DYNAMICS OF INTERNATIONAL CONFLICT:

Some Policy Implications of Population, Resources, and Technology

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INTERNATIONAL conflict has been accounted for in many different ways—in terms of aggressive "instincts," territoriality, population growth, the search for basic resources or seaports, the protection of trade routes, psychopathological deviations, plunder and profit, a drive for imperialist control, and so forth. Some theorists have considered grievances, competition, anxieties, tension, threat, and provocation to be of special importance. Others have laid heavy emphasis upon national power or capability, military preparedness, strategic considerations, and the competition for dominance.[1] No doubt most if not all of these variables are relevant, but this recognition does not help much in the development of a theory of war, its dynamics, and contributing causal networks. In the long run all factors need to be pulled together in some systematic way. A serious difficulty emerges from the fact that the various "causes" that contribute to war tend to be highly interactive, that is, they affect each other in various ways and often in many different directions. The problem is to find out, if possible, which variables are contributing most to international violence and in what proportion. The purpose of this paper is to take an early step in this direction by

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[1] See Raymond Aron, *Peace and War* (New York 1967); A.F.K. Organski, *World Politics* (New York 1968); Hans J. Morgenthau, *Politics Among Nations: The Struggle for Power and Peace* (New York 1964); Richard N. Rosecrance, *Action and Reaction in World Politics: International Systems in Perspective* (Boston 1963); R. J. Rummel, "Dimensions of Dyadic War, 1820–1952," *Journal of Conflict Resolution*, x (March 1966), 65-73; Raymond Tanter, "Dimensions of Conflict Behavior Within and Between Nations, 1958–1960," *Journal of Conflict Resolution*, x (March 1966), 41-64; J. David Singer, "Capability Distribution and the Preservation of Peace in The Major Power Sub-System, 1816–1965" (Paper prepared for delivery at the 66th Annual Meeting of the American Political Science Association, Los Angeles, September 1970); and Quincy Wright, *A Study of War* (Chicago 1942). We are particularly indebted to Professor Organski for a treatment of the concepts that provided the basis for our investigations.

reporting on some empirical research currently under way and by presenting some tentative findings which suggest partial explanations and some implications and difficulties for national policies.

In general there seem to be at least three major types of dynamic processes tending toward conflict and warfare among nations: *the dynamics of the expansion of national or imperial interests; the dynamics of antagonistic competition and the arms race; and the dynamics of crisis.* In this paper we shall examine the processes of national expansion and some of their implications. We shall also somewhat sketchily examine the processes of military competition. A primary emphasis will be upon some of the basic dilemmas associated with important variables and upon the recurring paths to large-scale violence. Some of these are readily manipulable by national policy-makers and some are not. The dynamics of crisis will be touched upon briefly, not for purposes of analysis but only as they relate to expansion and competition.

An important question, of course, remains as to the role of rationality and the rational calculus in national interactions. Many of the dynamics we shall be considering are beyond the range of such a calculus. Some are not. Isolating the variables that are readily manipulable by the policy-maker (or manipulable at relatively low costs) provides some insight into the issue of control over decision outcome.

I

Early investigations by the Stanford Studies in International Conflict and Integration into the dynamics of conflict and warfare have centered on crises and the eruption of large-scale violence. A crisis, however, is only the small tip of an obscured iceberg of competitions, antagonisms, relatively non-violent conflicts, arms races, and previous crises. Is it possible, then, to look into the antecedents of a crisis of war, to identify in some systematic way the longer-range causal networks, and to isolate the points where alternative paths may have made a difference in the long run? Could some key variables have been manipulated in ways that would have yielded different outcomes?

We do not suggest that crisis studies ought to be abandoned. On the contrary, it is of the utmost importance that as much as possible be understood about the dynamics of both arms races and crises. Nevertheless, an adequate comprehension of crises is not likely until theoretical and empirical linkages are established between crises and the longer-run dynamics of international competition and conflict—between the tip and the part of the iceberg farthest below the surface of the water. This linking up remains to be done; and it is not an easy undertaking.

A sounder and more empirically verifiable framework needs to be developed as a proper context for investigations of crisis phenomena.

In large part, longer-range sequences can be accounted for in terms of submerged phenomena such as population differences, technological growth, differential access to (and competition for) resources, trade, markets, and influence, the expansion of national interests, and so forth. These considerations may yield useful and even invaluable insights into the dynamics of conflict and warfare.

This essay is a report on research in progress. This research, if pursued in greater depth and on a broader front, may be of potential importance to long-range policy-making. This work proceeds from the assumption that there is an operational milieu in which national leaders and their advisors and deputies conceive and effect policy. It is also assumed that the elements of this milieu ought to be examined to see which are relatively constant and which are relatively manipulable—given the costs of manipulation.[2] The concept of such an operational milieu is interdisciplinary in its broad implications, drawing on the theories, data, and analytical techniques of the demographer, ecologist, economist, human geographer, and even the physicist, as well as the political scientist and other specialists in foreign policy.

For some years now we have been compiling extensive sets of annual data, some going back to 1870, for major powers and for some lesser and small powers. This collection includes data on national areas, populations, indicators of technology and production, military budgets, men under arms, colonial territories and expansions, trade, casualties, and so forth. For some countries over certain time periods we have gathered, coded, and analyzed data on conflict and cooperation. Gradually, and in an experimental fashion, we have developed a theoretical framework. We have been analyzing parts of these data using various types of multivariate analysis; and we have done a limited amount of computer simulation. In this paper we report our findings to date.

The specific problem we address ourselves to is this. From the policy-maker's viewpoint it may be theoretically interesting to know, for example, that in any particular situation population growth (the sheer numbers of people and their rates of increase) is more (or less) important than technological growth (the levels, distribution, and rates of advance of knowledge and skills among the people) in producing high conflict outcomes. However, the head of state or foreign minister (or an advisor or deputy) is not likely to consider this relevant to

[2] Harold Sprout and Margaret Sprout, *Foundations of International Politics* (Princeton 1962).

policy—although perhaps he should. Research such as ours will be of much more interest to a policy-maker if it identifies independent variables that are manipulable—defense budgets, for example, or alliance links—and if it informs him of the costs of manipulating these variables. He will also be interested in ways of using such variables for the achievement of his (or the nation's) purposes. In this paper we attempt (1) to specify the theoretical framework which provides the basis for our investigations, (2) to distinguish between those variables that are readily manipulable and those that are less manipulable or manipulable only at relatively higher costs, (3) to spell out some alternative long-range consequences of basic variables such as population growth, technological developments, and resource constraints, (4) to discuss our recent efforts to operationalize the conceptual framework and submit specific propositions to the empirical test, and (5) to specify some alternative implications for the policy-making community. It should be explicitly recognized, however, that our analysis is in a formative stage. Many of our findings are tentative at best. We expect revisions and modifications of both theoretical framework and empirical analysis in the course of further investigations.

II

We proceed on the following assumptions: that no one single cause ever determines international violence; that the over-all constellation of critical variables—psychological, sociological, demographic, economic and political—are not randomly distributed; and that it is possible to discern over-all patterns contributing to the outbreak of external conflict and war. We further assume that the outbreak of violence is the result of several developments which have their origins in the most basic attributes and capabilities of nations. We recognize also, however, that the leaders' perceptions of their nations' capabilities (accurate or inaccurate as the case may be) are equally, or perhaps even more, critical than this demonstrable reality. The leaders' perceptions are likely to be especially pertinent to an analysis of the *shaping* of a policy or decision. *Outcome* may well be more determined by the reality of things than by the perceptions of various leaders. The two, however, tend to be highly interconnected but the relationship is neither clear nor direct.

The basic proposition underlying our investigations of the dynamics of national expansion is that differential rates of population growth in combination with differential rates of technological growth contribute to international competition and sometimes to conflict, insofar

as competing nations have differential—grossly unequal—access to resources and capabilities. These relationships are not direct or simplistic. Complex and intricate interdependencies dominate every stage in the development of conflict situations. And we do not underestimate the importance of human perceptions, values, preferences, goals expectations, decisions, and the like.[3] But a viable theoretical framework should be able to accommodate both longer-range and shorter-range considerations. It should also offer possibilities for an eventual linking of objective and cognitive phenomena in the expansion, competition, and crisis phases of international conflict.

After examining long sweeps of history we have developed a set of further propositions about the dynamics of expansion which serve as a tentative conceptual framework. This framework is based in part on inferences drawn from history, in part on the writings of general systems theorists,[4] cyberneticists,[5] anthropologists,[6] and others,[7] and in part on our own preliminary analyses of data from selected great and smaller powers during the years between 1870 and 1970. Both the framework propositions and our specific working hypotheses involve some independent variables that are relatively non-manipulable by the head of state or other responsible policy-maker or are manipulable only at high costs (such as population and technology). Other variables (such as military budgets and troop deployments) are from the policy-maker's viewpoint more readily manipulated. Many of these variables —particularly population, area, resources, technology, military budgets, trade levels, and so forth—have in the past been regarded as important by historians, sociologists, and political scientists. *The propositions we are putting forward are not new, but they point to relationships among these same variables recently perceived by ourselves and others as im-*

[3] In the shorter-run, during a crisis of a few days' or weeks' duration, for example, the numbers of people or the broad levels of their knowledge will not vary appreciably. In such instances, perceptions, values, preferences, goals, expectations and decisions may be the crucial variables, with dimensions of population, level of technology, and so forth, serving as constraining parameters. But in the longer-run, over years and decades, the numbers of people, their rate of increase, their level of technology, their rate of technological development, and the availability of natural resources in the environment, all seem to be powerful shaping and constraining influences.

[4] Ludwig von Bertalanffy, *General Systems Theory* (New York 1968); James G. Miller, "Living Systems: Basic Concepts," *Behavioral Science*, x (October 1965), 337-79; and James G. Miller, "Living Systems: Cross Level Hypotheses," *Behavioral Science*, x (October 1965), 380-411.

[5] Norbert Wiener, *Cybernetics* (New York 1948), and *The Human Use of Human Beings* (New York 1956).

[6] Elman R. Service, *Primitive Social Organization* (New York 1962); and Peter Farb, *Man's Rise to Civilization as Shown by the Indians of North America* (New York 1968).

[7] See especially Organski (fn. 1), and Sprout and Sprout (fn. 2).

portant for the analysis of national behavior. These propositions should be considered as a temporary framework subject to alterations as our operationalized hypotheses (the systems of equations presented later on) are tested in a variety of situations. By specifying the sequence of developments and the linkages between dynamics internal to the nation-state and those of a more external, international nature, we shall try to make explicit both long-range effects of critical variables and the short, more immediate considerations.

We assume that in formulating and carrying out policies national leaders are motivated in many ways. *To simplify the problem we may view them as operating to minimize, or close, one or a combination of three fundamental types of gap*: (1) *a gap between resources that are "needed" or demanded and those that are actually available*;[8] (2) *a gap between an expectation and the reality that materializes, as, for example, when climbing productivity tapers off*;[9] and (3) *a gap between the resources or growth rate of one's own country and that of a competitor or rival.* There are, of course, many other possible gaps that could be identified. The main point to be made here is that, in seeking to close any gap or combination of gaps, a national leader must either apply the specialized capabilities that are available to him, strengthen certain capabilities (perhaps at the expense of others), or develop new capabilities. The leader's ability to act, and his opportunity to employ one specialized capability rather than another (i.e., expanded trade rather than expanded agriculture, or heavy industry rather than light industry, or air power rather than sea power) will depend not only on available knowledge, skills, and resources, but also on how these capabilities have been organized and mobilized prior to the moment of his decision. In this way the leader is likely to be limited and constrained from action in some areas and influenced or even impelled toward other directions of activity. As we use the term in this paper, a constraint may not be absolute. We assume that, at the very least, (a) some additional amount of effort or other cost will be involved in overcoming it, or (b) some considerable amount of time, or (c) both.

The crucial, most basic "master" variables in our partial theory are population, resources, and technology, where technology refers to the level and rate of development of human knowledge and skills in a

[8] Alan Howard and Robert A. Scott, "A Proposed Framework for the Analysis of Stress in the Human Organism," *Behavioral Science*, x (April 1965).

[9] Raymond Tanter and Manus Midlarsky, "A Theory of Revolution," *Journal of Conflict Resolution*, xi (September 1967); James C. Davies, "Toward a Theory of Revolution," *American Sociological Review*, xxvii (February 1962).

society. A combination of growing population and developing technology places rapidly increasing *demands* upon resources, often resulting in internally generated *pressures*. The greater this pressure, the higher will be the likelihood of extending national activities outside territorial boundaries. To the extent that two or more countries with high capability and high pressure tendencies extend their interests and psycho-political borders outward, there is a strong probability that eventually the two opposing spheres of interest will intersect. The more intense the *intersections*, the greater will be the likelihood that competition will assume *military* dimensions. When this happens, we may expect competition to become transformed into conflict, and perhaps an *arms race* or cold war. At a more general level of abstraction, *provocation* will be the final act that can be considered as the stimulus for a large-scale conflict or *violence*. But an act will be considered a provocation only in a situation which has already been characterized by high lateral pressure, intersections among spheres of influence, armament tensions and competitions, and an increasing level of prevailing violence. Major wars, we shall argue, often emerge through a two-step process: in terms of internally generated pressure, and in terms of the reciprocal comparison, rivalry, and conflict, on a number of salient capability and behavior dimensions. Each process tends to be closely related to the other, and each, to a surprising degree, can be accounted for by relatively non-manipulable variables (or variables that are controllable only at high costs).

Because much of our empirical work rests on these hypothesized relationships it seems worthwhile to specify more fully the "causal" network and linkages between internal and external dynamics. We proceed from an assumption that man is much more a creature of his physical environment than is sometimes conceded. Recently biologists have been making explicit the extent to which each human being literally owes his life to the earth and ultimately to the sun.[10]

In any bounded environment, an island, a continent, or the world, *the larger the number of people, the greater will be the need and demand for some irreducible minimum of food and other indispensable resources*. There is no escaping this. For survival without serious damage to the human organism, each person requires approximately 2000

[10] Paul R. Ehrlich and Anne H. Ehrlich, *Population, Resources, Environment* (San Francisco 1970), 54-55, 82; see also Howard T. Odum, "Energetics of World Food Production," *The World Food Problem*, A Report to the President's Science Advisory Committee, III, Report of the Panel on the World Food Supply (Washington 1967); *Resources and Man*, Committee on Resources and Man, National Academy of Sciences, National Research Council (San Francisco 1969).

calories a day. A million people require at least a million times as much. Each human being also requires at least some minimal amount of water, air, and living space—and, again, a million people require a million times these irreducible amounts in order to survive without serious physical penalty.[11] The number of people in society (relative to resources and capabilities) is a critical variable, although the policy-maker is likely to accept the population of his country as a given. From his viewpoint this is a non-manipulable variable, or one that can be manipulated only at high costs. History presents numerous examples of large-scale population movements (forced or otherwise), and the creation of new polities based on massive immigration or emigration. But this has generally been a costly solution to political problems. And only infrequently can it be considered in short-range, low-cost terms.

Human beings rely on technology (knowledge and skills) in their efforts to meet physical, psychological, and emotional needs. A unique characteristic of man is his spectacular capacity for applying knowledge and skills to harness energy in the physical environment. At various levels of cultural development, man has derived energy from the burning of woods and charcoal, the generation of steam power, the tapping of coal and oil, and recently from the application of nuclear energy. Scientific and technological advances are among "the master variables, to which almost all other changes and transformations are directly or indirectly related."[12]

It appears self-evident that every practical application of technology (knowledge and skills) requires resources from the environment—although the amounts required tend to vary with the complexity of the tool, machine, or weapon. Thus, *the more advanced the level of technology—from the stone axe to the nuclear reactor—the greater the variety and quantity of resources needed by that society.* Applications of technology consume (or, more properly, "degrade") certain amounts of energy even when energy is being used for "positive" purposes, such as irrigating a desert.[13] As a rule, *the more advanced the level of tech-*

[11] Some societies obviously possess and "demand" considerably more than the irreducible minimum. Often, within a single society, some sectors of the population are affluent and others exist on the borderline of subsistence. In general, the societies with more affluence tend to be those which through one means or another, have access to relatively more resources and possess higher specialized capabilities. Useful suggestions for the analysis of complex relations are provided in W. Ross Ashby, "Constraint Analysis of Many-Dimensional Relations," in *General Systems*, Yearbook of the Society for General Systems Research, IX (Michigan 1964).

[12] Sprout and Sprout (fn. 2), 8.

[13] The consumption of resources (according to the First Law of Thermodynamics) does not mean the destruction of energy, but (according to the Second Law of Thermodynamics) usable energy is *degraded* with each transfer from more usable forms to a

nology in a given society, the greater the range and quantity of things people perceive themselves as "needing." Such societies with advanced technology will also be more capable of securing much more than their worldwide per capita share of resources. We would expect these considerations to give rise to competition and conflict in many different situations.[14] This dependency, however, is certainly neither clear nor likely to be direct. One important problem lies in determining the nature of the intervening processes, and the extent to which differences in intervening processes give rise to different outcomes.[15] From the viewpoint of the policy-maker, the prevailing level of technology in his country, like the level of population, is likely to be accepted as a given, a less manipulable variable. Specific technologies, such as armaments, can be acquired in a relatively short period of time, and thus are readily manipulable. The general level of technology in a society—the distribution of knowledge and skills—is less easily manipulable. A major change may take decades or a generation.[16]

The point is that both population and technology use resources. Even technologies which acquire new resources require resources. Demands may refer not only to unsatisfied basic needs (food, water, space, and

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less usable form. New applications of technology (the breeder reactor, for example, or nuclear fusion) may provide more efficient uses of primary energy. But such advances are likely to involve large amounts and a considerable range of other resources (such as minerals, fibers and so forth) in the construction of plants, machinery and auxiliary equipment and by way of raw materials for the production of artifacts. A more advanced technology is likely to be more efficient than a less advanced technology, that is, it is likely to produce more useable power per unit of input. However, the more advanced and efficient a given technology turns out to be, the greater is likely to be the variety and instances of the uses to which it is put, and consequently, the amount (as well as the range) of resources is likely to increase over-all.

[14] "Effects of Population Growth on Natural Resources and the Environment," *Hearings, Subcommittee of Committee on Government Operations*, House of Representatives, 91st Congress, 1st Session, September 15-16, 1969.

[15] We need not assume a fixed resource base to appreciate the full implications of these relationships. The interdependence of technology and resources is high. For example, resources may be discovered, or "created," where they were not known to exist. Or they may be acquired through trade, conquest, or other means. As long as the flow of resources is not severely impeded, or not perceived to be impeded, then the technology-resource-population relationship poses fewer problems for a society than otherwise. For elaboration of these points see especially *Resources and Man* by the Committee on Resources of Man and the Division of Earth Sciences, National Academy of Sciences, National Research Council, 1968.

[16] Over the course of human pre-history and history the broad advancement of knowledge and skills has tended to be exponential (extremely slow for many centuries, increasingly rapid in more recent times). However, at any given period, certain societies have tended to advance more rapidly than others. Often, a comparatively backward country, such as Japan around 1870, has displayed very rapid growth partly as a result of diffusion from more technologically advanced countries.

what is needed to supply tools, machines, and industrial processes) but also to such things as people *think* they need or yearn for (better food, housing, clothing, luxuries, and so forth). Objectively, resources may be available, but their usefulness may not be perceived. Or, resources may be present but not immediately available. Or, they may be available but as yet untapped. Making use of resources is, to a large extent, dependent upon the level of technology. To complicate matters further, "demands" are in considerable part a psychological variable. And only their empirical correlates are possibly subject to investigation.

In their efforts to meet what is needed or demanded, societies tend to allocate certain proportions of available capital, resources, and human energy in order to develop specialized capabilities.[17] Some of these allocations and investments are made by the government itself. Others are undertaken by the private sector. Both public and private decisions at an earlier point in time help to determine what the society can (and cannot) do, and also what it is likely to do at some subsequent period. Levels and changes in specialized capabilities are thus manipulable in part by national policy-makers (through budgetary allocations, governmental research and development programs, contract research, loans to private enterprises, and the like). But, on short notice, these specialized capabilities are non-manipulable, or manipulable only at very high costs. On the other hand, given an optimum foundation of basic capabilities, policy-makers can often manipulate appropriations and expenditures in the relatively short run of a few months or a year or so. This tends to be true of military capabilities (given either a sufficient industrial base, or the possibility of acquisitions from other nations), especially if the society as a whole has been alerted to some (real or fabricated) outside threat.

Countries have often increased their specialized capabilities rather quickly by forming an alliance with another country. This type of possibility amounts to a relatively manipulable variable, depending largely upon the discretion of the decision-makers (and on requirements of constituent support that differ considerably from one country to another). Alliances can impose serious constraints, however; or a country may be drawn into a conflict which its leaders or citizenry might prefer to avoid.[18]

[17] Howard and Scott (fn. 8).

[18] Such an interdependency of alliance commitments and obligations had a great deal to do with expanding what was a local conflict during the summer of 1914 into a major war. And the Cuban Missile Crisis of 1962 defined in a number of ways the limits beyond which neither Castro nor the USSR could move without risk of great cost to one or the other, or both.

The demands and specialized capabilities of a society combine multiplicatively to produce what might be called lateral pressure.[19] *This amounts to a tendency to undertake activities farther and farther from the original boundaries of the society, to acquire some degree of influence or control over a wider extent of space or among a larger number of people.* Such specialized capabilities as mechanized agriculture, commerce, finance, light industry, heavy industry, and military capability facilitate the meeting of demands. Without specialized capabilities of one type or another (or in some combination), a society will be hard put to acquire or achieve what is required and wanted. A society with few demands, and few specialized capabilities, will not generate much lateral pressure. Similarly, a society with a relatively large population, for example, may generate high demands. And if specialized capabilities are poorly developed, it will have difficulty satisfying such demands. It will not be able to expand major efforts very far beyond its borders.

Lateral pressure is thus a neutral term conveying the effort to extend in one or more directions (by exploration of territory, acquisition of new land, search for fishing grounds, expansion of trade, military conquest, and so forth), farther and farther beyond the original boundaries of the society. Alternatively, it is conceivable a society might invest its efforts and energies in tapping internal resources and capabilities, or move in both directions at once. However high their demands, a people cannot expand their efforts very far unless the appropriate capabilities have been developed.

The characteristics of the prevailing technology, and the specialized capabilities that a society has developed, will strongly influence its domestic, social, economic, and political institutions. It will also effect the mode in which lateral pressure is expressed—by settlement beyond its immediate frontier, by trade, by expansion of its frontiers, by conquest, by exploration of untapped internal resources, or by other means at its disposal.[20] For example, a strong commercial society may manifest lateral pressure through trade. It may also build an army (or navy)

[19] Again, what the correlates of lateral pressure are is subject to investigation. In contrast to "demands," explicit indicators of lateral pressure are readily available. See the *Research Note* below.

[20] Barrington Moore, Jr., *Social Origins of Dictatorship and Democracy: Lord and Peasant in the Making of the Modern World* (Boston 1967), 40. Moore emphasizes the importance to English institutions of relationships between the landed gentry and emerging commercial elements. Commerce and manufacturing lagged in France, as compared with England, and in consequence "All the main structural variables and historical trends in French society of the *ancien régime* differed sharply from those in England from the sixteenth through the eighteenth centuries."

and undertake conquest, acquire overseas colonies and establish settlements, or pursue a combination of these modes.[21] By extension, different societies may adopt different modes of lateral pressure. Alternatively, a society may choose to make use of one or more available modes.[22]

In these terms, then, we would expect a society with a rapidly growing population and rapidly advancing technology to generate high demands, develop strong specialized capabilities, and create considerable lateral pressure which would be manifested in a variety of modes.[23] A society with a rapidly growing population, but a seriously lagging technology, might be expected to generate high demands and suffer severe limitations in terms of specialized capabilities. The predicted outcome in the latter case would be low lateral pressure (Imperial China around 1900) in a society vulnerable to penetration by countries with greater capabilities.[24] Thus, during the late nineteenth and early twentieth centuries, traders, missionaries, engineers, gunboats, and marines proceeded *from industrialized western countries into China*—not the other way around.

Conceivably, a country of higher capability could turn inward. It might not require any great amount of resources from the outside.

[21] Thus Britain, as she became more and more a commercial nation, developed merchant shipping capabilities and a powerful navy. These specialized capabilities were critical factors in her achievement of an overseas empire. Russia tended, on the other hand, to expand her interests overland—eastward across Siberia—although she built fleets for Baltic, Black Sea, and Pacific service. See also Arnold J. Toynbee, *A Study of History*, III (London 1935).

[22] In these terms the concept of lateral pressure provides a link between theories of imperialism and colonialism on the one hand, and integration theories, functionalism, and federalism on the other. Much of the Marxist argument rests on the notions of surplus value and investment of energy outside territorial boundaries. In this context Hobson's interpretation seems as likely a hypothesis as the Leninist. Societies do not necessarily have to expand externally by adopting various modes of domination and conquest. It is conceivable, and possible, for societies to turn inward. By the same token, the mode in which lateral pressure is expressed does not necessarily have to be imperialistic, but could conceivably develop along lines of integration and building of political community. The history of the United States provides (as we note later on) a useful example of the interrelation between expansion, imperialism, and integration. Each of these processes reflects, in the terms described above, different dimensions or manifestations of lateral pressure. For a related discussion see Robert C. North and Nazli Choucri, "Population, Technology, and Resources in the Future International System," *Journal of International Affairs*, XXV, No. 2 (1971), 224-38.

[23] Such relationships would characterize Rome in the late republican and early imperial phases; Britain after the decline of Spain and again in the nineteenth century, as a consequence of her early initiatives in the industrial revolution; Germany in the late nineteenth and early twentieth centuries; Japan after the Meiji Restoration; the United States beginning a decade or so after the Civil War; and Russia in the late nineteenth century (despite her outmoded political and economic system) and increasingly after the Bolshevik Revolution.

[24] Moore (fn. 20).

New technologies could be used to uncover hitherto unavailable resources or to make new use of old resources. Sufficient fields for capital investment could be located at home, and hence foreign investment may not appear attractive. One has difficulty, however, identifying countries of high capability that are not manifesting lateral pressure (outwardly extending their activities and interests) in one mode or another. In general, the inward-turning countries seem to be those of low capability (China and Japan in the early nineteenth century, or modern Afghanistan or Bolivia).[25] If, on the other hand, a country is isolationist and has high capabilities (the United States during several phases of her history), we are likely to find it "spilling over" into relatively empty adjacent territory, filling out a continent, perhaps—and thus manifesting lateral pressure.[26] Or, countries turn inward with respect to many activities, but manifest lateral pressure in foreign trade or other essentially nonviolent, nonexploitative modes. It does not *necessarily* follow that lateral pressure always results in territorial expansion. Sweden presents a noteworthy pattern in this respect. There a growing, highly specialized technology, a relatively low and stable population, considerable forest and mineral resources, and limited amounts of arable land appear to be associated with highly developed commercial capabilities and a tendency to exert lateral pressure through somewhat distinct modes (by participation in United Nations peacekeeping forces, for example, rather than conquest or domination).[27]

In principle, a society can express lateral pressure in any mode provided the appropriate knowledge, skills, and resources are available and it is willing to incur the accompanying costs. Leadership seems to have free choice constrained only by whatever influences the rank and file of its constituents can bring to bear on policy-making. It is tempting to view lateral pressure as a variable which policy-makers—especially a powerful emperor or dictator—can manipulate almost at will. And this is, in fact, often the case, especially when a country is in a position to float a large foreign loan or move troops into foreign terri-

[25] It must be noted, however, that Afghanistan exerts some amount of lateral pressure toward Pakistan, although Pakistan probably exerts more toward Afghanistan. Something similar could probably be said about Bolivia.

[26] The full impact of United States' lateral pressure from around 1785 through the latter decades of the nineteenth century is sometimes obscured by the fact that the victims were largely Indian tribes. Hence, it was easy to think of the West as "empty." The same kind of observation is relevant to Russia's expansion eastward to the Pacific.

[27] Different parameter values associated with key variables are expected to yield different characteristic patterns of attributes and behavior. In other words, variation in the strength and relationship of key variables—population, technology resources—explain different modes of external behavior and differences between Sweden in comparison with Great Britain, France, or the United States.

tory. Yet important limitations, impulsions, and drifts are likely to emerge at almost every stage of the capability-building and interest-extending process. Because of lags and other reasons a head of state or policy-maker may not be able to influence either the level or rate of change of technology on a day-to-day basis. Specialized capabilities are more accessible to manipulation, but again, there are lag times involved. Many pertinent decisions are likely to be made in the private sector beyond direct governmental control.[28] Over longer periods of time, the major distributions of human energies, capital, and other resources tend to become institutionalized (both in terms of government budgets and private investments and distributions). They thus become parameters for the day-to-day decisions of state. They may be manipulable in a narrow sense—cut the military budget 10 per cent this year, raise education 2 per cent, and so forth—but to alter their distribution grossly is likely to be exceedingly difficult. Such distribution ratios may become virtually institutionalized and thus strongly incline a society toward the expression of lateral pressure in one mode (the expansion of military influence, for example) rather than another (nonexploitative trade, for instance). A major break, such as a revolution, may be required in order to alter such institutionalized priorities. Budgetary distribution thus provides a fairly accurate measure of a nation's operational, as opposed to its professed, values. At least it measures the operational values of the ruling group.

Nation-states and empires with high lateral pressure (whether generated by ruling elites, wide sectors of the populace, or by a combination of both) tend to extend their influence in search of raw materials, markets, or other needed resources.[29] *Also, high levels of energy and surplus capital often seek outside investment opportunity even when resources are relatively plentiful.* The nature of resources sought tends to change with the level and character of the technology of the country exerting lateral pressure. This includes the character of financial and commercial institutions, as well as the machines of production. In line with an earlier suggestion, something like the Law of the Instrument

[28] Policy-makers in socialist states are likely to have more control over specialized capabilities. But even Soviet and Chinese Communist leaders have been seriously constrained by the vast difficulties associated with the planning and management of developments in a bewildering array of specialized enterprises.

[29] The types of individuals, groups, classes, or levels of government instrumental in extending national influence may vary enormously from society to society, and even within the same society through time. Thus, the United States and the Soviet Union both extend their influence in search of raw materials and markets, but the modes and mechanisms are quite different. This is not to suggest that Soviet-American rivalry can be explained only in terms of competition for raw materials.

seems to operate: societies with high specialized capabilities, and high levels of human and mechanical energy, frequently have their capabilities put to expansive use—even if it means exploring the moon. In high-capability societies we would expect this predisposition for the deployment of available facilities, capacities, and power to operate on lower and middle-range bureaucratic levels, as well as at the top.

The higher the lateral pressure generated by a given state or empire, the greater the tendency to extend its interests into (and often domination over) territories and countries with lower levels of capability. This is illustrated by Rome's expansion in Europe, North Africa, and the Middle East; by the imposition of Spanish control in South America, Mexico, California, the Philippines, and elsewhere; and by the spread of British and French dominions. So, too, the United States, during its westward movement, pushed aside or destroyed Indian tribes and absorbed Texas, New Mexico, Arizona, California, and other territories belonging to Mexico. Along her northern border, the United States encountered a stiff British-Canadian lateral pressure and was somewhat constrained.[30]

The desire to achieve and maintain law and order (as defined by national leadership) and to protect national interests (or large private interests) in far-off places may lead to wars against low-capability societies (indigenous tribes, colonies, semi-colonies, so-called underdeveloped societies, regional warlords, and clients of rival states). It may also lead to efforts to attract, equip and partially finance client chiefs, princes, warlords, military leaders, other rulers, ruling groups, or classes benefitting from the presence of one's own national or imperial interests. The pattern is ubiquitous throughout history with extraordinarily close parallels in British, French, Dutch, German, Japanese, Russian, and United States practice. Prevailing modes are somewhat different today. But both the United States and the Soviet Union have sought to maintain "law and order" (as each defined the term) in their respective spheres of interest. Both have supported their own clients, and both have tried to deny the establishment of a client of the rival power.

If a high-capability, high lateral-pressure country extends its interests and defenses too far, however, its leaders may find costs proliferating on two fronts. As decisions, control, and defense *apparati* are extended farther from home territory, transportation, communication, and administration costs tend to rise, even though operations in some

[30] Conceptually one might consider one country's resistance to external penetration as the response to another country's lateral pressure.

parts of the world may be less expensive than in others. The resistance of hostile elements in a widening sphere of interest is also likely to become more difficult to control. If, at the same time, dissatisfied sectors of the home populace tend to raise overt objections, costs will tend to rise at both ends. Under such conditions a head of state is likely to find his decision latitude considerably constrained. Previously manipulable variables become less and less responsive to efforts at control.

To the extent that two (or more) countries with high capabilities and high lateral-pressure tendencies extend their interests and psychopolitical borders outward, there is a strong probability that sooner or later the opposing perimeters of interest will intersect at one or more points. There is often a feeling on the part of an aspiring, but still somewhat weaker or less prestigious, power that it is being "encircled" by rivals. When this happens, we may expect the competition to intensify. The intersection of Roman and Carthaginian interests in Sicily and Spain gave rise to the Punic Wars. Spanish and English interests intersected in the Caribbean and elsewhere, although the defeat of the Spanish Armada marked a sharp alteration in the "balance of power." English and French perimeters of interest intersected in North America, India, Africa, and so forth, English and Dutch in places as far apart as Manhattan and the East Indies. United States, Soviet Russian, and Chinese interests intersect today in Southeast Asia and elsewhere.

Competitions and conflicts between two or more high lateral pressure countries frequently lead (directly through colonial or client wars, or through some combination of local and more diffused conflicts) into arms races and crises. Again, Rome and Carthage, Spain and England, England and Holland in the late sixteenth and early seventeenth centuries, France and England, and England and Germany offer examples. To one degree or another, client forces were involved in nearly all these conflicts. Since World War II (with the decline of territorial imperialism and colonialism, and with the division of much of the world through cold-war conflicts) the tendency of major powers to rely upon client relationships has become critical and especially widespread.[31]

Countries may be in competition without developing hostile relations with each other. To the extent that their perimeters of interest

[31] The Korean and Vietnamese Wars; the Middle East Conflict; the Quemoy and Matsu crises; the division of Germany, Korea, and Vietnam into separate states; and the emergence of Communist and anti-Communist satellite systems are only a few of the more obvious examples of contemporary linkages between "colonial" or "client" conflict and arms races, crises, and wars involving two or more major powers.

intersect, however, competition—especially for resources that are perceived as scarce (including prestige, influence or power)—may give rise to "antagonizing," the process by which "each side forms an increasingly unfavorable picture of the other as evil, hostile, and dangerous."[32] Thus competition *may* lead to non-violent conflict, which *may* lead to an arms race, which is *likely to* lead to crisis, which is *likely to* increase the probabilities of war.[33]

Such a reaction process opens the possibility that a state's defense operations systems—undertaken for "deterrence" or for security, and not for aggressive purposes—may incite another state to responses which will, in the long run, bring about the warfare which the initial system was designed to inhibit. Such, in essence, were the circumstances in which Great Britain, Germany, France, and other European powers were operating throughout the decade or so prior to World War I.[34]

Among nation-states we find the reaction process functioning in commercial competition, competition for power, arms races, and in exchanges of threat and counter-threat at times of acute international crisis. United States Secretary of Defense Robert McNamara described nuclear proliferation in similar terms. "If Nation *A* acquires nuclear weapons, very likely her potential adversary, Nation *B*, must acquire them, and then Nation *C* is concerned because Nation *B* might possibly have aggressive intentions with respect to Nation *C*, and therefore Nation *C* acquires them. The result is there can be a very rapid and dramatic expansion in the number of nuclear powers."[35] Reaction in this situation does not depend upon the objective reality, but upon the leadership's perception of the nation and the relative position of its rivals.[36]

As competition between rival countries becomes more antagonistic, the intersection of perimeters of interest, or other confrontation, may initiate a crisis situation. The question of who is responsible, of who is at fault, of who is "right" and who is "wrong," is not of any great importance. Crucial are the dynamics of the crisis itself.[37] Involved in

[32] Arthur Gladstone, "Relationship Orientation and Process Leading Toward War," *Background*, VI (Fall 1962), 13-25.

[33] The objective of our research in the long run is to replace the qualifying terms by numerical probabilities.

[34] Kenneth E. Boulding, *Conflict and Defense* (New York 1962), 25.

[35] U.S. Department of State *Bulletin* (August 29, 1966), 305.

[36] Boulding (fn. 34), 35.

[37] Charles F. Hermann, *Crises in Foreign Policy* (Indianapolis and New York 1969); and Ole R. Holsti, "The 1914 Case," *American Political Science Review*, LIX (June 1965), 369-77.

such dynamics are the increasing anxieties, the apprehensions, fears, threats and counter-threats among those involved. Many escalations de-escalate. "There are down-escalators as well as up-escalators, and there are landings between escalators where one can decide to get off or to get on, to go up or down, or to stay there; or to take the stairs."[38] Nevertheless, once a nation is caught in the dynamics of a crisis, its leaders often face great difficulty in finding an easy way out.[39]

The occurrence of break-points—shifts from one set of dynamics to another, for example from the dynamics of expansion to the dynamics of antagonistic competition to the dynamics of crisis—accounts for the progression of a conflict situation in the direction of large-scale violence. Earlier stages of competition are dominated by dynamics *internal* to the nation-state. At a later stage processes of competition, reciprocal comparisons, and perceptions of immediate threat and counter-threat become salient. It is important to keep in mind that shifts in the underlying dynamics take place more than once. In practical terms it is often possible to distinguish among different stages in a conflict situation. The farther along the progression of conflict, the narrower the available alternatives are likely to appear. Later we shall present some empirical evidence for break-points during the forty years prior to war in 1914.

The general framework and accompanying propositions should be interpreted in probabilistic terms, and not deterministically.[40] If any determinism is operating it is not "ironclad," but the outcome of human ignorance, confusion, and habit. We are profoundly impressed by the power of resistance to significant change on the part of individual and social habit structures, institutions, and points of view. We believe that many perseverant behavior patterns—for example, many patterns of cooperation, organization, conflict, and resort to violence—make certain outcomes *highly probable.*

Some variables are less amenable to control than others. This recognition should be taken into account explicitly by the policy-maker. It then becomes the task of the national leader to control the effects of less readily manipulable variables while maximizing the effects of those

[38] Albert Wohlstetter and Roberta Wohlstetter, "Controlling the Risks in Cuba," *Adelphi Papers,* XVII (London 1965), 19.

[39] Lewis F. Richardson, *Arms and Insecurity* (Chicago 1960).

[40] It is entirely possible for two (or even three) of these dynamic processes to take place concurrently, but one may be more salient at a given time. These relationships and the broader partial theory upon which they rest need additional clarification and further tightening. This is only a first step toward the development of an empirically verifiable theory of international behavior.

variables that are more easily controllable. This is perhaps another way of saying that a policy-maker should act in such a way as to maximize his decision latitude with the understanding that under some conditions his actions will amount to little more than reaction to the actions of others. At such times every conscious effort should be made to "opt out" of the reaction process and reestablish decision latitude. These observations, however self-evident they may seem, become more compelling when one notes that even the configuration of less manipulable variables is subject to some decision, by some individual, at some point in time. In fact, with respect to most data, *each statistic is an indicator of—and a consequence of—a discrete decision by an individual human being governed by a value preference.*[41] Population growth, for example, may be viewed as the outcome of a large number of discrete private decisions over which the policy-maker is not likely to have much control. The determinism involved is thus a kind of social determinism. That is, a whole society is impelled, or simply drifts, in a predictable direction—sometimes almost in spite of the head of state or foreign minister—because thousands or millions of private citizens and lesser public servants are behaving in (often) legitimate, customary, routine ways.

Indicators of technology and technological growth, like population, can be viewed as the outcome of large numbers of widely dispersed decisions in the private sector—decisions (and inspirations) of individual scientists, inventors, designers, developers, and manufacturers. This is less true in socialist states. But even there a certain amount of invention, research, and development is likely to take place beyond the immediate and direct control of national leaders—although they may set or approve the budget. In the United States, on the other hand, invention, research, and development are much more a matter of public policy than they used to be. Large amounts are undertaken or contracted out by the Department of Defense, NASA, and other governmental agencies. The development of technology is thus somewhat less influenced by private individuals now and somewhat more influenced by organizations and bureaucratic decisions.

A considerable amount of routine, but often extremely influential decision-making, takes place in governmental bureaucracies. Departments and department heads, division and division chiefs, to say noth-

[41] Statistics involve descriptions of, and generalizations about, aggregates. It is extremely difficult, if not impossible, to trace the relationship of the individual to the aggregate.

ing of higher officers, often pursue immediate goals which have very little to do with national goals and policies.[42] Some of these may emerge from the subsystem (departmental or divisional) values, some from personal ambition, and so forth. There seems to be a general tendency for even lower-level bureaucracies to put to some use whatever power they can accumulate. The incremental accumulation of such decisions can exert constraints or contribute to "drifts." Much of the literature of organizational theory suggests that organizations determine outcomes. Or, rather, outcome is determined by groups of discrete individuals playing organizational roles. Outcomes are often not the result of conscious value-maximizing choices, but of inertia, habit patterns, or a mixture of personal and organizational purposes. In any case, social habit patterns at the general level can be considered as the outcome of some earlier, discrete (conscious or unconscious) individual choices made by members of the population at large, or by individuals in government, and so forth. In the intermediate term, the accumulation of such decisions produces parameters for national decision-making. Over the longer term, the accumulated decisions may appear as external constraints wholly beyond the direct or immediate control of national leaders.

Our earlier analyses have focused on individual leaders' perceptions and cognitions. At this point we are not at all sure that such a focus represents the best possible choice. Our strategy now is to explore the capabilities of longer-range models to their fullest. The residual would therefore be subject to investigation with other models, supporting different kinds of assumptions, offering alternative kinds of implications. Complications arise when the longer-range theoretical structure is itself subject to different models, an issue which we shall return to momentarily.

More basic than the above considerations is the problem of "linking up," in operational and theoretical terms, long-range dynamics with medium- and short-range decision-making, especially in crisis situations. It then becomes an important question whether or not policy-makers *in fact* perceive the long-range variables (differentials in population, resources, technology, specialized capability, and so forth) as constraints. Does the policy-maker *in fact* compare his own capabilities

[42] See, for example, Graham T. Allison, "Conceptual Models and the Cuban Missile Crisis," *American Political Science Review*, LXIII (September 1969), 689-718. See also Herbert York, *Race to Oblivion: A Participant's View of the Arms Race* (New York 1970).

with those of rivaling states? Are there conscious efforts to manipulate less manipulable variables? Does the policy-maker resort to any kind of cost-benefit calculus?

In operational terms the linkages could perhaps be found in the policy-maker's rule book, if it were readily available. It would then become a relatively easy matter to test hypotheses concerning the nature of the linkages. Considerable work along these lines has already been undertaken using historical documents, namely the Parliamentary Debates in Great Britain between 1870 and 1914. In open documents such as these, policy-makers do *in fact* argue for appropriation of funds in terms of comparisons between their nation's capabilities and those of other states. The calculus is often very explicit and even expressed in numerical terms. Specific calculations of both long-range and short-range variables are undertaken, as well as projections of future alternatives and outcomes. This, of course, is nothing new. But from our particular perspective such information becomes a ready source of data relevant to linkages between long-range and short-range dynamics, data relevant to linkages with crisis situations.

Our theoretical structure is presented at a high level of abstraction. The cost of generality in this case is loss of relevance to short-range decision-making. We would be at a loss to advise the policy-maker in a crisis, or even with respect to much day-to-day decision-making. On the other hand, we can point out the long-term costs of some short-term manipulations, or the short-term obstacles to the control of less readily manipulable variables, such as population or level of technology. Yet the possibility remains that the policy-maker, if he can absorb the feel and impact of our partial theory and data, may stretch his decision latitude and achieve more of a reconciliation between short-term and longer-term outcomes.

In this context, the charge might be made that the prominence given in our propositions to population growth, demands for food, and demands for other basic resources amounts to biological reductionism. We take issue with this on the grounds that the other prominent variable, *technology* (or more precisely, the level of knowledge and skills), encompasses a wide range of other considerations. Technology contributes demands that are often more psychological and cultural than biological in their genesis and implications. Perhaps one most serious vulnerability is the exclusion of perceptual and other cognitive data. Any theory that tends to bypass or minimize cognitions, values, and decision processes is incomplete. In the last analysis, there is no doubt

but that cognitive variables need to be taken explicitly into account. It is a matter of research strategy as to the particular timing of such additions to the present structure of the partial theory. Our preference is to build a reasonably sound and empirically verifiable substructure before including cognitive and perceptual data.

III

The transition from a general theoretical statement to a model capable of sustaining the empirical test is seldom easy. A first step is to identify those variables or conditions that are to be explained. These are eventually to serve as the outputs of the model. A second step is to specify as clearly as possible those effects that contribute to outcome variables by developing an equation designed to explain the behavior of the dependent variable. A third step is to develop similar specifications and related equations for each of the outcomes to be explained. At the present stage of our investigations we have attempted to formulate systematic "explanations" of the dynamics of *lateral pressure*, of *intersections* among spheres of influence, of *military competition*, and of prevailing levels of *violence*. Each of these considerations serves as an outcome variable. Each is dependent upon a series of explanatory variables and specific relationships.

Those explanatory variables that contribute to our understanding of the outcomes in question may be other dependent variables (lagged or unlagged); or they may be variables that are exogenous and not explained by the model. It is important to select variables (and, by extension, accompanying parameters) that are either manipulable by the policy-maker, a "given" in the situation, or influenced by "givens" or manipulables.[43] For obvious reasons, it would not be useful to select variables that are all "givens," or variables that are all manipulable only at very high costs. The particular mix of "given" manipulables and controllables is an important consideration in designing the model. The extent that a model is (or is not) useful in explaining variance in behavior of a given country in a particular situation is in large part an empirical question. It can be answered through analysis, provided the appropriate data are available.

Formulation of an identifiable model is a slow and arduous task. We have found it advisable to proceed with a considerable degree of

[43] Albert Ando and others, *Essays on the Structure of Social Sciences* (Cambridge 1963), I.

caution. The operational question was first reduced to identifying a small set of variables and specifying inter-relationships and patterns of dependencies.[44] Only after a good deal of experimentation were more intricate formulations developed. It has been very useful, for operational and heuristic purposes, to "map out" the problem by moving explicitly from theoretical structure, to components of a model, to key variables, to operational definition of key variables, to the development of structural equations.[45] These steps are presented in Table 1. As a first approximation we have treated each component of the theoretical structure as generating one individual equation. In the longer run, these should be developed more appropriately into a set of block recursive structures. For example, lateral pressure then would be represented not by one equation but, conceivably, by a set of equations. Alternatively, it is quite possible for each equation to "fit" historical data. However, when coefficients are estimated simultaneously, errors may accumulate and bad fits will be obtained. For this and other reasons we would not expect individual equations adequately to represent dynamics as intricate as those described by the partial theory. Only by constructing the system bit by bit can a viable model be developed.

The development of an empirically verifiable model of the theoretical structure is only a beginning. Such a model may then be used to provide quantitative answers to particular questions, answers such as the effects of specific policy actions. The application of different exogenous variables, different decision rules and different initial conditions to the model would allow for experimentation with "what if" kinds of questions. This may help the policy-maker develop a feel for some of the middle- and longer-range components of actions which seem immediately desirable. Simulation techniques are important in this context because equations that cannot be solved by mathematical

[44] See Choucri and North, "The Determinants of International Violence," *Peace Research Society, Papers, Volume XII* (Cambridge 1968), 33-63; Choucri and North, "Aspects of International Conflict: Military Preparedness, Alliance Commitments, and External Violence," prepared for delivery at the Western Political Science Association Meetings, Hawaii, April 3-5, 1969; and Choucri and North, "Pressure, Competition, Tension, and Threat: Toward a Theory of International Conflict," prepared for delivery at the 65th Annual Meeting of the American Political Science Association, New York, September 2-6, 1969.

[45] Note the distinction between structural equations and model equations. This is especially important when evaluating the last column of Table 1: "A *structure* is a set of autonomous relationships sufficient to determine the numerical values of the endogenous variables, given the value of the exogenous variables." But a structure is meaningful only within the context of the model which makes explicit the nature of the equations and the kinds of variable included. See Carl F. Christ, *Econometric Models and Methods* (New York 1965) 21-22.

TABLE 1

STEPS IN THE DEVELOPMENT OF OPERATIONAL THEORY

Theoretical Structure	*Components of a Model*	*Key Variables*	*Operational Definition of Key Variables*	*Structural Equation* (as the base for model equation for analysis of the 1870–1914 period)***
DEMANDS	The constraints imposed by resources on the interactive effects of population and technology, giving rise to variable demands.	Population, technology, resources (growth and level).	Level and rate of national population, level and rate of industrial production (or more specialized variable), level and rate of resource variable (or area as approximation).	colonial population = Δ [home population/home area] + [Δ steel per capita] + Δ [home population/home area]. [Δ steel per capita] — [Δ total trade per capita] + [defense budget per capita] + u
LATERAL PRESSURE	The combined effects of increasing demands and the availability of specialized capabilities giving rise to lateral pressure.	Differentials between variables that increase likelihood of lateral pressure and those that minimize or dilute (or which influence one mode of lateral pressure rather than another).	Combined effects of differential between population and resource (area), favorable trade, and specialized capabilities (merchant fleet and defense budget).	
INTERSECTIONS	Variable expansionist tendencies in conjunction with specialized capabilities.	Variables indicating expansionist activities (either functional or literal).	Rates of increases in controlled territory of self and adversaries, or rate of penetration in areas, or economic control, or investments, and specialized capabilities (military).	Δ intersections = [Δ expansion of self] + [Δ expansion of others] + [Δ defense budget of self] + [Δ violence toward others] + [Δ violence of others] + u
MILITARY COMPETITION	Comparative calculations of capabilities and increases in armament provisions in combination with intersecting spheres.	Defense capabilities (budgets, men under arms, inventories) of nation and rivals (both rates and levels), expansion variables, gaps.	Rate of increase in defense expend., or men, or inventory, or advanced def. technology for self and rival, in combination with expansion variables.	Δ defense budget = [Δ defense budget$_{t-1}$] + [Δ defense budget of rivals$_{t-1}$] + [Δ expansion of self] + [Δ intersections] + u
EXTERNAL VIOLENCE	Increasing thresholds of prevailing violence resulting from intersections, military competition and international alignments.	Variables indicating level of violence in international behavior (level and rate), military and alliance variables.	Violence variable computed on the basis of action data, casualties, "deathly quarrels," alliance commitments, military expenditures (rates and level of self and others).	Δ violence = [Δ defense of self] + [Δ defense of others] + [Δ intersections] + [Δ alliance commitments] + u

* See the *Research Note* for operational details and theoretical justification. The use of delta variables already assumes the choice of the underlying model. Alternatively level, percentage change, or ratio could be employed, as well as different data specifications for the indicator values.

** For other time periods and other situations different indicator variables are more appropriate. These four equations are *highly tentative*. Considerable reformulations are currently underway.

operations to derive precise analytical solutions can be solved by numerical operations to obtain specific numerical solutions.[46] Simulation allows us to determine the implications of a model, the consequences of various combinations of initial conditions. We can determine the implications of specific policy actions or sequences of policy actions (such as increases or decreases in defense expenditures, entering into novel alignment commitments, and modifying budgetary appropriations) and the effects of alternative values and rates of increases in the givens or in the less readily manipulable variables.[47] Such efforts offer the national leaders an opportunity to develop a feel for a proposed policy (and its alternatives) without entering into any commitment. They provide insights into the risks and costs of a particular policy or a particular decision-rule. For long-range as well as short-range purposes what is needed is an explicit estimate of coefficients for the most important policy instruments available to the decision-maker. By manipulating these coefficients it is then possible to begin raising questions about the cost-benefit calculus of policy choices. The model must also provide for the effect of a policy on other countries in the international system and anticipate their probable responses to the initiative being considered.

We have attempted to develop a model which includes both national and international effects while resolving the basic problems of estimation and identifiability. In theoretical terms different types of variables are more appropriate at some stages in the development of a conflict situation than at others. For example, dynamics internal to the nation-state (demands and lateral pressure) tend to dominate early stages. As nations extend their activities outside national boundaries and come into direct contact with other states, other sets of dynamics are likely to operate (such as intersections among spheres of influence). Mechanisms of competition in these later stages may become expressed in terms of armaments (military competition). In many cases our explanation of military competition will depend more upon external factors than upon internal factors, although a combination would probably be more likely. In this manner it should be possible to identify the "breakpoints" where external dynamics become more important than internal dynamics. A correct specification of these shifts could provide useful guidelines to the policy-maker. For example, insights would be

[46] An excellent illustration of this kind of procedure is provided by James S. Duesenberry and others, eds., *The Brookings Quarterly Econometric Model of the United States* (Chicago 1965).

[47] Charles C. Holt, "Validation and Application of Macroeconomic Models Using Computer Simulation," in Duesenberry and others, *ibid.*, 640.

provided into the payoff for minimizing the importance of internal constraints at times when international considerations appear to bear more directly on the issues. Break-points are very real, and their relevance for theory-building or empirical analysis should not be minimized. So far we have been able to isolate empirically some critical break-points in the progression of a conflict situation (Europe, 1870–1914).[48] The problem is to be able to *predict to* a break-point. This amounts to a major challenge. It is not difficult to specify in theoretical terms conditions under which critical shifts are likely to occur. It is not at all an easy matter to operationalize those conditions in quantitative and empirical terms. What we are suggesting, therefore, is that optimum specifications would, by necessity, include both internal and external variables. A "mixed" model of this sort is likely to yield greater payoffs in the long run; and the potential implications for policy purposes should not be minimized.

IV

Much of our empirical work to date has focused on major powers in Europe between 1870 and 1914. This is a period of considerable change and turmoil for which empirical data and documentation are readily available.[49] The four equations in the last column of Table 1 provided the bases for a first attempt at a mixed model, one including both internal and external variables. Indicators of lateral pressure, intersections among spheres of influence, military preparedness, and external violence served as the dependent variables to be explained by a combination of domestic and international considerations. Much of the statistical and methodological detail is discussed elsewhere.[50] We shall confine ourselves here to some results and implications.

Throughout the forty years or so prior to World War I all the major powers were generating more and more demands and improving their specialized capabilities—but from different bases and at unequal rates of change.[51] All were generating some amount of lateral pressure, and

[48] In this context sensitivity analysis would be extremely useful: that is, systematically altering the parameters and observing changes in the system and the extent of stability among basic relationships. See the *Research Note* at the end of the present article for some data on break-points.

[49] North and Choucri, *Nations in Conflict: Prelude to World War I* (in preparation).

[50] Choucri and North, 1968 (fn. 44), and North and Choucri (fn. 49). The specific nature of the empirical formulations providing the basis for the findings discussed in the following is described in the *Research Note* below and in the last column of Table 1.

[51] Because of the difficulties involved in measuring "demands" this statement is purely inferential.

most of them tended to express it in terms of colonial expansion. Those powers that expanded most widely were also those that were growing most rapidly in domestic population and/or technology and production. Between 1870 and 1900 the colonial populations under British control more than doubled in size (accompanied by a slightly larger increase in territory). Seventy-five per cent of the variance in this expansion can be accounted for: mainly by the differential between domestic population growth in relation to national (home) territory, by technological advancement, by the combined effects of population and technology, and by military preparedness.[52] The remainder of the variance—the unexplained 25 per cent—may well be accounted for by conscious decisions on the part of the national leadership, by policy calculations, and the like. But with so much of the variance accounted for by relatively non-manipulable variables, decision latitudes appear to have been considerably reduced.[53] This tendency stands in sharp contrast to the patterns in Sweden and other Scandinavian countries. The Scandinavian countries were inclined to rely upon trade, rather than colonial expansion, for the satisfaction of demands.[54]

Eighty-five per cent of the variance in the colonial population under French control from 1902 to 1914 can be accounted for: mainly by technological advancement, by the combined effects of population and technology, and by increases in military capability.[55] These variables were even more significant during the earlier years when French colo-

[52] Standardized regression (or path) coefficients for Britain are as follows: Population: —.40 (.17); technology; 13.13 (.29); the interactive effect of population and technology: 12.80 (.29); commerce: —.06 (.10); and military capability: —.43 (.11). Parentheses refer to standard errors. See Table 1 and the *Research Note* at the end of this article for operational definitions. The interactive term adds little to the information contained in the technology variable. There are some instabilities which are currently being ironed out.

[53] In the context of a stationary national area during the 1870–1914 period, Britain's domestic population growth averaged .89 per cent annually, increases in iron averaged .33 per cent and in steel 2.80 per cent annually, and national income per capita 1.4 per cent. These percentages are based on our data files for this period.

[54] See Nazli Choucri (with the collaboration of Robert C. North), "In Search of Peace Systems: Scandinavia and the Netherlands," in Bruce M. Russett, ed., *War, Peace, and Numbers* [forthcoming, 1972]. In 1960 the combined population of the Scandinavian countries was almost ten million lower than Great Britain's population one century earlier. The rates of growth for Sweden and Norway during the 1870–1914 period held annual averages of .65 per cent and .80 per cent respectively. Further comparisons are presented in this paper. Because of probable measurement error in the data series, these and following percentages are approximations at best.

[55] French domestic population growth averaged approximately .13 per cent annually, while growth in per capita income averaged 2.8 per cent—one of the highest among the powers—and industrial production (steel) almost as high (2.5%). In the French case it was the combination of low population growth and high technological achievement that contributed to lateral expansion. By 1914 the French empire extended to over twenty times its size in 1870.

nial expansion was at its height. The remainder of the variance, though unexplained by these variables, is nonetheless constrained by one basic relatively non-manipulable master variable (population) and one more readily manipulable variable (defense capability). But, as has been pointed out, severe constraints can sometimes seriously limit the decision latitude of national leadership.[56]

By 1892 well over 60 per cent of the variance in German expansion can be accounted for: in terms of gains in home population (relative to home territory), technological advancement, and the interactive effect of population growth and industrial production.[57] These are relatively non-manipulable variables on a day-to-day basis—variables difficult to change at the discretion of the political leadership. As will become apparent, however, even the more readily manipulable variables, such as military capability, are subject to serious constraints. It is true that the unexplained variance—37 per cent or so—might well be accounted for by variables that could be more easily manipulated. But the considerable constraints imposed by relatively non-manipulable variables cannot be ignored.[58]

Territorial expansion (and accompanying expansions of national interest) helped cause two major types of violent conflict. The first category consists of colonial wars which involved the subduing or policing of local bands, tribes, chiefdoms, and petty states lying in the path of great-power expansion. Great Britain became engaged in 14 such

[56] For a discussion of empirical data, methodological issues, and statistical results see Choucri and North, "Causes of World War I: A Quantitative Analysis of Longer-Range Dynamics," in Klaus Jurgen Gantzel and others, eds., *Grossmachtrivalität und Weltkrieg: Sozialwissenschaftliche Studien zum Ausbruch des Ersten Weltkrieges und Historikerkommentare* (Gütersloh, forthcoming, 1972). The problems associated with a logarithm transform of the first and third terms of the expansion equation are discussed in Choucri and North, above, as are modifications of the results. We have been able to determine the relative importance of the main effects of population and technology rather than the interaction effects. The implications of interaction, in terms of high collinearity with main effects, are also discussed. These coefficients pertain to analysis with the logarithm transform in the first and third terms.

[57] Standardized regression (or path) coefficients for Germany are as follows. Population: .77 (.40); technology: .71 (.28); the interactive effect of population and technology: .44 (.20); commerce: .20 (.02); and military preparedness: .08 (.17). In this case there is a distinct interactive effect.

[58] The average annual rate of population growth of Germany during this period stood at 1.14 per cent approximately; the rate of growth in steel, 5.28 per cent; in iron, 4.36 per cent. The rate of increase in national income averaged 2.3 per cent per year and in per capita income at 1.2 per cent (in comparison with 1.4 per cent for Great Britain, the difference being accounted for in large part by the higher rates of growth in the German population). It should be pointed out that the German rate of growth was not particularly high *per se*, but *in comparison with the other powers* (especially Britain and France) and in combination with German technology, it could be considered a potent variable.

wars, involving somewhere around three thousand casualties or less; France, nine wars; and Germany, Russia, Austria-Hungary, and Italy, one war each at that casualty level. The other category consists of wars between major powers themselves, or wars between the client states of major powers. These wars tended to come about somewhat indirectly. Great Britain became involved in nine wars of this nature, incurring between three thousand and thirty-one thousand casualties in each; Russia and Austria-Hungary, four wars each; and France, Germany, and Italy, three wars respectively.[59]

With all this expansion taking place, it is not surprising that the colonial territories, and the "perimeters of interests" of major powers tended to collide or intersect. These confrontations, many taking place at distant frontiers in Africa, the Middle East, and Asia, gave rise to further competitions in specialized capabilities, and for territory and resources. Thus the way was prepared for arms races, crises, and war.

The intersection equation in Table 1 accounts for more than 80 per cent of the variance in the intersections of each major power.[60] It becomes apparent that changes in prevailing levels of conflict [$\triangle$ violence of self and $\triangle$ violence of others] contributed significantly to intersections, as did each power's own military establishment. From this it could be inferred that a critical variable—defense capability—might have been manipulated in such a way as to decrease the intensity of intersection. For example, between 1872 and 1892 Great Britain's own defense capability provided considerable impetus to the intensification of her intersections with other powers. This means that the larger the increases in the defense budget, the more intense were her intersections with other powers. It suggests that measures taken in part, at least, to enhance national security contributed to conflict and sometimes to violence. This comes about because, as the international system operates, one nation's security tends to become another nation's insecurity.[61] It would follow, somewhat paradoxically, that decreases in the defense budget *might* have resulted in lowering the intensity of such intersections, although such a reduction might also be interpreted as compromising security.

From this limited and somewhat tentative evidence, we could argue that manipulating a variable such as the defense budget is likely to have important consequences in terms of intersections among spheres of

[59] Lewis F. Richardson, *Statistics of Deadly Quarrels* (Chicago 1960), 52-69.

[60] High R^2 are due, in part, to the loss of degrees of freedom. These, however, are taken into account when computing coefficients and related standard errors.

[61] J. David Singer, "The Political Science of Human Conflict," in Elton McNeil, ed., *The Nature of Human Conflict* (Englewood Cliffs, N.J. 1965), 144.

influence. But the probabilities of outcome are difficult for the policy-maker to assess. Since nations do not operate in a vacuum, their defense calculations are normally influenced, and sometimes set, by standards exterior to the nation-state itself. The policies of country *A* are both impelled and constrained by some of the policies of countries *B*, *C*, and *D*. During the 1870–1914 period, for example, each power predicated its naval policy on the naval policies of its perceived "adversaries." For Great Britain the Three-Power, Two-Power, and eventually the "twice-Germany" standards provided the basic decision rules.[62] By the turn of the century Germany's decision rule was to attain—and maintain—a strength within a margin of .6 of Britain's own defense increases. Such calculations were based on specific projections of their respective rates of change and variable performance. This essentially reciprocal arrangement amounted to a loss, or self-denial, of decision latitude on the part of both (but especially the British) leaderships. France, too, seemed to base her own policies on those of her "adversaries." Russia did also.

The linkages between increasing defense preparedness and intersections of spheres of influence to increasing levels of conflict behavior are yet to be made explicit, although in narrative fashion diplomatic history is rich with such linkages. In simple terms we found that expansion leads to intersections. These contribute in turn to increasing military preparedness on all sides. From this it would naturally follow that increasing military budgets would raise the probability of external violence. But the effects are more complex. It is the combined impact of intersections and defense preparedness that contributes most strongly to an intensification of conflict behavior.

The single most significant determinant of external violence is the *intensity* of intersections among respective spheres of influence. And intersections, it will be recalled, were highly conditioned by variable rates of lateral expansion and variable rates of military preparedness. On the other hand, we found that at least in this case changes in the number of each power's alliance commitments had very little effect on a nation's external violence. In the context of the 1870–1914 situation (a classical case of the conflict spiral) alignment commitments *per se* contributed only minimally to the intensification of conflict behavior.[63] The determinant variables were intersections and increasing military competition, as indicated by the military budget. Both these variables

[62] Kendall M. Moll, *The Influence of History Upon Seapower, 1865–1914* (Stanford 1968); Robert C. North and Richard P. Lagerstrom, "An Anticipated Gap, Mathematical Model of International Dynamics" (Stanford 1969).

[63] This finding refers to long-term trends and not to crisis confrontations where alliance commitments may be more influential.

were potentially manipulable, but as pointed out earlier, highly constrained by basic master variables. The critical link in the long-term conflict spiral seems to be the point at which a nation extends its behavior outside national boundaries. Intersections (and violence) are often outcomes of growth, generally considered highly desirable, along dimensions of population, technology, production, and military capability. The contrast between the great powers and the Scandinavian countries during the 1870–1914 period serves to underscore the range of variability in external behavior. The initial mode of behavior undertaken beyond national boundaries tends to condition eventual outcomes. In this sense the leadership of nations involved in arms races (presumably undertaken to optimize national security and decision latitude) may in effect abdicate (or deprive itself of) decision freedom at some later point of choice.

After World War II colonial expansion was no longer a feasible mode for the expression of lateral pressure. There is often a tendency, however, for leaders and some of the populace of a country to feel that overseas interests (of whatever mode) ought to be defended. Also, high capability, high lateral-pressure countries, are inclined to attempt to deny their rivals the possibility of economic, political, or military penetration into low-capability areas. This suggests that some of the processes of competition and conflict characteristic of the pre-World War I period may have analogues in the postcolonial system following World War II. We might expect to find lateral pressure expressed in terms of trade, aid, investment, military assistance, troops overseas, military bases on foreign soil, and control of political parties in foreign countries.

Recent Japanese trends illustrate some of the problems that appear to be just around the corner for other major powers. From 1870 through 1941 Japan—in terms of population growth, rapid technological advancement, limited home territory and resources, territorial expansion, and international conflict—presents a clear-cut, extreme example of increasing demands, the development of specialized (including military) capability, and the generation of strong lateral pressure. In retrospect, the concept of a Greater East Asia Co-Prosperity Sphere may be viewed as a crude measure of Japanese demands. The acquisition of control over Taiwan, Korea, Manchuria, large sectors of China, Indochina, the Dutch East Indies, and so forth serves as a rough indicator of lateral pressure. Japanese expansion was counteracted by the expansionist activities of western powers as they expressed their own lateral pressure in various ways.

After World War II Japan reduced her birth rate considerably. The an-

nual percentage increase in the 1950's was about .9. During the late 1960's it increased slightly to 1.1 per cent. By then, however, the level of population was sufficiently high so that each increment—approximately one million per year—added to an already large base. Writing in 1946, Warren Thompson presented two predictions for the Japanese population in 1970: (1) 88 million or (2) 105 million, as estimated by the Population Institute of Japan. Thompson inclined toward the lower estimate. It is now evident that the higher estimate was more nearly correct. Thus, in spite of Japan's lower population growth rate after the war, the outcome so far has been somewhat above Thompson's personal expectation.[64] The population of Tokyo, currently approaching 16 million, is projected to reach 40 million by the year 2000.[65]

The probable magnitude of future demands (as we have defined the term) is further suggested by post-World War II trends in primary energy consumption and GNP. Between 1950 and 1964 the consumption of solid fuels, natural gas, oil, and hydroelectric power nearly quadrupled. At the beginning of that period "indigenous resources supplied 90 per cent of the total requirements"; by 1964, on the other hand, "imports represented more than 60 per cent of the total."[66] Around 1980 Japan's total requirements may be twelve or thirteen times what they were in 1950.[67] These figures are only illustrative. Obviously a wide range of other resources will be demanded in larger quantities and supplied largely through imports. Between 1958 and 1967 the GNP increased at an average rate of about 10 per cent. Chemicals and heavy industry accounted for nearly 70 per cent of this growth. Tendencies toward urbanization were strong. Over the next ten to twenty years, moreover, the Japanese Islands will be plagued with many of the same problems of pollution, ecological imbalance, and extensive urbanization that will increasingly trouble other highly industrialized countries. Other problems will be added to the extent that Japan confronts limitations and constraints on her access to materials and markets.

The combination of the demands of a rapidly growing technology with those generated by a relatively moderate population growth makes it highly probable that access to resources and markets will remain one of the basic underpinnings of a stable and peaceful Japan in the foreseeable future. To the extent that our findings for the major European powers (1870–1914) are suggestive for the analysis of the Japanese case

[64] Warren S. Thompson, *Population and Peace in the Pacific* (Chicago 1940), 99.
[65] Ehrlich and Ehrlich (fn. 10), 48.
[66] *Energy Policy: Problems and Objectives*, Organization for Economic Co-Operation and Development (Paris 1955), 91.
[67] *Energy Policy: Problems and Objectives, ibid.*, 94.

in the present and immediate future, we would expect Japanese leaders to be increasingly confronted by the implications of longer-term, relatively non-manipulable variables. And, so far as the foreign affairs of Japan are of interest and consequence to other countries (the United States, Canada, U.S.S.R., the People's Republic of China, Taiwan, Australia), leaders in these countries also will be increasingly concerned with the same long-term, relatively non-manipulable variables. These variables, especially population and technology, are at least in considerable part the aggregation of millions of private, individual decisions (or their side effects). Or they are the accumulation of small, disjointed incremental decisions by leaders, bureaucrats, and at least some of the citizenry. For these reasons these long-term variables are frequently difficult for even the far-sighted leader to influence or plan for without sophisticated forecasting techniques.

Among the more easily manipulable variables are diplomatic negotiations of various sorts, the administration of trade, technical assistance, and military aid programs, and troop movements and mobilizations. The problems of Japanese trade, for example, are susceptible to, and sometimes dependent upon, manipulation by the leadership of many other countries interacting with Japan. Such manipulations are limited, however, by such medium-range variables (which become parameters for day-to-day operations) as military budgets, draft quotas, men-under-arms, alliance commitments, trade treaties, tariff arrangements, and the like. Between the relatively non-manipulable long-range variables and the day-to-day responses of other national leaders, a considerable amount of decision latitude and control over the course of events is lost, putting the nation at the "mercy" of earlier developments.

Given present levels and rates of population growth, technological advances, and the depletion of basic resources—together with the high risks of conflict in an age of massively destructive weaponry—national leaders might begin to undertake longer-range studies of these "non-manipulable" variables. To what extent can they be controlled by careful planning, by the introduction of incentives, penalties or other countervailing forces, by educational programs affecting externalities, and by disjointed incremental drifts? Possibly business and industrial leaders, small investors, entrepreneurs, and private citizens in all trades and professions might be shown some of the ways in which their legitimate (and sometimes personal and intimate) decisions, or the side effects of these decisions, may constrain a whole society or contribute to disjointed incremental drifts.

As suggested earlier, the constraints and impulsions affecting heads of state or other high-level decision-makers are not the outcome of an ironclad determinism. They emerge from decisions made by predecessors, from the polities of other countries, from bureaucratic decisions made at least partially in pursuit of personal or narrowly departmental goals, and from millions of private decisions made by individual citizens in terms of normally legitimate personal, family, or professional values and goals. The national leader or policy-maker will remain seriously boxed in—caught in the interstices of the larger international system and its component subsystems (including wide sectors within his own country). To the extent that he shapes policy, it is largely within a narrow, day-to-day context without careful thought for middle- and longer-range consequences, and to the extent that he accepts the constraints and impulsions as givens.[68]

We recognize that national policy-makers cannot easily escape from these day-to-day concerns, nor free themselves from the responsibility for tomorrow morning's decision. Yet the implications of our findings, if projected to the future, are in no sense encouraging. The prospect of states and super-states carrying their leaders along in response to dynamics of which few people are aware, and over which no one seems to have adequate control, is somewhat chilling in a nuclear world. We believe that such conditions ought to be monitored on a systematic basis—not in terms of the usual intelligence operations—but in terms of (a) how the international system has been operating over the last two or three decades (in terms of impulsions and drifts); (b) projections of what the world is likely to look like if recent and current impulsions and drifts continue; (c) alternative courses of action and the identification of variables that can and should be altered; and (d) specification of the means for changing these variables and the probable benefits and costs associated with such means.

With these tools at hand, the head of state and his advisers would have a more systematic and professionally-based opportunity to balance immediate or short-term benefits against probable medium- or long-range costs. He would be in a better position to perceive each potential

[68] Otto A. Davis and others, "A Theory of the Budgetary Process," *American Political Science Review*, LX (September 1966), 529-47. Also see J. David Singer, ed., *Quantitative International Politics, Insights and Evidence* (New York 1968), Part I. Relevant also are N. B. McEachron, "Modelling Macro-Social Tension and Change in American Society," presented at the Fourth Hawaii International Conference on Social Science, Stanford Research Institute, 1970; and Kenneth E. F. Watt, "State Planning Failures: What to Do About It," *Cry California* (Winter 1969-70).

as a stimulus reverberating through the system, so to speak, and affecting the future in a large number of ways. With some reasonable assessments of both benefits and costs he would find himself in a stronger position for undertaking long-term policies which are in the interests of the more distant future. Moreover, he would be able to present to his constituents the rationale of his actions. And possibly he would be able to elicit public support that otherwise would not be available.

The idea of using more readily manipulable variables, such as budget allocations, as leverage for altering less readily manipulable, longer-range variables is not new. The post-World War II Marshall Plan offers a well-known example. What the evidence of this paper suggests is that the network of interdependencies may be more intricate, more pervasive, more extensive—and yet potentially more susceptible to planning—than is sometimes assumed. Conceivably, a more unified strategy of long-term/short-term policy-making might emerge. While undertaking whatever feasible to minimize the immediate outcome of a population-technology-resource imbalance, for example, a head of state might also make effective use of more easily manipulable variables in order to achieve leverage for bringing about a preferable technology-resource balance in the future.

If a larger body of theory and experience had been available in recent years, it would have been feasible for a President of the United States to initiate a massive shift from defense allocations into sustained, ecologically-oriented investments and projects, a shift of resources from "high-pollution" sectors of the economy into research and development for "low-pollution" (and relatively high demand-satisfying) production and services. As another illustration, in the sphere of international relations a President might have commissioned a half-decade ago a set of thirty-year projections of Pacific Basin trends so that countries around the ocean periphery could cooperate to meet future needs and demands. The intent would be to alter undesirable probabilities by acting earlier to encourage more universally favorable outcomes farther down the road.

Conceivably, too, such undertakings might have been systematically monitored so that negative information secured at one point in time could be used with long-range criteria as a basis for operational correction at a subsequent point in time.

These observations suggest the utility, in other words, of *long-range* trend analyses and alternative projections by components of a national leadership. They point out the desirability of setting early priorities in terms of long-range variables and middle-range variables, and the desir-

ability of establishing parameters that have some possibility of widening the alternatives in day-to-day decision-making.[69]

Research Note

This note includes a brief discussion of some basic methodological issues, a summary of our statistical work to date, a description of the operational measures employed, and some empirical evidence for the occurrence of breakpoints in the development of conflict systems between 1870 and 1914.

Perhaps the most basic issue in making the transition from a theoretical structure, stated verbally, to a model amenable to empirical verification is specification of the causal ordering. In the most general sense "causation" refers to hierarchies of influences or effects, most readily characterized by asymmetrical relations within a specified system. The two dominant views on this issue can be summarized as follows. On the one hand there is the argument that because causal models approximate "reality" only to a limited degree, variables are by necessity excluded from each equation in the system. Therefore the real number of variables is always understated, and to consider only the explicitly stated variables is to run the risk of treating truly endogenous variables as exogenous. For these reasons it is not possible to unravel causal dependencies among complicated sets of interrelated variables.[1] The opposing position is based on the argument that the real world is not composed of simultaneous dependencies, but that hierarchies characterize relationships, and that true systems are always of a recursive, hierarchical nature.[2] It is therefore possible to determine causal relations.

The adoption of either position results, of necessity, in the construction of vastly different systems of equations.[3] A plausible reconciliation of these very real concerns suggests that simultaneity is present within some localized domain; that at a more general level simultaneity, though present, is probably not overriding; and that the world outside is more nearly block recursive than it is completely simultaneous or completely hierarchical.[4] And it is this middle position that has provided the basis for our model-building efforts. Its theoretical justification lies in the theorem that if a system is clearly decomposable it is plausible to proceed *as if* it were completely decomposable.[5] In the short run the costs of such an assumption will be minor.

[69] For an elaboration of the implications of both theoretical framework and empirical data presented in this paper see Robert C. North and Nazli Choucri, "Population and the International System: Some Implications for United States Policy and Planning," prepared for the National Commission on Population Growth and the Future of America, August 1971.

[1] T. C. Liu, "A Simple Forecasting Model for the U.S. Economy," International Monetary Fund, *Staff Papers* (August 1955), 434-66.

[2] H. Wold, in association with L. Jureen, *Demand Analysis* (New York 1953).

[3] In one case single equation estimation methods for recursive systems are called for, in the second simultaneous estimation techniques are appropriate.

[4] Franklin M. Fisher, "On the Cost of Approximate Specification in Simultaneous Equation Estimation," in Albert Ando and others, *Essays on the Structure of Social Sciences* (Cambridge, Mass. 1963), 32-63.

[5] *Ibid.*, 92-106.

A further complication arises in that causation is not necessarily implied by a particular time sequence, nor does a particular sequence of events necessarily imply causation. In a persuasive argument Herbert Simon has suggested that causal orderings can best be determined by the appearance of zero coefficients in a system of equations.[6] This *a priori* specification of zero coefficients thus raises the issue of identifiability. For operational purposes causation is closely related to identifiability. And the requirements of identifiability impose certain constraints on the process of model-building.[7]

With these considerations in mind, the comments that follow are in the nature of a progress report regarding the development of the model presented in Table 1. The equations in the last column are still *highly* tentative, and considerable experimentation is yet to be undertaken. Nonetheless, a brief survey of the research plan that has led to this model may highlight some of the difficulties encountered.

The first attempt to operationalize aspects of our partial theory involved two different, and fairly artificial, sets of hypotheses with different, and equally artificial, implications for the policy-maker. The first set was based on the proposition that a nation's behavior is, in large part, determined by *internal* processes—population growth, technological advancement, the development of specialized capabilities, such as a defense establishment, and so forth. Thus, actions could be accounted for by a model specifying only *national* considerations. The second set of hypotheses, proceeding from different assumptions, argued that national behavior is determined first and foremost by the capabilities and behavior of *other* nations. In the gap or distance between one's own capabilities and those of others (often the closest rival) is to be found much of the explanation for a nation's actions in the international system.[8]

The major policy guidelines provided by the first model are that national leaders explicitly recognize both the limited effects of other nations in conditioning outcomes and the importance of internal dynamics and internal considerations when evaluating competing constraints on their freedom of action. The implications of the second model are almost the reverse: that greater attention should be paid to external variables, and internal considerations be relegated to secondary importance. Obviously these different guidelines or implications give rise, by necessity, to different assessments of priorities and different policy alternatives.

The artificial nature of these hypotheses was further reinforced by the consideration that a model focusing either on national *or* on international

[6] *Ibid.*

[7] Here we are again indebted to recent econometric literature on problems of model-building. See especially J. Johnston, *Econometric Methods* (New York 1963), and Arthur S. Goldberger, *Econometric Theory* (New York 1964).

[8] Two variants of this model were developed. In one the independent variables were defined in terms of the rival's attributes and capabilities. And in the second the independent variables were defined as the distance or gap between a state's capabilities and those of the rival. See Choucri and North (fn. 44 of text), 43-61. We are grateful to Raymond Tanter for assisting us in spelling out the implications of these models.

effects is likely to be vulnerable on theoretical terms (by reducing everything to internal factors or to considerations external to the system) and incomplete in operational terms (by allowing for large serial correlation reflecting incomplete specification). Certain features of both models yielded fairly good "fits" with empirical data for the 1870–1914 period. But because national and international hypotheses were not included *in the same model* it is difficult to compare their respective explanatory power and, by extension, the accompanying assumptions and implications. Of course, problems related to identifiability compound when estimating the parameters of a model which includes level as well as gap or distance variables. And estimation problems increase as larger numbers of independent variables are included in each equation.

The next step, therefore, was the development of a model comprising internal *as well as* external considerations without violating the requisites of identifiability. The four equations in Table 1 represent an initial operational statement within which more explicit structures could then be derived. For example, the equation combining both demands and lateral pressure is clearly a summary statement of more intricate processes which need be made explicit. Furthermore, uni-directional effects estimated by ordinary least squares do not adequately represent a system in which mutual dependencies are known to operate. It therefore becomes necessary to model these dependencies as clearly as possible employing appropriate techniques for simultaneous estimation. A related, and equally important, problem involves the isolation of break-points (shifts in dynamics). If unnoticed, these may give rise to poor "fits" and misleading inferences.[9]

Many alternative formulations may be empirically consistent with the same set of data. Identifying the most valid equations is seldom an easy task. Statistical criteria for evaluating an equation or model include (1) proportion of variance explained, R^2, (2) magnitude of standard errors, and (3) sign of the coefficients. Misspecifications may give rise to bad fits and to severe serial correlation. Corrective procedures such as a re-specification of the model or the application of iterative methods to reduce autoregressive effects are often necessary.

We have attempted to incorporate the element of change by expressing each variable in terms of its delta value $(x_t - x_{t-1})$, although we recognize that other specifications such as relative or percentage change are also valid.[10] Our selection of this measure is exploratory, subject to further experimentation with alternative values.

[9] On empirical grounds alone it is difficult, if not impossible, to determine exactly when a break-point has occurred. It is also as difficult to predict break-points as it is to predict the behavior of the system beyond the break. On the other hand it is possible to test for the existence of a break-point and for the significance of the break. We are grateful to Professor Franklin Fisher of the Economics Department, M.I.T., for a clarification of this problem and for suggesting means of redefining the issues in ways that can be amenable to empirical inquiry.

[10] Theoretically, at least, we postulate that, in the long run, changes are more important than absolute levels, but in terms of short-range day-to-day decision-making levels are probably more important. We have conducted parallel analyses with level variables as well.

The first equation representing the process of lateral pressure summarizes the combined effects of internal demands and specialized capabilities on a state's external expansion. The effects of population, technology, commerce and military capability are depicted as follows:[11]

$$\Delta \text{ col. pop.} = a + B_1 \Delta [\text{home pop./home area}] + B_2 \Delta [\text{steel production per capita}] + B_3 \Delta [\text{home pop./home area}]. \Delta [\text{steel per capita}] - B_4 \Delta [\text{total trade per capita}] + B_5 \Delta [\text{defense budget per capita}] + u.$$

The dependent variable represents only a first order approximation of expansion (since colonial population is subject to a natural growth component independent of dynamics internal to the major powers) but at the same time it depicts the extent of external involvement. The effect of home population is summarized in the first term Δ (pop./area) where the denominator reflects internal constraints on the demands generated by the population.[12] Technology is represented by change in the production of steel per capita.[13] And the combined effect of population and technology, so central to our theoretical framework, is summarized in an interactive variable composed of the product of the first and second terms. Trade (imports and exports per capita) is included in this equation to indicate attempts to meet internal demands through commerce. The negative sign relating this term to the others signifies a hypothesized inverse effect. That is, high rates of increase in per capita trade are likely to contribute to lower rates of expansion, although a certain simultaneity or feedback effect is likely to operate. The next term in the equation represents a specialized capability that may enable a society to translate demands into actions or behavior. Again, the defense budget on a per capita basis is only a first order approximation of specialized capability. And finally, the error or disturbance term, u, represents random factors as well as deterministic effects that should have been explicitly modelled.[14] The greater the serial correlation among the u's (and the greater the deterministic component), the more extensive are the effects of those unmodelled factors. It then becomes necessary to incorporate these in the equation (or to expand

[11] Estimation was undertaken with the use of the TROLL interactive computer system for the analysis of non-linear models developed by the Econometrics Project at M.I.T. We are grateful to the supervising staff for their assistance.

[12] See Choucri and North (fn. 56 of text) for the rationale underlying the use of logarithm transform in the first and third terms and comparison of results obtained without the transform and without the interactive term.

[13] Steel per capita can be considered only as a rough indicator of industrial production, and, by extension, of technology. The unavailability of data for other, more appropriate, indicators necessitates the use of this variable for the 1870–1914 period. A critique of our choice of indicators is provided by Joseph M. Firestone, "Remarks on Concept Formation: Theory Building and Theory Testing," Prepared for Delivery at the 66th Annual Meeting of the American Political Science Association, Los Angeles 1970.

[14] We have employed the Hildreth-Lu iterative procedure for estimating the autocorrelation parameter and specifying the needed adjustments. See Clifford Hildreth and John Y. Lu, "Demand Relations with Autocorrelated Disturbances," *Technical Bulletin*, No. 276 (Michigan 1960).

the equation into a larger number of relationships involving more than one equation).

An alternative and comparable (though not identical) formulation of the lateral pressure equation employs colonial area as the expansion term, national income as the technology term, and navy budget as the defense or specialized capability term:

$$\begin{aligned}\Delta \text{ colonial area} = a &+ B_1\ \Delta\ [\text{home pop./home area}] + \\ &B_2\ [\Delta \text{ national income}] + \\ &B_3\ \Delta\ [\text{home pop./home area}].\ \Delta\ [\text{national income per capita}] - \\ &B_4\ [\Delta \text{ total trade per capita}] + \\ &B_5\ [\Delta \text{ navy budget per capita}] + u\end{aligned}$$

The second equation in the model is considerably more straightforward and represents the effects of expanding spheres of influence as follows:[15]

$$\begin{aligned}\Delta \text{ intersections} = a &+ B_1\ [\Delta \text{ expansion of self}] + \\ &B_2\ [\Delta \text{ expansion of others}] + \\ &B_3\ [\Delta \text{ defense budget of self}] + \\ &B_4\ [\Delta \text{ violence toward others}] + \\ &B_5\ [\Delta \text{ violence of others}] + u\end{aligned}$$

The dependent variable summarizes changes in the intensity of intersections among the major powers. The independent variables include expansionist activities, indicators of capability, and variables denoting prevailing conflict and violence in interactions among nations. Again, the operational definition of the variables approximates the conceptual terms only to an approximate degree. The [Δ expansion of others] term was operationalized as five separate variables denoting the expansionist activities of each power. Intersection and violence variables were derived from the same data base, but the coding rules which yielded each variable differ considerably. Extensive care was taken not to create (theoretically and operationally) redundant indicators.[16]

The military budget equation has perhaps been the subject of greatest experimentation—with gap variables, with internal variables, and with external variables.[17] It gradually became possible to incorporate break-points

[15] Operationalizing intersections involved first, isolating those instances in which major powers interactions revolved around disagreements, disputes, conflicts, etc. over colonial territories or potential colonial territories or spheres of influence in Europe and overseas; second, noting the intensity of the intersection on a conflict-cooperation scale designed specifically for purposes of inter-nation and inter-situation comparisons; and third, isolating the most intense intersection variable. (Some index or aggregation would yield a more representative value, but serious methodological problems are involved in the construction of such a measure.) For the interaction scale, see Lincoln E. Moses and others, "Scaling Data on Inter-Nation Action," *Science*, 156, 3778 (July 1967), 1054-59, and Edward Azar and others, "Methodological Developments in the Quantification of Events Data," paper presented at the 1970 Michigan State University Events Data Conference, April 15-16, 1970, for a more intensive discussion of operational issues.

[16] See North and Choucri (fn. 49 of text), for operational definition of violence, and Moses and others (fn. 15), for coding rules.

[17] Moll (fn. 62 of text); North and Lagerstrom (fn. 62 of text).

explicitly in the equation (in terms of a redefinition of rivals and adversaries, perceived or actual), and thus account for some shifts over the period in question. Of the many equations we have examined the following functional form seems to be the most valid:[18]

$$\begin{aligned}\Delta \text{ navy budget} = a + {} & B_1\,[\Delta \text{ navy budget}_{t-1}] + \\ & B_2\,[\Delta \text{ navy budget of adversary}_{t-1}] + \\ & B_3\,[\Delta \text{ expansion of self}] + \\ & B_4\,[\Delta \text{ intersections}] + u\end{aligned}$$

The first term is an internal variable representing bureaucratic and organizational effects (approximating habit patterns or bureaucratic constraints), the second is the adversary allocations, and the third and fourth refer to dynamics of an international nature. We should emphasize, however, the tentative nature of this analysis by noting that further work is necessary before accepting this formulation as a valid statement of the dynamics in question.

The fourth equation in the model seeks to depict the intensity of violence among the major powers as follows:

$$\begin{aligned}\Delta \text{ violence} = a + {} & B_1\,[\Delta \text{ defense budget of self}] + \\ & B_2\,[\Delta \text{ defense budget of others}] + \\ & B_3\,[\Delta \text{ intersections}] + \\ & B_4\,[\Delta \text{ alliance commitments}] + u\end{aligned}$$

The first term represents an internal variable, and the other three refer to external considerations.[19] Operationally [Δ defense budget of others] was defined as five separate terms, one for each major power. It is still an open question whether gap or distance variables need to be included in this final stage.

Shifts in underlying dynamics became apparent in light of the fact that the explanatory power of each equation changes considerably for different periods between 1870 and 1914. In general, best "fits" were obtained not for the forty-five years as a whole but for shorter periods.[20] As an example, the best fits for the lateral pressure equation were during the earlier years, whereas the intersection equation best fit the intermediary and later years. The best fits for the violence equation were also obtained in later years. But because break-points were explicitly included in our analysis of armament competition, extremely good fits were obtained for the period as a whole as well as for sub-periods. Knowledge of these shifts was based on the historical and documentary record. Without this information, however, it would have been very difficult to take into account breaks and estimate the relation-

[18] We have also experimented with gap variables, but have encountered severe identification problems. The same equation was examined employing army budget and total defense budget as alternative measures of the endogenous and exogenous budget variables.

[19] The last term was operationalized as the *number* of alliance commitments based on the Singer-Small data. See J. David Singer and Melvin Small, "Alliance Aggregation and the Onset of War, 1815–1945," in Singer, ed. (fn. 68 of text), 247-86.

[20] Sub-periods were selected somewhat arbitrarily by trial and error. The possibilities are limited, however, with only 45 years.

ships successfully beyond the break. Comparative R^2 for all four equations, presented in Table 2, are illustrative of shifts in underlying processes.[21] And it is then a relatively straightforward exercise to test for break-joints.[22]

TABLE 2

SOME INFERENTIAL EVIDENCE FOR THE OCCURRENCE OF BREAK-POINTS[1]

Period and Equation	*Britain*	*France*	*Germany*	*Russia*	*Austria-Hungary*	*Italy*
LATERAL PRESSURE						
1872–1914	.06	.05	.02	.04	.08	.03
1872–1892	.05	.19	.03	.15	.11	.14
1892–1902	.24	.50	.75	.79	.73	.20
1902–1914	.28	.21	.16	.07	.25	.48
1872–1900	.48	.06	—	.11	.11	.05
INTERSECTIONS						
1872–1914	.43	.56	.26	.55	.46	.43
1872–1892	.84	.50	.40	.56	.83	.70
1892–1902	.49	.96†	—	.98‡	.92	—
1892–1914	.11	.87	.45	.75	.57	.62
1902–1914	.85†	—	.97	.85	.76	—
MILITARY COMPETITION[2]						
1870–1914	.03	.34	.11	.21	.56	.30
1872–1892	.28	.47	.55	.19	.26	.58
1892–1902	.27	.56	.88	.79	.55	.65
1902–1914	.21	.76	.34	.34	.68	.60
1906–1914	.41	.81	.62	.50	.46	.79
VIOLENCE						
1872–1914	.25	.17	.36	.30	.31	.30
1872–1892	.43	.35	.63	.69	.20	.43
1892–1914	.73	.61	.49	.27	.45	.55
1892–1904	.89	.73	.67	.30	.63	.60
1904–1914	.96†	.85	.49	.98†	.92§	.96†

[1] Empty cells arise as a result of missing observations or problems in matrix inversion due to low variance in the independent variables.

[2] These results represent navy budget competition. See Choucri and North (fn. 56 of text) for additional comments on methodology, regression coefficients, and empirical data, and for a comparison of results for army, navy, and total defense budgets. In general, the same patterns persisted across the three operational measures.

† Significant coefficients and high R^2 despite the loss of degrees of freedom due to the inclusion of a large number of variables in relation to the number of observations.

‡ High R^2 and 5 significant coefficients.

§ High R^2 but only 1 significant coefficient.

These results pertain to analysis of rates of change and not absolute values. Because of the degrees of freedom problem, results pertaining to longer time periods are likely to be more stable than those for progressively shorter periods.

[21] These data are presented for illustrative purposes only. The magnitude of R^2 *alone* is not an adequate indication of fit. The progressive loss of degrees of freedom effects R^2, but not the significance of individual coefficients (since this loss is taken into account when computing the F ratio or t statistic).

[22] See Gregory C. Chow, "Tests of Inequality Between Sets of Coefficients in Two Linear Regressions," *Econometrica*, XXVIII (July 1960), 591-605.

When this is done it becomes possible to employ this model for simulation and forecasting.[23]

From these (tentative) results we infer partial (and equally tentative) validation of the change-in-dynamics thesis and of the particular sequence postulated. Considerable extensions of this analysis (and of the equations) need be undertaken before adequate validation can be achieved. None of the operational or methodological issues raised in this note are trivial. They can be resolved only by experimentation, trial and error, and further analysis. At the very least, alternative formulations of the underlying theoretical specification need be undertaken along with the use of alternative data series for different countries and different time periods.

Finally, we should point out once more that a theory (or set of hypotheses) cannot be "tested" adequately against the same set of data which has provided at least a partial basis for the development of the theory. Our analysis of the 1870–1914 period should be considered illustrative of the dynamics postulated and not as an empirical "test" of the partial theory in the strict sense of the term. Altogether different sets of data and empirical referents are needed to provide the systematic test. In this respect also, much is still to be done.

[23] For an extended discussion, illustrations, and empirical results see Nazli Choucri, "Applications of Experimental Econometrics to Forecasting in Political Analysis," prepared for the Conference on International Relations Forecasting, December 1970; revised August 1971.