

Collective Goods and Future International Collaboration*

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There appears to be emerging among students of highly industrialized societies a consensus that a fundamental institutional transformation is under way, that signs of a "postindustrial,"¹ if not "postmodern," order are becoming evident. Views differ less on whether these changes are occurring, than on their magnitude and their desirability. Two fundamental changes, concerning the *kinds of goods* which are predominantly produced by these societies, and the *manner in which* these goods are produced, are foreseen. First, the postindustrial society is characterized as one which has become preoccupied with the production of services, research and development, education and knowledge, and various social amenities—publicly relevant goods, in sum. Second, it is characterized as a society in which these goods are produced and/or purchased communally—in which public decisions and planning will have replaced the market "as the arbiter of various social and economic choices."²

The growth of the public sector, resulting from attempts to regulate market irregularities, to provide social welfare which the market failed to provide, and to support enterprises which otherwise would not exist, is part of the tradition of the advanced industrial societies.³

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¹ Daniel Bell popularized this term in his "Notes on the postindustrial society," *The Public Interest*, No. 6 (Winter 1967), pp. 24–35; No. 7 (Spring 1967), pp. 102–118.

² Bell, p. 103.

³ For an extended, informed and informative analysis of these developments, consult Andrew Shonfield, *Modern Capitalism: The Changing Balance of Public and Private Power* (London: Oxford University Press, 1965).

But it is argued today that a qualitative change, of major dimension, is being effected by the impact of science and technology upon these societies. In a growing, highly uneven, and often mystifying literature, science and technology are portrayed as offering possibilities and posing problems of such a nature that the most characteristic institutions of the industrial order—whether the mature corporation,⁴ the market economy,⁵ bureaucratic forms of organization,⁶ or representative government⁷—find themselves unable to exploit fully the possibilities, and unable to deal adequately with the problems. Basic organizational changes are said to follow from attempts to respond to this predicament.

Much the same kind of reasoning is exhibited by students of international organization: the incidence and the character of international organization is changing, they argue, as states find themselves incapable of fully exploiting the possibilities offered by, and of adequately coping with the problems posed by, developments in science and technology. For example, industrial efficiency and economic growth, military security and the ability to play a major role in world affairs, are all said to have become dependent upon leadership in a number of research-intensive sciences. Nations lacking sufficient national resources to maintain high levels of research and development, yet wishing to enjoy its benefits, must look to their neighbors for

⁴ John Kenneth Galbraith argues that the mature corporation is being fundamentally transformed, especially in its relations with the social system around it, as a result of the rise of the "technostructure" in turn brought about by the impact of science and technology. *The New Industrial State* (New York: Signet Books, 1968).

⁵ Robert L. Heilbroner contends that the market economy is being fundamentally transformed, as a result of ever greater reliance upon planning, in turn generated by the impact of science and technology. *The Limits of American Capitalism* (New York: Harper & Row, 1966), Part II.

⁶ As a result of the general uncertainties and complexities generated by modern sciences and technologies, which traditional organizational structures have difficulty coping with, we are said to be heading "beyond bureaucracy," by, among others, Warren Bennis and Philip Slater (in *The Temporary Society* [New York: Harper & Row, 1968]).

⁷ The classic work of this genre is Don Price's study of the impact of public science funding, and of advisory structures of various kinds, upon American government. *The Scientific Estate* (New York: Oxford University Press, 1965).

cooperative production arrangements. As a French Minister of Science has declared: "Europe will be made by the atom, space, aeronautical construction, and computers, or it will not be made."⁸ Moreover, coping with the unforeseen and unanticipated consequences of past, present and future technological developments is said to require the systematic exchange of information among states, as well as the monitoring, coordination and harmonization of national behavior. In addition, within the next quarter century, technologies will offer a number of new capabilities, such as that of environmental alteration, including the modification of weather and climate conditions, the fuller exploitation of the seabed, the developing of new sources of energy and of new modes of communication and transportation. As a result of the problems posed by these developments, students of international organization have predicted that "nation-states will have to accept a degree of international regulation and control over their nominally domestic activities that goes well beyond the situation today."⁹ In sum, just as the kinds of goods and the manner in which they are coming to be produced is said to be changing domestically, so it is internationally: greater amounts of joint services and joint production, and a greater degree of joint regulation of national activities will be required.

But what does it mean to say that these will be required, or that these will have to be accepted? Are there technological imperatives to which states will respond?¹⁰ Are there human imperatives to which states will respond?¹¹ Are there general environmental conditions, which are exacerbated by the impact of science and technology, to which states will respond?¹²

⁸ Cited in Robert Gilpin, *France in the Age of the Scientific State* (Princeton: Princeton University Press, 1968), p. 416.

⁹ Eugene B. Skolnikoff, *The International Imperatives of Technology* (Berkeley: Institute of International Studies, Research Series, No. 16, 1972), p. 153.

¹⁰ The most extensive compendium of such "imperatives" is Skolnikoff's *The International Imperatives of Technology*; see also his "The International Functional Implications of Future Technology," prepared for delivery at the 66th Annual Meeting, American Political Science Association, Los Angeles, September 8-12, 1970.

¹¹ See, for example, Richard A. Falk, *This Endangered Planet* (New York: Random House, 1971).

¹² Among the general environmental conditions which have received attention of late is that of interdependence. Much of the political science work with the concept was stimulated by Richard N. Cooper's *The Economics of Interdependence* (New York: McGraw-Hill, 1968). In Cooper's usage, the term is only loosely defined; and the political science work based on Cooper's formulation has, thus far, simply drawn our attention to the phenomenon. Among the better discus-

What kind of world order will these responses of states generate? And what will be the consequences for political life, both national and international, of whatever world order is in fact generated?

In attempting to deal with these questions, we might employ any number of available metaphors or approaches, some of which are briefly assessed in the next section. To anticipate the argument, the formulation I will propose, and which is demonstrated and illustrated below, poses the basic problem of international organization as one of national *choice under constraints*: that is, given the structure of the contemporary interstate system, what are the general conditions under which states, with differing objectives and different capabilities, choose to collaborate with others? How do developments in various sciences and technologies affect those general conditions? And what are the consequences of various kinds and levels of collaboration states choose?

Functionalism and International Organization

Among the most powerful of metaphors available to us in the study of international organization is one or another variant of "functionalist" thinking, or the belief that somehow specialized structures will evolve to perform new tasks or to fulfil new needs as these arise.¹³ The most general and most ambitious variant is that which actually postulates the existence of evolutionary trends: that in reacting to, and adapting to, its environment, a people will build for itself ever higher forms of sociopolitical organization, from tribes to baronies to global systems:

The long-run trend toward integration seems to be for functions, authority and loyalties to be transferred from smaller units to larger ones; from states to federations; from federations to supranational unions; and from these to super-systems.¹⁴

sions are Oran R. Young, "Interdependencies in World Politics," *International Journal*, 24 (Autumn 1969), 726-750; and Edward R. Morse, "The Transformation of Foreign Policies: Modernization, Interdependence, and Externalization," *World Politics*, 22 (April 1970), 371-393. The extent to which particular situations might increase the level of interdependence between states, or effect interdependencies of a new kind, is only loosely explored at best.

¹³ An excellent discussion of functionalist thinking in the context of international organization may be found in James Patrick Sewell's *Functionalism and World Politics* (Princeton: Princeton University Press, 1966).

¹⁴ This kind of argument is quite common. The particular citation is from Amitai Etzioni, "The Dialectics of Supranational Unification," *International Political Communities* (Garden City: Anchor Books, 1966), p. 147.

We might, then, simply correlate levels of technological development with levels of sociopolitical organization, and go on to postulate the emergence of supranational forms.

Albeit tempting as an intellectual shortcut, this variant of the metaphor is quite deceptive. First, it overemphasizes linear continuity, at the expense of crucial differences and discontinuities between forms of social organization. Second, it offers precious little insight to the scholar concerned with understanding and linking together the many discrete activities which such historical sweeps subsume and distort.¹⁵ Finally, it offers no guidance whatever to political actors, through whose everyday lives historical evolution is presumably expressed.

Alternatively, one might adopt a less pretentious variant of the same metaphor, that from an initial need specific organizational responses will follow:

Given the initial need and an operation of technical self-determination, the individual functional units will develop.¹⁶

Applying these notions to the functional area before us, we might conclude that:

1. All technologies in the long run have global impacts of varying intensities as a consequence of their diffusion.
2. Some technologies possess a stronger international logic than others because successful research and application are beyond the effective capacity of any single nation-state.¹⁷

Hence, a certain level of cooperation and collaboration will follow. The difficulty with this formulation is that it is essentially apolitical, relying, as it does, upon the "logic" of technology. And the step which is presumably of greatest interest to political scientists and most crucial for political actors, namely the manner in which initial needs become expressed in organizational results, "is treated as a residual consideration."¹⁸

¹⁵Note, for example, the refutation by Karl W. Deutsch and his collaborators, in *Political Community and the North Atlantic Area* (Princeton: Princeton University Press, 1957): "In this view, as villages in the past have joined to make provinces, and provinces to make kingdoms, so contemporary states are expected to join in ever-larger states or federations. . . . Our findings do not support this view" (p. 24).

¹⁶Sewell, *Functionalism*, p. 12.

¹⁷Edward Miles, "Relationships between Technology and Intergovernmental Cooperation in International Organization," Prepared for the Conference on Functionalism and the Changing Political System, Bellagio, November 20-24, 1969. Miles appears to be summarizing functionalist thought and not necessarily expressing his own theoretical preferences. The citation is from pp. 1-2.

¹⁸Sewell, *Functionalism*, p. 9. A related line of reasoning, containing elements of both this and the

Finally, the least presumptive variant of this mode of thinking might be employed, that of "neofunctionalism," particularly since it constitutes the best and the most elaborate body of theory about the processes of international organization. Thus—using an early formulation for illustrative purposes—the expectations and aims of various political actors within states in the functional area of science and technology might be investigated. Will such actors favor the international regulation of problems associated with technological developments? Will they be opposed? Or will they exhibit "convergent expectations," such purely instrumental and short-run aims which can, by "creative compromise," be translated into support for integrative policies and institutions? And do possibilities of task-expansion and spillover attend these policies and institutions?¹⁹

Neofunctionalism too has been criticized on a number of grounds; for our purposes here two aspects of the approach represent important constraints. First, by relying upon functions and functional contexts as major explanatory variables, one tends to attribute an independent existence to them:

Decisions made by identical officials, in organizations with a stable membership, in a non-revolutionary socio-ideological setting with similar institutional characteristics, nevertheless vary sharply, in terms of their integrative impact, *depending on the functional context*.²⁰

Such an attribution obscures the fact that functional contexts do not exist *apart from* a particular configuration of actor attributes in relation to any given issue: different actors' differing objectives, pursued with unequally distributed resources, define "functional" contexts. And

previous variant of the basic metaphor, argues that *because* the modern state is outmoded and ill-suited as an organizational form in the face of the interdependencies and the complexities of contemporary political life, particularly those generated by the impact of technologies, *therefore* new transnational or supranational systems will arise. (See, for example, Louis Armand and Michel Drancourt, *The European Challenge* [New Work: Atheneum, 1970].)

¹⁹This illustration, which obviously does not do justice to the subtlety of the neofunctionalist argument and research, is drawn from Ernst Haas's early work on European integration. (For a summary statement, see Haas, "The Challenge of Regionalism," *International Organization*, 12 [Autumn, 1958], 440-459.) The most recent and most extensive presentation of neofunctionalist thinking and re-evaluation is contained in *Regional Integration: Theory and Research*, ed. Leon N. Lindberg and Stuart A. Scheingold, *International Organization*, 24, No. 4 (Autumn, 1970).

²⁰Ernst B. Haas, "International Integration—The European and the Universal Process," *International Political Communities*, pp. 103-104; emphases added.

scientific or technological developments affect international organization only to the extent that they affect such a configuration.

Second, the very concern with *integration*—while having obvious relevance to ongoing political processes, particularly in Western Europe—has tended to obscure the fact that integration is itself the limiting case of a more general phenomenon, and that questions about integration are themselves a subset of a more general set of questions.²¹ Briefly, these are: given the structure of the contemporary interstate system, when, where, and how do states seek to organize activities internationally? And what particular mode of organization—coordination, collaboration, integration—is selected under what conditions? They are, then, a subset of questions about *international organization* in general. It is this more general phenomenon that I propose to analyze here.

In sum, I too am concerned with new forms of sociopolitical organization, with new international arrangements and policies, and with new aims and expectations national actors may come to hold; but I wish to make no assumptions about these evolving from new environments, following from new and inherently international needs, or being generated by new functional contexts enjoying an independent existence. Given this perspective, the problem becomes one of determining why and how states choose from among alternate modes of organizing activities, both national and international, given certain possibilities and constraints; and of suggesting the consequences thereof, for the manner in which political life is organized both nationally and internationally.

Choice, Constraints, and the Propensity for International Organization

The task for students of international organization is to specify when, where, and how states seek to organize activities internationally. Scientific and technological developments will affect international organization only to the extent that they affect a particular configuration of actor objectives and capabilities, *vis-à-vis* a particular issue. Hence, we must first inquire into the basic dynamics of international organization in the contemporary interstate system. Only then can we speculate about the likely impact of scientific and technological developments.

My purpose here will be to demonstrate and

²¹ The difficulties entailed by this particular limitation of the approach are encountered whenever the original formulations are applied to a geographical region other than Western Europe, or at the global level.

to illustrate one possible theoretical system allowing the exploration of these questions. In order to keep the discussion manageable, the focus throughout will be limited to an individual actor's changing propensity to organize activities internationally, as that actor faces different possibilities and constraints. The analysis is based upon certain assumptions about the structure of the contemporary interstate system and about states as actors within that system; these must first be explicated.

The contemporary interstate system is here viewed as a modified Westphalia system.²² In theory, since the Peace of Westphalia the interstate system has been a decentralized one: states are subject to no external earthly authority, and there exists no organization *above* states, only *between* them. The Westphalia system consists of a multiplicity of independent states, each sovereign within its territory, and each equal to every other. It recognizes only one organizing principle, the will of states, thereby giving the collective decision-making system its decentralized character. In practice, the Westphalia system has become partially but progressively modified: spheres of influence modify the principle of equality; supranational actors modify the principle of no external earthly superior authority; an ever more complex pattern of interconnectedness of decisions, events, and developments modifies the principle of independence. And to the extent to which states subsequently "will" collective principles and forms of decision making, the decentralized character of the system is itself modified—much as the market economy is modified by governmental intervention and regulation.²³ In fact, one can sensibly speak of an interstate system only insofar as the international organization of activities exists, however informal or minimal it may be.

Thus, I view the contemporary interstate system as a partially modified Westphalia system: still essentially decentralized, and based upon the will of states, but with each state willing to accept and to engage in some form and some

²² A superb discussion of the origins and significance of the Westphalia conception is presented by Leo Gross, "The Peace of Westphalia, 1648–1948," in Richard A. Falk and Wolfram F. Hanrieder, eds., *International Law and Organization* (Philadelphia: J. B. Lippincott, 1968); an equally good discussion of the various modifications the Westphalia system has undergone is Falk's "The Interplay of Westphalia and Charter Conceptions of International Legal Order," in Richard A. Falk and Cyril Black, eds., *The Future of the International Legal Order*, Vol. I (Princeton: Princeton University Press, 1969).

²³ This is the analogous situation I wish to exploit for proposition and insights.

extent of international organization. An understanding of the basic dynamics of international organization, then, entails the determination of when states will seek to organize activities by means of informal arrangements and when by institutionalized; when the arrangements will concern simply the coordination of unilateral behavior, and when actual collaboration in joint enterprises; when arrangements will deal only with the exchange of information, and when with joint and binding decision making.

Further, in the context of the kinds of alternatives here posed, I view states as knowing what it is they will, and of being able to order the various things they will in terms of priority. Moreover, I view them as preferring to accomplish more of an objective rather than less, and of wishing to do so with the least necessary expenditure of limited resources. Finally, in keeping with the basic structure of the interstate system, I view states as preferring to limit their dependence upon others to the least necessary level above that assumed for all states.

The analysis will begin with the least complex case, that of one state pursuing one objective; and with the least complex issue, that of what combination of international and national organization that state will choose in pursuing its one objective. A state may tend toward greater international organization of an activity, or international performance of a task or resolution of a problem (with "international" referring, for the time being, to any "extranational" form), to the extent to which it discovers the inadequacy (or lack) either of one or of both of two resources. These are: (1) physical capabilities, which may be inadequate simply because there are not enough of them, or which may be irrelevant because the extant definition of property rights places the source of the problem within the jurisdiction of another; and (2) knowledge of cause/effect relations underlying either problems or solutions. These two resources will be referred to as "capabilities" and "techniques," respectively.

Thus, the inadequacy (or lack) of either capabilities or techniques, or of both, may lead a state to seek to cooperate with others. At the same time, however, cooperating with and thereby becoming dependent upon others for either capabilities or techniques itself poses a problem for that state, by giving rise to "interdependence costs,"²⁴ reckoned in such terms as

²⁴ The concept of "interdependence costs" is used by James M. Buchanan and Gordon Tullock, in *The Calculus of Consent* (Ann Arbor: University of Michigan Press, 1962), to refer to the sum of "external costs" (those incurred through the actions of others in

circumscribed options or general loss of autonomy.²⁵ These are incurred over and above the more direct payments, to whatever institutional arrangement the state has selected, for the cost of performing the task. Given our assumptions, even though such costs may not appear significant, or may not be calculable, for any one particular arrangement, over the long run a state is expected to seek to keep such interdependence costs to the least necessary level. Hence, in calculating a state's propensity to organize activities internationally, not only the direct gains and the direct costs of performing a task with others will be considered, but the overall interdependence costs too will be included.

Thus, it follows that *the propensity for international organization will be determined by the interplay between the need to become dependent upon others for the performance of specific tasks, and the general desire to keep such dependence to the minimum level necessary. A point demonstrating that relationship can now be defined.*²⁶

The General Model.²⁷ For the time being, imagine a world consisting of: two completely identical states—identical preferences, capabilities, techniques—states *A* and *B*, where *B* simply refers to the composite of "all other states in the system"; two fixed resources (that is, the level of capabilities and techniques is limited) to be expended in the pursuit of a given task; state *A* being confronted with the choice of through which combination of organizational arrangements, national and international, to perform the given task; an autonomy of decisional contexts, so that decisions made in one context remain independent of decisions made in another; constant returns to scale (that is, changes in inputs

the collective arrangement) and "decision-making costs" (the costs of participating in a collective arrangement). Here I use the concept to mean a more general loss of independence or loss of control over one's own activities, resulting from the accumulation of collective constraints.

²⁵ Cooper, in *The Economics of Interdependence*, describes such constraints in international economic affairs.

²⁶ By propensity is meant what a state will try to accomplish, or that which it wishes and technically can accomplish; it does not define the ultimate outcome since that, of course, depends upon others as well. This latter dimension is introduced into the analysis in a later section.

²⁷ The figures accompanying the verbal argument which follows do not constitute a formal deductive model in the strict usage of the term. Instead, they are intended as diagrammatic representations of the various assumptions and modifications which are introduced into the analysis, and are utilized so that the latter can be more effectively demonstrated.

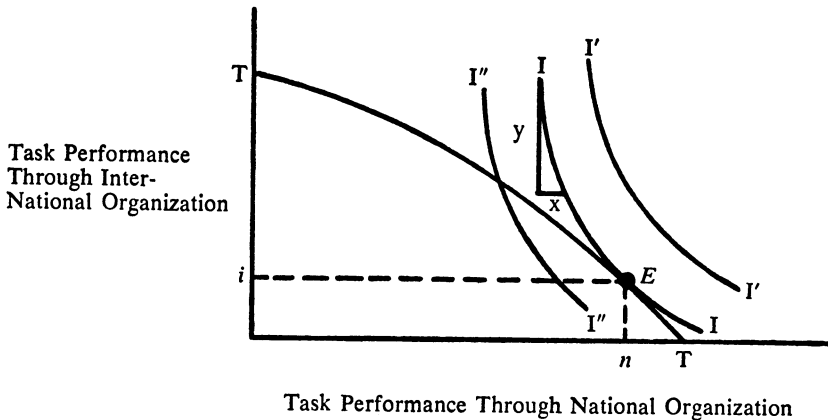


Figure 1. The General Model

by *A* into either international or national arrangements yielding proportional changes in the respective levels of task performance); and, finally, no direct interaction between *A* and *B*.

In calculating the combination of organizational arrangements *A* will select, the first problem is determining the optimum allocation of *A*'s resources (capabilities and techniques), between national and international organizational arrangements, given a fixed contribution to the latter on the part of *B*. Analytically, this determination consists of finding the locus of points at which the resources are so allocated that it is no longer possible to increase performance through international arrangements without decreasing the level of performance through national arrangements, or vice versa.²⁸ From such a locus of points, the feasible and efficient combinations of national and international task performance that *A* can secure can be plotted. Every point on the curve—called a transformation curve, and labeled *TT* in Figure 1—is both feasible and efficient; any point between the curve and the origin is inefficient (since greater total performance can be obtained), while any point beyond the curve, away from the origin, is infeasible (since it is beyond the scope of *A*). The slope of the curve at any point indicates precisely how much more international performance can be obtained by transferring re-

sources from national arrangements, and vice versa.

Curve *TT*, however, plots only one of the two factors which go to make up our basic premise, the level of national resources. Juxtaposed to the "utility" (satisfaction) derived from cooperating with others in the performance of any one particular task, it was argued above, is a general desire to keep dependence upon others limited. These preferences are represented in the curves labeled *II* in Figure 1. They are "indifference" curves, plotting the combinations *A* views as being equally acceptable. That *A* derives satisfaction from the international performance of a task is represented by the very existence of indifference curves. That any state wishes to keep dependence upon others limited is represented by the slope of the curves: as shown on *II*, the ratio of *y* to *x* is quite large, indicating that before *A* would be willing to relinquish one unit of *x*, the payment in terms of units of *y* would need to be high indeed. An entire map of such curves exists, each one ranking preferences for a total level of utility.²⁹

In sum, the curve *TT*, or transformation curve, plots what *A* is able to do: the curves *II*, or indifference curves, plot what *A* would like to do. What *A* will seek to do is defined at the point at which the two come together. Such a point, measured by the ratio of *i* to *n*, is point *E* in Figure 1. Here *A* is in equilibrium. For, at the point of tangency between the transformation curve and an indifference curve, their

²⁸ Formally, this locus consists of the points of tangency between the "production isoquants" of the two goods. While there is no need to pursue it here, the interested reader might wish to consult Michael J. Brennan, *Theory of Economic Statics* (Englewood Cliffs: Prentice-Hall, 1965), Chap. 31; Edwin Mansfield, *Microeconomics: Theory and Applications* (New York: W. W. Norton, 1970), Chap. 14; and, in particular, Francis M. Bator, "The Simple Analytics of Welfare Maximization," *American Economic Review*, 47 (March, 1957), 22-59.

²⁹ The fact that the indifference curves are represented as being asymptotic to the axes indicates that diminishing marginal rates of substitution too are assumed; that is, extreme cases of complete internationalization and complete isolation are both excluded from the preferences of states in this analysis.

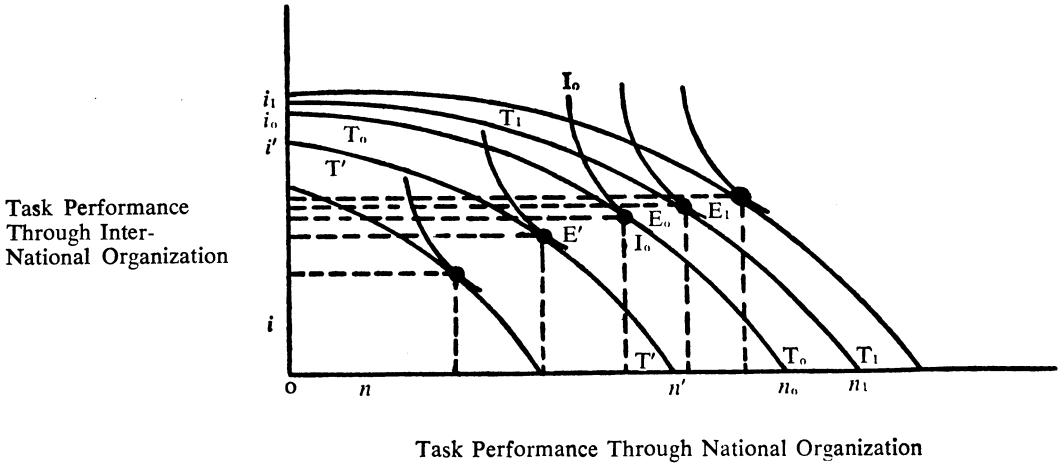


Figure 2. The Impact of Inequality of National Resources

slopes being equal, the extra benefit or satisfaction gained by foregoing one extra unit of n for one extra unit of i , or vice versa, is just equal to the extra cost of transforming one more unit of one into the other. At E

$$(1) \text{MRS} - \text{MRT} = 0,$$

where MRS refers to the marginal rate of substitution in consumption (loosely speaking, the extra satisfaction gained), and MRT refers to the marginal rate of transformation in production (roughly speaking, the extra cost, of one in terms of the other).³⁰ The coordinates of the point E mark the combination of organizational arrangements A will select. Given our assumptions, a state can do no better, nor ought it do worse, than being at E .

Thus, the propensity for international organization, a resultant of the interplay between the need to become dependent upon others for the performance of particular tasks, and the general preference to keep such dependencies limited, is defined by the coordinates of the point E . While it may well be impossible to operationalize such a point in an empirical setting, there is no pressing need to do so here. For the

purposes set forth, it will be sufficiently instructive to relax a number of the initial assumptions, to introduce additional conditions, and then to compare the different points of equilibria of nonidentical actors under dissimilar conditions.³¹ The first assumption to be relaxed is the identity of states: inequality of national resources is introduced, and its impact postulated.

Inequality of National Resources. Since complete identity of states was assumed in the above formulation, only one point of equilibrium was determined. We shall now want to relate inequality of national resources to the propensity for international organization.

Figure 2 repeats the general model for state A : a transformation curve, T_0T_0 , a set of indifference curves, I , and the point of equilibrium at point E_0 . The transformation curve, it will be remembered, is the locus of points indicating the efficient and feasible combinations of both national and international task performance, and it assumes a fixed level of resources. If A 's level of resources were, however, actually lower than that assumed in the plotting of T_0T_0 , clearly the overall level of possibilities would de-

³¹ In the context of more sophisticated and discrete analyses, it may, however, be desirable to operationalize the point E . In that case, some of the technical suppositions of the formulation, resting, as it does, upon differential calculus, might prove to be a constraint. In particular, it might be found that the resources available to a state are not perfectly substitutable, and that the objects of choice are not continuously divisible. While different mathematical systems (such as set theory) are now beginning to be utilized in this area of inquiry, much of the work in the theory of collective goods is based upon the mathematics of a prior vintage. For our exploratory intent, the latter will suffice.

³⁰ The precise formulation would require taking partial derivatives of the transformation and utility functions, the point of equilibrium being where the slope of one minus the slope of the other equals zero. Where lower-case u 's and t 's refer to these partial derivatives, a to state A , the case for B being identical,

$$(1.1) \quad \frac{u^a I_a}{u^a N_a} - \frac{t^a I_a}{t^a N_a} = 0.$$

For a geometric and algebraic demonstration, see James M. Buchanan, *The Demand and Supply of Public Goods* (Chicago: Rand McNally, 1968), chap. 2. I have found Buchanan's volume to be an enormously helpful formulation of public goods phenomena.

crease, and the transformation curve would shift inward, toward the origin. Similarly, were A 's level of resources to be higher, the transformation curve would shift outward, away from the origin. The original x-intersect (marking the total level of national performance A could secure if all of its resources were spent nationally) was at point n_0 . In the case of lower resources the x-intersect will have shifted to a point such as n' , and in the case of higher resources to n_1 .

What of the y-intersect? Even though A 's contribution within an international arrangement might decrease, it is reasonable to assume that the total level of international performance from which A is able to benefit does not decrease by a like amount, *provided* that the contribution of B remains constant. Hence, the y-intersect too will shift toward the origin, but *not* by as great a magnitude as the x-intersect. Similarly, in the case of higher national resources, the y-intersect will increase but *not* by as great a magnitude as the x-intersect, since the increased benefits from international performance will have to be shared with B . In short, rather than assuming constant returns to scale in the international performance of a task, we recognize and assume the more realistic situation of increasing returns to scale for countries with smaller resource bases, and the possibility of decreasing returns to scale for countries with high levels of national resources.

As a demonstration, five situations are plotted in Figure 2, two with higher, and two with lower levels of resources than the original (T_0T_0). Both n and i can be seen to increase as resources increase, and decrease as resources decrease, but not by like amounts. The points of equilibria, or the combination of the two which will be selected, however, indicate that the *ratio* of i/n *increases* the *lower* the level of national resources, and *decreases* the *higher* the level of national resources. More precisely, *there is an inverse relationship between the ratio of i/n and the total level of national resources.*

An additional implication is that a state's propensity to organize internationally will change over time, as its national resource base changes. This implication will now be explored, introducing another dimension, time.

Changes in Resources Over Time. If we take Figure 2 as representing the same state at different points in time, the postulated impact of changing levels of national resources over time can be demonstrated. In Figure 2, as national resources rise (represented by the transformation curves moving further away from the ori-

gin), the combination of i and n change: i increases, but at ever-smaller increments, and eventually levels off; n , on the other hand, continues to rise (as long as resources rise, and as long as the specified task remains to be performed). What this indicates is that—under the assumed conditions—as national capabilities increase and become sufficient to perform a given task, the propensity for international organization (in that instance) decreases.

Put differently, over the long run i will respond little, and eventually not at all, to increases in national resources, whereas n always responds positively. Were we to calculate a coefficient of responsiveness of i to changes in national resources, R , taking the percentage change in i over the percentage change in R , then

$$(2) \quad \frac{\frac{\Delta i}{i}}{\frac{\Delta R}{R}} \approx 0.$$

Likewise, the coefficient of responsiveness of national performance to increased resources will be positive.

Hence, *built into the international performance of any given task is a process of encapsulation—ending in the situation in which no further commitments are made, and in which no further increase in the scope of the collective arrangement nor in its institutional capacity occurs.* And the generally expected processes of task-expansion and spillover will *not* take place *unless* those factors now held constant change. Thus, to predict the growth and impact of collective arrangements internationally, it will not do—in view of the perspective here developed—simply to point to new problems that states will face (such as those generated by science and technology), then to posit new tasks for international arrangements, and finally to draw inferences on that basis. For unless the constants are shown to change, such growth will be truncated.

In the analysis thus far the cases selected have been simple and the conceptual categories utilized have been nondiscriminating. Nevertheless, a number of propositions, characterizing basic behavioral tendencies of states, have been developed:

- (1) The propensity for international organization is determined by the interplay between the need to become dependent upon others for the performance of specific tasks, and the general desire to keep such dependence to the minimum level necessary.

The point of equilibrium was defined; the impact of varying conditions upon this point demonstrated that

- (2) There exists an inverse relationship between the ratio of i/n and the total level of national resources.
- (3) Over time, as national capabilities increase and become sufficient to perform a given task, the propensity for international organization (in that instance) decreases.
- (4) Built into the international performance of any given task is a process of encapsulation, which will end in the situation of no further commitments to, and no further increase in scope or capacity of, the collective arrangements.

These propositions are based upon, and follow from, the assumed conditions.

To speculate intelligently about the probable impact of specific scientific and technological developments upon the processes of international organization, more refined categories and more complex cases will have to be introduced. But since these will be based on the analysis thus far, the above propositions must first be illustrated and the utility of this mode of analysis thereby demonstrated.

The Propositions Illustrated

Two fundamental changes, a preoccupation with the production of publicly-relevant goods, and a preoccupation with goods which are produced and/or purchased communally, are said to characterize the transformation of the advanced industrial societies. Our concern is with a parallel phenomenon internationally: the extent to which joint production and joint regulation of goods and services are selected by states, particularly in response to developments in science and technology. In offering some preliminary illustrative observations, I will limit myself, then, to the advanced industrial states, to those generating and most immediately affected by sciences and technologies.³²

The General Model. The extent of international organization among the industrialized states is, first and foremost, the result of the interplay between the need to become dependent upon others for the performance of particular tasks, and the general desire to keep such dependencies to the minimum level necessary. The most telling illustration of this principle is offered by the most extensive experiment in international organiza-

³² Even though the model deals with any form of international organization, the following illustrations are drawn from intergovernmental organizations, simply because data from these are more readily available.

tion extant, the European Community. Pointing to the "very special conditions" out of which the Community grew, two of its students have concluded that it emerged

... in part at least, as a result of the inability of national systems to process certain kinds of economic, social, and welfare demands. Its continued growth will be a function of its ability to provide decision capabilities that national governments acting alone cannot command.³³

The concomitant desire to limit the dependencies incurred through collaborating with others has been exhibited by the European case as well, and has been most succinctly expressed by General de Gaulle. Speaking of collaboration in science and technology, he said

... when it is opportune in a selected branch to join our inventions and money and skill with those of another country, we must choose the country nearest to us and whose weight would not crush us.³⁴

Finally, the Community experience offers examples of the interplay between these two factors as well. Summarizing these tendencies on the part of member governments,

... the history of *Euratom* bears out their fear of supranational European organizations in which decisions are taken by majority vote and individual countries cannot exercise a veto.³⁵

The evidence suggests that one reason *Euratom's* performance has been so disappointing is that the final organizational arrangement turned out to entail dependencies far in excess of the need to become dependent—Suez was reopened, new sources of natural gas were discovered, new and larger tankers were introduced and ocean freight rates, therefore, were lowered, and the need for nuclear fuel consequently diminished. A less demanding organizational context, while equaling *Euratom's* successes, might have avoided its severe difficulties.³⁶

Thus, national actors within the European Community appear to organize activities collec-

³³ Leon N. Lindberg and Stuart A. Scheingold, *Europe's Would-Be Polity* (Englewood Cliffs. Prentice-Hall, 1970), p. 95.

³⁴ Cited in Gilpin, *France in the Age of the Scientific State*, p. 377.

³⁵ Gilpin, p. 407.

³⁶ I base this judgment on Gilpin's account, in the volume previously cited; upon an excellent analytical study of *Euratom* by Lawrence Scheinman ("Euratom: Nuclear Integration in Europe," in *International Regionalism*, ed. J. S. Nye, Jr., [Boston: Little, Brown, 1968]); and a detailed documentary and historical account by Warren B. Walsh (*Science and International Public Affairs* [Syracuse: The Maxwell International Relations Program, 1967]).

tively, first and foremost, to meet certain salient demands which otherwise cannot be met. Once collective organization and performance are decided upon, their extent would appear to be limited by the desire to be no more dependent upon others than is necessary. This interplay is expressed by the point of equilibrium of the general model (Figure 1). To illustrate the postulated changes in that point of equilibrium, we will examine the behavior of the industrialized countries in two areas: (1) the development of their own scientific and technological capabilities, and (2) their response to the needs of the Third World. We would expect actual behavioral tendencies in both areas roughly to approximate those postulated; the illustrations which follow suggest that this is generally so. Yet systematic differences of behavior in the two areas appear to exist as well, and these suggest the direction that more discrete and discriminating analyses might take.

Inequality of National Resources. Under the conditions assumed, it was argued that an inverse relationship exists between the ratio of i/n and the total level of national resources. To illustrate this relationship, we shall first take the economic and social development of the Third World as a "task," and the members of the Development Assistance Committee (all except Portugal) as the universe of industrialized countries engaged in the performance of that task. The proportion of net official resources distributed to developing countries through multilateral agencies will constitute our measure of i , while that proportion distributed bilaterally will constitute our measure of n . We expect an inverse relationship between the multilateral/bilateral assistance ratio, and the total level of national resources, the measure of which is GNP. Table 1 displays this relationship.

The ratio of multilateral/bilateral assistance is indeed negatively correlated with the total level of national resources (GNP). The negative correlation is high, and almost equally so for the entire nine year period for which it was calculated. Hence there does appear to be an inverse relationship between i/n and the total level of national resources.

In addition, however, in examining Table 1 we find another and equally interesting inverse relationship, i.e., between the *percentage* of GNP devoted to development assistance, and the ratio of multilateral/bilateral assistance. This relationship suggests an additional proposition, namely, that the higher the *proportion* of national resources devoted to a particular task,

the lower the ratio of i/n . This proposition is illustrated in the context of the funding of research and development as well.

Taking as a "task" the financing of research and development by those industrialized countries about which comparable information is available, we include two measures of i and two of n . For the former, the calculations were based upon total governmental expenditures for R & D abroad, and total governmental R & D expenditures in selected intergovernmental organizations. For the latter, the corresponding calculations were based upon total governmental expenditures for R & D, and total governmental domestic expenditures on R & D.³⁷ Again we expect an inverse relationship between the i/n ratio and the proportion of national resources (% GNP) devoted to R & D (GERD). Table 2 displays this relationship.

All four expressions of the ratio of i/n are negatively correlated with the proportion of national resources devoted to R & D. While calculations could not be performed for a period of years, it was possible to compare the "global" sample of industrialized countries with a smaller "European" sample. In all cases the inverse relationship is substantial, although it is systematically lower than in the case of development assistance distribution.³⁸ In other words, generally similar behavioral tendencies are exhibited in both areas, but differences too appear to exist; their significance is turned to later in the analysis.

Thus, as expected, the condition of possessing a certain level of national resources seems to be related to a state's propensity to organize the performance of a task internationally. In addition, however, the proportion of national resources a state has chosen to allocate to the performance of a task will show much the same effect. Both have interesting implications for the future, should national resources with which to perform tasks, and national priorities

³⁷ Data on international R & D expenditures are difficult to obtain. The various sources utilized, and the various procedures by means of which the measures were arrived at, are described in the notes to Table 2.

While expenditures have changed since 1963/64, the pattern of expenditures appears reasonably stable. International R & D funding increased from 1963 to about 1968 (Louis Villecourt, "Forms of Cooperation," *Problems of Science Policy* [Paris: OECD, 1968]). Since then, "as far as the increasing share of national science budgets going to international projects is concerned in different OECD states, it seems that this share has either stabilized or even slightly decreased" (Louis Villecourt, private communication to the author, 4 June 1970).

³⁸ This is true of the relationship between the i/n ratio and GNP as well, the R & D correlations there being lower still.

Table 1. Development Assistance Correlations:^a Showing Inverse Relationship Between National Resources and the Ratio of Multilateral/Bilateral Assistance 1960-1968

	1960 ^b			
	(1)	(2)	(3)	(4)
(1) GNP	—			
(2) Total assistance	.76	—		
(3) Total as % of GNP	.37	.71	—	
(4) Ratio of multi/bilateral	-.43	-.81***	-.85***	—
	1962 ^c			
	(1)	(2)	(3)	(4)
(1) GNP	—			
(2) Total assistance	.92	—		
(3) Total as % of GNP	.71	.90	—	
(4) Ratio of multi/bilateral	-.76**	-.77**	-.68*	—
	1964 ^d			
	(1)	(2)	(3)	(4)
(1) GNP	—			
(2) Total assistance	.93	—		
(3) Total as % of GNP	.69	.87	—	
(4) Ratio of multi/bilateral	-.73**	-.78***	-.70**	—
	1966			
	(1)	(2)	(3)	(4)
(1) GNP	—			
(2) Total assistance	.95	—		
(3) Total as % of GNP	.57	.75	—	
(4) Ratio of multi/bilateral	-.68**	-.79***	-.75**	—
	1968 ^e			
	(1)	(2)	(3)	(4)
(1) GNP	—			
(2) Total assistance	.95	—		
(3) Total as % of GNP	.37	.56	—	
(4) Ratio of multi/bilateral	-.83***	-.81***	-.31	—

$P < .001$ ***

.01 **

.05 *

^a An examination of scattergrams, on which actual amounts were plotted, evidenced the effect of one or two extreme values, at both ends, in GNP and in Total Assistance. Therefore, the correlations here reported are based on rankings, using the *rho* coefficient. Correlations were computed for each year, from 1960-1968, and those reported here are representative. Moreover, the correlations were also calculated on the basis of actual amounts, with the coefficient being systematically lower, but still substantial and negative.

^b The sample is drawn from members of the Development Assistance Committee; for 1960 these included Belgium, Canada, France, Germany, Italy, Japan, Netherlands, United Kingdom, and the United States.

^c In 1962, disbursements of Austria, Denmark, and Norway were reported as well.

^d In 1964 Sweden and Australia too were added.

^e The 1968 DAC group included Switzerland.

Sources: For GNP: OECD, *National Accounts of OECD Countries: 1957-1966* (Paris: 1968); OECD, "The OECD Member Countries," 4th Year, 5th Year, 6th Year, Supplements to the *OECD Observer*; United Nations, *Yearbook of National Accounts Statistics*, Vol. I (New York: 1969). For development assistance: OECD, *Development Assistance Efforts & Policies*, annual reviews, 1961-1969.

about what tasks to commit resources to, change.

Changes in Resources Over Time. In the absence of further specifications, it is difficult to illustrate the proposition that as national capabilities be-

come sufficient to perform a given task, the propensity for international organization in that instance decreases. One would need to calculate, for instance, precisely when capabilities had become adequate. For illustrative purposes only, we might consider the case of three small Euro-

Table 2. R & D Correlations:^a Showing Inverse Relationship Between Proportion of National Resources Devoted to R & D, and the Ratio of International/National R & D Expenditures 1963/1964

	"Global" Sample ^b (1)	European Sample ^c (1)
(1) Percentage of GNP Devoted to Gross National Expenditures on R & D (GERD)	—	—
(2) Governmental R & D Expenditures Abroad/ ^d Total Governmental R & D Expenditures ^e	-.53	-.54
(3) Governmental R & D Expenditures in Selected Intergovernmental Organizations/ ^f Total Governmental R & D Expenditures	-.58*	-.63*
(4) Governmental R & D Expenditures Abroad/Governmental Domestic R & D Expenditures ^g	-.52	-.53
(5) Governmental R & D Expenditures in Selected Intergovernmental Organizations/Governmental Domestic R & D Expenditures	-.56*	-.61*

$P < .05$

^a The various ratios, on the basis of which these correlations were computed, are far more comparable than are the actual dollar amounts in the case of the development assistance correlations. There was, therefore, no reason not to use the actual ratios in computing r . Nevertheless, because of the small sample, and to assure maximum possible reliability, a number of additional calculations were performed, including computing levels of significance (with the results as shown in the body of the table), and generating scatterplots for each set of relationships (with visual confirmation of r).

Moreover, since no single source of data on international R & D expenditures is either complete, or completely reliable, every attempt was made to assure the *comparability* of the figures collected from more than one source. In addition, where discrepant figures could not be avoided, the various ratios were calculated on the basis of both. In *no* case did using one as opposed to another figure affect the relative positions of the countries in the sample, nor was the final coefficient affected in any significant way.

^b The "global" sample of highly industrialized countries for which comparable R & D expenditure statistics could be found were: Austria, Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Norway, Sweden, United Kingdom, United States.

^c Since the "selected intergovernmental organizations" might be thought to be biased in favor of the European countries, an additional set of calculations on these alone was performed. The European sample consists of all countries listed in note *b* above, but Canada, Japan, and the U.S.

^d The basic figure for governmental expenditures abroad came from OECD's *ISY* (see *Sources*, below), which included an account labeled "Governmental extramural expenditures for R and D to abroad." These were admittedly incomplete and incorrect in some cases, apparently so in others. Where possible, the OECD country reviews of science policy (see *Sources*, below) were consulted and, where necessary, adjustments were made.

^e The basic figure for total governmental expen-

ditures came from *ISY*, adding expenditures to abroad to total intramural expenditures (i.e., domestic). Since the same conditions held as described in note *c* above, the identical procedures were followed.

^f Since, to my knowledge, no published source on national participation in internationally collaborative R & D ventures at *all* levels, including the regional and global, exists, a set of intergovernmental organizations, for which comparable data could be found, was selected. Thus, expenditures in "selected intergovernmental organizations" refers to: UNESCO, IAEA, WMO, the Science Committee of NATO, ENEA, CERN, EURATOM, ELDO-ESRO. These figures derive from national responses to an OECD questionnaire; I am grateful indeed to M. Jean-Jacques Salomon, Head of the Science Policy Division, for making these available to me.

^g The basic figure for total governmental domestic expenditures came from *ISY*. Since the same conditions held as described in note *c* above, the identical procedures were followed.

Sources: For GNP (at market prices): OECD, *National Accounts of OECD Countries: 1957-1966* (Paris: 1968); for GERD: OECD, *International Statistical Year for Research and Development*, Vol. II, *Statistical Tables and Notes* (Paris: 1968).

The remaining statistics, with the exception of expenditures in selected intergovernmental organizations, are from *ISY*, and from the following country reviews: OECD, *Reviews of National Policy for Science and Education: Sweden* (1964); OECD, *Reviews of National Science Policy: Belgium* (1966); *France* (1966); *United Kingdom-Germany* (1967); *Japan* (1967) *United States* (1968); *Italy* (1969); *Canada* (1969).

The figures for international organizations came from: OECD, *National Participation in International Scientific Undertakings: Replies received from Member Countries*, Interim Committee Reference Papers on "Problems of International Co-operation in Scientific and Technological Research," prepared for the Ministerial Meeting on Science, 12th and 13th January, 1966.

Table 3. Increasing National Resources and the Ratio of Multilateral/Bilateral Assistance

	1962		1968	
	GNP†	Ratio	GNP	Ratio
Austria	7.29	14.167	11.40	.951
Denmark	7.44	9.571	12.39	.816
Norway	5.32	4.750	9.02	.840
U.S.*	569.12	.079	880.77	.075

Sources: Same as for Table 1.

† Billion \$U.S.

* Included for comparative purposes.

pean states which first appeared in the Development Assistance Committee in 1962—Austria, Denmark, and Norway—and compare the ratios of i/n in that year with the much reduced ratios in 1968. These are displayed in Table 3. GNP, of course, increased year by year.³⁹

Similarly, it is difficult to illustrate the proposition that built into the international performance of any given task—all else remaining constant—is a process of encapsulation which will ultimately result in the situation of no further commitments to, and no further increase in, the scope of the collective arrangement. Here, for instance, we would need to specify just how long the long run is. But again, for purely illustrative purposes, consider the “coefficients of responsiveness” of equation (2) as applied to multilaterally distributed aid (c_i) and bilaterally distributed aid (c_n), respectively, where GNP is taken to represent the level of national resources (R). Taken over the entire range of years, 1960–1968, $c_i = .001$, or very nearly zero, even though the calculation is based upon the nine members of the DAC in 1960, whereas the 1968 calculation is based upon fifteen members. On the other hand, taken over the entire range of years, $c_n = .114$.

My intent is to develop a theoretical system on the basis of which to analyze the impact of scientific and technological developments upon international organization. A number of basic behavioral tendencies of states, under varying conditions, have been postulated, and these have been illustrated in the context of some actual issue areas. The analysis and illustrations suggest that as levels of national resources become inadequate for the performance of tasks—as is generally argued to be the case with problems and possibilities posed by scientific

and technological developments—the propensity to organize the performance of such tasks internationally will increase. But this initial tendency may be counteracted under several conditions: first, should national resources in general increase; second, should the proportion of national resources devoted to the performance of a task increase, as a result, for example, of a reordering of national priorities.

In addition, the illustrations suggest a further dimension which has been neglected thus far, that states' general propensities may come to be modified depending upon the extent to which it is situationally possible to act these out. For example, the inverse relationships reported in Table 1 are systematically more substantial than those in Table 2. One possible explanation is that the basic behavioral tendencies the model portrays operate to a greater extent in the area of development assistance funding than in the financing of research and development. This in turn may be due to the greater unilateral control the industrialized states have over aid and its distribution than over the more intense and immediate interdependencies generated by science and technology. To pursue these possibilities, and to engage in more specific speculation, at least one crucial dimension must be added to the model: the impact of the behavior of one state upon another.

Theoretical Extensions and the Impact of Selected Technological Developments

Our analysis of the conditions under which a state would seek the joint production or joint regulation of goods and services internationally, and of the conditions and policy decisions which might counteract such a tendency, explored only an exceedingly restrictive case: that of no direct interaction between states; that of a completely undifferentiated conception of task or activity; and that in which the international organizational arrangement was simply any extranational form. Yet we know that the activities of one state are affected by others, and, in turn, have consequences for others—that there is a collective dimension to the behavior of states, which may well be increasing in scope and in importance as a result of precisely the kinds of issues we wish to analyze. In addition, we know that different kinds of activities lead to different forms of organizational arrangements internationally. Here I will seek to demonstrate that different kinds of activities will lead to different organizational forms, *not* because of *a priori* substantive differences, but because of the impact of the collective dimension that the behavior of states may exhibit.

³⁹ The percentage of GNP devoted to development assistance in 1968 by each of the three was at least twice that of 1960. Comparable R & D information was not available.

Hence, a number of extensions in the analysis will be developed and illustrated. The first postulates some modifications in a state's general propensity to organize activities internationally (as defined by point *E* in Figure 2), resulting from the recognition that its behavior in the performance of a task is affected by and has consequences for others. The second differentiates various kinds of international collaborative arrangements, which may subsequently be created, from international organization in general. Finally, these theoretical extensions will be illustrated in the context of internationally significant issue areas which are affected by scientific and technological developments.

The behavior of a state in the performance of a task may exhibit collective characteristics. To the extent that these affect others significantly, we might expect some measure of collective activity to follow. In exploring this relationship, we must first explicate more rigorously the notion of "collective characteristics."

According to the classical definitions, goods and services are of two polar types: either purely private or purely collective (or public). Purely private goods and services (X_1, X_2, \dots, X_n) can be parceled out among different individuals (1, 2, ..., *s*) so that this relation is satisfied:

$$(3) \quad X_j = \sum_{i=1}^s X_j^i .$$

That is, the good or service, *j*, is completely divisible, so that the total quantity of it available to the group equals the sum of the quantities of it available to the individuals within the group. On the other hand, purely collective goods and services ($X_{n+1}, X_{n+2}, \dots, X_{n+m}$) are common to the group, in the sense that the benefits are perfectly indivisible among the separate individuals, and this relation is satisfied:

$$(4) \quad X_{n+j} = X_{n+j}^i .$$

That is, the total quantity of *n* + *j* available to the group is precisely the same as that available to any *i*th member of the group, and no one individual's consumption of the good in any way subtracts from the consumption of any other.⁴⁰

Thus, for example, were *A*'s performance of a task to exhibit pure collective characteristics, the benefits of its activities would be extended to each and every member of the entire system.

⁴⁰ These standard definitions of private and public (or collective) goods were first developed formally by Paul Samuelson, in "The Pure Theory of Public Expenditures," *Review of Economics and Statistics*, 36 (1954), 387-389.

If those benefiting from *A*'s activities fail to pay for those benefits, and if state *A* acts in accordance with our assumptions, then *A* might cease those activities providing collective benefits, or seek to have their production organized collectively.

These are polar types, and their applicability would appear to be limited to very special cases indeed. Yet, a closer examination of the concept of collective goods reveals two major dimensions, yielding a more discrete and more generally applicable fourfold classification.

The first basic dimension of a collective good is that, rather than being perfectly divisible, in the sense that each producer captures the full benefits of his own product, the good is in "joint supply," or is "indivisible." By joint supply is meant that once the good or service is produced or performed, for and by one producer, its extension to others is facilitated: "once produced, any given unit of the good can be made equally available to all." And, up to a point, its extension to one additional individual does not imply a corresponding reduction in the quantity of that good available to others.⁴¹

Simply because such an "indivisibility of product," or "equal potential availability" exists, however, does not necessarily imply that the good *must* be made equally available to all; it may be perfectly possible to exclude outsiders. In essence, it means only that the opportunity cost of extending the good or service to one additional individual may be virtually negligible.⁴²

There is, in addition, a second basic dimension of a collective good. Instead of being able to limit the utilization of it to those participating in its production, a state may confront "impossibility of exclusion," or "nonappropriability of costs." In other words, it may not be possible to exclude others from sharing, or to charge them the full cost of sharing, the benefits of the good. (Or, it may not be possible to exclude oneself from the suffering caused by the production of a good by others, nor to obtain compensation for such suffering.)⁴³

But impossibility of exclusion or nonappropriability of costs do not necessarily imply that the good in question is in joint supply; in the technical sense it may be perfectly divisible. What is implied is that there exist "imperfec-

⁴¹ The classification and the various definitions are based upon an extraordinarily clear presentation of the concept of collective goods by J. G. Head; see "Public Goods and Public Policy," *Public Finance*, 17 (1962), 197-219; this particular definition appears on pp. 201-202.

⁴² Head, p. 207.

⁴³ Head, p. 203.

tions in property titles," making it impossible to contain benefits or exclude suffering.⁴⁴

In sum, the two basic dimensions of a collective good lead to the following four-fold classification of all goods and services:

	Perfectly Divisible	In Joint Supply
Possibility of Exclusion/ Appropriability of Cost	(1)	(2)
Impossibility of Exclusion/ Nonappropriability of Cost	(3)	(4)

Each of these four sets of characteristics that national behavior may exhibit will be briefly discussed in turn, and I will show how each might lead to a different form of internationally collaborative arrangement. The only additions to the model of the previous sections, then, are the collective dimensions of state behavior—all else remains constant.

(1) Divisibility and Appropriability. In the strict sense here employed, *A*'s production of a good or service which is perfectly divisible and from which others can be kept from benefiting (or be charged for benefiting), exhibits no collective dimension whatever. Yet, it is the production of just these goods and services which accounts for most of the activities of intergovernmental organizations. This is the case in part for the kinds of reasons explicated in the previous sections. In addition, all states may bring to bear various efficiency criteria, such as economies of scale, and therefore seek the collaborative production of a particular good or service. Thus, simply in order to be able to do what it cannot now do, or to do more, or more efficiently what it is already doing, a state may enter into international arrangements facilitating such desires.

What kinds of organizational arrangements would⁴⁵ these be? Their purpose, clearly, would

⁴⁴ Although the two properties appear to be similar, joint supply and problems of exclusion "are conceptually quite distinct properties . . . and are in no way related. A clear differentiation between them is therefore extremely important to preserve." (Head, p. 210)

⁴⁵ I emphasize *would*, because the idealized conditions of the model are assumed to hold. According to the model, equilibrium for the entire system (here taken to mean the establishing of an organization) would be reached when this relation is satisfied:

$$(1.2) \quad \text{MRS}^a + \text{MRS}^b = \text{MRT}.$$

In other words, the *summed* marginal rates of substitu-

tion to facilitate or enhance a particular national capacity—to enlarge the range of what is technically possible for each member, in the performance of a particular task.⁴⁶ Their role would essentially be limited to the coordination of national activities. For given the grounds for initially entering into such an arrangement, the interdependence costs of a more demanding organizational arrangement would soon exceed the benefits obtained from it.⁴⁷ An illustration follows.

International Collaboration in R & D. The most common example of international collaboration in the areas of science and technology is the joint production of essentially private goods: national scientific and technological capabilities. The European case offers a number of illustrations. A European technological community, *The Guardian* has argued,

. . . is the real Europe of the future. To build it will be a test of nationalism versus rationalism. . . . [T]he only alternative is economic decline, and probably complete domination by the United States.⁴⁸

The European countries have long complained of an Atlantic "technology gap" in terms of a brain drain, the production of scientific papers, innovation, the technological balance of payments, and so forth.⁴⁹ And, to derive the benefits of economies of scale, more integrated European scientific and technological efforts have often been proposed and sometimes executed.⁵⁰

tion (summed over all relevant states) must be equal to the marginal rate of transformation.

⁴⁶ In the terms of Figure 2, the transformation curve for each state would shift outward, away from the origin, or at least no state would be left worse off as a result of some being better off.

⁴⁷ The example of Euratom, as described above, and in particular the rather fundamental changes in the organization of joint research activities effected between 1968 and the present, appear to attest to this conclusion.

⁴⁸ Cited by J.-J. Servan-Schreiber, in *The American Challenge* (New York: Avon Books, 1969), p. 112.

⁴⁹ The technology gap, and various European responses to it, are discussed in Gilpin, *France in the Age of the Scientific State, passim*. OECD has conducted a major study of the gap, and its findings have been published in a number of volumes. See, most importantly, *Gaps in Technology: Analytical Report* (Paris: OECD, 1970).

The Americans, in turn, have recently begun to complain that the technology gap is shifting in their disfavor, citing an alleged increasingly unfavorable technological balance of payments. These allegations are examined in Philip M. Boffey, "Technology and World Trade: Is There Cause for Alarm?" *Science*, 172 (2 April, 1971), 37-41.

⁵⁰ The most famous exhortation was that of Servan-Schreiber, in *The American Challenge*. A more sophisticated analysis and set of proposals, in much the same tradition, may be found in Christopher Layton,

But the basic reasoning is not limited to the Europeans: ". . . cooperation enables the United States to complete its national research efforts through the division of labour among many countries"⁵¹ as well.

The organizational arrangements through which such collaboration is facilitated include standard intergovernmental organizations; in addition, still less demanding arrangements are being developed. Within ENEA, for example, specific member countries may participate project by project, without involving other OECD members not interested in a particular concern.

This minimizes the extent of bargaining and has led to the development of co-operation based on common self-interest, which is perhaps the most sound basis for intergovernmental co-operation in science.⁵²

In assessing how future scientific and technological developments might come to affect international organization, one arrives at the conclusion that in a great many cases states will respond to problems and possibilities such developments may pose by seeking the extension of national capacities through joint production facilities and information services. Because these arrangements are thought to introduce a collective dimension into the interstate system, we generally view them as potentially modifying that system. Yet, being producers of essentially private goods, which facilitate and enhance national capacities, their first consequence will be to augment the ability of states to act in that system.

(2) Joint Supply and Appropriability. The second case which may affect a state's basic propensity arises when the product of one of its activities is in joint supply, in the sense that extension of that good to others is facilitated, even though others can be excluded or charged for it. If other states were of the impression that *A* would supply the good or service in any case, they would have no incentive to contribute to its production. But even if others were willing to contribute, the opportunity cost of supplying the good or service to the last user might well be negligible.⁵³ Finding itself in a

situation of this kind, state *A* has a number of available alternatives: exclude others, and ignore the social pressure which may result; extend the good to others and absorb the cost; cease the activity altogether; or seek to organize the production of the good internationally in the first place, with all contributing from the beginning. Any or all of these are possible, depending upon circumstances. The international production of such goods becomes more likely, however, to the extent that *A*'s situation is mutual among states and that the interdependence costs of so doing are acceptable.

What kinds of international arrangements would these be? Their purpose would no longer simply be to enhance or facilitate national capacities and behavior. In addition, they would be designed to compensate for the decentralized structure of the interstate decision-making system, by organizing internationally those national activities exhibiting joint supply. Their role, then, in addition to producing a particular good or service, would include at least the partial introduction of collective criteria into the interstate decision-making system. Some examples follow.

Observation, Surveillance, and Monitoring. Many cases of joint supply with possibilities of excluding others, in the areas of science and technology, concern the observation, surveillance, and monitoring of the earth's surface, the climate, and the oceans. In most cases, however, the full realization of these techniques and, therefore, their full significance for the objectives and capabilities of states, are still to come. Thus far, a great many examples have concerned primarily one state, the United States, producing a good or service, and then—sometimes through international auspices—choosing to extend it to others and to absorb much of the cost of so doing. Daily pictures of global weather systems, taken from U.S. satellites, and distributed through the World Weather Watch, are one example. Another example is the various experiments carried out under the auspices of the Global Atmospheric Research Program. But as these experiments

to hold, *A* would seek to impose the *average* cost upon each user. However, as long as some states, who would be willing to pay the *marginal* cost, are excluded by the average cost, Pareto-efficient pricing does not exist. And, in a world of optimum conditions, such as that described by our model, "the position could be substantially improved by lowering the uniform price toward the true marginal social (opportunity) cost of supplying the service to the last user" (Head, "Public Goods and Public Policy," p. 212). If this were negligible, *A*'s compensation would amount to virtually nothing.

European Advanced Technology: A Programme for Integration (London: George Allen & Unwin, 1969).

⁵¹ OECD, *Reviews of National Science Policy: United States* (Paris: 1968), p. 307.

⁵² Alexander King, "International Scientific Relations: Introduction," *Problems of Science Policy* (Paris: 1968), p. 141. King is Director, Directorate for Scientific Affairs, OECD.

⁵³ More precisely, were the conditions of our model

have become more costly, they have also become more collaborative.⁵⁴

Much the same is true of monitoring systems and earth-sensor satellites. When they become operational, they will have an immensely diverse range of applicability, from prospecting to pollution control. As national policies come to depend upon the capabilities provided by these technologies, and as the costs of their production and operation and the costs of collecting and processing the data they will generate become serious, no state will simply extend these services to others. And those states excluded will pressure for inclusion. Thus, cost-sharing plans for both resource surveys and pollution monitoring, organized internationally from the beginning, are already being discussed and agreed upon in the UN and elsewhere.⁵⁵

(3) Divisibility and Nonappropriability. The third case that may affect a state's basic propensity is that in which the good or service in question is strictly divisible, but because of "imperfections in property titles," i.e., the nature of political jurisdictions, others cannot be excluded from benefiting from it or cannot protect themselves from any disservice it might be causing them. If other states are enjoying the benefits of *A*'s production of a good or service, and *A* can in no way exclude them or charge them the cost of partaking, it would be unrealistic—given our assumptions—to expect them to contribute voluntarily. Or, if other states are suffering from *A*'s production of a good or service, and cannot exclude themselves from such suffering, it would be unrealistic to expect *A* voluntarily to offer compensation. In both cases, a divergence between private and social costs results, as *A* would tend to underproduce the first kind of good, and to overproduce the second. (In neither case would the relation in

[1.2] be satisfied.) Again a number of alternatives are available; but to the extent to which such divergences become costly, and mutual, the international production of the first kind of good and the international regulation of the second kind become more likely.

These would be still different organizational arrangements. In performing a specific task, they would be required to compensate for those "imperfections in property titles" within the interstate system which generated the divergence between private and collective costs in the first place. Within a task-specific context, their role would include introducing and representing definitions of collective ownership and jurisdiction.

Exploitation of the Seabed. The exploitation of the seabed beyond the limits of national jurisdiction has become a particularly interesting case of this third kind of good. It is all the more interesting because it indicates clearly how political factors interact with technological developments to define a situation.

Until recently, the exploitation of mineral resources and deposits was considered to be a purely private good and was enshrined as such in the Conventions of 1958.⁵⁶ These legally defined five zones: internal waters, the territorial sea, contiguous zones, the continental shelf, and the high seas. The delimitation between territorial and high seas was not universally fixed; and the definition of the continental shelf has raised still greater uncertainties.⁵⁷ Essentially, the latter has meant that a state can exploit the seabed off its coast for as far as its technology will take it. Both the technologies facilitating exploitation at ever greater depths, and subsequent exploitation, have continuously advanced.⁵⁸

⁵⁶ The texts are reproduced in Norman J. Padelford, *Public Policy for the Seas* (Cambridge: The MIT Press, 1970).

⁵⁷ National sovereignty over the continental shelf and its subsoil was agreed to, but the area itself was barely defined:

For the purposes of these articles the term "continental shelf" is used as referring (a) to the seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the territorial sea, to a depth of 200 meters or, beyond that limit, to where the depth of the superjacent waters admits of the exploitation of the natural resources of the said area; (b) to the seabed and subsoil of similar areas adjacent to the coasts of islands.

Cited in Padelford, *Public Policy for the Seas*, p. 69; emphases added.

⁵⁸ For a review, a suggestion of what the consequences could be, and an expression of fear of what the consequences will be, see Wolfgang Friedman, *The Future of the Oceans* (New York: Braziller, 1971).

⁵⁴ For a review of these various projects, see Nancy Gruchow, "Weather Services: Working toward Worldwide Forecasts," *Science*, 168 (17 April, 1970), 352-353. The administrative and decision-making arrangements of the GARP observational experiments are described in, WMO-ICSU, "Report of Interim Planning Group on GARP Tropical Experiment in the Atlantic, London, July 1970," *GARP Special Report No. 2* (Geneva: August 1970).

⁵⁵ In the context of the UN these issues are reviewed in "Issues Before the 25th Assembly," *International Conciliation*, 579 (September 1970), 59-64; see also the recommendations prepared for the 1972 Stockholm conference on the human environment (UN, A/CONF. 48/PC.9; 26 February 1971). The recent US initiative to establish a UN environment fund, which would include financing for monitoring, should be noted as well ("Nixon Offers Environment Plan," *International Herald Tribune*, February 9, 1972).

States not possessing the requisite technology, those which are landlocked, and developing states in general have feared the loss of the seabed to unilateral national claims. They, in turn, have sought to have the area beyond the limits of national jurisdiction declared "the common heritage of mankind," and to have an equitable distribution system established. Although the issue has been before the U.N. since 1967, differences between the developed and developing countries prevented substantive agreement for three years. In December 1970, a Declaration was adopted by the General Assembly setting forth fifteen principles, including the principles that the area *is* the common heritage of mankind and that exploration and exploitation should be governed by an equitable international regime, which is to be established.⁵⁹

While the issue is far from settled, it is apparent that the nature of the seabed is becoming redefined; "imperfections in property titles" are being seriously discussed, and will be compensated for by establishing an international regime. How might this redefinition be coming about? Unilateral claims to the seabed can be made by states with the requisite technology; all coastal states can threaten such claims. And they can make these threats credible, irrespective of levels of technological development, by extending their territorial jurisdiction and/or by licensing corporations to exploit the seabed off their shores. No state can then avoid suffering the loss of the seabed through unilateral and competitive exploitation. That is, the situation has come to resemble our third case, and the proposed collective arrangement is designed not only to facilitate the performance of a particular task—the exploitation of the seabed—but also to compensate for imperfections in the basic definitions of political jurisdiction by establishing an international regime.

(4) Joint Supply and Nonappropriability. The fourth and final set of characteristics approximates a pure collective good; equal potential availability to all exists once the good or service is provided for one state; and it is impossible to exclude other states from sharing in the benefits (or for other states to protect themselves from the suffering) provided by the good or service. In other words, state *A* may be providing a good or service which *must* be extended to all; or *A* may find it *must* suffer from another's good or service, in the sense that it cannot pro-

tect itself. To the extent that such situations become mutual and costly, the international production and/or regulation of the goods in question becomes likely.

The kinds of international organizational arrangements these situations would lead to would be of a fourth variety. They would perform a particular task of production or regulation. But in so doing their purpose would be to compensate for both the decentralized nature of the interstate decision-making system *and* for the definition of political jurisdiction and ownership. Their task, in sum, would include the introduction of elements of collective decision making *and* collective ownership into a particular activity.

Large-Scale Climate Modification. An enormously important case of this fourth kind of good will emerge if and when technologies for weather control and for intentional climate modification become realized.⁶⁰ The case of weather control provides a localized example. Insofar as the amount of moisture in the atmosphere is fixed, rainmaking by one state will deprive others of a resource rightfully theirs—others *must* suffer from the behavior of one. Climate modification is a larger scale and still more pressing case of the same phenomenon—once produced by one, the "good" must be extended to all within the system.

Although experiments in rainmaking and localized weather control are quite common, the modification of the climate is some ways off. Given our set of assumptions, both kinds of modifications will be considered to be purely private goods until the suffering (actual or anticipated) becomes costly and mutual. At that time, we would expect both collective ownership and collective decision-making systems to be established to participate in the production and regulation of this particular activity.

In sum, the analysis of the preceding sections explored only a restrictive set of behavioral and organizational forms. These indicated the general conditions under which joint production and/or regulation would or would not be sought. In the present section, on the basis of more specific characteristics exhibited by the behavior of states, more specific organizational forms were explored and illustrated. The four-fold classification by no means exhausts the range of possibilities.⁶¹ But, together with the

⁵⁹ The state of technology of weather control is assessed in Allen L. Hammond, "Weather Modification: A Technology Coming of Age," *Science*, 172 (7 May, 1971), 548–549.

⁶¹ For example, every activity could be analyzed from the perspective of the second-order consequences it

⁵⁹ These principles are briefly summarized in the *UN Monthly Chronicle*, 8 (April 1971), 21–26.

basic model, it does facilitate the explication of some fundamental dynamics of international organization, their application to specific cases, and systematic speculation about future possibilities.

Conclusions

Two fundamental changes are said to characterize the transformation of the highly industrialized societies: a preoccupation with the production of publicly relevant goods and a preoccupation with goods which are produced and/or purchased communally. The concern of this paper has been a parallel phenomenon internationally, namely, the joint production and joint regulation of goods and services by the advanced industrial states. In particular, I have sought to explore the impact of scientific and technological developments upon this process, and to suggest some consequences of collective decision making and collective ownership for future international organization.

What is more, this inquiry sought explicitly to avoid evolutionary or functionalist assumptions. Instead, the processes of international organization were here formulated as being generated by states selecting from among alternate modes of organizing activities, both national and international, given certain constraints and possibilities, and given an assumed *modus operandi*. This analysis leads to a number of conclusions.

First, *logically*—in the dynamics of the internationalization of tasks as here defined—there is little that is unique about science and technology, little that inherently differentiates the issues they raise from other kinds of issues. The utilization of specific sciences and technologies (or of the category in general) as independent variables or as “issue-areas” in the analysis of international organization is not, then, the most propitious perspective. Such *a priori* substantive differences as might appear to exist among international trade, monetary affairs, pollution, and the exploration and exploitation of outer

generates. The vast literature on externalities could then be employed. (Among the finest works on externalities is William J. Baumol, *Welfare Economics and the Theory of the State* [Cambridge, Mass.: Harvard University Press, 1965]). Or, each activity may be classified according to whether it is perceived as being distributive, redistributive, regulative, or self-regulative, as defined by Theodore J. Lowi. (See, for example, “American Business, Public Policy, Case Studies, and Political Theory,” *World Politics*, 16 [July 1964], 677–715; Robert H. Salisbury has extended Lowi’s work in “The Analysis of Public Policy: A Search for Theories and Roles,” *Political Science and Public Policy*, Austin Ranney, ed. [Chicago: Markham, 1968], pp. 151–175.) Other possibilities, of course, exist.

space and of the seabed do not determine the calculations of states. Instead, the decision-making calculus of states is determined by the configuration of problems and possibilities these activities pose for states *as organizational systems* having certain objectives and capabilities and acting in accordance with certain behavioral tendencies in the context of a particularly structured interstate system. As described in the previous section, by facilitating national behavior while extending its benefits due to joint supply, by offering new capabilities while raising problems of nonappropriability, and so forth, certain scientific and technological developments *are* interacting with states’ and systems’ attributes in such a way as to lead to more and to different kinds of collective activity.

Second, the central concern now pursued in the study of international organization is the evolution of collective actors—how organizations come to be established, how they come to grow, to have important functions, and to acquire authority “above” the level of states. The analysis here has been of a prior phenomenon—prior both logically and chronologically—namely, the *devolution* of existing structures: the complex modification or mutation of the modern state and modern interstate system, as a consequence of the introduction of collective dimensions into decision making and into definitions of political jurisdiction and ownership internationally. Not the emergence of “higher” forms of sociopolitical organization “above” states, then, but the differentiation and disaggregation of existing forms of organization, are suggested by this analysis as being the central phenomena in international organization today.⁶²

Third, the devolution of existing structures appears to be an issue-specific and actor-specific process. It is asymmetrical, reflecting differences in national capacities to perform different tasks, as well as discontinuous, reflecting the differential impact of interdependence costs in different issue areas and for different states. Moreover, it appears to generate issue-specific and actor-specific collective arrangements, existing at different levels in the interstate system,

⁶² This process of differentiation and disaggregation *without* a synthesis at a “higher” level has been noted even amongst the members of the European Community, which was recently found to be “a collection of structures rapidly growing in many directions and each very imperfectly responsive to the behavior of the others.” (James A. Caporaso and Alan L. Pelowski, “Economic and Political Integration in Europe: A Time-Series Quasi-Experimental Analysis,” this *Review*, 54 [June 1971], 418–433; the passage cited is on p. 433.)

and compensating for different imperfections in processes and structures of the interstate system and of states as actors in that system. The resulting international order promises to be both highly differentiated and exceedingly complex. And while we are only beginning to develop an adequate conceptual vocabulary with which to describe it, we may safely conclude that it will share virtually nothing with typical visions of "supersystems" toward which the natural logic of events is said to be propelling us.⁶³

⁶³I have elsewhere suggested that the devolution of organizational forms described above is resulting in a complex and fundamental reordering of political space and restructuring of public authority across states. Further, I have sought to demonstrate that just as extant theories do not adequately capture contemporary processes of international organization,

In sum, within the advanced industrial societies the shortcomings of a market-rational orientation to public decision making, in coping with highly interdependent and complex phenomena, are being experienced daily. In some sense, an analogous phenomenon is occurring within the interstate system. I have here tried to suggest a means by which we may begin to analyze this phenomenon, so as better to understand its consequences not only for the future of the international order, but for the future organization of political life in general.

so extant images do not adequately express their emergent structures. (John Gerard Ruggie, "The Structure of International Organization: Contingency, Complexity, and Post-Modern Form," *Papers, Peace Research Society International*, 18 [1972], 73-91.)