Designing institutions for global security

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This article synthesizes selected recent research in the economics of military alliances, conflict, bargaining, and mechanism design and suggests directions for future research. It argues that insight might be gained by combining certain aspects of these research streams. The literature on military alliances in particular might gain by applying techniques from bargaining theory and mechanism design. In fact, other areas of conflict studies have incorporated these latter techniques to a large degree and have benefitted from such incorporation.[1]

Starting with Olson and Zeckhauser's seminal contribution, the literature on the economics of alliances is rich.[2] Much of this literature was driven by the real-life context of NATO responses against the perceived threat of the Warsaw Pact bloc. Another significant strand of the literature was, and continues to be, motivated by alliance responses to nonstate terrorism. In this context, security-related actions of an alliance member (or of military expenditure, often taken as a proxy for such actions) were thought to have two kinds of effects for other alliance members. First, a positive externality effect (a beneficial spillover) on other alliance members and, second, a negative externality, occurring either when greater arming by any one ally leads to an adverse reaction by the alliance's adversary and inducing all other alliance members to arm more as well or when more effort by any one ally deflects nonstate terrorist organizations to target other allies, especially when actions against terrorists are defensive (deterrence) rather than offensive (preemptive) in nature.

The war with Iraq (2003) introduced a new type of occurrence that was somewhat different from the traditional interaction observed among NATO allies. Negative externalities accrued to allies like France and Germany, mostly due to unilateral actions by another ally, the United States. At least contextually, this was very different from the phenomena studied in the earlier alliance literature, even when that literature had considered the possibility of negative externalities.

As to bargaining theory and mechanism design, they have by now found their place in the toolkit of applied economists and have been used to analyze many contemporary events. Elements of both bargaining theory and mechanism design have been used in the conflict economics literature. Analyses of conflict regarding environmental and resource issues have also been analyzed using these techniques. The design of international institutions to mitigate conflict using mechanism design techniques was highlighted in a collection of articles in the *Review of Economic Design* (v13 n3, 2009). In the introduction, Massimo Morelli writes that "even in the most pessimistic world of anarchy, the quest for self-enforcing institutions that may help conflict resolution or the reduction of negotiation and renegotiation costs is an important one, and a lot more work can be done by economists and political scientists

to identify self-enforcing institutional mechanisms that work better than others and that therefore the relevant players could coordinate on."[3]

Given the recognition in the conflict economics literature that bargaining theory and mechanism design techniques are useful, there is much scope to use such techniques to study the interaction between and among members of defense alliances where, however, use of these techniques has been lacking in the recent literature.[4] To be clear, the focus here is on interactions between and among the allies themselves, not between allies and their adversaries. Such studies have been done.[5] Alliance cost sharing has also been studied, but one pair of authors argues that "applicability and success of [the suggested cost sharing] mechanism depends on the orders of a supranational planning agency and on some minimal amount of cooperation among ... members."[6] This article, then, synthesizes two recent studies that bridge the gap between alliance theory, on the one hand, and bargaining theory and mechanism design, on the other.[7] These papers analyze the efficient provisioning of effort by a military alliance to combat the perceived threat posed by a rogue nation. One of the main contributions of these papers is to suggest an institutional mechanism by which to move the joint effort of an alliance from a unilateral, inefficient level to an multilateral, efficient level. The mechanism involves the delegation of certain privileges to a neutral agency within the alliance to suggest a scheme (or deal) involving transfers and effort levels among alliance members whose adoption is voted on by a subset of member nations under unanimity rule.[8]

The next section outlines a model and numerical example to present some of the conceptual aspects and findings of the synthesized studies. The section thereafter discusses the findings in the broader context of mechanism design and their practical use. The final section concludes with an agenda for future research.

A model and numerical example

Suppose an alliance consists of five countries, $i = 1, 2, ..., 5$, which jointly combat a rogue nation. The preferences of any one country i might be written as

Arguing that insight might be gained by combining certain aspects of research streams in the economics of military alliances, bargaining, and mechanism design, the article provides a model and a numerical example regarding the creation of an intra-alliance agency with the power to propose an alliance level of effort that would be economically efficient. A voting mechanism is proposed whereby alliance members can achieve the desired outcome. The article concludes with an extensive discussion of and suggestions for further research on intra-alliance design.

(1) $U_i (m_i, e) = m_i + \lambda_i e - e^2$,

where m_i is a private good (money) consumed by i and $e = \Sigma_i\, e_i$ is the sum of joint effort expended by the alliance against the rogue nation. In turn, e_i is country i's contribution to the joint effort. The use of the squared term in the function means that in addition to a positive externality, joint effort can also exert a negative externality. Thus, each nation has an "ideal point" as far as security effort is concerned (a "single-peaked" utility function with respect to such effort). The term λ_i is a shorthand description for an index of public support for the security effort of nation i. It can reach from zero to infinity [$\lambda_i \in (0,\infty)$]. In a more elaborate model, this index could be made a reactive function of the perceived threat delivered by the rogue nation, i.e., $\lambda_i = \lambda_i (t)$, where t is the perceived threat level, but in the current example the index is treated as a constant. Joint alliance effort is assumed to be offensive, nonrival, and nonexcludable in that its results jointly accrue to every member of the alliance. This effort might include military action, trade embargoes, and other kinds of punitive action. The budget constraint of country i is written as $m_i + ce_i \leq M_i$, where M_i can range, in principle, from zero to infinity ($0 < M_i < \infty$) and reflects the initial endowment of the private good of nation i. The term ce_i, with $c > 0$, captures the cost of effort level e_i.

The unilateral outcome

For the purposes of a numerical example, let $M_i = M = 100$, $c = 2$, $\lambda_1 = \lambda_2 = \lambda_3 = 1$, $\lambda_4 = 8$, and $\lambda_5 = 10$. Given these numbers, country 5's utility function, net of effort cost, then is

(2) $V_5 = M + \lambda_5 e - e^2 - ce_i = 100 + 10e - e^2 - 2e_5$.

Similarly, for country 4, $V_4 = 100 + 8e - e^2 - 2e_4$, and for countries 1, 2, and 3, one obtains $V_1 = V_2 = V_3 = 100 + 1e - e^2 - 2e_i$, where $i = 1, 2$, and 3, respectively. Country 5's effort maximization problem gives the first-order condition (FOC) as follows:

(3) $\delta V_5 / \delta e_5 = 10 - 2e_5 - 2\Sigma e_{-5} - 2 = 0$,

where Σe_{-5} refers to the sum of the efforts of countries 1 to 4, i.e., excluding the effort of country 5, hence the "–5" in the subscript of the third term. If this sum is zero ($\Sigma e_{-5} = 0$), then for equation (3) to hold, it follows that $e_5 = 4$. In the Nash equilibrium, total alliance effort is equal to the effort of country 5 alone, $e = e_5 = 4$, with $e_1 = e_2 = e_3 = e_4 = 0$. This is seen by substituting $e_5 = 4$ in the FOC's of the other countries' maximization problems. (If $e_5 = 4$, their FOCs will return an individual optimal effort level that is nonpositive. But since effort cannot be negative, their optimal effort level

must therefore be zero.) The equilibrium level of the joint effort provision by all five countries is, in this case, a unilateral outcome.

Country 5's utility in the unilateral outcome is $V_5{}^* = 100 + 10\times4 - 4^2 - 2\times4 = 116$. Similarly, country 4's utility is also 116, namely $V_4{}^* = 100 + 8\times4 - 4^2 = 116$. Note that country 4 free-rides on country 5's effort so that country 4 has no effort cost. By analogy, countries 1, 2, and 3 each have utilities of $V_1{}^* = V_2{}^* = V_3{}^* = 100 + 1\times4 - 4^2 = 88$.

Now suppose that country 4 had to fight the perceived threat all by itself. How much effort would it put in? The "private equilibrium" effort of country 4 would be given by

(4) $\delta V_4 / \delta e_4 = 8 - 2e_4 - 2 = 0$,

which, when solved, gives $e_4 = 3$ and $V_4 = 100 + 8\times3 - 3^2 - 2\times3 = 109$. Since $V_4{}^* = 116 > 109$, country 4 indeed has strong free-riding benefits under the unilateral outcome. The private equilibrium of country 1 (or 2 or 3) can similarly be computed. Since $V_1 = V_2 = V_3 = 100 + e_i - e_i{}^2 - 2e_i = 100 - e_i - e_i{}^2$, when i is the only effort provider (put $i = 1, 2$, and 3, respectively), this gives an optimal private effort level of zero for these countries, respectively, and a corresponding private utility level of 100. For each of them, this is *more* than in the unilateral outcome ($100 > 88$). Also note that the "ideal" effort level for these countries is 0.5 (differentiating $m_i + 1\times e - e^2$ with respect to effort, setting the resulting equation equal to zero, and solving for effort). So, these countries would benefit from a reduction in effort from the unilateral level of 4.

The efficient outcome

By maximizing a Benthamite social welfare function, i.e., the sum of the countries' utilities, one would get the following formula for an efficient joint effort:

(5) $e_E = [1/(2I)]\times[\Sigma\, \lambda_i - c] = [1/(10)]\times[21 - 2] = 1.9$,

where the capital I denotes the total number of countries (i.e., 5). If country 5 makes the entire effort of 1.9 by itself, so that its effort alone equals the alliance effort, then its utility is

(6) $V_5[E] = 100 + 10(1.9) - 1.9^2 - 2(1.9) = 111.59$,

which, however, is *less* than its utility level in the unilateral outcome (which was equal to 116). For country 4, utility would be $V_4[E] = 100 + 8(1.9) - 1.9^2 = 111.59$, again *less* than in the unilateral outcome. But for countries 1, 2, and 3, the utilities are $V_1[E] = V_2[E] = V_3[E] = 100 + 1.9 - 1.9^2 = 98.29$. Since these are *higher* values than

in the unilateral outcome (of 88), each of them should be willing to pay between just over 0 and 10.29 for a reduction in effort from the unilateral level of 4 units to the efficient level of 1.9 units. As things stand, however, none of the five countries have an incentive to move toward the efficient alliance effort.

Inefficient overprovision of effort

If country 5 did make a credible commitment to provide 1.9 units of effort—the efficient level—and countries 1, 2, and 3 continued to make no effort, then country 4 would want to make $3 - 1.9 = 1.1$ units of effort, that is, the difference between its private effort level and the effort country 5 is making. This can be checked by plugging the values into country 4's reaction function:

$$(7) \qquad e_4 = [½] \times [8 - 2\lambda e_{-4} - 2] = [½] \times [8 - 2(1.9) - 2] = 1.1.$$

Country 4's utility in this case is $V_4 = 100 + 8 \times 3 - 3^2 - 2 \times 1.1 = 112.8$, greater than the utility it gets in the case of the efficient outcome ($112.8 > 111.59$). The joint effort level now is $e = 3$, with 1.9 units contributed by country 5 and 1.1 units by country 4. While country 4 pays for 1.1 units, it enjoys the benefits of 3 units. Thus, if country 5 did move from the unilateral to the efficient level (from 4 to 1.9), it would induce country 4 to make an effort of its own. (For countries 1, 2, and 3, whose private effort levels of zero are less than the efficient level ($0 < 1.9$), their best-response effort remains zero, even if country 5 were to move from the unilateral to the efficient level.) One consequence of this scenario is that if country 4 cannot be stopped from starting to make an effort of its own when country 5 reduces its effort to the efficient level, then joint effort cannot be sustained at the efficient level. Since $3 > 1.9$, there will be an overprovision of alliance effort!

Efficiency condition

Three things become clear from this example. If one has to design a scheme to sustain the efficient outcome, then it should have the following features:

1. *Country 5 must be compensated* for the amount of its utility loss ($116 - 111.59 = 4.41$) if it moves from the unilateral effort (4 units) to the efficient level (1.9 units).
2. *Country 4 must be compensated* for its utility loss as well ($112.8 - 111.59 = 1.21$) when joint effort level is at 3—with 1.9 units contributed by country 5 and 1.1 units by country 4—rather than at the efficient outcome of 1.9 units only.
3. *Countries 1, 2, and 3 should pay* in the range [0,10.29], where 10.29 is the difference between their utility levels at the efficient outcome (1.9) and the unilateral outcome (4).

For there to exist such a scheme, the total compensation to be paid to countries 4 and 5 must be less than the total amount countries 1, 2, and 3 are willing to pay. This condition is satisfied here since $4.41 + 1.21 < 3 \times 10.29$.

How to obtain the efficient outcome

In the following game, it is assumed that a coordinating supranational agency comes into existence which is able to make proposals to the alliance members. Institutional rules under which this agency makes proposals include that it is not a totalitarian planner for the alliance, since there is voting on its proposal. What follows can be thought of as a "ready-made recipe" that an independent supranational agency within an alliance might follow if, in the presence of heterogeneous preferences of its members, it wants the alliance to achieve efficiency against perceived threat.

The supranational agency is a neutral player. Its role is restricted to making a certain proposal in the game and then to act according to the proposal if it is adopted. To be clear, the neutral player is not choosing anything in this game: The agency proposes, but the alliance members choose. The central result is that there exists a particular scheme that the neutral player can propose that will get the alliance to its efficient effort level.

In terms of the example, countries 1 to 5 and the neutral player, N, are the players in the institutional game. This is a game of complete and perfect information and consists of four stages. In stage 1, N makes a proposal of the following form:

$$(8) \qquad P, R, T, f, g, e_i = 0, 0, 0, 0, e_E,$$

where

- ▸ P is a set of *payees*, here countries 1,2, and 3.
- ▸ R is a set of *recipients*, here countries 4 and 5. In general, this set will contain the unilateral agent and all other agents whose private effort provision level exceeds the efficient level.
- ▸ T is a total amount of *transfers* paid by payees and received by recipients. In the example this is (4.41 + 1.21).
- ▸ f is a *sharing rule*, here any rule that shares (4.41 + 1.21) among countries 1, 2, and 3 such that the payment share of each falls in the interval [0,10.29). Note that there are many sharing rules which can do this. A simple example would be that each pays $(1/3) \times (4.41 + 1.21)$.
- ▸ g is a *dividing rule*, here dividing T between countries 4 and 5. In this case, country 5 gets 4.41 for adhering to the proposal, and nothing otherwise, and country 4 gets 1.21 for adhering to the proposal, and nothing otherwise.
- ▸ $e_E = (0, 0, 0, 0, 1.9)$ is an *effort vector* where the fifth country, country 5, makes the efficient amount of effort (1.9 units) and the others make no effort.

In stage 2, the unilateral player and the payees vote on the proposal under unanimity rule. In the example, this would be countries 1, 2, 3, and 5. Country 4 is not included in the vote. (The exclusion of country 4 from stage 2 will be explained later.) If the proposal passes, this means that the voters commit themselves to the provisions of the proposal, that is, to the payment and effort aspects, respectively. Countries 1, 2, and 3 hand over the amount of (4.41 + 1.21) to the neutral player, each paying its share according to the proposed sharing rule.

In stage 3, if the proposal does not pass, the status quo game occurs with all countries making their individual effort choice. As shown, this effort choice game will lead to the unilateral provision of 4 units by country 5. But if the proposal does pass stage 2, then only country 4 makes an effort choice according to the provisions of the proposal.[9] As seen, the proposal states that country 4 gets a transfer of 1.21 for adhering to the proposal (and making zero effort), and it gets nothing if it deviates from the proposal. Again, note that country 4 did not vote in the second stage. It is the other recipient country designated in the proposal, in addition to country 5.

In stage 4, which occurs only if the proposal passes, the neutral player makes payments to the recipients according to its proposal.

The main result is that the effort vector (0, 0, 0, 0, 1.9) is sustained as the subgame-perfect effort outcome of the institutional game for the scheme suggested by the neutral player. Features of this outcome are (1) multilateral participation, at least via payments; (2) that countries 1, 2, and 3 are better off than in the unilateral outcome, even after paying compensation; (3) that, after obtaining compensation, country 5 is better off than under the unilateral outcome; and (4) that after receiving compensation, country 4 is worse off than under the unilateral outcome (where it was free-riding) but better off than it would have been at its private equilibrium outcome. Country 4 it is still obtaining free-riding benefits, only smaller than before.[10]

A illustrative parable

To put the example in the context of a parable relevant for our times, suppose that country A is trying to acquire nuclear weapons capability, with adverse consequences for global security. The five-country alliance in the example is trying to stop this. Country 5, the leading alliance power, has the capability to invade country A and to bring about a regime change. Left alone, country 5 might just undertake this venture. Let country 4 be a regional power that expects to benefit from a regime change in country A but, on its own, would attempt no more than a small strike on the suspected nuclear capabilities of A. Countries 1, 2, and 3 would prefer not to take any military action at all, perhaps because of trade ties they have with A, which might be disrupted in case of military tensions in the region. (For example, A might be the supplier of commercially important resources.) Nonetheless, countries 1, 2, and 3 also prefer for A not to acquire nuclear weapons status.

Now suppose that the efficient effort by the alliance is to stop the nuclear weapons ambitions of country A not through invasion or other military strike but through means such as embargoes, strong enforcement of nonproliferation, or subversion of A's scientific capabilities. The result outlined in this article says that a neutral agency could propose the efficient outcome to the alliance members and have everyone except country 4 to vote on it under unanimity rule. (It is easy to see that country 4 would prefer country 5 to invade country A rather than that the proposal succeed; therefore, it makes sense to exclude country 4 from the initial vote.) The efficient outcome would occur mostly through country 5's direct effort, but with "compensation" such as material and logistical support offered by countries 1, 2, and 3. Country 4's security would also be guaranteed, up to the point of its private provision (enough effort to ensure that there is no attack against its territory), perhaps through transference of military assistance (anti-missile technology, early detection devices, etc.). Thus, alliance efficiency would be brought about not through country 1, 2, and 3's disengagement from the whole process, but through their multilateral participation.

Discussion

The example demonstrates that in principle it is possible to design a supranational agency within a military alliance that would lead to the provision of an efficient level of security against a perceived threat. This section discusses whether the features suggested by the model are necessary or desirable in achievement of that goal. To do that, it is necessary that summarize various results from the two synthesized papers.[11]

First, the institutional mechanism needed to move the joint effort level of an alliance from a unilateral, inefficient level to a multilateral, efficient level involves the delegation of certain powers to a neutral agency that proposes a deal involving transfers and assignment of effort levels among alliance members, and whose adoption is voted on by a subset of alliance member under unanimity rule. Potential deal-breakers are left out of certain stages of the voting process so that sequential voting takes place. This emphasizes the bargaining and mechanism design features within this alliance theory example. While the move to efficiency is not sure to happen under every circumstance, even with the facilitation of the neutral agency, these papers outline the conditions under which it is likely to occur.

Second, the transfer scheme is likely to work when the support for the movement toward efficiency through payments arises from the desires of the payers regarding security effort (captured by the public opinion parameter, λ) either "getting close" or "remaining close" to the desire of the country that might act unilaterally. Thus, for the mechanism to work, a partial "meeting of minds" among alliance members must occur. This finding is important as it arises only when the security-related desires of the payers evolve, rather than stay fixed. Technically, this evolution of security-related desires is brought about through the endogenization of the security threat.[12] In contrast, when security-related desires of the countries are fixed, "distance

between opinions" would provide the incentive for the proposed mechanism to work.[13] When it is the perceived threat that is evolving, one realizes that there is another possible path for the mechanism to work, namely a "convergence of opinions" that would cause a fall in the level of transfers needed to move to efficiency.

Third, when the security-related desires of alliance members diverge rather than converge in the face of changing perceived threat levels, there are implications for the workability of the mechanism. On the one hand, an efficient level higher than the unilateral level might be easier to sustain in the situation where opposite movement in security desires among alliance members occurs, as compared to the situation where changes in security desires move in the same direction. This happens because payer countries become more willing to pay up in the former case. On the other hand, an efficient level which is lower than the unilateral level might be harder or easier to sustain, depending on certain specific conditions regarding the desired amounts of payment-transfers, of both payers and recipients. This result demonstrates the presence of "fair-weather friends" within an alliance, i.e., allies that increase support for joint security effort when the threat becomes less dangerous, but withdraw support in more dangerous circumstances.

Given these results, several questions come to mind, including the following: (1) Is the restriction of the set of voters on the deal proposed by the neutral player strong enough to break the alliance? (2) Why is the unanimity rule among the set of voters needed; why not apply another voting rule? (3) Given the restrictions imposed in the model, are the results obtained of practical use? And (4) How can one ensure the proper working and feasibility of a neutral player in reality?

The answer to the first question is "no." The countries that are not given first-round votes (in the example, the stage 2 vote) can vote later (in stage 3) to be compensated such as to realize at least the same utility levels that they would obtain by staying out of the alliance. Even though this level is lower than the even greater benefits they would receive under the unilateral (but inefficient) status quo outcome, clearly they can do no better by breaking off from the alliance. Thus, restricting the initial set of voters—to keep out potential deal-breakers—should not lead to a depletion of the alliance's membership.

With respect to the second question—regarding the unanimity rule—its role is to secure commitment from all beneficiaries from the ex-ante to the ex-post outcome. All alliance members will benefit from the transfer payment, so there is no reason for any one of them not to vote "yes," other than that the potential payers under the deal would wish to vote "no" in order to secure free-riding on the alliance contribution of the others. But that is just the point: One can circumvent this destructive (inefficient) behavior either by securing commitment through a unanimity rule or through the stipulation that all voters follow a majority "yes" vote, even if any one member individually votes "no." Given sovereignty, if we require the latter, this comes to the same as requiring commitment under unanimity rule. (In fact, note that given the unanimity rule, ex-post beneficiaries will always vote in favor of change.)[14]

With regard to question three, given the restrictions in the model (for instance, no transactions cost, linear effort technology, linear costs, no income effects, and nonbinding wealth constraints), would the conclusions seen here be valid in a more general context? The omission of transactions costs is not of much import as their existence can be included in the payments structure, if necessary. Obviously, the presence of insurmountable transactions costs would make the scheme unworkable (as would be the case with any Coasean scheme). Of greater import are the other simplifications, the relaxation of which will not give us the strong unilateral outcome seen in the benchmark model discussed here with only one effort provider. However, even though there will be more countries making efforts, the joint effort level will likely not be at the efficient level and, given the features of the model, can be either more or less than efficient for different parameter values. The question is: Will the mechanism outlined work in more general cases as well? Intuitively, yes. To understand why, note that the main features of the mechanism are (1) that potential deal-breakers, those that make no effort but gain utilities under the status quo, are excluded from early-round voting; (2) that the unanimity rule prevents potential payers to free-ride on other payers; (3) that the effort-maker is fully compensated, up to its status quo utility level; and (4) that only partial compensation is offered to nonproviders who would benefit from the status quo.

Other than added complexity, there is no immediately obvious reason why a generalization of this mechanism to the case of multiple effort providers—when the assumptions of the model are relaxed and strong unilateralism does not occur and where all providers at status quo are fully compensated up to their status-quo utility levels—will not work as well. (The payers might have to make compensation through effort, and not just monetary transfers.) But such extension should be modeled of course, and additional insights might be obtained. Another valuable extension of the model might involve the consideration of weakest-link and best-shot effort technologies. For example, it has been shown that effort (in-kind) transfers versus income transfers may have different welfare effects when weakest-link effort technologies are considered.[15] Further, it might be useful to incorporate the role of uncertainty in the model. Uncertainty might arise from regime change in any of the governments of the alliance members (for example, the different tastes for direct action by the G.W. Bush and Obama administrations in the United States) or due to regime change in a rogue nation. With uncertainty, it will likely be difficult to maintain an ex-post balanced budget constraint for the transfer of funds, and the workability of the suggested mechanism may have to depend on a lump-sum membership fee that can be charged to all alliance members, perhaps in the form of annual dues.

Finally, with respect to question four—how can one ensure the proper working and feasibility of a neutral player in reality?— the underlying paper suggests how a neutral agency might be structured in a real-world situation, and it also discusses some of the problems that it might face in its operations.[16] These include, first, that the

agency would be staffed by career officers belonging to an international civil service whose membership would be determined by technical qualifications and clearance of a suitable examination process. Second, checks and balances (both top-down and bottom-up) among the ranks of these career officers might be required to ensure neutrality. And third, as the challenges to the neutrality of this agency would likely be similar to those faced by central banks and their staff with respect to independence from political interference, it might beneficial to parse that literature to learn if some of its (suitably modified) findings may be applicable in the present context.[17] Additionally, when the neutral agency suggests a scheme to a set of voting members, the details of the proposal should be crafted by a team led by a manager whose nationality matches one of the voting countries on that issue. It may be presumed that the preferences of this manager will be aligned with the preference of the country whose citizen she is. This would ensure a level of oversight by her which would be beneficial to the production of a workable scheme. Note that the mechanism suggested in this article is incentive compatible for the set of voting countries, so that choosing an overseeing official from one of these countries would not be a bad idea. This removes some of the skepticism regarding the possibility of finding a neutral agent (team manager) in a real world scenario: Our neutral agent need not be perfectly "neutral," but only needs to be a "good enough" citizen of one of the countries which are willing to vote (and then act) on the issue under deliberation.

In sum, the role of the neutral agency is two-fold: First, it acts as a coordinator that provides the nudge[18] for the alliance to move to efficiency and, second, once affirmatively voted on, it ensures smooth transfers between payer and recipient alliance members. For Coasean bargaining to work, we need institutions and mechanisms to facilitate the process (a role played by laws, legal enforcers, and courts in other social spheres). In the present context, the neutral agency plays the role of such a facilitator.

Conclusion

Tools from bargaining theory and mechanism design can be used to analyze issues pertaining to intra-alliance interactions. This article discusses two such attempts that demonstrate, more than anything, the large extent of unexplored territory that remains to be investigated. No doubt, input will be needed from scholars in the fields of international relations and diplomacy to construct truly workable solutions to the problem of the efficient provision of global security. Proposed solutions must be presented to practitioners who, in real-life, might be policymakers with the ability to implement any such reforms (and who could provide valid critiques from a real-world perspective). This unified, collaborative venture across various fields in economics, between economics and other disciplines, and a conversation between academia and policymaking will be important in the evolution of a civil global order. The adoption of the ideas proposed in this article will ultimately occur if policymakers are convinced of their usefulness and exert the necessary political will to institutionalize them in an appropriate manner.

Notes

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1. For a review of bargaining models used in the study of conflict, see Jackson and Morelli (2011). For the role of mechanism design in trade and environmental conflicts see, e.g., Staiger (1995) as well as Oates and Portney (2003, pp. 341-346) and Stavins (2003), respectively. An interesting application of mechanism design to resolve conflict arising from land-acquisition policies in a developing economy can be found in Ghatak and Mookherjee (2011).

2. Olson and Zeckhauser (1966). For a comprehensive review of the literature see Sandler and Hartley (2001). Gupta (2010) also provides a broad review.

3. For surveys on bargaining theory and mechanism design, see Muthoo (2004) and Sjostrom and Maskin (2002), respectively. Their use in conflict economics: see, e.g., Hirschlifer (1985); Fearon (1995); Skaperdas (2006); Jackson and Morelli (2007). In environmental and natural resource literatures: see, e.g., Chander and Tulkens (1992; 1994); Adams, Rausser, and Simon (1996). In the international relations field, there is a literature on of rational design of international institutions. A collection of influential work may be found in the special issue of *International Relations*, vol. 55, no. 4 (2001). In two papers Koremenos, Lipson, and Snidal (2001a; 2001b) introduce the theoretical underpinnings of the "rational design project" and then summarize the empirical findings of the project. Wendt (2001) addresses some of the gaps of the rational design project. Of particular interest is his view that making institutions is about the future and has an intrinsic normative element, so there is a need of knowledge about what values to pursue in designing institutions.

4. This despite Boulding's (1966) advocacy long ago for the incorporation of such techniques, or as he might have called it, the proper control of organizations using various mechanisms. A reading of pages 178-188 of Boulding's classic reveals that some of the proposals made in this article were anticipated, although not wholly elaborated, by him.

5. For a strategic model of bargaining with terrorists see, e.g., Lapan and Sandler (1988). For a contribution that deals with offering "safe havens" to terrorists, see, e.g., Lee (1988). Another interesting topic is the use of "cheap talk" in adversarial arms races, e.g., in Baliga and Sjostrom (2004).

6. Weber and Wiesmeth (1991, p. 196). It should be noted that Weber and Wiesmeth make no mention of the form and nature of this agency. Arce and Sandler (2001) analyze the use of "correlated signals" among alliance members but the details of the "signaling device" are not much discussed in the context of military alliances except to note that political entrepreneurship or leadership might let alliance members to coordinate their efforts.

7. Gupta (2010; 2012).

8. Gupta (2010) also proposes ground rules that would govern the neutral agency.

9. The way the stage 3 is described in the main text, country 4 gets to make a "free choice" regarding effort (conditional on receiving the transfer), but it makes no effort and chooses to receive the positive transfer instead (its weakly dominant strategy). One could also have said that country 4 gets a "vote" in stage 3 to accept the {zero effort, transfer} bundle versus the {effort, no transfer} bundle and would have chosen the former. As long as one keeps the rule that country 4 does not have a vote earlier, in stage 2, the model in the main text is okay because at stage 2, country 4 would have voted "no" to scuttle the proposal and return to the status quo (unilateralism), where it would get a higher utility.

10. The example does not demonstrate an additional scenario, namely that there might be an additional country whose utility might rise when the alliance moves from the unilateral to the efficient outcome (i.e., the unilateral outcome was "too bad" for this country), but the efficient outcome might be lower than its private security level, so it will need to be compensated at the efficient outcome to maintain zero effort level. Specifically, suppose there was another country, country 6 say, whose single-peaked utility function (with respect to effort) was such: The unilateral outcome lies far to the right of the peak, on the decreasing stretch of the function. This would give it low utility. Suppose the efficient effort level lies to the left of the peak on the increasing stretch, and at a point that gives higher utility compared to the earlier unilateral effort point. So this country has a positive gain if effort shifts from unilateral to efficient level. However, if the marginal cost = marginal benefit tangency condition for this country occurred on the rising stretch of the U-function, but to the right of the efficiency point (and there is no reason why this cannot happen), then even though this country benefits from a movement from unilateralism to efficiency, it still needs to be compensated at the efficient outcome to stop it from making effort! So, this country is different from countries 1, 2, and 3 who benefit from moving to the efficient outcome and pay for that. But country 6 benefits from the movement, yet also gets a transfer to sustain the efficient outcome.

11. Gupta (2010; 2012).

12. See Gupta (2012).

13. As in Gupta (2010).

14. One might wonder why alliance member would tolerate the existence of the neutral agency in the working of the alliance. In my view, since members would stand to gain by its establishment, the agency can be established at an opportune time and institutionalized and, once institutionalized, would be hard to dislodge.

15. Vicary and Sandler (2002).

16. Gupta (2010, especially pp. 190-192).

17. See, e.g., Neumann's (1991) work on personnel independence in central banks.

18. Thaler and Sunstein (2008).

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