3 of the Introduction.

In this chapter, for our empirical analysis we use the subset of our full dataset, which includes 113 countries with presidential and semi-presidential systems that assume executive-legislature separation.[14]

We analyse 52 international environmental agreements (IEAs) signed between 1975 and

[12] The precise description of the dependent variable and our empirical model is presented in Section 2.3.

[13] In this section for our empirical analysis and the following discussion, we label the equilibrium with E and L acting discordantly as 'ideology equilibrium', implying that E is more policy-motivated and places less weight on political capital.

[14] Database of Political Institutions 2017 (DPI) Codebook defines the presidential types of systems as follows: Systems with unelected executives; systems with presidents who are elected directly or by an electoral college (whose only function is to elect the president), in cases where there is no prime minister.

In systems with both a prime minister and a president, the following factors are considered to categorize the system: a) Veto power: president can veto legislation and the parliament needs a supermajority to override the veto. b) Appoint prime minister: president can appoint and dismiss prime minister and / or other ministers. c) Dissolve parliament: president can dissolve parliament and call for new elections. d) Mentioning in sources: If the sources mention the president more often than the PM then this serves as an additional indicator to call the system presidential (Romania, Kyrgyzstan, Estonia, Yugoslavia).

The system is presidential if (a) is true, or if (b) and (c) are true. If no information or ambiguous information on (a), (b), (c), then (d).

2017. Our dataset was constructed using the information from primary sources (open access texts of IEAs) and the data from two other sources. Firstly, institutional and electoral results data are taken from the Database of Political Institutions (2017) (DPI) of Inter-American Development Bank (Cruz et al., 2018). The current version of the database covers about 180 countries for 40 years, 1975-2017.

Secondly, the Polity V Project of the Center for Systemic Peace (2020) provides information about indicators of democracy and autocracy, authority characteristics and polity regime transitions. It contains data for the period from 1800 to 2018.

Economic indicators are taken from the World Bank (2023) Open Data Project. Due to the limitation of the DPI (2017) data, our analysis is restricted to the period 1975-2017. For each 'treaty-country' observation, the dataset provides information about variables at three different points in time: the year of treaty adoption, the year of signing, and the year of ratification. Each pair 'treaty-country' is unique, as each country can sign (in case it signs) and ratify/accede to a treaty only once, while during one year a country can ratify/accede to more than one treaty. The full description of variables and descriptive statistics are presented in Appendix 2. Good variation among the countries in the sample is provided.

The variable 'democracy' ranges from +10 (strongly democratic country) to -10 (strongly autocratic country). In our sample, democratic countries with a positive level of democratization make up a proportion of approximately 47% of all observations, observations are fairly evenly distributed between the countries with different levels of democratization. We observe good variation among the countries in the sample. It demonstrates that both democratic and autocratic countries are actively involved in international environmental activity.

While the mean for variable 'years in office' is 8.6 years, we observe that the distribution is skewed to the right, meaning that a few countries have an executive with a very long staying in power. We observe the different level of activity among the executives who were in power for a long time.

In terms of other variables, we also observe a high dispersion of economic characteristics among the countries. For example, GDP per capita ranges from 164 constant (2010) US dollars for Ethiopia to 102,669 constant (2010) US dollars for the UAE. A right-skewed distribution is observed in our sample for GDP per capita variable, with only 7 countries whose GDP per capita is higher than 30 thousand constant (2010) US dollars. We will talk more about independent variables in Section 2.3.2.

The literature traditionally uses global IEAs with open membership for empirical analysis, downplaying the role of local treaties, which instead may solve regional environmental problems. Unlike previous empirical studies in this field, our dataset includes both types

of environmental treaties, thus providing a comprehensive empirical analysis and a robustness check for different types of treaties. In our analysis we distinguish them by the type of membership: open and close. [15] The impact of factors that affect negotiation, implementation and, eventually, the success of an international agreement, may be different for treaties with open and restricted membership.

In order to test our main hypothesis we estimate a logit model, where the dependent variable Y_{ij} is represented by an indicator variable 'zero' or 'one'. A dependent variable is equal to one if a country signs and does not ratify a treaty in the same electoral cycle, or a country does not sign a treaty and accedes to it in the same electoral cycle as its adoption, and zero otherwise. The probability of the dependent variable taking 'one', is modelled as a function of political variables, economic variables, and variables that capture country- and treaty-fixed effects:

$$Pr(Y_{ij} = 1|x) = Z(\beta_0 + \sum_{f=1}^{F} \chi_f P_f + \sum_{k=1}^{K} \gamma_k E_k + \alpha_i + \lambda_j) \tag{7}$$

where i – a country; i = 1,2,...113.

j – a treaty; j = 1,2,....52.

P – set of political variables for country i in treaty j

E – set of economic variables for country i in treaty j

α_i - a country fixed effect to control for variables that vary across countries but are constant over treaties

λ_j - a treaty fixed effect to control for variables that vary across treaties but are constant across countries

Z – the logistic cumulative distribution function.

The independent variables correspond to the political and economic characteristics of the country in the year of adoption.

In order to create a dependent variable for our analysis in STATA, we combine two cases:

[15] IEAs that deal with global environmental problems typically are open for all the countries (open membership), while IEAs that focus on local issues often have restricted participation. We assume that the essence of the environmental problem underlies a dissimilarity in the factors that affect the treaty-making process. In particular, we conjecture that it is easier for countries to combine resources and efforts to solve the particular problem through 'neighbouring' links (if it is a local problem), historically established relations and well-defined logistics between countries. There are also fewer incentives for free-riding: it is easier to monitor efforts, to calculate costs and benefits, to punish noncompliance by imposing sanctions.

1) a country does not sign a treaty, and accedes to it in the same electoral cycle as a treaty adoption.

2) a country signs a treaty, and does not ratify it in the same electoral cycle.

The dependent variable is constructed for the 4-year electoral cycle: in the first case, the difference between the year of ratification (accession) and the year of adoption is less or equal to 4; in the second case the difference between the year of ratification and the year of signature is larger than 4.

In the first case the difference between the year of ratification (accession) and the year of adoption is taken as a measurement of the length of the electoral cycle. We use the year of adoption instead of the year of signature due to the fact that the years of signature are missing values if a country does not sign a treaty. In this case the year of adoption is used as a proxy for the year of signature. Indeed, more than 96% of countries in our dataset have signed a treaty within the first year after the treaty adoption, meaning that these two events are close in time to each other.

This also captures the countries that have signed a treaty and have never ratified them.

Table 1 reports the results from the logistic regression in equation (7). In order to control for the unobserved heterogeneity across countries and treaties, we estimate our model using different fixed effects.

2.3.2 Empirical findings and discussion.

We begin with describing the coefficients for the variable 'electoral cycle', which is the main focus of our research. The variable shows the number of years left in the current term for E. We use the time within the electoral cycle as a proxy for the level of E's office motivation, in other words, for the weight E places on political capital.

Earlier in the introduction of the political capital concept in section 2.2.1, we pointed out that E's concern about her political capital is subject to changes during the electoral cycle: at the beginning of the electoral cycle, E places zero weight on gaining political capital; closer to the election, the weight placed on political capital rises and reaches its maximum when E faces reelection. Therefore, the number of years left in the current term for E is negatively correlated with the immeasurable variable of interest, which is weight on political capital: more years left leads to lower weight on political capital.

The results presented in Table 1 show that coefficients for the variable 'electoral cycle' are positive and significant in the specifications with country-, and country- and treaty-fixed

effects (Table 1, Columns (2), (4), (5)).

The frequency distribution of the independent variable 'electoral cycle' demonstrates that 94.35% of observations lie within the 4-year electoral cycle, and are approximately evenly distributed between the years within the electoral cycle. It is in line with our dependent variable, which is generated for the 4-year electoral cycle.

There is evidence that the number of years left in the current term for E, positively affects the probability of ideology equilibrium, all the other explanatory variables are held fixed.

As an example, we calculate the predicted probabilities of ideology equilibrium for different points in time within the electoral cycle, setting all the other explanatory variables to their mean values in the sample.

Figure 1 shows the relationship between the points in time within the electoral cycle and predicted probabilities of ideology equilibrium for the specification with both country- and treaty-fixed effects (Table 1, column (5)).

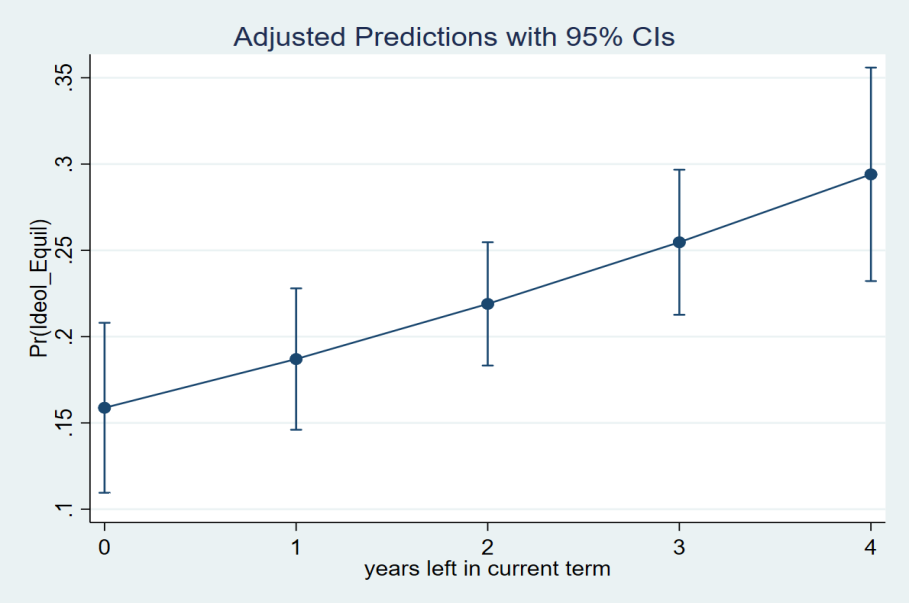


Figure 1: Predicted probabilities of ideology equilibrium (time within the electoral cycle).

The predicted probability of ideology equilibrium decreases with E being closer to the next election. As an example, for the specification with country- and treaty-fixed effects (Table 1, column (5)), the predicted probability that E and L will act discordantly in the last year before the election (elec = 1) is 18.7%, while three years before the election (elec = 3) the predicted probability is 25.5%.

We provide robustness checks by estimating our model for two types of treaties: with open and restricted membership, taking into account the difference in the nature of the agree-

ments. (Table 2).

For the sample of treaties with open membership that deal with global environmental issues, the results are similar to the whole sample: the coefficient for 'electoral cycle' is statistically significant at the 5% level of significance in the specifications with country FE and country- and treaty-FEs; and at the 10% level of significance in the specification without FEs.

For the treaties with restricted membership, the coefficients are not significant for the most of specifications (Table 2, Columns (5)-(8)). Moreover, the specification with country- and treaty-FEs (Table 2, Columns (8)) has a relatively small number of observations, and the results should be interpreted with caution due to the possible selection bias. There is little evidence that time within the electoral cycle has an impact on the interaction between E and L in international treaties with restricted membership.

Treaties that deal with local environmental problems are likely to involve the countries that are located around the given area. These countries may have historically established relations and 'neighbouring' links, which helps them to combine resources and efforts to solve a particular problem. The impact of E's reelection concerns may be less significant than in the case of the treaties with open membership. More unanimity is expected in the decisions of E and L, regardless of the timing of the elections. Costs and benefits are more transparent for negotiators, as well as it is easier to monitor efforts, to punish noncompliance by imposing sanctions. Our results support this intuition, and show that the impact of political factors such as time before the election may be less significant than in the case of treaties with open membership, which often have a more complex structure.

Table 1: General model: logistic regression.

ideol_equilibrium	(1)	(2)	(3)	(4)	(5)
electoral cycle	0.0639	0.119**	0.0905	0.170**	0.198***
	(0.210)	(0.049)	(0.119)	(0.017)	(0.003)
democracy	0.0142	0.0356	-0.00340	0.0308	
	(0.386)	(0.234)	(0.864)	(0.394)	
GDP	0.0854***	0.235**	0.116***	0.323**	0.179
	(0.008)	(0.021)	(0.003)	(0.042)	(0.120)
GDP squared	-0.00136*	-0.00440*	-0.00219**	-0.00703**	-0.00190
	(0.061)	(0.051)	(0.016)	(0.047)	(0.163)
years in office	0.0149	0.0175	0.00525	0.00766	
	(0.227)	(0.309)	(0.725)	(0.707)	
share of industry in GDP	-0.0129	-0.0486**	-0.00584	-0.0554**	-0.0462**
	(0.173)	(0.014)	(0.600)	(0.027)	(0.039)
share of agriculture in GDP	-0.0121	-0.0228	-0.00151	0.0184	
	(0.235)	(0.297)	(0.895)	(0.513)	
trade openness	0.00167	-0.00184	-0.00334	-0.00860	
	(0.488)	(0.758)	(0.251)	(0.245)	
No.Obs.	889	823	861	795	840
No.Countries	85	73	85	73	77
No.Treaties	10.5	11.3	10.1	10.9	10.9
PseudoR2	0.036	0.135	0.179	0.265	0.246
$Prob > chi2$	0.000	0.000	0.000	0.000	0.000
$F-test$	-	88.92	106.24	141.79	148.84
$p-value$	-	0.086	0.000	0.006	0.004
Country FE	-	*	-	*	*
Treaty FE	-	-	*	*	*

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: 1) A dependent variable is a dummy variable equal to one if a country signs and does not ratify a treaty in the same electoral cycle, or a country does not sign a treaty and accedes to it in the same electoral cycle as its adoption, and zero otherwise.

2) The F-test entries refer to the test of the joint significance of fixed effects.

Table 2: General model for the split sample: treaties with open and restricted membership

ideol_equilibrium	(1) open	(2) open	(3) open	(4) open	(5) restricted	(6) restricted	(7) restricted	(8) restricted
electoral cycle	0.101*	0.158**	0.0995	0.184**	-0.0699	-0.109	0.00427	-3.644**
	(0.072)	(0.018)	(0.102)	(0.017)	(0.632)	(0.638)	(0.983)	(0.018)
democracy	0.0215	0.0325	-0.00268	0.0306	-0.00992	0.118	0.00931	5.752
	(0.244)	(0.308)	(0.900)	(0.429)	(0.804)	(0.790)	(0.877)	(0.996)
years in office	0.0128	0.00868	0.00346	0.00678	0.0892**	0.322**	0.0685	3.383
	(0.344)	(0.643)	(0.824)	(0.754)	(0.041)	(0.032)	(0.325)	(0.996)
GDP	0.0905**	0.299**	0.118***	0.391**	0.0288	-0.901	0.177	2.130
	(0.014)	(0.014)	(0.004)	(0.025)	(0.733)	(0.342)	(0.129)	(0.640)
GDP squared	-0.00140*	-0.00729**	-0.00206**	-0.00982**	-0.000532	0.0344	-0.00436	-0.040
	(0.089)	(0.017)	(0.029)	(0.015)	(0.785)	(0.196)	(0.101)	(0.561)
share of industry	-0.0102	-0.0672***	-0.00746	-0.0849***	-0.00507	0.200	0.00976	9.461**
	(0.333)	(0.004)	(0.521)	(0.003)	(0.853)	(0.141)	(0.834)	(0.049)
share of agriculture	-0.00455	-0.0253	-0.000699	0.00202	-0.0487	-0.218	0.0166	-0.234
	(0.679)	(0.274)	(0.953)	(0.947)	(0.135)	(0.390)	(0.730)	(0.727)
trade openness	0.000642	0.00252	-0.00231	-0.00418	0.00170	0.00480	-0.0150	-1.266**
	(0.815)	(0.703)	(0.456)	(0.589)	(0.778)	(0.865)	(0.135)	(0.029)
No.Obs.	762	684	762	684	127	81	99	55
No.Countries	85	70	85	70	50	15	49	13
No.Treaties	9.0	9.8	9.0	9.8	2.5	5.4	2.0	4.2
PseudoR2	0.0290	0.1186	0.1625	0.2611	0.0636	0.2628	0.2225	0.6078
Prob > chi2	0.002	0.084	0.000	0.000	0.192	0.165	0.087	0.002
Country FE	-	*	-	*	-	*	-	*
Treaty FE	-	-	*	*	-	-	*	*

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: 1) A dependent variable is a dummy variable equal to one if a country signs and does not ratify a treaty in the same electoral cycle, or a country does not sign a treaty and accedes to it in the same electoral cycle as its adoption, and zero otherwise.

In our research we control for a number of other factors that have been identified in the literature as important determinants of environmental policy. There is a large body of theoretical and empirical literature that focuses on the economic and political determinants of environmental policy issues.

Economic variables.

a) GDP per capita.

The effect of economic activity on the environment has been broadly discussed. The literature investigates how different forms of environmental degradation depend on the level of economic determinants, in particular GDP.

A non-monotonic type of the relationship between economic growth and the environment, illustrated specifically by an inverted-U curve (as an example, see Grossman and Krueger (1991)), may cause the different approaches of states to address the environmental issues on

the different levels of economic development. For our analysis, we have tested two models: the first model is with a linear term for GDP per capita, while our main model investigates the Kuznets curve pattern and includes linear and quadratic terms for GDP per capita (Table 1). The results in the latter model demonstrate that coefficients for the linear and quadratic terms for GDP per capita are significant in the specifications with different fixed effects. The results of the model with a linear term for GDP per capita show that the coefficients for GDP per capita are only significant in the specification without FE (p=0.016) and in the specification with a treaty FE (p=0.065) (Appendix 3. Table 6).

Our empirical results in Table 1 demonstrate the evidence that the probability of ideology equilibrium is lower for the countries with the lowest level of GDP, and it increases at a decreasing rate as a country experiences economic growth, all the other explanatory variables are held fixed. After a certain threshold, the probability of ideology equilibrium is likely to decline as GDP per capita rises. The results imply that E and L are more likely to act in accordance with each other if GDP per capita of the country is very low or very high.

For countries with a low level of economic development, there is a small concern about the environment. For poor countries environmental quality is a luxury good, they prioritize improving material living standards rather than protecting the environment (Bernauer and Koubi, 2009). Through joining an IEA, a country may get access to financial funds, such as the Green Climate Fund established within the framework of the UNFCCC. It aims to assist developing countries financially in order to limit or reduce greenhouse gas emissions, and to help vulnerable societies adapt to the unavoidable impacts of climate change (Green Climate Fund (2020)). Both E and L acknowledge the importance of such foreign aid for the economy. They may equally estimate the possible effect of an IEA on the country's economy, and L's action is likely to be consistent with E's message.

As soon as some threshold in the level of GDP per capita is reached, the probability of ideology equilibrium is likely to decline as GDP per capita rises. At higher levels of development, countries may control their pollution by introducing structural changes towards information-intensive industries and services, demonstrate increased environmental awareness, impose more stringent environmental regulations, cleaner technology and higher environmental expenditures. (Panayotou, 1993). These resources may motivate economically developed countries to join an IEA.

The results demonstrate that E and L are more likely to act in accordance with each other in countries with very low and very high economic development. However, the motivation for their action is different: while highly developed countries may join IEAs in order to solve global environmental problems, the poor countries attempt to get financial support through

IEAs.

As an example, we calculate the predicted probabilities of ideology equilibrium for different values of GDP per capita, setting all the other explanatory variables to their mean values in the sample. Here we present the results for the model with a quadratic term with treaty-fixed effect from Table 1, Column (3).

Figure 2 shows the relationship between GDP per capita and predicted probabilities of ideology equilibrium. The threshold is 26.586 (GDP per capita in thousands of 2010 US dollars).

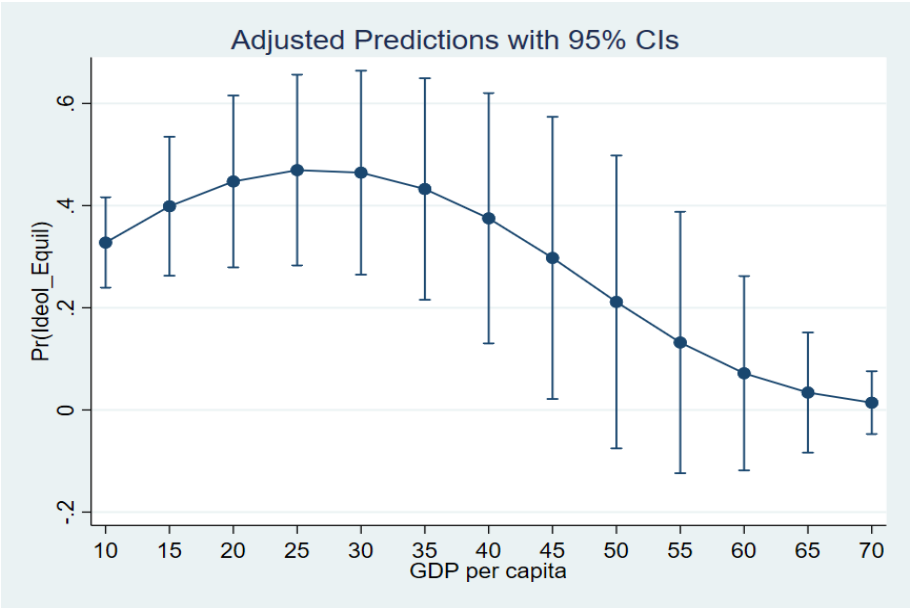


Figure 2: Predicted probabilities of ideology equilibrium (GDP per capita).

The predicted probability of ideology equilibrium initially increases with GDP per capita at a decreasing rate (marginal effects at the average fall), it reaches a maximum of 47.09 % at the level of GDP per capita about 26.586 thousand 2010 US dollars. After the threshold is reached, the predicted probability of ideology equilibrium decreases (marginal effects at the average are negative).

The sample mean is 5.9745 thousand 2010 US dollars. Descriptive statistics show that about 75% of observations lie on the upward part of the curve. It means that for a large proportion of the countries the probability of facing the discordance in E's and L's actions is increasing with the rise of GDP per capita, all the other explanatory variables are held fixed.

The results for the split sample (Table 2) show that the coefficients for GDP and GDP squared are significant in the subset of the treaties with open membership, which often have complex structure and use economic mechanisms described above in this section to make the treaty effective. There is no evidence that the level of GDP affects the probability of ideology

equilibrium in the sample of the treaties with restricted membership.

b) The shares of agricultural and industrial production in GDP.

We predict that E and L are more likely to act in accordance with each other with the rise of the share of agricultural and industrial production in GDP. It might be explained through the direct effect: for example, if the share of industrial production in GDP is high, both E and L acknowledge the importance of the industrial sector for the economy. They may equally estimate the possible effect of an IEA on the country's economy, and L's action is likely to be consistent with E's message.

The direct effect may be diminished by the impact of lobbying, which is the practice of trying to influence policy-making through all the stages: from agenda setting and policy formulation to decision making and implementation (Adelle and Anderson, 2012). The share of agricultural and industrial production in GDP may act as proxies for lobby influence: the higher the share of agricultural and industrial production in GDP, the stronger is lobbying. Indeed, agricultural and industrial production is provided by firms in the different sectors of the economy. Larger sectors represent a greater number of firms and stronger lobbying. In order to comply with IEA provisions, a country may introduce pollution control instruments (output quotas, emissions taxes, input controls over quantity, etc.), which increase the firms' costs. Lax environmental regulations benefit businesses, thus, explaining their activities in opposing the stringent environmental regulation.

The existing literature demonstrates that the lobby groups exert some influence over the policy-making process. For example, Fredriksson et al. (2004) discusses the positive effect of industry concentration on political influence, (Mazey and Richardson, 2003) find that business groups are more powerful in comparison with environmental ones.

With respect to international environmental activity, Fredriksson and Ujhelyi (2006) examine the impact of environmental and industry lobby group activities on the probability of IEA ratification under different institutional structures. They used a multi-principal, multi-agent model of government decision-making where government veto players (such as the legislative chambers or the president) are offered political contributions from environmental and industry lobby groups. The authors use logit and stratified proportional hazard models and panel data from 170 countries on the timing of Kyoto Protocol ratification. The results demonstrate that greater environmental lobby group strength raises the probability of ratification. The effect of the industry lobbying on the probability of ratification is ambiguous.

With respect to our empirical results, the coefficients for the share of industrial production in GDP in the year of treaty adoption are negative and significant in most of the specifications in Table 1. It implies that the higher the share of industrial production in GDP, the lower the

probability of ideology equilibrium, all the other explanatory variables are held fixed. There is no evidence that the shares of agricultural production in GDP have an impact on the probability of ideology equilibrium. Following the intuition presented above, we may suspect that agricultural lobbying might be more significant than industrial one, thus demolishing the direct effect.

c) Trade openness.

Trade openness is calculated as the ratio of the sum of exports and imports of goods and services to GDP.

With respect to our empirical results, the coefficients for the trade openness in the year of treaty adoption are not statistically significant (Table 1). There is no evidence that the level of trade openness has an impact on the probability of ideology equilibrium, all the other explanatory variables are held fixed.

The integration of the country into the global trade system has been widely studied. Neumayer (2002) points out that openness to trade may foster cooperation in other policy areas, in particular promoting multilateral environmental cooperation. There are a few theories that explain the diverse impact of trade openness on different countries. The first one is the pollution heaven hypothesis. It predicts that relatively low-income countries will experience environmental degradation with trade expansion. Large industrialized countries seek to avoid the cost of stringent environmental regulations and relocate production to countries where environmental norms are laxer.

Barrett (2005) explains one more concept, known as trade leakage, which is connected with participating in an IEA: if signatures to a treaty reduce their pollution emissions, they lose their comparative advantage, and the pollution-intensive industries are likely to shift to non-signatories. As a result, global emissions may fall by less than the reduction undertaken by signatories. The IEA mechanism may help to solve such problems, however, it requires full participation.

In order to attract more participants, and encourage maximum participation in IEAs, negotiators implement different mechanisms that could successfully promote international cooperation. For example, they may negotiate on an environmental issue and a linked economic agreement (an agreement for R & D cooperation, or trade liberalization cooperation). The phenomenon is known as issue linkage. Diamantoudi et al. (2018) argue that trade measures in IEAs may be an effective tool, they play an important role in reducing the free-riding incentives and increasing countries' willingness to cooperate. Their results demonstrate that the formation of an environmental agreement can be more successful when environmental policies are linked with trade policies. Countries have stronger incentives to cooperate and

take the necessary measures to protect the environment. Thus, larger stable agreements may be achieved that reduce substantially aggregate emissions and improve welfare.

Trade openness may benefit the country through the mechanism of issue linkage. Certain politicians may have strong incentives to take advantage of issue linkage. If a country is economically open, E has more options to enhance cooperation, and it will lead to gaining more political capital. For example, E can bargain for foreign assistance, get access to markets and credit, participate in economic and financial programs, etc. (Cazals and Sauquet, 2015). Moreno-Dodson et al. (2012) show that the more aid a leader receives, the greater their chances of staying in office. This motivation is mostly associated with developing countries.

In order to distinguish the effects, which trade openness has on the probability of ideology equilibrium for developing and developed countries, we estimate the model with the dummy variable, equal to 1 if a country is low-income or lower-middle-income economies according to the World Bank classification, and zero otherwise. The World Bank methodology uses gross national income (GNI) per capita data in U.S. dollars, converted from local currency using the World Bank Atlas method, which is applied to smooth exchange rate fluctuations. (Appendix 3, Table 7). The coefficients of 'openness', 'low_gni' and interaction term are not significant. Tests for joint significance demonstrate that the variables 'openness', 'low_gni' and interaction term are not jointly statistically significant.

Political variables.

a) Level of democratization

There is no uniform opinion in the literature about the relationship between democracy and international cooperation on environmental issues. On the one hand, it is often expected that some characteristics of the democratic countries may support international environmental activities (see,for example Winslow (2005)), such as:

- accountability of leaders, who are obliged to act in the best interests of society or face consequences

- public involvement in policy making, which supports the environmental issues being recognized and resolved;

- access to information about environmental problems;

- the presence of non-governmental environmental organizations and agencies that can take part in raising public awareness about environmental problems, and can directly lobby members of the government.

Given that intuition, we expect that the probability of E and L acting in accordance with

each other, is higher for the countries with the higher level of democratization, all the other explanatory variables are held fixed.

On the other hand, democracy may not be an ideal system of government to solve environmental issues. For example, Spector and Korula (1993) argues that open pluralistic systems are likely to delay a ratification decision due to public debate and following negotiations with domestic stakeholders, while highly centralised and closed systems have a power to sign and ratify treaties quickly, provided it will serve for the national interest.

Similarly, Midlarsky (1998) in his paper points out the following features of democracy, which may cause obstacles with respect to environmental activities:

1) actual decision-making within both branches of power can be often rough and disordered;

2) under the conditions of inequality and budget constraints, environmental problems require tough redistribution schemes, which are unlikely to be performed in democratic regimes.

Our results do not provide evidence that the level of democratization has an effect on the probability of ideology equilibrium: the coefficients for the variable 'democracy', which represents the degree of country democratization, are insignificant in all the specifications in Table 1 and Table 2.

b) A number of years E has been in office

The variable represents E's political experience. Casey (2005) considers political experience as one of the components of political capital. E, who is in power for a long time, possesses more political capital, than E, who wins the election for the first time in her political career. E, who is at the beginning of her political career, tends to put more weight on political capital in her decisions, and less weight the longer she is in power.

This idea is supported by Lott and Reed (1989), they argue that politicians who have been in office a long time may be motivated primarily by ideological, and not, reelection concerns.

Furthermore, politicians possess finite time in office. As their remaining time recedes, and they approach the final years of political career, their policy preferences may change (see, for example, (Potter, 2016)). The existing literature provides evidence that the final years of presidential administration are not productive and are characterized by weakness (see, for example, (Shogan, 2006) and (Combs, 2000)). We expect that E puts the minimum weight on political capital in the final years of administration.

At the same time, E tends to put a minimum weight on political capital at the beginning of her political career. This assumption is consistent with our main hypothesis.

During the course of her political career E puts more weight on political capital than in the

beginning and in the end of her political career due to the reelection concern. Taking into consideration our main assumption that E gains the political capital if her action is accordant to L's action, we also tested the model with the quadratic relationship between the number of years E has been in office and the probability of ideology equilibrium. However, the model with a linear term for the number of years E has been in office and the model with linear and quadratic terms do not provide evidence that political experience affects the probability of ideology equilibrium, all the other explanatory variables are held fixed.

For the split sample, the coefficients are significant at the 95 % confidence level for the treaties with restricted membership in two specifications: without FEs and with treaty FE (Table 2, Columns (5)-(6)). There is evidence that the number of years E has been in office positively affects the probability of ideology equilibrium all the other explanatory variables are held fixed. The results are in line with the intuition above that E and L are more likely to act discordantly if E stays in office for a long time putting the minimum weight on political capital in the final years of administration, but only for the treaties with restricted membership.

On the whole, the results demonstrate that the cyclical nature of political capital is more explicitly expressed within the electoral cycle rather than during the whole period of E's political career.

2.4 Conclusion to Chapter 2.

In the second chapter we address the problem that is common for international environmental agreements: even if a treaty is signed by a large number of countries, long time lapses may occur before the countries ratify it and begin to comply with it. In particular, we focus on the interaction of domestic institutions at the stages of signature and ratification in the post-negotiation period, which is crucial for the transformation of the international treaty terms to domestic policy and largely defines the success of the treaty. Our work is the first one that provides the theoretical and empirical analyses of this interaction and the factors that affect it.

While the role of signature in the treaty-making process is widely discussed in political science literature, economists often consider it as a formality at best and valueless at worst. In economic models, ratification is taken in isolation from signature, or signature is totally ignored. However, a signature is not only a gesture that symbolises the end of the negotiation: political leaders are often wary about signing a treaty and may sign it later if sign at all. Our theoretical model considers the Executive's decision to sign a treaty as a separate stage in a treaty-making process, which is made by an individual leader who may be subject to the

reelection concern. The Executive's decision to sign or not is taken in connection with the expected action of the Legislature. Equally, the Legislature ratifies/accedes to a treaty following the Executive's action. The actions of both agents are analysed within one electoral cycle.

The Executive who cares about her political status sends a signal to the Legislature by signing or not signing a treaty. The Legislature observes the message sent by the Executive, and then chooses an action according to his conditional beliefs. The Executive's motivation changes within the electoral cycle: the Executive is more office-motivated at the end of the electoral cycle, and more ideology-motivated at the beginning of it. The Executive's office motivation is captured in our analysis through the weight, which she places on political capital. The theoretical model demonstrates that in the extreme case with the maximum weight, which the Executive places on political capital, the action of the Legislature is likely to be accordant to the Executive's message. The Executive, who is facing an election, in an attempt to accumulate political capital, tends to act in accordance with the Legislature's preferences. If the Executive does not place the maximum weight on political capital, the behaviour of agents depends on the ideological preferences of the Executive and the Legislature, in our model they are captured by the discounted utilities of agents. Our findings demonstrate that the electoral incentives of the Executive affect the decisions made by both key players, and the outcome in the treaty-making process. The results deepen the understanding of the post-negotiation period and the factors that lead to delay in the ratification of the treaty, or the failure of it in case of being not ratified by the required number of countries.

For the empirical analysis we use the sample, which includes 113 countries with presidential and semi-presidential systems that assume executive-legislature separation. The sample consists of 52 international environmental treaties signed between 1975 and 2017. In order to look into the correlation between the level of the Executive's motivation and the behaviour of agents in a treaty-making process, we use the logistic regression. Our independent variable of interest is the time within the electoral cycle, which is used as a proxy for the level of the Executive's office motivation that changes within the electoral cycle. It provides a more accurate estimation of the effect that the Executive's reelection concern has on the agents' behaviour than the previous empirical models have done. The results demonstrate that the number of years left in the current term for the Executive, positively affects the probability that the Executive and the Legislature act discordantly, which implies that the behaviour of the Executive who is subject to the domestic reelection concern, exhibits electoral cycles. Our dataset allows us to control for the unobserved heterogeneity across countries and treaties, we estimate our model using different fixed effects.

In order to control for a number of other factors that have been identified in the literature

as important determinants of environmental policy, we study the effect of economic and political factors on the behaviour of agents and the probability of the ideology equilibrium, in which actions of the Executive and the Legislature are discordant. Our results show that economic factors affect the probability of ideology equilibrium, while the impact of political factors, such as the democracy level and the Executive's governing period, remains ambiguous.

The literature traditionally uses global IEAs with open membership for empirical analysis, downplaying the local treaties, which may play a crucial role in solving local environmental problems. Unlike previous empirical studies in this field, our dataset includes both types of environmental treaties, thus providing a comprehensive empirical analysis and a robustness check for different types of treaties. Indeed, we obtained different results for the treaties with open and restricted membership. Our main variable of interest, which is the time within the electoral cycle, demonstrates mostly robust significance in all the specifications in the sample of treaties with open membership, while in the sample of treaties with restricted membership we observe the significant coefficient for this variable only in the specification with country- and treaty- FEs. Variables GDP and the share of industrial production in GDP lose their significance in the sample of the treaties with restricted membership. The results support the intuition presented earlier in the chapter, that the treaties with open membership often have complex structure and use various economic and political mechanisms to make the treaty effective. At the same time, treaties that deal with local environmental problems are likely to involve the countries that may have historically established relations and 'neighbouring' links, which helps them to combine resources and efforts to solve a particular problem. The impact of political and economic factors may be less significant than in the case of treaties with open membership.

Although our empirical analysis is made for international environmental agreements, the findings may be relevant for other public good agreements with similar mechanisms of treaty-making.

2.5 Appendix 1. Models for the extreme cases.

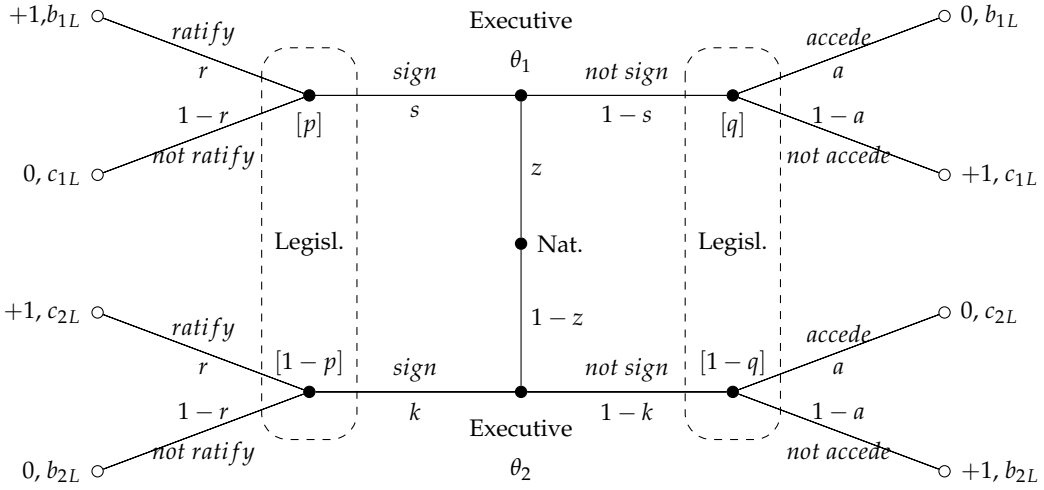
2.5.1 Model 1

The initial conditions for the Model 1 are the same as for the general model described above. In the model 1 the executive, E, chooses the probability, s, to play 'sign' when the state of the world is θ_1 and the corresponding probability, k, to play 'sign' when $\theta = \theta_2$.

The legislature, L, chooses r, the probability of playing 'ratify' after observing 'sign', and a, the probability of playing 'accede' after 'not sign'.

Key parameters are b_{1j}, b_{2j}, c_{1j}, c_{2j} with $j \in \{E, L\}$. The other parameters are z, and μ. L's belief p of being at θ_1 rather than θ_2 given that L observes 'sign' and the corresponding belief, q, of being in θ_1 when observing 'not sign' are both derived using Bayes' rule and are functions of z, s and k.

For the purpose of these notes we let $\mu = 1$ and $z = \frac{1}{2}$.



The payoff for the Executive is:

$$\begin{aligned}\pi_E = z\{s(r*(+1)+(1-r)*0)+(1-s)(a*0+(1-a)*(+1))\} \\ +(1-z)\{k(r*(+1)+(1-r)*0)+(1-k)(a*0+(1-a)*(+1))\},\end{aligned}$$

$$\begin{aligned}\pi_E = \{sr+(1-s)(1-a)\} \\ +\{kr+(1-k)(1-a)\},\end{aligned}$$

Similarly, for the Legislature, we have – keeping in mind that $p = \frac{s}{s+k}$ and that $q = \frac{1-s}{2-s-k}$:

$$\pi_L = (sz + k(1-z)) \left\{ \frac{s}{s+k} (rb_{1L} + (1-r)c_{1L}) + (\frac{k}{s+k}) (rc_{2L} + (1-r)b_{2L}) \right\}$$
$$+ ((1-s)z + (1-k)(1-z)) \left\{ \frac{1-s}{2-s-k} (ab_{1L} + (1-a)c_{1L}) + (\frac{1-k}{2-s-k}) (ac_{2L} + (1-a)b_{2L}) \right\}.$$

We are now going to discuss the first-order conditions for the associated maximization problems:

$$\max_{s,k} \pi_E, \text{ and } \max_{r,a} \pi_L.$$

Differentiating π_E with respect to s and k we get the following expression, which we have rearranged for ease of presentation:

$$\frac{\partial \pi_E}{\partial s} : r \gtreqless 1 - a; \tag{8}$$
$$\frac{\partial \pi_E}{\partial k} : r \gtreqless 1 - a. \tag{9}$$

The equation (8) implies that if the $>$ relationship holds then $s = 1$, if $<$ holds, $s = 0$, whereas any s solves the problem for FOC=0.

Similarly, the equation (9) implies that if the $>$ relationship holds then $k = 1$, if $<$ holds, $k = 0$, whereas any k solves the problem for FOC=0.

Differentiating π_L with respect to r and a we get, instead:

$$\frac{\partial \pi_L}{\partial r} : \frac{s}{s+k} b_{1L} + \frac{k}{s+k} c_{2L} \gtreqless \frac{s}{s+k} c_{1L} + \frac{k}{s+k} b_{2L};$$
$$\frac{\partial \pi_L}{\partial a} : \frac{1-s}{2-s-k} b_{1L} + \frac{1-k}{2-s-k} c_{2L} \gtreqless \frac{1-s}{2-s-k} c_{1L} + \frac{1-k}{2-s-k} b_{2L}.$$

After some algebraic transformations:

$$\frac{\partial \pi_L}{\partial r} \gtreqless 0 \iff \frac{s}{k} \gtreqless \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}}; \tag{10}$$
$$\frac{\partial \pi_L}{\partial a} \gtreqless 0 \iff \frac{1-s}{1-k} \gtreqless \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}}. \tag{11}$$

We can use similar interpretations to infer from the FOCs whether $r = 1$, 0 or any: the equation (10) implies that if the $>$ relationship holds then $r = 1$, if $<$ holds, $r = 0$, whereas any r solves the problem for FOC=0. The equation (11) implies that if the $>$ relationship holds then $a = 1$, if $<$ holds, $a = 0$, whereas any a solves the problem for FOC=0.

We can now use these fours equations to characterize possible equilibria for this game.

I

We consider now the first possible equilibrium, when:

$$\begin{cases} \dfrac{s}{k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

If both these conditions hold, $r = 1$ and $a = 1$.

In this case, expressions (8) and (9) are reduced to:

$$\frac{\partial \pi_E}{\partial s} : 1 > 0, \text{ and}$$
$$\frac{\partial \pi_E}{\partial k} : 1 > 0,$$

implying that $s = 1$ and $k = 1$.

We need to check that this is consistent with both conditions:

$$\begin{cases} \dfrac{s}{k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

When we plug in $s = 1$ and $k = 1$, we get that the second condition is indeterminate. Indeed, the second condition is for the 'right-hand side' information set, which is off the equilibrium path. It is certain not to be reached, because, given L's playing 'accede', E does not get political capital playing 'not sign'.

Equilibrium (I):

E chooses 'sign' after observing θ_1 with the probability $s = 1$, and chooses 'sign' after observing θ_2 with the probability $k = 1$ such that

$$\begin{cases} \dfrac{s}{k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} - \textit{off the equilibrium path} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 1$, L chooses 'accede' after observing 'not sign' with the probability $a = 1$.

The equilibrium (I) is a pooling equilibrium, in which E chooses 'sign' for both states θ_1 and θ_2. In this case she gets political capital.

E's message 'sign' does not transfer any information for L about the state Θ. In this equilibrium E always signs an agreement, having a goal to gain political capital, even if the agreement is not beneficial for the country.

II

We consider now the next possible equilibrium:

$$\begin{cases} \dfrac{s}{k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

When both these conditions hold, $r = 0$ and $a = 0$.

In this case, expressions (8) and (9) are reduced to:

$$\frac{\partial \pi_E}{\partial s} : 0 < 1, \text{ and}$$
$$\frac{\partial \pi_E}{\partial k} : 0 < 1,$$

implying that $s = 0$ and $k = 0$.

We need to check that this is consistent with both conditions:

$$\begin{cases} \dfrac{s}{k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

When we plug in $s = 0$ and $k = 0$, we get that the first condition is indeterminate. Indeed, the first condition is for the 'left-hand side' information set, which is off the equilibrium path. It is certain not to be reached, because, given L's playing 'not ratify', E does not get political capital playing 'sign'.

Equilibrium (II):

E chooses 'sign' after observing θ_1 with the probability $s = 0$, and chooses 'sign' after observing θ_2 with the probability $k = 0$ such that

$$\begin{cases} \dfrac{s}{k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} - \textit{off the equilibrium path} \\ \dfrac{1-s}{1-k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 0$, L chooses 'accede' after observing 'not sign' with the probability $a = 0$.

The equilibrium (II) is also a pooling equilibrium, in which E chooses 'not sign' for both states θ_1 and θ_2. In this case she gets political capital.

E's message 'not sign' does not transfer any information for L about the state Θ. In this equilibrium E never signs an agreement, having a goal to gain political capital, even if the agreement is beneficial for the country.

III

We consider now the next possible equilibrium:

$$\begin{cases} \dfrac{s}{k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

When both these conditions hold, $r = 0$ and $a = 1$.

In this case, expressions (8) and (9) are reduced to:

$$\begin{aligned} &\frac{\partial \pi_E}{\partial s} : 0 = 0, \text{ and} \\ &\frac{\partial \pi_E}{\partial k} : 0 = 0, \end{aligned}$$

implying that E can choose and combination of strategies s and k.

Equilibrium (III):

E chooses 'sign' after observing θ_1 with the probability s, and chooses 'sign' after observing θ_2 with the probability k such that

$$\begin{cases} \frac{s}{k} < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \frac{1-s}{1-k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 0$, L chooses 'accede' after observing 'not sign' with the probability $a = 1$.

In this case, E does not get political capital. The payoff of E does not depend on the choice of her strategies. We are not expecting this equilibrium to have an empirical relevance. Indeed, every E is rational and she is unlikely to choose the strategies that offer her zero payoff.

In the equilibrium (III) L gets a possibly noisy signal from E.

IV

We consider now the next possible equilibrium:

$$\begin{cases} \frac{s}{k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \frac{1-s}{1-k} < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

When both these conditions hold, $r = 1$ and $a = 0$.

In this case, expressions (8) and (9) are reduced to:

$$\frac{\partial \pi_E}{\partial s} : 1 = 1, \text{ and}$$
$$\frac{\partial \pi_E}{\partial k} : 1 = 1,$$

implying that E can choose any combination of strategies s and k.

In this case, E gets political capital. The payoff of E does not depend on the choice of her strategies. In the equilibrium (IV) L gets a possibly noisy signal from E.

Equilibrium (IV):

E chooses 'sign' after observing θ_1 with the probability s, and chooses 'sign' after observing θ_2 with the probability k such that

$$\begin{cases} \dfrac{s}{k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 1$, L chooses 'accede' after observing 'not sign' with the probability $a = 0$.

As a particular case, we consider a separating pure-strategy equilibrium: E chooses 'sign' after observing θ_1 with the probability $s = 1$, and chooses 'sign' after observing θ_2 with the probability $k = 0$.

In the separating pure-strategy equilibrium

$$\begin{cases} \dfrac{1}{0} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{0}{1} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

$$\begin{cases} \infty > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ 0 < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases},$$

implying that this equilibrium holds for any b_{1L}, b_{2L}, c_{1L} and c_{2L}.

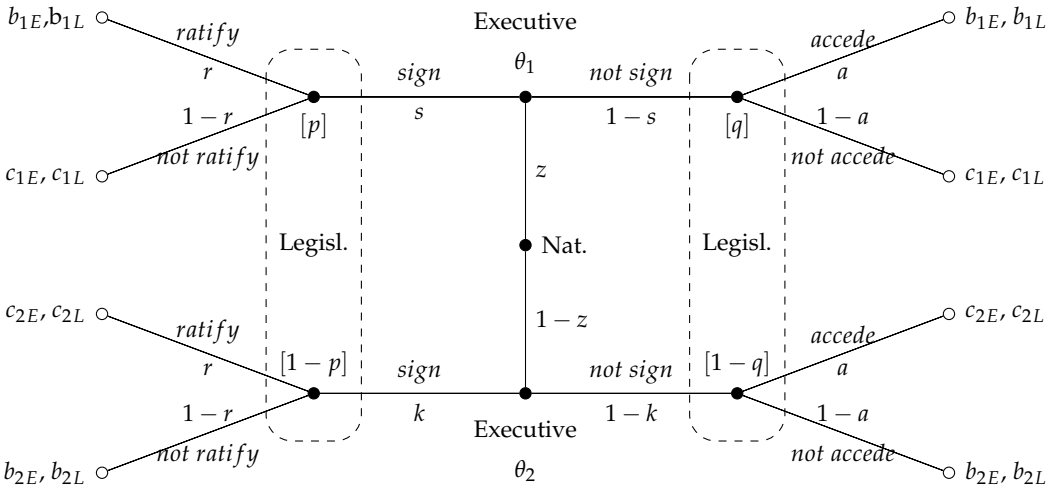
2.5.2 Model 2

The initial conditions for the Model 2 are the same as for the general model described above. In the Model 2 the Executive, E, chooses the probability, s, to play 'sign' when the state of the world is θ_1 and the corresponding probability, k, to play 'sign' when $\theta = \theta_2$.

The Legislature, L, chooses r, the probability of playing 'ratify' after observing 'sign', and a, the probability of playing 'accede' after 'not sign'.

Key parameters are b_{1j}, b_{2j}, c_{1j}, c_{2j} with $j \in \{E, L\}$. The other parameters are z, and μ. L's belief p of being at θ_1 rather than θ_2 given that L observes 'sign' and the corresponding belief, q, of being in θ_1 when observing 'not sign' are both derived using Bayes' rule and are functions of z, s and k.

For the purpose of these notes we let $\mu = 0$ and $z = \frac{1}{2}$.



The payoff for the Executive is:

$$\begin{aligned}\pi_E = z\left\{s\left(rb_{1E}+(1-r)c_{1E}\right)+(1-s)\left(ab_{1E}+(1-a)c_{1E}\right)\right\}\\ +(1-z)\left\{k\left(rc_{2E}+(1-r)b_{2E}\right)+(1-k)\left(ac_{2E}+(1-a)b_{2E}\right)\right\},\end{aligned}$$

Similarly, for the Legislature, we have - keeping in mind that $p=\frac{s}{s+k}$ and that $q=\frac{1-s}{2-s-k}$:

$$\begin{aligned}\pi_L = (sz+k(1-z))\left\{\frac{s}{s+k}\left(rb_{1L}+(1-r)c_{1L}\right)+\left(\frac{k}{s+k}\right)\left(rc_{2L}+(1-r)b_{2L}\right)\right\}\\ +((1-s)z+(1-k)(1-z))\left\{\frac{1-s}{2-s-k}\left(ab_{1L}+(1-a)c_{1L}\right)+\left(\frac{1-k}{2-s-k}\right)\left(ac_{2L}+(1-a)b_{2L}\right)\right\}.\end{aligned}$$

We are now going to discuss the first-order conditions for the associated maximization problems:

$$\max_{s,k}\pi_E, \text{ and } \max_{r,a}\pi_L.$$

Differentiating π_E with respect to s and k we get the following expression, which we have rearranged for ease of presentation:

$$\begin{aligned}\frac{\partial\pi_E}{\partial s}&: rb_{1E}+(1-r)c_{1E}\gtreqless ab_{1E}+(1-a)c_{1E};\\ \frac{\partial\pi_E}{\partial k}&: rc_{2E}+(1-r)b_{2E}\gtreqless ac_{2E}+(1-a)b_{2E}.\end{aligned}$$

$$\frac{\partial \pi_E}{\partial s} : r \gtreqless a; \tag{12}$$

$$\frac{\partial \pi_E}{\partial k} : r \gtreqless a. \tag{13}$$

The equation (12) implies that if the $>$ relationship holds then $s = 1$, if $<$ holds, $s = 0$, whereas any s solves the problem for FOC=0. The equation (13) has a reverse relationship, which implies that if the $>$ relationship holds then $k = 0$, if $<$ holds, $k = 1$, whereas any k solves the problem for FOC=0.

Differentiating π_L with respect to r and a we get, instead:

$$\frac{\partial \pi_L}{\partial r} : \frac{s}{s+k} b_{1L} + \frac{k}{s+k} c_{2L} \gtreqless \frac{s}{s+k} c_{1L} + \frac{k}{s+k} b_{2L};$$
$$\frac{\partial \pi_L}{\partial a} : \frac{1-s}{2-s-k} b_{1L} + \frac{1-k}{2-s-k} c_{2L} \gtreqless \frac{1-s}{2-s-k} c_{1L} + \frac{1-k}{2-s-k} b_{2L}.$$

After some algebraic transformations:

$$\frac{\partial \pi_L}{\partial r} \gtreqless 0 \iff \frac{s}{k} \gtreqless \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}}; \tag{14}$$

$$\frac{\partial \pi_L}{\partial a} \gtreqless 0 \iff \frac{1-s}{1-k} \gtreqless \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}}. \tag{15}$$

We can use similar interpretations to infer from the FOCs whether $r = 1$, 0 or any: the equation (14) implies that if the $>$ relationship holds then $r = 1$, if $<$ holds, $r = 0$, whereas any r solves the problem for FOC=0. The equation (15) implies that if the $>$ relationship holds then $a = 1$, if $<$ holds, $a = 0$, whereas any a solves the problem for FOC=0.

We can now use these four equations to characterize possible equilibria for this game.

I

We consider now the first possible equilibrium, when:

$$\begin{cases} \dfrac{s}{k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

When both these conditions hold, $r = 1$ and $a = 1$.

In this case, expressions (12) and (13) are reduced to:

$$\frac{\partial \pi_E}{\partial s} : 1 = 1, \text{ and}$$
$$\frac{\partial \pi_E}{\partial k} : 1 = 1,$$

implying that E may choose any combination of strategies s and k.

As particular cases, we consider two pooling pure-strategy equilibria, and two separating pure-strategy equilibria.

In the potential pooling pure-strategy equilibria: $s = 1$ and $k = 1$, or $s = 0$ and $k = 0$.

One of the conditions (14) and (15) is indeterminate (and off the equilibrium path), the other condition gives the following inequality:

$$1 > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}}$$

We note that from (1) the ratio $0 < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} < 1$. It means that this condition holds for any b_{1L}, b_{2L}, c_{1L} and c_{2L}.

Potential separating pure-strategy equilibria: $s = 1$ and $k = 0$, or $s = 0$ and $k = 1$ cannot exist.

Indeed, after plugging in $s = 1$ and $k = 0$, or $s = 0$ and $k = 1$ into equations (14) and (15), we get systems of inequalities that cannot hold together:

$$\begin{cases} \infty > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ 0 > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

and

$$\begin{cases} 0 > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \infty > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

It means that we can predict two pooling pure-strategy equilibria with $s = 1$ and $k = 1$, or $s = 0$ and $k = 0$.

Equilibrium (I):

a) E chooses 'sign' after observing θ_1 with the probability $s = 1$, and chooses 'sign' after

observing θ_2 with the probability $k = 1$ such that

$$\begin{cases} \dfrac{s}{k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} - \textit{off the equilibrium path} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 1$, L chooses 'accede' after observing 'not sign' with the probability $a = 1$.

b) E chooses 'sign' after observing θ_1 with the probability $s = 0$, and chooses 'sign' after observing θ_2 with the probability $k = 0$ such that

$$\begin{cases} \dfrac{s}{k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} - \textit{off the equilibrium path} \\ \dfrac{1-s}{1-k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 1$, L chooses 'accede' after observing 'not sign' with the probability $a = 1$.

II

We consider now the next possible equilibrium:

$$\begin{cases} \dfrac{s}{k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

This case is very similar to the equilibrium (1).

When both these conditions hold, $r = 0$ and $a = 0$.

In this case, expressions (12) and (13) are reduced to:

$$\frac{\partial \pi_E}{\partial s} : 0 = 0, \text{ and}$$
$$\frac{\partial \pi_E}{\partial k} : 0 = 0,$$

implying that E may choose any combination of strategies s and k.

However, considering particular cases with pooling and separating equilibria, we find the following:

In the potential pooling pure-strategy equilibria: $s = 1$ and $k = 1$, or $s = 0$ and $k = 0$.

One of the conditions (14) and (15) is indeterminate (and off the equilibrium path), the other condition gives the following inequality:

$$1 < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}},$$

which is not consistent with (1).

Potential separating pure-strategy equilibria: $s = 1$ and $k = 0$, or $s = 0$ and $k = 1$ also cannot exist.

Indeed, after plugging in $s = 1$ and $k = 0$, or $s = 0$ and $k = 1$ into equations (14) and (15), we get systems of inequalities that cannot hold together:

$$\begin{cases} \infty < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ 0 < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

and

$$\begin{cases} 0 < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \infty < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

Equilibrium (II):

does not exist.[16]

III

We consider now the next possible equilibrium:

$$\begin{cases} \dfrac{s}{k} < \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \dfrac{1-s}{1-k} > \dfrac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

[16]Given the assumption (1), the strategy 'not accede' and 'not ratify' are strictly dominated strategies for L. Indeed, if L chooses 'not ratify' and 'not accede' in each decision node, the payoffs for both agents are obviously less than in the equilibrium (I).

When both these conditions hold, $r = 0$ and $a = 1$.

In this case, expressions (12) and (13) are reduced to:

$$\frac{\partial \pi_E}{\partial s} : 0 < 1, \text{ and}$$
$$\frac{\partial \pi_E}{\partial k} : 0 < 1,$$

implying that $s = 0$ and $k = 1$.

We need to check that this is consistent with both conditions:

$$\begin{cases} \frac{s}{k} < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \frac{1-s}{1-k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

When we plug in $s = 0$ and $k = 1$:

$$\begin{cases} 0 < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \infty > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

implying that this equilibrium holds for any b_{1L}, b_{2L}, c_{1L} and c_{2L}.

Equilibrium (III):

E chooses 'sign' after observing θ_1 with the probability $s = 0$, and chooses 'sign' after observing θ_2 with the probability $k = 1$ such that

$$\begin{cases} \frac{s}{k} < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \frac{1-s}{1-k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 0$, L chooses 'accede' after observing 'not sign' with the probability $a = 1$.

IV

We consider now the next possible equilibrium:

$$\begin{cases} \frac{s}{k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \frac{1-s}{1-k} < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

When both these conditions hold, $r = 1$ and $a = 0$.

In this case, expressions (12) and (13) are reduced to:

$$\frac{\partial \pi_E}{\partial s} : 1 > 0, \text{ and}$$
$$\frac{\partial \pi_E}{\partial k} : 1 > 0,$$

implying that $s = 1$ and $k = 0$.

We need to check that this is consistent with both conditions:

$$\begin{cases} \frac{s}{k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \frac{1-s}{1-k} < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

When we plug in $s = 1$ and $k = 0$:

$$\begin{cases} \infty > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ 0 < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

implying that this equilibrium holds for any b_{1L}, b_{2L}, c_{1L} and c_{2L}.

Equilibrium (IV):

E chooses 'sign' after observing θ_1 with the probability $s = 1$, and chooses 'sign' after observing θ_2 with the probability $k = 0$ such that

$$\begin{cases} \frac{s}{k} > \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \\ \frac{1-s}{1-k} < \frac{b_{2L} - c_{2L}}{b_{1L} - c_{1L}} \end{cases}$$

L chooses 'ratify' after observing 'sign' with the probability $r = 1$, L chooses 'accede' after observing 'not sign' with the probability $a = 0$.

Equilibria (III) and (IV) provide the same payoff for both E and L, which is greatest for this model.

2.6 Appendix 2.

Table 3: Descriptive statistics.

Variable	Obs.	Mean	Stand. Dev.	Min	Max
ideology equilib	1,474	0.2591588	0.4383216	0	1
electoral cycle	1,098	2.176685	1.582068	0	6
democracy	1,432	0.2793296	6.918123	-10	10
years in office	1,472	8.637228	8.56797	1	45
share of industry	1,232	28.23328	12.11224	2.073173	84.79598
share of agriculture	1,240	18.50723	13.57897	0.1179066	76.53359
openness	1,303	69.80935	35.70204	0.0995824	376.2241
GDP	1,330	5.974507	10.37884	0.1643366	102.6686
GDP squared	1,330	143.334	583.2603	0.0270065	10540.85

Table 4: Correlation coefficients.

	ideol.equil	electoral cycle	democr	years in office	GDP	GDP sq	industry	agricult	trade openness
ideology equilibrium	1.0000								
electoral cycle	0.0251	1.0000							
democracy	0.0907	-0.1342	1.0000						
years in office	-0.0088	-0.1015	-0.4591	1.0000					
GDP	0.1711	-0.0333	0.2611	-0.0756	1.0000				
GDP squared	0.1144	-0.0326	0.1315	-0.0020	0.9022	1.0000			
share of industry	0.0233	0.0522	-0.0573	0.0225	0.1837	0.0483	1.0000		
share of agriculture	-0.1464	0.0291	-0.3602	0.1510	-0.5449	-0.3056	-0.5311	1.0000	
trade openness	0.0589	0.0329	0.0430	0.0217	0.1431	0.0796	0.2099	-0.2047	1.0000

Table 5: Variables description.

Variable (year of adoption)	Variable description	Source
democracy	A variable defines the level of democracy. It ranges from +10 (strongly democratic) to -10 (strongly autocratic)	Polity V Project (http://www.systemicpeace.org/inscrdata.html)
years in office	A number of years the chief executive has been in office	Inter-American Development Bank (2017) The Database of Political Institutions 2017 (DPI2017). Available at: https://publications.iadb.org/en/database-political-institutions-2017-dpi2017sthash.Zes0A737.dpuf
electoral cycle	A number of years left in current term. A "0" is recorded in an election year, n-1 is the year after an election, where n is the length of the term	Inter-American Development Bank (2017) The Database of Political Institutions 2017 (DPI2017). Available at: https://publications.iadb.org/en/database-political-institutions-2017-dpi2017sthash.Zes0A737.dpuf
GDP	Gross Domestic Product divided by midyear population in constant 2010 thousand US dollars	The World Bank Group (2019) https://data.worldbank.org/
trade openness	the sum of exports and imports of goods and services measured as a share of GDP	The World Bank Group (2019) https://data.worldbank.org/
share of agriculture	a share of agricultural production in GDP	The World Bank Group (2019) https://data.worldbank.org/
share of industry	a share of industrial production in GDP	The World Bank Group (2019) https://data.worldbank.org/

2.7 Appendix 3.

Table 6: Estimation results. GDP linear model.

	(1) ideol_equil	(2) ideol_equil	(3) ideol_equil	(4) ideol_equil	(5) ideol_equil
electoral cycle	0.0661	0.129**	0.0941	0.172**	0.198***
	(0.193)	(0.032)	(0.102)	(0.016)	(0.003)
democracy	0.0176	0.0353	0.00301	0.0221	
	(0.277)	(0.234)	(0.878)	(0.533)	
years in office	0.0138	0.0176	0.00317	0.00805	
	(0.262)	(0.303)	(0.831)	(0.692)	
GDP	0.0292**	0.0296	0.0262*	-0.0124	0.0136
	(0.016)	(0.528)	(0.065)	(0.847)	(0.673)
share of industry	-0.0122	-0.0522***	-0.00520	-0.0599**	-0.0529**
	(0.198)	(0.008)	(0.640)	(0.016)	(0.016)
share of agriculture	-0.0199**	-0.0342	-0.0137	0.0170	
	(0.037)	(0.113)	(0.196)	(0.545)	
trade openness	0.00197	0.000106	-0.00304	-0.00575	
	(0.412)	(0.986)	(0.294)	(0.420)	
No.Obs.	889	823	861	795	840
No.Countries	85	73	85	73	77
No.Treaties	10.5	11.3	10.1	10.9	10.9
PseudoR2	0.032	0.129	0.173	0.259	0.243
Prob > chi2	0.000	0.000	0.000	0.000	0.000
Country FE	-	*	-	*	*
Treaty FE	-	-	*	*	*

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Estimation results. Trade openness.

	(1) ideol_equil	(2) ideol_equil	(3) ideol_equil	(4) ideol_equil
electoral cycle	0.0523	0.113*	0.0794	0.165**
	(0.316)	(0.067)	(0.179)	(0.025)
democracy	0.0110	0.0262	-0.00331	0.0237
	(0.527)	(0.395)	(0.873)	(0.519)
years in office	0.0117	0.0184	0.00715	0.00940
	(0.369)	(0.314)	(0.643)	(0.661)
GDP	0.0191	0.0958	0.0660	0.184
	(0.641)	(0.453)	(0.193)	(0.335)
GDP squared	-0.000290	-0.00264	-0.00133	-0.00535
	(0.725)	(0.286)	(0.195)	(0.164)
share of industry in GDP	-0.0110	-0.0623***	-0.00525	-0.0790***
	(0.265)	(0.004)	(0.649)	(0.005)
share of agriculture in GDP	-0.0184*	-0.0511**	-0.0112	-0.0213
	(0.099)	(0.047)	(0.367)	(0.524)
trade openness	0.00423	0.00756	0.00108	0.00690
	(0.318)	(0.439)	(0.833)	(0.571)
low gni	-0.404	0.0309	0.187	0.607
	(0.353)	(0.964)	(0.720)	(0.461)
low gni*openness	-0.00252	-0.00519	-0.00670	-0.0128
	(0.637)	(0.561)	(0.297)	(0.242)
No.Obs.	864	803	838	777
No.Countries	85	73	85	73
No.Treaties	10.2	11.0	9.9	10.6
PseudoR2	0.0422	0.1413	0.1831	0.2675
Prob > chi2	0.000	0.001	0.000	0.000
Country FE	-	*	-	*
Treaty FE	-	-	*	*

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3 Application of the Cox proportional hazards model with time-varying covariates for the estimation of the factors that affect the ratification timing.

3.1 Introduction to Chapter 3.

In the second chapter, we focus on the interaction of domestic institutions at the stages of signature and ratification in the post-negotiation period, which is crucial for the transformation of the international treaty terms to domestic policy and largely defines the success of the treaty. The signature is studied as a signal that an office-motivated Executive sends to the Legislature. The Legislature observes the message sent by the Executive, and then chooses an action according to his conditional beliefs. The Executive's motivation changes within the electoral cycle: the Executive is more office-motivated at the end of the electoral cycle, and more ideology-motivated at the beginning of it.

Our findings demonstrate that the electoral incentives of the Executive affect the decisions made by both key players, and the outcome in the treaty-making process. The results deepen the understanding of the post-negotiation period and the factors that lead to delay in the ratification of the treaty, or the failure of it in case of being not ratified by the required number of countries.

In the third chapter, we further look into the role of signature in the post-negotiation period and study its effect on the ratification decision. We are doing that by analysing signature as a step that connects two milestones: negotiations and ratification.

First, we estimate the overall effect that signature has on the subsequent ratification. Using a duration model in which time is measured on a daily basis, we test the hypothesis that the probability of ratifying an IEA is greater if it is preceded by signature. Furthermore, we assess the magnitude of that effect depending on the type of Executive who has signed the treaty: the Executive who negotiated a treaty, and the Executive who has not taken part in the negotiations.

3.2 Conceptual framework.

The idea that signature may serve as a signal to other states or domestic actors about the leader's intentions is not novel. One of the recent papers that studies the signature as a signal is a paper by Hugh-Jones et al. (2018). They introduce a model where executives, having access to information, form their summed expertise during negotiations. This expertise is

revealed to domestic actors through the signature as a signaling device. The greater the weight of international opinion signaled by initial signatures, the greater the likelihood of a legislature ratifying a treaty.

Their model estimates the effect of international factors, namely, the pooled expertise of states initially signing environmental treaties on the decision of the domestic veto players. In our work, we also argue that signature can provide a signal to domestic veto players that the issue under consideration is important, which may persuade them to ratify the treaty. However, we mostly focus on the domestic factors that may define the magnitude of this signal and affect the subsequent ratification. Our empirical analysis aims to estimate the magnitude of that signal depending on the type of Executive who has signed the treaty.

The role of signature is largely defined by its position on the treaty-making timeline: this step connects negotiations and ratification. Treaties are signed after the negotiations, and the executives (or their representatives) are involved in both. However, not all signatures are done immediately after negotiations. Instead, we may observe a signature that is made later and or by a different Executive. In this chapter, we try to understand in what way the signature may affect the timing of ratification and distinguish between the types of Executives who sign an agreement - negotiator versus non-negotiator.

The motivation of the Executive who has negotiated a treaty may be explained by the concept of the two-level game presented in Putnam (1988). In his model, a negotiator becomes involved in a bargain between international and domestic politics. On the one hand, a negotiator takes part in the negotiations that connect various interests of different countries and their leaders in order to achieve a trade-off on debating points and to tailor an agreement to the needs of the negotiators; on the other hand, the Legislature may provide certain conditions to be met for ratification, and the negotiator has to find the optimal terms to present at the negotiations. By signing a treaty after the negotiations, in which the Executive has taken part, she may signal to the ratifiers that their conditions for ratification are met.

The other type of Executive is the one who has not participated in the negotiations. It may mean that the negotiator has not reached the conditions required to ratify. However, the next Executive may sign a treaty when she considers a country to be ready to change national environmental laws, that previously were not compliant with the treaty provisions.

To test the effects of signing on the likelihood of treaty ratification, we use the Cox proportional hazards regression model. Hugh-Jones et al. (2018) employ similar model in their study, however, the time scale is measured in years while we use observations which are measured in days. This approach allows us to use the information about the exact dates of signature and ratification and construct the observations with more accuracy.

3.3 Empirical model description.

We use the Cox proportional hazards model due to its versatility: it allows us to assess simultaneously the effect of several risk factors on the survival time (in comparison with other duration models which describe the survival according to one factor under investigation), moreover, it works for both quantitative predictor variables and categorical variables. For the construction of the dataset, we employ the time scale measured in days. The data takes the form of treaty-country-year observations.

The ratification process of a given treaty is seen as a failure time process; units (countries) are observed from a specific date (the date of treaty adoption), survive for some length of time, and then 'fail' (ratify) or are censored (had not yet ratified in 2017).

The model allows us to examine how specified factors influence the hazard rate of treaty ratification happening at a particular point in time.

The Cox model is expressed by the hazard function denoted by h(t), which can be interpreted as the risk of failing at time t. It can be estimated as follows:

$h(t) = h_0(t)exp(b_1x_1 + b_2x_2 + \ldots + b_px_p)$ where,

t represents the survival time;

$h(t)$ is the hazard function determined by a set of p covariates $(x_1, x_2, \ldots, x_p)$

the coefficients $(b_1, b_2, \ldots, b_p)$ measure the impact (i.e., the effect size) of each covariate.

h_0 is the baseline hazard. It corresponds to the value of the hazard if all the x_i are equal to zero (the quantity $exp(0)$ equals 1). The t in $h(t)$ means that the hazard may vary over time.

As quantitative predictors, we use the economic and political characteristics of countries. The description of economic and political variables is presented in Appendix 4.

Our independent variables vary through time, and the empirical model allows us to take into account these changes. We construct our dataset as multiple-record data. The similar approach is employed in Cazals and Sauquet (2015). In their paper, they assess when leaders are more likely to ratify international environmental agreements: during pre- or post-electoral period.

Table 8 provides an example of the dataset construction for one country in one treaty. Each treaty enters the analysis on the day of the treaty adoption. Each observation ends when the value of a covariate changes or when the country ratifies the treaty. In the latter case, the observation ends at the ratification date. For the ratification date, we consider the date on which one of the following instruments has been deposed: accession, acceptance/approval,

or ratification. Ratification equals 0 for the first observation. Mechanically, this removes the subject from the data at the end date and the country is treated as censored. The next record adds the country back into the data with new characteristics.

Table 8: Dataset construction (example).

Treaty_ID	Country code	start date	end date	Signature	Ratification	GDP per capita
3	BEL	0	165	0	0	34568
3	BEL	166	365	1	0	34568
3	BEL	366	632	1	1	35068

We observe a failure (ratification) at day 632, signature at day 165, and independent variables that change at the end of each year (day 365), such as the GDP per capita of the country, or level of democratization. This is equivalent to three independent observations: one started at zero but was censored at 165; the next started at 166 and was censored at 365; the third started at 366 and was observed to fail at 632. Information concerning a given country-treaty pair will therefore be split into several independent observations.

Our estimating equations take the general form:

$$h(t|x_j)=\mathrm{h}_{0a}(t)exp(b_1 Signature_j + b_2 within_j + b_3 out_j + b_4 GDPpc_j + b_5 democracy_j + b_6 elec_j + b_7 trade_j) \quad (16)$$

where t is the time scale measured in days; j is a unit of observation.

Although each observation includes a country-treaty-year dimension, we do not index them by three different subscripts, because during one year a treaty can be signed and later in the same year the covariate changes, which creates two separate observations for the same country-treaty-year combination and makes the triple index not unique for observations.

In our empirical model, we allow the baseline hazard functions to differ for the treaties (a). This is equivalent to fitting separate Cox proportional hazards models under the constraint that the coefficients are equal but the baseline hazard functions are not.

We begin our analysis with estimating a model with a dummy variable 'Signature', which is equal to 'one' if the observed country has signed the treaty before, irrespective of the time of signature. Then we estimate the effect of signature on the ratification timing according to the type of Executive. If a treaty is signed within the same electoral cycle as treaty adoption, the Executive (or her representative) is likely to have participated in the negotiations. The terms of the treaty are negotiated with a focus on the subsequent ratification, and account for the

Legislature's preferences (see, for example, Putnam (1988), Hugh-Jones et al. (2018)). Moreover, if the Legislature ratifies a treaty within the same electoral cycle as its signature, the Executive may get electoral support in the coming election (the model discussed in Chapter 2). We expect that signature made soon after the negotiations by the Executive who has participated in the negotiations, may serve as a strong signal of issue importance to domestic ratifiers and accelerate ratification.

Alternatively, signature, which takes place in an electoral cycle different from the treaty adoption is made by the Executive, who is less likely to have been involved in the process of negotiations. In this case, by signing in an electoral cycle different from treaty adoption, she may signal that it is the right time for the country to implement the environmental policy. Signature made at a later stage by the Executive who has not taken part in the negotiations, may also serve as means to gain political capital if ratification takes place within the same electoral cycle as signature. (the model discussed in Chapter 2). In order to estimate the magnitude of the signal conveyed to domestic ratifiers, we construct two dummy variables that differ in the time of signature in relation to the date of treaty adoption: whether the treaty adoption and signature take place within the same electoral cycle, or the treaty is signed in a different electoral cycle. We assume that the date of treaty adoption marks the end of the negotiations.

1) a dummy variable 'within_elec' is equal to 'one' if a country signs a treaty in the same electoral cycle as its adoption, and zero otherwise. In this case we conjecture that the Executive has taken part in the negotiations.

It takes a value 'one' for the country which signs a treaty within the same electoral cycle as its adoption for all the observations from the date of signature till the end of observations for the country within the treaty.

2) a dummy variable 'out_elec' is equal to 'one' if a country signs a treaty in the electoral cycle which is different from the electoral cycle of its adoption, and zero otherwise. In this case we conjecture that the Executive has not taken part in the negotiations.

It takes a value 'one' for the country, which signs a treaty in the electoral cycle different from the electoral cycle of its adoption, from the date of signature till the end of observations for the country within the treaty.

As a basis for the dummies construction, we use the annual data from the Inter-American Development Bank dataset (2017). The full electoral cycle is taken from the first year after an election and till the year of election.

As a reference category in our analysis we take the treaties that have never been signed.

The reference category is not included in the model in order to avoid the situation of perfect multicollinearity.

3.4 Baseline results.

The regressions are run on a dataset of 203 countries that face the decision to commit to 52 IEAs during the 1975–2017 period. We estimate a Cox proportional hazards model and report coefficients and hazard ratios. Our baseline results are presented in Table 9 and Table 10.

We first report estimates computed on the full sample that we then split into developing and developed countries, and treaties with open and restricted membership.

Developing and developed countries are distinguished according to the World Bank classification on income levels of countries. Countries that are low- and middle-income are categorized as developing, whereas high-income countries are classified as developed. The World Bank methodology uses gross national income (GNI) per capita data in U.S. dollars, converted from local currency using the World Bank Atlas method, which is applied to smooth exchange rate fluctuations.

Table 9 presents the results of the estimation of the model specified in Equation (16). The baseline model includes the variable 'Signature' to capture the impact of treaty signature following adoption, as well as the control variables. The first column of the table contains the coefficient estimates and the second column presents the corresponding hazard ratios. The coefficient estimates represent the increase in the expected log of the relative hazard for each one unit increase in the predictor, all else equal. The hazard ratios are computed by exponentiating the coefficient estimates. For 'Signature', for example, exp(0.400) = 1.492. Signing a treaty leads to an increase of 49.2% in the hazard rate relative to the situation when a treaty is not signed.

The second set of results in Table 9 refers to a similar model run on the same set of control variables, with the inclusion of two different variables for signature. 'within_elec' indicates whether the treaty has been signed by the same executive who took part in the treaty negotiations, whereas 'out_elec' informs us that an election took place between the treaty adoption and the act of signing.

For completeness, in Table 10 we report the results of re-running the models discussed above after splitting the sample along two dimensions. The first four columns present the hazard ratios for the sample of lower and higher-income countries, respectively. The idea here is that countries at different levels of economic development might exhibit different levels of

Table 9: General model: Cox PH model.

	Coefficient	Hazard Ratio	Coefficient	Hazard Ratio
Signature	0.400***	1.492***	–	–
	(0.065)	(0.097)	–	–
Within_elec	–	–	0.427***	1.533***
	–	–	(0.066)	(0.102)
Out_elec	–	–	0.366***	1.443***
	–	–	(0.088)	(0.127)
Per-capita GDP	0.007***	1.007***	0.007***	1.007***
	(0.002)	(0.002)	(0.002)	(0.002)
Trade openness	0.0004	1.0004	0.0004	1.0004
	(0.001)	(0.001)	(0.001)	(0.001)
Democracy	0.015***	1.015***	0.015***	1.015***
	(0.005)	(0.005)	(0.005)	(0.005)
Time to next election	-0.019	0.981	-0.019	0.981
	(0.016)	(0.016)	(0.016)	(0.016)
No.Observations	16,105	16,105	16,105	16,105
No.Subjects[†]	2,372	2,372	2,372	2,372
No.Failures	2,059	2,059	2,059	2,059
Equality test[††]	–	–	0.68	–
p-value	–	–	(0.408)	–

Notes: Cox PH estimations with stratification of the baseline hazard by treaties.

The dependent variable is the number of days from the date of treaty adoption till the date of ratification

Standard errors associated with the reported coefficients and hazard ratios are in parentheses.

[†] Subject is a country in a treaty.

[††] The test is for the null hypothesis of equality between the coefficient of 'within_elec' and 'out_elec'

Significance level denoted by * for $p < 0.10$, ** for $p < 0.05$, *** for $p < 0.01$

sensitivity to the signature signal. Similarly, in columns (5)-(8), we replicate the analysis using the subset of open- and restricted-membership treaties, respectively. We suspect that the strength of the signal provided by the signature may be strongest when it relates to a much more complex, open-membership treaty.

Table 10: General model for split samples. Hazard Ratios.

	Lower Income (1)	Lower Income (2)	Higher Income (3)	Higher Income (4)	Open treaties (5)	Open treaties (6)	Restricted treaties (7)	Restricted treaties (8)
Signature	1.556***		1.266**		1.516***		1.451**	
	(0.140)		(0.130)		(0.110)		(0.215)	
within_elec		1.590***		1.300**		1.541***		1.570***
		(0.150)		(0.133)		(0.115)		(0.233)
out_elec		1.623***		1.195		1.469***		1.396**
		(0.215)		(0.153)		(0.145)		(0.276)
Per-capita GDP	0.984	0.983	1.007***	1.007***	1.006***	1.006***	1.010***	1.010***
	(0.023)	(0.023)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Trade openness	0.9996	0.9996	1.001	1.001	1.0002	1.0002	1.002	1.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Democracy	1.004	1.004	1.036***	1.036***	1.018***	1.018***	0.997	0.995
	(0.006)	(0.006)	(0.010)	(0.010)	(0.005)	(0.005)	(0.013)	(0.013)
Time to next election	0.992	0.991	0.991	0.991	0.989	0.989	0.950	0.949
	(0.022)	(0.022)	(0.025)	(0.025)	(0.018)	(0.018)	(0.035)	(0.035)
No.Observations	7,786	7,786	7,932	7,932	10,883	10,883	5,222	5,222
No.Subjects	1,236	1,236	1,262	1,262	1,742	1,742	630	630
No.Failures	981	981	1,029	1,029	1,548	1,548	511	511

Notes: Cox PH estimations with stratification of the baseline hazard by treaties.
The dependent variable is the number of days from the date of treaty adoption till the date of ratification.
Subject is a country in a treaty.
Standard errors associated with the reported hazard ratios are in parentheses.
Significance level denoted by * for $p < 0.10$, ** for $p < 0.05$, *** for $p < 0.01$

1) Dummy variable 'Signature'.

Treaties are mostly signed in the first year after their adoption. The descriptive statistics support that: the number of observations with signature taking place within the same electoral cycle as treaty adoption is approximately five times higher than the number of observations when a treaty is signed in a different electoral cycle. We also observe a strong positive correlation between the dummy variable 'Signature' and 'within_elec' ($r_{Signature;within\_elec} = 0.8124$).

The dummy variable 'Signature' has a positive impact on the ratification speed, and is statistically significant at 99% confidence level (Table 9, Column (2)). Holding the other covariates constant, signature increases the likelihood of treaty ratification by 49.2 percent.

The results show that signature may lead to a time reduction between treaty adoption and subsequent ratification of IEAs.

Columns (1) and (3) of Table 10 confirm that the impact of signing on the speed of ratification is higher for lower-income countries. This is due to the fact that for less developed countries, the benefits derived from IEAs are likely higher than for more developed countries and linked to their integration in world politics and trade. This result also chimes with the discussion in Cazals and Sauquet (2015), who argue that higher-income countries often perceive participation in IEAs as an unnecessary constraint imposed on domestic economic agents, similar to the imposition of a new tax. At the same time, we observe no significant difference in hazard ratios between different types of treaties.

2) Signature within the same electoral cycle as treaty adoption.

Column (4) of Table 9 demonstrates that for the whole sample the hazard ratio for the variable 'within_elec' is greater than 1 and is significant at 99% confidence level. The ratification hazard is higher by 53.3% for the treaties where adoption and signature take place in the same electoral cycle than for the treaties that have never been signed, all else equal. The results for the variable are consistent across all specifications. In Table 10 the lowest hazard ratio of 1.300 is obtained in the sample of developed countries. It is in line with the results for the variable 'signature' and similarly may be explained by the idea presented in Cazals and Sauquet (2015) that participation in an environmental agreement for developed countries is often perceived as a constraint imposed on domestic economic agents and is sometimes considered to have an impact similar to the adoption of a new tax. Another reason for the lower hazard rate may be the fact that developed countries are mostly democratic with open pluralistic systems where the delay in ratification may be the result of the public debate and negotiation that ensues (Spector and Korula, 1993). It is supported by a moderate level of correlation between GDP per capita and the level of democratization $r_{GDPpercapita;democracy} = 0.4586$.

3) Signature in a different electoral cycle.

Column (4) in Table 9 reveals that the ratification hazard is lower if adoption and signature happen in different electoral cycles than if they happen in the same electoral cycle. It may mean the weaker signal of issue importance to the Legislature. If a treaty is signed in the different electoral cycle as its adoption, the ratification hazard is 1.443.

However, after conducting the coefficient equality tests for the variables 'within_elec' and 'out_elec', we observe that the test 'within_elec = out_elec' is not significant for all specifications. The results demonstrate that signature has the same effect on the subsequent ratification irrespective of the signature timing: within the same electoral cycle as its adoption, or

in a different electoral cycle.

Interestingly, the variable loses its significance in the sample of higher-income countries (Table 10, Column (4)), demonstrating that for developed countries signature acts as a 'cheap talk' if delivered by a non-negotiator and it does not affect the probability of ratification.

Finally, all of our control variables affect international cooperation in the direction expected. The hazard ratio for a continuous variable is interpreted as the proportional change in hazard when the variable increases by 1 unit, all else equal.

4) The level of democratization.

The variable 'democracy' ranges from +10 (strongly democratic country) to -10 (strongly autocratic country). In our sample, democratic countries with a positive level of democratization make up a proportion of over 60% of all observations. About half of them are countries with a very high level of democratization with scores 9 and 10. It demonstrates that democratic countries are actively involved in international environmental activity.

If the level of democratization increases by 1, the proportional change in ratification hazard increases by 1.5% for the whole sample, all the other explanatory variables are held fixed (Table 9, Column (2)). However, the coefficient is not significant for treaties with restricted membership. It means that the speed of ratification in these treaties does not depend on the form of government or its change, hinting at the fact that global environmental treaties may be more politically salient, and therefore more likely to be ratified, in democratic societies. Conversely, treaties with restricted membership, which typically deal with local environmental issues, are likely to be decided upon, irrespective of the degree of democracy.

5) Time within the electoral cycle.

The variable shows the number of years left in the current term for the Executive. The results in Table 9 and Table 10 show no evidence that time within the electoral cycle affects the ratification timing. The coefficients are insignificant in all the specifications.

Our results do not support the findings of Cazals and Sauquet (2015), who found that developed country leaders tend to delay ratification to the post-election period, while for developing countries the ratification hazard is higher in the pre-election time.

This is due to the difference in variables construction and datasets used: Cazals and Sauquet (2015) exploit precise election dates to build the variables of interest, namely, pre- and post-election dummies, while we use annual electoral variables as control variables. The analysis may be improved if to include in our dataset the exact dates of elections.

6) Economic variables.

The coefficients for GDP per capita are significant in all the specifications except low-income countries, which means that the likelihood of a treaty ratification increases with the level of affluence. However, the hazard ratios in all the specifications are close to 1, meaning that the response of the hazard rate to changes in GDP per capita is quite sluggish. An increase in GDP per capita by 1,000 US$ leads to less than a 1% increase in the hazard rate. The level of economic development does not have impact on the ratification timing for the countries with low income.

Trade openness does not seem to statistically affect the ratification decision, all else equal.

Interesting results are obtained when comparing two sub-samples of developing and developed countries. Variables GDP and Democracy lose their significance for the group of countries with lower income, while ratification timing in the developed countries seem to be sensitive to these factors. In particular, political economy factors may be more important for developed countries, driving a wedge between the interests of the executive and the legislature. The misalignment in ideology or political objectives between the national executive and legislature also varies depending on the quality of domestic institutions. The degree of independence from the executive enjoyed by the national legislative body, for example, is likely to be correlated to the level of democracy, thus making ratification more complex process. At the same time, the level of economic development is important for the ratification timing if a country is classified as a high income country.

3.5 Tests of the proportional-hazards assumption.

The Cox proportional hazards model is a semiparametric model, where the effect of the covariates is still assumed to take a certain form, but no parametric form of the survivor function is specified. In the Cox model, the covariates are assumed to multiplicatively shift the baseline hazard function (Cleves, 2010).

The main assumption of the Cox model is the proportional hazards (PH) assumption: the ratio of the hazards for any two individuals is constant over time. In this section we are going to test this assumption using the information mainly from Cleves (2010) and STATA manuals.

Our main variable of interest is a categorical variable 'signature', and first we plot the Kaplan-Meier survival distribution as a function of survival time for each level of the covariate 'signature' (Figure 3). We present the results for different subsamples. Notably, in all the graphs we observe diminishing treatment effect when the hazard ratio decreases over time. Moreover, in all samples, while the curves start by drifting apart, they eventually draw

closer and around different points in time they intersect, indicating that the PH assumption is violated.

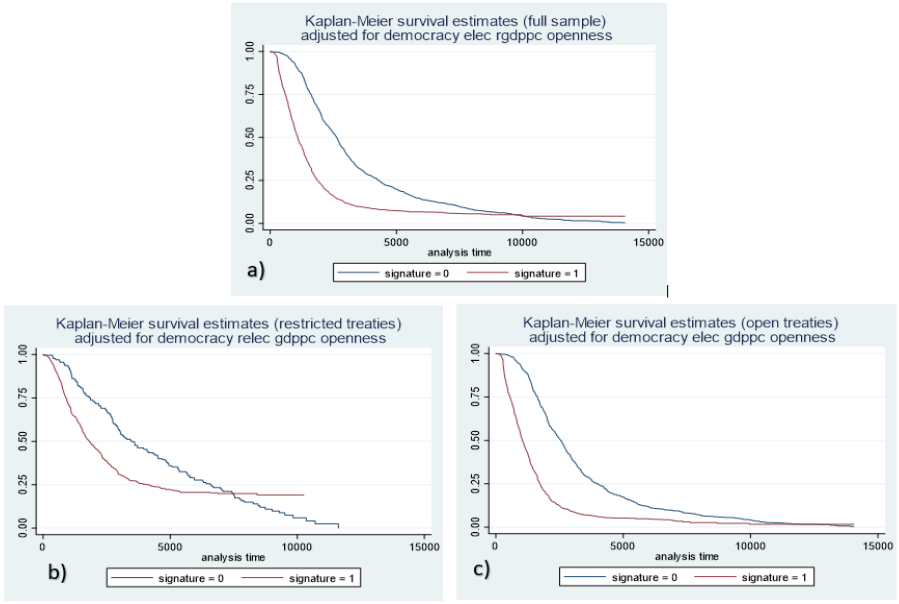


Figure 3: Kaplan-Meier survival curves for a) full sample; b) treaties with restricted membership; c) treaties with open membership.

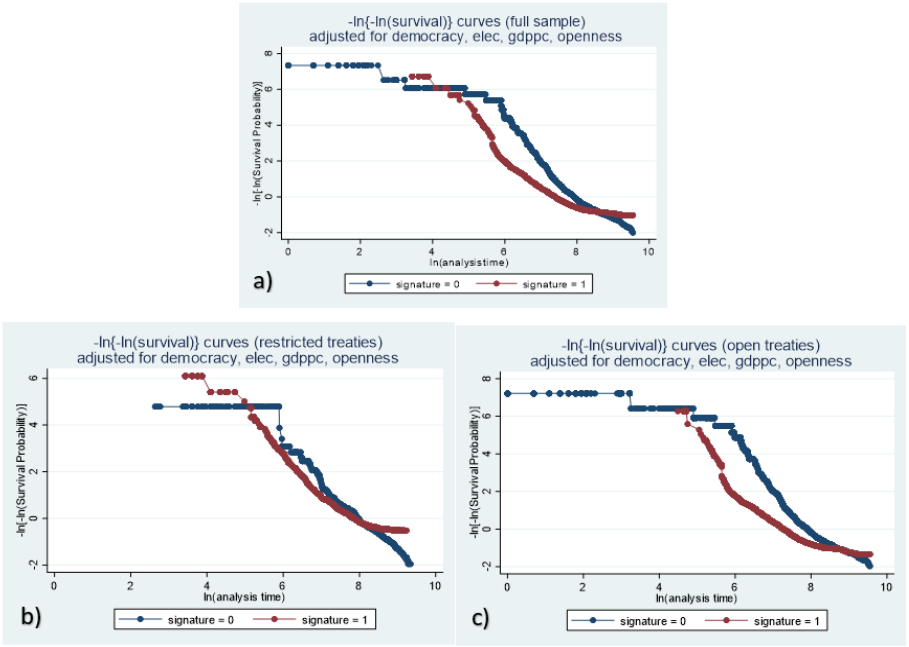


Figure 4: -ln (-ln(survival) curves for a) full sample; b) treaties with restricted membership; c) treaties with open membership.

We also plot the transformed Kaplan-Meier survival curves -ln (-ln (survival)) as a function

of the log survival time using *stphplot* command. If the PH assumption is satisfied, the curves are expected to be approximately parallel. However, in Figure 4 we see that the lines are not parallel and the PH assumption is violated.

Another graphical method to evaluate the PH assumption is to compare the observed Kaplan-Meier curves with the Cox predicted curves for the same variable. In STATA this plot is produced with *stcoxkm* command. We compare the Kaplan-Meier curve and the Cox curve for signed versus non-signed treaties. Separate plots for each level of variable 'Signature' are presented in Figure 5. Although we observe no considerable differences between the observed and predicted values, the curves cross each other, which means that the PH assumption is violated. [17]

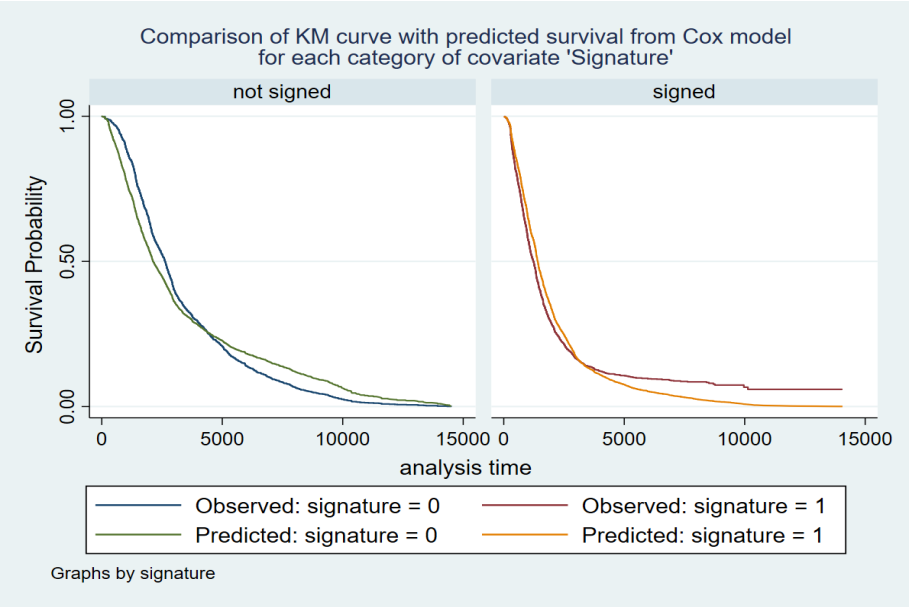


Figure 5: Comparison Kaplan-Meier and Cox curves.

Although graphical methods of evaluating the PH assumption are very popular tools to detect the problem, it is important to support the results with numerical methods. We begin with the test based on Schoenfeld residuals using the command *estatphtest*. It tests the PH assumption on the basis of Schoenfeld residuals after fitting a model with *stcox*. [18]

Schoenfeld residuals are calculated at every failure time under the PH assumption. They are defined as the covariate value for the individual that failed minus its expected value

[17] Here we present the test results only for the model with 'signature' variable. The results are similar and following the same patterns for the model with variables 'within_elec' and 'out_elec'

[18] The test of the PH assumption is based on the principle that the assumption restricts $\beta(t_j) = \beta$ for all t_j for a given regressor. This implies that a plot of $\beta(t_j)$ versus time has a slope of zero. Grambsch and Therneau (1994) showed that $E(s_j^*) + \hat{\beta} \approx \beta(t_j)$, where s_j^* is the scaled Schoenfeld residual at failure time t_j and $\hat{\beta}$ is the estimated coefficient from the Cox model. Thus a plot of $s_j^* + \hat{\beta}$ versus some function of time provides a graphical assessment of the assumption.

assuming the hypotheses of the model hold (Bellera et al., 2010).

In Table 11 we present the results for the full sample, and for treaties with open and restricted membership. Variables 'signature', 'GDPpc' and 'openness' violate the PH assumption in the full sample. The global test suggests strong evidence of non-proportionality ($p<0.01$).

Table 11: Test for non-proportionality based on the scaled Schoenfeld residuals.

1. Full sample.				
Variable	rho	chi2	df	Prob > chi2
Signature	-0.17453	71.12	1	0.0000
GDPpc	-0.05130	6.05	1	0.0139
Openness	0.04531	3.95	1	0.0469
Democracy	0.02026	0.92	1	0.3379
Electoral cycle	0.02153	1.02	1	0.3133
Global test		101.70	5	0.0000
2. Treaties with restricted membership.				
Variable	rho	chi2	df	Prob > chi2
Signature	-0.24342	32.90	1	0.0000
GDPpc	-0.06690	2.82	1	0.0933
Openness	0.07133	2.29	1	0.1302
Democracy	0.15886	13.58	1	0.0002
Electoral cycle	0.02167	0.27	1	0.6024
Global test		45.93	5	0.0000
3. Treaties with open membership.				
Variable	rho	chi2	df	Prob > chi2
Signature	-0.16384	47.74	1	0.0000
GDPpc	-0.04787	3.85	1	0.0497
Openness	0.03712	2.06	1	0.1514
Democracy	-0.00693	0.08	1	0.7761
Electoral cycle	0.02337	0.89	1	0.3466
Global test		72.20	5	0.0000

Figure 6 shows a scatter of $s_j^* + \hat{\beta}$ for the variable 'Signature' versus analysis time, $\_t$. A slope significantly different from zero, this gives evidence against proportionality: a decreasing trend indicates a decreasing hazard ratio over time.

Schemper (1992) suggests the following methods of analysis in case of non-proportionality of hazards:

- stratification of a model by a covariate with non-proportional hazards;

- separate models for disjunct time periods;

- the use of time-dependent covariate terms in a model.

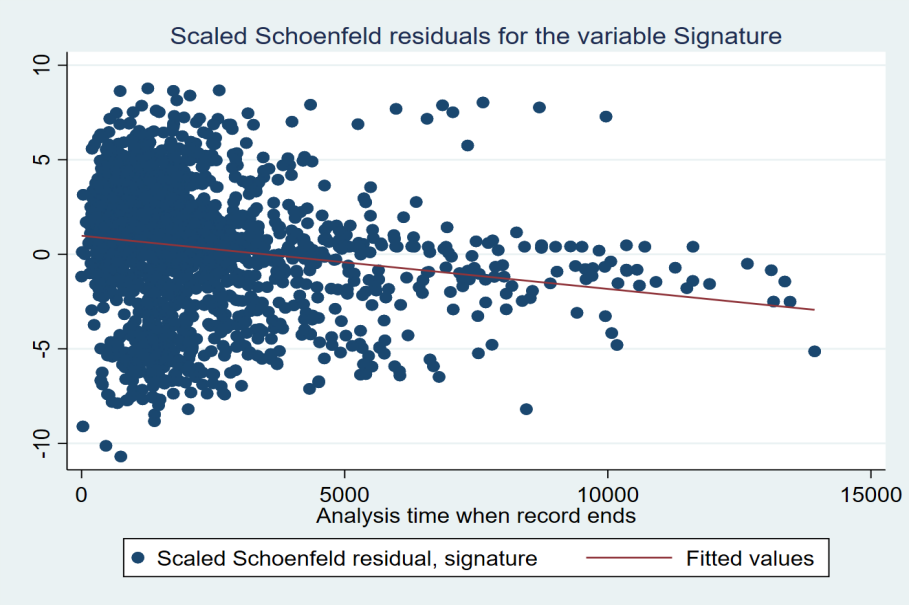


Figure 6: Scaled Schoenfeld residuals for the variable Signature.

The first option is to stratify by the variable for which the PH assumption is violated, in our case the main variable of interest 'Signature'. Each stratum has a distinct baseline hazard but common values for the coefficient vector assuming that the other covariates act in the same way in each stratum, that is, hazard ratios are similar across strata. Bellera et al. (2010) point out that although stratification is effective in removing the problem of non-proportionality and simple to implement, it has some disadvantages. Most importantly, stratifying by our main variable of interest, we cannot quantify its effect on the dependent variable.

The second option is also mentioned in Bellera et al. (2010) which is to test time-varying effects of covariates by fitting different Cox models for different time periods, for example, for a shorter time window. In Bellera et al. (2010), two subsets of data are created based on the median event time. A first subset is created by censoring everyone still at risk beyond this time point, and a second one by considering only those subjects still at risk thereafter.

We tried different cut-off points of time to identify time intervals for which the PH assumption holds. For example, for the observations within the 1995-2005 period, we obtained the results that support our main hypothesis that signature increases the likelihood of treaty ratification; a further test based on Schoenfeld residuals demonstrates that the PH assumption on the given time interval holds. (Table 12, Columns (2) and (4) show p-values of the test for non-proportionality based on the scaled Schoenfeld residuals for each covariate in the models). We observe higher coefficients than in the full sample (Table 9), predicting a stronger effect of signature on the ratification timing. However, the interpretation of the models in Table 12 within a restricted time interval is conditional on the length of the survival time,

and results should thus be interpreted with caution.

Table 12: General models for the period 1995-2005.

	(1) Coeff.	(2) Test of PH p-value	(3) Coeff.	(4) Test of PH p-value
signature	0.601***	0.2111		
	(0.0901)			
within_elec			0.578***	0.2744
			(0.0919)	
out_elec			0.626***	0.3980
			(0.123)	
GDPpc	0.00555**	0.1510	0.00553**	0.1473
	(0.00230)		(0.00230)	
openness	0.00112	0.2256	0.00110	0.2169
	(0.000726)		(0.000727)	
democracy	0.0115*	0.3753	0.0113	0.3646
	(0.00692)		(0.00694)	
electoral cycle	-0.0295	0.9595	-0.0296	0.9687
	(0.0241)		(0.0242)	
Global test		0.3293		0.4806
N	7271	7271	7271	7271

Standard errors in parentheses
The dependent variable is the number of days from the date of treaty adoption till the date of ratification.
Significance level denoted by * for $p < 0.10$, ** for $p < 0.05$, *** for $p < 0.01$

The third option is including time-dependent covariates in the model. It is introduced by adding an interaction term with time for the covariates for which the PH assumption is violated, using the *tvc* option. In our case, it is the variables 'Signature', 'within_elec', 'out_elec', 'GDP per capita' and 'trade openness'. The results presented in Table 13 suggest that the hazard ratios are decreasing over time. The hazard ratio for 'Signature' is 3.678 at time 'zero' and is multiplied by 0.9995489 for each 1 unit increase in time, which is a day in our model. This implies that after 2,886 days the hazard ratio becomes less than one indicating the opposite effect of signature.

The potential way to depart from the model with the violated PH assumption is the estimation of a parametric PH model. We leave the parametric analysis for further research due to the time limitation. In this chapter, we provide only preliminary analysis and results. The representation of the distribution of our dependent variable gives us an idea of the actual distribution as a Weibull random variable, and thus we estimate the Weibull survival model. Table 14 Column (1) demonstrates that the hazard ratio for the variable 'signature' is greater than one. It means that signature increases the likelihood of treaty ratification. The results for the model with two dummy variables 'within_elec' and 'out_elec' (Table 14, Column (2)) are also in line with our main results from Table 9.

Table 13: General models with time-varying interaction terms.

	(1) Hazard Ratio	(2) Hazard Ratio
main		
signature	3.678***	
	(0.452)	
within_elec		3.781***
		(0.46845)
out_elec		3.561***
		(0.55416)
GDPpc	1.014***	1.014***
	(0.0023)	(0.002321)
openness	0.9985*	0.9984*
	(0.000793)	(0.0007942)
democracy	1.014***	1.014***
	(0.00483)	(0.0048399)
elec	0.9823	0.9824
	(0.0159)	(0.01597)
tvc		
signature	0.9995489***	
	(0.0000542)	
within_elec		0.9995484***
		(0.0000556)
out_elec		0.9995318***
		(0.0000817)
GDPpc	0.9999957***	0.9999956***
	(0.00000110)	(0.00000111)
openness	1.000001***	1.000001***
	(0.000000344)	(0.000000344)
N	16105	16105

Standard errors in parentheses
The dependent variable is the number of days from the date of treaty adoption till the date of ratification.
Significance level denoted by * for $p < 0.10$, ** for $p < 0.05$, *** for $p < 0.01$

Table 14: Weibull survival model.

	(1) Hazard Ratio	(2) Hazard Ratio
_t		
within_elec		1.458***
		(0.0754)
out_elec		1.598***
		(0.1183)
signature	1.467***	
	(0.0731)	
GDPpc	0.996**	0.996**
	(0.00145)	(0.00145)
openness	1.0014***	1.0013**
	(0.00052)	(0.00052)
democracy	1.0029	1.0027
	(0.00449)	(0.00449)
electoral cycle	0.9705*	0.9699**
	(0.0151)	(0.0151)
N	16105	16105

Standard errors in parentheses
The dependent variable is the number of days from the date of treaty adoption till the date of ratification.
Significance level denoted by * for $p < 0.10$, ** for $p < 0.05$, *** for $p < 0.01$

3.6 Conclusion to Chapter 3.

In the third chapter, we study whether signature may impact a leader's ratification decisions. Estimating a duration model with time-varying covariates, we assess the magnitude of that effect depending on the type of Executive who has signed the treaty: the Executive who negotiated a treaty, and the Executive who has not taken part in the negotiations. Two dummy variables are included in our empirical model, which serves as proxies for the Executive's type. Our results demonstrate that signature increases the likelihood of treaty ratification, and this effect does not depend on the type of Executive and time of signature. The effect of main and control variables on ratification timing is different for developing and developed countries and for the treaties with open and restricted membership.

The Cox proportional hazards model employed in this chapter allows us to measure the time continuously (in days, in our case). This improves the accuracy in generating variables when the information about the dates is available, as we are able to measure the exact time in days before and after the event of interest. In our case, this is the date of signature.

We conducted tests to check if the PH assumption holds. Graphical and numerical methods provide evidence of violating the PH assumption for the main variables of interest. After establishing non-proportionality, we employ and discuss the potential strategies to account for non-proportionality. In particular, we cut the time into shorter intervals, and found that on some time intervals the PH assumption holds. In addition, we estimate the model with variables that violate the PH assumption, interacted with time. The results demonstrate strong evidence that the hazard decreases for our main variables of interest.

With regard to further research, our dataset constructed for estimating a duration model with time-varying covariates can be expanded with information about the date when treaties enter into force. The effect of signature on the ratification timing might be different depending on whether a treaty is in force or not: a country would not be interested in being bound by a treaty until enough other states were bound by the same obligations. A minimum participation clause is considered to be a very common and potentially successful tool to increase IEA participation, given their self-enforcing nature, where countries decide voluntarily to join a treaty or not. However, studies on the minimum participation criteria are mostly theoretical; they do not address the delay in reaching the minimum participation requirement and the treaty's entering into force, the analysis that can be done using our dataset and the empirical model from the third chapter.

3.7 Appendix 4.

Table 15: Descriptive statistics.

	Obs	Mean	Std.Dev.	Min	Max
dependent variable	28,146	2151.058	2222.329	0	14498
signature	28,146	0.4154054	0.4928005	0	1
within_elec	19,925	0.4036136	0.490634	0	1
out_elec	19,925	0.0907403	0.2872466	0	1
GDPpc	24,678	14.21281	21.89046	0.1641919	194.1882
Democracy	21,729	3.086888	6.890655	-10	10
Electoral cycle	19,855	2.007454	1.459277	0	7
Trade openness	23, 015	81.73463	45.47128	0.0209992	425.3634

Table 16: Correlation coefficients (obs = 16,283).

	Dep.Var.	Signature	within_elec	out_elec	GDPpc	Trade	Democracy	Elec
dependent variable	1.0000							
Signature	-0.0632	1.0000						
within_elec	-0.0607	0.8124	1.0000					
out_elec	-0.0174	0.3078	-0.2835	1.0000				
GDPpc	-0.0442	0.3050	0.2547	0.0769	1.0000			
Trade openness	0.0199	-0.012	-0.0224	0.0238	0.2624	1.000		
Democracy	-0.0368	0.2736	0.2336	0.0703	0.4586	0.0636	1.0000	
Electoral cycle	0.0096	-0.0387	-0.0314	-0.0116	-0.0961	0.0083	-0.1407	1.0000

Table 17: Control variables description.

Variable Name	Variable Label in primary dataset	Data source	Variable Description
Economic indicators			
GDPpc	GDP per capita	the World Bank Open Data Project (1)	Gross Domestic Product divided by midyear population in constant 2010 thousand US dollars
openness	Exports of goods and services (% of GDP); Imports of goods and services (% of GDP)	the World Bank Open Data Project	Trade openness is the sum of exports and imports of goods and services measured as a share of GDP
Indicators of democracy and autocracy, polity regime transitions			
democracy	POLITY2	Polity V Project of the Center for Systemic Peace provides information about indicators of democracy and autocracy, authority characteristics and polity regime transitions. It contains data for the period from 1800 to 2018.(2)	A variable defines the level of democracy. It ranges from +10 (strongly democratic) to -10 (strongly autocratic)
Institutional and electoral results data			
elec	ELEC	Inter-American Development Bank (2017). The Database of Political Institutions 2017 (DPI2017).	The number of years left in the current term for the Executive. '0' if there is an election in this year.

Notes: 1. The World Bank Open Data Project available at: https://data.worldbank.org/indicator/NE.EXP.GNFS.ZS
2. Polity V Project is available at: http://www.systemicpeace.org/inscrdata.html.
The previous version of the dataset known as a Polity IV Project has been widely used in empirical works that studied the effect that the level of democratization has on the participation in IEAs. (see, for example, Battaglini and Harstad (2020), Cazals and Sauquet (2015)).
3. The Database of Political Institutions 2017 (DPI2017) Inter-American Development Bank (2017) is available at: https://www.iadb.org/en/research-and-data/dpi2017.

4 Interdependent ratification behaviour of countries: empirical evidence from International Environmental Agreements.

4.1 Introduction to Chapter 4.

The coordinated efforts of countries form the basis for delivering effective international policy in many areas. States can commit to cooperative efforts via the ratification of or accession to a formal treaty that addresses an international problem. From an economist's point of view, such cooperative outcomes are still puzzling. A straightforward game-theoretic analysis predicts that in equilibrium, cooperation among countries in managing global public goods may give a larger pay-off to each member than noncooperation. Any individual country, however, may appropriate the benefits from cooperation without assuming commitments of their own: this is the well-known free-rider problem. This behaviour is driven by the positive externalities that the provision of public goods generates and the individual rationality of countries: given the level of provision, every country is better-off by not incurring the costs while benefiting from the actions of others. The literature specifies three types of determinants of states' participation in international agreements: treaty design characteristics, domestic influence, and international systemic factors.[19]. Previous research focused mostly on the first two determinants, while assessing the role of international factors that imply state-to-state influence has proven difficult.

In this chapter, we study the interdependent ratification behaviour of countries using our novel dataset of international environmental agreements (IEAs). Such interdependent behaviour may be driven by a country's intention to enhance its economic position or demonstrate its influence in geopolitical space. Our empirical model estimates the effect which the existing interdependencies between countries have on the ratification timing. We do it by introducing the indexes that are constructed as shares (weights) and capture the status/position of a country relative to the group of ratifiers and group of non-ratifiers (different from the approach presented in the literature that uses pairwise weights). The indexes estimate the magnitude of group effects on ratification timing and allow us to see, for example, whether geopolitical and economic pressure may overcome free-riding incentives.

In this context, IEAs represent an extreme case of international cooperation. The existence of IEAs in practice rises interest among the researchers, mostly due to the market failure caused by the nature of environmental quality as a public good: in the presence of externalities, the incentives to free-ride, the absence of supra-national authority, countries are reluctant to join IEAs, thus, reducing the efficiency in regulating environmental quality issues. The situation

[19]This taxonomy is suggested in Campbell et al. (2019)

is aggravated by the fact that IEAs often do not include effective enforcement or monitoring mechanisms (Battaglini and Harstad, 2020).

Classical models of the private provision of a pure public good, which is the main focus of IEAs, argue that a country's incentive to cooperate is decreasing in the number and size of other players who cooperate, predicting the negative effect from ratification. Our work contributes to the recent economic studies which build on these models, looking into the other sources of interaction between countries in their decisions to ratify an international treaty in an attempt to addresses the question: what makes voluntary arrangements such as IEAs possible?

The recent case studies of international treaties provide evidence of the influence that countries have on each other's decisions at the international level. There are examples when one country or a group of countries put pressure on others to join the treaty.[20] In this case, state influence is 'positive' in that it increases the likelihood that other countries ratify or speed up the ratification decision. On the contrary, joining the international agreement by one country may have a 'negative' effect (negative state influence) on the decisions of others, causing delays in ratification and even discouraging the other countries from joining the treaty. Such negative effect may be a result of the free-riding incentives discussed above.

Among these studies, there is a paper by Beron et al. (2003) who argues that there is an interdependent behaviour among the countries when one nation exerts political and economic pressure on another within the context of IEAs. As drivers of such pressure Beron et al. (2003) specify the existence of international trade, joint memberships in international alliances, foreign aid flows, military security arrangements, oil flows, geographic proximity, and so on.

Another paper that studies the interdependencies between countries in their decisions to ratify an international treaty is Wagner (2016), who considers ratification to be a strategic substitute or strategic complement, depending on whether the relative payoff to cooperation decreases or increases with the number of treaty members. As a relative payoff to cooperation, he employs the timing of the ratification decisions. Strategic complementarity accelerates the participation by reinforcing the incentive to cooperate: treaty ratification by one country triggers ratification by others. In contrast, if ratification becomes less desirable as treaty membership grows, it is a strategic substitute. This parallels the free-riding incentive in a public good game with decreasing marginal benefits.

In order to estimate the spillover parameter that determines strategic interaction effect, Wag-

[20]Campbell et al. (2019) provides the example of the influence of the Nordic states together with Germany that eventually led to the establishment of the Convention on Long-Range Transboundary Air Pollution in 1979 and other states joining this agreement.

ner (2016) employs the method of simulated moments. The results demonstrate that the spillover parameter is positive and statistically significant, indicating that ratification decisions are strategic complements in the case of the Montreal protocol.

The presence of states interdependencies largely determine the success of international treaties: for example, negative state influence can cause a delay in a treaty coming into force, a reduction in the effectiveness of a treaty and, finally, undermine collective efforts.

The existing evidence of interdependencies between states is largely based on the analysis of single treaties amid attempts to find the correct model for panel and cross-sectional data that will account for the states interdependencies in the decisions made at the international level. We conduct multi-treaty analysis, which takes into account time-invariant unobserved effects, caused by the nature of a treaty. Moreover, as we use the panel data with variables observed over a period of time, we also take into account the time effect, which reflects the impact of the factors common for all potential ratifiers of a treaty, such as technological changes, political and economic cycles, etc. Our work proposes an empirical approach to the estimation of the factors that affect the decisions of countries to ratify an international treaty in the presence of interdependencies between states by estimating a panel data model that takes into account heterogeneity among countries and treaties. Our analysis looks into how the country's incentives to join an international treaty are affected by the decisions made by other countries, and, eventually, what is the role of interdependencies between countries in overcoming the collective action problem. We do this by evaluating the significance and sign of the interdependencies associated with the political and economic pressure that might be exerted on the country facing the decision to join an international treaty. In this chapter, for this country we use the term 'the next joiner'. Such pressure is created by the group of ratifiers, by which we mean the countries that ratified the treaty before the observed country's ratification. The indexes capture the group-effect rather than pairwise links between countries traditionally used in the literature.

The first index captures the trade links between the group of ratifiers and the next joiner. Previous research demonstrates that economic dependence on other countries may affect a country's ratification decision. In particular, Beron et al. (2003) conjecture that country i is more likely to follow suit to country j's ratification if a large share of j's exports go to i, because of influence, or power, that country j has on country i in terms of their bilateral trade: country j may exert pressure on country i and disrupt the flow of goods from i through tariffs, quotas, regulatory restrictions, or other means. In order to measure power Beron et al. (2003) construct a power weight index that is related to the magnitude of bilateral trade flows. The magnitude of this power effect in the case of the Montreal Protocol is estimated to be statistically insignificant. Wagner (2016) uses similarly constructed trade weights and

finds that, on average, countries are more likely to ratify the Montreal Protocol when their principal trading partners are among the members. In our analysis, the economic interdependency among states is captured by trade weights with the group of ratifiers constructed similarly to the bilateral spillover weights used in Wagner (2016) and Beron et al. (2003).

The second index captures a country's intention to gain a high political and economic position in the geopolitical space and achieve its wider geopolitical goals by becoming a part of a group of other countries. It is constructed as the ratio of a country's GDP per capita in the average GDP per capita of the group of ratifiers. If a country with a high GDP joins a group of countries with a relatively low level of GDP, it may seek to become a local regional power. The opposite situation is when a country with a low level of GDP enters a group of welfare countries. Small countries may seek ways to get financial support and access to the achievements of modern science and technology by joining a treaty. In addition, a country with a low level of GDP may enhance its geopolitical position by becoming a part of a group of welfare countries.

The third index captures the free-riding incentive of countries, which is increasing in the number of other countries who cooperate. The index is constructed as a size of the group of countries that a country joins relative to the set of all countries to which the treaty is open for ratification. Rather than controlling for the number of countries that ratified before (in this case, we expect that the rising number of countries that join the treaty will cause delays in ratifications), we construct an index that captures the economic size of the countries and takes into account heterogeneity across countries. This is a better way to capture the free-riding incentive of a country that decides on joining a group of ratifiers, as the group that consists of many small countries who seek financial and technological support rather than take actions towards the common goal, may create the same or even fewer incentives to participate than a group that consists of few large countries.

Indexes are constructed using GDP of the countries. GDP itself is an important indicator, which is employed in political science literature as one of the main determinants of a country's power. In particular, it defines wealth, which 'provides independence and can be used to put pressure on opponents' (Wijk, 2015). While the economic literature widely uses GDP and GDP per capita as one of the factors that affect international cooperation, we use a *relative* GDP to construct two indexes as indicators of the relative power of the group of countries who ratified a treaty before the observed country's ratification.

The papers by Beron et al. (2003) and Wagner (2016) analyse a case of one treaty, there are papers that develop the methods which account for interdependencies between the agents' decisions for larger datasets. One of the problems seen by researchers in this respect is

one with using traditional binary choice models. Such models do not take into account interdependencies between agents, leading to a violation of the assumption of independence among observations.

Glasgow and Golder (2015) address the problem of finding the correct empirical models for assessing the factors that affect the decision of parties to join governments in the presence of interdependencies. They point out that, in this case, employing traditional logit or probit models is not appropriate, as they treat each party as an independent observation, while, in reality, the likelihood of a particular party joining the government necessarily depends on the characteristics of the other parties in the government formation opportunity.

They compare a binary logit (BL) model that uses political parties as the unit of analysis with conditional logit (CL) and mixed logit (ML) models that use government formation opportunities as the unit of analysis and potential governments as the choice alternatives, thus accounting for the interdependencies between the parties. [21]

Although the treaty-making process in the post-negotiation period may be considered similar to coalition formation, when the countries which join the treaty form the group of ratifiers, the approach of Glasgow and Golder (2015) does not seem to be feasible here. It is a methodologically sound way to model the government formation process where the number of parties is small. However, in the case of treaty-making, the number of possible combinations of coalition membership rises exponentially, leading to a time-consuming analysis. Moreover, the government coalition formation process in Glasgow and Golder (2015) is observed as a simultaneous move, while our model assumes that the treaty signatories move sequentially, thus accounting for the time dimension.

We offer an alternative approach to the estimation of the factors that affect the decisions of countries to ratify IEAs in the presence of interdependencies between states. It aims to address the problem of biased estimates in the models that assume independent observations and, at the same time, accounts for states interdependencies. In order to do it, we generate the outcome variable as the time elapsed between subsequent ratification dates. These discrete time intervals characterise the incentives of an observed country to join an IEA: whether a country will delay the ratification of a treaty or join it shortly after the previous country. Each ratification decision is preceded by ratification actions of other countries (a 'group of ratifiers'), and this is a unique combination for each observation. We analyse how

[21] The dependent variable for CL and ML models is a dummy variable coded 1 if a particular coalition formed the government, and 0 otherwise. These models in addition to party-level characteristics allow to control for coalition-level effects. The coefficient of the independent variable of interest Incumbent party is positive in BL model, but negative in CL and ML models. In general, the results demonstrate that an initial binary logit model that uses political parties as the unit of analysis leads to the mistaken conclusion that incumbent parties are advantaged when trying to join governments, while CL and ML show that it is the incumbent coalition, not the incumbent parties, that holds the incumbency advantage.

the time between the subsequent ratification dates is affected by the characteristics of the observed country taking into account the influence of other countries.

Our research contributes to the existing literature through the following aspects: first, we focus on interdependent ratification behaviour of countries that participate in international treaties. In order to analyse the drivers of such interdependent behaviour, we construct indexes that take into account the existing interdependencies between the countries coming from their economic and political links. It allows us to estimate the magnitude of the conflicting forces that affect ratification timing and to see whether geopolitical and economic pressure may overcome free-riding incentives.

Second, our work makes an empirical contribution by estimating the panel data model that assesses both domestic factors and international factors including existing spillovers and interdependent ratification behaviour of countries. The empirical analysis is done using a comprehensive dataset which consists of 203 countries and 52 international environmental treaties ratified between 1975 and 2017. The analysis takes into account the heterogeneity among treaties and countries. Previous analysis has been done for limited data or single cases only.[22] Moreover, while the literature traditionally uses global IEAs with open membership for empirical analysis, downplaying the role of the treaties with restricted participation, which instead may solve regional environmental problems, our dataset includes both types of environmental treaties, thus providing a comprehensive empirical analysis and a robustness check for different types of treaties. In our analysis we distinguish them by the type of membership: open and restricted. IEAs that deal with global environmental problems typically are open for all the countries (open membership), while IEAs that mostly focus on local issues often have restricted participation.

Our findings demonstrate that countries' domestic characteristics traditionally considered as important determinants of international cooperation, together with international influence indexes affect ratification timing, and the effect is different for the treaties with open and restricted membership.

[22] Wagner (2016) provides the analysis for the Montreal Protocol that includes the sample of 140 countries with 20 years elapsed between the first and last ratification.

4.2 Spillovers and treaty ratification: methodology

We start with a brief introduction of the conceptual framework that underpins our empirical analysis of the role of international spillovers in treaty ratification. We then discuss the empirical implementation, including the construction and the role of key variables.

4.2.1 Conceptual framework

We model treaty participation as an infinite-horizon game played among a set of N countries indexed by $i \in I$, with $I = \{1, 2, ..N\}$. Countries are assumed to have complete information about all primitives of the game. In each period $t \in T = \{0, 1, ...\}$, all countries eligible for treaty participation and who have not already ratified it, simultaneously decide on their action, a_i, i.e. whether to ratify the treaty ($a_i = 1$) or not ($a_i = 0$). Each country decides on her action by weighting off the expected benefits from the treaty against the expected costs.

If country i does not participate in the treaty, it incurs no direct costs while also receiving no direct benefits. Given the other countries' ratification decisions, however, the country will experience the consequences of the changed international situation. For example, a decision to reduce fishing in the North Atlantic by a large group of nations may increase the price of fish and benefit those fishing nations who did not commit to the agreement. Conversely, as the price of fish increases, net importers may suffer from the agreement as their trade balance deteriorates. We capture these aspects by introducing the country-specific function $R_i\left(a_{-i}(t)\right) : \{0,1\}^{N\setminus\{i\}} \rightarrow \mathbb{R}$, which maps the ratification decisions of all other countries up to time t into net benefits/costs for i. We can therefore write the payoff for country i, which decides not to ratify at time t, as follows:

$$\pi_i\left(0, a_{-i}(t), t\right) = \gamma_0 R_i\left(a_{-i}(t)\right).$$

If country i decided to join the group of treaty ratifiers, instead, it is likely to face some individual costs and to accrue direct benefits, as well as been exposed to the spillovers from the other countries' decisions capture by R_i. That is, the payoff for a ratifier is:

$$\pi_i\left(1, a_{-i}(t), t\right) = B_i - C_i + \gamma_1 R_i\left(a_{-i}(t)\right).$$

In the expression, B_i represents the direct benefits from ratification, whereas C_i are the costs. Costs and benefits are defined through a discounted utility as environmental commitments are likely to generate both short-term and long-term costs and benefits for countries. For example, agreements on the conservation of endangered species populations often include

monitoring and work through legislation, education, conservation measures and international co-operation with Agreement members and with those who have not yet joined. All these international activities and consequences of such activities may stretch over years.

The benefits are likely related to the monetary and environmental values, which is the basic strategy of cost-benefit analysis in relation to the environment. The environmental component comes from the improvements in the ecological situation if a country becomes a party of a treaty, while monetary benefits may take a shape of foreign direct investments that are linked to specific environmental programs.[23] In addition, Cazals and Sauquet (2015) describe indirect benefits from participation in IEAs which may include international support for developing countries in such issues like trade, alleviation of poverty, access to markets, etc. The developing country leaders can exchange their participation in IEAs for international support through ratification of logrolling agreements can bargain for policy concessions to improve economic and fiscal performance. Foreign aid may be such a policy concession.

Costs are those incurred by companies to prevent, reduce or compensate for any harm to the environment according to the environmental policy introduced by the country in order to comply with an IEA.

In order to account for the factors affecting the individual costs and benefits, in our empirical model we include the set of economic and political variables widely used in the literature as the determinants of international cooperation. In the next sections we describe them in more detail. In order to control for unobservable characteristics of countries that are time-invariant and may affect the dependent variable, we use country-fixed effect. Examples of such unobservable characteristics may be climatic conditions or cultural background. We also use the treaty-fixed effect in order to control for the average differences across treaties.

This specification allows for both exogenous and endogenous factors affecting the incentives for participation. Taking the difference between the two expressions above, we can write the relative payoff from treaty participation as

$$\Delta\pi_i(a_{-i},t) = \pi_i(1,a_{-i},t) - \pi_i(0,a_{-i},t) = B_i - C_i + (\underbrace{\gamma_1 - \gamma_0}_{\gamma})R_i\left(a_{-i}(t)\right), \tag{17}$$

[23] For instance, the Clean Development Mechanism (CDM), defined in Article 12 of the Kyoto Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction credits, each equivalent to one tonne of CO2, which can be counted towards meeting Kyoto targets. A CDM project activity might involve, for example, a rural electrification project using solar panels or the installation of more energy-efficient boilers. The mechanism stimulates sustainable development and emission reductions in developing countries, while giving industrialized countries some flexibility in how they meet their emission reduction or limitation targets.(UNFCCC, 2020).

where the last expression at the right-hand side includes the country's net benefits from ratification, $B_i - C_i$ – i.e. its private incentives to ratify – that depends on the country's own institutional, socio-economics and political characteristics, as well as the strategic interaction effect, $\gamma R_i(\cdot)$, which captures the way in which other countries' decisions affect the action taken by country i.

Transparently, the relative payoff from cooperation may increase or decrease depending on the size and composition of the group of ratifiers at each point in time and depends on the sign of the last term in equation (17). Depending on the type of spillovers, strategic complementarity or substitutability may arise. If ratification becomes less desirable as the treaty membership grows, we have strategic substitutability, which may delay subsequent ratifications. This parallels the behaviour of free-riders in public good games with decreasing marginal benefits. In contrast, if the relative benefit to cooperation increasesas new countries join the treaty, ratification is a strategic complement. Strategic complementarity accelerates participation by reinforcing the incentive to cooperate. Moreover, if this effect is sufficiently strong, treaty ratification by a certain country may trigger ratification by others, leading to clustered ratification decisions (e.g. Wagner, 2016).

4.2.2 Empirical implementation

The endogenous variable in Wagner (2016)'s model is the day on which a country ratified the Montreal Protocol, which marks the legal act of acceding to the agreement. The dependent variable is the total amount of days since treaty adoption till the day of ratification by a country i. It characterises the relative benefits to cooperation of a country i.

In order to estimate the vector of parameters, Wagner (2016) employs the method of simulated moments which is feasible for limited data availability. He estimates the sign and magnitude of strategic interaction in the ratification of the Montreal Protocol and the results demonstrate that global ratification effects (in the ratification of the Montreal Protocol) are strategic complements rather than substitutes. The results are consistent with the success of the Montreal Protocol, which provided a considerable reduction in ozone-depleting substances around the globe.

While the empirical model of Wagner (2016) is bespoke for a one-treaty case, it is not applicable for the econometric estimation of the panel data models. One of the issues with the analysis of the processes such as treaty ratification is that countries do not join a treaty in an independent fashion. Instead, their actions are often thought to depend on the actions of other states, thus causing the problem of finding the correct model that captures the existing spillovers and interdependent ratification behaviour of countries. Such interstate

influence may lead to a violation of the assumption of independence among observations which underlies the estimation of panel data models.

In this chapter, we introduce an approach for the econometric estimation of the model (equation 17), which we apply to our panel dataset of treaties. We conduct multi-treaty analysis, which takes into account time-invariant unobserved effect, caused by the nature of a treaty. Moreover, as we use panel data with variables observed over a period of time, we also take into account the time effect, which reflects the impact of such factors as technological changes, political and economic cycles, etc. Our work proposes an empirical approach to the estimation of the factors that affect the decisions of countries to ratify an international treaty in the presence of interdependencies between states by estimating a panel data model that takes into account heterogeneity among countries and treaties. We expand our analysis by estimating the model for the treaties with open and restricted membership. By introducing the empirical analysis for a split sample, we test whether the impact of countries characteristics and the magnitude of international influence is different for them. In order to estimate the sign and magnitude of the strategic interaction effect, which depends on the spillover parameter γ in (17), we introduce three indexes. The empirical counterparts of country's private net benefits of ratification include economic and political indicators listed in Appendix 5 (Table 27).

In this section, we first explain the way in which the dependent variable is constructed, then we present the empirical model, and finally we describe the indexes that capture economic and political sources of interdependencies between countries.

In order to generate independent observations for the estimation of a panel data model, we consider the 'initial' state of the world for each country i as a stationary state, that does not depend on the sequence of entries, but depends only on the characteristics of countries within the group of ratifiers. In this case, the number of days between subsequent ratification dates is independent of the number of days it took for another country to ratify the treaty: the net benefits for a country i to join the treaty, measured in the number of days since the last ratifier, depends only on its own characteristics and the characteristics of the group of ratifiers, but not on how long it took for the other countries to ratify.

Figure 7 demonstrates graphically the timeline, where the countries ratify a treaty sequentially. t_1, t_2,...t_n are the days on which countries 1, 2, ..., n ratify a treaty after it was open for signature and ratification (time of a treaty adoption). The first country ratifies at time t_1. We refer to the countries that have ratified a treaty before the observed country as a group of ratifiers. After one of the groups of ratifiers has been formed, the next country ratifies a treaty within a particular period of time. We assume that the net benefits of each

country-ratifier depend on both the country's private net benefits of ratification and the net spillovers between the observed country and the countries that ratified before.

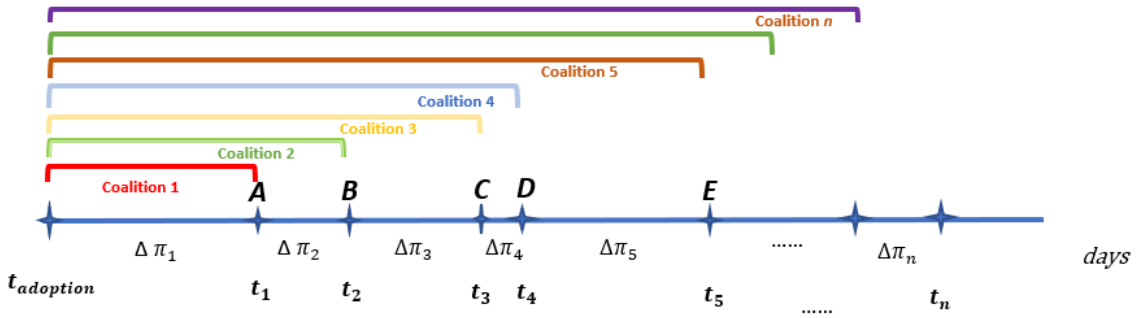


Figure 7: Timeline for ratification

As the initial state of the world, we take the characteristics of the group of ratifiers on the date when the last country before the one under consideration ratifies (the time of the formation of the group of ratifiers). Constructed in this way, our dependent variable captures the actual effects of spillovers that are generated by the the group of ratifiers from the time when this group of ratifiers formed. Indeed, taking a country D that ratifies at time t_4: during the time from treaty adoption to treaty ratification other countries ratify and begin to generate spillovers in different times: for country C this time is t_3, for country B - t_2 etc. Thus for country D the initial state of the world is captured at t_3, so the time $t_4 - t_3$ captures the impact of the group of countries who have already ratified on the decision of the observed country. [24]

Our estimating equations take the general form:

$$y_{it} = \mathbf{x}_{it}\beta + \mathbf{I}_{it}\gamma + \alpha_i + \lambda_t + \varepsilon_{it} \tag{18}$$

where dependent variable y_{it} is a number of days between subsequent ratification dates;

the subscripts i and t denote country and treaty respectively.

The vector $\mathbf{x}$ contains country's characteristics that determine the private net benefit of ratification. The description of economic and political variables included in the vector $\mathbf{x}$ is presented in Appendix 5 (Table 27).

$\mathbf{I}$ refers to the variables that determine the effect that a group of ratifiers may have on a

[24] This approach to constructing the dependent variable is in line with the assumption of Wagner (2016) that the relative payoff to cooperation increases over time. The assumption implies that countries start out as non signatories to a treaty and participate only at a later stage.

joining country. The regressors are constructed as indexes and capture the sources of interdependencies between countries. The indexes are described later in this section.

α_i is a country fixed effect to control for variables that vary across countries but are constant over treaties; λ_t is a treaty fixed effect to control for variables that vary across treaties but are constant across countries.

4.2.3 Indexes.

We begin this section with a detailed description of the indexes that capture economic and political sources of interdependencies between countries, as they are the primary focus of this chapter.

The intricacy of measuring international influence attracts many researchers. Amid the rise of literature addressing this topic, we offer a novel approach to measure and analyse interdependencies. Our goal is to develop an empirical model that explains countries' ratification choices in the presence of existing interdependencies. Our approach is designed primarily for the panel data, because many existing studies offer the analysis of single treaties only. In order to measure existing spillovers and interdependent ratification behaviour of countries, we construct three indexes that capture different types of spillovers.

1) The first type of spillovers is based on the pairwise relationships between countries. This way of measuring interdependencies is traditionally used in the literature. Existing empirical models employ trade flows, issue linkage, oil flows and other links between two countries as a measure of the interdependencies. For example, Beron et al. (2003) develop a correlated probit model using power weight matrices, which are based on bilateral trade flows between countries. As a case study, they analyse the Montreal Protocol using the simulation-based approach for estimating their models. However, the assessment of the power effect magnitude does not provide significant results.

Similarly constructed trade weights that measure the intensity of country j's participation decision on country i's payoff are used in Wagner (2016) who estimates the spillover effect coming through the economic dependency channel. The spillover parameter estimates obtained using trade weights are positive and statistically significant. This means that, on average, countries are more likely to ratify the Montreal Protocol when their principal trading partners are among the ratifiers.

In our analysis, the economic interdependency among states is captured by trade weights with the group of ratifiers. This is the share (percentage) of the total exports from a country i to the countries that ratified before it in all exports from country i.

$$w_{trade\_ik} = \frac{\sum_{j \in C_i(k)} X_{ijt}}{\sum_{j \in N} X_{ijt}} * 100$$

where X_{ijt} measures total exports from country i to country j in year t, which is the year when country i ratifies agreement k.

$C_i(k)$ is the set of countries that have ratified before country i ratifies agreement k, whereas N is the set of all countries.

Constructed in this way, the index captures the existing pairwise spillovers rising from the trade between the countries. This is one of the straightforward but important type of interdependencies, and is similar to the bilateral spillover weights used in Wagner (2016) and Beron et al. (2003) as we generate trade weights for each 'group of ratifiers-country' pair in all the treaties based on pairwise trade flows.

In terms of the effect that international trade has on the decision of a country to join an international treaty, it may be negative or positive. The negative effect is observed if ratification leads to changes in the type of economic activity. The classical theory of trade states that trade intensification leads to structural changes in a country's economy, allowing specialisation in those goods or services where the country has a comparative advantage, for example, in low labour costs, natural resource abundance, or high availability of skills and socio-economic infrastructure. The country may lose its comparative advantage if it joins a treaty imposing constraints on domestic economic agents. As regards our analysis, this may lead to a delay in ratification decisions. At the same time, the wide trade links may cause a change in the methods of production employed and attract technological innovations. A country may be more likely to ratify an international agreement, if it provides an access to know-how and technology, either through imports of 'green' goods and services or through cleaner production techniques embodied in foreign direct investment (Kirkpatrick and Scrieciu, 2008).

Trade weights are computed using average bilateral export flows for the period 1975-2016, which were obtained from the NBER-United Nations Trade Data (constructed for the period 1962-1999) (Feenstra et al., 2005), and from the World Trade Flows bilateral data available on the web page of Robert C. Feenstra (for the period 2000-2016). Values of bilateral trade are expressed in US $ 1,000 (nominal, not adjusted for inflation). The countries' total exports are taken from the World Bank Open Data Project.

2) The second type of spillovers arises from the links between a country and the group of previous ratifiers taken as a formed coalition or a separate unit. The internal index that captures these 'coalition-country' interdependencies employs the average GDP per capita

of countries in the group of ratifiers as a main characteristic of the formed coalition.

The decision to join a treaty may be driven by a country's intention to enhance its political and economic influence on other countries. In this case, we speak of the 'internal' status of the country. It might be through strengthening a country's position in the geopolitical space in the case of a regional treaty, or through gaining another political or economic benefits when joining a group of countries. An index that captures country i's 'internal' position relative to the group of previous ratifiers is computed as the ratio of country i's GDP per capita in the average GDP per capita of countries in the group of ratifiers $C_i(k)$ including country i.

$$w_{internal\_ik} = \frac{GDPpc_{it}}{\frac{1}{|C_i(k)|+1} \sum_{j \in C_i(k) \cup \{i\}} GDPpc_{jt}}$$

where $GDPpc_{it}$ is country i's GDP per capita measured in 2010 US dollars in year t.

$C_i(k)$ is the set of countries that have ratified before country i ratifies agreement k

$|C_i(k)|$ is the number of countries in the set $C_i(k)$

The internal index is equal to 1 for the first ratifier.

In our dataset, the internal index has a mean value of 0.8221053. For approximately 25 percent of observations, the internal index is larger than 1. In this case, we observe the situation when country i with a high GDP per capita joins a group of countries with a relatively low level of GDP. We may expect that country i might be reluctant to do it because of unequal distribution of the potential costs and benefits within the group of ratifiers. The share of costs that the countries with high GDP bear may be higher than that for the countries with low GDP. Similarly, countries with a high level of GDP per capita may expect correspondingly smaller benefits when joining the group of countries with low GDP.

Anecdotally, this intuition is supported by the experience with existing IEAs designed to engage developing countries in the process of protecting the global environment. Developing countries often lack technology and resources, and demand assistance from developed countries to deal with global environmental problems.

Examples include the Montreal Protocol that established the Multilateral Fund in 1991 to provide financial and technical assistance to signatory developing countries; or the Green Climate Fund established within the framework of the UNFCCC that aims to assist developing countries financially in order to limit or reduce greenhouse gas emissions, and to help vulnerable societies adapt to the unavoidable impacts of climate change.

At the same time, in case of a regional treaty, an economically developed country may be

attracted to a specific treaty by the chance to improve its local geopolitical status in a particular region. By joining a treaty, it may become the big 'fish' in a small 'pond', reaping the benefits associated with being the local regional power.

If the internal index is less than 1, we observe the opposite situation when a country with a low level of GDP enters a 'large' group of ratifiers. Small countries may seek ways to get financial support and access to the achievements of modern science and technology by joining a treaty. In addition, a country with a low level of GDP may enhance its geopolitical status by becoming a part of a group of welfare countries. This is the case when a country may derive both economic and political benefits as a member of the group of ratifiers, so we expect that the smaller a country is, the sooner it joins the large group of ratifiers.

3) The third index captures not only interdependencies between countries who already ratified, it also includes the set of all countries to which the treaty is open for ratification. This captures the status/position of a country within the group of ratifiers relative to the 'world' group, which includes both ratifiers and non-ratifiers.

The 'free-riding' index that captures the free-riding incentive of country i is calculated as the share of the total wealth of countries that committed to agreement k including country i in the world GDP:

$$w_{free-riding\_ik} = \frac{\sum_{j \in C_i(k) \cup \{i\}} GDP_{jt}}{\sum_{j \in N} GDP_{jt}}$$

where GDP_{jt} is country j's GDP in constant 2010 US dollars in year t.

$C_i(k)$ is the set of countries that have ratified before country i ratifies agreement k

N is the set of all countries to which the treaty is open for ratification.

The set N differs for the treaties with open and restricted membership. Participation in the treaties with restricted membership is limited due to the local nature of the agreements or some other reasons (for example, if the subject of the agreement is very narrow). In this case, N is the set of potential parties to the agreement as stated in the text of it.

The index captures the free-riding incentive of countries in a public good game with decreasing marginal benefits. Standard models of the private provision of public goods predict that a country's incentive to cooperate is (weakly) decreasing in the number of other countries who cooperate. Rather than controlling for the number of countries that ratified before (in this case, we expect that the rising number of countries that join the treaty will cause delays in ratifications), we construct an index that captures the economic size of the countries and takes into account heterogeneity across countries. This is a better way to capture the

free-riding incentive of a country that decides on joining a group of ratifiers, as the group of ratifiers that consists of several small countries may create the same or even fewer incentives to participate than a group of ratifiers that consists of one large country. A country with a high level of GDP may contribute a lot of resources to solving the environmental problem, while smaller countries may seek financial and technological support rather than take actions towards the common goal.

The free-riding index also captures other motivations of countries that may impact ratification timing in the opposite direction, such as a country's intention to join a large group of ratifiers in pursuing common goals, in order to gain world recognition and achieve a higher global status through collaboration with a wealthy countries. In this case, the motivation to combine efforts may overcome the free-riding incentive of countries.

In addition to economic and political origins of interdependence, there are other mechanisms that may cause interdependent ratification behaviour of countries that participate in international treaties. In particular, Bernauer et al. (2010) point out that countries' location in the same geographical region may cause their contingent behaviour. In Appendix 5 we provide the overview of the geographical index.

We estimate a fixed-effect model with the dependent variable ('time_subseq') represented by the number of days between subsequent ratification dates. Those time intervals characterise the incentives of an observed country to join an IEA: whether a country will delay the ratification of a treaty or join it shortly after the preceding ratifier. A country i's ratification decision is preceded by the ratification actions of other countries. We model these countries as a group of ratifiers $C_i(k)$, which consists of a unique combination of the countries for each observation. We analyse how the time between the subsequent ratification dates is affected by the characteristics of the observed country and spillovers between the observed country and the group of countries who ratified before.

4.3 Data

Our dataset comprises of 52 international environmental agreements (IEAs) ratified between 1975 and 2017. It was constructed using the information from primary sources: open access texts of IEAs. The dataset includes IEAs with open and restricted membership. In our dataset, however, we have not included amendments to treaties, which constitute the biggest part of IEAs. The treaty-making process for amendments differs from one for conventions and protocols, thus is not relevant to our analysis. The information about the name of treaties and the type of participation is presented in Appendix 5 (Table 28).

To construct the dataset we use information from the following sources: institutional and electoral results data are taken from from the Database of Political Institutions (2017) (DPI) provided by the Inter-American Development Bank (Cruz et al., 2018); the Polity V Project of the Center for Systemic Peace (2020) provides information about indicators of democracy and autocracy, and polity regime transitions.[25] Economic indicators are taken from the World Bank (2023) Open Data Project. They are used as control variables and for the construction of interdependencies indexes.

Table 23 in Appendix 5 shows the descriptive statistics of the variables employed. The sample presents a good variation of countries in terms of their economic development. This is important as our indexes are constructed using countries GDP per capita. We observe a high dispersion of GDP per capita values among the countries. It ranges from 178.8 US dollars (2010) for Ethiopia in 1990 to 194188.2 US dollars (2010) for Monaco in 2016.

In this section we briefly present the summary statistics of our variables. In our dataset, the internal index has a mean value of 0.8221053. For approximately 25 percent of observations, the internal index is larger than one: the situation when country i with a high GDP per capita joins a group of countries with a relatively low level of GDP. The free-riding index for the treaties with open membership ranges from 0.0000542 to 0.9853052, taking its highest levels for the countries that ratify latest in large agreements that involve most of the world countries, for example the UN Framework Convention On Climate Change, or the Montreal Protocol On Substances That Deplete The Ozone Layer. For the treaties with restricted membership the free-riding index varies between 0.0001185 and 1 with seven treaties where all the potential members have ratified.

Our dependent variable is constructed as the number of days between subsequent ratification dates with the mean of 104.3 days. The maximum period between two ratification decisions is 4772 days. However, the distribution is different among samples with different types of membership: in the treaties with open membership the average time between subsequent ratification dates is 50.9 days, in the treaties with restricted participation it is 272.8 days. It means that free-riding incentives of countries are expected to be stronger in the treaties with restricted membership. It is in line with descriptive statistics which show that although a minimum participation rule require less ratifiers for the treaties with limited number of potential participants to become effective, the average time between the treaty adoption and its entry into force is very similar: for the treaties with restricted membership, the average number of years is 5.0 years, for the treaties with open membership is 5.4 years.

[25] The previous version of the dataset known as the Polity IV Project has been widely used in empirical works studying the effect that the level of democratization has on the participation in IEAs. (see, for example, Battaglini and Harstad (2020), Cazals and Sauquet (2015)).

More detailed information about the political and economic indicators and their sources is presented in Appendix 5 (Table 27).

For the empirical analysis, we declare our dataset to be a panel. The country code is a variable identifying the panels. In our dataset, some countries ratify more than one treaty in one year, in this case we observe the same year for the same country in different treaties, that is why we cannot use the year of ratification as a *timevar*. The observations within panel are considered ordered by the treaty ID.

4.4 Results

Table 18 reports the results of the estimation of equation (18). In Table 18, Column (1) we first present a fixed effects model without controls, in which the dependent variable is regressed only on the indexes. The next three columns introduce a fixed effects model with three indexes and all the control variables that capture economic and political factors in our analysis. Column (2) reports estimates computed on the full sample that we then split into treaties with open membership (Column (3)) and treaties with restricted membership (Column (4)).

Next, we introduce our preferred specification. Column (5) reports estimates computed on the full sample that we then split into treaties with open membership on the one hand (Column (6)) and treaties with restricted membership on the other (Column (7)). All standard errors are clustered at the state level to correct for potential serial correlation.

Table 18 demonstrates the results for the models with country and treaty-fixed effects. All the models use robust standard errors ($vce(robust)$). Values of independent variables are taken for the year of ratification by an observed country.

The coefficients of all three indexes are significant, which is in accordance with our conceptual framework and demonstrates that the existing links between countries affect ratification timing and may reduce or increase the number of days between subsequent ratification dates. Moreover, the effect is different for the treaties with open and restricted membership. We observe significant effects of large magnitude in the treaties with restricted membership, which is consistent with the fact that historically established relations may catalyse the peer effect.

Below we describe the results from Table 18 in more detail:

Column (5) reveals that the economic interdependencies between countries have a negative effect on the time elapsed between subsequent ratification dates. The higher the trade index, the sooner the country ratifies a treaty after the group of ratifiers.

Table 18: General model: fixed effects model.

	(1) all	(2) all	(3) open	(4) restricted	(5) all	(6) open	(7) restricted
trade_index	-9.008	-1054.0***	-297.3***	-3247.1*	-1166.4***	-264.4**	-3718.2*
	(0.136)	(0.003)	(0.008)	(0.072)	(0.002)	(0.013)	(0.058)
internal_index	32.42**	28.20*	5.239	32.24	29.17**	7.556	37.58
	(0.034)	(0.077)	(0.501)	(0.312)	(0.041)	(0.344)	(0.258)
free-riding_index	269.6***	291.7***	93.67***	607.5***	319.1***	85.03***	611.6***
	(0.000)	(0.001)	(0.000)	(0.010)	(0.000)	(0.000)	(0.003)
log_gdppc		134.7**	15.47	44.90	161.4***	14.25	229.8
		(0.021)	(0.455)	(0.821)	(0.004)	(0.516)	(0.162)
trade openness		0.0979	0.0711	0.0269			
		(0.846)	(0.739)	(0.992)			
democracy		1.712	0.214	15.11			
		(0.567)	(0.933)	(0.190)			
durable		1.429	0.441	9.013**			
		(0.139)	(0.347)	(0.032)			
leg_left		-9.434	-15.75	-9.176			
		(0.730)	(0.207)	(0.873)			
leg_right		-38.29*	-11.81	-101.0**	-30.27	-0.748	-83.60
		(0.068)	(0.308)	(0.040)	(0.118)	(0.920)	(0.103)
legelec		-14.78	-6.631	-24.93			
		(0.277)	(0.137)	(0.646)			
sign_before		-31.22**	-5.071	-158.6**	-33.29**	-5.135	-184.9**
		(0.035)	(0.595)	(0.027)	(0.027)	(0.614)	(0.012)
mp		32.95	21.16***	92.47*	35.31*	21.02***	61.34
		(0.143)	(0.005)	(0.097)	(0.080)	(0.003)	(0.185)
No.Obs.	2347	1895	1382	513	2125	1557	568
No.Countries	182	141	140	77	161	160	89
No.Treaties	12.9	13.4	9.9	6.7	13.2	9.7	6.4
$(a) F-test(FE)$	43.97	25.25	7.81	319.53	25.61	8.07	271.51
$p-value(FE)$	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$(b) F-test(control)$	-	1.38	0.66	0.53	-	-	-
$p-value(control)$	-	0.2341	0.7297	0.7536	-	-	-
$corr(u_i, Xb)$	-0.0403	-0.9000	-0.9063	-0.8470	-0.8354	-0.1714	-0.5875

p-values in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: 1.The dependent variable is a number of days between subsequent ratification dates.

2.The F-test entries refer to the tests of the joint significance of fixed effects (a) and insignificant control variables (b).

3. High $corr(u_i, Xb)$ in columns (2)-(7) means that the fixed effects (FE) are strongly correlated with the explanatory variables, so we correctly control for these FE. A strong correlation of this type usually indicates that pooled OLS or random effects are not suitable for this purpose, because both of these models assume that the correlation between the FE residuals and the FE predicted values is zero.

Descriptive statistics demonstrate that for 95% of observations in our sample the trade index are lower than 0,0968, so here we explain the effect of the 0.01 change in the trade index. If the index rises by 0.01, the number of days after the preceding country ratifies is predicted to decrease by 11.66 days, all the other explanatory variables are held fixed. (Table 18, column (5)).

The effect is stronger for the treaties with restricted membership and differs by at least one order of magnitude: the number of days since the preceding ratification is 14 times larger for the local treaties than for the global treaties. The expansion of trade between neighbours leads to strengthening ties in other sectors, including international environmental cooperation. The possibility of arranging robust schemes for common property resources and public goods may seem more feasible at the regional level than the global, given strong trade links.

The results are in line with Beron et al. (2003)'s predictions and the findings of Wagner (2016) who show that, on average, countries are more likely to ratify the Montreal Protocol when their principal trading partners are among the members.

Another index that captures the spillover effects that may arise from the economic rationality of the decision to join a treaty as well as the intention of countries to enhance geopolitical status in the particular region is the internal index.

The results demonstrate that the coefficients for the internal index variable are positive and significant. It implies that the higher the internal index, the longer it takes for the country to ratify after a preceding country ratifies, all the other explanatory variables held fixed.

If the internal index rises by 1, the time after a preceding country ratifies increases by 29.17 days, all the other explanatory variables are held fixed (Table 18, column (5)). But this effect disappears once the sample is split.

With the internal index lower than 1, we observe cases when a country with a low level of GDP enters a 'large' group of ratifiers, and with the internal index higher than 1, a 'rich' country joins a small group of ratifiers.

The results support our intuition in both cases:

1) When the internal index is lower than 1, the country's incentives to join a treaty are driven by the economic rationality of countries with a relatively low level of GDP. The higher the internal index, the longer it takes for the country to ratify after a preceding country ratifies, all the other explanatory variables held fixed. Small countries seek ways to get financial support and the access to the achievements of modern science and technology. This is an example of positive international technology spillovers that IEAs may provide for developing countries. However, the overall effect of the change in the internal index is expected

to be rather small: if internal index rises by 0.1, the time after a preceding country ratifies increases by 2.9 days, all the other explanatory variables held fixed (Table 18, column (5)). But this effect disappears once the sample is split.

2) The economic rationality, rather than the country's intention to enhance geopolitical status in the particular region is also driving the welfare countries in their decision to join a treaty. This is the case with the internal index higher than 1. Country i with a high internal index may be reluctant to join a 'small' group of countries with a relatively low level of GDP, as it may require significant investment from country i into the group of ratifiers.

While the internal index reflects the position of a country in relation to the group of ratifiers, the free-riding index captures the positive externalities from the provision of public goods generated by the group of ratifiers to the rest of the world. Through the internal and free-riding indexes we estimate spillover effects arising in two directions - in relation to the group of ratifiers and outside the group of ratifiers.

Positive and significant coefficients (Table 18, all specifications) of the free-riding index imply that the number of days between subsequent ratification dates is affected by the spillover effect that arises on the global scale: the higher the free-riding index, the later the country ratifies a treaty after the previous country. If the free-riding index rises by 0.1, the number of days between subsequent ratification dates are predicted to increase by 31.91 days, all the other explanatory variables held fixed (Table 18, column (5)). The results are in line with the standard models of the private provision of a pure public good: a country's incentive to cooperate is decreasing in the size of other countries who cooperate. However, this incentive may be overcome by the motivation of a country to join a large group of ratifiers in pursuing common goals, in order to gain world recognition and achieve a higher global status through collaboration with a large number of countries. In this case we could predict that as the group of ratifiers is getting larger, the country will join the group of ratifiers sooner.

The results demonstrate that the free-riding incentive of countries are not overcome by the countries' motivations to join a large group of ratifiers when working on global issues to achieve a higher global status. For the treaties with restricted membership, the free-riding incentives provide a stronger effect on ratification timing: the number of days since the preceding ratification is approximately 7 times larger for the local treaties than for the global treaties.

While the indexes are constructed to estimate the sign and magnitude of strategic interaction effect, we also include several control variables that capture economic and political factors in our analysis. The role of these domestic factors is widely discussed in the existing literature. Empirical studies demonstrate that economic and political controls might affect

international cooperation, however, the results are often mixed.

Columns (2)-(4) demonstrate the results for the specification with all of our control variables. Such variables like trade openness, the level of democratization, regime durability, left-wing orientation, and the dummy variable for the legislative election year are not significant for the whole sample (Table 18, column (2)). The F-test of the joint significance for this group of variables demonstrates that they are not jointly significant. The other control variables affect the dependent variable in the direction expected, although they do not exhibit systematic effects.

We begin with GDP per capita, which has a positive effect on the number of days elapsed between subsequent ratification events over the whole sample, but this effect disappears once the sample is split.

A right-skewed distribution of this independent variable is observed in our sample, with only 9 countries whose GDP per capita is higher than 60 thousand US dollars (2010). In order to transform a highly skewed distribution into the the log-normal one, in our analysis we use natural logarithms of GDP per capita values. We also do it as we expect a non-linear relationship between GDP per capita and the time elapsed from preceding ratification.

In our analysis, there is evidence that the higher the level of economic development, the longer it takes for a country to ratify after the preceding country ratifies. If GDP per capita rises by 1%, the number of days for a country to ratify, following the ratification of the most recent ratifier, is predicted to increase by 161.4 days, all the other explanatory variables held fixed (Table 18, column (5)).

The effect of economic activity on the environment has been broadly discussed in the literature. Countries with a high level of economic development are associated with a more advanced technological level, innovative capacity, as well as they possess financial and administrative resources large enough to implement effective steps for improving the ecological situation within a short period of time. In the empirical studies the level of economic development is often used as a control variable that captures the size effects. Countries with a higher GDP are found to ratify environmental treaties more quickly than those with lower GDPs (see for example, Spector and Korula (1993), Wagner (2016), and others), as well as they are more willing to participate in IEAs (Cazals and Sauquet, 2015).

Our results differ from those presented in the literature. This may be due to the way of constructing our dependent variable: it does not take into account the ratification order. The descriptive statistics show that the mean of GDP per capita for the countries who ratified within a 'minimum participation group' is 20240.31 US dollars (2010) while for the countries that ratify after the treaty enters into force the mean is 11926.08 US dollars (2010). T-test for

means equality demonstrates strong evidence that the means in the samples are not equal.

It means that, on average, countries that ratify a treaty before it enters into force have higher GDP per capita than countries that ratify after the treaty enters into force, supporting the idea that wealthier countries demonstrate more willingness to participate in IEAs and address environmental issues soon after a treaty adoption than poor countries. At the same time, it takes more time for countries with high GDP per capita to ratify following other ratifiers. This may explain why it takes a long time to form the minimum participation group.

Another variable that demonstrates the significant coefficients in the full specification (Table 18, Column (2)) is equal to one if the largest party in the Legislature is defined as conservative, Christian democratic, or right-wing, and zero otherwise. However, it loses its significance in our main model (Table 18, Column (5)).

Although, to our knowledge, no paper has studied the effect that parties' ideology has on international environmental cooperation, there are papers that study the effect of ideology on domestic environmental policies or environmental outcomes.

A consistent finding in the literature is that ideology (or positioning on the left–right dimension) affects environmental policy support, with left-leaning individuals being more pro-environmental (Jagers et al., 2018). Such studies traditionally use the results of surveys of public opinion and polls (see, for example, Clements (2014), Krosnick et al. (2000), or Dunlap and McCright (2008)). Jagers et al. (2018) point out that the attitude to environmental issues of left and right social groups is coming through the formation of preferences for market regulation and economic growth. Individuals who position themselves to the left on the political spectrum are less negative to the introduction of environmental policies, because such measures are compatible with their conviction that the market economy needs to be regulated, they also believe that government should take a more active role in establishing 'the good society'.

There are also a few papers that analyse the effect of ideology on environmental outcomes. For example, Neumayer (2003) in his paper studies the effect of left-wing party strength on air pollution levels in 21 OECD countries over the period from 1980 till 1999. He found that traditional left-wing party strength is associated with lower pollution levels.

We estimate the effect of two dummies: 1) equal to one if the largest party in the Legislature is defined as conservative, Christian democratic, or right-wing, and zero otherwise.

2) equal to one if the largest party in the Legislature is defined as communist, socialist, social democratic, or left-wing, and zero otherwise.

Though the coefficients of a right-wing dummy are significant in the full specifications (Table 18, columns (2)-(4)), they lose their significance in our main model. We find no evidence that party's ideology affects the ratification timing.

In our analysis we have included a dummy variable, which is equal to 'one' if the observed country has signed the treaty before.

About 60% of observations in our sample are the countries that signed treaties before ratification.

The literature considers the role of signature as a signaling device that can be examined in two directions: one refers to state-to-state signaling, in which states use treaties to signal the importance of an issue, or their own intentions, to other states (see, for example, Fearon 1997; Morrow 2000). The other role of signature is a signal to domestic actors as that addressed in the paper by Hugh-Jones et al. (2018). They argue that when multiple well-informed executives publicly sign an international treaty, this can provide a strong signal of issue importance to domestic veto players, and in turn may persuade them to ratify the treaty. The greater the weight of international opinion signaled by initial signatures, the greater the likelihood of a legislature ratifying a treaty.

Their model takes into account the international factors (the pooled expertise of states initially signing environmental treaties) that may affect the decision of the domestic veto players. Our analysis done in the previous chapters, focuses on the Executive's reelection concern as a domestic factor that has an impact on the ratification decision made by Legislature. Both studies demonstrate that signature does matter, and conveys important information to domestic veto players, therefore, it has an impact on treaty ratification.

The dummy variable which is used in our model captures the domestic signal sent from the Executive to the Legislature, and allows to estimate the magnitude of this signal.

Our results demonstrate that time elapsed between subsequent ratification dates is predicted to be less for the country that has signed the treaty before, thus supporting the idea that signature may facilitate treaty ratification. If a country signs a treaty before ratification, the number of days since the previous country ratifies decreases, on average, by 33.29 days, all the other explanatory variables are held fixed (Table 18, column (5)).

In order to analyse if indexes have different marginal effects on ratification timing for the countries that have signed a treaty before ratification, we estimate models which include interaction terms of all the indexes with a dummy variable equal to 'one' if the observed country has signed a treaty ('sign_before'). The results are presented in Appendix 5 (Table 22).

As an example, we discuss the results in Table 22, column (5):

We observe the weaker effect from the change in the free-riding index on the outcome variable if a country ratifies after the treaty has been signed: if the free-riding index rises by 0.1, the number of day between subsequent ratification dates is predicted to increase by 19.85 days, all the other explanatory variables held fixed. If the free-riding index rises by 0.1, the number of day between subsequent ratification dates is predicted to increase by 46.6 days, if the treaty has not been signed before, all the other explanatory variables held fixed.

The results imply that free-riding incentives of countries are stronger when treaty has not been signed, supporting the idea that the signature may facilitate treaty ratification.

One more dummy variable introduced in our analysis is 'one' if the observed country has ratified within a 'minimum participation group' (before a treaty enters into force).

International environmental treaties do not become effective immediately after the negotiations. Instead, they often include a minimum participation clause that sets a minimum number of countries, necessary for the agreement to enter into force. Minimum participation constraints are frequent in the case of environmental treaties dealing with global commons, where free-riding incentives are strong.

The intuition behind the need for a minimum participation clause (MPC) is the following: a country would not be interested to be bound by a treaty until enough other states were bound by the same obligations. MPC is considered to be a very common and potentially successful tool to increase IEA participation, given the self-enforcing nature of IEAs where countries decide voluntarily to join a treaty or not.

Regardless of the rising interest in the mechanism of a minimum participation requirement in the literature, and a variety in the approaches aiming to understand the mechanism of it, studies on the minimum participation criteria are mostly theoretical and focus on finding the optimal minimum number of ratifiers. These studies do not provide empirical evidence; also, they do not address the delay in reaching the minimum participation requirement and the treaty's entering into force, which may undermine collective efforts.[26]

[26]One of the first papers that studied the role of a minimum participation requirement in IEAs under uncertainty is by Black et al. (1993). They argue that given the uncertainty about net benefits, it is disadvantageous to set the approval target too high, because this increases the chance that it is not reached, or too low, because this invites free-riding. Countries are assumed to be symmetric, they know their cost function but do not know their benefits from the agreement. Countries are uncertain about whether a coalition will be formed or not. According to the underlying assumptions of the model, coalition formation is only possible under the condition that a minimum participation rule is incorporated into the treaty. Under uncertainty about payoffs, the grand coalition might not be efficient (individual marginal abatement costs may exceed the sum of expected marginal benefits). Therefore, a social planner would eventually choose a threshold below the grand coalition.

Numerical examples demonstrate that whichever minimum participation number is selected, the expected surplus, while above zero and better than no plan, is well below what could be achieved if all countries N were forced to participate (unanimity rule). However, the probability of reaching the agreement under the unanimity

Our dataset and empirical model allow us to study the impact of minimum participation requirement on ratification timing. On average, the number of days between subsequent ratification dates within the MPG is larger by 35.31 than for the countries that ratify after a treaty enters into force, all the other explanatory variables held fixed.

In order to analyse if indexes have different marginal effects on ratification timing before and after a treaty enters into force, we estimate models which include interaction terms of all the indexes with a dummy variable equal to 'one' if the observed country has ratified within a minimum participation group ('mp'). The results are presented in Appendix 5 (Table 21).

As an example, we discuss the results in Table 21, column (5):

We observe the stronger effect from the change in the free-riding index on the outcome variable if a country ratifies after the treaty enters into force: if the free-riding index rises by 0.1, the number of day between subsequent ratification dates within the MPG is predicted to increase by 3.1 days, all the other explanatory variables are held fixed. If the free-riding index rises by 0.1, the number of day between subsequent ratification dates after the treaty enters into force is predicted to increase by 37.75 days, all the other explanatory variables held fixed.

The results imply that the effect of free-riding incentives of countries on the decision of countries to ratify is weaker when treaty is not in force, supporting the idea that minimum participation clause plays an important role in enhancing the effectiveness of IEAs.

In terms of types of agreements, we observe similar trends as in the whole sample, however the coefficients are higher for the treaties with restricted membership. It means that free-riding incentives of countries are stronger in regional treaties. It is in line with descriptive statistics that show that although a minimum participation rule require less ratifiers for regional treaties to enter into force, the average time between the treaty adoption and its entry

rule is much lower than for the agreement where the number of countries required for the treaty to come into force is lower than N.

One of the assumptions of this model is about incomplete information. Indeed, IEAs address the long-term environmental issues and countries' abatement options are generally uncertain. This leads to uncertainty about countries' payoff functions. In addition, coalition formation is a political process and there may be uncertainties about policy preferences as well.

While Black et al. (1993) take a minimum participation requirement as an exogenously imposed, Carraro (2009) endogenises the minimum participation rule in international treaties. They models it as the equilibrium outcome of a three-stage coalition formation game. In the first stage, countries unanimously set the minimum coalition size that is necessary for the treaty to come into force. In the second stage, they decide whether to sign the treaty. In the last stage, they set the equilibrium values of the policy variables. Their results show that the endogenously chosen minimum participation rule achieves the goal of enlarging the equilibrium number of signatories.

Using the above theoretical framework, Carraro (2009) shows that, at the equilibrium, a non-trivial coalition will form, and will be sustained by a binding minimum participation constraint. It also shows that the number of signatories is increased by the presence of a minimum participation rule, even when this rule is endogenous. This explains the occurrence of minimum participation clauses in most international environmental agreements.

into force is very similar: for the treaties with restricted membership, the average number of years is 5.0 years, for the treaties with open membership is 5.4 years)

The coefficients of the interaction term between the trade index and dummy variable 'mp' and the interaction term between the internal index and dummy variable 'mp' are not significant. There is no evidence that marginal effects on ratification timing before and after a treaty enters into force are different.

4.5 Conclusion to Chapter 4.

The existence of international agreements that deal with public good provision remains a puzzle for economic theory mostly due to the market failure caused by the existing externalities, incentives to free-ride, and the absence of supra-national authority. In this chapter we analyse the drivers of international cooperation and their role in overcoming free-riding incentives.

The process of treaty participation is modelled as a sequential game, where countries decide on the time to join an international treaty based on the decisions made by other countries. We estimate whether international influence has an effect on ratification timing.

Our work presents an empirical approach to estimate countries' interdependent ratification behaviour. In order to do it, we construct the indexes that capture economic and geopolitical sources of interdependencies between countries. Such interstate influence is analysed together with the other political and economic factors that are traditionally considered as important determinants of international cooperation. Our comprehensive dataset allows us to estimate the panel data model taking into account heterogeneity among countries and treaties.

The outcome variable characterises the country's incentives to cooperate. It is constructed as a time elapsed between subsequent ratification dates. International influence associated with the political and economic pressure between countries is estimated through three indexes that capture the 'group of ratifiers-state' influence, where by 'group of ratifiers' we mean the countries that ratified the treaty before the observed country's ratification. It allows us to estimate the magnitude of the forces that affect ratification timing and see whether geopolitical and economic pressure may overcome free-riding incentives.

The results demonstrate that the existing links between countries affect ratification timing and may reduce or increase the number of days between subsequent ratification dates. In particular, strong trade links between countries may accelerate their international environmental cooperation and reduce the time between subsequent ratification actions. At the

same time, we observe the opposite effect of the indexes that capture the internal and global position of countries relative to the group of countries that ratified before: the results demonstrate that countries are not interested in obtaining higher global or internal status, and their decisions about the time of ratification are driven by economic rationality (the internal index), or free-riding incentives (the free-riding index). Furthermore, the fixed effects model allows us to estimate the role of heterogeneity that comes from the types of treaties: with open and restricted membership. The effect that interdependencies have on ratification timing is stronger for the local treaties. This may be explained by the role of historically established neighbouring links that accelerate the existing international influence.

4.6 Appendix 5.

4.6.1 Geographical index.

The existing literature on international cooperation widely uses geographical dummies as control variables to account for the externalities that the provision of public goods generates. Since we use the model with country fixed effects, the inclusion of dummy variables makes the estimation of our model problematic. Instead of including the geographical dummies for regions, we use the approach presented in Bernauer et al. (2010). In their study, Bernauer et al. (2010) examine international and domestic factors that affect international cooperation, and, in particular, the motivation of countries to ratify international treaties. Among other determinants of international cooperation, they analyse the countries' contingent behaviour exhibited when countries share some common characteristics, such as their location in the same geographic region. These common characteristics may result in so-called 'policy diffusion', when nations take similar actions if their neighbours are doing so (Simmons (2009)).

The sources of such contingent behaviour may include existing trade and economic ties between neighbours, as well as dependence on political relations with neighbours when countries fortify their borders through establishing political alliances and expand their influence in the particular regions.

At the same time, neighbours' participation in a treaty may have an opposite effect and cause delays in subsequent ratification times due to an incentive to free-ride.

In order to capture the effects coming from the location of countries, Bernauer et al. (2010) use the index, which is constructed as a share of the countries who ratified the agreement in the total number of countries in a particular region. The results of Bernauer et al. (2010) demonstrate that the propensity of a country to join an international environmental agreement increases with the share of other countries in the same geographic region that have joined this agreement.

In our analysis, a similarly constructed index gives us the results for the whole sample that are in line with the findings of Bernauer et al. (2010): if the proportion of countries who ratified the agreement in the total number of countries in a particular region rises by 0.1, the number of days between subsequent ratification dates are predicted to decrease by 17.1 days, all the other explanatory variables are held fixed (Table 19, column (5)). However, we get unstable results once the sample is split. While for the whole sample the coefficient is negative and significant, it loses its significance for the treaties with restricted membership, and becomes positive and strongly significant at 95 percent confidence level for the treaties with open membership. Unstable and biased results may be due to imperfect multicollinear-

ity: the geographical index is highly correlated with the trade index ($r_{geo\_index;trade\_index} = 0.6027$ for the whole sample, $r_{geo\_index;trade\_index} = 0.5640$ for the treaties with open membership: $r_{geo\_index;trade\_index} = 0.6505$ for the treaties with restricted membership) and the free-riding index ($r_{geo\_index;free-riding\_index} = 0.6541$ for the whole sample, $r_{geo\_index;free-riding\_index} = 0.7168$ for the treaties with open membership: $r_{geo\_index;free-riding\_index} = 0.4457$ for the treaties with restricted membership).

Given the high correlation with trade and free-riding indexes, we estimate our model without the geographical index. The way of constructing our three main indexes described in the previous sections allows us to do it, as they capture the variety of links and interdependencies between countries, including those that may have a geographical origin.

Table 19: General model with geographical index.

	(1) all	(2) open	(3) restricted	(4) all	(5) open	(6) restricted
trade_index	-924.8***	-330.1***	-2127.1	-1023.5***	-308.9***	-3279.8*
	(0.002)	(0.002)	(0.181)	(0.001)	(0.002)	(0.068)
internal_index	27.00*	5.108	31.84	27.93**	7.614	37.65
	(0.088)	(0.508)	(0.299)	(0.048)	(0.339)	(0.250)
free-riding_index	385.7***	20.71	668.0**	409.1***	14.47	638.8***
	(0.002)	(0.415)	(0.010)	(0.000)	(0.582)	(0.006)
geo_index	-171.0**	97.26***	-461.1	-167.4**	97.80***	-174.9
	(0.026)	(0.001)	(0.114)	(0.020)	(0.000)	(0.460)
log_gdppc	137.3**	11.80	31.96	165.6***	10.50	246.6
	(0.019)	(0.556)	(0.874)	(0.003)	(0.622)	(0.142)
openness	0.0625	0.111	0.105			
	(0.901)	(0.604)	(0.967)			
democracy	2.131	-0.107	19.51			
	(0.470)	(0.966)	(0.112)			
durable	1.504	0.460	11.60**			
	(0.125)	(0.323)	(0.036)			
leg_left	-11.42	-15.92	-20.41			
	(0.669)	(0.191)	(0.706)			
leg_right	-40.46*	-11.38	-102.5**	-31.50	-0.219	-83.01*
	(0.058)	(0.316)	(0.028)	(0.108)	(0.977)	(0.099)
legelec	-15.26	-6.621	-33.92			
	(0.258)	(0.145)	(0.552)			
sign_before	-26.31*	-8.609	-159.1**	-29.13**	-8.445	-187.3**
	(0.056)	(0.361)	(0.025)	(0.041)	(0.394)	(0.012)
mp	30.03	19.48***	62.02	32.53*	19.40***	49.94
	(0.161)	(0.009)	(0.199)	(0.091)	(0.006)	(0.239)
No.Obs.	1895	1382	513	2125	1557	568
No.Countries	141	140	77	161	160	89
No.Treaties	13.4	9.9	6.7	13.2	9.7	6.4

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 20: General model without missing values.

	(1) all	(2) all	(3) open	(4) restricted	(5) all	(6) open	(7) restricted
trade_index	-1092.6***	-1054.0***	-297.3***	-3247.1*	-1050.1***	-294.5***	-3205.4
	(0.005)	(0.003)	(0.008)	(0.072)	(0.003)	(0.009)	(0.100)
internal_index	34.18**	28.20*	5.239	32.24	30.73*	6.402	32.20
	(0.043)	(0.077)	(0.501)	(0.312)	(0.051)	(0.429)	(0.317)
free-riding_index	310.5***	291.7***	93.67***	607.5***	298.4***	96.42***	653.9***
	(0.000)	(0.001)	(0.000)	(0.010)	(0.000)	(0.000)	(0.005)
log_gdppc		134.7**	15.47	44.90	150.7**	18.28	206.7
		(0.021)	(0.455)	(0.821)	(0.011)	(0.426)	(0.256)
openness		0.0979	0.0711	0.0269			
		(0.846)	(0.739)	(0.992)			
democracy		1.712	0.214	15.11			
		(0.567)	(0.933)	(0.190)			
durable		1.429	0.441	9.013**			
		(0.139)	(0.347)	(0.032)			
leg_left		-9.434	-15.75	-9.176			
		(0.730)	(0.207)	(0.873)			
leg_right		-38.29*	-11.81	-101.0**	-30.66	-1.927	-94.18
		(0.068)	(0.308)	(0.040)	(0.168)	(0.820)	(0.110)
legelec		-14.78	-6.631	-24.93			
		(0.277)	(0.137)	(0.646)			
sign_before		-31.22**	-5.071	-158.6**	-32.97**	-5.496	-163.6**
		(0.035)	(0.595)	(0.027)	(0.030)	(0.575)	(0.031)
mp		32.95	21.16***	92.47*	32.09	20.84***	89.98*
		(0.143)	(0.005)	(0.097)	(0.146)	(0.007)	(0.094)
No.Obs.	1895	1895	1382	513	1895	1382	513
No.Countries	141	141	140	77	161	141	140
No.Treaties	13.4	13.4	9.9	6.7	13.2	13.4	9.9

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 21: General model interactions with 'mp'.

	(1) all	(2) all	(3) all	(4) all	(5) all	(6) open	(7) restricted
trade_index	-8.530	-1062.2***	-289.1**	-3319.6	-1190.4***	-253.1**	-3615.2
	(0.153)	(0.004)	(0.012)	(0.106)	(0.003)	(0.021)	(0.102)
(I) mpc.trade_index	16.09	486.0	144.6	738.9	682.2	26.04	410.8
	(0.968)	(0.305)	(0.588)	(0.685)	(0.228)	(0.915)	(0.831)
internal_index	34.90**	30.27*	7.907	-21.18	29.76**	9.626	-1.341
	(0.024)	(0.072)	(0.378)	(0.577)	(0.046)	(0.307)	(0.969)
(I) mpc.internal_index	-3.307	-4.873	-9.033	73.30*	-2.573	-6.921	55.60
	(0.631)	(0.524)	(0.115)	(0.072)	(0.721)	(0.185)	(0.142)
free-riding_index	410.4***	339.0***	108.9***	738.5***	377.5***	100.3***	756.5***
	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)
(I) mpc.free-riding_index	-334.5***	-282.1***	-110.6***	-457.5**	-346.5***	-104.0***	-524.2***
	(0.001)	(0.000)	(0.001)	(0.017)	(0.000)	(0.001)	(0.007)
mp	140.8***	97.53***	51.65***	150.7*	110.9***	50.62***	164.1**
	(0.002)	(0.003)	(0.000)	(0.075)	(0.000)	(0.000)	(0.045)
log_gdppc		138.5**	17.61	1.443	164.3***	15.78	196.4
		(0.016)	(0.396)	(0.994)	(0.003)	(0.470)	(0.236)
openness		0.0877	0.0502	-0.0467			
		(0.862)	(0.809)	(0.985)			
democracy		1.608	0.118	14.58			
		(0.590)	(0.963)	(0.202)			
durable		1.292	0.418	9.605**			
		(0.182)	(0.378)	(0.024)			
leg_left		-9.140	-15.64	-2.778			
		(0.738)	(0.210)	(0.961)			
leg_right		-37.04*	-12.47	-89.82*	-28.50	-1.142	-78.26
		(0.080)	(0.279)	(0.071)	(0.143)	(0.878)	(0.139)
legelec		-15.57	-7.243	-21.51			
		(0.254)	(0.119)	(0.690)			
sign_before		-31.06**	-6.447	-140.3*	-32.25**	-6.266	-164.3**
		(0.038)	(0.506)	(0.058)	(0.033)	(0.544)	(0.029)
No.Obs.	2347	1895	1382	513	2125	1557	568
No.Countries	182	141	140	77	161	160	89
No.Treaties	12.9	13.4	9.9	6.7	13.2	9.7	6.4

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 22: General model interactions with 'sign'.

	(1) all	(2) all	(3) all	(4) all	(5) all	(6) open	(7) restricted
trade_index	-667.9*	-1689.3**	-370.4*	-3118.6	-1891.6***	-325.0*	-2990.7
	(0.059)	(0.019)	(0.081)	(0.343)	(0.009)	(0.099)	(0.328)
(I) sign_beforec.trade_index	666.2*	1113.3	122.3	454.7	1275.4*	88.55	-463.6
	(0.060)	(0.137)	(0.602)	(0.904)	(0.082)	(0.680)	(0.875)
internal_index	68.70**	81.06**	65.76	15.63	62.76*	50.60	4.684
	(0.028)	(0.045)	(0.113)	(0.929)	(0.053)	(0.108)	(0.978)
(I) sign_beforec.internal_index	-42.81*	-57.85*	-60.45*	20.57	-39.24	-45.36*	34.90
	(0.083)	(0.080)	(0.091)	(0.904)	(0.138)	(0.090)	(0.835)
free-riding_index	466.8***	415.5***	115.8***	825.7***	466.0***	108.5***	856.2***
	(0.000)	(0.001)	(0.000)	(0.008)	(0.000)	(0.001)	(0.003)
(I) sign_beforec.free-riding_index	-310.1***	-220.5**	-42.52	-373.6	-267.5***	-44.60	-416.2*
	(0.000)	(0.016)	(0.244)	(0.134)	(0.003)	(0.192)	(0.078)
sign_before	106.2***	56.47*	41.12*	-2.163	62.95**	37.09**	17.25
	(0.003)	(0.053)	(0.055)	(0.989)	(0.028)	(0.040)	(0.910)
log_gdppc		121.1**	5.483	-22.06	149.6***	5.654	151.3
		(0.035)	(0.794)	(0.918)	(0.006)	(0.794)	(0.395)
openness		0.0989	0.0454	0.108			
		(0.838)	(0.829)	(0.968)			
democracy		1.619	0.0000408	13.51			
		(0.583)	(1.000)	(0.285)			
durable		1.472	0.413	8.954*			
		(0.101)	(0.346)	(0.069)			
leg_left		-9.166	-13.93	-16.13			
		(0.736)	(0.255)	(0.787)			
leg_right		-36.71*	-9.303	-99.64**	-29.56	-1.288	-76.87
		(0.085)	(0.434)	(0.046)	(0.110)	(0.858)	(0.121)
legelec		-15.99	-6.316	-22.47			
		(0.231)	(0.164)	(0.682)			
mp		23.02	17.06**	72.35	22.94	16.66***	33.90
		(0.268)	(0.011)	(0.172)	(0.231)	(0.007)	(0.422)
No.Obs.	2347	1895	1382	513	2125	1557	568
No.Countries	182	141	140	77	161	160	89
No.Treaties	12.9	13.4	9.9	6.7	13.2	9.7	6.4

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.6.2 Clusters.

In our dataset, we observe clustered ratification decisions, when countries ratify simultaneously. This may be a result of interdependent behaviour of countries. The nature of clustered decisions is addressed in Áureo de Paula (2009), who studies the problem of determining the existence and uniqueness of equilibrium stopping strategies by using a simultaneous duration model with multiple decision makers and interdependent durations. Their findings demonstrate that endogenous effects (direct strategic effects of a player's action on other agents' choices) are necessary and sufficient for simultaneous exits with positive probability in the proposed environment. For the empirical illustration Áureo de Paula (2009) uses data on desertion of soldiers in the Union Army during the American Civil War and find evidence of such endogenous influences.

Wagner (2016) explains clustered ratification decisions by strong strategic complementarity when ratification by one country triggers ratification by another, generating clusters of ratification events in the data.

In order to account for the simultaneous ratification decisions, we generate the indexes for the clustered observations in the following way:

1) the trade index for the countries that ratify simultaneously is constructed as the share (percentage) of the sum of exports from a country i to all the countries that ratified before it and the countries that ratify at the same day with the country i in the total exports from the country i.

2) the internal index for the countries that ratify simultaneously is constructed as the ratio of the country i's GDP per capita in the average GDP per capita of countries in the group of ratifiers $C_i(k)$ including the country i and the countries that ratify at the same day with the country i.

3) the free-riding index for the countries that ratify simultaneously is constructed as the share of the total wealth of countries that committed to the agreement k including a country i and the countries that ratify at the same day with the country i in total world GDP.

4.6.3 Descriptive statistics.

Table 23: Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Dep.Variable (days)	3,313	104.297	287.8435	0	4772
trade_index	2,464	0.0483828	0.422237	0	20.85173
internal_index	3,077	0.8221053	1.201111	0.0090547	12.98467
free-riding index	3,056	0.4913457	0.2837111	0.0000542	1
log_gdppc	3,088	8.567744	1.537571	5.186277	12.17658
trade openness	2,934	83.22492	47.40295	0.1831036	425.3634
democracy	2,737	3.870296	6.661153	-10	10
durable	2,738	25.30789	31.00958	0	207
leg_left	2,749	0.3306657	0.4705385	0	1
leg_right	2,749	0.2644598	0.4411254	0	1
legelec	2,916	0.2301097	0.4209751	0	1
sign_before	3,576	0.6017897	0.4895977	0	1
mp	3,576	0.2706935	0.4443802	0	1

Table 24: Correlation coefficients (whole sample, obs = 1,895).

	Dep.Variable (days)	trade_index	internal index	free-riding index	log_gdppc	trade openness	democracy	durable	leg_left	leg_right	legelec	sign_before	mp
Dep.Variable (days)	1.0000												
trade_index	-0.0130	1.0000											
internal index	-0.0170	-0.2010	1.0000										
free-riding index	0.1324	0.5903	-0.1883	1.0000									
log_gdppc	0.0541	-0.2661	0.6970	-0.1976	1.0000								
trade openness	0.0230	-0.0109	0.1967	-0.0018	0.2145	1.0000							
democracy	0.0165	-0.1190	0.2899	-0.1005	0.4829	0.0515	1.0000						
durable	-0.0372	-0.1871	0.5575	-0.1761	0.5697	0.0342	0.2057	1.0000					
leg_left	0.0315	-0.0175	-0.0033	-0.0374	0.0276	-0.0029	0.0390	0.0691	1.0000				
leg_right	-0.0030	-0.1025	0.1810	-0.0538	0.3006	-0.0430	0.3013	0.1470	-0.4368	1.0000			
legelec	-0.0133	-0.0230	0.0293	-0.0001	0.0613	-0.0164	0.1052	0.0240	0.0194	0.0273	1.0000		
sign_before	-0.1682	-0.2329	0.2390	-0.2963	0.2973	-0.0598	0.2172	0.2343	0.0156	0.0723	0.0413	1.0000	
mp	-0.0865	-0.4915	0.1246	-0.7221	0.1974	0.0067	0.0898	0.2001	0.0392	0.0453	0.0155	0.2810	1.0000

Table 25: Correlation coefficients (open membership, obs = 1,382).

	Dep.Variable (days)	trade_index	internal index	free-riding index	log_gdppc	trade openness	democracy	durable	leg_left	leg_right	legelec	sign_before	mp
Dep.Variable (days)	1.0000												
trade_index	0.0540	1.0000											
internal index	0.0370	-0.1850	1.0000										
free-riding index	0.0445	0.5933	-0.1882	1.0000									
log_gdppc	0.0377	-0.2093	0.7587	-0.1782	1.0000								
trade openness	0.0196	-0.0356	0.2331	0.0023	0.2354	1.0000							
democracy	-0.0471	-0.1083	0.2910	-0.1221	0.4006	0.0194	1.0000						
durable	0.0328	-0.1502	0.6107	-0.1755	0.5809	0.0613	0.1673	1.0000					
leg_left	-0.0413	0.0164	-0.0019	-0.0215	0.0162	0.0300	0.0692	0.0924	1.0000				
leg_right	0.0123	-0.1022	0.1981	-0.0680	0.2982	-0.0561	0.3071	0.1492	-0.3880	1.0000			
legelec	-0.0291	-0.0199	0.0237	-0.0067	0.0688	0.0127	0.0989	0.0161	0.0218	0.0328	1.0000		
sign_before	-0.1757	-0.1854	0.2317	-0.2643	0.2318	-0.0689	0.1809	0.1860	-0.0105	0.0670	0.0303	1.0000	
mp	-0.0511	-0.4778	0.1140	-0.7203	0.1271	0.0083	0.0719	0.1609	0.0082	0.0331	0.0068	0.2346	1.0000

Table 26: Correlation coefficients (restricted membership, obs = 513).

	Dep.Variable (days)	trade_index	internal index	free-riding index	log_gdppc	trade openness	democracy	durable	leg_left	leg_right	legelec	sign_before	mp
Dep.Variable (days)	1.0000												
trade_index	0.1586	1.0000											
internal index	-0.1194	-0.2881	1.0000										
free-riding index	0.3550	0.5855	-0.1900	1.0000									
log_gdppc	-0.2112	-0.1683	0.6109	-0.1225	1.0000								
trade openness	0.0143	0.1538	0.0316	0.0025	0.1455	1.0000							
democracy	-0.0874	0.0793	0.2907	0.0557	0.6430	0.1444	1.0000						
durable	-0.1738	-0.2352	0.4705	-0.1376	0.5653	-0.0454	0.2411	1.0000					
leg_left	0.0629	-0.0963	-0.0156	-0.0554	-0.0046	-0.1101	-0.0874	0.0045	1.0000				
leg_right	-0.0998	0.0095	0.1287	0.0284	0.2290	-0.0229	0.2312	0.1052	-0.5832	1.0000			
legelec	-0.0114	-0.0350	0.0514	0.0190	0.0471	-0.1092	0.1301	0.0399	0.0123	0.0130	1.0000		
sign_before	-0.3876	-0.3156	0.2664	-0.3394	0.3992	-0.0508	0.2423	0.3123	0.0646	0.0274	0.0735	1.0000	
mp	-0.2690	-0.5036	0.1563	-0.7082	0.2244	-0.0180	0.0213	0.2259	0.0847	0.0086	0.0342	0.3455	1.0000

Table 27: Control variables.

Variable Name	Variable Label in primary dataset	Data source	Variable Description
Economic indicators			
log_gdppc	GDP per capita	the World Bank Open Data Project (1)	A natural logarithm of a Gross Domestic Product divided by midyear population in constant 2010 US dollars
openness	Exports of goods and services (% of GDP); Imports of goods and services (% of GDP)	the World Bank Open Data Project	Trade openness is the sum of exports and imports of goods and services measured as a share of GDP
Indicators of democracy and autocracy, polity regime transitions			
democracy	POLITY2	Polity V Project of the Center for Systemic Peace provides information about indicators of democracy and autocracy, authority characteristics and polity regime transitions. It contains data for the period from 1800 to 2018.(2)	A variable defines the level of democracy. It ranges from +10 (strongly democratic) to -10 (strongly autocratic)
durable	DURABLE	Polity V Project	Regime Durability: The number of years since the most recent regime change (defined by a three-point change in the POLITY score over a period of three years or less) or the end of transition period defined by the lack of stable political institutions.
Institutional and electoral results data			
leg_right	GOV1RLC	Inter-American Development Bank (2017). The Database of Political Institutions 2017 (DPI2017). The current version of the database covers about 180 countries for 40 years, 1975-2017. (3)	The orientation of the 1st largest party in the Legislature with respect to economic policy, coded based on the description of the party in the sources. Right is a dummy variable equal to one if party is defined as conservative, Christian democratic, or right-wing, and zero otherwise
leg_left	GOV1RLC	Inter-American Development Bank (2017). The Database of Political Institutions 2017 (DPI2017).	The orientation of the 1st largest party in the Legislature with respect to economic policy, coded based on the description of the party in the sources. Left is a dummy variable equal to one if a party is defined as communist, socialist, social democratic, or left-wing, and zero otherwise
legelec	LEGELEC	Inter-American Development Bank (2017). The Database of Political Institutions 2017 (DPI2017).	'1' if there is a legislative election in this year

Notes: 1. The World Bank Open Data Project available at: https://data.worldbank.org/indicator/NE.EXP.GNFS.ZS
2. Polity V Project is available at: http://www.systemicpeace.org/inscrdata.html.
The previous version of the dataset known as a Polity IV Project has been widely used in empirical works that studied the effect that the level of democratization has on the participation in IEAs. (see, for example, Battaglini and Harstad (2020), Cazals and Sauquet (2015)).
3. The Database of Political Institutions 2017 (DPI2017) Inter-American Development Bank (2017) is available at: https://www.iadb.org/en/research-and-data/dpi2017.

Table 28: List of agreements.

No.	IEA Name	Open / Restricted
1	Convention On The Law Of The Non-Navigational Uses Of International Watercourses	O
2	Agreement On Cooperative Enforcement Operations Directed At Illegal Trade In Wild Fauna And Flora	R
3	Convention To Combat Desertification In Those Countries Experiencing Serious Drought And/Or Desertification, Particularly In Africa	O
4	Agreement On The Conservation Of Small Cetaceans Of The Baltic And North Seas	R
5	Convention On Biological Diversity	O
6	Cartagena Protocol on Biosafety to the Convention On Biological Diversity	O
7	Nagoya-Kuala Lumpur Supplementary Protocol on Liability and Redress to the Cartagena Protocol on Biosafety to the Convention On Biological Diversity	O
8	Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity	O
9	United Nations Framework Convention On Climate Change	O
10	Protocol To The United Nations Framework Convention On Climate Change	O
11	Paris Agreement under the United Nations Framework Convention on Climate Change	O
12	Convention On The Protection And Use Of Transboundary Watercourses And International Lakes	R
13	Protocol On Water And Health To The Convention On The Protection And Use Of Transboundary Watercourses And International Lakes	R
14	Convention On Environmental Impact Assessment In A Transboundary Context	R
15	Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context	R
16	Convention On Access To Information, Public Participation In Decision-Making And Access To Justice In Environmental Matters	R
17	Protocol on Pollutant Release and Transfer Registers to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters	R
18	Convention On Long-Range Transboundary Air Pollution	R
19	Protocol On Long-Term Financing Of The Cooperative Programme For Monitoring And Evaluation Of The Long-Range Transmissions Of Air Pollutants In Europe To The Convention On Long-Range Transboundary Air Pollution	R
20	Protocol On The Reduction Of Sulphur Emissions Or Their Transboundary Fluxes By At Least 30 Per Cent To The Convention On Long-Range Transboundary Air Pollution	R
21	Protocol Concerning The Control Of Emissions of Nitrogen Oxides Or Their Transboundary Fluxes To The Convention On Long-Range Transboundary Air Pollution	R
22	Protocol Concerning The Control Of Emissions Of Volatile Organic Compounds Or Their Transboundary Fluxes To The Convention On Long-Range Transboundary Air Pollution	R
23	Protocol On Further Reduction Of Sulphur Emissions To The Convention On Long-Range Transboundary Air Pollution	R
24	Protocol On Heavy Metals To The Convention On Long-Range Transboundary Air Pollution	R
25	Protocol On Persistent Organic Pollutants To The Convention On Long-Range Transboundary Air Pollution	R
26	Protocol To Abate Acidification, Eutrophication And Ground-Level Ozone To The Convention On Long-Range Transboundary Air Pollution	R
27	Convention On The Control Of Transboundary Movements Of Hazardous Wastes And Their Disposal	O
28	Protocol On Liability And Compensation For Damage Resulting From Transboundary Movements Of Hazardous Wastes And Their Disposal	O
29	Convention For The Protection Of The Ozone Layer	O
30	Montreal Protocol On Substances That Deplete The Ozone Layer	O
31	Convention On The Prior Informed Consent Procedure For Certain Hazardous Chemicals And Pesticides In International Trade	O
32	Convention On Persistent Organic Pollutants	O
33	Minamata Convention on Mercury	O
34	Convention For The Protection Of The Mediterranean Sea Against Pollution	R
35	Protocol For The Prevention And Elimination Of Pollution Of The Mediterranean Sea By Dumping From Ships And Aircraft	R
36	Protocol Concerning Cooperation In Combating Pollution Of The Mediterranean Sea By Oil And Other Harmful Substances In Cases Of Emergency	R
37	Protocol For The Protection Of The Mediterranean Sea Against Pollution From Land-Based Sources	R
38	Protocol Concerning Mediterranean Specially Protected Areas	R
39	Protocol For The Protection Of The Mediterranean Sea Against Pollution Resulting From Exploration And Exploitation Of The Continental Shelf And The Seabed And Its Subsoil	R
40	Protocol Concerning Specially Protected Areas And Biological Diversity In The Mediterranean	R
41	Protocol On The Prevention Of Pollution Of The Mediterranean Sea By Transboundary Movements Of Hazardous Wastes And Their Disposal	R
42	Protocol Concerning Cooperation In Preventing Pollution From Ships And, In Cases Of Emergency, Combating Pollution Of The Mediterranean Sea	R
43	Protocol on Integrated Coastal Zone Management in the Mediterranean	R
44	International Convention For The Conservation Of Atlantic Tunas	O
45	Convention For The Conservation Of Salmon In The North Atlantic Ocean	R
46	Agreement On The Network Of Aquaculture Centres In Asia And The Pacific	R
47	Convention For The Prohibition Of Fishing With Long Driftnets In The South Pacific	R
48	Convention On Fisheries Cooperation Among African States Bordering The Atlantic Ocean	R
49	Agreement On The Conservation Of Cetaceans Of The Black Sea, Mediterranean Sea And Contiguous Atlantic Area	R
50	Inter-American Convention For The Protection And Conservation Of Sea Turtles	R
51	Agreement On The International Dolphin Conservation Program	R
52	Convention on the Conservation of Migratory Species of Wild Animals	O

5 Conclusion.

5.1 Main empirical findings.

In the domain of public good provision, implementation of the agreements, which may have reached success in negotiations, is particularly problematic. Ratification of the agreements by a minimum number of countries can often take many years. Because of the ratification delay and time criticality of the problems addressed by environmental agreements, successfully negotiated outcomes are often not enough if they arrive too late to resolve or save a situation. For that reason, a post-negotiation period in a treaty-making process requires particular attention of researchers. Our work addresses a number of timely and important questions about the decisions made by countries during the post-negotiation period.

The second chapter examines the interaction between the Executive and the Legislature as domestic institutions involved in a treaty-making process. We study their interaction using a game-theoretical model where the Executive who cares about her political status sends a signal to the Legislature by signing or not signing a treaty. The payoff of the Executive depends on the degree of her office motivation, which reaches its maximum when the Executive is facing an election. Our findings demonstrate that the electoral incentives of the Executive affect the decisions made by both key players, and the outcome in the treaty-making process. The Executive, who is facing an election, experiences strong reelection concerns and tends to act in accordance with the Legislature's preferences.

In order to test the main hypothesis and look into the correlation between the level of the Executive's motivation and the behaviour of agents in a treaty-making process, we use the logistic regression for the sample of countries with presidential and semi-presidential systems that assume executive-legislature separation. Our independent variable of interest is the time within the electoral cycle, which is used as a proxy for the level of the Executive's office motivation that changes within the electoral cycle. The results support our main hypothesis and show that the Executive's electoral incentives affect the probability of the ideology equilibrium, in which the actions of the Executive and the Legislature are discordant. In addition, we study the impact of political and economic factors on the behaviour of agents. Our results show that economic factors affect the probability of ideology equilibrium, while the impact of political factors, such as the democracy level and the Executive's governing period, remains ambiguous. Furthermore, the results demonstrate that the impact of political and economic factors is expected to be more significant in treaties with open membership that often have complex structure and use various economic and political mechanisms to make the treaty effective. Treaties that deal with local environmental problems are likely

to involve countries that have historically established relations and 'neighbouring' links, which helps them to combine resources and efforts to solve a particular problem. For such treaties the impact of economic and political factors may be less significant.

The third chapter is inspired by the theoretical contribution of the second chapter which treats the signature as a signalling device. The third chapter revisits the empirical evidence on the role of treaty signing in determining the timing of the ratification decision.

In order to test whether signing a treaty affects the ratification timing, we employ the Cox proportional hazard model with multiple-record data, which allows us to take into account the changes of independent variables through time. We also estimate how the ratification timing depends on economic and political factors and on the type of the Executive who has signed the treaty: the Executive who has negotiated a treaty, and the Executive who has not taken part in the negotiations. We construct two dummy variables that describe the signature timing in relation to the negotiations. The results show that the decision of the Executive to sign a treaty significantly increases the probability that the treaty is subsequently ratified. This effect does not depend on whether the Executive participated in the negotiations or didn't. The effect of main and control variables on ratification timing is different for developing and developed countries and for the treaties with open and restricted membership.

Finally, the fourth chapter turns to the international factors that affect the ratification timing, in particular, the interdependent ratification behaviour of countries in the post-negotiation period. We propose a novel empirical approach to the estimation of the factors that affect the ratification timing in the presence of interdependencies between states. We employ a fixed effect model, in which international influence associated with the political and economic pressure between countries is estimated through indexes that capture the existing interdependencies between the countries. They are constructed in a way that captures three types of spillovers: spillovers between two countries (pairwise spillovers); between a country and a group of ratifiers as a formed coalition; and between a country within a group of ratifiers and a set of all countries to which the treaty is open for ratification including non-ratifiers. It allows us to estimate the magnitude of the conflicting forces that affect ratification timing and to see whether geopolitical and economic pressure may overcome free-riding incentives.

The results demonstrate that the existing links between countries affect ratification timing and may reduce or increase the number of days between subsequent ratification dates. In particular, strong trade links between countries may accelerate their international environmental cooperation and reduce the time between subsequent ratification actions. At the same time, we observe the opposite effect of the indexes that capture the internal and global

position of countries relative to the group of countries that ratified before: the results demonstrate that countries' decisions about the time of ratification are driven by economic rationality (the internal index), or free-riding incentives (the free-riding index) rather than their interest in obtaining higher global or internal status.

This research aims to deepen the understanding of international cooperation in the domain of public goods provision and investigates the role of factors facilitating and accelerating participation in IEAs, making them more effective in addressing international environmental problems. The results provide some ideas for policy implications. The analysis of the link between the electoral cycles and the decisions to sign an agreement is informative to the international organisations and government bodies responsible for the arrangement of negotiations. Our research demonstrates that time within the electoral cycle may affect the behaviour of leaders both at the international and domestic levels. Finding the right time for organizing the negotiations between the leaders of countries or their representatives about IEA terms when they are in a position favourable towards signing the agreement, may affect the negotiation outcomes and finally the success of the treaty. Identifying such points in time may even be easier for treaties with restricted membership.

Moreover, while ratification remains the main instrument that makes a treaty effective, in our research we demonstrate the role of signature as a factor that may accelerate the ratification decision. Signing appears to be a signal to the domestic legislature in presidential and semi-presidential systems. The number of signatures may indicate the potential number of ratifications and the speed at which the treaty enters into force. After the text of the treaty is adopted and the treaty is open for signature and ratification, one can predict the sequence of countries who will ratify the treaty based on the number of signatories, the political and economic situation in their countries, as well as existing links between countries.

5.2 Future research.

In our empirical analysis we use newly compiled data. This makes a significant contribution to the domain of international treaty-making research. However, increasing environmental damage requires immediate action from governments who negotiate and introduce new IEAs every year. Our dataset is limited by the period 1975-2017, and new IEAs can be added to it. It will increase the sample size, increase the confidence and precision of the estimate, and reduce the uncertainty.

The theoretical model presented in Chapter 2 can be developed if we introduce the environmental positions of the Executive and the Legislature. For example, in terms of the Legislature it might be the relatively "green" party, which has more environmentally friendly

preferences than the median voter does; or the relatively "brown" party, which has less environmentally friendly preferences than the median voter does. It will shift the cost and benefit functions and may result in different types of equilibria.

Another interesting topic for future research could be related to the study of a minimum participation clause (MPC). A minimum participation clause establishes that a treaty becomes effective only if a certain threshold of a minimum number of ratified countries is met. It ensures that the agreement has a certain level of support and relevance before it becomes binding. MPC is considered to be a very common and potentially successful tool to increase IEA participation, given the self-enforcing nature of IEAs, because countries who have already ratified an agreement are not obliged to commit to any obligation of an agreement until enough other states join the treaty. The specific requirements and a minimum number of countries are different for each treaty and are discussed by the negotiators before the treaty adoption. Recent studies have developed theoretical approaches to better understand the mechanism of minimum participation requirements and find the optimal minimum number of ratifiers. However, they do not provide empirical evidence; also, they do not address the delay in reaching the minimum participation requirement and the treaty's entering into force, which may undermine collective efforts. In addition, the comprehensive dataset of IEAs allows us to estimate the impact of political and economic factors on the choice of the minimum number of countries and on the speed of the treaty becoming effective. The model with time-varying covariates employed in Chapter 3 is a good tool for the estimation of the models when information about important milestones for the treaties is available. For example, the dataset can be expanded with information about the date when treaties entered into force. The effect of signature on the ratification timing might be different depending on whether a treaty is in force or not: a country would not be interested in being bound by a treaty until enough other states were bound by the same obligations.

The approach presented in the fourth chapter can be used for the construction of other indexes that measure interdependencies between the countries. For example, the index that takes into account the international organisations membership, intergovernmental alliances and other formal agreements between nations.

The other index may reflect the level of democracy within the group of ratified countries. If many democratic countries participate in an agreement, the probability of other democracies joining them increases. At the same time, autocratic countries may follow each other in the joint goals and form a coalition as well.

One more issue that requires further analysis is upper-censoring. Indeed, the dataset in Chapter 4 includes only countries that ratified before 1 January 2018. Countries that have

not ratified by that date are considered right-censored observations and at the moment they are not included in our analysis. In further research, we can include the countries that have the right to ratify after 1 January 2018, but we don't know when they ratify after that date, in what order, if ratify at all [27].

Survival analysis, for example, the Cox proportional hazards model employed in Chapter 3, deals with right-censored data: our dependent variable is constructed as a number of days between the date of treaty adoption and ratification, which means that values of censored observations will be larger than a particular value. However, in Chapter 4, we cannot say the same about our dependent variable, and we cannot predict the value of it. One of the reasons for that is the way we construct our dependent variable, which is a number of days between subsequent ratification dates. The 'initial' state of the world for each country is a stationary state, that does not depend on the sequence of entries, but depends only on the characteristics of countries within the group of ratifiers (the countries who ratified before).

The Heckman selection model might be a potential solution for this type of dependent variable, however, as we don't know the order of ratification decisions after 1 January 2018 for censored observations, we cannot correctly construct the indexes at the initial state of the world for each country that measure interdependencies. It might be a problem, as indexes are included in the set of independent variables, which is the same for both regression and selection equations in the Heckman model. We could suggest the potential assumption that all the countries ratify at the same date in the future, however, this is a very strong assumption, and it also states that all the countries will ratify, which is not true. In this case, the results should be interpreted with caution.

[27] Surely, the information about some new ratifiers in the 2018-2023 period is already available and can be added to further analysis, however, here we discuss the particular case with the exact cut-off time.

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