

An Economic Theory of Alliances

Author(s): Mancur Olson, Jr. and Richard Zeckhauser

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AN ECONOMIC THEORY OF ALLIANCES*

Mancur Olson, Jr. and Richard Zeckhauser

I Introduction

THIS ARTICLE outlines a model that attempts to explain the workings of international organizations, and tests this model against the experience of some existing international institutions. Though the model is relevant to any international organization that independent nations establish to further their common interests, this article emphasizes the North Atlantic Treaty Organization, since it involves larger amounts of resources than any other international organization, yet illustrates the model most simply. The United Nations and the provision of foreign aid through the Development Assistance Committee are discussed more briefly.

There are some important respects in which many observers in the United States and in some other countries are disappointed in NATO and other ventures in international cooperation. For one thing, it is often argued that the United States and some of the other larger members are bearing a disproportionate share of the burden of the common defense of the NATO countries,¹

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Any views in this paper are those of the authors. They should not be interpreted as reflecting the views of the critics, the Center of International Studies at Princeton University, or of The RAND Corporation or the official opinion or policy of any of its governmental or private research sponsors.

Both authors are consultants to the Economics Department of The RAND Corporation. Mancur Olson is also Assistant Professor of Economics, and Faculty Associate of the Center of International Studies at Princeton University. Richard Zeckhauser is a Junior Fellow of the Society of Fellows of Harvard University.

¹ Hedley Bull, *Strategy and the Atlantic Alliance: A Critique of United States Doctrine* (Princeton: Center of International Studies, Princeton University, 1964), 42; Edward S. Mason, "The Equitable Sharing of Military and Economic Aid Burdens," *Proceedings of the Academy of Political Science*, XXVII (May 1963), 256-269, especially 264; John A. Pincus, *Sharing the Costs of Military Alliance and International Economic Aid* (Santa Monica, California: The RAND Corporation, RM-3249-ISA, 1962, and *Economic Aid and International Cost*

and it is at least true that the smaller members of NATO devote smaller percentages of their incomes to defense than do larger members.² There is also some concern about the fact that the NATO alliance has systematically failed to provide the number of divisions that the NATO nations themselves have proclaimed (rightly or wrongly) are necessary or optimal.³ Similarly, many nations, especially smaller nations, have failed to fulfill their quotas for U.N. contributions with the result that the United States contribution rises to a degree that threatens the independence of the organization. The meager level of total support for the U.N. and the mean and haphazard state of its finances are also sources of concern.

Some suppose that the apparent disproportion in the support for international undertakings is due largely to an alleged American moral superiority, and that the poverty of international organizations is due to a want of responsibility on the part of some other nations. But before resorting to any such explanations, it would seem necessary to ask whether the different sized contributions of different countries could be explained in terms of their national interests. Why would it be in the interest of some countries to contribute a larger proportion of their total resources to group undertakings than other countries? The European members of NATO are much nearer the front line than the United States, and they are less able to defend themselves alone. Thus, it might be supposed that they would have

Sharing (Baltimore: Johns Hopkins, 1965); and Bernard Brodie, "What Price Conventional Capabilities in Europe," *The Reporter*, XXVIII (May 23, 1963), 27.

² See table 1.

³ "NATO was created as, and is still today officially proclaimed to be, the shield that protects Western Europe from a Soviet attack on land. Yet it has never been clear how NATO could perform that function with the forces actually at its disposal or how it could have performed that function even with the much larger forces which its official spokesmen from time to time declared to be indispensable." Hans J. Morgenthau, "Foreword," in Robert Osgood, *NATO: The Entangling Alliance*, (Chicago: University of Chicago Press, 1962), vii. John Pincus speaks of "... the relative willingness of countries to accept NATO force goals," and the fact that "... the trouble comes in meeting those goals," *Economic Aid and International Cost Sharing*, 58.

TABLE 1. — NATO STATISTICS: AN EMPIRICAL TEST

Country	Gross National Product 1964 (billions of dollars)	Rank	Defense Budget as Percentage of GNP	Rank	GNP Per Capita	Rank
United States	569.03	1	9.0	1	\$2,933	1
Germany	88.87	2	5.5	6	1,579	5
United Kingdom	79.46	3	7.0	3	1,471	8
France	73.40	4	6.7	4	1,506	6
Italy	43.63	5	4.1	10	855	11
Canada	38.14	6	4.4	8	1,981	2
Netherlands	15.00	7	4.9	7	1,235	10
Belgium	13.43	8	3.7	12	1,429	9
Denmark	7.73	9	3.3	13	1,636	3
Turkey	6.69	10	5.8	5	216	14
Norway	5.64	11	3.9	11	1,484	7
Greece	4.31	12	4.2	9	507	12
Portugal	2.88	13	7.7	2	316	13
Luxembourg	.53	14	1.7	14	1,636	4

Ranks:														
GNP	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Defense Budget as % of GNP	1	6	3	4	10	8	7	12	13	5	11	9	2	14
GNP Per Capita	1	5	8	6	11	2	10	9	3	14	7	12	13	4

SOURCE: All data are taken from the Institute for Strategic Studies, *The Military Balance 1965-1966* (London, Nov. 1965).

an interest in devoting larger proportions of their resources to NATO than does the United States, rather than the smaller proportions that they actually contribute. And why do the NATO nations fail to provide the level of forces that they have themselves described as appropriate, i.e., in their common interest? These questions cannot be answered without developing a logical explanation of how much a nation acting in its national interest will contribute to an international organization.

Any attempt to develop a theory of international organizations must begin with the purposes or functions of these organizations. One purpose that all such organizations must have is that of serving the *common* interests of member states. In the case of NATO, the proclaimed purpose of the alliance is to protect the member nations from aggression by a common enemy. Deterring aggression against any one of the members is supposed to be in the interest of all.⁴ The analogy with a nation-state is obvious. Those goods and services, such as defense, that the government provides in the *common* interest of the citizenry, are usually called "public goods." An organization of states allied for defense similarly produces a public good, only in this case the

⁴ "Peace is indivisible, and nuclear war even more so." Prime Minister Harold Wilson, as quoted in *The New York Times* (Dec. 17, 1964), 2.

"public" — the members of the organization — are states rather than individuals.

Indeed, almost all kinds of organizations provide public or collective goods. Individual interests normally can best be served by individual action, but when a group of individuals has some common objective or collective goal, then an organization can be useful. Such a common objective is a collective good, since it has one or both of the following properties: (1) if the common goal is achieved, everyone who shares this goal automatically benefits, or, in other words, nonpurchasers cannot feasibly be kept from consuming the good, and (2) if the good is available to any one person in a group it is or can be made available to the other members of the group at little or no marginal cost.⁵ Collective goods are thus the characteristic outputs not only of governments but of organizations in general.⁶

Since the benefits of any action an individual takes to provide a public or organizational good also go to others, individuals acting independently do not have an incentive to provide optimal

⁵ See John G. Head, "Public Goods and Public Policy," *Public Finance*, XVII, No. 3 (1962), 197-219.

⁶ See Mancur Olson, Jr., *The Logic of Collective Action: Public Goods and the Theory of Groups* (Cambridge: Harvard University Press, 1965), which treats organizations of individuals somewhat as this article treats organizations of nation-states.

amounts of such goods. Indeed, when the group interested in a public good is very large, and the share of the total benefit that goes to any single individual is very small, usually no individual has an incentive voluntarily to purchase any of the good, which is why states exact taxes and labor unions demand compulsory membership.⁷ When — as in any organization representing a limited number of nation-states — the membership of an organization is relatively small, the individual members may have an incentive to make significant sacrifices to obtain the collective good, but they will tend to provide only suboptimal amounts of this good. There will also be a tendency for the “larger” members — those that place a higher absolute value on the public good — to bear a disproportionate share of the burden, as the model of alliances developed below will show.

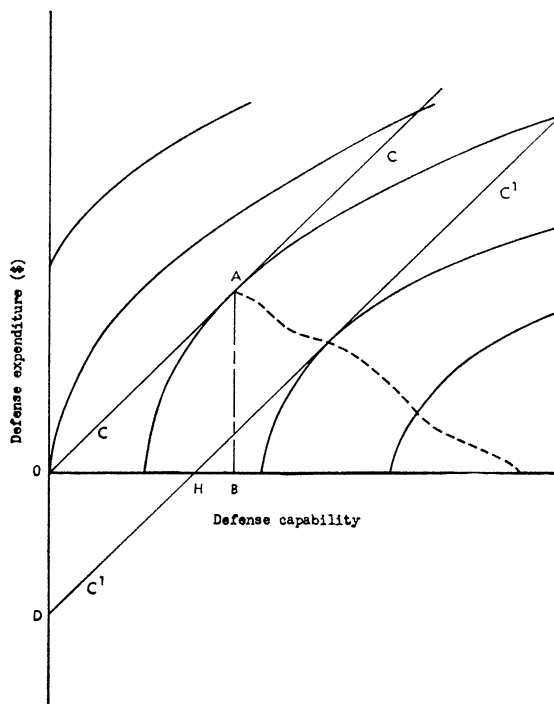
II The Model

When a nation decides how large a military force to provide in an alliance, it must consider the value it places upon collective defense and the other, nondefense, goods that must be sacrificed to obtain additional military forces. The value each nation in an alliance places upon the alliance collective good vis-a-vis other goods can be shown on a simple indifference map, such as is shown in figure 1. This is an ordinary indifference map cut off at the present income line and turned upside down. Defense capability is measured along the horizontal axis and valued positively. Defense spending is measured along the vertical axis and valued negatively. The cost curves are assumed to be linear for the sake of simplicity. If the nation depicted in figure 1 were not a part of any alliance, the amount of defense it would obtain (OB) could be found by drawing a cost curve coming out of the origin and finding the point (point A) where this cost curve is tangent to the “highest” (most southeasterly) indifference curve.

In an alliance, the amount a nation spends on defense will be affected by the amount its allies provide. By moving the cost curve down along the vertical axis beneath the origin we can represent the defense expenditure of allied nations as the distance between the origin and the juncture

⁷ *Ibid.*, 5–52.

FIGURE 1. — INDIFFERENCE MAP

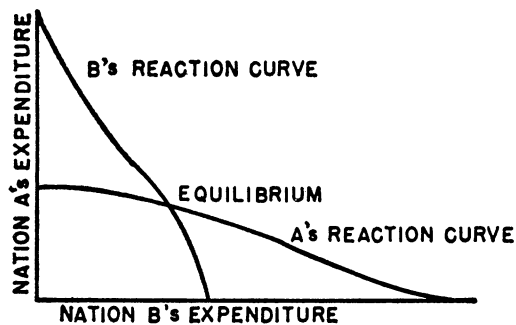


of the cost curve and the vertical axis. If a nation's allies spend OD on defense, and their cost functions are the same as its own, then it receives OH of defense without cost. This is directly equivalent to an increase in income of OD.⁸ The more defense this nation's allies provide, the further the cost constraint moves to the southeast, and the less it spends on defense. By recording all the points of tangency of the total cost curve with the indifference function, we can obtain this nation's reaction function. The reaction function indicates how much defense this nation will produce for all possible levels of defense expenditure by its allies. The amount of defense that this nation provides will in turn influence the defense output of its allies, whose reaction curves can be determined in the same way.

Figure 2 shows the reaction curves for a two-country model (which can easily be generalized

⁸ Free defense is not, however, the direct equivalent of an increase in income if the nation has already received so much defense that it would like to sell some if that were possible. This is what an ally would want to do if the CC curve had shifted so far to the right that it was no longer tangent to any indifference curve. In such a case, there is a corner solution and the nation provides none of the collective good itself.

FIGURE 2. — REACTION CURVES



to cover N countries).⁹ The intersection point of the two reaction curves indicates how much of the alliance good each ally will supply in equilibrium.¹⁰ The two reaction curves need not always intersect. If one nation has a very much larger demand for the alliance good than the other, its reaction curve may lie at every point outside that of the other, in which case it will provide all of the defense. The equilibrium output will then be the same as the isolation output of the country with the largest isolation output. Whether the reaction curves intersect or not, the equilibrium output is necessarily determinate and stable unless defense is an inferior good, in which case there may be a number of equilibria, one or more of which may be unstable.¹¹

In equilibrium, the defense expenditures of the two nations are such that the "larger" nation — the one that places the higher absolute value on the alliance good — will bear a *disproportion-*

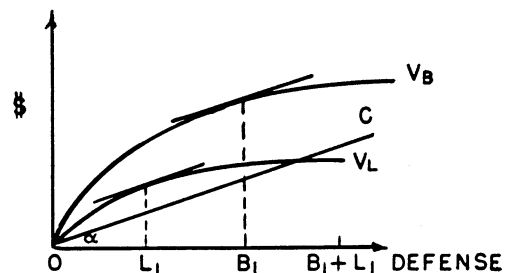
⁹ The reaction curve is an n -dimensional surface in the n -nation alliance. This surface is symmetrical about all axes except the one for the reacting nation. The equilibrium is found at the point of joint intersection of these n surfaces. The symmetrical quality of these surfaces enables us to convert them into two-dimensional reaction curves relating the spending of one nation to the spending of all its allies.

¹⁰ The general model being developed here has several important advantages over Erik Lindahl's much different analysis of how two parties interested in a public good might interact, and over the very interesting modern versions of Lindahl's theory put forth by Leif Johanson and Richard Musgrave. For example, unlike Lindahl's model, it takes account of income effects, it shows that there are generally a multitude of Pareto-optimal outcomes, and it reveals the tendencies toward disproportionality and suboptimality.

¹¹ To see this, suppose that A and B in figure 2 trade reaction curves. Then the equilibrium point given by the intersection point will be unstable, and there will be a tendency for one of the nations to provide all the defense. If one nation's reaction curve lies wholly outside that of the other, there will be a unique and stable equilibrium, whether or not defense is an inferior good.

ately large share of the common burden. It will pay a share of the costs that is larger than its share of the benefits, and thus the distribution of costs will be quite different from that which a system of benefit taxation would bring about.¹² This becomes obvious when income effects — i.e., the influence that the amount of non-defense goods a nation has already forgone has on its desire to provide additional units of defense — are neglected.¹³ This is shown in figure 3 below,

FIGURE 3. — EVALUATION CURVES



which depicts the evaluation curves of two nations for alliance forces. The larger nation, called Big Atlantis, has the higher, steeper valuation curve, V_B , because it places a higher absolute value on defense than Little Atlantis, which has evaluation curve V_L . The CC curve shows the costs of providing defense capability to each nation, since both, by assumption, have the same costs. In isolation, Big Atlantis would buy B_1 units of defense and Little Atlantis L_1 , for at these points their respective valuation curves are parallel to their cost functions. If the two nations continued to provide these outputs in alliance each would enjoy B_1 plus L_1 units of

¹² The authors do not advocate benefit taxation, but believe that proportionality of benefits and costs provides a useful standard of comparison, particularly in alliances which nations join to further their national interests rather than to bring about any particular distribution of income among member nations. The equilibrium outputs are not consistent with any ordinary conceptions of ability-to-pay either. They would involve a very regressive sharing if the larger nation in an alliance had the lower per capita income.

¹³ Income effects are probably very important in practice, partly because it is usually very difficult for a government to increase taxes enough to bring military or other government spending far above the customary levels. Moreover, large increases in defense spending may lead to serious reductions in capital formation. There appears to be a remarkable constancy of the percentage of GNP that is made up by the sum of defense spending and capital formation. See Richard Zeckhauser, "Defense Spending, Capital Formation, and Economic Growth" (to be published).

defense. But then each nation values a marginal unit at less than its marginal cost. Big Atlantis will stop reducing its output of deterrence when the sum applied by the two nations together is B_1 . When this amount (or any amount greater than L_1) is available, it is not in Little Atlantis' interest to supply any defense whatever. The two nations are therefore simultaneously in equilibrium *only* when Big Atlantis provides B_1 of defense and Little Atlantis provides no defense whatever.

The disproportionality in the sharing of burdens is less extreme when income effects are taken into account, but it is still important. This can be seen most easily by supposing that Big Atlantis and Little Atlantis are identical in every respect save that Big Atlantis is twice the size of Little Atlantis. Per capita incomes and individual tastes are the same in both countries, but the population and GNP of Big Atlantis are twice that of Little Atlantis. Now imagine also that Big Atlantis is providing twice as much alliance defense as Little Atlantis, as proportionality would require.¹⁴ In equilibrium, the marginal rate of substitution of money for the alliance good (*MRS*) must equal marginal cost for each of these countries, i.e., $MRS_{\text{Big}} = MRS_{\text{Little}} =$ marginal cost. But (since each country enjoys the same amount of the collective good) the *MRS* of Big Atlantis is double that of Little Atlantis, and (since the cost of an additional unit of defense is the same for each country) either Big Atlantis will want more defense or Little Atlantis will want less (or both will be true), and the common burden will come to be shared in a disproportionate way.

There is one important special case in which there will be no tendency toward disproportionality. That is when the indifference maps of the member nations are such that any perpendicular from the ordinate would intersect all indifference curves at points of equal slope. In this case, when the nation's cost constraint moves to the right as it gets more free defense, it would not reduce its own expenditure on defense. In other words, none of the increase in income that the nation receives in the form of defense is spent on

¹⁴ It could be the case that even in isolation Big Atlantis would buy proportionately more defense than Little Atlantis. This would be the case if a nation's income elasticity of demand for the good were greater than one in the relevant range.

goods other than defense. Defense in this situation is, strictly speaking, a "superior good," a good such that all of any increase in income is used to buy the good.¹⁵

This special case may sometimes be very important. During periods of all-out war or exceptional insecurity, it is likely that defense is (or is nearly) a superior good, and in such circumstances alliances will not have any tendency toward disproportionate burden sharing. The amount of allied military capability that Great Britain enjoyed in World War II increased from 1941 to 1944 as the United States mobilized, adding more and more strength to the allied side. But the British war effort was maintained, if not increased, during this period.¹⁶

¹⁵ Apparently the literature has neglected goods of this kind, and not made clear that they are simply the logical converse of the much discussed inferior goods. When the phrase "superior good" has been used it has usually been given an unsymmetrical and unclear meaning. We therefore distinguish the following classes of goods, realizing that the category to which a good belongs may depend on the level of income.

Class	Characteristic	Income elasticity of expenditure = E
Inferior good	Expenditure on the good decreases or is unchanged as income increases	$E \leq 0$
Inelastic good	Expenditure on the good increases, but by a smaller per cent than income increases	$0 < E < 1$
Elastic good	Expenditure on the good increases by a percentage that is as great or greater than the percentage by which income increases, but by a smaller absolute amount	$1 \leq E < Y_0/S_0^*$
Superior good	Expenditure on the good increases by as much or more than income increases	$E \geq Y_0/S_0$

* S_0 is the expenditure on the good when income is Y_0 .

In terms of an ordinary indifference map (rather than the inverted form used in this article) an inferior good is a good that has an income-consumption line that (in the relevant range) approaches (or is parallel to) the axis along which income is measured, as the income constraint shifts outward. A superior good is a good with an income consumption line that (in the relevant range) approaches (or is parallel to) the axis along which the quantity of the good is measured, as the income constraint shifts outward. If there is an inferior good for an individual, there must be at least one superior good for that individual (saving is here considered a good) and all other goods in the aggregate must be superior. The converse is true for a superior good.

¹⁶ W. K. Hancock and M. M. Gowing, *British War Economy* (London: HMSO, 1949), 369-370; and Mancur Olson, Jr. *The Economics of the Wartime Shortage: A History of British Food Supplies in the Napoleonic War and World Wars I and II* (Durham: Duke University Press, 1963), 117-131.

Although there is then one exception to the rule that alliance burdens are shared disproportionately, there is no equivalent exception to the rule that alliances provide suboptimal amounts of the collective good. The alliance output will always be suboptimal so long as the members of the alliance place a positive value on additional units of defense. This is because each of the alliance members contributes to the point where its *MRS* for the good equals the marginal cost of the good. In other words, the result of independent national maximization in an alliance, when the cost function is linear and the same for all members, is that $MRS_1 = MRS_2 = \dots MRS_N = MC$. There could be an optimal quantity of the collective good only if the total value which all of the alliance members together placed on an additional unit of the good equalled marginal cost, i.e., only if $MRS_1 + MRS_2 + \dots MRS_N = MC$. The individual nations in an alliance would have an incentive to keep providing additional alliance forces until the Pareto-optimal level is reached only if there were an arrangement such that the alliance members shared marginal costs in the same proportions in which they shared additional benefits (that is, in the same ratio as their marginal rates of substitution of money for the good). When there is such a marginal cost sharing scheme, there need be no tendency toward disproportionality in the sharing of burdens.

III Qualifications and Elaborations

One simplification assumed in the foregoing model was that the costs of defense were constant to scale and the same for all alliance members. Although military forces are composed of diverse types of equipment and manpower, and thus probably vary less both in cost from one country to another and with scale of output than many single products, it is still unlikely that costs are constant and uniform. For some special types of weapon systems there are undoubtedly striking economies of large scale production, and for conventional ground forces there are probably rising costs as larger proportions of a nation's population are called to arms. Because of this latter tendency, a small country can perhaps get a considerable amount of conventional capability with the first few percentiles of its national

income. This tends to keep the military expenditures of small nations in an alliance above the very low level implied by our constant cost assumption. In any event, cross-country variations in marginal costs should not normally alter the basic conclusions deduced from the model. The differences in the amounts which member nations would be willing to pay for marginal units of an alliance good are typically so great that the cost differentials could hardly negate their effect. Even if there were very large differences in marginal costs among nations, there is no reason to assume that national cost functions would vary systematically with the valuation a country places on alliance forces.¹⁷

A nation's valuation of alliance forces obviously depends not only on its national income, but also on other factors. A nation on the enemy's border may value defense more than one some distance away. A nation that has a large area and long frontiers in relation to its resources may want a larger army than a compact country. On the other hand, if bomb and missile attacks are the main danger, a crowded country may wish to invest more in defense against attack by air. Similarly, a nation's attitudes or ideologies may partly determine its evaluation of defense. Many observers think that the uniformity and intensity of anti-communism is greater among the NATO countries with the highest per capita incomes, and these also happen to be the largest countries in the alliance. It also seems that many people in small and weak countries, both inside and outside of NATO, tend to be attracted to neutralist or pacifist ideologies. This pattern of attitudes may perhaps be partly explained by our model, for it suggests that small nations, which find that even large sacrifices on their part have little effect on the global balance, would often be attracted to neutral or passive foreign policies, and that large nations which know that their efforts can decisively influence world events in their own interest will continually need to

¹⁷ There could be pathological cost functions that would prevent any disproportionate burden sharing of the kind predicted by the model. If for example all of the nations had total cost curves with sharp kinks indicating abruptly rising costs after a certain point, they might all have an incentive to choose the defense outputs suggested by these kinks. These kinks would not, except by accident, be such as to lead the larger allies to bear a disproportionate share of the common burden.

emphasize the urgency of the struggle in which they are engaged. The popularity of pacific ideologies, the frequent adoption of neutralist policies in small and weak countries, and the activist attitudes and policies of the United States and the Soviet Union are at least consistent with our model.¹⁸

Whatever the reasons for the different evaluations different nations have for military capabilities in an alliance, the model here still applies. If two countries in an alliance had equal national incomes, but one was more concerned about the common enemy for geographic, ideological, historical, or other reasons, the more concerned nation would not only put a higher valuation on the alliance's military capacity, but would bear a share of the total alliance costs that was even greater than its share of the total benefits.¹⁹ The model deals with the general case of differences in the absolute valuation that nations put upon additional units of an alliance good, whether these differences are due to differences in national income or to other reasons.²⁰

Another assumption in the model developed in the foregoing section was that the military forces in an alliance provide only the collective benefit of alliance security, when in fact they also provide purely national, non-collective benefits to the nations that maintain them. When Portugal mobilizes additional forces to suppress the independence movement in Angola, a national goal unrelated to the purposes of NATO, she may at the same time be increasing the total strength of the alliance. Similarly, allied nations may be suspicious of one another, even as they

cooperate in the achievement of common purposes, and may enlarge their military forces because of conceivable future conflicts with each other. In any situations in which the military forces of alliance members provide important non-collective benefits as well as alliance benefits, the degree of suboptimality and the importance of the disproportionality will decrease because the non-collective benefits give the member nations an incentive to maintain larger forces.

This fact leads to the paradoxical conclusion that *a decline in the amity, unity, and community of interest among allies need not necessarily reduce the effectiveness of an alliance*, because the decline in these alliance "virtues" produces a greater ratio of private to collective benefits. This suggests that alliances troubled by suspicions and disagreements may continue to work reasonably well. To be sure, the degree of coordination among the allies will decline, and this will reduce the efficiency of the alliance forces (in a sense leaving them on a poorer production function), but the alliance forces will be larger.

However important the non-collective benefits of alliances may be, there can be little doubt that above all alliances produce public goods. It is not easy to think of alliances that provide only private goods, though such alliances are perhaps conceivable. If nations simply trade sites for military bases, no common interests or public goods would necessarily be involved. An alliance might also be set up simply to provide insurance in the sense that two nations without any common purpose or common enemy would agree to defend each other in case of attack, but in which neither knew in advance which would

¹⁸ One factor that might conceivably make small countries outside of an alliance spend little or nothing on defense is that they might think that the maximum force they could raise alone would not be sufficient to defeat any potential enemy, so that there would be no point in having any military forces at all. In an alliance, on the other hand, a small nation might suppose that its forces could provide the margin of victory and therefore increase their defense spending. The kink in the evaluation function that this argument implies is however made much less likely by the fact that even a small military force may be quite valuable to a small, unaligned country, for it might increase the costs and risks to an aggressor enough to deter him from attacking a small (and therefore probably not very valuable) country. This seems to be one argument used to support the French nuclear force.

¹⁹ Benefits are of course defined in terms of the preferences of the two countries, which we here assume have been revealed.

²⁰ The value which a nation puts upon alliance forces may also vary with alliance policies. An alliance must sometimes choose which of two or more alternative public goods to pro-

vide, and one public good may be more valuable to some alliance members and another more valuable to others. The NATO alliance, for example, provides conventional defense as well as nuclear protection, and there have been disagreements about the proper mix between these two goods. In such a case it is possible that some nations may supply additional forces in return for more influence on alliance policy, whereas other nations may make policy concessions in order to get other members to assume a greater share of alliance costs. Such trade-offs need not change the qualitative conclusions about disproportionate burden sharing. They might simply mean that a nation can bear part of its alliance burden by making policy concessions rather than by providing additional forces. When this happens, though, the allies that obtained the policy they wanted find they value the alliance good more than before, and the opposite is true for those who have relinquished some of their control over alliance policy. This in turn makes the former set of nations provide still more defense and the latter still less.

suffer aggression. On the other hand, if these two nations thought (as they presumably would) that the fact of their alliance would make it less profitable for other nations to attack either of them, the alliance would provide a public good — a degree of deterrence that could deter an attack on either or both of these nations about as well as it could deter an attack on one alone. There is, moreover, no reason to describe a mere transaction in private goods as an alliance, and the word does not normally appear to be used in that way. A transaction in private goods would be quite as useful between enemies as between “allies,” and would normally be completed by a single pair of actions or a single agreement which would not require the continuing consultation, cooperation, and organization characteristic of alliances.

Normally, an additional member can be added to an alliance without substantially subtracting from the amount of defense available to those already in the alliance, and any good that satisfies this criterion is by definition a public good.²¹ Suppose two nations of the same size face a common enemy with an army larger than either of them provides by itself. They then form an alliance and maintain a level of military forces larger than either of them had before, but smaller than the sum of their two pre-alliance armies. After alliance both nations enjoy (1) more military security, and (2) lower defense costs, than they had before. This result comes about, not only because a military force can often deter attack by a common enemy against an additional nation without a substantial increase in cost, but also because an alliance may make a greater level of security economically feasible and desirable, and the gains from obtaining this extra security can leave both nations better off.²²

²¹ The number of people defended by a given military force can clearly increase without reducing the security per person. However, additional land area will normally require some additional military forces, if the area previously protected is to have the same degree of security as before, and if actual defensive conflict, rather than deterrence, is at issue. When the additional land area has no common border with the enemy, it can usually be defended without any significant extra cost. The extra cost to NATO of defending Belgium against a Soviet attack, once Germany and France are already defended, is negligible. Even when the extra land does have a common border with an enemy it is not always true that it costs much more to defend it. If the French had believed they had to defend Belgium as well as France in World Wars I and II, they might have fared better.

Another defining characteristic that is sufficient (but not necessary) to distinguish a collective good is that the exclusion of those who do not share the cost of the good is impractical or impossible. Typically, once an alliance treaty has been signed, a member nation is legally bound to remain a member for the duration of the treaty. The decisions about how the common burden is to be shared are not, however, usually specified in the alliance treaty. This procedure works to the disadvantage of the larger countries. Often the smaller and weaker nations gain relatively more from the existence of an alliance than do the larger and stronger powers, and once an alliance treaty has been signed the larger powers are immediately deprived of their strongest bargaining weapon — the threat that they will not help to defend the recalcitrant smaller powers — in any negotiations about the sharing of the common burden. Even at the time an alliance treaty is negotiated exclusion may very well not be feasible, since most alliances are implicit in an already existing danger or goal common to some group of states. That common danger or goal gives the nations that share it an incentive tacitly to treat each other as allies, whether or not they have all signed a formal agreement. A nation can only lose from having another nation with whom it shares a common interest succumb to an enemy, for that will strengthen the enemy's side at the expense of the first nation. It may well be that most alliances are never embodied in any formal agreement. Sometimes a nation may have a geo-political position (e.g., behind an alliance member serving as a buffer state) such that it would be unusually difficult, if not impossible, to deny it the benefits of alliance protection. Then, if it regards alliance membership as a special burden, it may have an incentive to stay out of, or when legally possible to withdraw from, the alliance's formal organization.

²² This suggests that the conventional view, that a good is a pure public good if it can be offered to additional consumers for free without any less being available to those already consuming the good, is somewhat too simple. For a good might be such that, if extra consumers enjoyed it, there would be a little less for those who had already been consuming it. Yet it might pay to let new consumers enjoy the present supply of the good at a zero price (or even less), if they would agree to share the costs of providing the additional amount of the good that it would be optimal to purchase once the additional consumers were involved.

This paper also made the simplifying assumption that no alliance member will take into account the reactions other members may have to the size of its alliance contribution. The mutual recognition of oligopolistic interdependence can be profoundly important in small groups of firms, but in the NATO alliance at least, it seems to have been somewhat less important (except with respect to the infrastructure, which will be considered later). There are at least two important reasons why strategic bargaining interaction is often less important in alliances than in oligopolistic industries. First, alliances are often involved in situations that contain a strong element of irreversibility. Suppose that the United States were to threaten to cut its defense spending to nothing to get its allies to bear larger shares of the NATO burden. The Soviet Union, if it has the characteristics that American policy assumes, would then deprive the United States of its independence, in which case future defense savings would have little relevance. The United States threat would have only a limited credibility in view of the irreversibility of this process. The second factor which limits strategic bargaining interaction among alliance members stems from an important difference between market and non-market groups. In an oligopolistic group of firms, any firm knows that its competitors would be better off if it were made bankrupt or otherwise driven out of the industry. Large firms thus sometimes engage in price wars or cut-throat competition to drive out the smaller members of an oligopolistic group. By contrast, non-market groups and organizations, such as alliances, usually strive instead for a larger membership, since they provide collective goods the supply of which should increase as the membership increases. Since an ally would typically lose from driving another member out of an alliance, a bargaining threat to that effect may not be credible. This will be especially true if the excluded nation would then fall to the common enemy and (as we argued before) thereby strengthen the enemy at the expense of the alliance.

Even when strategic interaction is important in alliances, the advantage paradoxically still rests in most cases with the smaller nations.²³ There are two reasons for this.²⁴ First, the large country

loses more from withholding an alliance contribution than a small country does, since it values a given amount of alliance force more highly. In other words, it may be deterred by the very importance to itself of its own alliance contribution from carrying out any threat to end that contribution. Second, the large country has relatively less to gain than its small ally from driving a hard bargain. Even if the large nation were successful in the bargaining it would expect only a relatively small addition to the alliance force from the small nation, but when the small nation succeeds in the bargaining it can expect a large addition to the alliance force from the large nation. There is, accordingly, no reason to expect that there is any disparity of bargaining in favor of the larger ally that would negate the tendency toward disproportionality revealed by our model.

IV Empirical Evidence

When other things are equal, the larger a nation is, the higher its valuation of the output of an alliance. Thus, if our model is correct, the larger members of an alliance should, on the average, devote larger percentages of their national incomes to defense than do the smaller nations. This prediction is tested against the recent data on the NATO nations in table 1. The following specific hypotheses are used to test the model's predictions:

H_1 — In an alliance, there will be a significant positive correlation between the size of a member's national income and the percentage of its national income spent on defense. This hypothesis will be tested against:

H_0 — There will not be a significant positive correlation between the variables specified in H_1 .

Since there is no assurance that the data are parametrically distributed, non-parametrical statistical tests must be used. The Spearman rank

²³ Perhaps the bargaining advantage of the smaller, weaker nations should not be surprising. Schelling has found many other situations in which, for different reasons, weakness can be a source of bargaining strength. See Thomas C. Schelling, *The Strategy of Conflict* (Cambridge: Harvard University Press, 1960), especially pages 22, 23, 37, 52, and 158.

²⁴ These two reasons came to our attention through Klaus Knorr, "Notes on a Theory of Alliances," (unpublished manuscript, Center of International Studies, Princeton University), 23-24, and 28.

correlation coefficient for Gross National Product and *defense budget as a percentage of GNP* is .490. On a one-tailed test this value is significant at the .05 level.²⁵ We therefore reject the null hypothesis and accept H_1 . There is a significant positive correlation indicating that the large nations in NATO bear a disproportionate share of the burden of the common defense. Moreover, this result holds even when the level of per capita income is held constant.²⁶

Our model predicts that there are tendencies toward disproportionate burden sharing, not only in military alliances, but also in other international organizations, such as the United Nations. The test of this prediction is complicated in the case of the U.N. by the fact that the organization is supported primarily through assessments levied against individual members. These assessments are determined by a formula constructed by a committee of experts. The model would, however, suggest that the degree to which a member fulfills or over-subscribes its quota would be positively correlated with its size, and thus gives the following hypotheses:

H_2 — In a voluntary organization with quota assessments that are not always satisfied, there will be a significant positive correlation between a member's GNP and the percentage of fulfillment or over-fulfillment of its quota.

H_0 — There will not be a significant positive correlation between the variables in H_2 .

The Spearman rank correlation coefficient between 1961 *GNP* and *percentage total U.N. contributions in 1961/normal assessment scale* was .404. This result is significant at the .01

²⁵ See Sidney Siegel, *Nonparametric Statistics* (New York: McGraw-Hill, 1956), 284. As a corroborative test, a different set of data for a different year (1960) was also used. With these data the Spearman rank correlation coefficient for *Gross National Product* and *defense budget as a percentage of GNP* was .635, a value significant at the .05 level on a one-tailed test. Once again Iceland was excluded; since she ranked fifteenth for both variables, her inclusion in either test would have improved the correlation. (Source: Stanford Research Institute, "The Economic Feasibility of Proposed Changes in NATO Strategy, 1962-1975.")

²⁶ This was done because of concern that the positive correlation in H_1 might be simply the result of a joint correlation of both national income and the percentage of defense spending with per capita income, for it happens that the larger NATO nations often have the higher per capita incomes. The effects of differences in per capita income were "held constant" with the aid of the Kendall partial rank correlation coefficient, which measures the relationship between two variables after

level.²⁷ We thus accept H_2 and reject H_0 , for, as the model predicted, the larger nations in the U.N. did a better job of living up to their normal assessments. The fact that members may lose prestige and membership rights if they fail to meet their assessments, i.e., that there are distinctly private benefits from contributions to the U.N., makes this high correlation more striking.

The foreign aid that the industrialized democracies give to the underdeveloped countries is a collective good to these aid-giving nations, at least to the extent that they all value the development of the less developed areas. On the other hand, individual aid-giving nations often concentrate all of their aid on particular underdeveloped areas, such as past or present colonies, in which they have a special interest. To the extent that different aid-giving nations are interested in different underdeveloped areas, their aid allocations constitute private rather than collective goods. This tends to limit any tendencies toward suboptimality and disproportionality in the provision of foreign aid. We can test for any such disproportionalities with the aid of the following hypotheses:

H_3 — Among a group of developed nations there will be a significant positive correlation between foreign aid expenditures as a percentage of national income and the size of the national income.

H_0 — There will not be a significant positive correlation between the variables in H_3 .

the effects of a third, possibly related, variable have been removed. The Kendall partial rank correlation coefficient of *Gross National Product* and *defense budget as a percentage of GNP*, net of the effects of *per capita GNP*, is .445. To our knowledge there is no test for the significance of the Kendall partial rank correlation coefficient, but it is perhaps suggestive that this is virtually the same as the Kendall rank correlation coefficient (.384) that results when the effects of differences in per capita income are not partialled out. Moreover, there is no statistically significant relationship between *per capita GNP* and *defense budget as a percentage of GNP*, in fact, the correlation is slightly negative. Thus we concluded that the correlation between the size of an ally's national income and the percentage of its national income spent on defense cannot be explained in terms of any relationship of these two variables with per capita income.

²⁷ The data were taken from Norman J. Padelford, "Financial Crisis and the Future of the United Nations," *World Politics*, XV (July 1963), 531-568. Our sample included 97 of the U.N. members cited, since separate GNP statistics were not given for the Ukraine or Byelorussia. We employed the Student's "*t*" distribution with conversion from the Spearman rank correlation coefficient to test the significance of the correlation (see Siegel, *op. cit.*, 212).

One set of data used to test these hypotheses revealed a correlation between *real national income* and *total grants and loans to underdeveloped countries as a percentage of national income* in 1960 of .770.²⁸ This figure is significant at the .01 level. A different set of data for a different year (1962) showed a correlation between *GNP* and *total aid as a percentage of GNP* of .439.²⁹ With the small sample of only 12 nations, this value falls slightly short of the .05 level of significance (the borderline value is .506). Thus both sets of data yield correlation coefficients suggesting the expected positive relationship, but in one case the result is clearly statistically significant and in the other case it falls somewhat short of the .05 level of significance. We will take the most conservative course and await further research before finally accepting either H_3 or the null hypothesis. The most reasonable inference at the moment is that there is some tendency toward disproportionate burden sharing, but that the private, or purely national, benefits from foreign aid are probably also very important. This is, moreover, about what might be expected from the fact that the industrialized western nations express a common interest in the development of the poor nations generally, while at the same time many of these nations individually are interested primarily in particular underdeveloped areas with which they have special relationships.

Our model indicated that when the members of an organization share the costs of marginal units of an alliance good, just as they share in the benefits of additional units of that good, there is no tendency toward disproportionality or suboptimality. In other words, if each ally pays an appropriate percentage of the cost of any additional units of the alliance good, the results are quite different from when each ally pays the full cost of any amount of the alliance good that he provides. The costs of the NATO infrastructure (common supply depots, pipelines, etc.), unlike the costs of providing the main alliance forces, are shared according to percentages

²⁸ The data were taken from Irving B. Kravis and Michael W. S. Davenport, "The Political Arithmetic of Burden Sharing," *Journal of Political Economy*, LXXI (Aug. 1963), 323 and 325. Though this article does not explicitly rank the aid-giving nations by the percentage of their national incomes used for foreign aid, this ranking was none the less obtained from this article by comparing the figures given for each na-

worked out in a negotiated agreement. Since each ally pays some percentage of the cost of any addition to the NATO infrastructure, we have here a marginal cost sharing arrangement.

Thus our model suggests that the burdens of the NATO infrastructure should be borne quite differently from the rest of the NATO burden. There are other reasons for expecting that the infrastructure burden would be shared in a different way from the main NATO burdens. For one thing, the infrastructure facilities of NATO are all in continental European countries, and ultimately become the property of the host nation. Their construction also brings foreign exchange earnings to these countries, which for the most part are the smaller alliance members. In addition, infrastructure costs are very small in relation to the total burden of common defense, so a small nation may get prestige at a relatively low cost by offering to bear a larger percentage of the infrastructure cost. There are, in short, many private benefits for the smaller alliance members resulting from the infrastructure expenditures. Because of these private benefits, and more important because of the percentage sharing of marginal (and total) costs of the infrastructure, we would predict that the larger members of the alliance would bear a smaller share of the infrastructure burden than of the main alliance burdens.

This prediction suggests that the following hypotheses be tested:

H_4 — In an alliance in which the marginal costs of certain activities are *not* shared (but fall instead upon those members who have an incentive to provide additional units of the alliance good by themselves), and in which the marginal costs of other activities are shared (so that each member pays a specified percentage of any costs of these activities), the *ratio* of a member's share of the costs of the activities of the former type to his share of the costs of activities of the latter type will have a signifi-

tion's aid as a percentage of total aid with the figures given for each nation's national income as a percentage of the total income of the entire group of nations.

²⁹ The data are those prepared by John Pincus and presented in his *Economic Aid and International Cost Sharing* (Baltimore: Johns Hopkins Press, 1965), Tables 5-9 and 5-12, pp. 135 and 140. Pincus has usefully discounted the value of the loans given as foreign aid at the interest rate prevailing in the donor country in computing the value of each nation's foreign aid.

TABLE 2. — NATO INFRASTRUCTURE

Country	National Income 1960 ^a (billions of dollars) (1)	Infrastructure % Reconsidered in 1960 ^b (2)	$R = (2)/(1)$ (3)	Military Budget 1960 (billions of dollars) (4)	$T = (4)/(2)$ (5)
United States	411.367	36.98	.0899	41.000	1.1087
Germany	51.268	13.77	.2686	2.072	.1504
United Kingdom	57.361	9.88	.1722	4.466	.4520
France	43.468	11.87	.2731	3.311	.2789
Italy	24.950	5.61	.2248	1.076	.1922
Canada	28.178	6.15	.2183	1,680	.2732
Netherlands	9.246	3.51	.3800	.450	.1282
Belgium	8.946	4.39	.4907	.395	.0900
Turkey	4.929	1.75	.3550	.244	.1394
Denmark	4.762	2.63	.5569	.153	.0582
Norway	3.455	2.19	.6338	.168	.0767
Greece	2.684	.87	.3242	.173	.1989
Portugal	2.083	.28	.1344	.093	.3321
Luxembourg	.386	.17	.4404	.007	.0412

Ranks

(1) 1 3 2 4 6 5 7 8 9 10 11 12 13 14

(3) 14 9 12 8 10 11 5 3 6 2 1 7 13 4

(5) 1 8 2 4 7 5 10 11 9 13 12 6 3 14

^a United Nations, *Yearbook of National Accounts Statistics*, (New York, 1964); and *Balance of Payments Yearbook*, Vol. 15 (Washington, D.C.: International Monetary Fund, 1964).

^b Charles Croot, "Coordination in the Sixties," reprinted from *NATO Letter*, (August 1960).

cant positive correlation with national income.

H_0 — There will be no significant positive correlation between the variables in H_4 .

To test these hypotheses we calculated the correlation coefficient between *national income* and *variable T* in table 2. The Spearman rank correlation coefficient between these variables is .582, which is significant at the .05 level. We therefore reject the null hypothesis and conclude that the larger members bear a larger proportion of the costs of the main NATO forces than they do of those NATO activities for which the costs of each unit are shared. The difference between the distribution of infrastructure costs and the distribution of alliance burdens generally is quite striking, as the tests of the following hypotheses indicate:

H_5 — In the NATO alliance there is a significant negative correlation between national income and the percentage of national income devoted to infrastructure expenses.

H_0 — There is no significant negative correlation between the variables in H_5 .

The Spearman rank correlation coefficient between *national income* and *variable R* in table 2 is —.538, which is significant at the .05 level. Thus, not only is it the case that the larger nations pay a smaller share of the infrastructure costs than of other alliance costs; it is also true that there is a significant negative correlation between na-

tional income and the percentage of national income devoted to the NATO infrastructure, which is in vivid contrast to the positive correlation that prevails for other NATO burdens. This confirms the prediction that when there are marginal cost sharing arrangements, there need no longer be any tendency for the larger nations to bear disproportionately large shares of the costs of international organizations. If it happens at the same time that the smaller nations get greater than average private benefits from their contributions, they may even contribute greater percentages of their national incomes than the larger members.³⁰

³⁰ Irving Kravis and Michael Davenport, in their previously cited article, appear at first sight to come to conclusions in direct opposition to our own, for they say, "All in all, there seems to be little basis for the feeling that the United States is bearing a disproportionate share of the costs of international cooperation." They examine the structure of contributions to the Universal Postal Union, the United Nations, the OECD, and the NATO infrastructure. Since each of these organizations usually shares marginal costs on a percentage basis, their results for these organizations are consistent with our predictions about the effects of marginal cost sharing and in accord with our findings about the NATO infrastructure. As we saw in footnote 28, Kravis and Davenport also examined the foreign aid given by a number of industrialized countries, but we found their aid figures confirmed the hypothesis suggested by our model in situations where marginal costs are not shared. That Kravis and Davenport's article is not actually in conflict with our own is evident not only because their data are generally consistent with our model, but also because they are concerned in large part with ethical or ability-to-pay considerations that are not relevant to it.

V Conclusions and Recommendations

All of the empirical evidence tended to confirm the model. In the United Nations there appear to be systematic forces tending to make the small nations fail to meet their quotas and leading larger nations to assume larger shares of the costs. The larger industrialized nations, moreover, seem to bear disproportionate shares of the burden of aid to the less developed countries. In NATO there is again a statistically significant positive correlation between the size of a member's national income and the percentage of its national income devoted to the common defense.

As our model indicated, this is in part because each ally gets only a fraction of the benefits of any collective good that is provided, but each pays the full cost of any additional amounts of the collective good. This means that individual members of an alliance or international organization have an incentive to stop providing the collective good long before the Pareto-optimal output for the group has been provided.³¹ This is particularly true of the smaller members, who get smaller shares of the total benefits accruing from the good, and who find that they have little or no incentive to provide additional amounts of the collective good once the larger members have provided the amounts they want for themselves, with the result that the burdens are shared in a disproportionate way. The model indicated two special types of situations in which there need be no such tendency toward disproportionality. First, in cases of all-out war or extreme insecurity defense may be what was strictly defined as a "superior good," in which case a nation's output of a collective good will not be reduced when it receives more of this good from an ally. Second, institutional arrangements such that the members of an organization share marginal costs, just as they share the benefits of each unit of the good, tend to work against disproportionality in burden sharing, and it is a necessary condition of an efficient, Pareto-optimal output that the marginal costs be shared in the same proportions

³¹ We do *not* argue that the output of every international institution *ought* to be increased. This is partly a question of personal values, and we feel that sometimes spending on some alliances and other international organizations might best be curtailed. The point in this article is rather that, *given* the values or preferences of the members of an international organization, they will tend to provide less of the collective good than would be Pareto-optimal in terms of those values.

as the benefits of additional units. The NATO nations determine through negotiation what percentages of any infrastructure expenditure each member will pay, and this sharing of marginal costs has led the smaller members to bear a very much larger share of the infrastructure burden than they do of the other NATO burdens. The fact that the model predicts not only the distribution of the principal NATO burdens, but also the greatly different distribution of infrastructure costs, suggests that the results are in fact due to the processes described in the model, rather than to some other cause.

The model's implication that large nations tend to bear disproportionate shares of the burdens of international organization, and the empirical evidence tending to confirm the model, does *not* entail the conclusion that the small nations should be told they "ought" to bear a larger share of the common burdens. No moral conclusions can follow solely from any purely logical model of the kind developed here.³² Indeed, our analysis suggests that moral suasion is inappropriate, since the different levels of contribution are not due to different moral attitudes, and ineffective, since the less than proportionate contributions of the smaller nations are securely grounded in their national interests (just as the disproportionately large contributions of the larger countries are solidly grounded in their national interests). Thus, American attempts to persuade other nations to bear "fair" shares of the burdens of common ventures are likely to be divisive and harmful even to American interests in the long run.

The model developed here suggests that the problems of disproportionality and suboptimality in international organizations should be met

³² We must strongly emphasize that we are *not* here questioning the fairness of the present distribution of the costs of any international undertaking. No statement about what distribution of costs ought to prevail can be made unless some (logically arbitrary) assumption is made about what income redistributions among participating nations would be desirable. Jacques van Ypersele de Strihou, in "Sharing the Burden of Defense Among Allies," an interesting Ph.D. thesis available at Yale University, has shown that, if the British rates of progression are used as a standard of fairness, it appears that the larger European members of NATO pay an unfairly large share of the common costs, that the United States (partly because of its high per capita income) pays about the right amount, and that the smaller NATO nations (because of the same general forces explained in this paper) pay an unfairly small amount.

instead through institutional changes that alter the pattern of incentives. Since suboptimal provision is typical of international organizations, it is possible to design policy changes that would leave everyone better off, and which accordingly may have some chance of adoption. Appropriate marginal cost sharing schemes, such as are now used to finance the NATO infrastructure, could solve the problem of suboptimality in international organizations,³³ and might also reduce the degree of disproportionality. Substituting a union for an alliance or international organization would also tend to bring about optimality, for then the unified system as a whole has an incentive to behave in an optimal fashion, and the various parts of the union can be required to contribute the amounts their common interest requires. Even a union of smaller members of NATO, for example, could be helpful, and be in the interest of the United States. Such a union would give the people involved an incentive to contribute more toward the goals they shared with their then more nearly equal partners. Whatever the disadvantages on other grounds of these policy possibilities, they at least have the merit that they help to make the national interests of individual nations more nearly compatible with the efficient attainment of the goals which groups of nations hold in common.

³³ A similar proposal has been suggested by Thomas Schelling. He suggests that each country's share of the alliance's expenditure be fixed and the overall total spending be left open. Thus a country whose share of the cost was ten per cent would find that in return for spending this money it got not only the protection of the forces this money would buy, but also the forces created by those nations that paid the other 90 per cent. See his *International Cost Sharing Arrangements*, "Essays in International Finance, No. 24" (Princeton, N. J.: International Finance Section, Princeton University), 19.

A final implication of our model is that alliances and international organizations, as presently organized, will not work efficiently, or according to any common conception of fairness, however complete the agreement and community of interest among the members. Though there is obviously a point beyond which dissension and divergent purposes will ruin any organization, it is also true that some differences of purpose may improve the working of an alliance, because they increase the private, non-collective benefits from the national contributions to the alliance, and this alleviates the suboptimality and disproportionality.³⁴ How much smaller would the military forces of the small members of NATO be if they did not have their private fears and quarrels? How much aid would the European nations give if they did not have private interests in the development of their past or present colonies? How much would the smaller nations contribute to the U.N. if it were not a forum for the expression of their purely national enmities and aspirations? The United States, at least, should perhaps not hope for too much unity in common ventures with other nations. It might prove extremely expensive.

³⁴ Some other general reasons why alliances as presently organized will be inefficient, however complete the consensus among the members, are explained in our chapter in the forthcoming *Universities-National Bureau of Economic Research* volume on "The Economics of Defense."

The model's implication that increased noncollective benefits improve the functioning of an alliance, and other implications of our model, have been tested by James A. Robinson and Philip M. Burgess of the Merston Social Science Program at Ohio State University, through a most interesting gaming-simulation procedure. Their analysis of the data is not yet complete, but we are informed that the data generally appear to support the hypothesis that private, noncollective benefits can strengthen an alliance, and probably also other hypotheses suggested by our model.