Is There a Broader-Deeper Trade-off in International Multilateral Agreements?

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Abstract It is commonly thought that there is a trade-off between the breadth and depth of multilateral institutions—that is, multilaterals that are more inclusive in their memberships will necessarily be shallower in their level of cooperation. Using a multilateral bargaining model with self-seeking rational actors, I show that such a trade-off does not exist for a broad class of multilateral cooperation problems. The conclusion that there is a broader-deeper trade-off follows from the assumption that the members of the multilateral must set their policies at an identical level. The multilateral agreement modeled in this article allows states to set their policies at different levels. Once this change is made, there is no broader-deeper trade-off, a finding that has obvious empirical and policy implications. It explains why some regimes are created with fairly large memberships at the outset, and it calls into question the policy prescription of limiting membership of multilateral institutions to a small group of committed cooperators for the class of cooperation problems modeled in this article.

It is commonly thought that there is an inverse relationship between "broader" and "deeper" in international multilateral agreements—that is, multilaterals that are more inclusive in their memberships will necessarily be shallower in their level of cooperation. When there is a broader-deeper trade-off, a given member's treaty-mandated cooperative policy would be more cooperative if some other member of the treaty were excluded from it. Or to put it another way, adding a particular state to an agreement necessitates reducing the level of cooperation of the other members. The idea often arises in discussion of European integration. One reason why the European Community (EC) was created with six states rather than all of (Western) Europe was that some European states were unwilling to integrate their economies as much as the original EC six were. Presumably if those states had

I am indebted to the editor, an anonymous reviewer, Bruce Bueno de Mesquita, William Clark, Eric Dickson, Catherine Hafer, Charles Holt, Marek Kaminski, Dimitri Landa, Antonio Merlo, Robert Powell, Adam Przeworski, Ann Sartori, Shanker Satyanath, Randall Stone, and the participants at seminars at Rutgers and University of California-Berkeley in May and October 2000, respectively, for comments on earlier drafts of this work. I thank Jon Preimesberger for editorial assistance. All errors remain my responsibility.

International Organization 58, Summer 2004, pp. 459–484

DOI: 10.1017/S0020818304583029

been included the extent of integration embodied in the Treaty of Rome would have been lessened, because those less integration-inclined states would never have agreed to a treaty with such a "deep" level of integration. Excluding those states allowed the original six to cooperate (that is, integrate) to a greater extent.

The same argument has been applied to other areas of international cooperation. For instance Downs, Rocke, and Barsoom claim, "large multilaterals that start out small will tend to become deeper in a cooperative sense than those that start out with many members."[1] The idea is the same. By excluding states that are not committed to cooperation, the level of cooperation of the members that do join—reductions in pollution for instance—can be greater (deeper). Including those less cooperation-minded states will make the treaty broader (it will have more members), but each state's level of cooperation (reduction in pollution) will be lessened because those states will not sign a treaty that requires such deep levels of cooperation. Thus by excluding less cooperation-minded states the states that do join can engage in deeper cooperation.

The claim that there is a broader-deeper trade-off produces a puzzle though. A brief review of the creation of some multilaterals reveals that, in many cases, issues of broader versus deeper simply did not arise. Certainly the proposer of some of the most important multilaterals in the early postwar era (the United States) was concerned with making them as expansive as possible, not with limiting their membership to "hard core" members. Kahler put it this way: "Postwar multilateralism . . . expressed an impulse toward universality that implied relatively low barriers to participation in these instruments."[2]

The creation of the General Agreement on Tariffs and Trade (GATT) is an example of an important postwar institution in which one finds no references to a "broader versus deeper" debate. The GATT was created in 1947 with twenty-three members, not a large organization by today's standards, but it comprised about 60 percent of the states with market economies at the time, and a much larger share of world trade. States were invited widely. No state was excluded by the treaty's core members because they thought that state was too protectionist and would limit the depth of cooperation of the other members. Indeed some early members of the GATT were some of the most protectionist states in the world (India, which was admitted when it became independent in 1948, is a good example). Much of the "evolution" of the GATT—meaning the addition of states after the forming of the agreement—was pro forma as former colonies of GATT members were given easy membership in the organization.[3] The same could be said of the Bretton Woods system. The framers of the system hoped that it would be as expansive as possible. They did not seem to be concerned with restricting membership to those states that supported a stable fixed exchange rate system.[4] The International Monetary

1. Downs, Rocke, and Barsoom 1998, 398.
2. Kahler 1992, 681.
3. Jackson 1997, 60.
4. Gardner 1980.

Fund (IMF) opened its doors in 1946 with thirty-nine members, about 89 percent of the world's market economies at the time, and an even larger percentage global GDP or world trade. A more recent example might be the Montreal Protocol, which limited emission of ozone-depleting chlorofluorocarbons (CFCs). The treaty came into force in 1989 with a membership of twenty-nine states and the EC, not a large number of states, but it did account for 82 percent of world CFC consumption.[5]

If the broader-deeper trade-off is not a general phenomenon, what determines when it will arise? I show that the broader-deeper trade-off occurs when members of the multilateral choose a single policy that is applicable to all members, that is when all members of the agreement must set their policy at the same level. The assumption that states must set their cooperative policies at an identical level is appropriate in some contexts and not appropriate in others. The purpose of this article is to show that when this assumption is relaxed the broader-deeper trade-off disappears. The multilateral agreement modeled in this article allows states to set their policies at different levels. Once this change is made, there is no broader-deeper trade-off. Indeed once the "identical-policy" assumption is relaxed, broader multilateral agreements can actually engage in deeper cooperation than narrower ones.

The findings in this article have obvious empirical and policy implications. Empirically, the model offers an explanation for why some agreements seem to exhibit a broader-deeper trade-off and others do not. From a policy standpoint this article calls into question policy recommendations in favor of adopting multilateral agreements with relatively small exclusive memberships. The analysis in this article shows that the claim that "multilaterals that start out small will tend to become deeper" is not true for a large class of cooperation problems. For the types of cooperation problems modeled in this article, excluding states from the agreement only lessens the benefits of cooperation by reducing the number of states that set their policies cooperatively while offering no increase (and perhaps even some reduction) in the depth of cooperation. Thus creators of multilateral agreements should in fact strive for inclusiveness in these cases.

A further purpose of this article is to show that modeling multilateral bargaining is not so complex as to be avoided altogether. To date there has been little or no effort at modeling the creation of multilateral agreements formally. One reason for the lack of formal study of multilateral agreements is that the problem has been thought to be too complex analytically. One of the best formal studies of this topic avoids the multilateral bargaining issue stating: "The [multilateral institution] creation decision in its purest form is an unstructured bargaining problem of enormous complexity. For example in a world of fifty states there are over two million combinations by which a five state multilateral might form."[6] This article shows that that statement makes the problem seem rather more complicated than it needs to be and takes a first step at filling this gap in the formal international relations literature.

5. Benedick 1991.
6. Downs, Rocke, and Barsoom 1998, 398.

The article is organized as follows. In the following section I review a model of the creation of a multilateral agreement in which members choose an identical cooperative policy level, and I show how that assumption leads to the conclusion that there is a broader-deeper trade-off. In the next section I present informally my model of multilateral bargaining. The following section offers an informal discussion of the major findings that follow from the model. The next section illustrates the findings with a few empirical examples. The final section concludes. The Appendix contains the formal model and proofs of the propositions that are discussed in the body of the article.

The Identical-Policy Assumption

In this section I illustrate how the assumption that states set their cooperative policies at identical levels produces a broader-deeper trade-off. Downs, Rocke, and Barsoom provide the clearest example in the published literature of this line of reasoning, so I will use their model as the basis for my discussion. A more formal treatment of their model, including proofs for the claims that I mention here, is available in their paper. Figure 1 illustrates the policy space. One might think of the space as a continuum of the amount of pollution states pump into a common body of water with the left side corresponding to more cooperative policy—one that creates less pollution. I have depicted a world of eleven states. One can obviously generalize these claims to apply to a world of more states. States' ideal points for the policy in question are arrayed along a continuum—x_1 is state 1's ideal point, x_2 is state 2's ideal point, and so forth.[7] Members of the organization vote on the level of policy that they want set for the group as a whole. With simple majority voting, the ideal point of the median of the admitted members will be the equilibrium policy in the sense that it will win a majority of votes in a pairwise vote against any other policy.[8] If all the states are allowed to become members, the cooperative policy would be state six's ideal point. If instead a subset of states—for example, states one through five—created a more exclusive agreement, the cooperative policy would be state three's ideal point—much deeper cooperation than if the full group were admitted. This argument by itself does not definitively show that "deeper is better than broader," because excluding states achieves greater cooperation from states with low ideal points but completely forgoes cooperation with states with higher ideal points. It is, however, the basis for the recommendation that multilateral agreements should be relatively exclusive in their early stages and admit members only as they become more willing to set their policies at a low level such as x_3.

7. See ibid., 400, for the setup of their model.

8. Downs, Rocke, and Barsoom assume two-thirds majority voting but this does not change the substantive point.

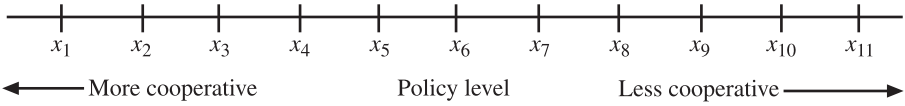

FIGURE 1. *Voting on a single cooperative policy with eleven countries*

London, Slantchev, and Stone offer a different model that also produces a broader-deeper trade-off. In their model, states do not vote on the single cooperative policy. Instead a hegemon proposes contribution levels for the provision of some international public good. The authors assume that the hegemon requires each member to contribute an identical percentage of its gross national product (GNP) to the provision of this good. Although the model is quite different from that of Downs, Rocke, and Barsoom the results in terms of the broader-deeper trade-off are similar. Small states are unwilling to contribute as large a percentage of their GNP as large states are, and so a broader-deeper trade-off is produced. The hegemon may exclude some of the smaller states from the organization, because including them would reduce the percentage of GNP that the remaining states would contribute.[9] There are fundamental differences between these two models—Downs, Rocke, and Barsoom's is a voting model and London, Slantchev, and Stone's is not. Despite this difference, both models predict a broader-deeper trade-off because both models make the identical-policy assumption.

The identical-policy assumption that drives these results is questionable in a variety of contexts. Multilateral agreements do not generally require that their members set their policies at exactly the same level, as is assumed by these models. For example, membership in the Montreal Protocol did not require that each state set the same level of ozone depleting substances. The U.S. level of pollution was different from Japan's, which was different from Canada's level and so on.[10] Similarly the Kyoto protocol set different levels of greenhouse gas emissions for each of the members.[11]

Furthermore, the identical-policy assumption can produce odd side effects. Assuming that the states' noncooperative equilibrium policies are their national ideal points, this model implies that states with ideal points below the median of the members of the multilateral would actually be allowed to increase their policy level and still be in compliance with the treaty. In other words, their cooperative policy could be higher (less cooperative) than their noncooperative policy had been. For instance, even in the more exclusive treaty containing only states 1 through 5,

9. London, Slantchev, and Stone 2003.
10. Benedick 1991.
11. Information about the Kyoto Protocol, including the treaty text that lists the abatement levels, is available at the United Nations Framework Convention on Climate Change Web site, ⟨http://unfccc.int⟩. Accessed 24 March 2004.

states 1 and 2 will actually be allowed to increase their policy level up to x_3 and still be compliant with the treaty.

The other assumption that might be questionable in this analysis is the assumption concerning voting. This assumption does not drive the broader-deeper trade-off, so I will not focus on it here except to say that in the international context bargaining models seem more appropriate.[12] Adopting a legislative voting approach does not take into account two important problems in the creation of international multilateral agreements. The first of these concerns states' incentive to participate in the agreement, and the second concerns compliance. Legislative districts that lose the vote on a national policy issue must still abide by that policy. They cannot opt out. States that lose a "vote" in a multilateral organization, on the other hand, can simply refuse to sign the agreement, in which case they will not be bound by its provisions. Furthermore, even if a state does sign the agreement, it can still cheat. Because there is no international authority to force states to participate in and comply with an international agreement, that agreement must offer its members sufficient incentive to sign it and it must be self-enforcing. The model presented in the next section will explicitly address the problems of participation and enforcement.

In summary, the identical-policy assumption is crucial to the conclusion that there is a broader-deeper trade-off. That conclusion is an artifact of the assumption that adding a less cooperative member increases every member's policy level because it raises the median or average policy level. This assumption is not generally appropriate. As I discuss below, it may have its place in certain contexts such as policy making within the European Union (EU) where states really do often adopt a single policy for the whole Union (the establishment of a single currency being the most prominent recent example) but it is not a close match for many multilaterals. In the next section, I informally present a model of multilateral bargaining in which states are allowed to set different levels of the policy in question and the cooperative solution is arrived at via bargaining. In that model the broader-deeper trade-off disappears.

The Model

Some complications arise in the multilateral setting that are not present in bargaining over a bilateral agreement. One of the more important complications is whether the benefits of cooperation are excludable or not. By excludable benefits I mean that nonsignatories can be prevented from receiving the benefits of cooperation among signatories. The key to excludability is whether or not a state can

12. In fact, models of policymaking in domestic legislatures within states increasingly treat it as a bargaining problem. See, for example, Austen-Smith and Banks 1988, 1990; Baron and Ferejohn 1989; Baron 1991; Merlo 1997; Diermeier and Merlo 2000; and Diermeier, Merlo, and Eraslan 2003. See Banks and Duggan 2000 for a generalization of those models and the one in this article.

target its policies toward other states. Some types of policies can be set differently toward different states. Trade policy is one example. State A's tariff on products from state B can be different than its tariff on products from state C. Extradition treaties and treaties on the granting of visas are other examples. Policies that are targetable in this way will allow members of a multilateral treaty to exclude nonmembers from the benefits of cooperation, because they can have different (presumably less cooperative) policies toward nonmembers than they have toward members.

In some cases, however, a state can only set its policy at one level. A state can only emit one amount of CFCs, for instance. State A cannot emit one level of CFCs toward state B and a different level toward state C. Similarly a state can only have one amount of biological weapons in its stockpile. In these cases, members of a multilateral agreement will not be able to set different policies toward members than they do toward nonmembers. Nonmembers will be able to enjoy the benefits of cooperation even when they do not participate in the agreement.

For modeling purposes excludable benefits treaties are quite different from nonexcludable benefits treaties. The two most important differences are (1) the punishments for cheating on the agreement, and (2) whether states that are invited to join the agreement have an unambiguous incentive to do so or whether they have incentive to free ride. The first of these differences concerns whether or not punishments can be targeted to states that cheat on the agreement. The latter of these differences has important implications for what states should do if some subset of them refuses to join the multilateral in the hope of free riding. This problem has implications for the number of ratifications that should be required for the treaty to come into force as I discuss below. These differences between the two types of cooperation problems are sufficient to require discussing each of them separately. In this article, I discuss a treaty in which benefits are nonexcludable because I regard it as the harder case for international cooperation. The main result should also apply to excludable-benefits treaties.

N is the set of states in the model, cardinality n. Although it is not an essential feature of the model, substantively it makes sense to think of N as the set of states that are relevant to the issue in question rather than all of the states in the world. For instance, an agreement to clean up the Black Sea would have no reason to include all of the states in the world. The agreement is only relevant to states that border that body of water. Even an agreement that regulates a global issue, such as protecting the ozone layer, would not necessarily include all states in the world, because many states' consumption of ozone-depleting substances is negligible.

Each state $i \in N$ sets a policy $x_i > 0$. One can think of this as a policy that produces negative externalities such as the amount of pollution produced by the state. Each state has an ideal level for its own policy, which I denote $z_i > 0$. I assume that i's ideal level for the other states' policies is zero. This assumption greatly reduces the amount of notation in the model and is not unreasonable substantively. If, for instance, one is discussing an environmental treaty, the assumption implies that states do not want other states to pollute at all. Although there

are cases that violate this assumption, it seems reasonable for many cases and offers substantial gains in the tractability of the model. Each state's utility is characterized by a standard quadratic loss function. Given this setup, each state will set its policy at its ideal point (z_i) in the absence of an agreement, and this outcome is globally suboptimal (this is a standard result, so I omit the proof). Each state would be willing to trade some reduction in its policy for some reduction in other states' policies. To accomplish this the states can agree to a treaty that reduces their policies. I will now discuss a game of bargaining over such a treaty and the subsequent enforcement of the agreement.

The game form can be described as follows. The game is divided into two phases, a bargaining phase and an enforcement phase. Each player can take actions at discrete times $t \in \{1, 2, 3, \ldots\}$ that correspond to the stages of the relevant phase of the game. I will begin by describing the bargaining phase. "Nature" chooses a proposer from N according to some rule (more on this rule later). The chosen proposer then makes a proposal Π_1 that includes a list of states to be invited along with cooperative policies, $c_i \geq 0$, for each of them. The proposal does not specify policies for uninvited states (that is, if Π_1 is accepted, those states may set their policies wherever they like.) The set of states that the proposer invites is allowed to be empty. The invited states either accept or reject Π_1. If one or more of these rejects Π_1, the proposal fails and bargaining proceeds to the next stage (stage 2) and the stage game repeats. Nature picks the next proposer from N according to the rule. The proposer that nature has just chosen then makes a proposal Π_2 that includes a list of the states invited and their policies. This list can include states that were not invited in the previous proposal. The invited states either accept or reject Π_2. If one or more of them rejects it, the game goes on to stage three. The bargaining stage game repeats in this way until all states accept the current proposal. Once this occurs the bargaining phase of the game ends and the accepted proposal is implemented. The game then proceeds to an enforcement phase in which the members of the agreement play a multilateral repeated prisoners' dilemma. In each stage of this phase of the game, members of the agreement either set their policies no higher than those mandated by the agreement or they do not (that is, they cheat). If a member cheats, the other members of the agreement punish the cheater by reverting to "punishment levels" of their respective policies (more on these later) for a specified period of time. After punishing the cheater for this specified period of time, states return to their cooperative policies as specified by the agreement. Nonmembers are allowed to set their policies wherever they like without punishment.

The empirical record does not suggest a clear answer to the question, "Who proposes?" While the United States may have had a dominant role in proposing many multilateral agreements during the early postwar years, a cursory review of the more recent history of the creation of multilateral agreements reveals that it no longer does. For the purposes of this model it is only necessary to assume that each state i is chosen to be the proposer with some probability r_i and that this

probability does not change from period to period.[13] Note that, if chosen twice in succession, states may make counterproposals to their (previous) proposals.

I now return to the issue of punishments. The treaty must be self-enforcing. Each state must receive utility from complying with the treaty that is at least as high as it would receive from cheating on the agreement and being punished for it. The proposer's problem is to put forward a treaty that maximizes its utility subject to the constraint that all the signatories will comply with it. One must specify the punishments to be able to determine this constraint. For simplicity I assume the members of the treaty will punish cheating by returning to their noncooperative Nash equilibrium policy levels (that is, set their policies at their ideal levels) for p periods. Note that in punishing a cheater, the members of the agreement also "punish" each other. This is unavoidable given the nonexcludability assumed here.[14]

I would like to highlight one final feature of the game form. Agreement requires unanimity. If any invited state rejects the treaty, no treaty is implemented in that period and the bargaining continues. Without this feature some nonproposers may have an incentive to reject the treaty in order to free ride on the cooperation of those that signed it. This is a step-level public goods problem with incentives similar to those of the well-known "paradox of (not) voting."[15] A sufficient number of states must ratify the treaty for it to come into force. States may prefer that other states ratify the treaty, so that it would come into force and they could free ride on the cooperation of the other members. However, if too many states play this strategy, the treaty will not come into force in which case states will regret their decision not to ratify the treaty. The game form I have described allows one to ignore these complications by effectively taking away the nonproposers' incentives to reject the treaty to free ride on the cooperation of the other members. Admittedly this assumption is a limitation of the model. In practice, treaties do not require that all relevant states ratify them before coming into force, although treaties usually do require that some substantial number of them do. Indeed the treaty's ratification requirement is typically part of the equilibrium—that is the number of ratifications required for the treaty to enter into force is decided as part of the negotiations. Unfortunately, endogenizing the ratification requirement is beyond the scope of this article.

To give an intuitive idea of how the model works, I turn to the proposer's problem. The proposer wants to put forward an agreement that both makes it as well off as possible and will be accepted by the other states. Indeed the proposer wants to make the other states an offer that just makes them indifferent between accepting and rejecting it. If the proposer gives the invited states a better offer, then it

13. Obviously $0 \leq r_i \leq 1$ for all $i \in N$ and $\sum_{i \in N} r_i = 1$.

14. See Pahre 1994 for further discussion of enforcement in a multilateral setting.

15. Ferejohn and Fiorina 1974. On step-level public goods, see Palfrey and Rosenthal 1984; and Goeree and Holt 2003.

will have given them more than it had to do to get them to sign the treaty. If the proposer offers the invited states less than that amount, they will reject the treaty, no agreement will occur in that period, and a new, potentially different, proposer will be chosen in the next period. Thus the proposer will make a proposal that equates the other states' utility from accepting it to their utility from rejecting it. I call this constraint the "participation constraint," because this constraint must be met if the invited state is to participate in the agreement.

There is a complication, however. The proposal must offer each member sufficient utility to keep them compliant with the agreement. Clearly, it does the proposer no good to obtain a treaty that the members will certainly cheat on. Therefore, if the proposal that just meets the invited states' participation constraints does not offer sufficient rewards to keep a state compliant with the agreement, the proposer must offer that state a better proposal—one just sufficient to ensure that state's compliance. I will call this constraint the "compliance constraint." See the Appendix for details.[16] Here too there is no reason for the proposer to offer such a state more than that amount because doing so is unnecessary to ensure that state's compliance and only offers the proposer lower utility.

I call the set of states for whom the compliance constraint binds C and the set of states for whom the participation constraint binds P. I show in the Appendix that both of these constraints cannot bind, so a state is either a member of C or P or neither. If neither constraint binds for some state, that state will sign and comply with the given agreement for any cooperative level of its policy that the proposer offers, so the proposer will set that policy at zero (see the Appendix for more details). In this case the state's participation and compliance constraints are not binding so it will actually receive more from the agreement than is necessary to get it to sign and comply with the agreement.

Results

As shown by Proposition 1, which is presented in the Appendix, the equilibrium proposal in this model possesses some standard features of complete information alternating offers bargaining games: the outcome is unique, bargaining ends in the first period, and the proposer receives a larger share of the gains, *ceteris paribus*. The reason for these features is the same as in the more standard two-person game so I do not dwell on them here.[17] Instead I focus on the main substantive point of this article, namely that there is no broader-deeper trade-off in the situation described by this model.

First, one must establish the equilibrium policies. Without loss of generality, I index the proposer as state 1. As proved in Proposition 1, the proposer's equilibrium cooperative policy is:

16. See Fearon 1998 for a discussion of the contradictions between bargaining and enforcement in the context of a different model.

17. Osborne and Rubinstein 1990, chap. 3.

$$c_1 = \frac{z_1}{1 + \rho \sum_{j \in C} \lambda_j + \sum_{j \in P} \lambda_j} \tag{1}$$

Proposition 1 also shows that the nonproposers' equilibrium cooperative policies are:

$$c_j = \frac{\lambda_j z_j}{1 + \lambda_j + \rho \sum_{k \in C \setminus \{j\}} \lambda_k + \sum_{k \in P \setminus \{j\}} \lambda_k} \tag{2}$$

The λs in Equations (1) and (2) are the Kuhn-Tucker multipliers on the members' relevant constraints and ρ is analogous to a discount rate (see the Appendix for more details).[18] In the discussion that follows it will be convenient to refer to the cooperative equilibrium policies in Equations (1) and (2) as percentages of the respective state's ideal level, which I will call α_j, so that $c_j = \alpha_j z_j$.

The main difference between this model and one that produces a broader-deeper trade-off is that states are allowed to set different policies. Equations (1) and (2) illustrate how states' policies will differ. States that have less cooperative policies (for example, more pollution) in the noncooperative equilibrium will also have less cooperative policies in the equilibrium treaty. There are two effects that produce this result. First, each state's cooperative policy is some percentage of its noncooperative policy, z_j, so that states with high z_js will also have higher treaty-mandated policies. Second, states with higher noncooperative policies will have larger λs, and thus these states will also reduce by smaller percentages. λ_j is the multiplier on state j's relevant constraint and will be larger the more binding the constraint is. States in P with large z_js will have larger λs because their participation constraints are more binding. The reason for this is that these states receive relatively higher utility from the status quo so they have to be given a better deal, (for example, allowed to pollute more than other states) to get them to sign the agreement. States with low z_js, by contrast, receive lower utility from the noncooperative status quo and therefore their participation constraints are less binding. These states are willing to accept less lucrative deals, and so the proposer offers them less in equilibrium. States in C with large z_js will have more binding compliance constraints for a similar reason—their utility from the status quo, which is the utility that they will receive when punished, is higher. Punishment is not so harmful for them so they must be given higher utility from cooperation to induce them to comply. The proposer accomplishes this by reducing their policy by less.

A numerical example will help illustrate these effects. Imagine a five-state multilateral in which each state's ideal level for its own policy is 1 and for the other states' policies is 0, the states' common discount rate is 0.98 and $r_i = 0.2$ for all

18. I show in the Appendix that the proposer's participation and compliance constraints do not bind.

states. State 1 is the proposer. Solving for the equilibrium policies shows that all nonproposers are in group *P* (the compliance constraint does not bind but the participation constraint does) and the λ_is are approximately 0.514. Plugging these multipliers into (1) and (2) reveals that the equilibrium policy for the proposer is approximately 0.486 and for the nonproposers is 0.25. Incidentally this example shows the substantial benefits of being proposer in this model.

Now suppose instead that state 5's ideal level for its own policy was not 1 but 2, and all other parameters were kept the same. In this case state 5 is still in *P* but λ_5 increases to 1.302 and $\lambda_2 = \lambda_3 = \lambda_4$ falls to 0.214. The states' policies in this case would be 0.514 for state 1, 1.34 for state 5, and 0.11 for the other states. State 5 would only have to reduce its policy to about two-thirds of its noncooperative level while state 1 (the proposer) would have to reduce to 51 percent and the other states would have to reduce to about eleven percent of their noncooperative level.

Why the difference? In the first example all three states received the same level of utility from the noncooperative status quo, namely -4. In the second example, states 1 through 4's utility from the noncooperative status quo is -7 while state 5's utility from the noncooperative status quo is -4. States 1 through 4 are disadvantaged by the status quo relative to state 5 in the second example and, therefore, they are willing to accept a worse cooperative deal than state 5 is. Decreasing marginal returns play a role as well. In the second example, state 5's policy is farther away from state 1 through 4's ideal level than state 1 through 4's policies are from state 5's ideal level. Therefore, a small change in 5's policy generates large gains for 1 through 4. Because state 1 through 4's policies are already relatively close to state 5's ideal level for their policies (zero), states 1 through 4 have to change their policies by more to generate sufficient gains for state 5 to be willing to sign the agreement.

I now turn to the absence of a broader-deeper trade-off. Proposition 1 shows that the equilibrium treaty will include all *N* states. I have not yet established the absence of a broader-deeper trade-off in this model. To do so I must show that a treaty with fewer than *N* members would not be more cooperative (specify lower policies) than a treaty that included more members. Because the equilibrium of the model in this article is a treaty among all members of *N*, answering the question of whether or not there is a broader-deeper trade-off necessitates comparing the policies of two treaties at least one of which is not an equilibrium because it does not include all *n* states. Discussing out-of-equilibrium behavior opens a Pandora's box because there are an infinite number of such equilibria. Therefore to discuss the broader-deeper trade-off in a theoretically meaningful way, one needs to put some additional structure on the discussion.

As I understand it, the claim that a broader-deeper trade-off exists is a counterfactual claim about what the policies in a particular agreement would be if somehow the membership of that treaty could be changed. More precisely, the claim that there is a broader-deeper trade-off, as I understand it, is that if some proper subset of *N*, which I will call *M*, could commit to excluding the states in $N \backslash M$

from the agreement, the equilibrium policies from such an agreement would be lower (more cooperative) than the equilibrium policies in the treaty with more members. This exogenous commitment device, while admittedly artificial, is necessary in this model because, as I mentioned, without such a commitment device a treaty among a proper subset of N will not occur. For the purposes of this article, I assume that such a commitment device exists. Proposition 2, which is presented in the Appendix, shows that in such a case the treaty among M is not deeper than a more inclusive treaty. More formally:

$$\alpha_i(M) \geq \alpha_i(M \cup \{j\}), i \in M\backslash\{1\}, j \in N\backslash M \tag{3}$$

where $\alpha_i(M)$ is state i's cooperative policy from an agreement with some given set of states M, cardinality $m < n$, as a percentage of its ideal level, z_i.

Equation (3) simply states that the policies of the nonproposing states will not be larger (less cooperative) for a treaty with more members. Adding an extra member can only change a member's policy by lowering it.[19] In this sense, broader treaties exhibit at least as much cooperation as narrower ones, and can actually be deeper. This statement is proven in Proposition 2 in the Appendix.

This result is perhaps best explained by thinking through the proposer's incentives. Imagine the proposer has already determined its optimal proposal for an agreement among the members of M and is deciding if it would prefer to propose its optimal treaty among the members of $M \cup \{j\}$, $j \in N\backslash M$ instead. In other words, the proposer is deciding if it would prefer to make a proposal that includes some extra state j in the agreement. For the sake of argument, I take a look at the effect of some small negative change on this additional state's policies as a result of it being added to the agreement. Suppose the additional state's policy is reduced from z_j to something slightly less than that, and the policies of the states in $M\backslash\{1\}$ remain fixed at their levels from a treaty without the additional state (that is, a treaty just among the members of M). All of these policies will in fact change in equilibrium—this is just for the sake of argument. Such an agreement obviously increases the utility of the states in M, because it reduces the additional state's policy from z_j to something less than that.

The policies of the invited states (that is, $M\backslash\{1\}$) in an agreement among the members of M had been chosen to give each of them just enough utility to get them to sign that agreement (unless they needed more to keep them compliant with it). The proposer has no incentive to give them any more than that amount, because doing so only offers them more utility than necessary and the proposer less utility than possible. Now with the reduction in the added state's policy these

19. Note that Proposition 2 says nothing about the effect of adding more members on the proposer's policy. The proposer's policy will typically be higher from a more inclusive treaty than a less inclusive one, but it will not be so much higher as to completely offset the lower policies of the nonproposers. In no case would the proposer's policy be higher than z_1.

states are in fact receiving more utility than necessary to sign the treaty and remain compliant with it, and so adding the extra state provides the proposer an opportunity to increase its own utility while keeping the invited states' utility at the level necessary for them to sign the agreement and remain compliant.

The proposer can do this in one of three ways: (1) increase its policy toward its ideal level, z_1, (2) reduce the policies of the invited states ($M\backslash\{1\}$) toward the proposer's ideal level for them (zero) or (3) some combination of (1) and (2). Consider option (1) first. If the proposer increases its policy toward its ideal level, it will increase its utility and decrease the utility of the invited states (recall that their ideal level for the proposer's policy is 0). The proposer can do this up to the point that the invited states are indifferent between accepting the agreement and rejecting it (unless they need greater utility to remain compliant with the agreement), but there is only this "first order" effect on the proposer's utility.

Compare this to option (2) where the proposer reduces the invited state's policies toward zero. It is immediately apparent that this is a more fruitful approach. There are more states whose policies the proposer can change in this option. In option (1) the proposer was only able to change one state's policy (its own), while in option (2) the proposer can change $m - 1$ states policies (that is, the number of states in M besides itself). But there is also a second-order effect in adopting option (2). Consider the effect of reducing the policy of state $2 \in M$. The proposer can reduce 2's policy to the point at which state 2 is indifferent between accepting the agreement and rejecting. Doing so increases the utility of all states in $M\backslash\{2\}$—the proposer as well as the other invited states. Similarly reducing state 3's policies in this way increases the proposer's utility and that of all the other states in M. The proposer can reduce the policies of every member of $M\backslash\{1\}$ in this way and in the process generate second-order increases in utility for the other members of M. What will the proposer do with these second-order increases in the invited states' utility? The same logic applies, so the proposer will do the same thing—reduce their policies even further to generate even more gains. Adopting option (2) creates a second round of utility increases for each state—utility increases that the proposer can exploit by reducing the invited states' policies even further. For this reason the reductions in the invited states' policies will be greater in option (2) than the increase in state 1's policy could be in option (1). In short, option (2) allows the proposer to move more policies toward its ideal point, and it allows the proposer to change each of those policies by a larger amount. Eventually, however, the effects of decreasing marginal gains from this approach will set in and the proposer will want to use some of the added gains in cooperation to increase its own policy. Thus the proposer will adopt option (3).[20]

20. Once again this discussion applies to states whose compliance or participation constraints bind. States for whom neither constraint binds in a treaty with M will also have nonbinding constraints in a treaty with $M \cup \{j\}$. The treaty-mandated policies of these states are zero in a treaty with M and zero in a treaty with $M \cup \{j\}$, because their policy cannot go below zero.

TABLE 1. *Numerical example*

M	λ_2	λ_5	c_1	c_2	c_5	U_1	U_2	U_5	$\sum_{i \in N} x_i$
1 through 5	0.214	1.302	0.514	0.11	1.34	−2.06	−2.87	−0.739	2.182
1 through 4	0.717	—	0.465	0.333	2.0	−4.62	−5.32	−0.549	3.465

I now present some numerical examples to illustrate the features of this model, using an example I discussed previously: five states, $z_i = 1$, $i \in \{1,\ldots,4\}$, $z_5 = 2$, $\delta = 0.98$. I compare the characteristics of two treaties in this world—one that includes all five states and a second in which the state with the largest ideal level is excluded. State 1 is the proposer in both examples. Several features of the equilibria from these two treaties are summarized in Table 1. The first column indicates the membership of the treaty. The second and third columns list the Kuhn-Tucker multipliers for states 2 and 5 respectively. The equilibrium policies of states 1, 2, and 5 are indicated in the next three columns; and the utility obtained from the treaty by states 1, 2, and 5 are indicated in columns 7, 8, and 9 respectively. The Kuhn-Tucker multipliers, policies, and utilities of states 3 and 4 are identical to those of state 2 in these two examples. The final column presents the total amount of "pollution" (that is the total amount of the policy) in the world. The first row lists these results for the treaty among all five members, assuming that $r_i = 0.2$. The second row shows the result if the states with lower ideal levels, states 1 through 4, could somehow commit to excluding state 5 from their agreement. Doing so necessitates a change in r_i which I assume is 0.25 for all four states.

The results in Table 1 clearly indicate the absence of a broader-deeper trade-off. The cooperative policies of the nonproposing members are larger (less cooperative) in the four-state treaty than they are in the five-state treaty. The proposer's policy is reduced somewhat in the four-state treaty but not sufficiently to offset the increase in the policies of states 2 through 4. State 5's policy obviously remains fixed at its ideal point of 2 in the four-member treaty. The last column shows that the total amount of the pollution increases in the four-state treaty compared to the one with all five states. In addition to the increased pollution of country 5, the total amount of pollution produced by countries 1 through 4 rises from about 0.84 to 1.465.

Table 1 also illustrates why it is necessary to make the assumption that there is some exogenous mechanism that allows states 1 through 4 to commit to this four-member treaty. Without such an assumption, state 1 would never propose this treaty because its utility is higher from the five-member treaty. Furthermore, even if state 1 did propose the four-member treaty, states 2 through 4 would reject it because it does not meet their participation constraint. The utility that they receive from the five-member treaty, −2.87, is the level that meets this constraint. The utility that they receive from the four-member treaty is lower than that level so they would

be better off, in expectation, rejecting such a proposal and taking the negotiations to the next round.

Finally notice that state 5 is actually better off by being excluded. It would prefer to free ride. Why then would it ever accept the treaty in equilibrium? This is where the unanimity assumption comes in. If state 5 rejects the treaty, no treaty will occur in that period and the negotiations will go to the next round. In such a case, state 5 would not in fact receive the free-riding utility because states will continue to set their policies at the noncooperative level while the bargaining continues. Thus by rejecting the treaty state 5 does not get the free-ride value. Instead it only prolongs the negotiations.

I have asserted that the identical-policy assumption is crucial to producing a broader-deeper trade-off. To illustrate the importance of this assumption I now look at what would happen in this model if all states are required to set the same cooperative policy level, c^*. The equilibrium policy in that case would be:

$$c^* = \frac{z_1 + \sum_{k \in C} \lambda_k z_k + \sum_{k \in P} \lambda_k z_k}{m + (1 + \rho(m-1)) \sum_{k \in C} \lambda_k + m \sum_{k \in P} \lambda_k} \tag{4}$$

Notice the difference between this cooperative policy and the ones described in Equations (1) and (2). The policies in Equations (1) and (2) are functions only of each individual state i's ideal level for its own policy, z_i. The single cooperative policy in Equation (4) by contrast is a weighted average of *all* members' ideal levels. It is easy to construct examples where there are no feasible agreements that both restrict all members to identical policy levels and contain all members of N. In such cases, agreements can only be created if the states with the largest ideal points are excluded. The purpose of this article is to question the general appropriateness of that restriction.

In summary, the key to the absence of a broader-deeper trade-off in the model is allowing states to set their policies at different levels. Imagine a case of three states—1, 2, and 3—deciding to create a multilateral agreement to reduce pollution of a common body of water. Two of the states, 1 and 2, are quite committed to this environmental project, but state 3 is not at all committed. If states 1 and 2 can come to an agreement with relatively low amounts of pollution between them, why should adding the third state in any way require them to increase their pollution from that level? Increasing their (1's and 2's) pollution in no way makes the agreement more palatable to state 3. On the contrary, state 3 wants to keep its pollution levels high; it does not want the other two states' pollution levels to be high. An agreement in which the two "environmentalist" states set relatively low pollution limits and the third state sets a relatively high pollution limit (but still lower than the pretreaty level) makes all three states better off. The broader-deeper trade-off is an artifact of the often unspoken assumption that all members

of a treaty must set their policy at the same level, so that a lower level of cooperation for everyone is required to coax the more intransigent states into the agreement. But, this assumption is not applicable to many multilateral institutions and as such should not always guide one's prescriptions about the proper size of multilaterals.

Examples

One does not have to look hard to find examples of bargaining over multilaterals where concerns about a broader-deeper trade-off simply did not surface. I have already discussed the cases of the GATT, the Bretton Woods system, and the Montreal Protocol.[21] These treaties did not require their members to set their policies at an identical level and they did not seem to exhibit a broader-deeper trade-off.

One can compare these agreements to EU institutions that often seem to meet the identical-policy assumption more closely. For instance, the EU (then EC) has set external trade policy as a unit since the late 1950s, which required that some states actually raise their tariffs on trade with states outside the EC. Indeed this was the cause for some trade frictions between the United States and the EC as some members of the EC raised tariffs on some products (notably frozen chicken) to comply with the Common External Tariff (CET). The United States argued that as states raised their tariff rates on frozen chicken to comply with the CET, they were violating their GATT commitments. The United States retaliated, starting "The Chicken War."[22]

European monetary union is another example where the identical-policy assumption is appropriate because a single money supply is set for all states in the monetary union. Issues of "broader versus deeper" did arise in the creation of monetary union. There were discussions of a "multi-speed" Europe in which "hard core" states would proceed with monetary union while "soft core" states waited.[23] Furthermore, the stringent conditions placed on states' macroeconomic policies (size of budget deficit, inflation, and so on) before they could join the union might be interpreted as an attempt to exclude states that would have had overly inflationary preferences on macroeconomic policy.

I should add, though, that even in the EU context the identical-policy assumption and the broader-deeper trade-off that it induces is not universally appropriate. Interestingly, cooperation has actually deepened in the EU even as its membership has broadened. Pahre offers one explanation for this phenomena. He presents a

21. One has to be cautious in interpreting the history of trade policy cooperation in terms of the model presented here, because trade policy cooperation is clearly a case where benefits are excludable. I expect the results to translate to excludable benefits treaties, although I have not actually modeled it.

22. Conybeare 1987.

23. These points have been raised in many writings. See, for example, Eichengreen and Frieden 1994; and Alesina and Grilli 1994.

model of joint provision of a club good. Enlarging the membership increases the number of states that can contribute to the cooperative provision of this good, thus "deepening" cooperation in the sense of greater provision of it.[24]

In the context of the model in this article, it might be possible to interpret the move in the EU away from harmonization and in favor of mutual recognition in some circumstances as an attempt to get around the broader-deeper trade-off that the identical-policy approach induces. In other words, as the membership of the EU has grown and become more diverse in terms of policy preferences, the members have been forced to abandon their identical-policy approach in favor of flexibility as a way of getting around the broader-deeper trade-off.[25]

In summary, the EU provides an example in which (1) the identical-policy assumption is sometimes appropriate, (2) there were concerns about "broader versus deeper," and (3) some potential members were effectively excluded as a result of it. The point of this article is that these conditions are not universal (indeed it was fairly easy to come up with examples where these conditions were not met). In other words, the identical-policy assumption and the tension between broader and deeper that it generates is not appropriate for the general class of multilateral agreements. As such, the normative conclusion that those treaties should be exclusive does not necessarily follow.

Conclusion

The claim that there is a trade-off between broader and deeper in international multilateral agreements flows from the assumption that the members of such agreements must set their policy at identical levels. This assumption is not appropriate for many important multilateral agreements, because states are allowed to set their policies at different levels. In multilateral agreements where each state sets a different policy level, the broader-deeper trade-off does not exist and the policy implication that membership in such agreements should be exclusive to a "hard core" of committed cooperators does not follow. The model in this article explains the historical patterns of the creation of some important multilateral agreements better than the "narrower and deeper is better" model does. In particular, it explains why the United States was interested in making the GATT and the Bretton Woods system as expansive as possible. It explains the same pattern in negotiations over more recent multilateral agreements such as the Montreal and Kyoto Protocols. It also explains why those agreements included (or at least attempted to include) states that did not appear to be particularly committed to the principles of liberal world trade, stable exchange rates, environmentalism, and so on.

The model also generates several interesting empirical implications. For instance, agreements that require members to adhere to a single cooperative policy are more

24. Pahre 1995.
25. I am indebted to Lisa Martin for these points.

likely to exhibit a broader-deeper trade-off and, therefore, should be more exclusive than agreements that allow greater flexibility in states' cooperative policies. There are many avenues for future theoretical work as well. One of the more prominent areas to research would be explaining why some treaties require an identical policy and some do not. Looking at different types of cooperation problems may provide one answer. In this model the purpose of cooperation is to limit policies with negative externalities, but for some types of agreements arriving at a single policy on which the members will coordinate is the whole point. This would be the case if there were some kind of network externalities associated with the policy. A second explanation may be that some subset of states may find that if they first unify their policymaking process they will have greater bargaining leverage in a larger bargaining game with the rest of the world. This may be part of the reason why Europe decided to unify its trade and monetary policy.

Obviously, there is still much work to be done in understanding bargaining over multilateral agreements. I make no claims about the generality of the game form presented in this article. Indeed it would be impossible to do so because so little is known about the "general" case of bargaining over multilateral agreements. For this reason, empirical work on how past agreements were negotiated will be very useful. Beyond the few most famous agreements, there is not a great deal of available data on which states proposed agreements, how long bargaining over them took, and so on. Gathering such data will be time consuming but very important.

I hope to accomplish three goals with publication at this stage. First, I would like to convince those who research the creation of multilateral treaties that modeling is not so difficult as to be avoided altogether, and I offer a simple model as a starting point. Second, I would like to call into question the appropriateness of the identical-policy assumption for many important multilateral agreements. Finally, I would like to caution that the policy recommendations that follow from that assumption, namely excluding states that would generate substantial cooperative gains, are questionable.

Appendix: Formal Presentation of the Model

The game form is described in the main text. There are N relevant states, cardinality n. Each of these states receives utility from its own and other states' policies according to the following quadratic loss function.

$$U_i = -(x_i - z_i)^2 - \sum_{j \in N \setminus \{i\}} x_j^2 \qquad \text{(A1)}$$

Equation (A1) implies that states have a dominant strategy to set their policy at z_i when they are not members of an agreement. Other choices of utility function might imply that states increase their policies when other states reduce theirs. I have chosen the utility function in equation A1 because it is reasonable and simplifies the model.

Call the set of members of the agreement M, cardinality $m \leq n$. $X = \sum_{h \in N \setminus M} x_h^2$. All of the states have a common discount rate δ. The proposer wants to ensure that the other states accept its proposal and comply with the resulting agreement. Compliance requires:

$$-(1 + \delta + \cdots + \delta^p)\left((c_i - z_i)^2 + \sum_{j \in M} c_j^2 + X\right)$$
$$\geq -\sum_{j \in M} c_j^2 - X - (\delta + \cdots + \delta^p)\left(\sum_{j \in M} z_j^2 + X\right)$$

for all $i \in M$, which simplifies to:

$$-(c_i - z_i)^2 + \rho \sum_{j \in M \setminus \{i\}} (z_j^2 - c_j^2) \geq 0 \tag{A2}$$

where $\rho = (\delta + \ldots + \delta^p)/(1 + \delta + \ldots + \delta^p)$ and p is the number of punishment periods.

As in other models of international cooperation, if the "shadow of the future" is not long enough there will not be sufficient gains from cooperation to ensure the compliance of the members of the agreement. In this model the shadow of the future is captured by ρ, which is a combination of the discount rate and the number of punishment periods (ρ acts like the usual discount rate, $\rho(p) < \rho(p+1)$ and $\lim_{p \to \infty} \rho = \delta$). I assume that ρ is not "too low" by this criterion throughout the article.

Notice that, as long as there is some bilateral treaty with some state j with which the proposer will comply, the proposer will always comply with a multilateral treaty that contains state j and maximizes the proposer's utility. To see why, notice that proposer i will comply with a bilateral treaty with state j if the following is true:

$$(1 + \delta + \cdots + \delta^p)\left((c_i - z_i)^2 + c_j^2 + \sum_{k \in N \setminus \{i,j\}} z_k^2\right)$$
$$\leq c_j^2 + \sum_{k \in N \setminus \{i,j\}} z_k^2 + (\delta + \cdots + \delta^p)\left(z_j^2 + \sum_{k \in N \setminus \{i,j\}} z_k^2\right)$$

The worst-case scenario for the proposer is that it could add another state k to this agreement with cooperative policies $c_k = z_k$ and not change its policies or those of state j. Doing so will not lower the proposer's utility. Thus, the proposal that includes state k and maximizes the proposer's utility cannot lower that utility and therefore adding some state k to the treaty will either not alter the above inequality relation or will strengthen it. Obviously if no such bilateral treaty with some state j exists, then there is no possibility of any treaty. Therefore, for the remainder of the Appendix, I will assume that such a treaty exists, which, by the argument above, implies that the proposer will comply with the treaty it proposes.

To ensure participation proposer i must offer the nonproposing state j per period utility V_{ji} such that:

$$\frac{V_{ji}}{1 - \delta} = Q_j + \frac{\delta\left(r_j W_j + r_i V_{ji} + \sum_{k \in N \setminus \{i,j\}} r_k V_{jk}\right)}{1 - \delta} \tag{A3}$$

where Q_j is state j's per period utility from the noncooperative equilibrium, W_j is the per period utility that state j would receive from the equilibrium agreement when it is proposer, and r_j is state j's probability of being chosen proposer.

There is an equation like (A3) for each state indexed by k in Equation (A3). These equations form a system that can be solved recursively to yield the level of utility that will meet state j's participation constraint solely as a function of the r_is, δ, Q_j, and W_j. I call this value V_j^*. The importance of V_j^* is that unlike V_{ji} it does not depend on the identity of the proposer but only on the parameters mentioned above. Furthermore, V_j^* is clearly less than W_j because it is a weighted average of W_j and Q_j, which is less than W_j.

State j's per period utility from i's proposed agreement must be at least equal to V_j^* if j is to accept the agreement. In other words:

$$-(c_j - z_j)^2 - \sum_{k \in M \setminus \{j\}} c_k^2 - X - V_j^* \geq 0 \tag{A4}$$

Because $V_i^* < W_i$, the proposer's own participation constraint will not bind. Notice also that the proposer will want to ensure that all states' participation constraints are met because if they are not states will reject the proposal and the bargaining will continue to the next period giving the proposer expected utility $V_i^* < W_i$.

If δ and/or r_j is small, V_j^* may be insufficient to keep state j compliant, in which case the proposer will have to choose policies that satisfy state j's compliance constraint as defined in Equation (A2). More formally the proposer must choose policies for state j such that:

$$(z_j - c_j)^2 \leq \min \left\{ \rho \sum_{k \in M \setminus \{j\}} (z_k^2 - c_k^2), -V_j^* - \sum_{k \in M \setminus \{j\}} c_k^2 - X \right\}$$

C is the set of states for which the compliance constraint binds, and P is the set of states for which the participation constraint binds. The proposer will choose a proposal so as to maximize its utility subject to the compliance and participation constraints. That is, the chosen proposer will propose the agreement that maximizes:

$$\begin{aligned} L_i = & -(c_i - z_i)^2 - \sum_{j \in M \setminus \{i\}} c_j^2 - \sum_{j \in C} \lambda_j \left((c_j - z_j)^2 - \rho \sum_{k \in M \setminus \{j\}} (z_k^2 - c_k^2) \right) \\ & - \sum_{j \in P} \lambda_j \left((c_j - z_j)^2 + \sum_{k \in M \setminus \{j\}} c_k^2 + X + V_j^* \right) \end{aligned} \tag{A5}$$

The λs in Equation (A5) are Kuhn-Tucker multipliers on the constraints in Equations (A2) and (A4).

Maximizing this equation with respect to each c_i and c_j and solving for c_i and c_j yields the policies mentioned in Equations (1) and (2) in the main text. Complementary slackness from the Kuhn-Tucker conditions requires:

$$\lambda_i \left((c_i - z_i)^2 - \rho \sum_{j \in M \setminus \{i\}} (z_j^2 - c_j^2) \right) = 0$$

for all $i \in C$, and

$$\lambda_i \left((c_i - z_i)^2 + \sum_{j \in M \setminus \{i\}} c_j^2 + X + V_i^* \right) = 0.$$

for all $i \in P$. This implies that if constraints do not bind on state j, λ_j is zero. Equations (1) and (2) in turn imply that state j's cooperative policy will be zero in that case.

For the remainder of this Appendix and without loss of generality, I will index the proposer as state 1.

Proof of Proposition 1

The equilibrium to the game described above has the following features.

1. Equation (A5) has a unique maximum.
2. The proposer's cooperative policy will be:

$$c_1 = \frac{z_1}{1 + \rho \sum_{j \in C} \lambda_j + \sum_{j \in P} \lambda_j} \tag{A6}$$

   and the cooperative policy of the other states $j \in M$ will be:

$$c_j = \frac{\lambda_j z_j}{1 + \lambda_j + \rho \sum_{k \in C \setminus \{j\}} \lambda_k + \sum_{k \in P \setminus \{j\}} \lambda_k} \tag{A7}$$

3. Bargaining will end in the first period.
4. The agreement will include all states in N.
5. All members will comply with the agreement.

I prove the proposition part by part.

1. Define E as the set of all points $(x_1, x_2, \ldots, x_m)$ such that $0 \leq x_i \leq z_i \; \forall \; i \in M$. E is a compact subset of R^m. The constraints define a closed subset of E, E^*, such that all the constraints are satisfied and E^* is nonempty (the constraints are satisfied at the Nash equilibrium, for example). Thus a maximum exists. Furthermore, because Equation (A5) is monotonically increasing in c_i and monotonically decreasing in c_j, $j \in M \setminus \{i\}$ that maximum is unique.
2. Equations (A6) and (A7) are derived from the first-order conditions for a maximum to Equation (A5).
3. The proposer chooses the policies of states in P to ensure their participation. The compliance constraints of states in C are more binding than their participation constraints. Since the former constraints are met, the latter will be met as well.

4. Part (3) has already shown that all invited states will accept their invitations. Furthermore, the proposer has a weakly dominant strategy to invite all states in N, because the proposer can always propose a cooperative policy $c_j = z_j$ and be no worse off than if it did not invite state j.

5. The policies of states in C are chosen to ensure their compliance. For states in P their participation constraints are more binding than their compliance constraint. The former constraints are met, insuring the compliance of these states. As shown above, the proposer will always comply with the equilibrium treaty it proposes.

Proof of Proposition 2

To recap Proposition 2:

$$\alpha_i(M) \geq \alpha_i(M \cup \{j\}), i \in M, j \in N \backslash M$$

where $\alpha_i(M)$ refers to state i's cooperative policy in an agreement with some given set of states M as a percentage of state i's ideal level for its policy, z_i.

It is only necessary to discuss the case when $\alpha_i(M \cup \{j\}) > 0$, because if this condition does not hold the proposition is immediate because $\alpha_i(M) \geq 0$.

The proof is by contradiction. Suppose, contrary to Proposition 2, that $\exists\ \alpha_i(M) < \alpha_i(M \cup \{j\})$, for some $i \in M \backslash \{1\}$, $j \in N \backslash M$.

I proceed in three steps. The first of these steps will prove that if one of the α_is, $i \in M \backslash \{1\}$ increases with the inclusion of state $j \in N \backslash M$, all such α_is do. The second step will establish that, if the proposition is false, the proposer's policy will be reduced as a result of adding the additional member. The third step will establish the contradiction that completes the proof.

Step 1 If $\alpha_i(M) < \alpha_i(M \cup \{j\})$, for some $i \in M \backslash \{1\}$, then $\alpha_i(M) < \alpha_i(M \cup \{j\})$ for all $i \in M \backslash \{1\}$.

Because I am only discussing the case where $\alpha_i(M \cup \{j\}) > 0$, one can ignore cases where $\alpha_i(M) = 0$. When $\alpha_i(M) > 0$, the claim is true because the complementary slackness condition for states in C requires:

$$(1-\alpha_i)^2 z_i^2 - \rho(1-\alpha_k^2) z_k^2 - \rho\left(\sum_{h \in M \backslash \{i,k\}} (1-\alpha_h^2) z_h^2\right)$$
$$= (1-\alpha_k)^2 z_k^2 - \rho(1-\alpha_i^2) z_i^2 - \rho\left(\sum_{h \in M \backslash \{i,k\}} (1-\alpha_h^2) z_h^2\right) = 0$$

for any two states i and k in C with nonzero cooperative policies. Rearranging reveals that:

$$\frac{(1-\alpha_i)^2 + \rho(1-\alpha_i^2)}{(1-\alpha_k)^2 + \rho(1-\alpha_k^2)} = \frac{z_k^2}{z_i^2} \tag{A8}$$

The right side of Equation (A8) is a constant, which means that any change in α_i must be matched by a proportional change in α_k in the same direction. A similar calculation using the complimentary slackness conditions for states in P shows that their policies must also move in the same direction.

Step 2 Show that if $\alpha_i(M) < \alpha_i(M \cup \{j\})$, then $\alpha_1(M) \geq \alpha_1(M \cup \{j\})$

It follows from the first-order conditions that:

$$\lambda_i(z_i - x_i) = \left(1 + \rho \sum_{k \in C \setminus \{i\}} \lambda_k + \sum_{k \in P \setminus \{i\}} \lambda_k\right) x_i \tag{A9}$$

Combining the λs on the right side and solving for λ_i yields:

$$\frac{\lambda_i}{1 + \rho\Lambda_C + \Lambda_P} = A_i \tag{A10}$$

where $\Lambda_C = \Sigma_i \lambda_i \; i \in C$, $\Lambda_P = \Sigma_i \lambda_i \; i \in P$ and A_i is either $[\alpha_i/(1 - \alpha_i)]/\{1 + \rho[\alpha_i/(1 - \alpha_i)]\}$ if $i \in C$ or $[\alpha_i/(1 - \alpha_i)]/\{1 + [\alpha_i/(1 - \alpha_i)]\}$ if $i \in P$. Note that A_i is strictly increasing in α_i. Summing the left and right side of Equation (A10) over all $i \in N$ produces the following relations:

$$\frac{\Lambda_C}{1 + \rho\Lambda_P} = \sum_{i \in C} A_i = A_C$$

$$\frac{\Lambda_P}{1 + \rho\Lambda_C + \Lambda_P} = \sum_{i \in P} A_i = A_P$$

$$\frac{\Lambda_C + \Lambda_P}{1 + \rho\Lambda_C + \Lambda_P} = \sum_{i \in C \cup P} A_i = A_{CP}$$

Returning to the earlier discussion, if one of the A_is on the right side increases with the addition of the extra member, j, all the A_is do. Because, by assumption, $\alpha_i(M) < \alpha_i(M \cup \{j\})$, it must be true that $A_i(M) < A_i(M \cup \{j\})$, $i \in \{C, P, CP\}$. This fact in turn implies $\Lambda_C(M) < \Lambda_C(M \cup \{j\})$ and $\Lambda_P(M) < \Lambda_P(M \cup \{j\})$. To see this note that Λ_C and Λ_P cannot both decrease with the addition of another state, because if they did it would imply a decrease in A_{CP}. Furthermore, Λ_C cannot decrease as a result of adding another state because if it did while Λ_P increased (or did not change), it would imply a decrease in A_C. A similar argument shows that Λ_P cannot decrease while Λ_C increases (or does not change). Thus I have shown that $\Lambda_C(M) < \Lambda_C(M \cup \{j\})$ and $\Lambda_P(M) < \Lambda_P(M \cup \{j\})$.

Recall from the first order conditions that:

$$\alpha_1(M) = \frac{1}{1 + \rho\Lambda_C(M) + \Lambda_P(M)} \tag{A11}$$

and

$$\alpha_1(M \cup \{j\}) = \frac{1}{1 + \rho\Lambda_C(M \cup \{j\}) + \Lambda_P(M \cup \{j\})} \tag{A12}$$

Using Equations (A11) and (A12), the fact that $\Lambda_C(M) < \Lambda_C(M \cup \{j\})$ and $\Lambda_P(M) < \Lambda_P(M \cup \{j\})$ implies that $\alpha_1(M) > \alpha_1(M \cup \{j\})$.

Step 3 In this final step I establish a contradiction. The discussion in Step 2 has indicated that if it is true that $\alpha_i(M) < \alpha_i(M \cup \{j\})$, then the effect of adding another state j is to decrease the policy of state 1. By assumption, this is the agreement that state 1 proposes in equilibrium (that is, the agreement that maximizes state 1's utility). Call this agreement $\Theta(M \cup \{j\})$, and call $\Theta(M)$ the equilibrium agreement with M. Consider instead an agreement among the members of $M \cup \{j\}$ in which the policies of the states in $M\backslash\{1\}$ are kept at the levels for the equilibrium treaty with M, while the policies of state 1 and the extra state, j, are kept at their levels for an equilibrium treaty among the members of $M \cup \{j\}$. Call this agreement Ω. If states 1 and the extra state, j, will comply with $\Theta(M \cup \{j\})$, they will surely comply with Ω because their policies are the same as those in $\Theta(M \cup \{j\})$ and $\alpha_i(M) < \alpha_i(M \cup \{j\})$, $i \in M\backslash\{1\}$. If the states in $M\backslash\{1\}$ will comply with $\Theta(M)$, they will surely comply with Ω because their policies are the same as those in $\Theta(M)$ and $\alpha_1(M \cup \{j\}) < \alpha_1(M)$, and $\alpha_j(M \cup \{j\}) < 1$. Ω offers state 1 unambiguously greater utility than agreement $\Theta(M \cup \{j\})$ does, but $\Theta(M \cup \{j\})$ supposedly maximized the proposer's utility. This contradiction completes the proof.

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