POLITICAL INSTITUTIONS, INTEREST GROUPS, AND THE RATIFICATION OF INTERNATIONAL ENVIRONMENTAL AGREEMENTS*

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Abstract

We investigate how domestic political institutions and interest group pressures jointly determine the probability that a country ratifies an international environmental agreement. We build a multi-agent, multi-principal 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 model suggests an asymmetry in the impact of political institutions on lobby groups. Institutional arrangements with a greater number of veto players reduce the positive impact of environmental lobbying on the ratification probability. Such institutional features have ambiguous effects on industry lobbying, however. We test these predictions using Logit and stratified proportional hazard models, and panel data from 170 countries on the timing of Kyoto Protocol ratification. Consistent with our theory, increased environmental lobby group pressure raises the probability of ratification, and the effect declines as the number of veto players increases. Firm lobbying is unaffected by the number of veto players.

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I. INTRODUCTION

To gain legal force, the Kyoto Protocol on greenhouse gases needed ratification by at least 55 countries representing 55% of OECD and former Eastern Bloc countries' 1990 emissions. This threshold was reached in November 2004 with the ratification of the Russian Federation, almost 7 years after the Protocol was opened for ratification on March 16, 1998.

Countries have exhibited widely different ratification behavior. While some island states like the Maldives or Fiji ratified after only a few months, France and Japan waited several years. A few countries, including Australia, Croatia, Kazakhstan, and the U.S., have not yet ratified (as of September 12, 2006). The slow entry into force of international environmental agreements (IEAs) appears to be an important obstacle to addressing global environmental problems in a timely manner. Thus, an improved understanding of ratification behavior is important for improving the IEA policy process. This paper seeks to uncover how domestic political institutions shape the ability of political interest groups to influence ratification of international environmental agreements. We provide a theory of ratification, and test the predictions on Kyoto Protocol data.

We study the game played by the various interested parties *within* a country facing a ratification decision, and the interaction between domestic institutions and interest group lobbying. Any international strategic influences are taken as given.[1] While various features of the domestic institutional environment may have an impact on the ratification of international environmental agreements, our focus is on the *number* of domestic individual or collective veto players (VPs) participating in a ratification decision (such as the president, the prime minister, the chambers of parliament, the majority party, or the government coalition parties; see Tsebelis, 1999, 2002).[2,3] Ratification decisions, similarly to most major policymaking, involve several VPs that are all subjected to lobby group pressures.

[1] Previous literature on the ratification of international environmental agreements (IEAs) has treated the domestic political process in each country as a black box, and has focused on the games of negotiation countries play against each other (see, e.g., Carraro and Siniscalco, 1993; Barrett, 1994). While such strategic aspects might be theoretically important for large countries, it is unclear to what extent they influence decision making in the many smaller nations. Moreover, the few empirical studies that exist on this aspect of IEA ratification have found no empirical support for strategic interactions (see Beron *et al*., 2003).

[2] The literature has identified positive effects of broad measures of democracy on the degree of international cooperation on global environmental problems (see, for example, Congleton, 1992; Neumayer, 2002a; and Beron *et al*., 2003). Moreover, see, e.g., Persson *et al*. (1997, 2000), Bennedsen and Feldmann (2002), and Fredriksson and Millimet (2004) for discussions of the role of domestic political institutions such as presidential and parliamentary regimes for fiscal policy, lobbying, and environmental policy, respectively.

We first present a simple model building on the vote-buyer approach of Groseclose and Snyder (1996) and Diermeier and Myerson (1999). In the model, firm and environmental lobby groups seek to affect an IEA ratification decision made by n identical and independent VPs by paying campaign contributions. Ratification occurs only if all VPs vote for it. The theory identifies an asymmetry between environmental and firm lobby groups' impact on the IEA process. While the pro-reform environmental lobby must convince *each* VP to support ratification, the anti-reform firm lobby needs only to convince *one* single VP to block ratification. The required contribution to each VP is constant, and thus while environmental lobbying raises the ratification probability, the effect is *conditional* on the number of VPs. In particular, an increase in the number of VPs *reduces* the impact of environmental lobbying on the ratification probability. On the other hand, the impact of firm lobbying is *independent* of the number of VPs.

We proceed to generalize these implications to a setting in which the lobbies move simultaneously, and VPs' effect on the ratification outcome is probabilistic. This extension builds on the common agency tradition (Bernheim and Whinston, 1986; Grossman and Helpman, 1994), but has multiple agents as well as multiple principals, with externalities among the agents.[4] In this model, contributions are made by budget-constrained industry and environmental lobby groups,[5] and each of the n VPs determines the level of her political support for ratification, taking both the contribution offers from the lobby groups and social welfare into account. The probability that the country ratifies the IEA is a function of the VPs' political support, with the property that any VP can unilaterally decrease this probability, but her ability to increase it depends on the other VPs' support. This feature generalizes the notion of veto power and allows for probabilistic ratification outcomes.[6]

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[3] The literature argues that the number of collective or individual actors whose agreement is necessary for a policy change (veto players), and the ideological distance between them, affects the stability of government policies, as well as their ability to address problems such as budget deficits and inflation (Roubini and Sachs, 1989; Tsebelis, 1999, 2002; and Keefer and Stasavage, 2003).

[4] See Segal (1999) and Martimort and Stole (2003) for different approaches to externalities in agency problems, and Prat and Rustichini (2003) for a general multi-principal multi-agent model without externalities. The lobbying literature has largely ignored the implications of multiple veto players, and the externalities created by policy decisions.See Grossman and Helpman (1996, 2001) for multiple-lobby group, multiple-party models.

[5] For example, budget constraints might result from the fact that lobby groups' ability to generate funds is restricted by free-riding incentives (see, e.g., Olson, 1965).

[6] This approach is consistent with our empirical work, which investigates the determinants of the probability of ratification. It is related to the contest success functions approach previously used to model environmental conflicts (see, for example, Heyes, 1997; Hurley and Shogren, 1998).

In this extended model, increasing the number of VPs increases the lobbying expenditures of the environmental lobby, and therefore reduces its positive impact on the ratification probability (as in the simple model). At the same time, the number of VPs might increase or decrease the lobbying expenditures of the firm lobby. Thus, the effect of VPs on the influence of the firm lobby is ambiguous, and therefore an empirical issue.

The theory's predictions are tested empirically using panel data on Kyoto Protocol ratification. We measure the number of VPs with (i) a dummy for bicameral (as opposed to unicameral) parliamentary systems, as well as (ii) a measure on political checks and balances from the World Bank's database of political institutions (Beck *et al*., 2001; Keefer and Stasavage, 2003).[7] First, a benchmark Logit model is specified. Second, we present a survival analysis using stratified proportional hazard models. While most earlier studies of the probability of environmental treaty ratification focus on the *event*, rather than the *timing* of ratification (for example, Congleton, 1992; Beron *et al*., 2003), real world ratification processes take place over time. A duration model, which captures *when* a treaty is ratified, may capture a greater amount of information regarding ratification probabilities. While Fredriksson and Gaston (2000) and Neumayer (2002a) also use this approach, they employ static datasets rather than a panel. A *stratified* proportional hazard model allows for different baseline hazard functions. This appears particularly appropriate since Annex 1 (OECD and former Eastern Bloc) and non-Annex 1 countries have widely different obligations under the Kyoto Protocol.

Both the Logit and hazard models reveal that environmental lobbying and political institutions are important for the probability of IEA ratification. Countries with a greater number of environmental lobby groups have a higher probability of ratifying the Kyoto Protocol, thus ratification occurs *earlier*. Moreover, the effect is conditional on the number of VPs. The impact of environmental lobbying diminishes as the number of VPs increases. However, we find no evidence that firm lobbying is affected by the number of VPs. We believe this is the first empirical evidence on the asymmetric impact of domestic political institutions on environmental and industry lobbying, and on domestic political institutions' implications for the provision of global public goods, here reflected in the degree of cooperation on a global environmental

[7] The effect of bicameralism on policy outcomes has "rarely been the focus of research" and, consequently, "its effects on policy processes and outcomes are not well understood" (Diermeier *et al.* 2002, p. 1). See also Tsebelis and Money (1997) and Congleton (2006).

treaty.[8] We also believe our findings may have more general applicability to other policy areas such as the ratification of WTO trade agreements and ILO conventions, where rival lobby groups seek to influence ratification in opposing directions.

The paper is organized as follows. Section II provides the theory, Section III reports the empirical results, and Section IV concludes.

II. THEORY

A simple model

In this section, we first set up a simple model that shows the intuition and delivers the main empirical predictions in a particularly parsimonious manner. We then show that the predictions generalize, with minor differences, to a more general setting.

Consider a political decision taken jointly by n veto players (VPs) on whether or not to ratify an international environmental agreement (IEA). VPs are the collective political units (chambers of the legislature, government coalition members) or individuals (president, prime minister) whose approval is necessary for the IEA to be ratified by the country (Tsebelis, 1999, 2002).

In the political process, VPs are influenced in their decision by an environmental and a firm lobby. These groups are assumed to have overcome their free-riding problems for collective action (Olson, 1965), and membership in the firm- and environmental lobby group equals f and e, respectively. Since the status-quo policy is 'no ratification', the environmental lobby, wanting to change the status quo, is assumed to move first in the political game, following Groseclose and Snyder (1996) and Diermeier and Myerson (1999) (see also Banks, 2000). It offers political contributions to one or more VPs in exchange for a promise to vote for ratification.[9] The firm lobby moves next to defend the status quo, by offering contributions to the VPs in exchange for their vote against ratification. In the third stage, voting takes place, and ratification occurs if and only if it gets unanimous support from the VPs.[10] Finally, lobbies make the political

[8] Fredriksson *et al*. (2005) study the effect of government corruptibility on Kyoto Protocol ratification behavior (but ignore the effect of multiple VPs). They find that an increase in corruptibility raises the environmental lobby groups', but not the firm lobbies', impact on the ratification outcome.

[9] See Riddel (2003) for recent empirical evidence of environmental lobby groups influencing political decisions made in the U.S. Senate with the help of political contributions (PACs).

[10] The precise manner in which the political decision is made is not important. For example it could be some combination of voting and political bargaining. What is important is that the VPs have veto power, and the lobbies do not make further offers during the process.

contributions based on the individual VPs' voting behavior, all the players collect payoffs depending on whether ratification occurred, and the game ends.

If IEA ratification occurs, each environmentalist gains v^E, and thus the environmental lobby group receives a payoff equal to $ev^E - c^E$, where c^E denotes total contributions. The payoff v^E reflects the value of improved environmental quality resulting from stricter environmental policies following ratification. If ratification does not occur, the environmental lobby receives a payoff equal to zero.

If ratification does *not* occur, individual members of the firm group each gain v^F, for a total payoff equal to $fv^F - c^F$, where c^F is total firm contributions. This payoff reflects the greater factor rewards associated with weaker environmental policies in the status quo. If ratification occurs, the firm lobby receives a payoff of zero. The value of ratification to each of the *n* VPs is given by W.[11] We assume that $fv^F > W$.

Proposition 1. *In a Subgame Perfect Nash Equilibrium, ratification occurs if and only if*

$$W + \frac{e}{n}v^E - fv^F \geq 0.$$

Proof. See the Appendix.

The condition in Proposition 1 implies that a country will be more likely to ratify if, *ceteris paribus*, the number of environmentalists, *e*, is larger, or the number of firm owners, *f*, is smaller. Proposition 1 suggests that the former effect is *conditional* on *n*, the number of VPs. Because with more VPs, a larger contribution is needed from the environmental lobby to achieve ratification, a rising *n* will reduce the positive effect of *e* on the likelihood of ratification. Note that since the firm lobby only needs to contribute to a single VP to prevent ratification, *n* has no effect on the negative impact of *f*. Thus, the impact of *n* on environmental (pro-reform) and industry (anti-reform) lobbying is asymmetric.[12] In Section II, we test these predictions of the model.

[11] For simplicity, we assume that all VPs have identical preferences. This is not crucial for the theoretical prediction.
[12] This result is complementary to the status-quo bias identified by Fernandez and Rodrik (1991) against trade policy reform. Their argument builds on the uncertainty associated with reform.

A more general model

While the above model is particularly transparent, one might find some of its assumptions unsatisfactory. First, the timing of moves might seem artificial (What guarantees that the environmentalist lobby moves first? If it does, what prevents it from responding to the industry's move?). In many respects, a simultaneous game seems more appropriate. Second, it might seem that the veto power of the VPs is taken too literally: in reality, a politician may have an impact on the *probability* of ratification through public statements, legislative negotiations, and, ultimately, voting. Below, we provide a model incorporating these features, and show that it delivers predictions consistent with those obtained from the simple model above.

Suppose it is known that, at a future date, *n* VPs, indexed by $h \in H$ will decide whether or not to ratify an international environmental agreement that has recently been negotiated. As suggested in the Introduction, the ratification process unfolds over time, implying that some economic decisions have to be taken based on the *projected* outcome of the VPs' decision. We therefore assume that *today* each VP announces its level of political support for ratification, represented by a number $\rho_h \in [0,1]$. We interpret $\rho_h = 1$ as a credible commitment to vote for ratification, $\rho_h = 0$ as a commitment to veto, and $\rho_h \in (0,1)$ as the likelihood that VP *h* will approve ratification. Together, these political supports determine the (objective) probability ρ that the country will ratify the IEA in the future. We assume $\rho = \prod_{h=1}^{n} \rho_h$. This simple specification shares (and generalizes) two defining characteristics of any model with veto powers: (i) a player can always *reduce* the likelihood of ratification, irrespective of the other players' political support (by choosing $\rho_h < 1$) ; (ii) a player's ability to *increase* the likelihood of ratification depends on the other players' support (no VP can increase ρ above any other VP's ρ_h).[13]

[13] This extension of unanimity voting has the advantage of allowing for probabilistic outcomes, providing a direct link between our model and the empirical tests, which focus on the hazard of ratification. Our approach is also related to the rent-seeking literature which models contests in which participants exert effort to increase their probability of winning a prize. There, each player's probability of winning is a function of all players' efforts (see, e.g., Heyes, 1997; Hurley and Shogren, 1998). Alternative specifications sharing these features would be to (i) have a country ratify with certainty if ρ larger than some threshold $\overline{\rho}$, and not ratify otherwise; or (ii) specify the outcome ρ to be $\min_{h \in H} \rho_h$ rather than the multiplicative form we use. Either alternative would give similar results to our specification, but ρ would be discontinuous in ρ_h, making the analysis less tractable.

The probability ρ that the IEA is ratified affects the expected environmental policy in the country.[14] To be concrete, assume that ratification means the introduction of an emission tax τ, where the value of τ is exogenously fixed by the IEA. The expected tax rate is then $t \equiv E(\tau) = \rho\tau$. Three separate groups - consumers, factor owners (firms), and environmentalists – have to make economic decisions before the uncertainty regarding the ratification outcome is resolved. These decisions, and the resulting payoffs, are based on the expected tax rate *t*. Consumers' payoffs (including consumer surplus and redistributed tax revenues) are given by $U(t)$, with $U' > 0$ for low *t* (driven by increasing tax revenues), $U' < 0$ for high *t* (resulting from reduced production in response to higher expected taxes), and $U'' < 0$. Factor owners' payoff (profit) is $v^F(t)$, with $(v^F)' < 0$ and $(v^F)'' < 0$. Finally, environmentalists' payoff (disutility from pollution) is $v^E(t)$, with $(v^E)' > 0$ and $(v^E)'' < 0$.[15] Assuming that the size of the three groups is $1, f$ and *e*, respectively, social welfare is given by $W(t) \equiv U(t) + V^F(t) + V^E(t)$, where $V^F(t) \equiv fv^F(t)$ and $V^E(t) \equiv ev^E(t)$. Clearly, $W'' < 0$, and we assume the existence of a unique ratification probability $\rho^o \in (0,1)$ such that $t^o = \tau\rho^o$ maximizes social welfare. Since τ is constant, and the quantity of interest is the probability of ratification, we henceforth write all payoffs as functions of ρ.

As before, firms and environmentalists are assumed able to organize into separate lobby groups. These groups coordinate (separate) prospective political contribution offers to the VPs, with an aim to influence the likelihood of ratification. The contribution offered by lobby group *j* to VP *h* is a continuous function $C_h^j(\rho_h)$ dependent on the VP's political support for ratification. Thus, lobby *j*'s payoff is given by $V^j(\rho) - \sum_{h=1}^{n} C_h^j(\rho_h), j = E,F$.

Both lobbies are assumed limited in their fund-raising abilities by borrowing constraints and free-riding incentives (see Olson, 1965). Thus, their budgets have hard constraints:

[14] The following specification of the payoffs is the reduced form of a general equilibrium model of a small open economy where the expected environmental tax determines production decisions (and hence pollution), consumers derive utility from consumption, firms care about increasing profits, and environmentalists care about reducing pollution (cf. Aidt, 1998).

[15] Strict concavity of the individual payoff functions is not crucial, as long as weighted averages of the payoffs (as described below) remain concave.

$\sum_{h=1}^{n} C_h^j(\rho_h) \le M^j$, so that the sum of contributions cannot exceed M^j.[16] Consumers are assumed to face sufficiently severe free-riding problems to be unable to organize political action.

VP *h* has objective function

$$V_h^{GU}(\rho) \equiv aW(\rho) + C_h^E(\rho_h) + C_h^F(\rho_h), \qquad (1)$$

which is a weighted sum of the expected aggregate social welfare and the contributions associated with VP *h*'s support for ratification. The exogenous parameter *a* is the VP's affinity for delivering welfare relative to political contributions.

The model defines a two-stage game between the VPs and the lobby groups. The timing assumptions are as follows:

Stage 1. The two lobby groups *j*, *j* = *E*,*F*, simultaneously and non-cooperatively offer each identical VP *h* a political contribution schedule $C_h^j(\rho_h)$.

Stage 2. Each VP *h* determines and announces her optimal level of support, ρ_h. IEA ratification occurs with probability $\rho = \prod_{h=1}^{n} \rho_h$. At the end of the game, the payoffs are realized, in particular, VPs receive the contributions associated with the chosen level of support.[17]

The Political Equilibrium

A political equilibrium is a subgame perfect Nash equilibrium of our two-stage game in which both lobby groups and all VPs use pure strategies. For this game, a set of political contribution schedules, $\{C_h^E, C_h^F\}_{h\in H}$, and a vector of levels of support, $\{\rho_h^*\}_{h\in H}$, is the outcome of a political equilibrium if the following three conditions hold (where $\rho_{-h} \equiv \prod_{q\neq h} \rho_q$):[18]

(C1) for every $h \in H$, ρ_h^* maximizes $aW(\rho_h \rho_{-h}^*) + C_h^E(\rho_h) + C_h^F(\rho_h)$ on (0,1)

[16] Our model focuses on only one policy and thus the lobby groups do not face a choice in allocating their budget among policy issues. We believe this may be a weak assumption since many lobbies (both firms and environmental groups) believe global warming policy to be a priority, and even a matter of survival.

[17] We assume "bilateral contracting with public offers" (Segal, 1999), i.e. that the lobbies can commit to publicly observable compensation schedules, and in the second stage all VPs choose their action simultaneously, taking as given the offered schedules.

[18] The characterization of the equilibrium is standard. See, for example, Prat and Rustichini (2003), Theorem 1.

(C2) $\{\rho_h^*\}_{h\in H}$ maximizes both (i) $V^E(\rho)-\sum_{h=1}^{n} C_h^E(\rho_h)$ on (0,1)^n, subject to $\sum_{h=1}^{n} C_h^E(\rho_h)\leq M^E$,

and (ii) $V^F(\rho)-\sum_{h=1}^{n} C_h^F(\rho_h)$ on (0,1)^n, subject to $\sum_{h=1}^{n} C_h^F(\rho_h)\leq M^F$

(C3) for every $h\in H$, $C_h^E(\rho_h^*)=\max_{\rho_h}\left(aW(\rho_{-h}^*\rho_h)+C_h^F(\rho_h)\right)-\left(aW(\rho^*)+C_h^F(\rho_h^*)\right)$, and

$C_h^F(\rho_h^*)=\max_{\rho_h}\left(aW(\rho_{-h}^*\rho_h)+C_h^E(\rho_h)\right)-\left(aW(\rho^*)+C_h^E(\rho_h^*)\right)$

Condition (C1) requires that each VP selects the political support that maximizes her utility, given the offered contribution schedules and the choices of the other VPs. Condition (C2) states the utility maximization problem of the lobbies: for a given equilibrium contribution schedule, they choose the vector $\{\rho_h^*\}_{h\in H}$ to be implemented so as to maximize their payoff minus the sum of contributions. Condition (C3) establishes that each lobby group *j* minimizes the lobbying expenditures necessary to obtain the equilibrium levels of support ρ_h^*. To achieve this, for each VP *h*, lobby *j* lowers its contribution offer until *h* is indifferent between the equilibrium level of support, ρ_h^*, and some alternative support ρ_h associated with a zero contribution from lobby *j*.

Equilibrium Levels of Support Assuming that the lobby groups use differentiable contribution schedules and the VPs pick their levels of support in the interior of the (0,1) interval, the FOC of each *h*'s maximization of condition (C1) equals

$$a\frac{\partial W(\rho)}{\partial \rho}\rho_{-h}+\frac{\partial C_h^E(\rho_h)}{\partial \rho_h}+\frac{\partial C_h^F(\rho_h)}{\partial \rho_h}=0\,. \tag{2}$$

The equilibrium levels of support also satisfy condition (C2), implying, for all *h*,

$$\frac{\partial V^E(\rho)}{\partial \rho}\rho_{-h}-(1+\mu^E)\frac{\partial C_h^E(\rho_h)}{\partial \rho_h}=0\,, \tag{3}$$

and

$$\frac{\partial V^F(\rho)}{\partial \rho}\rho_{-h}-(1+\mu^F)\frac{\partial C_h^F(\rho_h)}{\partial \rho_h}=0\,, \tag{4}$$

where μ^E and μ^F are the non-negative shadow prices of the environmental and firm lobby's budget, respectively. The shadow price $\mu^j=0$ if lobby *j*'s budget constraint does not bind.

Substituting (3) and (4) into (2) and rearranging yields the equilibrium characterization

$$a\frac{\partial W(\rho^*)}{\partial \rho}+\beta^E\frac{\partial V^E(\rho^*)}{\partial \rho}+\beta^F\frac{\partial V^F(\rho^*)}{\partial \rho}=0\,, \tag{5}$$

where $\beta^j \equiv 1/(1+\mu^j)$, $j=F,E$. The equilibrium ratification probability trades off social welfare effects (adjusted by *a*) and the welfare implications for the lobbies (adjusted by β^j).[19] As expression (5) demonstrates, budget constraints provide a natural way to represent the strength of lobbies' influence in the political process, as determined by their available resources. If a lobby's budget M^j goes to zero (e.g., due to fund raising difficulties), so that the shadow price of its budget constraint becomes high, its weight β^j in the political process diminishes. Lobbies with tighter resources are less able to lobby the VPs to obtain favorable policies. At the other extreme, as a lobby's budget becomes sufficiently large so that its constraint does not bind, β^j reaches its maximum value of 1.[20]

Intuitively, as the environmental lobby's impact on the equilibrium probability increases (the second term), we expect ρ to increase (and conversely for the third term, which reflects the firm lobby's influence). To guarantee that this is indeed the case, we make a technical assumption:

Assumption 1. For every ρ, $\frac{a}{1+a}CS_{\rho\rho}+V^F_{\rho\rho}<0$.

Assumption 1 requires that in equilibrium the weight of consumer surplus be sufficiently high, relative to the weight of the firm lobby. It is satisfied, for example, if the firm lobby's payoffs are linear, or if the VPs put enough weight *a* on social welfare relative to political contributions. This assumption rules out a substitution effect that could cause the VPs to reduce ρ in response to an increase in *e*. To see this, note that from (5), we have

$$\frac{\partial \rho}{\partial e}=\frac{(a+\beta^E)v^E_\rho}{-D(\beta^E,\beta^F)}\,, \tag{6}$$

where $D(\beta^E,\beta^F)\equiv aCS_{\rho\rho}+(a+\beta^E)V^E_{\rho\rho}+(a+\beta^F)V^F_{\rho\rho}$. Assumption 1 ensures that $D(\beta^E,\beta^F)$ is negative (as $\beta^F\le 1$). Hence, (6) is positive; an increase in the number of environmentalists (i.e. in the environmentalists' political pressure) unambiguously raises the ratification

[19] For example, an increase in the probability of delivering an environmental policy (through ratification) that yields greater welfare and a higher political contribution from the environmental lobby is weighted against a lower political contribution from the firm lobby.

[20] Note that the number of VPs enters (5) only through the β^j variables; therefore, if neither budget constraint binds (so that $\beta^E=\beta^F=1$), the number of VPs does not affect the overall ratification probability.

probability. Similarly, Assumption 1 implies that an increase in f unambiguously lowers the ratification probability:

$$\frac{\partial \rho}{\partial f} = \frac{(a + \beta^F) v_\rho^F}{-D(\beta^E, \beta^F)} < 0. \tag{7}$$

Finally, Assumption 1 also ensures uniqueness of the equilibrium ρ in (5), for given β^j.

Equilibrium Contributions The characterization of the equilibrium contributions is complicated by the fact that these depend on the shape of the *other* lobby's contribution offers away from the equilibrium (see condition (C3)). To put some structure on these off-equilibrium contributions, and thus to restrict the range of possible equilibria, the literature commonly assumes some form of "truthfulness" (Bernheim and Whinston, 1986), i.e. that the contribution schedules match the lobbies' gross payoff functions.[21] We adopt a similar approach and show that in a large class of equilibria (which contains truthful equilibria), it cannot be the case that both lobbies' budget constraint binds. Using this result, in the next section we turn to cases where only one budget constraint binds, and derive the effect of the number of VPs, n, on the equilibrium ratification probability.

Lemma 1. *Suppose that, holding other VPs' political support constant at its equilibrium level, lobby j's contribution to VP h is weakly increasing in lobby j's gross payoff, i.e., that for some weakly increasing functions* T_h^j, $C_h^j(\rho_h) \equiv T_h^j(V^j(\rho_h \rho_{-h}^*))$, $j = E, F$ *. Then, the following holds*:
(*i*) *If the budget constraint of the firm lobby group binds, then in equilibrium the environmental lobby group offers positive contributions iff* $\rho^* > \rho^o$.
(*ii*) *If the budget constraint of the environmental lobby group binds, then in equilibrium the firm lobby group offers positive contributions iff* $\rho^* < \rho^o$.

Proof. See the Appendix.

Lemma 1 establishes the following intuitive result. Suppose that in equilibrium lobby i cannot threaten to increase its contribution in order to induce a more favorable outcome (because

[21] For analyses of "truthful" contributions, see Bernheim and Whinston (1986), Grossman and Helpman (1994), and Dixit *et al*. (1997). See Prat and Rustichini (2003) for the concept of "weak truthfulness."

its budget constraint binds). Then the rival lobby $j \neq i$ will only be willing to pay for this equilibrium if it involves the VPs pushing the ratification probability in the direction favored by lobby *j*. In other words, the environmental (firm) lobby will only pay for a probability higher (lower) than the VPs' preferred probability, ρ^o. Thus, we have:

Lemma 2. *Under the conditions of Lemma 1, the equilibrium cannot have both lobbies' budget constraints binding simultaneously.*

Proof. From Lemma 1, if both budget constraints were binding, at least one lobby would not offer positive contributions. But then the budget constraint of this lobby cannot bind. *Q.E.D.*

Lemma 2 establishes that there cannot be an equilibrium in which both lobbies' budget constraints bind. In what follows, we therefore restrict our attention to cases when only one of the budget constraints binds.[22] In the next section, we investigate the effect of a changing number of VPs on the equilibrium probability of ratification.

The effect of Veto players

In this section, we investigate the effect of changing the number of VPs, *n*, on the equilibrium ratification probability. As Lemma 2 shows, the two relevant cases are when one lobby is budget constrained, while the other one is not. We assume that the lobby whose budget constraint does not bind uses truthful contribution schedules, i.e., that for all $h \in H$,

$$C_h^j(\rho_h) + \sum_{g \neq h} C_g^j(\rho_g^*) = V^j(\rho_h \rho_{-h}^*) - b^j, \tag{8}$$

where b^j is a constant chosen by lobby *j* (see Bernheim and Whinston, 1986; Grossman and Helpman, 1994).[23] For future reference, let us use ρ^j to denote the equilibrium probability that

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[22] From Lemma 1, we have the natural result that in these cases competition between a constrained (unconstrained) environmental lobby and an unconstrained (constrained) firm lobby implies that in equilibrium the VPs induce a ratification probability ρ^* that is lower (higher) than the welfare maximizing level ρ^o.

[23] Truthful contributions are commonly used to ensure uniqueness of the equilibrium. For our multi-principal multi-agent model with externalities, the definition in (8) effectively introduces outcome-contingent compensation schedules (as it implies that C_h will be a function of ρ, rather than ρ_h). Our qualitative results below hold for any contribution schedule for which it is true that the sum of a lobby's contributions weakly increases in that lobby's gross payoff (see Lemma 1).

the unconstrained lobby would achieve if it were the only lobby exerting political influence: $\rho^j \equiv \arg\max_{\rho}\left(aW(\rho)+V^j(\rho)\right), j = E, F$. Clearly, $\rho^F < \rho^o < \rho^E$, and the equilibrium probability ρ^* with both lobbies active may lie anywhere in the interval (ρ^F, ρ^E).

Our general results below establish an asymmetry in how the number of VPs affects the influence of environmental and firm lobby groups. To provide some intuition for the nature of this asymmetry, consider the following simple example.

Example Consider two countries, One and Two. While $\rho^F = 0.3$, $\rho^o = 0.5$, and $\rho^E = 0.7$ in both countries, in country One, *n* = 1, and in country Two, *n* = 2. Suppose first that $\rho^* = 0.4$ in both countries. In this case, from Lemma 1, the environmental lobby spends the full budget in equilibrium. How much does it have to spend? In country One, this lobby has to pay the amount necessary to make the single VP choose 0.4 rather than the 0.3 favored by the firm lobby. Call this amount *x*. In country Two, since $\rho_1^*, \rho_2^* > 0.4 > 0.3$ necessarily, both VPs can threaten to reduce the overall probability to 0.3, and hence they both have to receive *x*. As shown below, a VP's ability to favor the firm lobby (by reducing the ratification probability) never depends on the number of VPs. Thus, the environmental lobby's expenditure necessary to compensate the VPs always increases linearly in the number of VPs.

Suppose now that $\rho^* = 0.64$ in both countries. In this case, from Lemma 1, the firm lobby spends its budget completely. In particular, in country One the firm lobby has to pay the amount necessary to make the single VP choose 0.64 rather than the 0.7 favored by the environmental lobby. Call this amount *y*, and consider country Two. If the equilibrium in Two is such that $\rho_1^* = 0.64$ and $\rho_2^* = 1$, then VP 1 has the same bargaining power as the single VP in country One, and therefore has to receive *y*. VP 2, on the other hand, cannot threaten to increase the probability any further, and therefore receives zero from the firm lobby. In this case, VPs' ability to favor the environmental lobby (by increasing the ratification probability) is the same regardless of the number of VPs. Therefore, the firm lobby's expenditures are identical in countries One and Two. If, however, $\rho_1^* = \rho_2^* = 0.8$ in country Two, then either VP can unilaterally increase ρ^* from 0.64 to 0.7 (by choosing $\rho_h = 0.7/0.8 = 0.875$), therefore both have to be paid *y*. In this case, the firm lobby's expenditure will increase linearly in the number of VPs. As shown below, the firm lobby's expenditures may increase, stay constant, or even decrease with the number of VPs.

As shown in (5), the budget-constrained lobby group's weight in determining the equilibrium probability is affected by its lobbying expenditures.[24] Thus, unless lobbies' resources vary at least proportionately with the number of VPs across countries (controlling for observables), these differences in lobbying costs translate into testable differences in ratification probabilities.

Main Results We first consider the case when the environmentalists' budget constraint binds.

Proposition 2. *Assume that the environmental lobby's budget constraint binds, while the firm lobby's constraint does not bind. Assume further that the firm lobby uses truthful contribution schedules. Then, the contribution expenditures from the environmental lobby necessary for implementing any given ratification probability* ρ^* *increase linearly with the number of veto players*.

Proof. See the Appendix.

As suggested above, the result in Proposition 2 derives from the fact that ρ^* is always greater than ρ^F. Hence, in any equilibrium, it is always true that any given VP can reduce the overall probability to ρ^F, given the political support chosen by the other VPs. Since the equilibrium contributions must compensate each VP for not carrying out this threat, the environmental lobby must give the same contributions to *every* VP in order to implement a given ratification probability $\rho^* > \rho^F$, no matter how large n is. Thus, its expenditures are linearly increasing in n. Proposition 2 implies that if the environmental lobby's budget constraint binds in equilibrium, its influence declines with the number of VPs, because this lobby's budget constraint becomes increasingly tighter. Thus, a testable interaction exists between environmental lobby group strength and the number of VPs. We formulate this insight in the following Corollary, which confirms the environmental lobbying result of the simple model.[25]

[24] Note that the unconstrained lobby's weight in determining the equilibrium is the same in both countries (one).

[25] It is worth emphasizing that the bargaining power of any given VP does not change as n increases. Thus, we are not simply *assuming* that changing the status-quo is harder when more VPs are present. Instead, the result follows from the conditions the equilibrium contribution must satisfy, and the fact that the lobbies are budget constrained.

Corollary 1. *Assume that the environmental lobby's budget constraint binds, while the firm lobby's constraint does not bind. Assume further that the firm lobby uses truthful contribution schedules. Then, the influence of the environmental lobby on the equilibrium ratification probability,* ρ^* *, is decreasing with the number of veto players.*

Proof. Differentiation of (6) and rearranging yield

$$\frac{\partial^2 \rho}{\partial e \partial n} = -\frac{v_\rho^E}{D(\beta^E,1)^2}\frac{\partial \beta^E}{\partial n}\left[aCS_{\rho\rho} + (1+a)V_{\rho\rho}^F\right] \tag{9}$$

where $D(\cdot)$ is defined under (6). From Proposition 2, $\partial \beta^E / \partial n < 0$. Therefore, from Assumption 1, expression (9) is negative. *Q.E.D.*

The next proposition shows that if the firm lobby is budget-constrained and the environmental lobby uses truthful contributions, the effect of the number of VPs on the firm lobby's campaign contribution expenditures depends on the form of the equilibrium.[26]

Proposition 3. *Assume that the firm lobby's budget constraint binds while the environmental lobby's constraint does not. Assume further that the environmental lobby uses truthful contribution schedules. The effect of an increase in the number of veto players on the firm lobby's contribution expenditures is indeterminate. In particular, the firm lobby's lobbying expenditures* (*i*) *are unaffected by the number of veto players if* $\rho_h = \rho^*$ *for some h* (*such that* $\rho_{-h} = 1$); (*ii*) *increase with the number of veto players if* $1 > \rho_{-h}^*$ *for all h*, *and* $\rho^E \le \rho_{-h'}^*$ *for some h', and increase linearly when* $\rho^E \le \rho_{-h}^*$ *for all h*; (*iii*) *may increase or decrease with the number of veto players if* $\rho^E > \rho_{-h}^*$ *for all h.*

Proof. See the Appendix.

How could decreasing the ratification probability be more expensive for the firm lobby as a result of more VPs, when a single VP can make this probability arbitrarily low? As before, in the

[26] In stating Proposition 3, we are implicitly assuming that the specific conditions on the structure of the equilibrium given in the different cases remain valid after the increase in *n* (the effect on lobbying expenditures is indeterminate if we allow for switching between the cases).

political equilibrium, a VP has to be compensated for not favoring *the other* lobby. Moreover, with externalities among the VPs, any VP's ability to favor the environmental lobby (by inducing a higher ratification probability) depends on what the other VPs are doing. That is, on the structure of the political equilibrium. For example, when $\rho_1^*, \rho_2^* \in [\rho^E, 1)$, holding fixed the other VP's choice, either VP may unilaterally achieve the environmental lobby's preferred outcome, ρ^E. In this case, the firm lobby must therefore also pay both VPs equally, and its expenditures will be linearly increasing in *n*. The implication of Proposition 3 for a budget-constrained firm lobby is stated in the following Corollary.

Corollary 2. *Assume that the firm lobby's budget constraint binds while the environmental lobby's constraint does not. Assume further that the environmental lobby uses truthful contribution schedules. Then, the firm lobby's influence on the equilibrium ratification probability, ρ^*, may be conditional on the number of veto players.*

Proof. Differentiation of (7) yields

$$\frac{\partial^2 \rho}{\partial f \partial n} = -\frac{v_\rho^F}{D(\beta^F,1)^2}\frac{\partial \beta^F}{\partial n}\left[aCS_{\rho\rho} + (1+a)V_{\rho\rho}^E\right]. \tag{10}$$

From Proposition 3, the sign of $\partial\beta^F / \partial n$ is indeterminate, and thus the sign of (10) is indeterminate. An increase in *n* reduces (raises) [has no effect on] the influence of the firm lobby if $\partial\beta^F / \partial n$ >(<)[=]0. *Q.E.D.*

Corollary 2 shows that, in this more general model, the effect of the number of VPs on the firm lobby's influence on ratification is be ambiguous, and is therefore an empirical question.

III. EMPIRICAL APPROACH

In this section we test two implications derived from the above theoretical models. (*i*) Increased environmental lobbying strength raises the probability of IEA ratification, and the effect of environmental lobbying is conditional on the number of VPs. In particular, the effect is smaller in countries with a greater number of VPs. (*ii*) Firm lobbying reduces the probability of IEA ratification. Whether a greater number of VPs increases *or* decreases the impact of firm lobbying depends on the structure of the political equilibrium.[27]

Data and Main Variables We have panel data from 170 countries recording whether, and when, a country ratified the Kyoto Protocol. Time is measured in days. Countries enter the sample on March 16, 1998, when the Protocol was opened for ratification. They either exit the sample by ratifying, or remain "at risk" until December 15, 2002 (day 1735), the last observation date.[28] Throughout our empirical work, the dependent variable, $\rho(t)$, is the probability that a country ratifies at time *t*.[29]

In this sample, 88 countries (51.7 %) ratified before December 15, 2002, while the remaining countries exited without ratifying. Among ratifiers, the mean duration was 1230 days, with a standard deviation of 459 days. The first country to ratify was Fiji, after 185 days; the last was South Korea, after 1698 days. Table 1 breaks the sample down into ratifying/non-ratifying and Annex1/non-Annex1 countries. Our explanatory variables and sources are described in Table 2.

A variable of main interest is the number of VPs, *n*, for which we employ two different measures. VETOPLAYERS_1 is a dummy taking a value of one if the parliament in a given country is bicameral, and zero if it is unicameral. The data comes from Wallack *et al*. (2003), and was supplemented with data from the Parline database of the Inter Parliamentary Union (2004). The second measure, VETOPLAYERS_2, is the "*Checks*" variable from the World Bank's Database of Political Institutions (Beck *et al*., 2001), which counts the "number of decision makers whose agreement is necessary before policies can be changed (…) adjusting for whether these veto players are independent of each other, as determined by the level of electoral competitiveness in a system, their respective party affiliations, and the electoral rules" (Beck *et al*., 2001, p. 22).[30] VETOPLAYERS_1 and VETOPLAYERS_2 appear to closely follow our theory's focus on the high-level policy makers involved with IEA ratification decisions.

[27] Since VPs may act differently in different countries, resulting in different equilibrium structures, one can expect the interaction effect between industry lobbying and the number of VPs to be hard to identify. The empirical work offers the opportunity to shed light on whether VP behavior across countries shows any regularity.

[28] This cut-off date is due to the limited availability of panel data. It also has the advantage that countries' ratification decisions until that point in time were less likely to have been affected by the possibly changing (perceived) probabilities of the Protocol gaining legal force, as during 2003-04 the Russian Federation sent various conflicting signals regarding its ratification intentions.

[29] In the duration analysis, $\rho(t)$ is the hazard of ratification.

[30] Examples of VETOPLAYERS_2 include Nigeria with 1, the US and most of the EU with 4, and Denmark and Romania with 7. India had the highest score of 15 for most of the sample period.

However, the correlation between these VP measures is weak (0.136). Both are panel data variables.[31]

The next two variables of interest are the sizes of the environmental and firm lobbies. We measure the aggregate size of the environmental lobby (ENGO) by the number of national environmental non-governmental organizations (NGOs) that are members of the World Conservation Union, a large international organization drawing together environmental NGOs from all around the world.[32] For a given population size (and other controls listed below), we view ENGO as a proxy for the number of organized environmentalists in a country, i.e. the aggregate intensity of environmental lobbying.[33]

To capture the power of the firm (industry) lobby, we use a number of alternative proxies. "Symmetrically" to our ENGO variable, our first measure reflects firm lobbying strength through membership in the International Chamber of Commerce (ICC).[34] Several environmental/anti-globalization organizations view ICC as the main representative of firms' interests in the Kyoto process.[35] Since "the ICC has direct access to national governments all over the world through its national committees" (www.iccwbo.org), we use a dummy to measure whether a country has a national ICC committee (in our sample, 83 countries do). As a less direct measure, we also present results with a dummy for whether a given country is a fuel exporter (FUEL). This reflects the pressure arising from firms directly affected by changes in fuel prices.[36] Several alternative measures are discussed in the robustness section.

To isolate the effect of lobbying and political institutions across countries, we control for the general costs and benefits of environmental regulation, as well as environmental preferences of

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[31] VETOPLAYERS_2 had at the time of writing this paper not yet been computed for 2002, therefore we assume that the 2001 values remained unchanged in 2002. This index is available for 149 countries in our sample.

[32] The World Conservation Union claims to be "the world's largest and most important conservation network", with a "mission to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature" (see http://www.iucn.org). Its members include national and international NGOs, government agencies, and scientists in 181 countries. Our ENGO measure includes only the national NGOs.

[33] A possible objection to this interpretation is that in some cases *fewer* groups might mean that the environmental lobby is better organized (more concentrated) and hence more able to exert political pressure. However, this would go against finding a significant positive own effect of ENGO on ratification. Our robust finding of such a relationship below is hard to square with this alternative interpretation. ENGO's positive correlation with measures like population, GDP per capita and democratic liberties (0.24, 0.39, and 0.30, respectively) also suggests that larger values of ENGO reflect higher and not lower ability to organize political action.

[34] The ICC claims to be "the voice of world business". Because "government decisions have far stronger international repercussions than in the past…ICC – the world's only truly global business organization responds by being more assertive in expressing business views" (http://www.iccwbo.org).

[35] See, e.g., http://www.corpwatch.org/article.php?id=980 and http://www.corporateeurope.org/greenhouse/internationals.html.

society as a whole. Real income per capita (GDPPC) and population (POP) are two standard controls.[37] To capture environmental damages, we follow the literature in assuming that rising sea levels caused by global warming would adversely affect states with long coastlines (Fredriksson and Gaston, 2000); ISLAND is defined as a country's coastline divided by area.[38]

In the present context, an important measure of abatement costs is a dummy variable equal to one if the country is in Annex 1 (ANNEX1). Since these countries face binding requirements when the Protocol comes into force, their abatement costs become significantly higher. We also include per capita CO2 emissions (CO2PC). Higher levels of CO2PC may imply lower marginal abatement costs, assuming decreasing marginal returns to abatement.[39] We also include a dummy for the former socialist countries in Eastern Europe (SELLER), which have low marginal abatement costs. These are commonly believed to become sellers of tradable permits (hence obtain revenues) in the international permit trading system established by the Protocol, and therefore SELLER should have a positive effect on the ratification probability.

Finally, democratic values and institutions have consistently been found to have a positive effect on the probability of IEA ratification (Congleton, 1992; Murdoch and Sandler, 1997). We therefore include the combined democracy index published by Freedom House (DEMOCRACY), which takes values 1 (not free), 2 (partially free), and 3 (free).[40]

Benchmark Results Tables 3 and 4 present benchmark results from pooled Logit regressions.[41] This corresponds to asking whether the mechanism suggested by our model is a significant determinant of the probability that a country ratified the Protocol *at some point in time* during the first 4.5 years. That is, in these benchmark calculations, we ignore duration.

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[36] In a Probit analysis, Neumayer (2002a) found a significant negative effect of FUEL on the probability of *signature* of the Kyoto Protocol.
[37] For example, if environmental quality is a normal good, we expect citizens in countries with higher GDP per capita to demand a faster ratification. Similarly, a greater population (POP) might imply more exposure to the potentially negative consequences of climate change, raising the preference for ratification.
[38] The rationale behind using this ratio rather than the length of coastline is that, for example, the rise in the sea level is likely to affect the Seychelles islands, with a coastline of 491 km, more than Poland. The latter has a coastline of exactly the same length, but is 782 times larger.
[39] Alternatively, higher CO2PC may make a country more reluctant to ratify because the cost of inputs may rise relatively more (Fredriksson and Gaston, 2000). CO2PC refers to 1998 and is time-invariant since no suitable panel data for CO2 emissions is available.
[40] We use Freedom House's 3-scale classification (rather than the 7-scale classification) because the scores are more likely to represent real (significant) differences between countries.
[41] Logit and Probit models are presented by Congleton (1992) and Beron *et al*. (2003) who investigate Montreal Protocol ratification behavior, and by Neumayer (2002b) who analyzes the signature (rather than the ratification) of the Kyoto Protocol.

The first model in Table 3 contains our main controls. ISLAND has a significant positive effect on the ratification hazard in every specification.[42] Countries facing larger potential environmental damages due to a high coastline/area ratio appear more likely to ratify. POPULATION has a significant positive effect, and, consistent with most of the existing literature, DEMOCRACY is also (highly) significant in all models. However, GDPPC and ANNEX1 are insignificant. Model (2) experiments with CO2PC emissions and the SELLER dummy. Neither turns out to be significant. Potential abatement costs or windfall gains do not seem to have a significant effect on countries' ratification behavior towards the Kyoto Protocol.

Models (3)-(6') introduce our measures of VPs and lobby group influence (primed models use FUEL rather than ICC). Models (4) and (4') include the interaction of VETOPLAYERS_1 and ENGO, and models (5) and (5') interact VETOPLAYERS_1 with the firm lobby variables. Finally, models (6) and (6') include both interactions. These models demonstrate the importance of considering lobbying *and* the institutional environment, as suggested by the theory.

ENGO is significant (and positive) only if ENGO*VETOPLAYERS_1 is included. Models (4), (4'), (6) and (6') suggest that while the number of environmental interest groups has a significant positive effect on the ratification probability, the effect is *conditional* on the number of VPs. In particular, the positive effect of ENGO on the ratification probability is *reduced* in countries with a greater number of VPs (VETOPLAYERS_1). This finding lends support to our theory. A greater number of VPs make lobbying more costly for the environmentalists, which reduces their influence in the political process. Turning to the firm lobby measures, while FUEL has the expected negative sign throughout, neither ICC nor FUEL is significant, and the interaction terms with VETOPLAYERS_1 are all insignificant. Thus, the number of VPs does not appear to have a significant impact on firm lobbying in the Kyoto context. Table 4 replicates models (3)-(6') in Table 3, but with VETOPLAYERS_2. All significant qualitative findings in Table 3 are robust to this change, suggesting a degree of robustness. In addition, in these models ICC also has the expected negative sign once its interaction with VETOPLAYERS_2 is included, and the interaction term becomes significant in Model (6). This finding shows no signs of robustness, however.[43]

[42] Throughout, standard errors are adjusted for heteroscedasticity and clustered at the country level.

[43] Taken together, our results suggest that the strength of the firm lobby group might be hard to measure.

Duration Dependence While the results using a simple pooled Logit model are in line with our theory, we find it potentially worrisome that the estimation ignores duration dependence. Specifically, in our theoretical model, time-dependent factors which may influence all countries' ratification decision simultaneously are held fixed, therefore the empirical model should attempt to control for these. To illustrate why duration dependence might be an issue, Fig. 1 plots the estimated time-path of the Kyoto ratification probabilities using only the information on the timing of ratifications. Formally, we plot the estimated *cdf* of the ratification durations, computed as $\hat{R}(t) = 1 - \prod_{j|t_j \le t} \frac{N_j - r_j}{N_j}$, where t is calendar time, t_j is the ratification date of country j, N_j is the number of countries which have not ratified before time t_j, and r_j is the number of countries ratifying at time t_j.[44] Fig. 1(b) shows these values separately for Annex 1 and non-Annex 1 countries. Both Figures show the time periods starting 90 days before and extending 90 days after the Conference of the Parties (COP) meetings of the countries engaged in the Kyoto negotiations. A black triangle (▲) at time point 1081 (March 1, 2001) shows the publication date of the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Fig. 1 suggests that such events might affect the ratification probabilities, i.e. that ratification behavior exhibits duration dependence.[45] This is not accounted for in the standard Logit model.[46]

One way to introduce duration dependence is to add time dummies to the simple pooled Logit model. Table 5 re-estimates models (6) and (6') from Tables 3 and 4 with year dummies included. These year dummies are highly significant, confirming the strong duration dependence suggested by Fig. 1. Furthermore, controlling for duration dependence reinforces the significant effects previously found. In particular, the coefficients on ENGO and ENGO* VETOPLAYERS increase by a factor of around 1.5 compared to the models with no year dummies. Next, we turn to methods allowing greater flexibility in modeling duration dependence.

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[44] This estimate is one minus the Kaplan-Meier survival function. The theoretical hazard $\rho(t)$ can be obtained as $\rho(t) = R'(t)/R(t)$.

[45] The time path of the probabilities reveals a number of interesting features. The first ratification came immediately before the first COP meeting after Kyoto (COP 4). Note also the interval without any ratification following the second COP meeting in this period (COP 5), and the sharp increase in ratifications just before the last COP in the sample (COP 8). Moreover, note the difference between Annex 1 and non-Annex 1 country ratification behavior. Annex 1 ratifications started three years after the Protocol was opened, with the first ratification taking place directly after the publication of the IPCC report.

Duration Analysis In this section we test the predictions of our model using duration analysis.[47] We specify a Cox proportional hazard model, where $\rho(t)$ is interpreted as the probability of ratification at time t given that the country has not ratified before t; this is the *hazard* of ratification. The Cox proportional hazard model assumes that

$$\rho(t) = \rho_0(t)\exp(\boldsymbol{\beta}^T\mathbf{x}(t)). \tag{11}$$

Here, $\mathbf{x}(t)$ is our vector of covariates, and $\boldsymbol{\beta}^T$ is a vector of parameters to be estimated. The term $\rho_0(t)$ is the exogenous *baseline hazard*, which represents a flexible way of controlling for time-dependent factors common to all countries. As suggested by Fig. 1, such factors may include new scientific information about the uncertainty related to climate change, or public information on the expected functioning of the Protocol that becomes available during COP meetings.[48] We note that the baseline hazard will also capture strategic effects that have a similar impact on all countries (e.g., the increasing number of signatories, or a major player announcing its intention to participate/withdraw from the agreement).

As suggested by Fig. 1(b), and as shown below, stratification of the baseline hazard according to Annex-1 membership might be warranted. The stratified model can be written as

$$\rho(t) = \rho_{0s}(t)\exp(\boldsymbol{\beta}^T\mathbf{x}(t)), \tag{12}$$

where s denotes the stratum Annex 1 or non-Annex 1. Equation (12) is estimated by Maximum Likelihood, for arbitrary $\rho_{0s}(t)$ functions.[49]

Tables 6 and 7 re-estimate the Logit models from Tables 3 and 4 using the stratified Cox approach. All our reported coefficient estimates are interpreted as the marginal effect of a unit increase in x_p on the log of the ratification probability of a country, based on Eq. (12). The results are entirely consistent with the previous estimations and our theory. ENGO is significant only when its interaction with the VETOPLAYERS measures is included. VETOPLAYERS reduces the positive impact of environmental lobbying on the ratification probability. The identified interaction is strong. In Table 6, all else equal, an additional environmental NGO (ENGO) raises the ratification probability by 6.5-7.1 percent. Relative to a unicameral system, a bicameral

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[46] As is well-known, the standard Logit approach assumes a constant hazard rate (see, e.g., Box-Steffensmeier and Jones, 2004), implying that failure times are distributed exponentially. If this was true in the present context, Figure 1 should resemble the *cdf* of the exponential distribution. It does not.

[47] Duration analysis is used by Fredriksson and Gaston (2000) to investigate ratification behavior for the UN Framework Convention on Climate Change, and by Neumayer (2002a) to analyze ratification of the Montreal Protocol (in addition to two other environmental agreements). We note that in the context of IEAs none of these previous studies exploited the relative ease with which hazard models handle time-varying covariates. They consistently assume that all the explanatory variables were fixed at their initial level during the interval analyzed.

[48] Many details of the Protocol, including flexibility mechanisms such as emission trading, remain to be worked out.

parliament (VETOPLAYERS_1 = 1) reduces this effect of the environmental lobby by 8.4-9.1 percentage points, i.e. the aggregate marginal effect of ENGO is close to nil in bicameral systems. This explains the insignificant effect of ENGO in models without its interaction with VETOPLAYERS_1, and reinforces the importance of incorporating the institutional structure in studies of lobby group influence. Fig. 2 uses the results from Table 7 to illustrate the impact of VPs on the marginal effect of ENGO, conditional on VETOPLAYERS_2. At the mean of VETOPLAYERS_2, the marginal effect of ENGO is around 1.8 percent (depending on the year). This effect varies inversely with VETOPLAYERS_2. Again, the firm lobby measures are not statistically significant, and appear unaffected by the number of VPs.[50]

Specification Test and Robustness Analysis To check the specification in Eq. (12), we performed the Grambsch and Therneau (1994) test for the validity of the proportional hazard assumption. To illustrate, Table 8 shows the test for specification (6) from Table 7. In the first column, we do not stratify, and include Annex 1 as an explanatory variable. The test statistic displayed in the next column has a chi-squared distribution, and its null hypothesis is the validity of the proportional hazard assumption. The table shows tests for individual covariates as well as a global test for the model as a whole. The proportionality assumption is clearly rejected, and the individual test statistics suggest stratification according to the ANNEX1 variable. The next column shows the test statistics on the stratified model. Once we stratify by ANNEX1, the proportionality assumption is not rejected. This holds for all the specifications in Tables 6 and 7.

Turning to the robustness of the results derived from the hazard models, our first concern is "tied failures" (≥ 2 countries ratifying on the same day) in the dataset. Tied failures do not cause problems as long as they occur randomly. However, in this dataset, the 15 EU countries (representing more than half of Annex 1 ratifications) ratifying jointly is clearly non-random. To check whether this influenced the findings above, all the models were run on a modified dataset, in which the EU was treated as a single country. The results were robust to this modification.

Second, we checked whether our results were robust to removing dictatorships from the sample. Although dictators may be expected to place some positive weight on social welfare as

[49] For further discussions of duration models, see Cox and Oakes (1984) and Lancaster (1990).

[50] The ICC*VETOPLAYERS_2 interaction is significant in Table 7, Model (6). This result is not robust, however. Moreover, in some models in Table 7, VETOPLAYERS_2 has a significant positive impact on the probability of ratification. This effect, not accounted for by our theory, suggests that domestic institutions may have additional effects on the political process leading to ratification.

well as political contributions, it would be worrisome if the theoretical results derived from a rational lobbying model did not hold in the democracies-only sample. Dropping the 33 countries with the lowest DEMOCRACY score from the sample does not affect our results.

Third, we interacted the VETOPLAYERS measures with ISLAND (as well as ENGO). While ENGO is our direct measure of environmental lobbying strength, potential environmental damages might have an independent effect on the intensity of environmental lobbying. In line with this interpretation, the coefficient on ISLAND*VETOPLAYERS was found to be consistently negative. However, it was almost always insignificant, while the ENGO*VETOPLAYERS interaction retained significance throughout, confirming our previous findings.

Finally, we checked whether alternative measures of industry lobbying show a significant impact of firms on Kyoto ratification. Green/anti-globalization groups usually describe the World Business Council for Sustainable Development as an aggressive representative of business interests. We employed a dummy variable taking the value of 1 if the WBCSD has members in a particular country, and 0 otherwise.[51] Moreover, we also used (i) the number of vehicles per capita in a country, and (ii) the intensity of CO2 in commercial energy use (1998) (both from the World Bank's WDI). In line with the above results, all industry lobby interactions were insignificant. In addition, WBCSD (similarly to ICC) sometimes had the wrong sign and was insignificant throughout. The two indirect measures generally had the expected negative sign (similarly to FUEL), but were insignificant.

IV. CONCLUSION

We seek to uncover how political institutions and interest groups interact to determine the probability that a country ratifies an international environmental treaty. Using a multi-principal, multi-agent model, we develop a lobbying theory where the government consists of multiple units (legislative chambers, coalition parties, the president, the prime minister) that take part in the ratification decision. The theory identifies an asymmetry between the impact of environmental and industry lobbying. It predicts that institutional arrangements with a greater number of VPs always reduce the (positive) impact of environmental lobbying on the ratification probability, while the effect on the (negative) influence of the industry lobbying is ambiguous.

We test these predictions using Logit and stratified proportional hazard models with panel data from 170 countries on the timing of the ratification of the Kyoto Protocol. The empirical findings are consistent with the theory. We find that greater environmental lobby group strength raises the probability of ratification, but that this effect is lower where the number of VPs is greater. Consistent with the asymmetry identified by our theory, we find no evidence that industry lobbying is affected by the number of VPs.

Our findings suggest that the interaction between political institutions and lobby group pressures should not be ignored in settings where interest groups have opposing preferences regarding a status quo policy, and compete for political influence.

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APPENDIX

Proof of Proposition 1

In the second stage, the firm lobby group is willing to pay a maximum of fv^F to any single VP in exchange for a veto of ratification. Thus, to secure ratification, the environmental lobby group must, in the first stage, offer each VP a political contribution of at least $fv^F - W$ for a yes-vote. Thus, the total political contribution required from the environmental lobby to secure ratification is $n(fv^F - W)$. It follows that if $n(fv^F - W) \leq ev^E$, or $W + \frac{e}{n}v^E - fv^F \geq 0$, the environmental lobby will make the required contribution, and ratification occurs. If $W + \frac{e}{n}v^E - fv^F < 0$, the environmental lobby offers no contributions, and ratification does not occur. *Q.E.D.*

Proof of Lemma 1

(i) Suppose that the firm lobby's budget constraint binds, such that $M^F = \sum_{h \in H} C_h^F(\rho_h^*)$. This implies that

$$T_h^F(V^F(\rho_h \rho_{-h}^*)) = C_h^F(\rho_h) \leq C_h^F(\rho_h^*) = T_h^F(V^F(\rho^*)) \text{ for all } \rho_h. \tag{A1}$$

Consider the equilibrium contribution of the environmental lobby to VP *h*. When $C_h^F(\rho_h) \equiv T_h^F(V^F(\rho_h \rho_{-h}^*))$, condition (C3) of the political equilibrium implies that

$$C_h^E(\rho_h^*) = \max_{\rho_h}\left(aW(\rho_h \rho_{-h}^*) + T_h^F(V^F(\rho_h \rho_{-h}^*))\right) - \left(aW(\rho^*) + T_h^F(V^F(\rho^*))\right). \tag{A2}$$

(*a*) If $\rho^* > \rho^o$, then the first term in (A2) is maximized by $\rho_h = \rho^o / \rho_{-h}^*$. To see this, note that in this case $T_h^F(V^F(\rho^*)) \leq T_h^F(V^F(\rho^o))$, therefore $T_h^F(V^F(\rho^*)) = T_h^F(V^F(\rho^o))$ from (A1). Since the VP can never receive a higher contribution than this from the firm lobby, it will do best by choosing $\rho_h = \rho^o / \rho_{-h}^*$ to maximize *W*. Thus, $C_h^E(\rho_h^*) = aW(\rho^o) - aW(\rho^*)$. (*b*) If $\rho^* < \rho^o$, then the first term in (A2) is maximized by $\rho_h = \rho_h^*$. Decreasing the overall ρ below ρ^* is not in the VP's interest for the same reason as in case (*a*): a budget constrained firm lobby cannot pay more for a lower probability. Increasing the overall ρ above ρ^* cannot be in the VP's interest or the environmental lobby would gain by reducing its contribution on ρ_h^*. It follows that the VP cannot do better than by picking $\rho_h = \rho_h^*$, therefore $C_h^E(\rho_h^*) = aW(\rho^*) - aW(\rho^*) = 0$. With a binding budget constraint for the firm lobby, the environmental lobby does not offer positive contributions unless $\rho^* > \rho^o$.

(ii) Suppose that the environmental lobby's budget constraint binds, such that

$$M^E = \sum_{h \in H} C_h^E(\rho_h^*) \tag{A3}$$

and consider the equilibrium contribution of the firm lobby to VP *h*. Proceeding exactly as for case (i), one may show the following. (*a*) If $\rho^* < \rho^o$, then for all $h \mid \rho^o < \rho_{-h}^*$: $C_h^F(\rho_h^*) = aW(\rho^o) - aW(\rho^*) > 0$, and for all $h \mid \rho^o > \rho_{-h}^*$: $C_h^F(\rho_h^*) = aW(\rho_{-h}^*) - aW(\rho^*) > 0$. (*b*)

If $\rho^* > \rho^o$, then $C_h^F(\rho_h^*) = 0$. With a binding budget constraint for the environmental lobby, the firm lobby does not offer positive contributions unless $\rho^* < \rho^o$. *Q.E.D.*

Proof of Proposition 2

To avoid cumbersome indexing and summation, we show this only for the case where *n* increases from 1 to 2. The general proof is identical. For *n* = 1, using the definition of truthful contributions in (8) to write $C^F(\rho) = V^F(\rho) - b^F$, condition (C3) becomes

$$C^E(\rho^*) = \max_{\rho}\left(aW(\rho) + V^F(\rho) - b^F\right) - \left(aW(\rho^*) + V^F(\rho^*) - b^F\right). \quad \text{(A4)}$$

The first term in (A4) is maximized by $\rho = \rho^F$. Therefore, with a single VP the environmental lobby's expenditure equals

$$C^E(\rho^*) = \left(aW(\rho^F) + V^F(\rho^F)\right) - \left(aW(\rho^*) + V^F(\rho^*)\right). \quad \text{(A5)}$$

For *n* = 2, the definition of truthful contributions in (8) puts restrictions on the contribution schedules off the equilibrium. In particular,

$$C_1^F(\rho_1) = V^F(\rho_1\rho_2^*) - \tilde{b}^F - C_2^F(\rho_2^*) \quad \text{(A6)}$$

where $\tilde{b}^F$ is a constant that may be different from b^F above, and symmetrically for $C_2^F(\rho_2)$. From (A6), the contributions needed to implement the same ρ^* as when *n* = 1 are

$$C_1^E(\rho_1^*) = \max_{\rho_1}\left(aW(\rho_1\rho_2^*) + V^F(\rho_1\rho_2^*) - \tilde{b}^F - C_2^F(\rho_2^*)\right) - \left(aW(\rho^*) + C_1^F(\rho_1^*)\right) \quad \text{(A7)}$$

and

$$C_2^E(\rho_2^*) = \max_{\rho_2}\left(aW(\rho_1^*\rho_2) + V^F(\rho_1^*\rho_2) - \tilde{b}^F - C_1^F(\rho_1^*)\right) - \left(aW(\rho^*) + C_2^F(\rho_2^*)\right). \quad \text{(A8)}$$

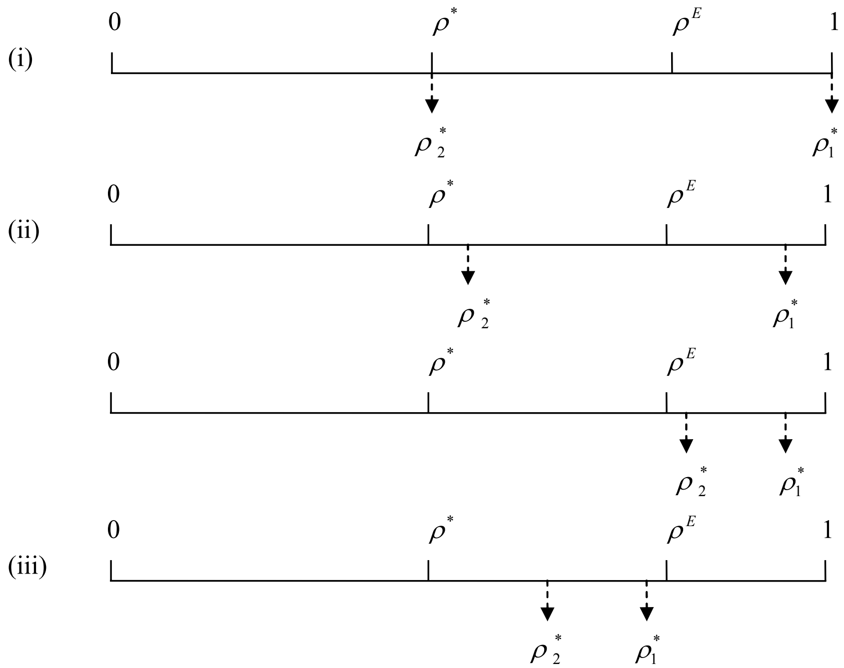
The first terms in (A7) and (A8) are maximized by $\rho_1 = \rho^F / \rho_2^*$ and $\rho_2 = \rho^F / \rho_1^*$, respectively. The sum of these contributions (after rearranging terms and making use of (A6)) equals

$$C_1^E(\rho_1^*) + C_2^E(\rho_2^*) = 2\left(aW(\rho^F) + V^F(\rho^F)\right) - 2\left(aW(\rho^*) + V^F(\rho^*)\right).$$

This is exactly twice the cost of implementing ρ^* with a single VP, given by (A5). *Q.E.D.*

Proof of Proposition 3

We will again focus on the case when *n* increases from 1 to 2. The following figure illustrates the different cases in Proposition 3 for *n* = 2.



For $n = 1$, we have

$$C^F(\rho^*) = \left(aW(\rho^E) + V^E(\rho^E)\right) - \left(aW(\rho^*) + V^E(\rho^*)\right). \tag{A9}$$

For $n = 2$, the contributions needed to implement the same overall ρ^* are

$$C_1^F(\rho_1^*) = \max_{\rho_1}\left(aW(\rho_1\rho_2^*) + V^E(\rho_1\rho_2^*) - \tilde{b}^E - C_2^E(\rho_2^*)\right) - \left(aW(\rho^*) + C_1^E(\rho_1^*)\right) \tag{A10}$$

$$C_2^F(\rho_2^*) = \max_{\rho_2}\left(aW(\rho_1^*\rho_2) + V^E(\rho_1^*\rho_2) - \tilde{b}^E - C_1^E(\rho_1^*)\right) - \left(aW(\rho^*) + C_2^E(\rho_2^*)\right). \tag{A11}$$

(i) If $\rho_2^* = \rho^*$ (and $\rho_1^* = 1$), the first terms in (A10) and (A11) are maximized by $\rho_1 = 1$ and $\rho_2 = \rho^E$, respectively. Therefore $C_1^F(\rho_1^*) = 0$ and the total lobbying expenditure equals

$$C_2^F(\rho_2^*) = \left(aW(\rho^E) + V^E(\rho^E)\right) - \left(aW(\rho^*) + V^E(\rho^*)\right),$$

which is the same as in (A9) for the $n = 1$ case.

(ii) If $1 > \rho_1^* \geq \rho^E > \rho_2^*$, then the maximizers in (A10) and (A11) are $\rho_1 = 1$ and $\rho_2 = \rho^E / \rho_1^*$, respectively. Summing the contributions and rearranging therefore gives

$$C_1^F(\rho_1^*) + C_2^F(\rho_2^*) = \left(aW(\rho_2^*) + V^E(\rho_2^*)\right) + \left(aW(\rho^E) + V^E(\rho^E)\right) - 2\left(aW(\rho^*) + V^E(\rho^*)\right).$$

It is easy to check that this is greater than (A9).[52] If $\rho_1^*, \rho_2^* \in [\rho^E, 1)$, then the first terms in (A10) and (A11) are maximized by $\rho_1 = \rho^E / \rho_2^*$ and $\rho_2 = \rho^E / \rho_1^*$, so the sum of contributions is

$$C_1^F(\rho_1^*) + C_2^F(\rho_2^*) = 2\left(aW(\rho^E) + V^E(\rho^E)\right) - 2\left(aW(\rho^*) + V^E(\rho^*)\right),$$

which is twice the single-VP contribution given in (A9).

(iii) If $\rho^E > \rho_1^*, \rho_2^*$, then the maximizers in (A10) and (A11) are $\rho_1 = \rho_2 = 1$, so that

$$C_1^F(\rho_1^*) + C_2^F(\rho_2^*) = \left(aW(\rho_2^*) + V^E(\rho_2^*)\right) + \left(aW(\rho_1^*) + V^E(\rho_1^*)\right) - 2\left(aW(\rho^*) + V^E(\rho^*)\right).$$

Now the comparison with the $n = 1$ case in (A9) is ambiguous and will depend on the shape of the $W(.)$ and $V(.)$ functions as well as the equilibrium levels of support. *Q.E.D.*

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[52] To see this, note that $\rho^E > \rho_2^* > \rho^*$ implies $aW(\rho_2^*) + V^E(\rho_2^*) > aW(\rho^*) + V^E(\rho^*)$.

Table 1. Breakdown of the sample by Ratification behavior / Annex1 membership

Ratified before 12/15/2002?	Country		Total
	Annex1	non-Annex1	
Yes	26	62	88
No	10	72	82
Total	36	134	170

Table 2. Variables and Data Sources

Variable	No. of Countries	Mean	Std. deviation	Min	Max	Source
VETOPLAYERS_1	170	0.39	overall: 0.49 between: 0.48 within: 0.09	0	1	WB_P & PARLINE
VETOPLAYERS_2	149	2.84	overall: 1.72 between: 1.64 within: 0.27	1	17	WB_DPI
GDPPC (1000 $)	170	6.83	overall: 11.13 between: 10.59 within: 0.45	0.11	56.45	WDI
POP (100 million)	170	0.38	overall: 1.36 between: 1.28 within: 0.02	0.00	12.42	WDI
DEMOCRACY	170	2.22	overall: 0.79 between: 0.78 within: 0.20	1	3	FH
ENGO	170	4.19	6.73	0	44	IUCN
ICC	170	0.49	0.50	0	1	ICC
FUEL	170	0.11	0.31	0	1	WDI
ANNEX1	170	0.21	0.41	0	1	UNFCCC
CO2PC (1000 kt)	170	0.43	0.55	0.00	3.24	WDI
SELLER	170	0.76	0.27	0	1	UNFCCC
ISLAND	170	0.90	3.39	0.00	33.17	CIA

Notes: WB_P: Data from Wallack *et al*. (2003).
PARLINE: Data from the Parline database of the Inter Parliamentary Union available at: http://www.ipu.org/parline-e/parlinesearch.asp.
WB_DPI: Data from Beck *et al*. (2001), available at: http://econ.worldbank.org
WDI: Data from the World Bank Development Indicators database, available at: http://www.worldbank.org.
FH: Freedom House country ratings, available at: http://www.freedomhouse.org/ratings/index.htm
IUCN: Data from the official IUCN website, at: http://www.iucn.org.
ICC: Data from http://www.iccwbo.org
UNFCC: Data from the official UNFCCC website, at: http:// www.unfccc.org.
CIA: Data from The World Factbook, 2002 (U.S. Central Intelligence Agency), available at: http://www.cia.gov/cia/publications/factbook.

Table 3. Logit regressions with VETOPLAYERS_1

Variable	(1)	(2)	(3)	(3')	(4)	(4')	(5)	(5')	(6)	(6')
ISLAND	0.061	0.068	0.067	0.060	0.068	0.064	0.066	0.060	0.068	0.064
	(0.025)	(0.024)	(0.026)	(0.024)	(0.028)	(0.026)	(0.027)	(0.024)	(0.028)	(0.027)
	[0.013]	**[0.005]**	**[0.009]**	**[0.013]**	**[0.014]**	**[0.014]**	**[0.014]**	**[0.014]**	**[0.014]**	**[0.017]**
POP	0.069	0.073	0.057	0.067	0.066	0.071	0.058	0.066	0.066	0.071
	(0.034)	(0.032)	(0.035)	(0.031)	(0.028)	(0.025)	(0.033)	(0.032)	(0.028)	(0.025)
	[0.040]	**[0.020]**	[0.102]	**[0.031]**	**[0.018]**	**[0.004]**	**[0.080]**	**[0.038]**	**[0.018]**	**[0.006]**
GDPPC	0.010	0.027	0.008	0.012	0.008	0.011	0.007	0.011	0.008	0.010
	(0.008)	(0.016)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
	[0.243]	[0.105]	[0.381]	[0.171]	[0.359]	[0.201]	[0.411]	[0.194]	[0.360]	[0.233]
DEMOCRACY	0.522	0.506	0.527	0.480	0.519	0.475	0.534	0.484	0.518	0.479
	(0.172)	(0.174)	(0.173)	(0.181)	(0.175)	(0.183)	(0.177)	(0.182)	(0.178)	(0.185)
	[0.002]	**[0.004]**	**[0.002]**	**[0.008]**	**[0.003]**	**[0.010]**	**[0.002]**	**[0.008]**	**[0.004]**	**[0.010]**
ANNEX 1	-0.231	-0.445	-0.285	-0.254	-0.197	-0.185	-0.271	-0.260	-0.198	-0.191
	(0.264)	(0.420)	(0.271)	(0.266)	(0.266)	(0.258)	(0.268)	(0.267)	(0.264)	(0.258)
	[0.382]	[0.290]	[0.292]	[0.341]	[0.458]	[0.472]	[0.312]	[0.329]	[0.455]	[0.460]
VETOPLAYERS_1			-0.070	-0.037	0.173	0.208	0.067	0.003	0.167	0.265
			(0.204)	(0.203)	(0.252)	(0.243)	(0.370)	(0.208)	(0.375)	(0.247)
			[0.730]	[0.856]	[0.492]	[0.392]	[0.856]	[0.987]	[0.656]	[0.284]
ENGO			-0.001	-0.001	0.054	0.055	0.001	-0.001	0.054	0.057
			(0.013)	(0.014)	(0.032)	(0.030)	(0.014)	(0.014)	(0.033)	(0.031)
			[0.953]	[0.956]	**[0.091]**	**[0.069]**	[0.921]	[0.919]	[0.101]	**[0.063]**
ENGO* VETOPLAYERS_1					-0.065	-0.068			-0.065	-0.070
					(0.034)	(0.033)			(0.037)	(0.033)
					[0.057]	**[0.040]**			**[0.075]**	**[0.033]**
ICC			0.216		0.122		0.286		0.117	
			(0.247)		(0.255)		(0.271)		(0.297)	
			[0.382]		[0.633]		[0.292]		[0.693]	
ICC* VETOPLAYERS_1							-0.238		0.013	
							(0.443)		(0.469)	
							[0.591]		[0.978]	
FUEL				-0.498		-0.487		-0.257		-0.189
				(0.507)		(0.513)		(0.552)		(0.560)
				[0.326]		[0.343]		[0.641]		[0.736]
FUEL* VETOPLAYERS_1								-0.738		-0.875
								(1.116)		(1.117)
								[0.508]		[0.433]
CO2PC		-0.388								
		(0.300)								
		[0.197]								
SELLER		0.469								
		(0.471)								
		[0.320]								
Observations	738	738	738	738	738	738	738	738	738	738
Pseudo R^2	0.031	0.034	0.032	0.033	0.036	0.037	0.033	0.034	0.036	0.038

Notes: (robust standard errors); [p-values]; $p < 10\%$ in bold. All models include a constant.

Table 4. Logit regressions with VETOPLAYERS_2

Variable	(3)	(3')	(4)	(4')	(5)	(5')	(6)	(6')
ISLAND	0.160 (0.062) **[0.010]**	0.149 (0.063) **[0.017]**	0.165 (0.064) **[0.010]**	0.158 (0.064) **[0.013]**	0.158 (0.060) **[0.009]**	0.149 (0.062) **[0.017]**	0.162 (0.060) **[0.007]**	0.158 (0.064) **[0.013]**
POP	0.047 (0.072) [0.514]	0.053 (0.073) [0.464]	0.105 (0.034) **[0.002]**	0.110 (0.034) **[0.001]**	0.035 (0.095) [0.711]	0.054 (0.071) [0.444]	0.131 (0.034) **[0.000]**	0.111 (0.035) **[0.002]**
GDPPC	0.006 (0.009) [0.506]	0.009 (0.009) [0.279]	0.007 (0.009) [0.398]	0.010 (0.008) [0.248]	0.006 (0.009) [0.531]	0.009 (0.009) [0.286]	0.007 (0.008) [0.374]	0.010 (0.008) [0.238]
DEMOCRACY	0.591 (0.199) **[0.003]**	0.568 (0.207) **[0.006]**	0.547 (0.202) **[0.007]**	0.526 (0.210) **[0.012]**	0.621 (0.200) **[0.002]**	0.563 (0.209) **[0.007]**	0.606 (0.203) **[0.003]**	0.530 (0.214) **[0.013]**
ANNEX 1	-0.352 (0.274) **[0.003]**	-0.332 (0.269) **[0.006]**	-0.446 (0.280) **[0.007]**	-0.441 (0.276) **[0.012]**	-0.364 (0.281) **[0.002]**	-0.332 (0.270) **[0.007]**	-0.557 (0.294) **[0.003]**	-0.444 (0.275) **[0.013]**
VETOPLAYERS_2	0.027 (0.059) [0.645]	0.033 (0.061) [0.587]	0.176 (0.108) [0.102]	0.187 (0.109) [0.086]	-0.093 (0.188) [0.622]	0.031 (0.060) [0.607]	-0.053 (0.194) [0.786]	0.193 (0.111) **[0.082]**
ENGO	-0.002 (0.012) [0.864]	-0.001 (0.012) [0.921]	0.051 (0.031) **[0.097]**	0.054 (0.031) **[0.080]**	-0.002 (0.013) [0.861]	-0.001 (0.012) [0.935]	0.093 (0.033) **[0.005]**	0.055 (0.032) **[0.079]**
ENGO* VETOPLAYERS_2			-0.015 (0.008) **[0.050]**	-0.016 (0.008) **[0.043]**			-0.028 (0.008) **[0.001]**	-0.016 (0.008) **[0.043]**
ICC	0.210 (0.256) [0.412]		0.139 (0.253) [0.584]		-0.146 (0.574) [0.800]		-0.971 (0.652) [0.136]	
ICC* VETOPLAYERS_2					0.139 (0.193) [0.473]		0.395 (0.211) **[0.061]**	
FUEL		-0.267 (0.505) [0.597]		-0.233 (0.507) [0.646]		-0.433 (1.082) [0.689]		-0.094 (1.133) [0.934]
FUEL* VETOPLAYERS_2						0.063 (0.281) [0.824]		-0.050 (0.295) [0.866]
Observations	631	631	631	631	631	631	631	631
Pseudo R^2	0.039	0.039	0.042	0.042	0.040	0.039	0.048	0.042

Notes: (robust standard errors); [p-values]; $p < 10\%$ in bold. All models include a constant.

Table 5. Logit regressions with year dummies

Variable	with VETOPLAYERS_1 (6)	(6')	with VETOPLAYERS_2 (6)	(6')
VETOPLAYERS	0.211 (0.514) [0.681]	0.370 (0.348) [0.288]	-0.011 (0.281) [0.968]	0.313 (0.162) **[0.053]**
ENGO	0.081 (0.048) **[0.089]**	0.087 (0.046) **[0.059]**	0.125 (0.048) **[0.010]**	0.087 (0.046) **[0.061]**
ENGO* VETOPLAYERS	-0.096 (0.053) **[0.068]**	-0.102 (0.049) **[0.036]**	-0.036 (0.012) **[0.004]**	-0.024 (0.012) **[0.047]**
ICC	0.201 (0.404) [0.620]		-1.121 (0.912) [0.219]	
ICC* VETOPLAYERS	0.093 (0.657) [0.887]		0.486 (0.300) [0.105]	
FUEL		-0.078 (0.737) [0.915]		0.660 (1.466) [0.653]
FUEL* VETOPLAYERS		-0.998 (1.376) [0.468]		-0.260 (0.410) [0.526]
D99	1.358 (0.613) **[0.027]**	1.356 (0.612) **[0.027]**	1.533 (0.699) **[0.028]**	1.516 (0.682) **[0.026]**
D00	1.149 (0.637) **[0.071]**	1.140 (0.640) **[0.075]**	1.317 (0.734) **[0.073]**	1.286 (0.717) **[0.073]**
D01	1.684 (0.611) **[0.006]**	1.678 (0.614) **[0.006]**	2.103 (0.690) **[0.002]**	2.070 (0.668) **[0.002]**
D02	3.660 (0.576) **[0.000]**	3.648 (0.574) **[0.000]**	4.068 (0.660) **[0.000]**	4.029 (0.636) **[0.000]**
Observations	738	738	631	631
Pseudo R^2	0.224	0.225	0.260	0.253

Notes: (robust standard errors); [p-values]; p < 10% in bold. All models include a constant and ISLAND, GDPPC, POP, DEMOCRACY and ANNEX 1.

Table 6. Stratified Cox models with VETOPLAYERS_1

Variable	(1)	(2)	(3)	(3')	(4)	(4')	(5)	(5')	(6)	(6')
ISLAND	0.060	0.070	0.066	0.059	0.065	0.061	0.064	0.058	0.067	0.060
	(0.018)	(0.022)	(0.020)	(0.019)	(0.020)	(0.019)	(0.021)	(0.019)	(0.022)	(0.019)
	[0.001]	**[0.001]**	**[0.001]**	**[0.002]**	**[0.001]**	**[0.001]**	**[0.003]**	**[0.002]**	**[0.002]**	**[0.002]**
POP	0.039	0.043	0.030	0.046	0.045	0.055	0.031	0.046	0.045	0.056
	(0.045)	(0.040)	(0.045)	(0.041)	(0.035)	(0.032)	(0.044)	(0.042)	(0.036)	(0.032)
	[0.377]	[0.285]	[0.507]	[0.265]	[0.197]	**[0.084]**	[0.486]	[0.273]	[0.201]	**[0.085]**
GDPPC	0.017	0.018	0.016	0.019	0.016	0.018	0.016	0.019	0.016	0.018
	(0.011)	(0.021)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
	[0.116]	[0.401]	[0.193]	[0.105]	[0.185]	[0.121]	[0.191]	[0.114]	[0.188]	[0.132]
DEMOCRACY	0.538	0.531	0.544	0.514	0.550	0.526	0.551	0.519	0.543	0.532
	(0.181)	(0.183)	(0.181)	(0.193)	(0.181)	(0.195)	(0.187)	(0.194)	(0.186)	(0.196)
	[0.003]	**[0.004]**	**[0.003]**	**[0.008]**	**[0.002]**	**[0.007]**	**[0.003]**	**[0.007]**	**[0.003]**	**[0.007]**
VETOPLAYERS_1			-0.052	-0.018	0.247	0.284	0.042	0.033	0.174	0.350
			(0.245)	(0.246)	(0.293)	(0.289)	(0.401)	(0.252)	(0.410)	(0.294)
			[0.831]	[0.942]	[0.399]	[0.326]	[0.917]	[0.897]	[0.671]	[0.233]
ENGO			-0.006	-0.004	0.065	0.070	-0.004	-0.006	0.067	0.071
			(0.019)	(0.019)	(0.034)	(0.033)	(0.020)	(0.019)	(0.035)	(0.033)
			[0.759]	[0.822]	**[0.053]**	**[0.037]**	[0.829]	[0.775]	**[0.055]**	**[0.035]**
ENGO* VETOPLAYERS_1					-0.084	-0.088			-0.088	-0.091
					(0.039)	(0.039)			(0.043)	(0.039)
					[0.030]	**[0.022]**			**[0.039]**	**[0.018]**
ICC			0.293		0.182		0.338		0.133	
			(0.260)		(0.263)		(0.286)		(0.304)	
			[0.260]		[0.489]		[0.237]		[0.661]	
ICC* VETOPLAYERS_1							-0.165		0.155	
							(0.522)		(0.555)	
							[0.752]		[0.780]	
FUEL				-0.279		-0.271		0.053		0.126
				(0.600)		(0.608)		(0.661)		(0.674)
				[0.642]		[0.656]		[0.936]		[0.852]
FUEL* VETOPLAYERS_1								-0.953		-1.092
								(1.231)		(1.236)
								[0.439]		[0.377]
CO2PC		-0.352								
		(0.377)								
		[0.350]								
SELLER		-0.273								
		(0.639)								
		[0.669]								
Countries	170	170	170	170	170	170	170	170	170	170
Wald	36.40	37.99	36.54	36.83	40.36	40.43	36.91	37.74	40.75	41.35
	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: (robust standard errors); [p-values]; p < 10% in bold.

Table 7. Stratified Cox models with VETOPLAYERS_2

Variable	(3)	(3')	(4)	(4')	(5)	(5')	(6)	(6')
ISLAND	0.189	0.177	0.200	0.193	0.185	0.176	0.192	0.193
	(0.052)	(0.057)	(0.056)	(0.060)	(0.049)	(0.056)	(0.047)	(0.060)
	[0.000]	**[0.002]**	**[0.000]**	**[0.001]**	**[0.000]**	**[0.002]**	**[0.000]**	**[0.001]**
POP	-0.042	-0.031	0.078	0.096	-0.077	-0.023	0.116	0.095
	(0.168)	(0.174)	(0.053)	(0.050)	(0.241)	(0.164)	(0.054)	(0.050)
	[0.800]	[0.858]	[0.140]	[0.055]	[0.751]	[0.890]	**[0.031]**	**[0.058]**
GDPPC	0.012	0.015	0.012	0.015	0.012	0.015	0.012	0.015
	(0.012)	(0.011)	(0.012)	(0.011)	(0.012)	(0.011)	(0.011)	(0.011)
	[0.334]	[0.176]	[0.280]	[0.177]	[0.335]	[0.177]	[0.264]	[0.178]
DEMOCRACY	0.536	0.542	0.497	0.509	0.559	0.529	0.566	0.508
	(0.204)	(0.218)	(0.208)	(0.221)	(0.200)	(0.216)	(0.205)	(0.223)
	[0.008]	**[0.013]**	**[0.017]**	**[0.021]**	**[0.005]**	**[0.014]**	**[0.006]**	**[0.023]**
VETOPLAYERS_2	0.100	0.105	0.302	0.321	-0.026	0.097	0.018	0.318
	(0.111)	(0.115)	(0.136)	(0.135)	(0.202)	(0.110)	(0.210)	(0.138)
	[0.369]	[0.360]	**[0.027]**	**[0.018]**	[0.898]	[0.378]	[0.934]	**[0.022]**
ENGO	-0.005	-0.002	0.071	0.079	-0.004	-0.003	0.128	0.079
	(0.019)	(0.019)	(0.041)	(0.040)	(0.020)	(0.018)	(0.048)	(0.041)
	[0.790]	[0.897]	**[0.082]**	**[0.049]**	[0.829]	[0.888]	**[0.008]**	**[0.058]**
ENGO* VETOPLAYERS_2			-0.022	-0.024			-0.039	-0.024
			(0.010)	(0.010)			(0.013)	(0.011)
			[0.033]	**[0.020]**			**[0.003]**	**[0.025]**
ICC	0.320		0.215		-0.089		-1.256	
	(0.277)		(0.275)		(0.742)		(0.790)	
	[0.247]		[0.433]		[0.905]		[0.112]	
ICC* VETOPLAYERS_2					0.157		0.508	
					(0.256)		(0.254)	
					[0.539]		**[0.046]**	
FUEL		0.038		0.118		-0.489		0.044
		(0.613)		(0.629)		(1.430)		(1.517)
		[0.950]		[0.851]		[0.732]		[0.977]
FUEL* VETOPLAYERS_2						0.201		0.027
						(0.462)		(0.490)
						[0.664]		[0.957]
Countries	149	149	149	149	149	149	149	149
Wald	31.40	30.49	31.32	30.58	36.70	31.06	46.75	31.17
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

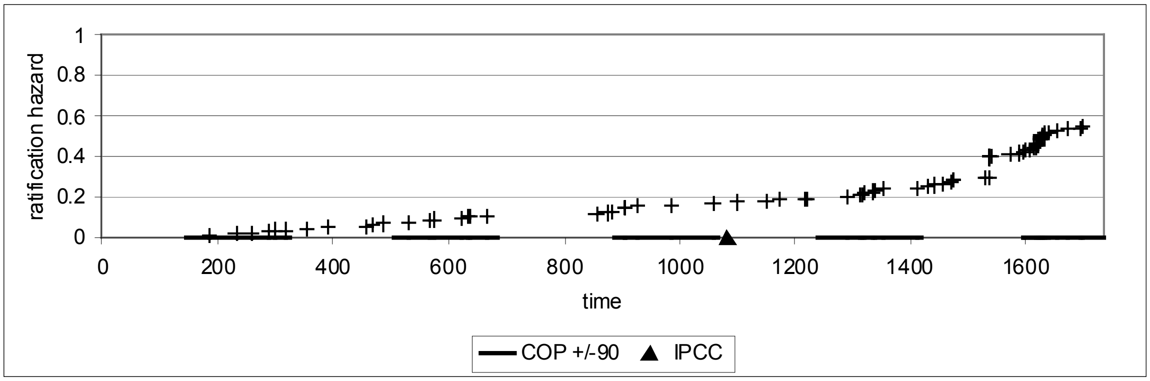
Notes: (robust standard errors); [p-values]; p < 10% in bold.

Table 8. Specification Test

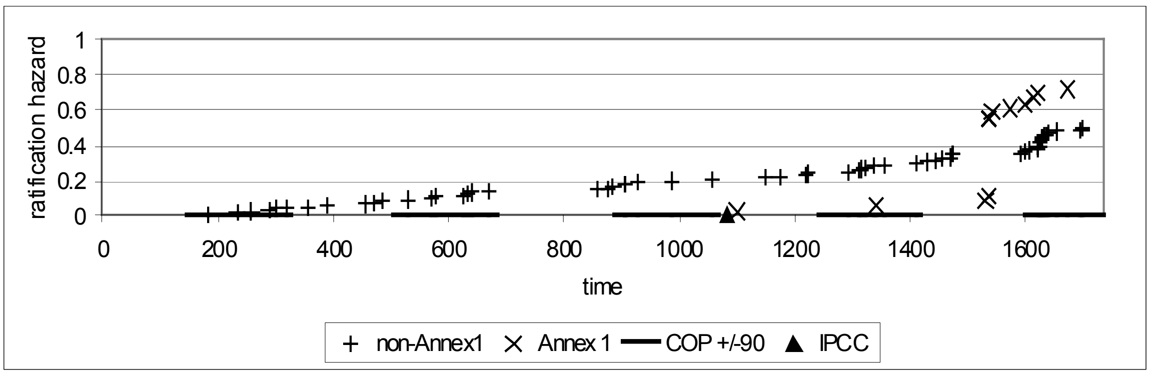
Variable	Model (6) Pooled	G-T test	G-T test for Model (6) Stratified
ISLAND	0.218 (0.046) **[0.000]**	0.07 [0.576]	-0.05 [0.682]
POP	0.096 (0.055) **[0.082]**	0.12 [0.430]	0.04 [0.786]
GDPPC	0.010 (0.010) [0.303]	-0.08 [0.602]	-0.02 [0.876]
DEMOCRACY	0.586 (0.209) **[0.005]**	-0.02 [0.859]	0.32 [0.790]
VETOPLAYERS_2	0.055 (0.230) [0.810]	0.06 [0.469]	0.04 [0.661]
ENGO	0.108 (0.041) **[0.009]**	-0.06 [0.666]	-0.05 [0.700]
ENGO* VETOPLAYERS_2	-0.031 (0.011) **[0.004]**	0.03 [0.820]	0.03 [0.830]
ICC	-0.900 (0.780) [0.248]	0.13 [0.180]	0.10 [0.338]
ICC* VETOPLAYERS_2	0.358 (0.256) [0.162]	-0.07 [0.403]	-0.06 [0.560]
ANNEX1	-0.503 (0.338) [0.137]	0.34 **[0.005]**	
Countries	149		
Wald	45.76 [0.000]		
Global test		30.14 **[0.028]**	3.26 [0.953]

Notes: Based on model (6) in Table 7. The null hypothesis of the G-T test is the validity of the proportional hazard assumption; (robust standard errors); [p-values]; p < 10% in bold.

Figure 1. Cumulative Distribution of Ratification Spells

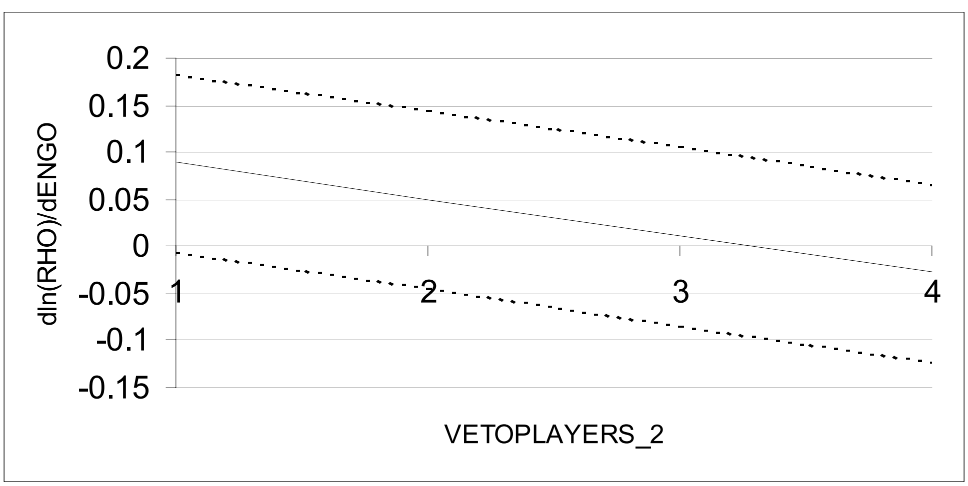


(a)



(b)

Figure 2. Marginal Effect of ENGO Conditional on VETOPLAYERS_2



Notes: The figure is based on Model (6) in Table 7. The dotted line represents the 95% confidence interval.