

1 Introduction

International treaty negotiations typically end with a treaty being signed. This is sometimes a newsworthy event where heads of state participate in a signing ceremony: for example, the Rio Summit on Environment and Development of 1992 concluded with the signing of two important United Nations (UN) Conventions – the Convention on Biological Diversity and the Framework Convention on Climate Change – by the great majority of the 172 participating governments. In most cases, however, signature is more low-key, and is likely only to be noted by policy-makers and affected interest groups in the countries concerned. But does treaty signature actually matter? Signature is not ascribed much legal importance in the process of treaty making insofar as only ratification obliges a state to comply with the treaty under international law.¹ While signing might have symbolic significance, it is difficult to understand its role in the treaty process from a rational actor perspective. However, we argue that signature does matter: when a number of states simultaneously sign a treaty, this conveys important information to domestic veto players, and therefore facilitates treaty ratification.

Our argument is that signing a treaty signals to other states and domestic audiences that action on an issue is necessary. This information can persuade potential domestic veto players to ratify when they would not otherwise have done so. In choosing to sign, states take into account not only what they know about the issue, but also what other states involved in the negotiation know. We label this pooled expertise of states the *weight of international opinion*. In the light of the weight of international opinion, domestic veto players update their prior beliefs (cf. [Igoe Walsh, 2007](#)), and may eventually ratify a treaty that they would not have otherwise accepted – if, for example, the same policy had been proposed as

¹In some cases (e.g. protocols and amendment instruments) states may accede, succeed, approve or accept a treaty without signing it. Ratification implies that an international agreement is binding ([Vienna Convention on the Law of Treaties, 1969](#), Art. 2(1b)). Signature, on the other hand, only commits a state “to refrain from acts that would defeat the object and the purpose of the treaty” ([Vienna Convention on the Law of Treaties, 1969](#), Art. 18a)

1 part of domestic legislation. Just as the expertise of US Congressional committees
2 influences the views of the median legislator (Gilligan and Krehbiel, 1990; Bendor
3 and Meirowitz, 2004), so the pooled expertise of leaders signing a treaty may shift
4 domestic veto players' support for ratification.

5 Our theoretical argument sheds new light on the importance of international
6 law, demonstrating that international legal action may succeed when purely do-
7 mestic action would fail. Like domestic legislation, ratification of a treaty requires
8 majorities or super-majorities in legislatures, and must often pass through multiple
9 domestic veto players – e.g. both houses of a bicameral legislature, regional as-
10 semblies in federal systems like Germany or constitutional courts as in the Czech
11 Republic (Elkins, Ginsburg and Melton, 2010). Powerful lobby groups can also
12 veto ratification if they think their interests would be adversely affected (Falkner,
13 2012). These veto players must therefore be persuaded that treaty ratification is
14 beneficial. With such a veto player the weight of international opinion counts for
15 more than the views of its own executive, because it sums the information held by
16 more actors. Other things equal, domestic veto players may be persuaded to rat-
17 ify an international agreement when they would have blocked domestic legislation.
18 Seen in this light, the treaty signing stage is of considerable significance, because
19 it may open up gridlocked domestic political agendas.

20 While treaty ratification and its effects have been intensively studied (e.g.
21 Bernauer et al., 2010; Neumayer, 2002; Roberts, Parks and Vásquez, 2004; Sim-
22 mons, 2009; von Stein, 2005; 2008; Vreeland, 2008), little attention has been paid
23 to the relationship between treaty signature and ratification. Focusing on what
24 happens after a treaty has been tabled for signature, we examine how a state's
25 decision to ratify a treaty is affected by the pooled expertise of its signatories.
26 Our empirical contribution is to show that the weight of international opinion –
27 represented by the expertise of states initially signing environmental treaties –
28 positively influences a state's likelihood of ratifying a treaty.

1 We begin by locating our contribution in the literatures on treaty commitments
2 and international signaling. In [section 3](#), we develop our argument regarding the
3 weight of international opinion. In [section 4](#), we test our hypothesis. In a data set
4 of 126 international, plurilateral and regional environmental agreements ([Bernauer
5 et al., 2010](#)), we show that treaties are more likely to be ratified when signatories
6 included many states with technical and environmental expertise. We conclude by
7 discussing some broad implications of international treaty signature as a signaling
8 device.

9 **2 Treaties as signaling devices**

10 Most of the existing literature examines *state-to-state signaling*, in which states
11 use treaties to signal the importance of an issue, or their own intentions, to other
12 states. Suppose that a treaty will only be signed by states which intend to carry
13 through their treaty commitments, because signing is too costly for untrustworthy
14 states, for reputational or other reasons. Then a treaty signals to other states that
15 you are trustworthy ([Lipson, 1991](#); [Fearon, 1997](#); [Morrow, 2000](#)).² By signing a
16 treaty, a state may also reveal information about its domestic audience costs of
17 non-compliance ([Espínola-Arredondo and Muñoz-García, 2011](#)). Powerful states
18 can use treaties to bring pressure to bear on reluctant weaker states ([Roberts,
19 Parks and Vásquez, 2004](#); [Schneider and Urpelainen, 2013](#)); and signing may signal
20 that they are willing to use their power. By ratifying a treaty, states signal to
21 other states that any domestic opposition to implementation can be overcome
22 ([Abbott and Snidal, 2000](#)). State-to-state signaling is a plausible explanation of
23 how treaties can facilitate cooperation between states. But we argue that it is by no
24 means the whole story, and that it neglects interactions between the international
25 and domestic levels that are important for securing domestic actors' consent for

²In practice the distinction between commitment and signaling may be blurred in relation to any particular institutional practice ([Slantchev, 2005](#)).

1 international cooperation.

2 There is some informal discussion of *signaling to domestic actors*.³ In the do-
3 mains of human rights ([Hafner-Burton, Victor and Lupu, 2012](#)) and climate change
4 ([Fredriksson and Gaston, 2000](#)) leaders sign a treaty to signal to their domestic
5 audiences their commitment to treaty-related action. [Hollyer and Rosendorff, 2012](#)
6 argue that some autocrats ratify human rights treaties to signal to domestic oppo-
7 nents their resolve to hold on to power and *not to comply*, thereby increasing their
8 tenure. Treaty negotiation and ratification may generate information that helps
9 overcome objections by domestic veto players in situations where there are knowl-
10 edge asymmetries between leaders and domestic audiences ([Milner, 1997](#)). Recent
11 empirical work on the ratification of environmental treaties shows that information
12 revealed in the process of negotiation and ratification may change domestic actors’
13 views about whether national action is required or desirable. [Perrin and Bernauer](#)
14 ([2010](#); also see [Bernauer et al. \(2010\)](#)) find evidence for bandwagon effects de-
15 pending on the numbers of other ratifying states in the region or income group.⁴
16 [Leinaweaver \(2011\)](#) finds that the effect of being a signatory significantly reduces
17 the impact of partisanship on subsequent ratification, which he takes as evidence
18 for information transfer. Unlike us, these authors do not account for variation in
19 states’ issue expertise.

20 **3 Our argument: Signing as a signal**

21 We formalize our argument about the weight of international opinion as a signaling
22 game between one or more executives (i.e. presidents or governments) and their
23 domestic veto players. We contrast the treaty ratification process with the alter-
24 native of passing domestic legislation. Formal proofs are in [Appendix A](#): here we

³Using a signaling game, [Chapman \(2007\)](#) models how the actions of pivotal members of the UN Security Council inform domestic politics.

⁴Our model could be extended to demonstrate how both signing and ratification disclose information through time.

1 simply provide our theoretical assumptions and results. We highlight why inter-
2 national action may succeed where purely domestic action would be vetoed; and
3 clarify when signing is (and is not) informative to veto players.

4 To recap, we argue that political executives must persuade domestic veto play-
5 ers of the importance of policy action on an issue, whether by participating in
6 international negotiations or by tabling purely domestic legislation. While in-
7 troducing legislation signals that an executive considers an issue important, that
8 alone may not persuade veto players, who may have different preferences and/or
9 prior beliefs, and who may view the executive as biased and/or cognitively fallible.
10 However, if executives from many countries simultaneously sign a treaty, then this
11 can potentially provide a stronger signal: not just one, but many actors believe
12 that action is important. This stronger signal can persuade domestic vetoes to
13 support policy change.

14 First we assume that policy is complex and political actors' cognitive resources
15 are limited: therefore, there is *uncertainty* about the effect of policy action. In
16 particular, we focus on a single binary policy which is aimed at addressing an
17 issue; with some probability, the policy will be beneficial to states that introduce
18 it; otherwise, the policy will bring no benefit but only costs. Policy makers are
19 uncertain what the true state of affairs is. We make no distinction between the
20 seriousness of the issue and the efficacy of the policy: policy makers may either
21 be uncertain whether the underlying issue is serious, or whether the policy is
22 appropriate to address an issue which is known to be serious.

23 Second we assume that different actors experience different *net costs* of in-
24 troducing a policy. For example, "greener" politicians will weigh the regulatory
25 costs and ecological benefits of environmental regulation differently than political
26 actors with ties to a business constituency. Thus, each executive, and each do-
27 mestic veto player, has a different cost for introducing legislation and an expected
28 payoff for acting. These costs can reflect not only objective beliefs about policy,

1 but also political preferences and ideological commitments, such as preferences for
2 international cooperation or skepticism towards human-induced climate change.

3 Domestic veto players often have less policy *expertise* than executives. Legis-
4 latures face a collective action problem in acquiring issue expertise ([Gilligan and](#)
5 [Krehbiel, 1990](#)), executives, on the other hand, have access to policy experts. State
6 agencies such as the US Environmental Protection Agency are legally obliged to
7 provide information and expertise to executives, whereas legislators' access to this
8 know-how is more mediated. On highly technical issues such as the environment,
9 this is likely to result in information asymmetries, although some legislators may
10 specialize in the issue. Our third simplifying assumption is that only executives
11 receive a private signal about the policy, while domestic veto players must rely on
12 their prior. Again, what matters is not our simplifying assumption that vetoes do
13 not get a signal, but the weaker condition that they do not already know all the
14 information known by all executives worldwide, and can therefore be persuaded
15 by that information and by actions which signal it.

16 We also assume that executives from different *countries* have different levels
17 of expertise. Executives from developed countries with high levels of scientific
18 expertise will be more informed about the policy's effects than those from coun-
19 tries with a weak scientific base; countries deeply affected by a particular issue,
20 such as fisheries policy for countries with a large fishing industry, will have more
21 expert executives than unaffected countries; and countries with long experience
22 of environmental treaty implementation will have more knowledge and expertise
23 available than countries with less experience.

24 Our model explicitly assumes away any *policy interdependencies* across states:
25 the benefit of the policy in a given country is independent of whether other coun-
26 tries introduce the policy. To be clear, we believe that treaty ratification typically
27 does involve international externalities ([Axelrod and Keohane, 1985](#)). However,
28 our assumption allows us to show that our signaling rationale for treaty signature

1 exists even in the absence of other, more substantive policy reasons for coordi-
2 nated action, such as externalities. Below, we argue that relaxing the assumption
3 of independent policy benefits would further strengthen the signaling rationale for
4 treaty signature.

5 Lastly, our game form embodies assumptions about the politics of the *treaty*
6 *process*. After a state’s executive (or her diplomatic representatives) has signed,
7 the treaty is submitted for ratification. Then each domestic veto players decides
8 whether to allow ratification of the treaty having observed which other executives
9 have signed it. Since any veto player (by definition) can block action, it is a
10 country’s *most skeptical* veto player that must be convinced. For expositional
11 brevity we sometimes call this player “the legislature”, but nothing hangs on this.

12 The domestic legislation and international treaty routes involve different *knowl-*
13 *edge conditions*. The treaty route involves a public signing event in which many
14 countries participate. This makes countries’ commitment visible to domestic veto
15 players, via e.g. reports in the media. For example, climate change agreements
16 have received considerable media attention ([Schmidt, Ivanova and Schäfer, 2013](#)).
17 By contrast, if domestic legislation is introduced, we assume that domestic veto
18 players do not observe action in other countries – a strong assumption, but one
19 which captures the direction of the difference we expect.

20 Note that both signing a treaty and introducing domestic legislation are more
21 than just “cheap talk”. Both actions have real effects, in that they can lead to
22 legislation being implemented. A country’s executive will only take either action
23 if it genuinely believes that legislation is necessary.⁵

⁵Technically, introducing legislation that you believe to be harmful is a weakly dominated action.

1 Under the above assumptions, an executive which introduces domestic legisla-
2 tion will pass it only if its own expertise is enough to convince the country's most
3 skeptical veto. An executive with a very strong preference for action – strong
4 enough that it always prefers legislation to pass, whether or not its private infor-
5 mation indicates that the policy is appropriate – will not be able to credibly signal
6 information to domestic audiences. Even a more neutral executive may simply
7 lack enough expertise to persuade domestic vetoes that the policy is appropriate.

8 However, if executives from many countries sign a treaty, then this can generate
9 a more powerful signal that the treaty's policy is the right response. The signal
10 does not necessarily incorporate the expertise of each and every signing country,
11 since in equilibrium, some executives may free-ride on the expertise of others –
12 a phenomenon known in domestic politics as the Swing Voter's curse ([Feddersen](#)
13 [and Pesendorfer, 1996](#)). However, we show computationally in [Appendix B](#) that in
14 general the strength of the signal is highly correlated with the sum of the expertise
15 of all signatories. This result leads us to our main hypothesis.

16 *The likelihood of a legislature ratifying a treaty increases with the summed*
17 *expertise of the signatory countries.*

18 Next, consider the effect of an increase in the number of domestic veto play-
19 ers. Recall that the relevant actor is the most skeptical veto player in a country.
20 Suppose that the number of veto players in this country increases by one. Clearly
21 the signal strength required to persuade the most skeptical veto can only stay the
22 same or increase. How will this change the marginal effect of an increase in pooled
23 expertise? In [Appendix B](#) we show that an increase in the number of veto players
24 can either increase or decrease this marginal effect. We therefore test empirically
25 for the interaction between expertise and number of veto players but are agnostic
26 about the direction of result.

1 Relaxing the assumptions

2 We now ask what happens when we relax our assumptions. In the basic model,
3 domestic veto players have *no private information* about the policy. This is unre-
4 alistic. If veto players receive their own private signal about the policy, then the
5 effects are ambiguous. A veto player who is wholly uninformed about the issue
6 and who perceives high costs of action might never ratify a treaty, even one signed
7 by countries with great policy expertise. The same veto player, after having re-
8 ceived its own reasonably accurate signal that the policy is beneficial, might be
9 persuaded to sign. However, as a domestic veto player gets more accurate informa-
10 tion about the issue, it eventually ceases to rely on information from others. In the
11 limit, a domestic veto player who knows for sure whether the policy is appropriate
12 will accept legislation only if it is, whether the domestic legislation or the treaty
13 route is taken, and irrespective of the expertise of other parties. At this point
14 our argument would no longer apply. Our theory requires, and we maintain, that
15 in many policy areas, domestic veto players are less well informed than this. As
16 an example, consider a domestic veto whose signal is exactly as accurate as the
17 executive's, and who is *a priori* skeptical about the policy, in the sense that prior
18 to receiving any signals, she would not prefer the policy to be implemented. The
19 executive alone can never persuade this veto to act against her own signal. For,
20 if the veto receives a negative signal about the policy, then a positive signal from
21 the executive simply brings her back to her skeptical prior. Only the treaty route
22 may provide enough information to override such a veto's negative signal.

23 In our model, countries *benefit from the policy* (if it is appropriate) irrespective
24 of whether other countries take action. In reality, treaties often serve to coordi-
25 nate action on issues where there are externalities. Transboundary pollution can
26 be dealt with better if many countries simultaneously commit to environmental
27 measures. Indeed, the literature treats this coordination as a central reason for
28 the existence of international treaties (and we agree). To consider this aspect, sup-

1 pose that each country's benefit from introducing an appropriate policy increases
2 with the number of other countries that do so. Now, there will be two benefits
3 to taking the treaty route, compared to introducing legislation on a country-by-
4 country basis. First, the signal of expertise will be stronger, as before. Second,
5 this stronger signal will lead each country to expect more other countries to ratify
6 the treaty. This will encourage the country to ratify, which in turn will encour-
7 age other countries, and so on. Thus, with positive externalities, the information
8 benefits of treaties, and the marginal effect of signatories' expertise, are likely to
9 increase.

10 The model assumes that *treaty signature is costless, and its only effect is to*
11 *allow the country's legislature to ratify the treaty.* Both these assumptions are
12 challengeable. Failure to pass a treaty, after a highly-publicized signing process,
13 can cause audience costs for executives, both with the international community
14 and among domestic publics for whom the issue is salient. On the other hand, leg-
15 islatures may be able to introduce domestic legislation irrespective of the treaty's
16 status, and countries may accede to an existing treaty without having been a sig-
17 natory. These facts push in different directions. If acceding to a treaty is as easy
18 as ratifying, then signing a treaty is pure "cheap talk" and can convey nothing.
19 On the other hand, audience costs of signing a treaty may serve to demonstrate
20 the executive's belief that the policy is appropriate, in line with a costly signaling
21 logic. Then, treaty signature may convey useful information even if it does not
22 affect the legislature's ability to accede or ratify.

23 Lastly, we assume that the *content of the treaty is fixed* at the start of the
24 game. In fact, we know that treaty content is negotiated with one eye on domestic
25 veto players (Putnam, 1988; Mo, 1995; Brown and Urpelainen, 2015). Moreover,
26 domestic vetoes may pre-empt the treaty from reaching the international agenda at
27 all, if it takes certain specific forms to which they are opposed (Barrett, 2003: 148).
28 This complicates the analysis, since now not only the set of signing executives, but

1 also the content of the treaty itself, might convey information to domestic vetoes.
2 One way of thinking about this is that in the existing setup, executives choose
3 between signing the treaty, and signing no treaty. A more complex model would
4 allow a range of possible treaties, taking weaker or stronger measures to deal
5 with the underlying issue, with executives negotiating to find a treaty that all are
6 willing to sign (including a possible “null” treaty that takes no meaningful action).
7 Legislatures would then observe the treaty signature and choose whether to ratify.

8 We believe that in such a more complex model, our basic insight would still
9 hold. So long as executives who desire a stronger policy (conditional on their pri-
10 vate information) will want to sign stronger treaties; the strength of the treaty
11 signed will be positively correlated with executives’ private information. Legisla-
12 tures will in turn be more influenced by this information if it comes from executives
13 with issue expertise, i.e. accurate signals. Thus, allowing treaty content to be ne-
14 gotiated may generate further predictions, but should not reverse our hypothesis.

15 4 Empirical analysis

16 4.1 Outcome variable and estimation technique

17 To test the effects of signing on the likelihood of treaty ratification, we use en-
18 vironmental treaty ratification data from [Bernauer et al. \(2010\)](#).⁶ The data set
19 includes 255 multilateral, plurilateral and regional treaties (covering conventions,
20 protocols and amendments) and spans the period 1952 to 2000.

21 Because our argument focuses on the relationship between treaty signature
22 and ratification, we study only treaties that require two separate approval steps,
23 signature and ratification, and exclude treaties which lack an explicit signature step
24 – protocols and amendments in particular. This leaves us with 126 environmental
25 treaties which require both signature and ratification.

⁶We thank these authors for making their data available to us.

1 Finally, while the data set includes environmental treaties, some of the treaties
2 are not narrowly environmental in focus, but are also concerned with other issues
3 (e.g. the Aarhus Convention touches upon human rights). This does not present
4 a problem for us as our argument is not restricted to any substantive domain.
5 However, we account for treaty heterogeneity by stratifying our models for issue
6 areas of treaties (see [Robustness checks](#)).

7 To study ratification data, we use event history analysis. Event history anal-
8 ysis is particularly suited to study the change in status from non-ratification to
9 ratification of a given treaty. It not only considers which states ratify a treaty, but
10 also takes into account the time lapse until ratification occurs. Moreover, event
11 history analysis accounts for the fact that observed data is incomplete.⁷ Time
12 to ratification cannot be observed in full and remains unknown for some states,
13 due to censoring and truncation of data ([Klein and Moeschberger, 2003](#)). We are
14 faced with fixed and random right-censoring as well as left-truncation. Fixed right-
15 censoring refers to states that had not ratified a particular treaty at the end of the
16 analysis in December 2000; random right-censoring refers to states that ceased to
17 exist before the end of the analysis in 2000, e.g. Czechoslovakia (state termination
18 in 1992). Left-truncation exists for successor states (e.g. of Yugoslavia and the
19 Soviet Union), since these states enter late into the database.

20 Another important feature of the event history method is its applicability to
21 data with “multiple events per subject” ([Therneau and Grambsch, 2000](#)). We
22 need to allow for the possibility that each state can ratify any number of our set of
23 treaties in any given year the treaty was open for ratification. In order to account
24 for this, we organized our ratification data as count data following [Andersen and](#)
25 [Gill \(AG\) \(1982\)](#). The data takes the form of country-treaty-year, with years being

⁷[Bernauer et al. \(2010\)](#) results are estimated with a time-series-cross sectional approach for annual ratification data ([Beck, Katz and Tucker, 1998](#)) controlling for the baseline hazard with polynomials in time ([Carter and Signorino, 2010](#)); they check for robustness by using event history methods. [Perrin and Bernauer \(2010\)](#) use similar method to [Bernauer et al. \(2010\)](#). [Roberts, Parks and Vásquez \(2004\)](#) is a cross-sectional study. Like us, [Fredriksson and Gaston \(2000\)](#) use the Cox proportional hazards model.

1 formulated as intervals indicating the start and end of the count. The year count
2 ends with the occurrence of an event for any given country and treaty (represented
3 by “status” equaling 1), resulting in a varying length of the count for any country-
4 treaty.⁸ Table 1 illustrates the count structure of our ratification data in more
5 detail, providing also examples for right-censoring and left-truncation.

Country	Treaty	Year	Start	Stop	Status	Interval
Federal Republic of Germany	CITES	1974	1973	1974	0	(0, 1+]
Federal Republic of Germany	CITES	1974	1974	1975	0	(1, 2+]
Federal Republic of Germany	CITES	1974	1975	1976	1	(2, 3]
German Democratic Republic	CITES	1974	1983	1984	0	(10, 11+]
German Democratic Republic	CITES	1974	1984	1985	0	(11, 12+]
German Democratic Republic	CITES	1974	1985	1986	0	(12, 13+]
German Democratic Republic	CITES	1974	1986	1987	0	(13, 14+]
German Democratic Republic	CITES	1974	1987	1988	0	(14, 15+]
German Democratic Republic	CITES	1974	1988	1989	0	(15, 16+]
German Democratic Republic	CITES	1974	1989	1990	0	(16, 17+]
Croatia	CITES	1974	1991	1992	0	(18, 19+]
Croatia	CITES	1974	1992	1993	0	(19, 20+]
Croatia	CITES	1974	1993	1994	0	(20, 21+]
Croatia	CITES	1974	1994	1995	0	(21, 22+]
Croatia	CITES	1974	1995	1996	0	(22, 23+]
Croatia	CITES	1974	1996	1997	0	(23, 24+]
Croatia	CITES	1974	1997	1998	0	(24, 25+]
Croatia	CITES	1974	1998	1999	0	(25, 26+]
Croatia	CITES	1974	1999	2000	0	(26, 27+]

Table 1: Excerpt of the count data.

Notes: Federal Republic of Germany is an untruncated and uncensored data example; German Democratic Republic is random right-censored (ceased to exist in 1989); and Croatia is left-truncated (exists since 1991) and fixed right-censored (no ratification at the end of period of analysis).

Treaty	CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora.
Year	Year in which treaty opened for ratification.
Start	Begin of the year count.
Stop	End of the year count.
Status	1: ratification; 0: no ratification.
Interval	The interval (<i>start</i> , <i>stop</i>] is open on the left and closed on the right; it indicates begin and end of the count (based on the year 1974 when treaty opened for ratification) for each treaty within a country. + indicates the incomplete nature of the data (no event or right-censoring).

⁸The count data is set up at annual intervals to accommodate time-varying covariates.

1 The AG approach assumes that observations for a subject are mutually inde-
2 pendent, meaning that the likelihood of a state ratifying a treaty is unaffected by
3 any its earlier ratification decisions (Box-Steffensmeier and Zorn, 2002: 1073–74;
4 Therneau and Grambsch, 2000: 185–86). Following this, state a can ratify treaty
5 x without or before ratifying treaty y , and state b can ratify treaty y without or
6 before ratifying treaty x .⁹ We also account for correlated groups of observations
7 (non-independence of multiple ratifications per country) by clustering on states,
8 applying robust sandwich variance estimators based on a grouped jackknife (Box-
9 Steffensmeier and Jones, 2004: 158).¹⁰

10 We run Cox proportional hazards regression models, with a partial likelihood¹¹
11 modified to take account of the presence of left-truncated and right-censored data
12 (Tableman and Kim, 2004).¹² In the Cox model the hazard ratio is the measure of
13 effect; it is the exponential of the regression coefficient. This gives the *proportional*
14 *change in the ratification rate* due to a one-unit change in a given covariate.¹³

15 4.2 Explanatory variables

16 Our hypothesis states that the greater the weight of international opinion in favor
17 of action, the more likely a state is to ratify a treaty, because domestic veto players
18 are more likely to be convinced of the desirability of this action.

19 To test this claim, we first need to operationalize the group of initial signatories.
20 For each of the treaties in our sample we coded when states signed the treaty, if

⁹Since we excluded protocols and amendments which are contingent on ratification of an earlier treaty from our data set, we do not compromise this conditional independence assumption.

¹⁰The clustering function is used in the context of survival models to account for intra-group correlations. It is thus similar to fixed effects, but does not yield additional fixed effects parameters.

¹¹The likelihood is approximated by the Efron method which is particularly accurate in dealing with tied data.

¹²The Cox model is characterized by an unspecified baseline hazard function. The unspecified baseline allows the hazard function to vary with time, and thus is able to capture potential time trends.

¹³The hazard ratio must be independent of time. Results based on scaled Schoenfeld residuals indicate that this proportional hazards assumption is satisfied by all covariates. Model checks and data diagnostics are available from the authors on request.

1 they did so (based on CIESIN, 2006; cross referenced with Mitchell and Hensel,
2 2007). Our formal model assumes a coordinated signing event. In practice such an
3 event does not always happen and signatures may continue to accumulate for some
4 time. However, signing is usually bunched in the first year of the life of a treaty;
5 and typically treaties are only open for signature for a limited period – often a
6 year. Over the treaties analyzed here, around 80% of the states that signed did so
7 in the first year after opening for adoption. We therefore define states that sign
8 within the first year as “first signers” of a treaty, for which the binary variable
9 FIRST_SIGN is 1 and 0 otherwise.

10 Next, we need to measure our main explanatory variable – states’ knowledge of
11 environmental issues, which is a challenge. We develop four alternative measures.
12 The most direct measure of a country’s environmental expertise is its research
13 output in this discipline. SCImago (2015) provides several measures of countries’
14 research output categorized by Scopus subject areas. We started with the number
15 of documents published by each country in each year categorized as environmental
16 science.¹⁴ For each treaty we summed across the group of first signers the number
17 of documents reported by SCImago for those countries in the first year of signing.
18 This variable is denoted by DOCS_1_SIGN. It captures the summed environmental
19 expertise of first signers, on the assumption that contacts between the research
20 community and the government are well-developed and executives listen to advice.
21 Although the variable provides a good measure of environmental-science output,
22 unfortunately its temporal coverage is quite limited, starting in 1996.

23 For each treaty we summed across the group of first signers the number of
24 patents lodged by each country in the year of first signing (World Bank, 2015).¹⁵
25 This patent variable is denoted by PATENT_1_SIGN and is standardized to avoid

¹⁴We considered weighting for citations, but such weightings are somewhat contentious and it made little difference to DOCS_1_SIGN.

¹⁵Where data on patents was missing for some country years we linearly interpolated. Some poorer and smaller states never report. In all likelihood they produce very few patentable ideas; so we treated such cases as zeros.

1 small coefficients. The bivariate correlation between PATENT_I_SIGN and DOCS_I_SIGN
2 is .915. This suggests that countries' expertise in environmental science is highly
3 correlated with their general expertise in the natural sciences and technology. Be-
4 cause the temporal coverage of PATENT_I_SIGN is much greater, allowing us to
5 make full-use of the ratification data going back to 1961, we report results using
6 PATENT_I_SIGN rather than DOCS_I_SIGN.

7 Another, more informal, type of expertise relevant for regulating and adapting
8 to environmental problems is based on experience and tacit knowledge. Countries
9 with long experience in implementing key environmental treaties are likely to be in
10 a better position to judge impacts. Our second proxy EXPERIENCE_I_SIGN reflects
11 this aspect of expertise, and captures the collective experience of first signers
12 with major multilateral environmental treaties. The variable is measured as the
13 standardized number of years a country has accumulated since ratifying nine key
14 environmental treaties as identified in the International Trade and Agricultural
15 Policy (IATP) treaty database (IATP, 2005).¹⁶ As before, the variable is then
16 summed over the group of first signers for a given treaty.

17 Finally, we also test for issue-specific knowledge focusing on a narrower do-
18 main of environmental regulation, marine treaties. Our proxy measure for issue-
19 specific expertise, MARINE_I_SIGN, is the ratio of coastline to land area (CIA,
20 2013), summed over first signers. The idea is that maritime states have a greater
21 incentive to gather knowledge on maritime issues. While past treaty experience
22 measured by EXPERIENCE_I_SIGN could be correlated with omitted variables, such
23 as an early signer's concern for the environment or central position in relevant
24 international networks (Ward, 2006), MARINE_I_SIGN, by contrast, is likely to be
25 exogenous to most forms of international power.

¹⁶These are: the UN Convention on the Law of the Sea, Montreal Protocol, the Basel Convention, the UN Framework Convention on Climate Change, Kyoto Protocol, the Convention on Biological Diversity, Cartagena Protocol, the UN Convention to Combat Desertification and the Rotterdam Convention. The Stockholm Convention and the International Treaty on Plant Genetic Resources for Food and Agriculture are also included in the IATP database but are not part of our treaty sample.

1 We also control in our models for obvious confounders. Because the number
2 of patents might just capture the general international influence of wealthy coun-
3 tries, not something specific about their knowledgeability, we constructed a control
4 variable `WEALTH_I_SIGN` reflecting the wealth of first signers. Similarly, because
5 countries that produce many patents tend to be large and powerful, a country's
6 number of patents might be associated with its power position in the international
7 system. To control for this correlation we constructed `POWER_I_SIGN`. Both vari-
8 ables are constructed in the same way as `PATENT_I_SIGN`. `WEALTH_I_SIGN` gives
9 the summed GDP per capita of countries belonging to the group of first signato-
10 ries in the year of signing ([World Bank, 2015](#)). `POWER_I_SIGN` gives first signers'
11 summed military capability scores (the Composite Index of National Capability –
12 CINC) from the Correlates of War Project ([Singer, Bremer and Stuckey, 1972](#)).
13 As shown in [Table 2](#), the correlations between these three variables are relatively
14 high.

	FIRST_SIGN	DOCS_I_SIGN	PATENT_I_SIGN	EXPERIENCE_I_SIGN	MARINE_I_SIGN	WEALTH_I_SIGN	POWER_I_SIGN
FIRST_SIGN	1.000	0.430	0.515	0.536	-0.100	0.539	0.504
DOCS_I_SIGN	0.430	1.000	0.917	0.763	-0.071	0.846	0.933
PATENT_I_SIGN	0.515	0.917	1.000	0.829	-0.129	0.935	0.964
EXPERIENCE_I_SIGN	0.536	0.763	0.829	1.000	-0.161	0.944	0.787
MARINE_I_SIGN	-0.100	-0.071	-0.129	-0.161	1.000	-0.170	-0.113
WEALTH_I_SIGN	0.539	0.846	0.935	0.944	-0.170	1.000	0.897
POWER_I_SIGN	0.504	0.933	0.964	0.787	-0.113	0.897	1.000

Table 2: Correlation matrix.

1 In models testing for issue specific knowledge by MARINE_L_SIGN, we control
 2 for a state's own coastline to land area ratio, R_COAST_LAND (CIA, 2013). We
 3 also include a number of other relevant factors largely following Bernauer et al.
 4 (2010). We include international influences on treaty ratification, measured as
 5 the number of international organizations (IO_MEMBERSHIP) a state belongs to
 6 (cf. Neumayer, 2002). Because a state may be more likely to ratify when other
 7 states have already done so (Simmons, 2009), we include the number of other
 8 states that have already ratified, both globally (THRESHOLD); and in the state's
 9 region (LAGPEREGION). We control for trade intensity – the sum of exports and
 10 imports divided by gross national product (OPEN) – as it might affect ratification
 11 negatively due to the possible effects of environmental provisions on international
 12 competitiveness. We also include real income per capita to baseline year 2005 US\$
 13 (RGDPL), calculated using the Lasperes method from Penn World Table, and its
 14 square (RGDPLSQ) (Heston, Summers and Aten, 2009).¹⁷ To capture whether a
 15 state is more likely to ratify as its environment deteriorates, we use sulphur dioxide
 16 emissions per capita, logged (LNSO2PC) as a general indicator for environmental
 17 quality (Bernauer et al., 2010). We test for the effects of democracy by mean scores
 18 on Freedom House's political and civil rights index (MEANPC) (Freedom House,
 19 2015),¹⁸ and the size of states' economy (GDPL) on ratification (Heston, Summers
 20 and Aten, 2009). Descriptive statistics for all explanatory variables are presented
 21 in Table 3.

¹⁷Both variables are standardized to avoid small coefficients.

¹⁸In Appendix C, Table 7 we also report results based on POLITY2 (Marshall, Gurr and Jaggers, 2014). While MEANPC is only available from 1972 onwards for 186 states, POLITY2 has temporal coverage back to 1950 but only for 157 states. Results based on POLITY2 are however similar to our primary findings.

	Min	Max	Mean	Std. Deviation	Observations
DOCS_I_SIGN	0 .00	40850	13320	13210.1	9172
PATENT_I_SIGN	-0.79	5.44	0.11	1.14	266642
EXPERIENCE_I_SIGN	-0.19	13.72	0.02	1.05	342668
MARINE_I_SIGN	0.00	15.60	0.90	1.86	161886
(based on subsample)					
Controls					
FIRST_SIGN	0.00	1.00	0.07	0.25	342668
WEALTH_I_SIGN	-0.64	6.85	0.37	1.21	266642
POWER_I_SIGN	-0.72	4.13	0.39	1.14	342668
R_COAST_LAND	0.00	8.71	0.11	0.58	157595
(based on subsample)					
IO_MEMBERSHIP	1.00	134.00	50.70	20.99	308238
THRESHOLD	0.00	180.00	18.62	23.39	342668
LAGPERCREGION	0.00	97.87	7.13	14.40	342668
OPEN	-0.77	10.31	0.00	1.01	317866
RGDPL	-0.76	6.78	0.00	1.01	313388
RGDPLSQ	-0.37	12.83	0.00	1.01	313388
LNSO2PC	-4.34	9.58	3.65	2.16	300197
MEANPC	1.00	7.00	3.97	2.04	307720
POLITY2	-10.00	10.00	-0.06	7.38	291960
GDPL	-0.26	15.67	0.00	0.99	292461

Table 3: Descriptive statistics.

4.3 Results

In [Table 4](#) we present four models. All models test our hypothesis regarding the effect of signatory countries' pooled expertise on the likelihood of a state ratifying a treaty, using our alternative measures of expertise. In all models we include the controls introduced above. Given that the controls do not show any unexpected directions of effects, we focus here on the interpretation of our key explanatory variables – PATENT_I_SIGN, EXPERIENCE_I_SIGN and MARINE_I_SIGN. In [Appendix C, Table 6](#) we also present equivalent models without the controls (except for FIRST_SIGN, and R_COAST_LAND in models including MARINE_I_SIGN). Overall, the coefficient values and significance levels were reasonably stable across the reduced and full variants of all our models.¹⁹

¹⁹To check whether the effect of pooled expertise is conditioned by the importance of countries at the negotiation stage, we interacted our main variables with the number of countries' signatures and also controlled our models for the number of countries' signatures. However, the inclusion of both terms did not make any substantive difference to our results.

	Model 1 exp(coef) (<i>p</i>)	Model 2 exp(coef) (<i>p</i>)	Model 3 exp(coef) (<i>p</i>)	Model 4 exp(coef) (<i>p</i>)
Pooled expertise				
PATENT_I_SIGN	1.369 (0.000***)			1.147 (0.000***)
EXPERIENCE_I_SIGN		1.262 (0.000***)		
MARINE_I_SIGN			1.068 (0.000***)	
Controls				
FIRST_SIGN	4.659 (0.000***)	4.937 (0.000***)	6.406 (0.000***)	4.037 (0.000***)
WEALTH_I_SIGN				1.449 (0.000***)
POWER_I_SIGN				0.755 (0.000***)
R_COAST_LAND			3.408 (0.026*)	
IO_MEMBERSHIP	1.005 (0.116)	1.004 (0.188)	1.007 (0.041*)	1.006 (0.030*)
THRESHOLD	1.005 (0.001***)	1.011 (0.000***)	1.015 (0.000***)	1.006 (0.000***)
LAGPERCREGION	1.019 (0.000***)	1.020 (0.000***)	1.017 (0.000***)	1.020 (0.000***)
OPEN	0.963 (0.402)	0.968 (0.410)	0.978 (0.680)	0.950 (0.281)
RGDPL	1.158 (0.234)	1.128 (0.337)	1.247 (0.222)	1.107 (0.408)
RGDPLSQ	0.922 (0.452)	0.936 (0.542)	0.897 (0.518)	0.964 (0.724)
LNSO2PC	1.095 (0.000***)	1.101 (0.000***)	1.076 (0.018*)	1.089 (0.000***)
MEANPC	1.116 (0.000***)	1.111 (0.000***)	0.990 (0.772)	1.120 (0.000***)
GDPL	0.959 (0.031*)	0.968 (0.073)	1.065 (0.004**)	0.962 (0.051)
LRT (<i>p</i>)	6002 (0)	6330 (0)	1591 (0)	6399 (0)
Wald test (<i>p</i>)	4373 (0)	4341 (0)	1179 (0)	4497 (0)
Robust (score) logrank test (<i>p</i>)	141.1 (0)	140.8 (0)	112.1 (0)	141.4 (0)
No. Observations	205384	250347	122285	205384
No. Events	3002	3124	858	3002
No. States	157	157	156	157
Period	1972–2000	1972–2000	1972–2000	1972–2000

Table 4: Cox proportional hazards regression models for treaty ratification.

Notes: Each cell entry [exp(coef)] is the exponential of the coefficient which is the hazard ratio (HR). The likelihood ratio test assumes independence of observations within a cluster (country); the Wald and robust score tests do not. *** $p|z| < .001$, ** $p|z| < .01$, * $p|z| < .05$.

1 Model 1 includes PATENT_I_SIGN. In this model the hazard ratio for PATENT_I_SIGN
2 is greater than one and significantly different from one at the .001 level. (A hazard
3 ratio of one indicates that a variable has no effect on treaty ratification. A ratio
4 of more than one indicates that the variable increases the likelihood of ratifica-
5 tion.) Increasing the pooled expertise of first signers by one standard deviation
6 increases the likelihood of ratifying a treaty by 37%.²⁰ This supports our hypoth-
7 esis: the weight of international opinion among the group of first signers increases
8 the propensity to ratify.

9 Model 2 uses the collective experience measure EXPERIENCE_I_SIGN. The col-
10 lective experience of first signers with key multilateral environmental treaties has
11 a substantial effect on other states' ratification likelihood (an increase by one stan-
12 dard deviation results in a 26% increase of the ratification likelihood); this effect
13 is statistically significant at a .001 level.

14 In model 3, we test the effect of issue-specific knowledge with MARINE_I_SIGN.
15 Though the treaties we deal with cover quite diverse environmental issues, around
16 50% of them concern maritime issues and fishing. States with extensive coastlines
17 are likely to have more knowledge and expertise on these issues than predomi-
18 nantly landlocked states. We fit model 3 for a subsample of marine and fishing
19 treaties. We include MARINE_I_SIGN (the sum of signatories' marine-related ex-
20 pertise, as proxied by their coast-land ratio), and, in addition to the previous
21 controls, a measure for a state's own coastline to land area ratio, R_COAST_LAND.
22 For both variables we found significant and positive effects, although the effect
23 for MARINE_I_SIGN is statistically stronger than for R_COAST_LAND (which is sta-
24 tistically significant only at a .05 level). Thus, when it comes to issue-specific
25 knowledge there is also evidence for the pooled expertise effect.

26 Finally, in model 4 we also tested whether the effect of pooled expertise mea-
27 sured by PATENT_I_SIGN holds against the inclusion of measures reflecting wealth

²⁰An equivalent model fit without FIRST_SIGN results in an even stronger effect for PATENT_I_SIGN (see [Appendix C](#), [Table 7](#)).

1 (WEALTH_L_SIGN) and the power position of first signers (POWER_L_SIGN). Again,
2 we find a significant and positive effect for pooled expertise increasing the ratifica-
3 tion likelihood by 15% (given a one standard deviation increases in the variable).²¹

4 4.4 Robustness checks

5 To confirm our results regarding the effect of signatories' expertise on ratification,
6 we conducted several robustness checks and fitted numerous models, which we
7 show in [Appendix C](#).

8 First, because our modeling framework involving multiple events is quite com-
9 plex, we ran bootstrap simulations as an additional cross-check for Model 1 from
10 [Table 4](#), based on sampling with replacement. In each of the 199 runs we fit-
11 ted the model to a random sample of treaties from the original data. In order
12 to test whether the variables have a significant effect, we constructed empirical
13 95% confidence intervals of the parameter estimates from the posterior distribu-
14 tion. The simulation results ([Appendix C, Figure 1](#)) confirm that our key variables
15 PATENT_L_SIGN from Model 1 has a significant and positive effect on the likelihood
16 of ratification (0 is not within the confidence interval).

17 Second, the Cox proportional hazards models in [Table 4](#) assume one baseline
18 hazard for all treaties, which however address different issues in environmental
19 regulation. Thus, we stratified our models on a categorical ISSUES variable al-
20 lowing the baseline hazard to vary across treaties. This variable differentiates
21 between ten areas of environmental regulation: general/governance; atmosphere;
22 hazardous substances; marine environment; nature conservation and terrestrial liv-
23 ing resources; energy; nuclear safety; marine living resources; freshwater sources;
24 conflict and disasters. The stratified models closely resemble those in [Table 4](#),

²¹Results for PATENT_L_SIGN in Model A4 ([Appendix C, Table 6](#)) are not robust to the inclusion of WEALTH_L_SIGN and POWER_L_SIGN when all other controls are excluded. Such a fit obscures the effect of PATENT_L_SIGN as it gives much more exposure to the high level of correlation between these three variables (see [Table 2](#)).

1 indicating that our major results hold across different areas of environmental reg-
2 ulation (Model 1 stratified on ISSUES is shown in [Appendix C, Table 7](#)).

3 Third, to account for potential correlation of ratifications patterns by treaty
4 rather than country we refitted all our models with a cluster on “treaties”. Cluster-
5 ing our observation on treaties, however, does not alter our major result for pooled
6 expertise. In [Appendix C, Table 7](#) we present Model 1 clustered on treaties.

7 Fourth, we also refitted models from [Table 4](#) including the full set of controls,
8 controlling for regime type with POLITY2 rather than MEANPC. All those estima-
9 tions confirm the major findings presented in [Table 4](#), and do not alter our results
10 in any substantial way (see [Appendix C, Table 7](#)).

11 Finally, we estimated several models to examine whether an increase in the
12 number of domestic veto players alters the effect of pooled expertise on states’
13 propensity to ratify. Although our theory does not make a directional prediction
14 for domestic constraints, we tested empirically for the interaction between expertise
15 and veto players, measured as the level of constraint on the executive.²² However,
16 we did not find a substantively important effect of domestic constraints in either
17 direction.

18 5 Conclusion

19 We argue that the signing of treaties is more than a political ritual. Our theory
20 predicts that the greater the weight of international opinion signaled by initial
21 signatories, the greater the chance that the treaty will subsequently be ratified.
22 Our theory highlights a non-obvious reason for choosing an international treaty
23 over domestic legislation: international treaties may sway domestic veto players if

²²To measure domestic veto structure, we used the executive constraint variable from the Polity project (XCONST) ([Marshall, Gurr and Jaggers, 2014](#)). Second, to specifically reflect environmental concerns, we calculate a score reflecting the position of the median member’s party on environmental issues (ENV_LEG) using the Comparative Manifestoes Project information on the emphasis placed on the environment in parties’ election manifestoes ([Klingemann et al., 2006](#)).

1 they distrust their own leader. Empirically, we provide evidence that the weight of
2 international opinion does, indeed, increase the chances of subsequent ratification
3 of environmental treaties. Our theory suggests that potential vetoes are swayed
4 by the pooled expertise of signatories. Qualitative case studies would allow us to
5 better understand the precise causal mechanism that underlies our finding. Where
6 vetoes are defined by the constitution as in the case of second chambers cited
7 above, it should be possible to carry out such research by examining debates and
8 reports and by carrying out interviews.

9 Although our empirical results concern environmental treaties, effects should
10 also operate in other domains, such as international human rights treaties. Even if
11 democratic states can act alone on human rights ([Simmons, 2009; 2010](#)), interna-
12 tional treaty signature may remove domestic legislative roadblocks and facilitate
13 the treaty route. Thus our analysis complements constructivist accounts of how
14 human rights norms arise (e.g. [Risse and Sikkink, 1999](#)). States use the weight
15 of international opinion strategically to persuade domestic veto players about a
16 norm.

17 Our findings counteract prevalent skepticism regarding the significance of inter-
18 national treaties. Some argue that it is harder to understand why states incur the
19 costs of treaty negotiation when domestic action would suffice or when one state's
20 action would not affect the payoffs of others. For instance, why must established
21 democracies ratify human rights treaties when their independent judiciaries pro-
22 vide credible commitment at the domestic level ([Simmons, 2010](#))?²³ Other argue
23 that states only sign shallow agreements that do not matter and that are consis-
24 tent with what they intend to do anyway for domestic reasons ([Downs, Locke and](#)
25 [Barsoom, 1996](#)), and the design of treaties may reflect this ([Mitchell, 2009; von](#)
26 [Stein, 2005](#)). Our model suggests that treaties persuade domestic veto players,

²³Indeed such states are somewhat less prone to ratify than new democracies that have an interest in signaling their commitment, both domestically and internationally [Hafner-Burton, Mansfield and Pevehouse, 2015](#).

1 even if the treaty does not go beyond what leaders would do for purely domestic
2 reasons. Pooling information at the international level and then transferring it to
3 the domestic level by highly visible signals is an important function of international
4 legal processes.

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1 **A Appendix: A formal model of signing**

2 There are N states. Each country has a legislature L and an executive E . The
3 states must decide whether to implement a policy to deal with an environmental
4 or other issue. There is an unobserved state variable $S \in \{0, 1\}$ which equals 1
5 with probability s , and 0 otherwise. If $S = 1$, then the policy is appropriate. If
6 $S = 0$, then the policy is not appropriate, either because the underlying issue is
7 not serious, or because the policy will not deal with it effectively. If the policy
8 is implemented in country $i \in \{1, \dots, N\}$, then actor $J \in \{E, L\}$ receives $S - c_{Ji}$;
9 otherwise s/he receives 0. Thus c_{Ji} is the relative cost of the policy, with the
10 benefit of the policy normalized to 1 or 0. Different actors may weigh the costs
11 and benefits of legislative action differently; however, we assume $c_{Ji} \in (0, 1)$, so
12 that all actors will prefer to legislate if and only if the probability of the policy
13 being appropriate is above some threshold.

14 **Information**

15 Each executive receives a private signal $S_i \in \{0, 1\}$ where $S_i = S$ with probability
16 $\pi_i > 1/2$. Executives differ in their level of expertise π_i . Legislatures receive no
17 signal. All the parameters c_{Ji} , π_i are common knowledge.

For actor J in country i , let

$$K_{Ji} \equiv \log \left(\frac{c_{Ji}}{1 - c_{Ji}} \right) - \log \left(\frac{s}{1 - s} \right). \quad (1)$$

18 This is the logged, risk-adjusted “cost-benefit ratio” as J sees things before his
19 prior beliefs, s , are updated. Note that $K_{Ji} > 0$ if and only if $s - c_{Ji} < 0$, which
20 means that the actor is an *ex ante* “sceptic” who would not pass legislation in the
21 absence of positive evidence that the policy is appropriate.

Let α_i be executive i 's logged odds of an accurate signal, or “expertise” for short:

$$\alpha_i \equiv \log \left(\frac{\pi_i}{1 - \pi_i} \right). \quad (2)$$

Since $\pi_i > 1/2$, α_i is positive. Suppose any actor has belief μ that the policy is appropriate. Then he will wish to pass legislation if

$$\mu - c_{Ji} \geq 0. \quad (3)$$

A little algebra transforms this into

$$\log \left(\frac{\mu}{1 - \mu} \right) \geq \log \left(\frac{c_{Ji}}{1 - c_{Ji}} \right) = K_{Ji} + \log \left(\frac{s}{1 - s} \right). \quad (4)$$

By Bayes' rule, for any signal S_i ,

$$\mu = \text{Prob}(S = 1 | S_i = 1) = \frac{\pi_i s}{\pi_i s + (1 - \pi_i)(1 - s)}. \quad (5)$$

and transforming to odds and taking logs:

$$\log \left(\frac{\mu}{1 - \mu} \right) = \alpha_i + \log \left(\frac{s}{1 - s} \right). \quad (6)$$

Similarly $\text{Prob}(S = 1 | S_i = 0) = -\alpha_{Ji} + \log \left(\frac{s}{1 - s} \right)$. Hence an executive will wish to implement the policy, conditional on his own positive signal, if $\alpha_i \geq K_{Ei}$; and conditional on his own negative signal, if $-\alpha_i \geq K_{Ei}$.²⁴ This additive logic extends to multiple signals: conditional on any number of observed or inferred

²⁴Signing on a negative signal can only occur if costs are negative. Reputational effects could be modelled in this way.

signals, player J in country i will wish to implement the policy if

$$\sum_{h; S_h=1} \alpha_h - \sum_{h; S_h=0} \alpha_h \geq K_{Ji}. \quad (7)$$

1 Adoption of domestic legislation

2 To show the signaling advantages of the treaty route over domestic legislation,
 3 we first model the introduction of domestic legislation to implement the policy.
 4 Recall that the standard advantages of international treaties (e.g. coordinated
 5 policy-making across nations) have been assumed away. Nevertheless, comparing
 6 domestic legislation to treaty signature shows a new potential advantage: treaty
 7 signature allows domestic vetoes to infer many executives' signals on the policy.

8 We assume that without the publicity afforded by the negotiation process, no
 9 state observes the legislative process in any other state. Therefore, individual
 10 legislation is modelled as follows: the executive chooses whether to propose the
 11 policy as a bill in parliament; if the executive proposes, then the legislature accepts
 12 or rejects; if the legislature accepts, legislation is passed.

13 The executive has three pure strategies: ALWAYS propose legislation, NEVER
 14 propose, or CONDITION on her signal i.e. propose iff $S_E = 1$. We rule out the
 15 fourth strategy, proposing if and only if her signal is 0, as weakly dominated.
 16 We also assume that, even if the legislature always rejects, the executive will
 17 only propose if he expects legislation to be beneficial. If the executive proposes,
 18 the legislature can either accept or reject. We will rule out some uninteresting
 19 equilibria with the Intuitive Criterion: if the executive plays NEVER, then out of
 20 equilibrium the legislature believes $S_J = 1$ if after observing a proposal.

21 [Table 5](#) shows the conditions for each pair of possible strategies to be in equilib-
 22 rium. (We drop the i subscript temporarily.) If the executive plays CONDITION
 23 or NEVER, then the legislature assumes after a proposal that the executive re-

Legislature\ Executive	ALWAYS	CONDITION	NEVER
<i>Accept</i>	$K_E \leq -\alpha$ $K_L \leq 0$	$-\alpha < K_E \leq \alpha$ $K_L \leq \alpha$	$\alpha < K_E$ $K_L \leq \alpha$
<i>Reject</i>	$K_E \leq -\alpha$ $0 < K_L$	$-\alpha < K_E \leq \alpha$ $\alpha < K_L$	$\alpha < K_E$ $\alpha < K_L$

Table 5: Single country conditions for different equilibrium strategies.

¹ ceived $S_E = 1$.²⁵

² Ratification of an international treaty

Just as in the domestic case executives have three undominated pure strategies: ALWAYS sign; CONDITION, i.e. sign conditional on your own positive signal; and NEVER sign. Suppose that a set of Q of executives condition on their signals and only sign if $S_i = 1$ for $i \in Q$. As before we will assume that executives who never sign are treated by executives, out of equilibrium, as conditioning: call the set of such executives R . Executives also benefit from the knowledge of their peers; hence executive i will sign if and only if

$$\sum_{j \in Q \cup R} \alpha_j \pm \alpha_i \geq K_{Ei}. \quad (8)$$

³ Therefore, in an equilibrium where the treaty is tabled, recalling that this
⁴ requires unanimity, each executive's best strategy is:²⁶

²⁵If the executive plays CONDITION then this belief is uniquely specified by Weak Perfect Bayesian equilibrium. If the executive plays NEVER, then this belief can be justified by the Intuitive Criterion: the out-of-equilibrium proposal would give a highest expected benefit to an executive who had received a positive signal, so this is what the legislature believes.

²⁶If the treaty is tabled, along the equilibrium path the set R is empty and all members of Q sign, so they all received positive signals. In the main text we ignore R , since if it is non-empty no treaty can be signed.

$$\text{ALWAYS} \quad \text{if} \quad \sum_{j \in Q \cup R, j \neq i} \alpha_j - \alpha_i \geq K_{Ei}, \quad (9)$$

$$\text{CONDITION} \quad \text{if} \quad \sum_{j \in Q \cup R, j \neq i} \alpha_j - \alpha_i < K_{Ei} \leq \sum_{j \in Q \cup R, j \neq i} \alpha_j + \alpha_i, \quad (10)$$

$$\text{NEVER} \quad \text{if} \quad \sum_{j \in Q \cup R, j \neq i} \alpha_j + \alpha_i < K_{Ei}. \quad (11)$$

The legislature in country i will then ratify in such an equilibrium if and only if

$$\sum_{j \in Q \cup R} \alpha_j \geq K_{Li}. \quad (12)$$

1 An equilibrium requires sets Q and R satisfying the appropriate condition
2 above for each individual in each set. There may be multiple equilibria in which
3 a treaty is tabled. For instance, suppose $N = 3$ with $\alpha_1 = \alpha_2 = \alpha_3 = \alpha$ and
4 $K_{E1} = K_{E2} = K_{E3} = K$. If $0 < K < \alpha$, then there are three equilibria in which
5 two executives condition on their signal, and the other always signs. This is a
6 typical example of the “swing voter’s curse” ([Feddersen and Pesendorfer, 1996](#)),
7 where conditional on the other two executives signing, the third executive wishes
8 to sign irrespective of his or her own signal. We examine the effect of the swing
9 voter’s curse below, by simulating equilibria.

10 To examine the effect of an increase in the number of veto players in country i ,
11 write the cost of the most skeptical veto player when there are fewer veto players as
12 K_{Li} , and the cost when there are more veto players as K'_{Li} . Of course $K_{Li} \leq K'_{Li}$;
13 assume the inequality is strict. Consider, in each of the two cases, the effect of
14 an increase in summed expertise $(\sum_Q \alpha_j)$, from a value of A to A' . There are the
15 following possibilities:

16 (a) $K'_{Li} < A$. In this case the most skeptical veto player in country i can be

1 convinced even by the lower level of expertise; more expertise has no further
2 effect, irrespective of the number of veto players.

3 (b) $K_{Li} < A < K'_{Li} < A'$. In this case, as the number of veto players goes up,
4 the effect of higher expertise is increased. With fewer veto players, country
5 i is always persuaded irrespective of the level of expertise. With more veto
6 players, only a stronger signal of expertise will persuade the most skeptical
7 veto player.

8 (c) $A < K_{Li} < K'_{Li} < A'$. Here again there is no marginal effect of an increase in
9 veto players, since either way country i is only persuadable by the higher level
10 of summed expertise.

11 (d) $A < K_{Li} < A' < K'_{Li}$. Now the marginal effect of an increase in veto players
12 is to reduce the effect of the increase in expertise. With fewer veto players,
13 country i only ratifies in response to a strong signal. With more veto players
14 it never ratifies.

15 (e) $K_{Li} < A < A' < K'_{Li}$.

16 (f) $A' < K_{Li}$. In both these cases there is again no marginal effect, since country
17 i is either persuaded at both levels of expertise or at neither.

1 B Appendix: Simulations of equilibria

2 In our model, some executives condition on their own signal of policy appropriate-
3 ness, while others do not and effectively free-ride on the knowledge of their peers.
4 Legislatures are only persuaded by those executives who are conditioning. How-
5 ever, in our empirics we only observe which states sign a treaty, and not whether
6 they were conditioning (or more broadly, how much information is conveyed by
7 their signature).

8 To check whether this makes a difference, we simulated equilibria for different
9 numbers of states and random draws of α and κ terms. We discarded cases where
10 there was no pure strategy equilibrium. We also discarded cases where the only
11 pure strategy equilibrium had one or more states never signing, since these equi-
12 libria are not observable in our dataset. We ran simulations until we had 100 valid
13 draws, for 3, 5, 8 and 15 states. We then correlated the total sum of α terms of all
14 signers, with the total sum of α terms of signers who were conditioning. Results
15 are shown below. The correlation was strong and significant for all numbers of
16 states, though the correlation is smaller as n increases. Thus, the total knowledge
17 of signing states appears to be a good proxy for the real causal variable in our
18 theory, the total knowledge of signers who are conditioning.

19 α values were drawn independently for each country from the uniform distri-
20 bution on $[0,3]$. κ values were drawn independently from the standard log normal
21 distribution. Code is available on request.

Number of countries	Correlation (95% conf. int.)	p -value
3	.79 (0.70, 0.85)	< 0.001
5	.75 (0.64, 0.82)	< 0.001
8	.49 (0.32, 0.62)	< 0.001
15	.27 (0.08, 0.45)	0.005

1 C Appendix: Further empirical tests

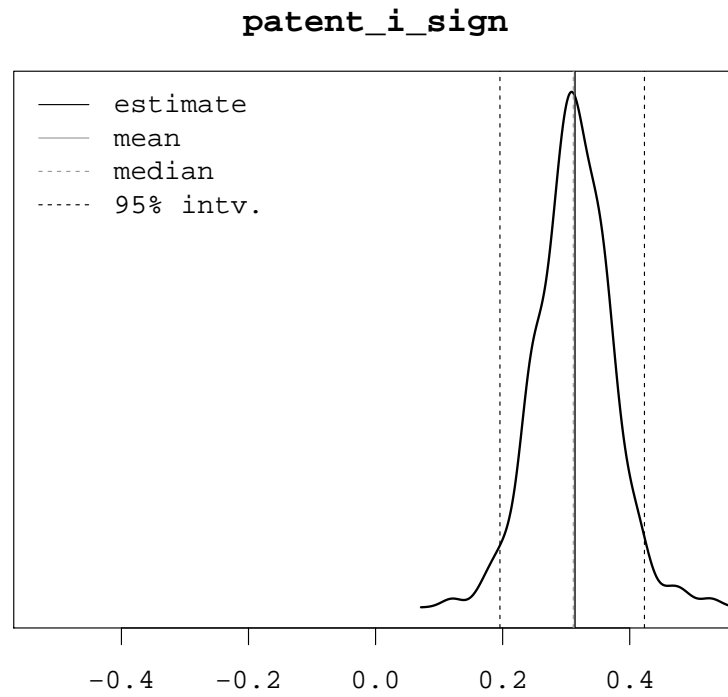


Figure 1: Posterior distributions of parameter estimates for coefficient values obtained by bootstrap resampling for Model 1 from Table 4.

Note: The figure reports estimates of coefficient values, not hazard ratios.

	Model A1 exp(coef) (<i>p</i>)	Model A2 exp(coef) (<i>p</i>)	Model A3 exp(coef) (<i>p</i>)	Model A4 exp(coef) (<i>p</i>)
Pooled expertise				
PATENT_I_SIGN	1.341 (0.000***)			0.998 (0.943)
EXPERIENCE_I_SIGN		1.152 (0.000***)		
MARINE_I_SIGN			1.093 (0.000***)	
Controls				
FIRST_SIGN	8.119 (0.000***)	10.889 (0.000***)	10.445 (0.000***)	5.788 (0.000***)
WEALTH_I_SIGN				1.360 (0.000***)
POWER_I_SIGN				1.025 (0.500)
R_COAST_LAND			1.093 (0.01**)	
LRT	5928 (0)	6052 (0)	1485 (0)	6285 (0)
Wald test	4210 (0)	3773 (0)	1533 (0)	5830 (0)
Robust (score) logrank test	152.3 (0)	139.5 (0)	121 (0)	158.5 (0)
No. Observations	266642	342668	157595	266642
No. Events	3870	4306	1150	3870
No. States	190	190	185	190
Period	1961–2000	1952–2000	1959–2000	1961–2000

Table 6: Cox proportional hazards regression models for treaty ratification.

Notes: Each cell entry [exp(coef)] is the exponential of the coefficient which is the hazard ratio (HR). The likelihood ratio test assumes independence of observations within a cluster (country); the Wald and robust score tests do not. *** $p|z| < .001$, ** $p|z| < .01$, * $p|z| < .05$.

	Model A5 (strata: ISSUES) exp(coef) (p)	Model A6 (cluster: treaties) exp(coef) (p)	Model A7 exp(coef) (p)	Model A8 exp(coef) (p)
Pooled expertise				
PATENT_I_SIGN	1.363 (0.000***)	1.369 (0.000***)	1.354 (0.000***)	1.634 (0.000***)
Controls				
FIRST_SIGN	4.195 (0.000***)	4.659 (0.000***)	5.205 (0.000***)	
IO_MEMBERSHIP	1.006 (0.036*)	1.005 (0.051)	1.005 (0.120)	1.012 (0.000***)
THRESHOLD	1.006 (0.000***)	1.005 (0.123)	1.004 (0.013*)	1.006 (0.000***)
LAGPERCREGION	1.020 (0.000***)	1.019 (0.000***)	1.019 (0.000***)	1.023 (0.000***)
OPEN	0.966 (0.460)	0.963 (0.241)	0.939 (0.102)	0.967 (0.373)
RGDPL	1.101 (0.432)	1.158 (0.093)	1.376 (0.047*)	1.067 (0.544)
RGDPLSQ	0.960 (0.698)	0.922 (0.316)	0.815 (0.222)	0.989 (0.899)
LNSO2PC	1.095 (0.000***)	1.095 (0.000***)	1.068 (0.014*)	1.099 (0.000***)
MEANPC	1.120 (0.000***)	1.116 (0.000***)		1.133 (0.000***)
POLITY2			1.021 (0.002**)	
GDPL	0.956 (0.028*)	0.959 (0.027*)	0.960 (0.023*)	0.954 (0.009**)
LRT	5071	6002	6006	4813
(p)	(0)	(0)	(0)	(0)
Wald test	3213	994.3	4297	2948
(p)	(0)	(0)	(0)	(0)
Robust (score) logrank test	140.3	55.74	131.9	141.1
(p)	(0)	(0)	(0)	(0)
No. Observations	205384	205384	199698	205384
No. Events	3002	3002	3036	3002
No. States	157		149	157
No. Treaties		112		
Period	1972–2000	1972–2000	1965–2000	1972–2000

Table 7: Cox proportional hazards regression models for treaty ratification.

Notes: Each cell entry [exp(coef)] is the exponential of the coefficient which is the hazard ratio (HR). The likelihood ratio test assumes independence of observations within a cluster (country); the Wald and robust score tests do not. *** $p|z| < .001$, ** $p|z| < .01$, * $p|z| < .05$.