

7

Population Dynamics and Social Inquiry: Some Methodological Imperatives

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The report of the Commission on Population Growth and the American Future represents a landmark in the analysis of the societal implications of population dynamics.¹ The commission's report is as extensive in its coverage as it is careful and cautious. The breadth of issues examined and the diversity of approaches adopted are indicative of a new dilemma confronting students of population dynamics: Because of increasing public awareness of demographic problems and prospects, it is incumbent upon us to examine more closely than we have done so far the critical methodological and conceptual problems imbedded in systematic inquiry.

It is no longer acceptable to engage in polemical discourse – informed or otherwise – nor is it sufficient simply to acknowledge the complexities involved in demographic investigations. It has become imperative that we address ourselves directly to the issue of method and procedure and to develop ways of recording our observations, the inferences we draw, and the conclusions we reach, in ways that are reliable, consistent, and empirically valid.

This chapter takes one step in the direction of order and precision by addressing itself to some critical methodological problems, basic conceptual distinctions, and alternative ways of analyzing the implications of population dynamics.

The Need for Conceptual Clarity: Statistical Uncertainties and Definitional Ambiguities

Almost everyone recognizes the existence of a population question in the world today, but there are significant differences in the ways by which this issue is defined and the degree to which it is thought to be problematic. We are presently witnessing the cumulative effects of dynamics that were developed at a time when population issues were less salient than they are today. We now realize that in many parts of the world the demographic calculus is becoming increasingly unmanageable, and we now appreciate the need to examine the implications of population-related factors in society. But we still remain fairly ignorant of the procedures by which we might gain insight into the demographic implications of variables that are conventionally viewed as nondemographic in nature.

We can no longer ignore the political consequences of population, nor can we ignore the demographic consequences of politics. Unless some clear procedures are undertaken to examine mutual dependencies between population and politics, we will continue to be taken unawares — in turn surprised and disturbed — by the apparent political implications of population variables, by demographic dislocations resulting from imbalances in the global rates of growth, and by imbalances resulting from regional distributions and compositions. It is as imperative that we appreciate the implications of added numbers for increasing demands upon the environment as it is to understand the relationship of added population to regional distributions of resources and to levels of technology, knowledge, and skills.

Different populations make different demands upon their environments. And demands are expressed differently in different contexts. For this reason it is necessary to sharpen the conceptual tools at our disposal so as to capture the intricacies and complexities of the population issue in ways that might increase our understanding of the interconnections between population and politics.

Statistical and Conceptual Uncertainties

Many uncertainties exist concerning the nature of the population issue and its domestic and international implications. Equally impressive is the extent of disagreement as to the optimal approach or mode of analysis. The population question is inevitably defined in terms of referent variables — such as space, food, and resources — and the definition of the problem is viewed as one of levels, rates of growth, distributions, compositions, densities, and movements — all of which depend largely upon these referent variables.

Further complications arise from the fact that existing data on absolute levels and rates of change, and on projections and expectations, are fraught with uncertainties occasioned as much by the difficulties of compiling accurate statistics (and gauging the range of measurement error) as by the choices of intervening sociological or economic indicators. For example, United Nations projections are based upon the assumption of continuing progress in economic and social development and upon the continued availability of needed resources.² Variability in these assumptions inevitably colors the nature of the projections and, by extension, our assessments of the problem.

Adding further to a rapidly growing list of uncertainties are those which relate to potential constraints upon continuing population growth. The question of constraints is imbedded in the dual considerations of absolute global shortages of life's sustaining materials versus imbalances in regional distributions. In each case, experts tend to identify sources of potential dislocation with (1) food, (2) availability of resources (in terms of energy and mineral needs), and (3) general environmental resistance, as three distinct but highly interrelated

dimensions of the earth's carrying capacity. Already the definition of the population issue assumes awesome proportions. And while there tends to be a general predisposition to view the constraints problem as one of distribution rather than of absolute shortages, there is in many circles a strong belief that the global "optimum" has long been surpassed and even that maximum world population has already been attained.

The concept of "optimum," so endemic to the issues at hand, is itself fraught with built-in conceptual and methodological difficulties, many of which are related to the referent variables — those variables against which population is viewed. The basic question is this: Optimum with respect to what? Since the economic optimum is not necessarily congruent with the political optimum, and since at the level beyond mere subsistence the optimum is culturally and sociologically defined, it is especially difficult to employ this concept as a useful measuring instrument for defining the population issue with any degree of precision. Any concept of optimum population must be viewed in the context of the goals or objectives against which such an assessment is made. For example, in any given society it may be that the optimum with respect to military capability is vastly different from the optimum with respect to political stability, or abundance of leisure, or the standard of living. This much we know from demographic and economic analyses and from the historical record, although we have little "hard" data on the subject.

Alternative Definitions of Population Problems

Statistical uncertainties and uncertainties pertaining to definitions of the "problem" are matched by uncertainties regarding the socioeconomic and political implications of added population or of continued growth. The basic Malthusian thesis that indefinite population growth would bring widespread poverty — applicable only under conditions of trade isolation, minimal standards of living, marginal flexibility in technology, and low energy output — is totally rejected by those espousing a Marxist perspective. These scholars define the problem in terms of distribution: If resources and technology were properly utilized and distributed, the entire population of the world could subsist on existing resources. The concept of overpopulation is in principle denied, and the problem is formally rejected.³

Many of these difficulties and contradictions can be attributed to the fact that missing from both the Malthusian and Marxist perspectives is sufficient appreciation of the implications of differential levels of technology and the associated repercussions on the available resource base and on the external environment. Also missing from these views is a necessary awareness of the social, economic, and political implications of added population for defining the issues at hand.

A non-Malthusian view, recently propounded by scholars like Jean Mayer, argues for a consideration of the relation between changes in levels of population to changes in level of wealth, and a case is made for population control on exactly the reverse of the basic Malthusian premise: Controlling the number of the rich is viewed as considerably more critical than controlling the number of the poor.⁴ The vast differentials in the comparative impacts on the environment of peoples at different levels of development makes the non-Malthusian perspective one that must, by necessity, be taken seriously in any examination of the societal – and international – implications of population dynamics.

A Three-Dimensional Perspective: Population, Resources, Technology

The Malthusian, Marxist, and non-Malthusian perspectives suggest that different views of the problem result from different assumptions and different priorities. These perspectives suggest also that when viewing the consequences of population dynamics it is imperative to transcend simple demographic boundaries and that, at the very least, two other considerations must be taken into account: (1) the extent of resource availability, accessibility, and utilization of any society, and (2) the level of technology or knowledge and skills. A population with high resource needs is likely to make demands on the environment that are different from one with low needs. Since resource utilization is a direct correlate of development, the overall knowledge and skills of a society bear directly upon the environmental impacts that its population is likely to have. Because we now recognize that population growth occasions a nonlinear, negative impact on the environment and that population dynamics generate social and economic consequences which are not simply additive, it is therefore imperative that population be considered in conjunction with resources and technology.⁵

These considerations all reduce what is conventionally viewed as a population "problem" to one that must be defined in terms of the two companion vectors in any demographic calculus: resource availability and technological development. For our purposes, therefore, resources and technology are the most critical referent variables defining the political context within which population must be viewed.

Resources generally include the mineral and energy wealth of the country. Technology is most frequently defined as the level of knowledge and skills. Both these factors are exceedingly broad, and it is often difficult to develop operational indicators. Nonetheless, when placed in the context of level of knowledge and skills, it becomes apparent that the same population characteristics often give rise to different political implications, depending upon the nature of the resources available to the national leadership and to the population

at large and upon their ability to sustain collective and organized action. When technology is defined more narrowly as tools (ranging from the hammer and the saw to sophisticated weapons), it becomes even more imperative to recognize that the consequences of alternative population dynamics depend very much upon the society's level of technology and on the resources at its disposal.

Although we do not argue for relegating population variables to secondary importance in the population/politics calculus, it must be recognized that we still have very little sound knowledge on the relationship of population to resources and technology and the implications of different relationships for internal and external conflict. Elsewhere, we have compared in nonquantitative, though systematic, fashion twelve countries in terms of population, resources, and technology and have attempted to highlight in a qualitative manner the implications for international behavior.⁶ Further work along these lines, however, must be done before we can cast these issues into sharper focus. The same types of general cross-national comparisons have not yet been undertaken with respect to the internal implications of alternative population, resource, and technology profiles. Such analysis is very much needed at this primitive stage in our knowledge of the sociopolitical implications of population dynamics.

Perceptions versus "Reality"

There is also a distinction to be drawn between the perceived versus the actual condition. While the relationship of population to resources, technology, food, or space is invariably occasioned by the hard, empirical realities of a situation, the actual definition of the situation by both analyst and participant is one that draws upon the subjective – upon perceptions and evaluations – regardless of the underlying empirical realities.

Political scientists readily admit that the definition of a situation by the actors involved is generally more indicative of potential outcomes than an analysis of empirical realities.⁷ Thus, when we confront the different types of population variables as defined by demographers, it becomes immediately apparent that the perception-versus-reality problem is a critical issue regarding the implications and consequences of population dynamics.

Under ideal research conditions it would be desirable to identify what the empirical realities are, how these are perceived by the actors in question, and what the relationship is between the reality and its perception. Important information is undoubtedly contained in the nature of the gap between perception and reality. For this reason, terms like population pressure, excess, or equilibrium are difficult to analyze empirically, particularly since the perception of these variables often determines their effect.

Implicit in the above is the hypothesis that only when theoretical and operational linkages are made between hard realities and their perception by

national leaders, policy makers, or the politicized population do population variables assume direct political relevance. But there are indirect effects. The alternative hypothesis appears equally plausible, namely that demographic realities are important in their own right by conditioning or constraining political outcomes — whether or not these are so perceived by the individuals in question. Without some assessment of how the subjective and the objective interrelate, it becomes exceedingly difficult to evaluate alternative perspectives on the social and political implications of population dynamics.

So far we have avoided repeated reference to a population “problem.” Elsewhere, the present author has discussed in general terms some of the distinctly political implications of population dynamics and has expressed some definite views on the issue. Here we seek only to untangle various theoretical threads that may involve definitional issues or value judgments.⁸

Some Methodological Imperatives: The Requirements of Systematic Inquiry

Of the many critical methodological issues, four are particularly important: (1) definitional problems associated with key variables, (2) alternative perspectives on causal relations, (3) the manipulability of variables and the constraints imposed by parameters, and (4) identification of nonlinearities and system breaks. Because the most important factors in systematic research are replication, validation, and cumulative effort, explicit cognizance of these issues amounts to a fundamental methodological imperative.

Definitional Problems: Population Dynamics and Political Consequences

The definitional issue involves careful specification of population variables, of political (or other) consequences, and of the processes intervening between population and politics.

Population Dynamics: Some Conceptual Distinctions. At first glance it might appear that the population variables are so clearly defined by demographers as to pose no serious problem for scholars seeking to examine the consequences of population dynamics. It is also customary to speak of population as a composite phenomenon, without differentiating between the type of demographic factor in question and the level of aggregation at which the variable is employed.

At a point of departure we must distinguish among size, composition, and distribution, as distinct population variables, and between their absolute level and their rates of changes. Even in this simplified manner, we are confronted

with the need to accommodate a two-dimensional perspective in terms of levels and rates of change.

Population size refers, of course, to the total number of people in a society or the total level. This number generates demands upon the environment, upon the society, upon governments, and upon the political system at large. The implications of these numbers differ according to the resources available and according to the level of knowledge and skills in a society. Any rapid change in this level may occasion added strains on the fabric of a society. Monitoring for departures from previous trends becomes an important task for students of political demography.

The composition of a population is conventionally thought of in terms of socioeconomic status, ethnic or racial divisions, and age structure. Rural-urban differentials are also viewed as composition variables, although they may also be viewed as distribution variables. A nonadditive perspective on the composition of the population would necessitate taking cognizance of all composition factors simultaneously. This is difficult to do without assistance of conventional statistical tools or without recourse to common modes of combining or aggregating data by categories. Sociologists and demographers, among others, excel in this type of activity, but political scientists have not yet become accustomed to treating the interactive effects of population variables in ways that shed light upon political considerations.

The same dimensionality issue pertains when viewing population distribution. Distribution is generally thought of in terms of spacial location or in terms of movement. There is also talk of population “density” and of “pressure.” In each case population is viewed in the context of (a) the two initial referents, resources and technology, and (b) empirical realities and their perception by the population in question. Often what we might think of as “pressure” is nothing more than an unwarranted subjective interpretation of the realities at hand. In the same fashion, a situation that should on all empirical counts be viewed as one of “pressure” might not be perceived as such by the participants themselves. These potential discrepancies — pertinent to all aspects of the population issue — are especially relevant to distribution variables where the interplay among population, resources, and technology is the most pronounced. This distinction must be formally acknowledged by any investigator and taken into account in any sound research design.

The introduction of change highlights further complexity by drawing our attention to an important theoretical problem: The coincidence of any two or more of these simple population variables introduces computational and other methodological difficulties, the solutions to which are not always intuitively obvious.

The task of conceptualizing and defining population variables becomes even more complicated when complex population factors are introduced, variables that refer to population as well as to social, economic, or political consider-

ations. For example, the term population *pressure* clearly involves some referent against which population is measured. The same may be said with respect to *overpopulation*, *excess population*, population *equilibrium*, or population *differentials*. Complex population variables such as these call for specification of the referents or context against which population is evaluated.

Political Consequences: Some Conceptual Distinctions. Just as it is imperative that we define the population variables as clearly as possible, so too we must define the political (or societal) variables of interest. Here conceptual problems abound. It is difficult to identify, quantify, measure, or monitor societal considerations. And, while we must appreciate the complexities associated with measuring variables that come in natural units of measurement — numbers of people — these difficulties pale in comparison with those involved in conceptualizing and measuring nonmetric societal factors. The determinants of fertility, mortality, and morbidity are comparatively well understood by professional students of population. The other side of the equation — the consequences of population dynamics — is much less well understood and much less well conceptualized.

The concerns of the present author revolve around the conflict-related implications of population dynamics — with violence, with hostilities, and with warfare. My interests lie in tracing the origins of violence between states and determining the extent to which these may be located in population variables. The intent is not to search for — or expect to find — a direct link between population and politics or between population and violence, but to determine the ways (if at all) population combines with other variables to make violence more (or less) likely. This type of enterprise necessitates a careful assessment of the dependent variables and equally careful measurement, quantification, and eventually, statistical (or functional) analysis of relationships to the independent variables.

An appreciation of the variety of operational approaches to conflict and violence and the problems these pose is of important methodological concern. Indeed, definitional issues go a long way in accounting for the primitive state of our empirical knowledge concerning both causes and consequences of violence. And when population variables are introduced in this calculus, it becomes increasingly difficult to define the relationships that one seeks to clarify. Much of the existing empirical evidence regarding the population/violence calculus is almost entirely contingent upon the ways by which violence is defined. There are some thorny theoretical issues at stake which make it imperative to look closely at alternative operational measures of the dependent variables.

Political scientists have defined violent conflict in a number of ways, with different implications for systematic inquiry and with limited degrees of success. Some have developed underlying indicators of its manifestations, for example, Lewis Fry Richardson who talked of “deadly quarrels” generating casualties.⁹

Others have employed factor analysis as a means of identifying the underlying dimension of this societal mode of behavior.¹⁰ Still others have recognized that violence cannot be isolated from the pool of actions and interactions among conflicting parties, that violence (or conflict) per se cannot be distinguished meaningfully from cooperation, and that the critical methodological (and conceptual) issue is not only one of degree but of dimension. Degrees of conflict can be identified, as can degrees of cooperation, but the two are analytically distinct.¹¹

The different ways one might define violent behavior point to the difficulties involved: A sound perspective on the dependent variables — violence and manifestations thereof — is as important as refining our conception and measurement of the population variables. Methodological difficulties imbedded in these political variables necessitate a further differentiation of the dependent variables, in terms of a three-fold distinction: power relations among two states (population, parties, or groups), propensities for violence, and predispositions toward armed conflict or organized violence.¹² These three factors point to different perspectives and different manifestations of the political (and violence) variables. For research purposes, it is imperative that clear correspondence be established between the underlying concept, its indicator, and the operational variable.

Linking Population and Politics: Intervening Variables. Apart from space, food resources, and technology — which we have termed *referent* variables — there are also variables or processes mediating between population and its consequences. Such variables refer to the dynamics that translate the effects of population into particular types of outcomes. Referent variables define the context within which population must be viewed, or the nature of the population problem (if there be one), or the peculiarities of the situation which might propel populations toward political outcomes. By contrast, *intervening* variables refer to the ways by which the effects of population reverberate throughout the social system, generating distinctly political outcomes and sometimes even conflict and violence. Here the calculus becomes increasingly complex: Methodological problems abound as do conceptual ambiguities.

Once careful definitions of the population and political variables are made and the intervening variables specified accordingly, it is then necessary to think about the *dynamic processes* linking population and politics. A simple accounting of dependent and independent variables is only the point of departure; how they interrelate lies at the core of the problems at hand.

An illustration might be in order.¹³ In recent studies of international behavior we have argued that the roots of conflict and warfare can be found in the basic attributes and characteristics of nations and that the most critical variables in that regard are population, resources, and technology, where technology refers to the level and rates of development of human knowledge and

skills in a society. We have then attempted to specify the intervening sequences between these three sets of variables on the one hand and conflict and warfare on the other and have tried to identify the role of population in this complex process. On the bases of empirical and historical analysis, we infer that the chain of developments intervening between population and violence appears to be the following.

A combination of 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. We have termed this tendency to extend behavior outside national boundaries *lateral pressure*. To the extent that two or more countries with high capability and high pressure tendency (and high lateral pressure) extend their interests and sociopolitical borders outward, there is a strong probability that eventually the two opposing spheres of interest will intersect. The more intense the intersection, the greater will the likelihood be that competition will assume military proportions. When this happens, we may expect competition to be 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 conflict.

Major wars, we have argued, often emerge through a two-step process: in terms of internally generated pressure (which can be traced to population dynamics, resource needs and constraints, and technological development) 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 nonmanipulable variables (or variables that are controllable only at high costs).

Because these relationships rest upon the population variable, we find it necessary to understand the ways by which man is related to his physical environment and the ways in which added numbers impose added burdens upon that environment. Indeed, recently biologists have made explicit the extent to which each human being literally owes his life to the earth and ultimately to the sun, and how rapid increases in numbers — or changes in composition or distribution — generate commensurate (and often disproportional) effects on the environment. The task of political scientists is to identify the political implications of such changes and to specify the ways by which we may expect further changes in the environment to be generated by increasing numbers.

Because the inferences we draw and the analyses we undertake are almost completely predicated upon the assumptions we hold and the perspectives on

reality that we espouse, it is necessary to examine the methodological implications of different ways of looking at the environment.

The Nature of Causal Relations: Alternative Perspectives on Reality

Perhaps the most important methodological problem involves the choice among alternative perspectives on causal relations.¹⁴ One's beliefs about causality determine in large part the methodologies one adopts for investigating the linkages between population and politics and the type of values one chooses to accommodate. Social scientists concerned with the consequences of population dynamics impose upon their subject matter a causal sequence different from that employed by those concerned with the causes of fertility, mortality, and morbidity. This simple fact highlights the interdependence between the definition of the problem (or the nature of one's concerns) and definition of causal sequence.

There are at least five different concepts of causation with equally numerous interpretations of empirical realities. The most common view involves *time precedence*: One thing followed by another. But this is a rather simplistic notion, and philosophers of science tend to agree that causality in terms of asymmetrical relations is more realistic. Others maintain that causal relations involve unidirectional or recursive dependencies and that causality, by definition, cannot accommodate mutual relations. Conversely, still others argue that simultaneous relations are not inconsistent with causal notions and that the "real" world is of this nature. And, by way of accommodating such differing perspectives, some attempts have been made to think of causality in terms of mutual dependencies *and* in terms of unidirectional relations. This compromise is based upon a bloc recursive view of reality, a perspective that assumes that within a localized domain causal relations are unidirectional, but that these localized systems of relations are imbedded in larger structures characterized by simultaneous dependencies.

This last view amounts to the following: In international relations, for example, one can think of the domestic sources of foreign policy as a localized system composed of unidirectional influences — from the system to the leadership and eventually to the external environment — but these localized relations are influenced by external considerations (international alliances, ongoing armament competitions, and so forth) which themselves are fairly independent of the internal determinants of foreign policy. By the same token, the political implications of changes in the size of a population might have localized effects — in that greater demands may be placed upon the government for goods and services, greater strains are imposed upon the political system, and greater propensities for instability might result from these demands and strains — and these effects can be adequately thought of within a unidirectional

perspective. Conversely, it is conceivable that added population means greater possibilities for channeling manpower into the military, which in turn might be perceived as a threatening factor by neighboring states, occasioning hostile exchanges, which then result in even greater stress upon increasing the number of men under arms. In such cases, a multidirectional perspective on causality would be more appropriate for purposes of systematic inquiry than one that is unidirectional. A bloc recursive view would also be acceptable and, in many cases, extremely desirable as well.

The choice of model type depends on several considerations: including underlying beliefs about the nature of the realities modeled (whether they can be represented in linear additive terms or not, whether they can be viewed in statistical rather than in functional terms, and so forth), the time perspective (whether one is concerned with the short-range or long-term dynamics), and the extent to which *linkage* between time perspectives and between levels of analysis is to be consciously undertaken as part of the investigation.¹⁵ These three sets of considerations go a long way in determining the type of model employed.

In sum: Different models and different perspectives on causality serve different purposes, and since what we see depends upon how we look at it, we must appreciate the consequences of selecting one type of model, or one view of causality, rather than another.

Identifying the Manipulables: Variables versus Parameters

While population is a variable that can be counted, sorted, scaled, and ranked, we tend to assume that the same degree of quantitative precision cannot be imposed upon the political variables of interest. Recent developments in nonmetric and multidimensional scaling and the quantification of political actions and events, however, suggest that it is not unreasonable to expect a high degree of precision in the measurement of political variables.¹⁶

For policy analysis it is important to include in the research design variables that can be manipulated on short order or variables that can be subject to legislation, policy, or government action. In the same vein, account must be taken of factors that are variables in the short run but parameters in the long run. This is particularly relevant in population-related research where the effects of population variables make themselves felt in the long range — demographic considerations eventually become parameters of a situation — even though often considered as varying in the short range. The transition from variables to parameters corresponds to the change of a system (or of the dynamics under consideration) as the time perspective unfolds.

For operational purposes one must appreciate that different methodologies are appropriate for different time frames. The tools one employs to examine short-run implications of population dynamics are by necessity different from

those employed to examine long-range factors. The recent controversy generated by *The Limits to Growth* is illustrative of the reactions modulated by short-term concerns (as is the case with economists, political analysis, and social critics), which are generally inappropriate to studies of long-term dynamics predicated upon a methodology suitable primarily for the analysis of system behavior in the long range.¹⁷

The dual issues of variables versus parameters and time perspectives have important implications for analyzing the consequences of population dynamics. We know that immediate short-range factors are imbedded in a larger societal context which is invariably conditioned as much by time as by habit, inertia, and social history. These conditions become the parameters of a situation in the shorter range. But in the long run, over years and decades, they change and take on new attributes and characteristics. Today's idiosyncracies become tomorrow's parameters. The methodological problem is this: If we can identify the conditions under which variables become parameters and if we can determine how it is and why it is that this change takes place, then we would resolve the problem of moving from shorter-range effects of population dynamics to long-range imperatives. The methodological task is to incorporate this information in the research design so as to alert us to the probabilities of change in the system under consideration.

Nonlinearities and System Breaks

A related question involves the identification of nonlinearities and breakpoints in the intervening processes and in the dependent variables.¹⁸ A breakpoint represents a sharp change (which in regression analysis, for example, is exemplified by a change in the regression slope), but a non-linearity indicates a gentler departure from linearity, the nature of which can often be captured by conventional non-linear functions. Nonlinearities generally represent a functional relationship among variables. Complex systems — such as social systems — are invariably nonlinear. Thus if we expect linearities (however erroneously), we will sensitize our model and methodologies to search for linearities. The result will almost certainly be an invalid analysis. When it comes to the identification of breakpoints the situation is much the same. Because there is a tendency in the social sciences to confuse breakpoints with nonlinearities when observing system change, we must guard against the erroneous inference that what is in fact a nonlinearity may be interpreted as a system break. Because nonlinearities and system breaks abound in complex systems, monitoring for such changes becomes an important aspect of any research design. This is particularly true in social systems where population variables are undergoing rapid change and where *some* societal consequences are anticipated.

The critical political sectors where monitoring for system breaks occasioned

by population variables has important implications for the society as a whole include the major institutions of society imposed by added population, potential changes in the nature of key institutions, changes in the distributions of goods and services, changes in resource allocations and utilizations, changes in patterns of budgetary allocations, changes in national priorities, and so forth. For example, almost every developing nation has, over the past several years, responded to increasing population by national plans of actions (development plans, family planning programs, health-care and delivery systems, and so forth), and in most cases the response has suffered from an absence of careful monitoring of demographic changes. This situation is in large part occasioned by the absence of reliable demographic statistics in many parts of the world, but also by a lack of appreciation of the importance of population dynamics for overall societal adaptation to the external environment, national as well as international.

Undoubtedly the most difficult conceptual and methodological problems encountered in examining the political (or societal) consequences of population dynamics involves an appreciation of the nature of a system *beyond* the change. For example, we referred earlier to recent studies tracing the origins of conflict and warfare to increases in levels and rates of growth in technological development and access to critical resources. Here we must emphasize that these aggregate societal factors provide the context within which day-to-day politics unfold and, in the long run, the parameters of a conflict situation where the belligerents confront each other in hostile stance.¹⁹ A large-scale war represents a system break. And the question is: How does the system change following such a break?

If we look at population, resources, and technology carefully we might be able to put together the alternative scenarios upon which politics, governance, and structural considerations are predicated. Students of political demography are beginning to investigate the consequences of war for population dynamics in order to determine the nature of the system beyond large-scale breaks and to construct alternative futures based upon such analysis. There are important methodological implications of such concerns.

An illustration may clarify the issue. We know, for instance, that wars often affect the demographic composition of a state and that, since population characteristics are an important aspect of societal attributes, we can introduce in our research and analysis some consideration for the potential of changes in demographic characteristics. The same must be done for the other parameters of a situation. If we developed some systematic procedures for recording our expectations along these three dimensions concerning probable departures from system behavior occasioned by such breaks, and if this procedure were generalized to issue areas other than population, resources, and technology, we might begin to enhance our understanding of probable outcomes beyond system breaks.²⁰

These methodological difficulties and problems only highlight the fact that a comprehensive research design should allow us to account for endogenous system change *without* any external intervention by the investigator. This is difficult to do. The point here is that a design could, by its very nature, incorporate those decision points at which a system change is likely to take place. This simple consideration will enhance the internal validity of the research in that factors external to the design itself – such as intervention by the investigator – would not be allowed to contaminate its outcome. It will then be easier to probe further into the weaknesses of the research design itself and isolate those problems resulting from the conception and conduct of the research and those that result from intervention by the investigator. This is not to suggest that all such intervention is undesirable but that controlled intervention must be distinguished from *ad hoc* manipulations.

These observations have the following methodological implications: How one constructs the research design, what one's assumptions are, and what notion of causality one chooses to espouse are of great importance. But it is more important by far to indicate the nature of one's decisions as explicitly as possible so as to communicate effectively with others engaged in similar research or with those concerned with translating the results of empirical investigations to practical use.

Research Alternatives: Costs and Benefits

At this point we indicate alternative research approaches to the analysis of population and politics and note the costs and the benefits of each. Our intent is to explore the alternatives before us and hopefully to render an educated judgment concerning the merits of different types of scholarly research.

There appear to be seven distinct modes of inquiry into the consequences of population dynamics:

The Case Study Approach

This method involves intensive analysis of one situation in which population appears to be related to the form of behavior or system change of interest to the investigator. The advantages are obvious: With research efforts concentrated on one case, it becomes considerably easier to investigate in depth the nuances and implications of the evidence at hand. But the disadvantages are equally obvious: Case studies, by their very nature, beg the issue of generalizability. One cannot draw inferences from one case to an underlying type of cases or to any other *single case*. Indeed, the expressed objectives of social science inquiry, namely the building of cumulative and consistent knowledge, is invariably defeated in

single-case investigations. Even the "critical case" approach amounts, at best, to systematic description. Despite these obvious drawbacks we must recognize that in the absence of some overarching theory or guidelines for research, case studies do provide us with information which, if used judiciously, might shed some light on the problems at hand.

The Population Dynamics and International Violence Project at M.I.T. is currently undertaking four case studies seeking to identify the role of population variables in conflict situations. These include studies of the South African situation, the Arab-Israeli conflict, the El Salvador-Honduras war, and the Sino-Soviet dispute. We believe that case studies of this nature will add to our understanding, however unsystematic, of the role of population in contributing to warring outcomes.

The Comparative-Cases Approach

This method involves a rigorous comparison of several cases along prespecified dimensions. It includes, by definition, all the disadvantages of the single case study with few of the advantages. But it promises to generate information that is cumulative, comparative, and internally consistent. In order to obtain useful data, however, it is necessary to develop a conceptual framework — or at least some general rules of thumb or general queries — to guide the research as data for individual cases are compiled. This is not an easy task. And, given the state of the art as we have described it in the foregoing pages, it is extremely difficult to develop a theoretically sound and analytically precise context within which to place the relevant information, case by case. The object of the exercise might be, for example, to compare the El Salvador-Honduras case with the Arab-Israeli conflict or with any other conflict and draw some inferences that *within a certain probability range* would be expected to hold.

The M.I.T. project is undertaking a comparative analysis of fifty-two conflicts in less developed areas since 1945. What we gain in terms of the proprieties of social inquiry, we lose in terms of in-depth analysis and richness of information. The comparative case-study approach would, hopefully, allow us to draw some rough generalizations concerning population dynamics and violent conflict in the Third World from 1945 to the present. But we do not expect to obtain anything like closure on the issue.

The Critical-Theme Approach

This method is often termed "functional analysis" in that the emphasis is upon a functional representation (such as the role of ideology, or population policy, and

so forth) and not upon a certain unit (such as country). The advantages are obvious: It allows the investigator to draw data, information, insights, and evidence from wherever possible without holding to the requirements of in-depth analysis or the rigor of cross-national comparability or of statistical propriety. But the disadvantages cannot be overlooked: Without some explicit theoretical or statistical control, it is difficult, if not impossible, to evaluate the information at hand or to assess its implications for the conclusions one is attempting to draw.

This mode of analysis is commonplace in traditional political inquiry, but students of population and political demography have not paid sufficient attention to this type of inquiry. Analytical description is often a useful, but initial, approach to a problem when the uncertainties and unknowns abound. For example, descriptive comparisons of alternative population policies and their role in national planning could be approached this way as a prerequisite for more systematic inquiry. Since we know very little about the consequences of population dynamics, critical-theme inquiries would provide worthwhile additions to the existing repertoire of research findings.

Cross-Sectional Quantitative Analysis

Two impressive studies — one by Douglas Hibbs, the other by Ted Gurr — illustrate this mode of analysis.²¹ It amounts to statistical investigations of the relationships among variables (attributes and behaviors) for many nations (generally the entire population of independent states) for one or more time periods. The advantages include (a) the use of systematic modes of recording, processing, and analyzing empirical data; (b) providing cross-national comparisons; and (c) allowing for the identification of "unique" cases, or those known in statistical parlance as "residuals." But the disadvantages are numerous. It is impossible to generalize findings from cross-national quantitative analysis to any one particular state or even to draw regional inferences (except perhaps by examining the residuals and identifying outliers). In this respect, at least, the costs and the benefits of cross-sectional quantitative analysis and of case studies converge: One cannot generalize from the aggregate to the single case, much as one cannot generalize from the single case to the aggregate. Both the Hibbs and the Gurr studies enable us to identify the role of population variables in domestic conflict. In each case the conclusion is that there appears to be no strong direct link between population and domestic violence. Hibbs suggests that the indirect links are too weak to allow for valid inferences. In each case, however, the caveats associated with the investigations necessitate a cautious assessment of these results: Cross-sectional studies do not allow for inferences concerning the single case, although the residuals provide important clues.

Quantitative Longitudinal Analysis

The Correlates of War Project at the University of Michigan represents this type of inquiry.²² Essentially it involves quantitative analysis of demographic, economic, and political data (recorded every five years) from 1815 to the present. The investigations so far have been confined to correlations and the use of elementary statistical techniques. The advantage is that this approach involves, almost by definition, all the rigor required for quantification and drawing valid inferences in the social sciences. The disadvantages, however, are shared by all statistical or mathematical approaches to political analysis, namely that the process of quantification is undertaken at a level of abstraction that cannot capture the intricacies of the political process or of day-to-day politics. The proponents of this approach argue that a probabilistic interpretation of quantitative results (or, by definition, the yield from all statistical analysis) can be employed to capture that element of volatility interjected by human "nature," by politics, or by the political process.

In the long run this approach represents a worthwhile undertaking, but here we can only point to the numerous pitfalls and very real problems involved in such an effort given the present stage of the conventional wisdom regarding the implications of population dynamics for organized armed conflict or propensities for violence.

Theoretical Definition of a Problem, Subsequent Quantification, and Statistical Analysis

This somewhat unwieldy title refers to the type of research undertaken at Stanford University where the initial objective is to develop a theoretical framework which would then allow the investigators to identify the variables of interest, to develop quantitative measures, and to move systematically from simple correlational analysis to model-building and multivariate investigations.²³ The intricacies of the "real" world are rarely captured by any method of quantification — at least at the present stage in the development of statistical methodology — and it becomes extremely important to define as precisely as possible the variables of interest and the ways in which they are thought to interrelate.

The disadvantages of this approach are the same as those indicated with respect to the Correlates of War Project. The advantages, however, lie primarily in the fact that careful theoretical specification of expected linkages from population to war was undertaken before extensive quantitative and multivariate analysis, although, as is always the case, the results of earlier investigations serve to refine subsequent work and the underlying theoretical framework. This project, however, is not concerned with the relationships of *specific* population

variables to organized armed conflict or to international violence. This is an area in which, to the best of our knowledge, no work has been undertaken to date. It is the strong belief of this writer that quantitative analyses of specific population variables as they relate to specific violence variables, internal and external, are called for as a logical extension of the present state of affairs in the population/violence investigations.

Quantitative, Statistical, and Longitudinal Analysis of a "Critical Case"

This approach involves a combination of the foregoing. It pertains to statistical analyses of a case which has already been examined descriptively, theoretically, and analytically. The conceptual framework for quantitative analysis is therefore already developed. There are obvious merits to such an approach in that it allows for statistical rigor in conjunction with in-depth analysis. But there are also the disadvantages associated with case studies and with quantitative analysis.

The Population Project at M.I.T. is currently attempting to undertake two studies of this complex nature. The first involves relating demographic variables to casualties incurred in battle, with particular emphasis upon the Arab-Israeli conflict. The second is a statistical analysis of the effects of the demographic profiles along both sides of the Sino-Soviet border upon the conflict between these two powers. It is unclear at this point whether problems with Chinese population data provide insurmountable obstacles. Soviet statistics, however, are available, and developing demographic series over time that are moderately reliable and consistent appears to be a manageable task. But whether *statistical* analysis of the relationship between composition, distribution, size, and change along border areas, on the one hand, and Sino-Soviet relations, on the other hand, can be undertaken remains to be demonstrated. Under ideal research conditions we should be able to combine area expertise with statistical analysis in order to maximize our understanding of the role of population variables in Sino-Soviet relations. This is one of the many geographic areas where political analysts rarely examine the implications of demographic variables.

These several modes of analysis can be thought of as descriptive, inferential, and to some extent explanatory. But they are not in any sense predictive, nor do they allow for strong inferences concerning alternative and probable future outcomes. Other methodologies are more applicable for forecasting and simulation.

Furthermore, these modes of inquiry do not enable us to address ourselves directly to the policy implications of our research. Not only is it imperative that we increase our understanding of population dynamics, but it is also crucial that this understanding be translated into practical terms: The policy implications of our investigations must be made explicit.

The second perspective on the policy question involves the ways by which we may relate our research concerns to their implications for public policy and national priorities. The concluding section of this chapter addresses itself to these issues by stressing some research imperatives and policy implications.

Future Perspectives: Research Imperatives and Policy Alternatives²⁴

The global implications of contemporary population dynamics can be fully appreciated only in the dual contexts of costs and feasibilities: What needs to be done and what the costs are likely to be. In political terms, the major demographic issues of the future concern population control and distribution in relation to the allocation and distribution of resources and technology. How this comes about, who develops the guidelines, and what institutional mechanisms are to be developed are all crucial questions which pertain directly to whatever type of international arrangement might be put forth for such purposes. However indispensable many of them may be, present international institutions are scarcely adequate for regulating the critical variables at the core of present population issues. Related obstacles involve existing discontinuities in national and international preferences and priorities and accompanying authority structures and processes. In those terms, at least, the evolution of congruent national, regional, and global priorities amounts to a major challenge.

A compelling difficulty emerges from the fact that the dynamics of our present predicament are not fully understood, nor are the long-range implications of proposed remedial action. Policies adopted to alleviate one kind of population problem all too often produce unexpected consequences. More than ever before it has become necessary to undertake long-range investigations of potential effects occasioned by alternative courses of action. In view of these uncertainties, it is important that we develop, refine, and apply methodologies *now* for analyzing relationships and interdependencies involving population dynamics, social organization and habit structure, acquisition of resources, pricing system, economic and social underpinnings, technological growth, and resulting environmental resistance.

But research and analysis represent only one side of the coin. The other and more critical imperative is to communicate the results of research to policy makers. The too frequent gap between academic and policy-oriented discourse is a luxury that can no longer be afforded.

The academic task is two-fold: (1) to specify and compile required data, and (2) to analyze the data in a critical fashion. It is necessary to develop priorities for the compilation of data on different aspects of the population issue. In some cases, data are indeed available and need only to be transferred to a format useful for analysis.²⁵ But this is not always so. Indeed, often we do not know

what it is that we ought to be asking. But in many cases the problem is one of gathering data in primary form.

The situation with respect to analysis is more encouraging. A number of useful and extremely promising methodologies are now available for undertaking concerted analyses of long-range dynamics. Several of these have been noted in the previous section. But it is necessary to explore ways of communicating their policy-relevant implications to others outside of the academic community. In general, the imperatives at hand necessitate less the development of novel modes of analysis than the application of existing modes to problems of concern. The actual choice of method or research technique depends largely upon the specific problem encountered, on intellectual preferences, and on assessments of potential payoffs.

Research Alternatives and Policy Directives

By way of illustrating critical linkages between (1) long-range scientific research, (2) analysis of implications for policy making, and (3) translation from academic to operational contexts, we draw upon three distinct though complementary modes of analysis, each representing different manifestations of policy-oriented methodologies and designed to clarify different aspects of any one issue.

The first of these, System Dynamics, is both a philosophical orientation and a specific methodology for analyzing long-range implications of policies and decisions in complex, nonlinear, multiloop systems, of which social systems are the most complex. This type of analysis simulates the behavior of systems over a long period, sometimes going as far as 100 years into the future.²⁶ The kinds of data needed for analyzing long-range dynamics associated with environmental issues involve observations on population levels, economic performance, resource allocation and utilization, patterns of consumption, technological advances, and so forth. Indeed, considerable analysis of such data are already underway.

A major capability of System Dynamics as a research tool lies in the isolation of sensitive points in the system, as well as those points which contribute to future outcomes. The policy relevance of such information is obvious: If we can identify long-range implications of short-range decisions, it might be possible to ground our planning efforts on stronger footing, avoiding actions which appear to occasion benefits in the short term but in fact produce negative outcomes in the long run.

The second research approach, Decision Analysis, based on Bayesian statistics, represents an alternative to classical statistics and is designed to trace the probabilities associated with various outcomes occasioned by alternative decisions at key points. In the context of population dynamics, the data requirements involve information on demographic statistics, national preferences and priorities, alternative policies and programs, and so forth. This form assesses

the probabilities attached to a range of proposed policies, thereby allowing for a critical evaluation of feasibilities.²⁷ However, as is also the case with System Dynamics, the cost factor is neither directly nor explicitly introduced in the analysis, a drawback that is not to be minimized for purposes of research.

The third of these research approaches, Policy Analysis of alternative allocations, deals specifically with cost considerations. It is addressed to different budgets based upon alternative preference structures and priorities. The data needed pertain to budgetary distributions as they relate to population issues. What emerges from this approach is the cost calculus attached to alternative modes of resource allocations.²⁸ The main advantage, therefore, is direct and explicit assessment of the cost-benefit equation, thus providing crucial information about the cost implications of proposed policies or, alternatively, setting up competing policies and observing their costs and feasibilities.²⁹

Obviously, these three modes of research into present demographic predicaments differ considerably in terms of abstraction from reality. Of the three, System Dynamics is the most comprehensive, yet also the most removed from concrete day-to-day decisions that face policy-making communities. Decision Analysis and Bayesian statistics represent one step in the direction of political realism by providing probabilities attached to alternative paths and outcomes. Analysis of budgeting and resource allocations are the most specific, and they are also closely related to the stuff of politics and most directly concerned with linkages between national resources and national priorities.

To date, each of these methods has been applied in discrete fashion with little consideration for the possibilities of bringing these different scientific procedures to bear upon the development of policy alternatives, domestic or international, and even less consideration for systematic analysis of long-range implications. Through the judicious use of such methods for the analysis of appropriate data, it is now possible to construct in a laboratory setting realistic models of social systems which allow for experimentation with hypothetical situations and alternative futures. Drawing upon empirical data on population dynamics, resource constraints, and technological development, these techniques allow us to alter various values for key variables subject to different policy decisions and *allow us now to observe the changes that would take place over future time*. In addition we can begin to identify the manipulables of a situation, as well as the cost of manipulation.

Conclusion

Systematic research is no substitute for immediate and specific action. But at the same time, an incremental, piecemeal, or band-aid approach to global problems is no substitute for judicious investigation and systematic analysis.

Currently underway at M.I.T. are a series of computer-based simulations of

the longer-range political and economic implications of population growth, technological developments, and resource constraints. A primary emphasis is on potentials for conflict and warfare. On the assumption that conflict might be avoided if the preventive action is undertaken early enough, these investigations have begun to raise a series of "what if" questions pertaining to alternative futures, costs, and feasibilities. For example, what would be the long-range implications for the United States (or other states) if population growth were curtailed significantly, or, alternatively, if consumption per capita were reduced, or if the costs of controlling external sources of raw materials and energy-producing fuels become too high, or if competition for resources becomes too intense?

Reports of these investigations are presented elsewhere.³⁰ Suffice it here to reiterate that appropriate technical skills and accompanying methodologies in addition to a certain amount of empirical data are presently available for an undertaking of extensive investigations of alternative futures and implications and consequences, both domestic and international. The transference of computer-based results from the academic community to the real world may be effectively undertaken through the application of Bayesian statistics in conjunction with policy analysis. The Bayesian paradigm would allow for the assessment of probabilities associated with different paths or policies that nations might pursue in seeking, for example, to assure continued resource availability or to minimize conflict-laden avenues of international behavior. The practical costs involved in adopting one policy over another can then be assessed in the context of overall national preferences and priorities by a judicious application of policy analysis, the most sophisticated and useful of such modes being represented by alternative budgeting analysis in the U. S. case as undertaken by the Brookings Institution.³¹ In this context, the political and economic costs and consequences attached to the "what if" or "if . . . then . . ." questions can be identified and evaluated accordingly. Equally possible are systematic assessments of the political costs and feasibilities of modifying national priorities and habits, expectations, and institutions. The situation becomes considerably more complex when viewing the world as a whole and when assessing the viability of alternative international policies and institutions and their accompanying implications for relations among nations.³²

Research imperatives for the present and immediate future are four-fold: (1) to examine systematically and objectively the longer-range implications of short-term actions and decisions; (2) to develop a whole series of alternative policies and alternative futures and examine their implications in laboratory and simulation settings; (3) to translate results in terms that are amenable to analysis of accompanying costs and feasibilities, economic as well as political; and (4) to devise means of disseminating information on methods, procedures, findings, and implications to national leaders and citizens alike in ways that are objective, valid, comprehensible, and believable.

Notes

1. The Commission on Population Growth and the American Future, *Population and the American Future* (Washington, D.C.: G.P.O., 1972).
2. United Nations, Department of Economic and Social Affairs, *World Population Prospects as Assessed in 1963* (Population Studies no. 41), New York, 1966, p. 6.
3. See Nazli Choucri, "Population, Resources, and Technology: Political Implications of the Environmental Crisis," pp. 9-46 of David A. Kay and Eugene B. Skolnikoff, eds., *World Eco-Crisis* (Madison: The University of Wisconsin Press, 1972), for a critical discussion of Malthusian and Marxist perspectives on population issues.
4. See Jean Mayer, "Toward a Non-Malthusian Population Policy," Hearings Before a Subcommittee of the Committee on Government Operations, House of Representatives, 91st Cong., 1st sess., September 15-16, *The Effects of Population Growth on Natural Resources and the Environment* (Washington, D.C.: Government Printing Office, 1969).
5. See, for example, Paul R. Ehrlich and John P. Holdren, "Impact of Population Growth," *Science* 171, no. 3977 (26 March 1971): esp. p. 1212.
6. Nazli Choucri, Michael Laird, and Dennis Meadows, *Resource Scarcity and Foreign Policy: A Simulation Model of International Conflict* (M.I.T.: Center for International Studies, C/72-9, March 1972).
7. Herbert C. Kelman, ed., *International Behavior: A Socio-Psychological Analysis* (New York: Holt, Rinehart and Winston, 1965).
8. See n. 3.
9. Lewis Fry Richardson, *Statistics of Deadly Quarrels* (Chicago: Boxwood Press, 1960).
10. See Raymond Tanter, "Dimensions of Conflict Behavior within and between Nations, 1958-60," *The Journal of Conflict Resolution* 10, no. 1 (March 1966): 41-64; R.J. Rummel, "The Dimensions of Conflict Behavior Within and Between Nations," *General Systems Yearbook*, vol. 8 (1963), pp. 1-53; R.J. Rummel, "Dimensions of Dyadic War, 1820-1952," *The Journal of Conflict Resolution* 10, no. 2 (June 1957): 176-83; and R.J. Rummel, "Dimensions of Conflict Behavior within Nations, 1947-59," *The Journal of Conflict Resolution* 10, no. 1 (March 1966): 65-73.
11. For both sides of this issue, see Lincoln E. Moses, et al., "Scaling Data on Inter-Nation Action," *Science* 156, no. 3778 (July 1967): 1054-59, and Walter H. Corson, "Conflict and Cooperation in East-West Crises: Measurement and Prediction," Paper prepared for delivery at the Michigan State University Events Data Conference, April 15-16, 1970.
12. Nazli Choucri, "Population Dynamics and International Violence:

Propositions, Insights, and Evidence" (M.I.T.: Center for International Studies, September 1972, revised March 1973).

13. Nazli Choucri and Robert C. North, "Dynamics of International Conflict: Some Policy Implications of Population, Resources, and Technology," *World Politics*, Supplementary Issue, *Theory and Policy in International Relations* 24 (Spring 1972): 80-122.

14. For an extended discussion of these issues, see Nazli Choucri, "Forecasting in International Relations: Problems and Prospects" (M.I.T.: Center for International Studies, March 1973).

15. See especially Figure 1, "Integrating Forecasting Methodologies: An Illustration from Conflict Analysis," in Choucri (n. 14).

16. See, for example, Edward Azar, "Analysis of International Events," *Peace Research Reviews* 4, no. 1 (November 1970), entire issue, and Edward Azar, "The Dimensionality of Violent Conflict: A Quantitative Analysis," *Peace Research Society (International) Papers* 15 (1970): 122-67.

17. See Donella H. Meadows, et al., *The Limits to Growth* (New York: Universe Books, 1972), and the critiques of this study, in *Science* 175, no. 4027 (March 1972): 1197, in *New York Times*, Magazine Section, April 2, 1972, and in the Book Review Section on the same date. Also see the letters in *Science* 176, no. 4032 (21 April 1972): 109-13. The review in *Newsweek*, March 13, 1972, and the editorial in the *Saturday Review*, March 18, 1972, are also relevant. Another important review is by Carl Kaysen in *Foreign Affairs* 50, nos. 1-4 (October 1971-July 1972): 660-68. These reviews generally criticize *The Limits to Growth* for sins of omission rather than commission. They also point to the absence of empirical base for this analysis. The first criticism is, in the opinion of this author, unfair on theoretical, methodological, and scientific grounds. The problems of including pricing systems, technological innovation, and political institutions in any analysis of this kind are close to insurmountable. The second criticism is simply incorrect: *The Limits to Growth* is based on cross-national (cross-sectional) quantitative data. The major difference between their treatment of such data and the conventional wisdom in statistical and quantitative analysis is that they have not "estimated" their coefficients but simply used table functions instead. This is indeed a weakness, but it is imminently rectifiable and does not warrant the degree of criticism levied. The most important point about both the volume and its critiques, however, is that it is basically a very conservative document, and not a radical departure from current thought as many suggest. Indeed, the analysis in *The Limits to Growth* is extremely consistent with the studies sponsored by Resources for the Future. The major difference is that the authors of this controversial volume consider a much longer time span than do studies sponsored by Resources for the Future. It must also be pointed out that both groups employ the same empirical data on mineral and energy resources, namely, publications of the United States Government Bureau of Mines.

Regarding criticisms of the assumptions employed in the Meadows Study and in the earlier work by J.W. Forrester, *World Dynamics* (Cambridge, Mass.: Wright-Allen Press, 1971), see Robert Boyd, "World Dynamics: A Note," *Science* 177, no. 4048 (11 August 1972): 516-19, illustrating the extent to which the Forrester world model is sensitive to changes in assumptions.

18. Nazli Choucri, "Applications of Econometric Analysis to Forecasting in International Politics," *Peace Research Society (International) Papers*, in press.

19. See ns. 3, 6, 12, and 13.

20. See n. 14.

21. Douglas A. Hibbs, Jr., *Mass Political Violence: A Cross-National Analysis* (New York: John Wiley and Sons, 1973) and Ted Gurr, *Why Men Rebel* (Princeton, N.J.: Princeton University Press, 1970).

22. J. David Singer and Melvin Small, *The Wages of War 1816-1965: A Statistical Handbook* (New York: John Wiley and Sons, 1972).

23. Nazli Choucri and Robert C. North, *Nations in Conflict: Population, Lateral Pressure, and War* in preparation, revised version February 1973.

24. This concluding section is identical to that of an earlier article argued from another perspective; see n. 3 pp. 37-42. Some of the substantive arguments in this chapter have also been noted earlier: It is often difficult to divorce methodological concerns from their substantive context.

25. The extensive body of statistical data compiled by the United Nations since its inception is only one case in point.

26. See Jay W. Forrester, "Counterintuitive Behavior of Social Systems," *Technology Review* 73, no. 3 (January 1971): 52-68; Jay W. Forrester, *Principles of Systems* (Cambridge, Mass.: Wright-Allen Press, 1968).

27. See Howard Raiffa, *Decision Analysis: Introductory Lectures on Choices under Uncertainty* (Reading, Mass.: Addison-Wesley Publishing Company, 1968).

28. See Charles L. Schultze, et al., *Setting National Priorities: The 1972 Budget* (Washington, D.C.: Brookings Institution, 1971).

29. In this connection it becomes imperative to broaden our concept of cost to incorporate other than direct monetary considerations. For persuasive arguments, see Alice Rivlin, *Systematic Thinking for Social Action* (Washington, D.C.: Brookings Institution, 1971).

30. See n. 6.

31. See n. 28.

32. Robert C. North and Nazli Choucri, "Population and the International System: Some Implications for United States Policy and Planning," pp. 236-78 of A.E. Keir Nash, ed. (for the Commission on Population Growth and the American Future), *Governance and Population* (Washington, D.C.: Government Printing Office, 1972).

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with apologies for the
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