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BURDEN SHARING AND PUBLIC GOOD PROVISION: A NUMERICAL SENSITIVITY ANALYSIS

by

Gordon C. Rausser and Leo K. Simon

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BURDEN SHARING AND PUBLIC GOOD PROVISION:

A NUMERICAL SENSITIVITY ANALYSIS.*

by

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Section I. Introduction.

This paper reports on our numerical analysis of the model developed in Rausser-Simon (1991a) and (1991b). We will assume the reader is thoroughly familiar with the latter paper and refer frequently to the terminology introduced there. Two conclusions were readily apparent from that paper. First, many of the more interesting comparative statics questions we want to ask about the model are unlikely to have simple and determinate answers. In particular, it is especially difficult to determine the impact on alliance performance of certain kinds of changes in the spatial configuration and distribution of power within the alliance. The reason is that the fortunes of different alliance members are intertwined in highly intricate ways. Distributional changes set off a chain of conflicting effects that are extremely difficult to disentangle. A second observation is that even when determinate comparative statics results can be obtained, it may be imprudent to assign much significance to them. The method of comparative statics involves infinitesimal changes in parameters, but the effects of such changes may be quite different from the effects of even very small, finite changes. Of course, this comment applies generally to all comparative statics, but the problem is exacerbated in our case by the highly discontinuous nature of our model. Whenever a change in some parameter leads some player in some round of the negotiations to choose a different coalition, there will generally be a discontinuity in each player's payoff function. Moreover, coalition choice is *intrinsic* to the problem at hand: in our view, any model that denies participants the opportunity to consider alternative coalitions cannot be considered a genuine model of multilateral bargaining. We conclude that these discontinuities are an unavoidable aspect of the problem at hand and cannot be assumed away.

To balance these rather pessimistic remarks, we reemphasize that our model does provide an unusual opportunity to address a wide variety of politico-economic issues that appear to have received relatively little *formal* analysis to date. Some of these issues are more interesting than others, and some are much more likely to yield sharp answers than others. As usual, it seems that the more interesting the question, the less likely it is to have a determinate answer. It seems prudent, therefore, to filter the universe of possible issues through some intellectually economical prescreening process, in order to determine a "short-list" of promising directions in which to devote serious effort. Accordingly, we have chosen to conduct an exhaustive and systematic numerical sensitivity analysis of the model, The goal of this analysis is to identify the most interesting questions from among the subgroup that offers some promise of yielding a determinate answer.

Our numerical sensitivity exercises can be classified into two groups. We begin by analyzing the external context in which the alliance operates. What are the rules of the negotiating process? Which variables are negotiable and which are not? What is the set of admissible coalitions? What is the distribution of power between the alliance and the center? What happens when the parameters of the production technology are changed? The second group of questions concern the internal structure of the alliance. We fix the preferences of alliance members, and vary the configuration of power. Power in our model has three facets: *access, risk aversion* and *influence.* We will consider two of these facets separately, varying the power of both individuals and factions, noting in particular the effect of changing the balance of power between more- and less communally-oriented members.

We also consider the effect of changes in members' preferences. In our model, this involves changing the *spatial configuration* of the alliance. Unfortunately, our computational algorithm found these changes particularly difficult to deal with, so that we have insufficient data to report. However, for completeness, we will describe the tests that we attempted to perform. We varied the extent to which members' locations are concentrated, and the degree to which they were polarized, considering locations distributed symmetrically about the mean and skewed distributions. Finally, we considered the extent to which the members of the alliance are willing to take a unified stand in support of one particular location. Specifically, we began with a spatial configuration that gave rise to a nonempty core, then increasingly perturbed preferences so that the core became "more and more empty."

Section II. Methodology.

We partition the parameter set of the model into three subsets, called *target parameters, variable parameters* and *fixed parameters.* Each *exercise* involves running the model twenty pairs of times. We begin by setting values for the fixed parameters that will be held constant throughout the exercise. We then randomly generate values for each of the variable parameters. Finally, we choose values for the target parameters. When these parameters are continuous variables, we choose them randomly. Some of the target variables are discrete, however--for example, we vary the minimal size of an admissible coalition--and in this case, values are chosen deterministically. We solve the model with the parameter set we have just constructed, perturb each of the target parameters by a small (deterministic) amount in a specified direction and solve the model again. We observe the qualitative changes in the key endogenous variables, in particular, the value of π, the location of y, the *aggregate* alliance payoff and the payoff to the center. We then repeat the above process nineteen more times, holding constant the fixed parameters but regenerating the variable parameters and, when appropriate, the target parameters.

In most of the exercises, we restrict the basic structure of the model in two ways. First, we almost always assume that the shares of the policy burden are nonnegotiable. This restriction is imposed primarily for computational reasons. When shares are negotiable, the policy vector has five more components than when they are not, and the nonlinear programming problems that we have to solve are much more computationally intensive. We consider this a serious limitation of the present study, which should be addressed when more resources are available. Second, we frequently restrict alliance members' locations to lie on the horizontal axis. This restriction is imposed on the grounds of parsimony. Most of our questions can be asked equally well, whether alliance members are located in one- or two-dimensional space. We believe that is best to answer them as best we can in the simpler setting, before complicating matters by adding an additional dimension.

Usually, our exercises consist of four different *scenarios*. These scenarios will be labelled *B-NP*, *B-P*, *RS-NP* and *RS-P*. The political wing of the government is excluded from negotiations in the "*-NP*" scenarios, and included in the *-P* scenarios. Of course, there are some exercises that are meaningful only when the political wing is included; in these instances, we consider only the two "*-P*" scenarios. The second source of difference between scenarios is a variation in the basic spatial configuration of the model. The mnemonic "*B*-" denotes "balanced", while "*RS*-" denotes "right-skewed." In the "*B*-" scenarios, we impose the restriction that the mean location coincides with the core location. Specifically, we fix alliance member #3's location at the origin, locate players #1 and #2 to the left of the origin, and #4 and #5 to the right of the origin. In the "*RS*-" scenarios, we impose the restriction that three players are located well to the right of the origin, and the other two are two the left. In this case, the core differs from the mean location. Since the alliance acting in isolation would negotiate to the core, while the benevolent wing of the government would choose the mean, the range of conflict between the benevolent wing and the alliance is greater in the second variation than the first.

Each of our continuous parameters is drawn from a uniform distribution on an appropriately specified interval. These intervals are specified in Table I below. The list includes two sets of values for the vector, α, of locations for the alliance members. The first set is for the "balanced" spatial configuration, in which the mean and the core coincide. The second set is for the "right-skewed" configuration, in which the core lies to the right of the mean. In each case, player #1's location is determined by the condition that given the other alliance members' locations, the mean location must be zero. Recall that the variable β_0 is also determined endogenously, by the condition that when there neither spatial nor sectoral inefficiencies, the inferior investment is exactly as productive as the superior investment.

Table I.
The Continuous Parameter Set: Bounds on the Variables.

Variable	Lower Bound	Upper Bound
Location Parameters - balanced spatial configuration:		
α_2	-0.5	0.0
α_3	0.0	0.0
α_4	0.0	0.5
α_5	0.5	1.0
Location Parameters - right-skewed spatial configuration:		
α_2	-0.5	0.0
α_3	0.5	0.7
α_4	0.7	0.9
α_5	0.9	1.0
Other Continuous Parameters:		
α_5	0.9	1.0
β_1	0.1	2.0
θ	0.0	1.0
γ	80.0	120.0
rtrn	80.0	120.0
$(w_i)_{i=1}^5$	0.8	1.2
$(w_i)_{i=6}^7$	4.0	6.0
$(\rho_i)_{i=1}^6$	0.1	0.9
$(\psi_i)_{i=1}^5$	0.0	4.0

Note that certain parameters are irrelevant for certain scenarios. Specifically, the variables of w_7, ρ_7 and the vector ψ of influence coefficients play a role only in the "$-P$" scenarios of the model.

Our exercises provide a great deal of numerical information about the comparative statics properties of the model. If we observe the same qualitative change in a target parameter for each of the twenty pairs of runs, then we can be fairly confident that there is a corresponding, determinate analytical comparative statics result. This result will, of course, be of more limited generality, the larger the set of fixed, as opposed to variable parameters. For this reason, we begin by varying all of the parameters. We planned to fix more and more parameters until we obtained determinate results, but found that the experiments were much more labor- and computation-intensive than we expected.

Of course, these numerical results are no substitute for mathematical analysis. We believe, however, that they have several very useful research purposes. First, they serve as a "filter," indicating fruitful directions in which to pursue a mathematical investigation. Second, they are an invaluable source of concrete examples, which sharpen our intuition, and provide insights into the workings of the model. Finally, they provide a means of verifying or refuting our mathematical calculations.

Section III. The External Context of the Alliance.

In this section we describe six different exercises, numbered from III(a) to III(h). In each exercise, the internal structure of the alliance is held constant while some "system parameter" is varied. Summary statistics from each exercise are displayed in tables at the end of this section. In exercise III(a), we allow the shares of the policy burden to be negotiable, and consider the effect of allowing these shares to vary over a wider interval. Exercises III(b) and III(c) change the relative power of the alliance and the benevolent wing of the government, i.e., player #6: in III(b) we increase player #6's access probability, and in III(c) we reduce the degree to which she is risk averse. Exercises III(d) and III(e) vary the role of the political wing of the government, i.e., player #7: III(d) considers the effect of including player #7 as an essential player but with an access probability of zero; in III(e), player #7's access probability is varied. In exercise III(f), we vary the minimum number of alliance members in an admissible coalition. This number is usually set to three, but in this exercise, we consider the effect of increasing it to four. In exercise III(g), we vary θ, the sectoral inefficiency factor. Exercise III(h) changes β_1, the spatial inefficiency factor.

The results of each exercise are summarized in table form. The tables are collected together at the end of the section. We will now briefly explain the tables, using Table III(b) below as an example. The first column of the table indicates the scenario being considered, using the mnemonics listed above. For example *B–NP* is the scenario with no political wing and a balanced spatial configuration. The second column lists the endogenous variables. The third column indicates the number of increases in the each endogenous variables when the target variables are perturbed. The fourth column indicates the number of decreases. Since a variable may be unaffected by a change in the target variables, the percentages reported need not sum to 100%. (Typically, variables remain unchanged only if they are initially at a boundary value.)

Before discussing the individual exercises, we review briefly the interpretation of each of the endogenous variables. The variable π is the fraction of the policy bounty that is invested in the inferior investment project. Each alliance members prefers π to be as large as possible, while the benevolent wing and the economy as a whole benefits more from lower π values. The variable $|y_1|$ is the absolute value of the horizontal coordinate of the location vector that defines the project. Since we restrict locations to the horizontal axis in all of these tests, the vertical component of y will always be zero. Since the socially optimal location is the origin, the magnitude of $|y_1|$ is an (inverse) measure of the social efficiency of the outcome. In the "right-skewed (RS–)" scenarios, the size of $|y_1|$ is in addition a measure of the bargaining power of the alliance relative to the benevolent wing. Specifically, the core in these scenarios is always a strictly positive number, while the benevolent wing's preferred location is always the mean of the alliance members' locations. By construction, the mean is always zero. Thus a decrease in the absolute value of y_1 reflects a shift away from the alliance members' collectively preferred outcome towards the outcome preferred by the benevolent wing. It is important to emphasize that in the "balanced (B–)" scenarios the magnitude of $|y_1|$ cannot be interpreted in this way: since the core and the mean locations are both zero, the solution value of y_1 must also be zero, regardless of the relative strengths of the negotiators. In these scenarios, the magnitude of $|y_1|$ is no more than a measure of the rate at which the outcomes of the T-period games are converging. For i running from 1 to 5, Eu_i is the utility that the solution vector yields to member i of the alliance. The variable $\sum_{i=1}^{5} Eu_i$ is aggregate alliance utility. This variable, together with π, provides us with a measure of alliance performance. Eu_6 is the utility that the solution vector yields to the benevolent wing of the government. It is also a measure of the performance of the system as a whole.

Exercise III(a). Increasing the extent to which shares are negotiable.

Our initial condition for this exercise was that each alliance member's share of the policy burden was drawn from the interval $[0.19, 0.21]$. We then weakened this restriction by widening the permissible interval to [0.18, 0.22]. Intuitively, it is clear what the effect should be. Alliance members will tend to pursue selfish interests at the expense of communal or factional interests. The change in admissible shares increases the scope for pursuing selfish interests. The effect of this change should be to increase an alliance member's utility, whenever she is chosen to be a proposer, and to reduce her utility whenever she is omitted from a coalition. Though each player should do better if she is selected to be a proposer, they do worse when they are not. Moreover, widening the admissible share interval increases the benevolent wing's opportunity to "play off" alliance members against each other, offering smaller burdens to the members she invites to join her coalition, in exchange for a lower π value. Clearly, we would expect that the net effect will be to degrade the performance of the alliance and enhance the performance of the benevolent wing.

Unfortunately, this exercise proved too difficult for our computational algorithm to handle. Because the algorithm almost always failed to converge, we obtained so few data points for this exercise that we were unable to draw any conclusions. A probable explanation for these computational difficulties is that players' payoffs depended linearly in their shares. We intend to reconsider this problem using alternative nonlinear specifications.

Exercise III(b): Increasing the benevolent wing's access probability, w_6.

Exercise III(c): Reducing the benevolent wing's risk aversion coefficient, ρ_6.

These exercises are closely related and relatively simple to analyze. First consider the effect of increasing player #6's access probability. In the final round of negotiations, greater weight is placed on the proposal that yields her the highest payoff, so her expected utility is higher. In the penultimate round, then, there will be two reinforcing effects. Once again, her favored proposal will be weighted more heavily. In addition, however, her "reservation utility" will be higher: since she does better in the final round, she will be willing to accept a smaller set of proposals in the penultimate round. Since she is an essential player, each of the alliance members must make additional concessions to her, in order to secure her agreement.

Applying this argument repeatedly, we conclude that the benevolent wing's payoff in the solution to the model should be an increasing function of her access probability. As a corollary, we would expect that as her access probability increases, the fraction, π, invested in the inferior project will decrease and an the location of the public good, y, will move closer to her preferred location, which by construction is zero. Very similar arguments apply when player #6 becomes less risk averse. In the penultimate and earlier round, she will be less unwilling than before to accept the gamble of rejecting the current proposal and entering the next round. Once again, alliance members will need to make greater concessions to her, in order to secure her agreement.

The results of the exercises are summarized in Tables III(b) and (c). The data provide strong support for some but not all of the above conjectures. As either w_6 rises or ρ_6 falls, π falls, the payoff to the benevolent wing increases and the aggregate alliance utility falls. The behavior of $|y_1|$ if less easy to explain. As we mentioned above, the statistics have little significance in the "$B-$" scenarios. In the "$RS-$" scenarios, however, we expected that the changes in w_6 and ρ_6 would reduce the level of $|y_1|$. This was the case 80% of the time when the political wing was excluded from negotiations, and only 45% when it was included. At this point, we have no explanation for this result, but plan to explore the issue at a future date.

Exercise III(d): Including the Political Wing Without Access.

Exercise III(e): Increasing the Political Wing's Access Probability, w_7.

In each of these exercises, we need consider only two of the four scenarios. In Exercise III(d), we started out with no politicians (hence the "$-NP$" mnemonic) and added them but with an access probability of zero. In Exercise III(e), the politicians were initially present and we increased their access. Since the political wing's utility is an increasing function of the alliance members' utilities, the principal effect of adding the political wing with no access is to make the benevolent wing more responsive to alliance members' preferences. We expected that including the government would increase the utilities of alliance members, reduce the utility of the benevolent wing, increase π and, in the "$RS-$" scenario, reduce $|y_1|$. When the political wing is already included, and its access probability is increased, the politicians' participation constraint will tighten more rapidly and the effects predicted for exercise (d) should be amplified.

Summary statistics are presented in Tables III(d) and III(e). Once again, the experimental data supports all of these conclusions except the one about $|y_1|$. Observe that in the "$B-$" scenarios, $|y_1|$ is closer to zero almost 100% of the time. This simply reflects the fact that in these scenarios, the government also prefers a zero location for y_1, and so acts as an additional impetus towards convergence.

Exercise III(f). Increasing the minimal number of alliance members in an admissible coalition.

Our initial assumption is that at least three alliance members are required to form an admissible coalition. In this exercise, we consider the effect of increasing this number to four. Note that this change dramatically increases the size of the core of the game. Originally, the core is the set $\{(\pi, y): \pi \in [0, 1], y_1 = \alpha_3\}$. That is in any core policy vector, the location of y coincides with player #3's location. When the minimal coalition size is increased to four, the core becomes $\{(\pi, y): \pi \in [0, 1], y_1 \in [\alpha_2, \alpha_4]\}$. A priori, then, the increase in coalition size appears to increase the indeterminacy of the problem. For this reason and others, we had no prior expectation about the outcome of this exercise. Surprisingly, The experimental results reported in Table III(f) are quite unequivocal. In all four scenarios, the increase in coalition size results virtually 100% of the time in an increase in π, an increase in alliance utility and a decrease in the benevolent wing's utility.

With hindsight, there is a very plausible explanation for these results. When a broader base of support is required in order to reach agreement, proposers must shift emphasis away from factional objectives towards communal objectives. For example, player #6 cannot "buy off" either the right or the left wing of the alliance by proposing a location either to the right or the left of the mean, because support is required from both wings of the alliance. The only way she can build broad support for her proposals is is to compromise on the one variable, π, that all alliance members value. Similarly, the alliance members themselves must focus more on consensus in order to build support for their proposals.

The increase in coalition size had a fairly clear distributional effect, especially in the "right-skewed (*RS*–)" scenarios. The effect was particularly striking in the right-skewed scenario without the political wing (*RS–NP*). In this scenario, the value of $|y_1|$ fell 100% of the time. At least 75% of the time, the utilities of the extreme right wing of the alliance (players #4 and #5) fell, indicating that the negative effect of the shift in location offset the positive effect of the increase in π. Again, the explanation is obvious with the benefit of hindsight. When only three members were needed for agreement, the right wing of the alliance formed a decisive voting bloc; once an additional member was required, compromises had to be made with the left-wing, resulting in a more centrist solution to the problem.

Exercise III(g). Reducing sectoral inefficiency by raising θ.

Recall that when the inferior investment is located at the mean of alliance members' locations, its productivity is θ times the productivity of the superior investment option. Thus, the higher is θ, the lower is the social cost of increasing π, i.e., committing more resources to the inferior investment option. Thus, an increase in θ results in an *decrease* in player #6's marginal rate of substitution of location for π. For example, if y is located very close to #6's optimal location (zero) then as θ approaches one, the loss in utility to #6 from increasing π approaches zero. That is, #6's marginal rate of substitution of π for y, evaluated at y close the zero, approaches zero as θ approaches one. For each alliance member, on the other hand, the tradeoff between location and π is independent of θ. Summarizing, an increase in π decreases #6's marginal rate of substitution, leaving other players' rates unchanged. From these observations, we expected that when θ was increased, each player would propose a higher value of π, and a location of y closer to zero. We expected that the ultimate solution to the model would exhibit the same qualitative properties.

Summary statistics are presented in Table III(g). Our predictions were usually borne out in the right-skewed scenarios, but not in the balanced scenarios. In the $B-P$ scenario, for example, we observed equal numbers of increases and decreases in π. The explanation turns out to be that in the final rounds of some of the runs with this scenario, the participation constraints for several players were binding. When θ was increased, the balance of power between these players shifted, and the effect of this shift dominated the effect described above. The two "right-skewed" scenarios conformed more closely with our intuition. In most cases, π increases and the location moved closer to the mean, reflecting the fact that for player #6, location becomes relatively more significant than π when θ is increased. Increasing θ resulted in an increase in the utility of all players. This is to be expected, since an increase in θ reduces systemic inefficiency.

Exercise III(h). Reducing spatial inefficiency by decreasing β_1.

Recall that the return to alliance member i declines at a rate β_1 as the distance between i's location and the location of y increases. Thus, the effect of a decrease in β_1 is to flatten the marginal rate of substitution of location for π, *both* for the benevolent wing and for the alliance. If the flattening effect is more significant for alliance members than for the benevolent wing, there should be a net increase in the willingness of alliance members to compromise on location relative to π. In this case, π should rise and, if the core diverges from the socially optimal location for y, the solution value for y should shift towards the mean. The reverse effect should occur if the decrease in β_1 affects the benevolent wing more than the alliance: π should fall and the solution value for y should shift toward the core. An additional complicating factor is that a change in β_1 results in a compensating change in β_0, and it is difficult to separate out the effects of the two changes. Given this degree of indeterminacy, then, our prior prediction was that the experimental data would be highly inconclusive.

Summary statistics are presented in Table III(h). The data on the aggregate statistics--π, $|y_1|$, aggregate alliance utility and the benevolent wing's utility--were inconclusive, as predicted. There were, however, some very sharp distributional effects that we cannot explain at this point. In the two balanced scenarios, the decrease in β_1 favored the median member (#3) and harmed the two extreme alliance members. For example, there are marked distributional effects in the and harming the extreme members of the alliance. Presumably, the decreases in the utilities for players #1 and #5 can be explained by the fall in β_0, but the 100% increase in player #3's utility is hard to explain. Another very striking result is the consistent shift to the right of y_1 in the *RS–NP* scenario. There is a possible explanation for this shift in 70% of the runs: since π decreases as y_1 shifts, it appears that the benevolent wing was prepared to compromise on location in order to obtain a lower π level. In the remaining 30% of the runs, however, the benevolent wing did worse on both dimensions. That is, in these runs, the right-wing of the alliance succeeded in negotiating a higher π level in addition to a preferable location. The only explanation that we can suggest to explain this unambiguous shift in the balance of power is that with the decrease in β_1, the divergence of interest within the alliance was reduced, and the more cohesive alliance was better able to negotiate with the benevolent wing.

Table III(b)
Increasing the benevolent wing's access probability, w_6.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	0%	100%
	$\lvert y_1 \rvert$	45%	55%
	$\sum_{i=1}^{5} Eu_i$	0%	100%
	Eu_6	100%	0%
	Eu_1	0%	100%
	Eu_2	0%	100%
	Eu_3	0%	100%
	Eu_4	0%	100%
	Eu_5	0%	100%
$B-P$	π	0%	100%
	$\lvert y_1 \rvert$	35%	65%
	$\sum_{i=1}^{5} Eu_i$	0%	100%
	Eu_6	100%	0%
	Eu_1	0%	100%
	Eu_2	0%	100%
	Eu_3	0%	100%
	Eu_4	0%	100%
	Eu_5	0%	100%
$RS-NP$	π	0%	100%
	$\lvert y_1 \rvert$	20%	80%
	$\sum_{i=1}^{5} Eu_i$	0%	100%
	Eu_6	100%	0%
	Eu_1	0%	100%
	Eu_2	0%	100%
	Eu_3	0%	100%
	Eu_4	0%	100%
	Eu_5	0%	100%
$RS-P$	π	0%	100%
	$\lvert y_1 \rvert$	55%	45%
	$\sum_{i=1}^{5} Eu_i$	0%	100%
	Eu_6	100%	0%
	Eu_1	0%	100%
	Eu_2	0%	100%
	Eu_3	0%	100%
	Eu_4	0%	100%
	Eu_5	0%	100%

Table III(c)
Reducing the benevolent wing's risk aversion coefficient ρ_6.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	0%	100%
	$\lvert y_1 \rvert$	50%	50%
	$\sum_{i=1}^{5} Eu_i$	0%	100%
	Eu_6	100%	0%
	Eu_1	0%	100%
	Eu_2	0%	100%
	Eu_3	0%	100%
	Eu_4	0%	100%
	Eu_5	0%	100%
$B-P$	π	0%	95%
	$\lvert y_1 \rvert$	55%	45%
	$\sum_{i=1}^{5} Eu_i$	5%	95%
	Eu_6	100%	0%
	Eu_1	0%	100%
	Eu_2	0%	100%
	Eu_3	5%	95%
	Eu_4	10%	90%
	Eu_5	10%	90%
$RS-NP$	π	0%	100%
	$\lvert y_1 \rvert$	55%	45%
	$\sum_{i=1}^{5} Eu_i$	0%	100%
	Eu_6	100%	0%
	Eu_1	0%	100%
	Eu_2	0%	100%
	Eu_3	0%	100%
	Eu_4	0%	100%
	Eu_5	0%	100%
$RS-P$	π	0%	95%
	$\lvert y_1 \rvert$	45%	55%
	$\sum_{i=1}^{5} Eu_i$	5%	95%
	Eu_6	100%	0%
	Eu_1	0%	100%
	Eu_2	5%	95%
	Eu_3	5%	95%
	Eu_4	5%	95%
	Eu_5	5%	95%

Table III(d)
Including the political wing but with no access

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
B–NP	π	100%	0%
	$\|y_1\|$	100%	0%
	$\sum_{i=1}^{5} Eu_i$	100%	0%
	Eu_6	0%	100%
	Eu_1	100%	0%
	Eu_2	100%	0%
	Eu_3	100%	0%
	Eu_4	100%	0%
	Eu_5	100%	0%
RS–NP	π	100%	0%
	$\|y_1\|$	45%	55%
	$\sum_{i=1}^{5} Eu_i$	100%	0%
	Eu_6	0%	100%
	Eu_1	100%	0%
	Eu_2	100%	0%
	Eu_3	100%	0%
	Eu_4	100%	0%
	Eu_5	100%	0%

Table III(e)
Increasing the political wing's access probability, w_7.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
B–P	π	100%	0%
	$\lvert y_1 \rvert$	95%	5%
	$\sum_{i=1}^{5} Eu_i$	100%	0%
	Eu_6	0%	100%
	Eu_1	100%	0%
	Eu_2	100%	0%
	Eu_3	100%	0%
	Eu_4	100%	0%
	Eu_5	100%	0%
RS–P	π	95%	5%
	$\lvert y_1 \rvert$	60%	40%
	$\sum_{i=1}^{5} Eu_i$	100%	0%
	Eu_6	0%	100%
	Eu_1	95%	5%
	Eu_2	95%	5%
	Eu_3	100%	0%
	Eu_4	100%	0%
	Eu_5	100%	0%

Table III(f)
Increasing the minimal size of an admissible coalition.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	100%	0%
	$\|y_1\|$	100%	0%
	$\sum_{i=1}^{5} Eu_i$	100%	0%
	Eu_6	0%	100%
	Eu_1	100%	0%
	Eu_2	100%	0%
	Eu_3	100%	0%
	Eu_4	95%	5%
	Eu_5	65%	35%
$B-P$	π	100%	0%
	$\|y_1\|$	50%	50%
	$\sum_{i=1}^{5} Eu_i$	95%	5%
	Eu_6	0%	100%
	Eu_1	100%	0%
	Eu_2	100%	0%
	Eu_3	100%	0%
	Eu_4	90%	10%
	Eu_5	65%	35%
$RS-NP$	π	100%	0%
	$\|y_1\|$	0%	100%
	$\sum_{i=1}^{5} Eu_i$	95%	5%
	Eu_6	0%	100%
	Eu_1	100%	0%
	Eu_2	100%	0%
	Eu_3	95%	5%
	Eu_4	25%	75%
	Eu_5	15%	85%
$RS-P$	π	95%	0%
	$\|y_1\|$	30%	70%
	$\sum_{i=1}^{5} Eu_i$	85%	15%
	Eu_6	0%	100%
	Eu_1	95%	5%
	Eu_2	90%	10%
	Eu_3	75%	25%
	Eu_4	45%	55%
	Eu_5	25%	75%

Table III(g)
Reducing sectoral inefficiency by increasing θ.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	45%	55%
	$\lvert y_1 \rvert$	30%	70%
	$\sum_{i=1}^{5} Eu_i$	100%	0%
	Eu_6	100%	0%
	Eu_1	100%	0%
	Eu_2	100%	0%
	Eu_3	100%	0%
	Eu_4	100%	0%
	Eu_5	100%	0%
$B-P$	π	55%	44%
	$\lvert y_1 \rvert$	11%	88%
	$\sum_{i=1}^{5} Eu_i$	100%	0%
	Eu_6	100%	0%
	Eu_1	100%	0%
	Eu_2	100%	0%
	Eu_3	100%	0%
	Eu_4	100%	0%
	Eu_5	100%	0%
$RS-NP$	π	92%	7%
	$\lvert y_1 \rvert$	7%	92%
	$\sum_{i=1}^{5} Eu_i$	100%	0%
	Eu_6	100%	0%
	Eu_1	100%	0%
	Eu_2	100%	0%
	Eu_3	100%	0%
	Eu_4	100%	0%
	Eu_5	100%	0%
$RS-P$	π	90%	10%
	$\lvert y_1 \rvert$	20%	80%
	$\sum_{i=1}^{5} Eu_i$	100%	0%
	Eu_6	100%	0%
	Eu_1	100%	0%
	Eu_2	100%	0%
	Eu_3	100%	0%
	Eu_4	100%	0%
	Eu_5	100%	0%

Table III(h)
Reducing spatial inefficiency by decreasing β_1.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	35%	65%
	$\lvert y_1 \rvert$	20%	80%
	$\sum_{i=1}^{5} Eu_i$	45%	55%
	Eu_6	65%	35%
	Eu_1	15%	85%
	Eu_2	90%	10%
	Eu_3	100%	0%
	Eu_4	80%	20%
	Eu_5	20%	80%
$B-P$	π	55%	45%
	$\lvert y_1 \rvert$	70%	30%
	$\sum_{i=1}^{5} Eu_i$	70%	30%
	Eu_6	35%	65%
	Eu_1	35%	65%
	Eu_2	90%	10%
	Eu_3	100%	0%
	Eu_4	90%	10%
	Eu_5	25%	75%
$RS-NP$	π	30%	70%
	$\lvert y_1 \rvert$	0%	100%
	$\sum_{i=1}^{5} Eu_i$	60%	40%
	Eu_6	50%	50%
	Eu_1	0%	100%
	Eu_2	90%	10%
	Eu_3	100%	0%
	Eu_4	100%	0%
	Eu_5	100%	0%
$RS-P$	π	60%	40%
	$\lvert y_1 \rvert$	40%	60%
	$\sum_{i=1}^{5} Eu_i$	65%	35%
	Eu_6	30%	70%
	Eu_1	0%	100%
	Eu_2	100%	0%
	Eu_3	85%	15%
	Eu_4	80%	20%
	Eu_5	75%	25%

Section IV. The Distribution of Power within the Alliance.

In this section, we consider the effects of changing the internal power structure within the alliance. Summary statistics from each exercise are displayed in a table at the end of this section. In the model described in RS2, bargaining power in our model has three facets: *access, risk aversion* and *influence*. We first consider the effect of changing agents' access, varying the probabilities both of individuals and factions, noting in particular the effect of changes in the balance of power between more- and less communally-oriented members. We then repeat the same set of exercises, except that we vary players' influence coefficients rather than their access probabilities. We did not experiment with variations in agents' risk aversion coefficients, because we assumed that the results would simply duplicate the results we obtained with access probabilities. In retrospect this decision was highly unfortunate. The results from the access exercises were sufficiently surprising that an independent set of data points would have been extremely valuable as a source of confirmation.

Exercises IV.w1-IV.w5: Increasing the access probability of one alliance member.

In the first series of exercises, we increase each alliance member's access probability by 0.1, and reduce each of the remaining members' probabilities by 0.025. Since aggregate access probability for the alliance remains constant, we are indeed considering a purely internal distributional change. As before, we consider four different scenarios. The exercise in which we increase alliance member *i*'s access probability is referred to as exercise IV.wi.

We had very strong prior expectations about the outcome of these exercises. We expected that starting from an even distribution of power among alliance members, a concentration of power in favor of one member or faction would enhance the performance of the alliance and degrade the performance of the benevolent wing. Moreover, we expected that if the shift favored more moderate members of the alliance (such as player #3), this effect would be more significant than if more extreme members (such as players #1 and #5) were favored.

These intuitions are explained in our discussion of communal versus personal objectives in RS2. In the terminology developed in that paper, the more extreme is a member of the alliance (that is, the further away she is located from the mean) the less group-oriented she is. We expected that a transfer in access (which can be viewed as a transfer in political power) away from group-oriented members towards a personally oriented members should degrade the performance of the alliance as a whole.

Summaries results for these exercises are presented in Tables IV.w1-IV.w5. In contrast to the exercises reported in the previous section, none of the exercises reported in this section yield unequivocal comparative statics results. As before, we repeated each pair of run at least twenty times, and on no occasion did a variable move in the same direction in each of the repetitions. From an analytical perspective, however, this indeterminacy turns out to be quite convenient. We can interpret the observed percentage of increases in an endogenous variable when an exogenous variable changes as a measure of the direction and strength of the relationship between the two variables. When an increase in variable x results in an increase in another variable y significantly more (less) than 50% of the time, we will (tentatively) conclude that $\frac{\partial y}{\partial x}$ is positive.

The data exhibits a weak but distinct trend, in the diametrically opposite direction from the one that we predicted. Except for the "$RS-P$" scenario, which does not fit into the pattern, the alliance performs significantly better when access is shifted towards the extreme players. Moving from Exercise IV.w1 to IV.w5 in each of the first three scenarios, we observe a dip in the the number of increases in π dips, followed by an increase; the aggregate alliance utility follows the same pattern; the utility level of the benevolent wing moves in the opposite direction. To highlight this trend, we have collected the relevant entries from Tables IV.w1-IV.w5 in Table IV(a) below: columns three through seven reproduce portions of the third columns of the original Tables.

Table IV(a)
Increasing One Alliance Member's Access Probability
Percentage of Increases in Alliance Performance Measures.

Scenario	Endogenous Variable	Exercise IV.w1	Exercise IV.w2	Exercise IV.w3	Exercise IV.w4	Exercise IV.w5
$B-NP$	π	70%	20%	30%	35%	60%
	$\sum_{i=1}^{5} Eu_i$	65%	20%	30%	35%	60%
	Eu_6	30%	80%	70%	65%	60%
$B-P$	π	80%	40%	45%	40%	60%
	$\sum_{i=1}^{5} Eu_i$	70%	30%	45%	25%	65%
	Eu_6	20%	60%	55%	65%	35%
$RS-NP$	π	60%	30%	30%	60%	75%
	$\sum_{i=1}^{5} Eu_i$	60%	30%	30%	60%	75%
	Eu_6	40%	70%	65%	40%	25%

This data strongly suggests that a shift in power in favor of an extreme member of the alliance tends to improve the performance of the alliance as a whole, while a shift in favor of one of the moderate members, tends to detract from alliance performance. We are quite unable to explain this phenomenon, and view it as an important issue for future research.

A second noteworthy aspect of this series of experiments relates to the distribution of benefits within the alliance. First note the surprising difference between the "$-P$" scenarios and the "$-NP$" scenarios. The data suggests that when the politicians are excluded from the negotiations (the "$-NP$" scenarios), the shifts in access power affects all players in roughly the same way: the percentage of increases in each alliance member's utility is virtually identical. The relevant statistics for these scenarios are collected in Table IV(b) below.

Table IV(b)
Distribution of Benefits among Alliance Members: the "–*NP*" Scenarios
Percentage of Increases in Alliance Performance Measures.

Scenario	Endogenous Variable	Exercise IV.w1	Exercise IV.w2	Exercise IV.w3	Exercise IV.w4	Exercise IV.w5
B–NP	Eu_1	70%	20%	30%	35%	60%
	Eu_2	70%	20%	30%	35%	60%
	Eu_3	70%	20%	30%	35%	60%
	Eu_4	70%	20%	30%	35%	60%
	Eu_5	65%	15%	30%	35%	60%
RS–NP	Eu_1	60%	30%	30%	60%	80%
	Eu_2	60%	30%	30%	60%	75%
	Eu_3	60%	30%	35%	60%	75%
	Eu_4	60%	30%	35%	60%	75%
	Eu_5	60%	30%	35%	60%	75%

On the other hand, when the politicians are included in the negotiations (the "–*P*" scenarios), the changes in access probabilities affect players' utilities in different ways. An increase in the access probability of any left-wing alliance member benefits each of the left-wingers more it benefits any of the right-wingers; conversely, an increase in access for any left-winger benefits each of them more it benefits the right-wingers. This pattern is quite predictable. However, we are unable to explain why there is such a marked pattern in the "–*P*" scenarios, and virtually no differentials at all in the "–*NP*" scenarios. Table IV(c) collects the relevant statistics for the "–*P*" scenarios.

Our final comment about this series of Exercises concerns the asymmetry of the data from the balanced scenarios. From Table I, it will be apparent that the locations of players #2 and #4 are distributed symmetrically about player #3's location at zero. Player #5's location is determined randomly while #1's location is defined by the condition that the mean of alliance members' locations is required to be zero. We expected that this asymmetry between

Table IV(c)
Distribution of Benefits among Alliance Members: the "$-P$" Scenarios
Percentage of Increases in Alliance Performance Measures.

Scenario	Endogenous Variable	Exercise IV.w1	Exercise IV.w2	Exercise IV.w3	Exercise IV.w4	Exercise IV.w5
$B-P$	Eu_1	95%	45%	30%	5%	50%
	Eu_2	75%	45%	40%	20%	55%
	Eu_3	55%	40%	45%	35%	60%
	Eu_4	55%	15%	45%	40%	80%
	Eu_5	50%	15%	45%	50%	95%
$RS-P$	Eu_1	90%	50%	20%	10%	10%
	Eu_2	70%	50%	40%	35%	30%
	Eu_3	45%	25%	55%	70%	80%
	Eu_4	45%	25%	55%	70%	80%
	Eu_5	45%	25%	55%	75%	80%

the extreme players' locations would not be highly significant, but Table IV(a) suggests that this presumption may have been incorrect. The differences observed in this table are relatively slight, but sufficient to warrant further investigation of the sensitivity of our results to the precise method of choosing members' locations.

Exercises IV.w15-IV.w24: Increasing the access probability of two alliance members.

In these exercises, we increase two of the alliance members' access probabilities by 0.05, and reduce the remaining three members' probabilities by 0.0333. Thus, aggregate access for the alliance remains constant. In Exercise IV.w15, the transfer in access favors the two extreme members (#1 and #5), while in in Exercise IV.w24, it favors the the two "moderate" players, #2 and #4. We also include Exercise IV.w3 in this series of experiments also, since the #3's increase in access equals the aggregate increase in the two members' access in the other two experiments. The summary results are reported in Tables IV.w15 and IV.w24.

Comparing the "$B-P$" scenarios in these three exercises, we find further evidence of the trend observed above. When access is transferred to players #1 and #5, both π and aggregate alliance utility increases at least 75% of the time. When access is transferred to players #2 and #4, both these variables increase only 40% of the time. When access is transferred to player #3, the percentage of increases drops to 30%. A similar trend occurs in the three "$RS-NP$" scenarios. Table IV(d) below collects the relevant data for the three exercises. We include the "$B-P$" scenario, although in this scenario the trend is not quite monotone.

Table IV(d)
Increasing Two Alliance Members' Access Probabilities
Percentage of Increases in Alliance Performance Measures.

Scenario	Endogenous Variable	Exercise IV.w15	Exercise IV.w24	Exercise IV.w3
$B-NP$	π	80%	42%	30%
	$\sum_{i=1}^{5} Eu_i$	80%	42%	30%
	Eu_6	20%	52%	70%
$B-P$	π	75%	42%	45%
	$\sum_{i=1}^{5} Eu_i$	75%	42%	45%
	Eu_6	25%	52%	55%
$RS-NP$	π	57%	45%	30%
	$\sum_{i=1}^{5} Eu_i$	57%	45%	30%
	Eu_6	38%	55%	65%

Exercises IV.w12-IV.w45: Increasing the access probability of a faction.

This pair of exercises is similar to the preceding pair except that we increase the access of two player with similar rather than diverse interests. In Exercise IV.w15, the transfer in access favors the two "left-wing" members (#1 and #2), while in in Exercise IV.w24, it favors the the two "right-wing" members, #4 and #5. The summary results are reported in Tables IV.w12 and IV.w45 below. It is interesting to compare these exercises those in which we increase just one member's access. (For example, compare Exercise IV.w12 with Exercises IV.w1 and IV.w2.) These comparisons suggest that transferring access to an individual member has less impact than spreading the transfer between two individuals who belong to the same faction. For example, in Exercise IV.w45, π increases 90% of the time, while in Exercises IV.w4 and IV.w5, π increases, respectively, 35% and 60% of the time. A second interesting comparison is between the "*RS–NP*" scenarios in Exercises IV.w12 and IV.w45. When access is transferred to the minority left-wing, the performance of the alliance deteriorates; when access is transferred to the majority right-wing, alliance performance improves. This observation provides some evidence for our theoretical prediction in RS2 that a transfer of power from the minority to the majority would improve alliance performance.

Exercises IV.ψ1-IV.ψ5: Increasing the influence coefficient of one alliance member.

This series of exercises parallels the series IV.w1-IV.w5, described above, except that since influence is relevant only when the political wing is involved in negotiations, we consider only the "*–P*" scenarios. The results are reported in Tables IV.ψ1-IV.ψ5 below. The results of this series are extremely dull. Most of the variables increase about half of the time and decrease the remaining half.

Exercises IV.ψ15-IV.ψ24: Increasing the influence coefficient of two alliance members.

This series parallels the pair of exercises IV.w15-IV.w24, described above. The results are reported in Tables IV.ψ15-IV.ψ24 below. Again, the results are rather dull. There is, however, some evidence supporting our observation above concerning the distribution of access power between the moderate and the extreme members of the coalition. Table IV(e) below corresponds to our earlier three-way comparison in Table IV(d).

Table IV(e) Increasing Two Alliance Members' Influence Coefficients Percentage of Increases in Alliance Performance Measures.				
Scenario	Endogenous Variable	Exercise IV.ψ15	Exercise IV.ψ24	Exercise IV.ψ3
$B-P$	π $\sum_{i=1}^{5} Eu_i$ Eu_6	70% 40% 30%	25% 40% 75%	25% 55% 80%

Note that aggregate alliance utility does not decrease as it does in Table IV(d). This aggregate statistic is a little misleading, however. A comparison of the statistics on individual utility levels reveals that increasing the influence coefficients of the extreme players results in increases in four out of five of the alliance members' utilities at least 50% of the time; increasing the influence coefficients of the moderate players results in *decreases* in four out of five of the alliance members' utilities at least 50% of the time.

Exercises IV.ψ12-IV.ψ45: Increasing the influence coefficient of a faction.

This series parallels the pair of exercises IV.w12-IV.w45, described above. The results are reported in Tables IV.ψ12-IV.ψ45 below. Once again, the results are monumentally uninteresting. Note in particular the striking contrast between the "$RS-P$" scenarios of exercises IV.w45 and IV.ψ45. In the former case, the shift in power to the right wing of the alliance led to a increase in aggregate alliance utility 80% of the time. In the latter case, aggregate utility increases and decreases with equal frequency.

Table IV-w1
Increasing the access probability of player #1, w_1.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	70%	30%
	$\lvert y_1 \rvert$	60%	40%
	$\sum_{i=1}^{5} Eu_i$	65%	35%
	Eu_6	30%	70%
	Eu_1	70%	30%
	Eu_2	70%	30%
	Eu_3	70%	30%
	Eu_4	70%	30%
	Eu_5	65%	35%
$B-P$	π	80%	20%
	$\lvert y_1 \rvert$	60%	40%
	$\sum_{i=1}^{5} Eu_i$	70%	30%
	Eu_6	20%	80%
	Eu_1	95%	5%
	Eu_2	75%	25%
	Eu_3	55%	45%
	Eu_4	55%	45%
	Eu_5	50%	50%
$RS-NP$	π	60%	40%
	$\lvert y_1 \rvert$	40%	60%
	$\sum_{i=1}^{5} Eu_i$	60%	40%
	Eu_6	40%	60%
	Eu_1	60%	40%
	Eu_2	60%	40%
	Eu_3	60%	40%
	Eu_4	60%	40%
	Eu_5	60%	40%
$RS-P$	π	65%	30%
	$\lvert y_1 \rvert$	60%	40%
	$\sum_{i=1}^{5} Eu_i$	45%	55%
	Eu_6	30%	70%
	Eu_1	90%	10%
	Eu_2	70%	30%
	Eu_3	45%	55%
	Eu_4	45%	55%
	Eu_5	45%	55%

Table IV-$w2$
Increasing the access probability of player #2, w_2.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	20%	80%
	$\lvert y_1 \rvert$	65%	35%
	$\sum_{i=1}^{5} Eu_i$	20%	80%
	Eu_6	80%	20%
	Eu_1	20%	80%
	Eu_2	20%	80%
	Eu_3	20%	80%
	Eu_4	20%	80%
	Eu_5	15%	85%
$B-P$	π	40%	60%
	$\lvert y_1 \rvert$	55%	45%
	$\sum_{i=1}^{5} Eu_i$	30%	70%
	Eu_6	60%	40%
	Eu_1	45%	55%
	Eu_2	45%	55%
	Eu_3	40%	60%
	Eu_4	15%	85%
	Eu_5	15%	85%
$RS-NP$	π	30%	70%
	$\lvert y_1 \rvert$	30%	70%
	$\sum_{i=1}^{5} Eu_i$	30%	70%
	Eu_6	70%	30%
	Eu_1	30%	70%
	Eu_2	30%	70%
	Eu_3	30%	70%
	Eu_4	30%	70%
	Eu_5	30%	70%
$RS-P$	π	45%	50%
	$\lvert y_1 \rvert$	50%	50%
	$\sum_{i=1}^{5} Eu_i$	35%	65%
	Eu_6	55%	45%
	Eu_1	50%	50%
	Eu_2	50%	50%
	Eu_3	25%	75%
	Eu_4	25%	75%
	Eu_5	25%	75%

Table IV-w_3 Increasing the access probability of player #3, w_3.			
Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	30%	70%
	$\|y_1\|$	45%	55%
	$\sum_{i=1}^{5} Eu_i$	30%	70%
	Eu_6	70%	30%
	Eu_1	30%	70%
	Eu_2	30%	70%
	Eu_3	30%	70%
	Eu_4	30%	70%
	Eu_5	30%	70%
$B-P$	π	45%	55%
	$\|y_1\|$	10%	90%
	$\sum_{i=1}^{5} Eu_i$	45%	55%
	Eu_6	55%	45%
	Eu_1	30%	70%
	Eu_2	40%	60%
	Eu_3	45%	55%
	Eu_4	45%	55%
	Eu_5	40%	60%
$RS-NP$	π	30%	65%
	$\|y_1\|$	70%	30%
	$\sum_{i=1}^{5} Eu_i$	30%	70%
	Eu_6	65%	35%
	Eu_1	30%	70%
	Eu_2	30%	70%
	Eu_3	35%	65%
	Eu_4	35%	65%
	Eu_5	35%	65%
$RS-P$	π	40%	50%
	$\|y_1\|$	40%	60%
	$\sum_{i=1}^{5} Eu_i$	60%	40%
	Eu_6	65%	35%
	Eu_1	20%	80%
	Eu_2	40%	60%
	Eu_3	55%	45%
	Eu_4	55%	45%
	Eu_5	55%	45%

Table IV-w4
Increasing the access probability of player #4, w_4.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
B–NP	π	35%	65%
	$\lvert y_1 \rvert$	50%	50%
	$\sum_{i=1}^{5} Eu_i$	35%	65%
	Eu_6	65%	35%
	Eu_1	35%	65%
	Eu_2	35%	65%
	Eu_3	35%	65%
	Eu_4	35%	65%
	Eu_5	35%	65%
B–P	π	40%	60%
	$\lvert y_1 \rvert$	40%	60%
	$\sum_{i=1}^{5} Eu_i$	25%	75%
	Eu_6	65%	35%
	Eu_1	5%	95%
	Eu_2	20%	80%
	Eu_3	35%	65%
	Eu_4	40%	60%
	Eu_5	50%	50%
RS–NP	π	60%	40%
	$\lvert y_1 \rvert$	75%	25%
	$\sum_{i=1}^{5} Eu_i$	60%	40%
	Eu_6	40%	60%
	Eu_1	60%	40%
	Eu_2	60%	40%
	Eu_3	60%	40%
	Eu_4	60%	40%
	Eu_5	60%	40%
RS–P	π	40%	55%
	$\lvert y_1 \rvert$	50%	50%
	$\sum_{i=1}^{5} Eu_i$	55%	45%
	Eu_6	55%	45%
	Eu_1	10%	90%
	Eu_2	35%	65%
	Eu_3	70%	30%
	Eu_4	70%	30%
	Eu_5	75%	25%

Table IV-$w5$
Increasing the access probability of player #5, w_5.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	60%	40%
	$\lvert y_1 \rvert$	65%	35%
	$\sum_{i=1}^{5} Eu_i$	60%	40%
	Eu_6	40%	60%
	Eu_1	60%	40%
	Eu_2	60%	40%
	Eu_3	60%	40%
	Eu_4	60%	40%
	Eu_5	60%	40%
$B-P$	π	60%	40%
	$\lvert y_1 \rvert$	40%	60%
	$\sum_{i=1}^{5} Eu_i$	65%	35%
	Eu_6	35%	65%
	Eu_1	50%	50%
	Eu_2	55%	45%
	Eu_3	60%	40%
	Eu_4	80%	20%
	Eu_5	95%	5%
$RS-NP$	π	75%	25%
	$\lvert y_1 \rvert$	80%	20%
	$\sum_{i=1}^{5} Eu_i$	75%	25%
	Eu_6	25%	75%
	Eu_1	80%	20%
	Eu_2	75%	25%
	Eu_3	75%	25%
	Eu_4	75%	25%
	Eu_5	75%	25%
$RS-P$	π	35%	60%
	$\lvert y_1 \rvert$	45%	55%
	$\sum_{i=1}^{5} Eu_i$	65%	35%
	Eu_6	65%	35%
	Eu_1	10%	90%
	Eu_2	35%	65%
	Eu_3	80%	20%
	Eu_4	80%	20%
	Eu_5	80%	20%

Table IV-*w* 15
Increasing the access probabilities of players #1 and #5

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	80%	20%
	$\lvert y_1 \rvert$	85%	15%
	$\sum_{i=1}^{5} Eu_i$	80%	20%
	Eu_6	20%	80%
	Eu_1	80%	20%
	Eu_2	80%	20%
	Eu_3	80%	20%
	Eu_4	80%	20%
	Eu_5	80%	20%
$B-P$	π	75%	25%
	$\lvert y_1 \rvert$	90%	10%
	$\sum_{i=1}^{5} Eu_i$	75%	25%
	Eu_6	25%	75%
	Eu_1	80%	20%
	Eu_2	70%	30%
	Eu_3	75%	25%
	Eu_4	75%	25%
	Eu_5	75%	25%
$RS-NP$	π	57%	38%
	$\lvert y_1 \rvert$	33%	61%
	$\sum_{i=1}^{5} Eu_i$	57%	38%
	Eu_6	38%	57%
	Eu_1	57%	38%
	Eu_2	57%	38%
	Eu_3	57%	38%
	Eu_4	57%	38%
	Eu_5	57%	38%
$RS-P$	π	61%	33%
	$\lvert y_1 \rvert$	66%	28%
	$\sum_{i=1}^{5} Eu_i$	42%	52%
	Eu_6	33%	61%
	Eu_1	71%	23%
	Eu_2	57%	38%
	Eu_3	42%	52%
	Eu_4	42%	52%
	Eu_5	42%	52%

Table IV-w24 Increasing the addess probabilities of players #2 and #4			
Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
B–NP	π	42%	52%
	$\|y_1\|$	71%	23%
	$\sum_{i=1}^{5} Eu_i$	42%	52%
	Eu_6	52%	42%
	Eu_1	42%	52%
	Eu_2	42%	52%
	Eu_3	42%	52%
	Eu_4	42%	52%
	Eu_5	42%	52%
B–P	π	42%	52%
	$\|y_1\|$	47%	47%
	$\sum_{i=1}^{5} Eu_i$	42%	52%
	Eu_6	52%	42%
	Eu_1	33%	61%
	Eu_2	38%	57%
	Eu_3	42%	52%
	Eu_4	42%	52%
	Eu_5	38%	57%
RS–NP	π	45%	55%
	$\|y_1\|$	55%	45%
	$\sum_{i=1}^{5} Eu_i$	45%	55%
	Eu_6	55%	45%
	Eu_1	45%	55%
	Eu_2	45%	55%
	Eu_3	45%	55%
	Eu_4	45%	55%
	Eu_5	45%	55%
RS–P	π	40%	55%
	$\|y_1\|$	35%	65%
	$\sum_{i=1}^{5} Eu_i$	55%	45%
	Eu_6	70%	30%
	Eu_1	15%	85%
	Eu_2	40%	60%
	Eu_3	55%	45%
	Eu_4	55%	45%
	Eu_5	55%	45%

Table IV-*w* 12
Increasing the access probabilities of players #1 and #2

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	76%	19%
	$\lvert y_1 \rvert$	71%	23%
	$\sum_{i=1}^{5} Eu_i$	76%	19%
	Eu_6	19%	76%
	Eu_1	76%	19%
	Eu_2	76%	19%
	Eu_3	76%	19%
	Eu_4	76%	19%
	Eu_5	76%	19%
$B-P$	π	85%	9%
	$\lvert y_1 \rvert$	52%	42%
	$\sum_{i=1}^{5} Eu_i$	76%	19%
	Eu_6	9%	85%
	Eu_1	85%	9%
	Eu_2	80%	14%
	Eu_3	80%	14%
	Eu_4	66%	28%
	Eu_5	57%	38%
$RS-NP$	π	30%	70%
	$\lvert y_1 \rvert$	10%	90%
	$\sum_{i=1}^{5} Eu_i$	30%	70%
	Eu_6	70%	30%
	Eu_1	30%	70%
	Eu_2	30%	70%
	Eu_3	30%	70%
	Eu_4	30%	70%
	Eu_5	30%	70%
$RS-P$	π	61%	28%
	$\lvert y_1 \rvert$	52%	42%
	$\sum_{i=1}^{5} Eu_i$	47%	47%
	Eu_6	28%	66%
	Eu_1	90%	4%
	Eu_2	71%	23%
	Eu_3	38%	57%
	Eu_4	33%	61%
	Eu_5	33%	61%

Table IV-w45
Increasing the addess probabilities of players #4 and #5

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-NP$	π	90%	4%
	$\lvert y_1 \rvert$	61%	33%
	$\sum_{i=1}^{5} Eu_i$	90%	4%
	Eu_6	4%	90%
	Eu_1	90%	4%
	Eu_2	90%	4%
	Eu_3	90%	4%
	Eu_4	90%	4%
	Eu_5	90%	4%
$B-P$	π	71%	23%
	$\lvert y_1 \rvert$	38%	57%
	$\sum_{i=1}^{5} Eu_i$	80%	14%
	Eu_6	23%	71%
	Eu_1	42%	52%
	Eu_2	61%	33%
	Eu_3	90%	4%
	Eu_4	95%	0%
	Eu_5	95%	0%
$RS-NP$	π	71%	23%
	$\lvert y_1 \rvert$	38%	57%
	$\sum_{i=1}^{5} Eu_i$	80%	14%
	Eu_6	23%	71%
	Eu_1	42%	52%
	Eu_2	61%	33%
	Eu_3	90%	4%
	Eu_4	95%	0%
	Eu_5	95%	0%
$RS-P$	π	71%	19%
	$\lvert y_1 \rvert$	57%	38%
	$\sum_{i=1}^{5} Eu_i$	85%	9%
	Eu_6	14%	80%
	Eu_1	57%	38%
	Eu_2	90%	4%
	Eu_3	85%	9%
	Eu_4	85%	9%
	Eu_5	85%	9%

Table IV-ψ1
Increasing the risk aversion coefficient of player #1, ψ_1.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-P$	π	60%	40%
	$\lvert y_1 \rvert$	75%	25%
	$\sum_{i=1}^{5} Eu_i$	40%	60%
	Eu_6	20%	75%
	Eu_1	85%	15%
	Eu_2	75%	25%
	Eu_3	40%	60%
	Eu_4	30%	70%
	Eu_5	20%	80%
$RS-P$	π	50%	35%
	$\lvert y_1 \rvert$	55%	40%
	$\sum_{i=1}^{5} Eu_i$	40%	55%
	Eu_6	55%	40%
	Eu_1	85%	10%
	Eu_2	70%	25%
	Eu_3	25%	70%
	Eu_4	20%	75%
	Eu_5	20%	75%

Table IV-$\psi 2$
Increasing the risk aversion coefficient of player #2, ψ_2.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-P$	π	55%	45%
	$\lvert y_1 \rvert$	50%	50%
	$\sum_{i=1}^{5} Eu_i$	55%	45%
	Eu_6	50%	45%
	Eu_1	50%	50%
	Eu_2	65%	35%
	Eu_3	45%	55%
	Eu_4	45%	55%
	Eu_5	35%	65%
$RS-P$	π	50%	35%
	$\lvert y_1 \rvert$	20%	75%
	$\sum_{i=1}^{5} Eu_i$	60%	35%
	Eu_6	55%	40%
	Eu_1	45%	50%
	Eu_2	60%	35%
	Eu_3	55%	35%
	Eu_4	40%	45%
	Eu_5	40%	55%

Table IV-$\psi 3$
Increasing the risk aversion coefficient of player #3, ψ_3.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-P$	π	25%	75%
	$\lvert y_1 \rvert$	25%	75%
	$\sum_{i=1}^{5} Eu_i$	55%	45%
	Eu_6	80%	20%
	Eu_1	20%	80%
	Eu_2	25%	75%
	Eu_3	60%	40%
	Eu_4	50%	50%
	Eu_5	50%	50%
$RS-P$	π	45%	45%
	$\lvert y_1 \rvert$	30%	70%
	$\sum_{i=1}^{5} Eu_i$	70%	30%
	Eu_6	65%	30%
	Eu_1	45%	55%
	Eu_2	45%	55%
	Eu_3	60%	40%
	Eu_4	55%	45%
	Eu_5	50%	50%

Table IV-ψ4
Increasing the risk aversion coefficient of player #4, ψ_4.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
B–P	π	30%	65%
	$\|y_1\|$	45%	55%
	$\sum_{i=1}^{5} Eu_i$	45%	55%
	Eu_6	70%	25%
	Eu_1	25%	75%
	Eu_2	25%	75%
	Eu_3	30%	65%
	Eu_4	45%	55%
	Eu_5	50%	50%
RS–P	π	40%	50%
	$\|y_1\|$	35%	60%
	$\sum_{i=1}^{5} Eu_i$	45%	50%
	Eu_6	60%	30%
	Eu_1	35%	60%
	Eu_2	35%	55%
	Eu_3	55%	40%
	Eu_4	55%	40%
	Eu_5	55%	40%

Table IV-ψ5
Increasing the risk aversion coefficient of player #5, ψ_5.

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-P$	π	30%	50%
	$\lvert y_1 \rvert$	35%	50%
	$\sum_{i=1}^{5} Eu_i$	40%	40%
	Eu_6	55%	25%
	Eu_1	20%	60%
	Eu_2	15%	65%
	Eu_3	35%	45%
	Eu_4	55%	25%
	Eu_5	65%	15%
$RS-P$	π	45%	45%
	$\lvert y_1 \rvert$	45%	55%
	$\sum_{i=1}^{5} Eu_i$	60%	40%
	Eu_6	55%	45%
	Eu_1	15%	85%
	Eu_2	50%	50%
	Eu_3	75%	25%
	Eu_4	85%	15%
	Eu_5	80%	20%

Table IV-ψ15
Increasing the access probabilities of players #1 and #5

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-P$	π	70%	30%
	$\lvert y_1 \rvert$	60%	40%
	$\sum_{i=1}^{5} Eu_i$	40%	60%
	Eu_6	30%	70%
	Eu_1	50%	50%
	Eu_2	45%	55%
	Eu_3	65%	35%
	Eu_4	80%	20%
	Eu_5	65%	35%
$RS-P$	π	50%	45%
	$\lvert y_1 \rvert$	70%	30%
	$\sum_{i=1}^{5} Eu_i$	35%	65%
	Eu_6	45%	55%
	Eu_1	50%	50%
	Eu_2	40%	60%
	Eu_3	45%	55%
	Eu_4	55%	45%
	Eu_5	55%	45%

Table IV-ψ24
Increasing the access probabilities of players #2 and #4

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-P$	π	25%	75%
	$\lvert y_1 \rvert$	30%	70%
	$\sum_{i=1}^{5} Eu_i$	40%	60%
	Eu_6	75%	25%
	Eu_1	60%	40%
	Eu_2	50%	50%
	Eu_3	25%	75%
	Eu_4	30%	70%
	Eu_5	30%	70%
$RS-P$	π	35%	60%
	$\lvert y_1 \rvert$	40%	60%
	$\sum_{i=1}^{5} Eu_i$	40%	60%
	Eu_6	60%	40%
	Eu_1	30%	70%
	Eu_2	40%	60%
	Eu_3	45%	55%
	Eu_4	45%	55%
	Eu_5	50%	50%

Table IV-ψ12
Increasing the access probabilities of players #1 and #2

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
B–P	π	50%	50%
	$\|y_1\|$	50%	50%
	$\sum_{i=1}^{5} Eu_i$	55%	45%
	Eu_6	45%	55%
	Eu_1	75%	25%
	Eu_2	70%	30%
	Eu_3	45%	55%
	Eu_4	40%	60%
	Eu_5	30%	70%
RS–P	π	35%	60%
	$\|y_1\|$	40%	60%
	$\sum_{i=1}^{5} Eu_i$	45%	55%
	Eu_6	70%	30%
	Eu_1	70%	30%
	Eu_2	65%	35%
	Eu_3	35%	65%
	Eu_4	30%	70%
	Eu_5	30%	70%

Table IV-ψ45
Increasing the access probabilities of players #4 and #5

Scenario	Endogenous Variable	Percentage of Increases	Percentage of Decreases
$B-P$	π	40%	60%
	$\|y_1\|$	40%	60%
	$\sum_{i=1}^{5} Eu_i$	55%	45%
	Eu_6	70%	30%
	Eu_1	20%	80%
	Eu_2	35%	65%
	Eu_3	45%	55%
	Eu_4	50%	50%
	Eu_5	65%	35%
$RS-P$	π	55%	40%
	$\|y_1\|$	65%	35%
	$\sum_{i=1}^{5} Eu_i$	50%	50%
	Eu_6	30%	70%
	Eu_1	40%	60%
	Eu_2	45%	55%
	Eu_3	75%	25%
	Eu_4	75%	25%
	Eu_5	75%	25%

Section V. Concluding Remarks.

In this paper, the burden sharing of a subsidy reduction and the provision of a public good are analyzed through numerical sensitivity analysis. The variables being negotiated are: (1) the distribution of a tax burden among the alliance members; (2) the portion of total tax receipts that will be allotted to producing a public good that benefits the agricultural sector; and (3) the characteristics of this public good. In the negotiated determination of each of these three variables, we have paid particular attention tot he distribution of power between the agricultural alliance and the government. In the formal model, power assumed three different forms: access, risk aversion, and influence. These forms of power were considered separately, varying the power of both individuals and factions. Particular attention was paid to the effect of changing the balance of power between more and less communally-oriented members of an agricultural alliance.

In many instances, the numerical sensitivity analysis that was conducted conformed to a priori notions. However, there were a number of interesting results that failed to conform to expectations. These surprises showed the richness of the basic specification and also the need for further analysis. The first surprise was that the absolute value of y_1, our measure of the location of of the agricultural public good did not move as expected. We had expected that in the "right-skewed" scenarios, when the alliance did better, a shift in y_1 to the core, away from the mean, would occur. However, this did not happen with any frequency, even when there was ample evidence of the alliance being far better off.

Second, the size of the coalition had especially dramatic effects in improving the performance of the alliance. In particular, increasing the minimal coalition size from three to four improved dramatically the performance of the alliance members. Third, the role of the political wing of the government was startling. Simulation experiments that were conducted when influence was incorporated through the political wing differed significantly from all other basic results. The political power, through influence on the political wing cries for further analysis.

Another surprising result for those experiments conducted with the political wing was the deterioration in the performance of the benevolent wing of the government when the basic parameter, β_1, was shifted. The return to any alliance member declines at the rate of β_1 as the distance between that member's location and the location of the public good increases. Accordingly, the effect of a decrease in β_1 is to flatten the marginal rate of substitution of the location for the agricultural public good, both for the benevolent wing of the government and for the alliance.

The remaining surprises are especially interesting. The first involved that facet of political power associated with access. In particular, a number of experiments were conducted that compared concentrated access among members of the alliance versus diffuse access. Increasing access of two members versus increasing access of any one member by the same amount yield a market improvement for the alliance. Finally, and perhaps most surprisingly, we expected that a shift in power away from group-oriented members toward personally oriented members would degrade the performance of the agricultural alliance as a whole. This did not occur. In particular, the shift toward extremes benefited the alliance.

Surprising simulations reported in this paper call for further investigation of the following basic questions:

- What is the relationship between the distribution of bargaining power within the alliance and the performance of the alliance?
- How does alliance performance depend on the structure of the set of admissible coalitions?
- What is the effect on alliance performance of changing the configurations of alliance members' preferences over the characteristics of the public good?

- What happens if we change the extent to which alliance members have flexibility to negotiate over the distribution of the tax burden?
- How do the characteristics of the public good in the negotiated solution respond to changes in the distribution of political power, the structure of admissible coalitions, the configuration of alliance members' preferences, and the flexibility in negotiating burdens

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