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QUANTITATIVE METHODS FOR LONG-RANGE ENVIRONMENTAL FORECASTING: LONG-RANGE EUROPEAN PROJECTIONS

VOLUME II

TECHNICAL VOLUME

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PROJECTIONS AND PLANS DEPARTMENT

PREFACE

This report describes the development and application of quantitative methods for long-range forecasting undertaken by the Projections and Plans Department of CACI, Inc. from March 1973 to February 1974. The research was supported by the Defense Advanced Research Projects Agency, Contract No. DAHC15-71-C-0201, Modification Nos. P00011 and P00013.

During March 1972 to February 1973, CACI, Inc. developed 3 single-equation models that forecast values of 3 key concepts, international conflict, international alignment, and domestic stability, for 20 Indian Ocean countries for the 1981 to 1990 period.[1] The work reported upon in this report is based partly on the Indian Ocean research, but develops an interactive model for Europe that examines the relationships among five central environmental descriptors: international conflict, international alignment, international trade, internal instability, and national power base. The overall purpose of the model is to acquaint national security analysts with modern long-range forecasting techniques and to provide a long-range forecast of Europe (1985-1995) for these five descriptors.

This Interim Technical Report is a three-volume document. Volume I, the Summary Volume, summarizes work on all tasks of the current contract in nontechnical language. Volume II, the Technical Volume,

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[1] See CACI, Quantitative Methods for Long-Range Environmental Forecasting, Interim Technical Report No. 2 (Arlington, VA, February 1973).

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contains various models that forecast the five descriptors for the European environment over the long range. Volume III, a Research Guide for long-range forecasting, develops a research design to be used by national security analysts to generate quantitatively based long-range forecasts.

STUDY PARTICIPANTS

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Each member of the study team contributed directly to this research report. Chapters 1, 3, 5, and 7 were prepared by Dr. Herman M. Weil; Chapter 2 by Mr. Aaron Greenberg; Chapter 4 by Dr. G. Robert Franco and Mr. Douglas Hartwick; and Chapter 6 by Mr. Larry German.

The study team would like to acknowledge the help and guidance received from Dr. Robert A. Young of the Defense Advanced Research Projects Agency. Dr. Young was the Principal Investigator of this project until November 1973 when he joined the Agency. Further acknowledgement should be given to Dr. Janice Fain, Mr. Robert Trice, Dr. Warren R. Phillips of CACI and to Mr. Robert M. Escavich. The team would also like to thank Col. James St. Cin, USAF; Col. William McDowell, USA; and Col. William Steinberg, USA for having read the manuscript and for providing many suggestions. We are also grateful to Major Michael J. Hanley, USMC, and to Mr. Edward L. Scherich for their valuable comments during many discussions. The study team is also indebted to Ms. Carol Franco for editing the report and to Ms. Debbie Post for typing it.

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INTRODUCTION: FORECASTING FOR PLANNING

During the past decade, scholars of international affairs have begun to direct more attention toward developing and utilizing techniques that could help systematize the explanation and prediction of international politics. In their research efforts they frequently use quantitative measures of international political concepts such as hostility, escalation, and alignment, as well as various techniques to express relationships among such measures. The purpose of the newer approaches does not differ fundamentally from the aim of traditional foreign affairs analysis. The goal is still to produce accurate descriptions of the state of international relations or some subset thereof, and to employ descriptions of some elements as explanations or predictors of others.

Researchers across the nation have received support from the U.S. Government, particularly the Department of Defense, to employ newer methods and techniques in the area of international relations. One cluster of important academic efforts funded by the Department of Defense is known as the Quantitative Political Science (QPS) program.[1] Until recently, however, few attempts had been made to apply the newer approaches to specific problems within the foreign affairs community (e.g., within DoD). The lag resulted from a variety of factors, including the characteristic absence of ongoing work in most academic

[1] These efforts are described in CACI, The Utilization of ARPA-Supported Research for International Security Planning (Arlington, Virginia, October 1972).

projects and their seemingly esoteric methods. There is a need, then, to bridge the gap between recent academic developments and the practicing foreign affairs community. The goals of this effort are straightforward: to communicate to the foreign affairs establishment the variety of newly acquired capabilities for foreign affairs planning and analysis; to suggest means of integrating recent quantitative developments with more traditional "judgmental" approaches; and to allow members of this community to evaluate experimental applications of the newer techniques. The present volume reports on an effort to accomplish these three goals with respect to one general subject area--long-range environmental forecasting. The foreign affairs community is well aware of the need to anticipate significant changes in the world situation in order to formulate policy in time to prepare for these changes. It is vital to be able to forecast in a planning context because varying time lags are required for reactions to be operative.

Planning is the attempt to exercise control over our future economic, political, as well as physical, environments. For planning efforts to be successful, planners must have a clearly defined set of goals with respect to those environments, knowledge about the nature of those environments under specified conditions, and an ordering of plans such that the congruence between goals and the environments is maximized. Simply put, we need to know what we want (goals), what our capabilities are (environments), and how to optimize our desires with respect to our capabilities (plans).

Forecasting is most often directed toward the second of these needs. Long-range environmental forecasting seeks to identify those factors or forces that will be prominent in shaping our environment and to determine, under various contingencies, their nature in the long-range future. For example, we know that patterns of international alignment are important in the international environment; yet we would like to know exactly what kinds of effects alignment patterns have and how those effects might change under specified conditions. At that point, the "what if" question becomes accessible to analysts and planners in the national security community. Thus we can ask, "What would be the effects of extensive political integration within the Western European community?" Likewise, the implications of decreasing Soviet hegemony over the Eastern European satellite countries become open to analysis.

Providing long-range forecasts that are genuinely useful to planners, therefore, requires systematic examination of the potential implications of changes in important environmental variables. Yet, as the world becomes more complex and interdependent, generating such knowledge becomes increasingly difficult. Quite clearly, as the solutions to many of our problems produce yet other problems, it becomes difficult to forecast the total impact of given policies, practices, and patterns of behavior upon our environment. For example, many analysts[2] failed to foresee the effects of stricter pollution-control policies upon the demand for and availability of nonhuman energy sources. Others regarded mechanized agriculture as a long-term means of providing food for the world's population without considering the effects of that kind of food-growing process upon the productivity of land.

It is particularly important that analysts recognize these previous shortcomings since the cost of misunderstanding accelerates as the

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2 See, for example, Herman Kahn and Anthony Weiner, The Year 2000 (New York: Macmillan Co., 1967).

world steadily becomes more interdependent. Such high costs point to the need for systematic approaches to long-range forecasting that are specifically designed to analyze the interdependencies of the problems we face. Such approaches, however, depend upon our ability to identify and specify the linkages among the myriad of important variables constituting our environment. Identification and specification, in turn, depend upon our use of theory. Contemporary social, economic, and political theories have vastly increased our understanding of the complexity and interrelatedness of the international environment. At the same time, they have alerted us to the fact that no single theory, or set of theories, can adequately explain those complexities. Any systematic long-range forecasting effort, then, requires not only the use of theory, but the integration of multiple and diverse theoretical approaches.

A theory, or model, constitutes a manageable abstraction and simplification of the thousands of potentially important aspects of an environment. Any theory, or model, in this sense, is an ordering schema that designates some subset of environmental variables as "important" or "relevant" and suggests how those variables are interrelated (the patterns of cause and effect among those variables). The particular selection of variables, and the criteria that govern that selection within any one theoretical framework, depend heavily upon the orientations of the individual researchers and users. Multiple sets of theory tend to override this restrictiveness and allow many fundamental research orientations to be considered simultaneously. To the extent that the value of a theoretical approach depends upon its inclusiveness as well as its ability to specify important variables and relationships, multiple theoretical approaches promise to be valuable in a forecasting effort.

Within this general orientation, three sets of theoretical approaches guide our efforts. The first consists of the vast body of traditional and empirical social science theory directed at the substantive relationships involving the variables of interest. The second is the body of statistical theory with which those relationships could be empirically validated and mathematically described. The third set of theoretical approaches is found in the literature of cybernetics. This body of knowledge focuses upon the characteristics of dynamic systems, both physical and social, and is useful in simultaneously modeling the entire set of central environmental descriptors over the long range.

These three research paradigms are integrated within a general systems framework.[3] Consistent with that body of literature, the economic and political environment of an area can be usefully described by a set of variables that are both of theoretical importance and of interest to users in the policymaking community. This set of variables has had numerous names in the general systems literature, among them "world problematique" and "essential variables"; we use the term central environmental descriptors. Our selection of descriptors is guided by our interests, the substantive considerations involved in developing long-range environmental forecasting technologies within the context of Europe, and the particular needs of our users in the national security community.

We attempt to isolate a set of factors or predictors that are strongly related to these central environmental descriptors and for which future values can be credibly generated. Once these relationships are

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3 See W. Ross Ashby, Design for a Brain (London: Chapman & Hall, Ltd., 1952), for a useful discussion and application of this framework.

identified and described, future values of predictors can be used to forecast the central environmental descriptors. Of course, some predictor variables are not other central environmental descriptors. But in order to understand the interrelationships among important variables of interest in the long-range environment, the relationships among the central environmental descriptors are also used to generate the long-range forecasts. What follows is a short description of the role of each of the three sets of theories and the manner in which they are integrated in this long-range forecasting effort.

<u>Substantive Social Science Theory</u>

Initial examinations of each of the central environmental descriptors under consideration consist of reviews of the substantive literature of a number of social science disciplines including economics, political science, sociology, and demography. The goal here is to develop background information on prior efforts to conceptualize, measure, and analyze relationships involving these descriptors. Of special interest, of course, are the interrelationships among the descriptor variables. From the many possible relationships involving each descriptor that is identified, an ordering of the relationships is made on the basis of their apparent significance and generalizability. In short, this is a winnowing process directed at extracting from the set of all possibilities those relationships most likely to be valuable in the forecasting effort.

Chapters 2 through 6 of this report discuss the results of this undertaking. They contain detailed discussions of the development of forecasting models for each of the central environmental descriptors: national power base, internal instability, international trade, international alignment, and international conflict. Previous theoretical and empirical studies directed at these concepts are examined and their usefulness with respect to long-range forecasting is evaluated. Each of the chapters describes the manner in which the central environmental descriptor is conceptualized and how empirical measures of each descriptor are developed and data for those measures collected. For each of the descriptors, the validity of the particular empirical measures developed is determined, both empirically and with respect to previous usage. In this context, the critical question concerns the value of the empirical measures as a representation of the concept, or descriptor, under examination.

Following these considerations, hypothesized relationships involving each central environmental descriptor are detailed and rationales for the hypotheses are developed. Of course, the relationships involve predictor variables that are either exogenous to (outside of) the forecasting model or are other central environmental descriptors themselves. In all cases, hypotheses are drawn from previous theoretical and empirical examinations of the concepts under consideration, and the reader is referred to the most relevant of these studies for further information.

Statistical Theory

Each of the relationships identified is subjected to empirical examination using data collected in accordance with the methods described, and analyzed with accepted statistical techniques. The results of tests of hypotheses and mathematical descriptions of particular relationships are described in detail in the appropriate chapters.

Generally, we use econometric methods to evaluate specific hypotheses and to describe relationships among descriptors and between descriptors and exogenous predictor variables. During the past few years, econometricians have developed reasonably complex and realistic models of our economic environment.[4] These models have been used, in turn, to produce relatively accurate forecasts of the economic environment. The basic approach used by econometricians has been to isolate a set of predictors that are strongly linked to a set of variables that describe the salient aspects of the economic environment. They estimate the nature of linkages between the predictor and descriptor variables, taking into account linkages among the descriptors themselves, and use known values of the predictors to make forecasts of the economic environment.

Econometric forecasting models are strictly dynamic since they consider the relationships among the descriptors and their predictors. Usually, however, they have been used to forecast the values of the economic descriptors only within a short-range time frame. That is, current values of the predictors are used to make forecasts about the

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4 See Gary Fromm and Lawrence R. Klein, "The Brookings - SSRC Quarterly Econometric Model of the United States: Model Properties," American Economic Review, Vol. 55 (1965), pp. 348-361; Gary Fromm, "An Evaluation of Monetary Policy Instruments," The Brookings Model: Some Further Results, ed. by J.S. Duesenberry, et al. (Chicago: Rand McNally and Co., Inc., 1969); George Green, "Short- and Long-Term Simulations with the OBE Econometric Model" (Conference on Econometric Models of Cyclical Behavior, Harvard University, November 1969); M. Liebenberg, A.A. Popkin, and P. Popkin, "A Quarterly Econometric Model of the United States," Survey of Current Business, Vol. 46 (1966), pp. 13-39; and M.K. Evans and L.R. Klein, The Wharton Econometric Forecasting Model (2nd. ed.; Philadelphia, Wharton School, University of Penn. Press, 1968).

values of the economic descriptors for the next quarter, or perhaps for the next year.

While econometricians have made numerous efforts to develop and improve methods of estimating relationships among variables, they have been constrained by the basic assumptions upon which their theoretical orientation rests. One of these is that relationships among variables are linear or can be transformed to linearity. This assumption does not limit our analyses substantially, however, inasmuch as the concepts that we are examining and the data at our disposal are too low and too gross to permit useful higher order modeling. A second important limitation of econometric methods is that they assume that the data which go into the analysis are free of measurement error, which is certainly not true of comparative, macro-level social science data. As a result, the ranges of the confidence intervals of the estimates produced in our regression analyses are rather large. This does not mean, of course, that those estimates are not useful for our purposes.

Where do we stand in the development of a forecasting model that incorporates both substantive social science theory and statistical theory? If our goal is to construct a model that is a realistic representation of the actual environment to be forecast, then each of the possible relationships among central environmental descriptors, and between those descriptors and exogenous predictor variables, must be considered. That subset of relationships which substantive research suggests are important with respect to the shape of the long-range environment is isolated. Each of the relationships, in turn, is expressed in the form of a testable hypothesis that relates measures of the concepts under consideration to one another.

Once data for each of the measures have been collected, the hypotheses can be subjected to further examination with statistical methods. These analyses can isolate a subset of those hypothesized relationships that may be valuable in a forecasting model subject to the specific space/ time constraints of our substantive concerns, namely, contemporary Europe. Statistical theory also allows mathematical descriptions of those relationships to be generated, descriptions that can be used to produce the desired long-range forecasts. These descriptions take the form of a linear equation relating the predictor variables--both other descriptors and exogenous predictors--to the descriptor under consideration. Thus, in the equation below, Y is the descriptor to be forecast and X is the predictor variable used to forecast Y. β_0 and

$$Y = \beta_0 + \beta_1 X$$

β_1 are parameters that describe the relationship between Y and X. Strictly speaking, however, the application of statistical theory produces a range of values for those parameters rather than a single estimate. Thus, for example, β_0 may have a confidence interval of 0.5 to 1.5, and β_1 a confidence interval of 3.2 to 3.8. The important question with regard to actually producing forecasts, and one that remains unanswered by statistical theory, is, "What value within the confidence interval should actually be used in forecasting Y?"

Cybernetic Theory

Elements of cybernetic theory are utilized to develop exact descriptions of the relationships among central environmental descriptors, and between descriptors and exogenous predictor variables. Cybernetic theory, in this context, is a subset of general systems theory concerned with the characteristics of dynamic, yet controlled, systems.[5] Cybernetic theory is directed at explaining the production and regulation of change in complex systems. Parameter estimates, then, can be evaluated with respect to cybernetic theory to determine the characteristics of change within the system being forecast.

Specifically, the descriptions of hypothesized relationships developed through the application of econometric techniques are combined into a simulation model that produces forecasts for the central environmental descriptors. Those forecast values are then examined to determine the extent to which their patterns of change conform to expectations generated from cybernetic theory. Parameters are adjusted within their respective confidence intervals when unreasonable forecast values are encountered, and the forecasting process is repeated.

Simulations are generally divided into two classes: discrete and

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[5] See Jay W. Forrester, Industrial Dynamics (Cambridge: The M.I.T Press, 1961); Jay W. Forrester, Urban Dynamics (Cambridge: The M.I.T. Press, 1969); Jay W. Forrester, World Dynamics (Cambridge: Wright-Allen Press, Inc., 1971); Dennis L. Meadows and Donella H. Meadows, eds., Toward a Global Equilibrium: Collected Papers (Cambridge: Wright-Allen Press, Inc., 1973); and Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, and William W. Behrens, III, The Limits to Growth (New York: Universe Books, 1972). See also Ashby, Design for a Brain; W. Ross Ashby, An Introduction to Cybernetics (New York: John Wiley & Sons, Inc., 1963); and W. Ross Ashby, "Regulation and Control," in Modern Systems Research for the Behavioral Scientist, ed. by Walter Buckley (Chicago: Aldine Publishing Company, 1968), pp. 296-303.

continuous simulation.[6] Simulations per se are usually discrete, that is, event powered. Outputs of a discrete simulation depend upon event occurrences that are input into the model. Our approach utilizes a continuous simulation model whose output depends primarily upon the particular parameter estimates used in a given simulation run. Thus, the ranges of estimates developed in the statistical analyses could yield a wide variety of forecast outputs. Particular estimates are selected from within those ranges according to specified criteria applied to the forecast outputs. Those criteria are discussed in some detail in the next section of this chapter.

In combining cybernetic theories with substantive social science theories and statistical theories, then, three levels of limitations are placed upon the possible set of relationships included within the forecasting model. Of all the possible relationships involving central environmental descriptors that could be utilized, a subset of them is selected which:

1. Is consistent with previous theoretical and empirical substantive work in economics, political science, sociology, anthropology, demography, and other social science disciplines.

2. Is shown to be statistically significant within the substantive context of the contemporary European environment; and

3. Produces a forecasting model consistent with criteria developed from examination of dynamic and cybernetic systems.

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[6] See M.R. Leavitt, "Computer Simulation," in Forecasting in International Relations: Theory, Methods, Problems, Prospects, ed. by Nazli Choucri and Thomas W. Robinson (San Francisco: W.H. Freeman and Co., forthcoming).

EVALUATION OF A FORECASTING MODEL

Three general positions on the validation of models are taken in the Long-Range Environmental Forecasting study.[7] The rationalist position suggests that models must be deduced from some set of "true" underlying assumptions to be considered valid. Thus, validation consists of working backward from the parameter estimates to their assumptions until what remains seems intuitively true. The empiricist position, on the other hand, maintains that "truth" cannot be logically deduced, but depends on sense observation. From a set of assumptions, empiricists generate a set of necessary consequences that can be observed as true or false, consistent or inconsistent with reality. The positivist position is that the validity of a model does not depend on the truth value of its assumptions, but rather on the characteristics of its output. One of their favorite tools is postdiction. The model is used to generate postdicted values of certain variables and the postdictions are then compared with the actual values of those variables. When the two are in agreement, the model is considered valid. In short, a model is considered valid if it works.

The important point to remember is that there is no way known to validate a model in any absolute sense. Rather, a model is considered valid to the extent that it fails to be disverified by the application of one of these verification criteria. Of course, a model may prove to be inadequate by one criterion and not be disverified by another. Thus,

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7 See Thomas H. Naylor and J.M. Finger, "Verification of Computer Simulation Models", The Design of Computer Simulation Experiments, ed. by Thomas H. Naylor (Durham, N.C.: Duke University Press, 1969).

a model subjected to multiple validation criteria has a greater likelihood of being useful. By applying multiple validation criteria to the selection of forecasting models, multiple theoretical approaches become a sound means of model building that result in useful forecasting methodologies for national security analysts.

The relationships among variables in an empirically derived forecasting model constitute the assumptions, or givens, of that model. Changes in those relationships, then, produce alternative sets of long-range environmental forecasts. Thus, any forecast is inextricably tied to the assumptions of the associated forecasting model. One important aspect of these assumptions, of course, is that they be based upon well-developed, substantive social science theory. Additional steps can be taken, however, to insure that forecasts conform in some meaningful way to the actual environment under study.

Quality of Assumptions

Any forecast can only be valid to the extent that the assumptions of the forecasting model are accurate reflections of the nature of processes in the real world. In the abstraction of real-world processes in a modeling effort, we must be concerned whether we, as observers of social reality, perceive that reality as it, in fact, exists. Phenomenological arguments notwithstanding, there is no way to be sure that our perceptions of reality are consistent with its "true" nature; the perceiver always imposes his own order, his own "reality," upon the world he sees. Nonetheless, philosophers of science have long recognized that some assurance of the coincidence of our perceptions and reality can be given, and that such assurance depends upon the intersubjectivity of observations. Simply put, this means that when nearly everyone sees the same thing, we can assume that it exists. This criterion implies that assumptions about the real world must be generated in a systematic and replicable manner.

Methods of analysis based upon statistical theory are ideal for selecting a subset of significant relationships in a manner consistent with these needs. The methods themselves and associated selection criteria are well documented so as to be replicable, and are logical extensions of relative frequency probability theory. Thus, the selection criteria are systematic as well.

Evaluation of Assumptions

Even when assumptions have been so generated, however, they must still be evaluated with respect to their implications. Despite the fact that nearly everyone in Columbus' day believed that the world was flat, the quality of that belief could not be evaluated until its implications were tested, that is, until someone either sailed around the world or fell off the edge. Consistent with the thrust of scientific philosophy, we regard the experimental setting as the most powerful and convincing means to evaluate the implications of a given assumption or set of assumptions.

When we speak of the experimental setting, however, we do not refer to the existence of a laboratory, gauges, measuring instruments, or the like, although these may be important in particular experimental settings. Rather, we refer to the manner in which the implications of assumptions are tested. Specifically, we see the experimental setting as composed of two elements:

1. The generation of variations in the assumptions under examination, variations sufficient to produce measurable differences in outcomes. (Obviously, sailing half-way around the world would not test the belief that the world was flat, for one could have stopped but a single mile from the edge.)

2. The existence of controls for other possible influences on the outcomes generated. (Using the same example, one could have, without proper navigational care, sailed in a circle around the edge of a flat world, arrived at his starting point, and incorrectly inferred that the world was, in fact, round.)

Once several sets of assumptions, in this case parameter estimates, are used while holding all other things equal, a set of alternative forecasts is available for comparison.

Simulation experimentation is one of the most powerful available techniques for evaluating the parameters of the relationships (assumptions) of a forecasting model.[8] Relationships between variables, both among central environmental descriptors and between descriptors and exogenous predictor variables, can be altered and the implications of these alternative assumptions examined. These implications can be compared within the context of dynamic and controlled (cybernetic) systems. Two specific characteristics of assumptions, or parameter estimates, are of special importance in the cybernetic theoretical framework--sensitivity and stability.

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8 See Leavitt, "Computer Simulation." See also Naylor, ed., The Design of Computer Simulation Experiments, and Thomas H. Naylor, ed., Computer Simulation Experiments with Models of Economic Systems (New York: John Wiley & Sons, Inc., 1971).

1. Sensitivity

With respect to the parameters, or assumptions, of a simulation model, sensitivity refers to the variation produced in forecasts from variations in the parameters under examination. Changes in a variable with a relatively insensitive parameter, then, would produce little or no change in the resultant forecast. Changes in the value of a variable with a highly sensitive parameter can produce radical changes in the forecasts being generated.

2. Stability

Stability in this context refers to the range, or pattern, of forecast values of a variable which results from the inclusion of a given parameter, or assumption. An unstable parameter can result in forecasts of a variable that contain wild fluctuations, or an unrealistically steep and unrestrained growth or decline.

Evaluation of the assumptions of a forecasting model by simulation experimentation, then, requires examining parameters that represent those assumptions to determine their sensitivity and their stability. Certain restrictions must be placed upon those parameters to insure that they are acceptably sensitive and stable. Of course, the restrictions placed on any given parameter are determined by the substantive role of that parameter and its associated predictor variable in the forecasting model, and by the substantive context of that model.

Although parameters in the model must be evaluated separately, some general guidelines can be offered for examining their stability and sensitivity. The following sections describe mathematical characteristics of extremely sensitive and insensitive parameters, and of extremely stable and unstable parameters.

Sensitivity. We noted earlier that parameters that are completely insensitive produce no changes in the dependent variables (forecasts) when associated changes in predictor variables occur. Thus, if β_i is a parameter relating a descriptor to a predictor variable, that parameter becomes less sensitive as β_i approaches zero, and the parameter is completely insensitive when $\beta_i = 0$.

No such absolute upper bound can be found that suggests when a parameter is overly sensitive. However, we can state as a general rule of thumb that whenever $\beta_i X_i > Y_i$, the parameter β_i is too sensitive. Whenever the change in a descriptor that is produced by an associated change in a predictor and its parameter is greater than the previous value of the descriptor itself, the parameter governing the extent of that relationship is too sensitive. This rule of thumb implies that no descriptor can change in value more than 100 percent from one time frame to the next.

Stability. In contrast to limitations on sensitivity, upper and lower bounds of stability can be generated. We can develop measures that identify when a parameter is completely stable or completely unstable. Completely stable parameters result in values of descriptors that do not alter, or alter only as a function of themselves, from one time point to the next. That is, knowledge of the value of the descriptor at one time point is sufficient for knowledge of the value of the descriptor in the following time period. A set of completely stable parameters for a descriptor results in the situation where $R_{y_t y_{t+1}} = 1$. That is, perfect correlation exists between the values of the descriptor over time. If a descriptor has a set of completely unstable parameters associated with it, knowledge about the value of the descriptor at time t will offer no information about its value at time t+1. Thus, $R_{y_t y_{t+1}} = 0$.

Except in rare cases, the analyst will want parameters that fall somewhere in that range; completely stable or unstable parameters are seldom required. Nonetheless, these measures do allow the analyst to gauge the relative stability of the parameters associated with a particular descriptor.

Summary

Application of the cybernetic criteria constitutes the third tier of evaluation used in constructing the long-range environmental forecasting model described in this report. The first of these tiers consists of the substantive social science knowledge upon which this work is based. Only those relationships that are consistent with previous theoretical and empirical analyses are included in the model. From that group, the subset of relationships that are not statistically significant is removed. Finally, statistically significant relationships which have unacceptable levels of stability or sensitivity are eliminated from the model. Thus, three sets of validation criteria, corresponding to three sets of theoretical frameworks--substantive social science theory, statistical theory, and cybernetic theory--are used in the validation process for the forecasting model.

SUBSTANTIVE OVERVIEW

In generating long-range environmental forecasts of the European milieu, seven basic steps are undertaken:

1. Selection of central environmental descriptors;

2. Development of empirical measures of the descriptors;

3. Generation of hypotheses relating descriptors to endogenous and exogenous predictors;

4. Collection of data for measures of descriptor variables and predictors;

5. Evaluation of hypotheses and mathematical description of relationships between central environmental descriptors and predictor variables;

6. Postdiction of central descriptors; and

7. Simulation experimentation on the dynamic model of the long-range European environment.

The remainder of this chapter will briefly discuss the manner in which each of these steps is undertaken in this long-range forecasting effort.

Selection of Descriptors

A "central environmental descriptor" is defined as an important and general characteristic of the environment under study. Examples include natural resource availability, alignment, and international conflict. Although each of the above steps is important in constructing a viable forecasting model, the first is crucial since all others depend on it. If, for any reason, the central concepts selected are inappropriate, the remainder of the analysis is useless. In isolating central environmental descriptors, then, special care is taken to examine those that are considered especially important in the user community, and those that can be forecast most credibly over the long range.

The needs of users are taken into account by selecting the central concepts in close consultation with our user in the national security community, the Joint Chiefs of Staff, J-5, Long-Range Planning Branch. The selection of concepts which can be credibly forecast, however, involves several considerations. First, the concept should be general enough to be amenable to a long-range forecast. For example, the user might wish to forecast future alliances; but that concept is probably too specific to allow useful and credible forecasts. Alignment, however, is perhaps general enough to allow credible forecasts; at the same time, alignment reflects most of the policy-relevant characteristics of alliance. Selecting an appropriate concept, then, often involves determining the overlap between user needs and research capabilities.

A second consideration concerning forecasting credibility is the availability of reasonable quality data on potential measures of the concepts. The greater the amount of quality data available, the greater the likelihood a given concept will be included in the analysis. A related concern is the state of development of substantive social science theory relevant to the concept. The need for substantive theory in the forecasting model partially determines the selection of concepts. In light of these criteria, five central concepts are chosen: national power base, internal instability, international trade, international alignment, and international conflict.

Development of Empirical Measures

Once the central environmental descriptors are chosen, extant theoretical and empirical literature are reviewed. The goal here is to generate empirical measures of the concepts and to extract potentially useful hypotheses relating the concepts to one another and to exogenous predictor variables. A detailed discussion of these steps is found in each of the discussions of individual descriptors in Chapters 2 through 6 of this report. Suffice it to say here that the selection of measures is primarily guided by previous research and the availability of data, which usually overlap, and the generation of hypotheses according to their credibility within the substantive context of contemporary Europe.

In the process of that literature survey, it is necessary to divide many of the central environmental descriptors into components. Usually this action is taken because the descriptor as initially conceptualized is too broad for operationalization. Figure 1 shows how each descriptor is broken down into components. Thus, national power base is conceptualized with two major dimensions, economic and military. Although economic and military power are, of course, strongly related, separating them analytically allows them to be explicitly examined rather than hidden within the conceptualization of national power base. That is, the conditions that control the relationship between economic and military power base can be examined in the analysis.

Similarly, two dimensions of internal instability are identified, turmoil and revolt. Although our findings suggest that these two dimensions of instability probably reflect only different levels of the same type of internal strife within contemporary Europe, previous investigations of political strife on a worldwide basis led consistently to this differentiation. The two dimensions are maintained to keep our efforts generalizable to parts of the world other than Europe.

Two major aspects of a nation's alignment with major powers are considered. In the case of the European context, two major powers, the United States and the Soviet Union, are identified as particularly salient. Measures are developed for the distribution of nations'

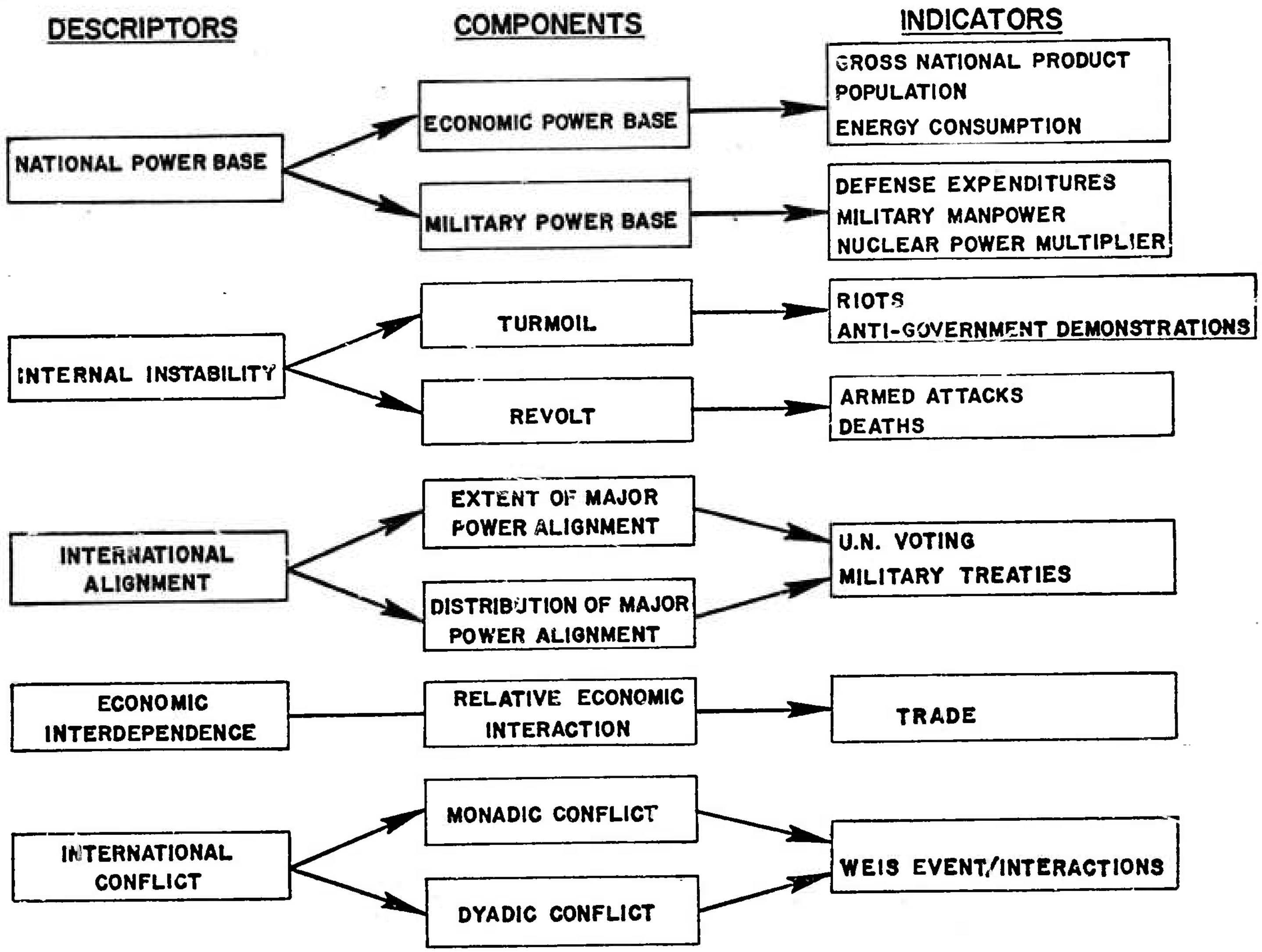

Figure I. Central Environmental Descriptors.

major-power alignments between those two countries, and the extent of their major-power alignments, or the propensity of the European nations to align themselves with one or more major powers. By considering both aspects of major-power alignment, multialigned nations can be differentiated from nonaligned countries.

Likewise, two aspects of a nation's participation in international conflict are considered. The first, monadic conflict, refers simply to the total amount of conflict experienced by a given nation within the European region. Monadic conflict is essentially a concept referring to the quantity of a nation's conflict. Dyadic conflict is a concept directed at the source of a nation's conflict.[9] Thus, if monadic conflict measures the amount of a nation's conflict, dyadic conflict locates the source of its conflict among the other countries in the European region.

After components of the five descriptors are identified, empirical measures are developed for each of these components. Gross national product, population, and energy consumption are used as indicators of economic power, while defense expenditures and military manpower are used as indicators of military power. Turmoil and revolt are measured by numbers of riots, antigovernment demonstrations, armed attacks against governmental institutions, and deaths experienced in political conflict. Alignment is measured by U.N. voting patterns and mutual security treaties, and international conflict is measured by hostile event/interactions between nations.

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9 Dyadic conflict scores measure the quantity of conflict a given European country has with each of the other 25 nations studied here.

Generation of Hypotheses

The relationships among components of the central environmental descriptors are shown in Figure 2. Each of the components or indicators actually forecast in this effort is shown within a heavy box. Lagged values (last-year's values) of these variables are shown within oblong rounded figures while the circles contain exogenous predictor variables which themselves are not forecast by the model. Arrows connecting descriptors and predictor variables, which include other descriptors, lagged descriptors, and exogenous predictors, show the direct and indirect linkages, or relationships, which constitute the final forecasting model.

Figures 3 through 6 show segments of the forecasting model. Figure 3 depicts the power base sector of the model. The relationships between economic power indicators and military power indicators are explicitly shown. Thus, gross national product is found to affect defense expenditures directly and indirectly, and to affect manpower directly. Defense expenditures, in turn, are found to have an impact upon GNP, while population is found to affect manpower.

Figure 4 shows the relationships within the internal instability sector of the forecasting model. As we noted above, for reasons of generalizability, turmoil and revolt are initially analytically separated. As the flow chart suggests, explicit linkages are found between these two components of instability in the analysis of the European region. Nations experiencing turmoil are likely to be experiencing revolt as well. In addition, previous levels of revolt are important factors in generating turmoil. Note that many components of economic and military power play an important part in determining the levels of turmoil and revolt

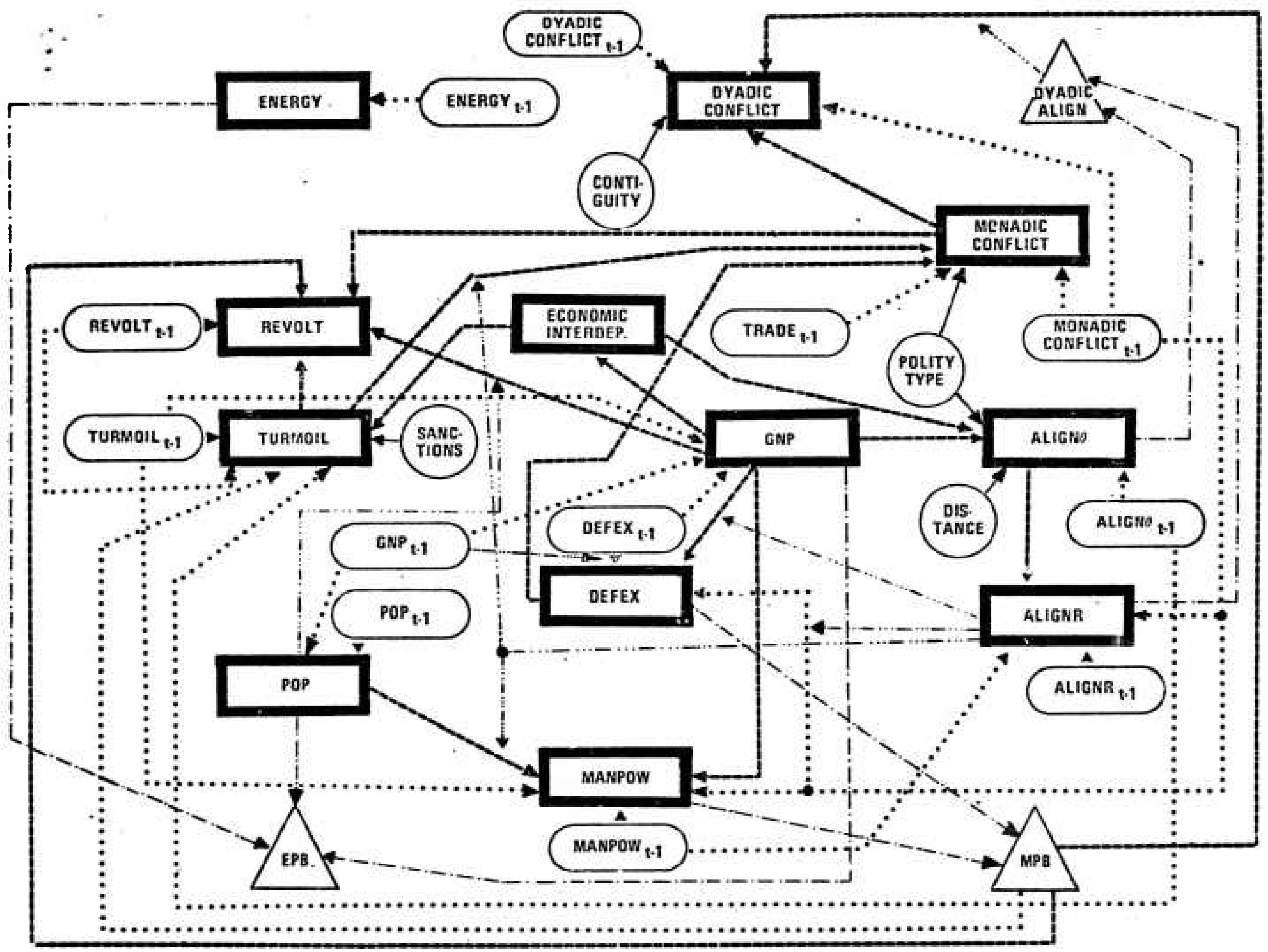

Figure 2. Long-range Environmental Forecasting Model.

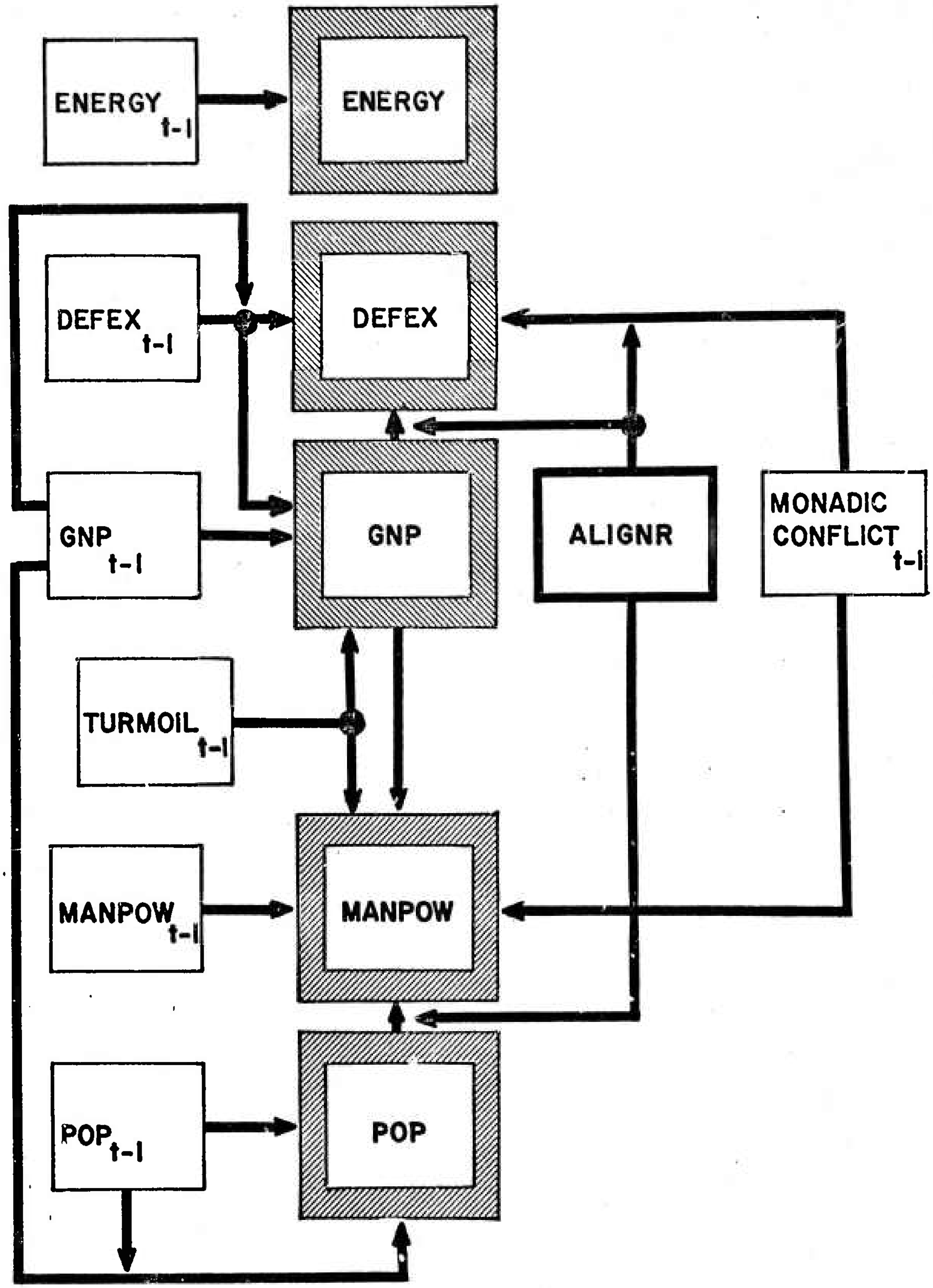

Figure 3. Power Base Sector.

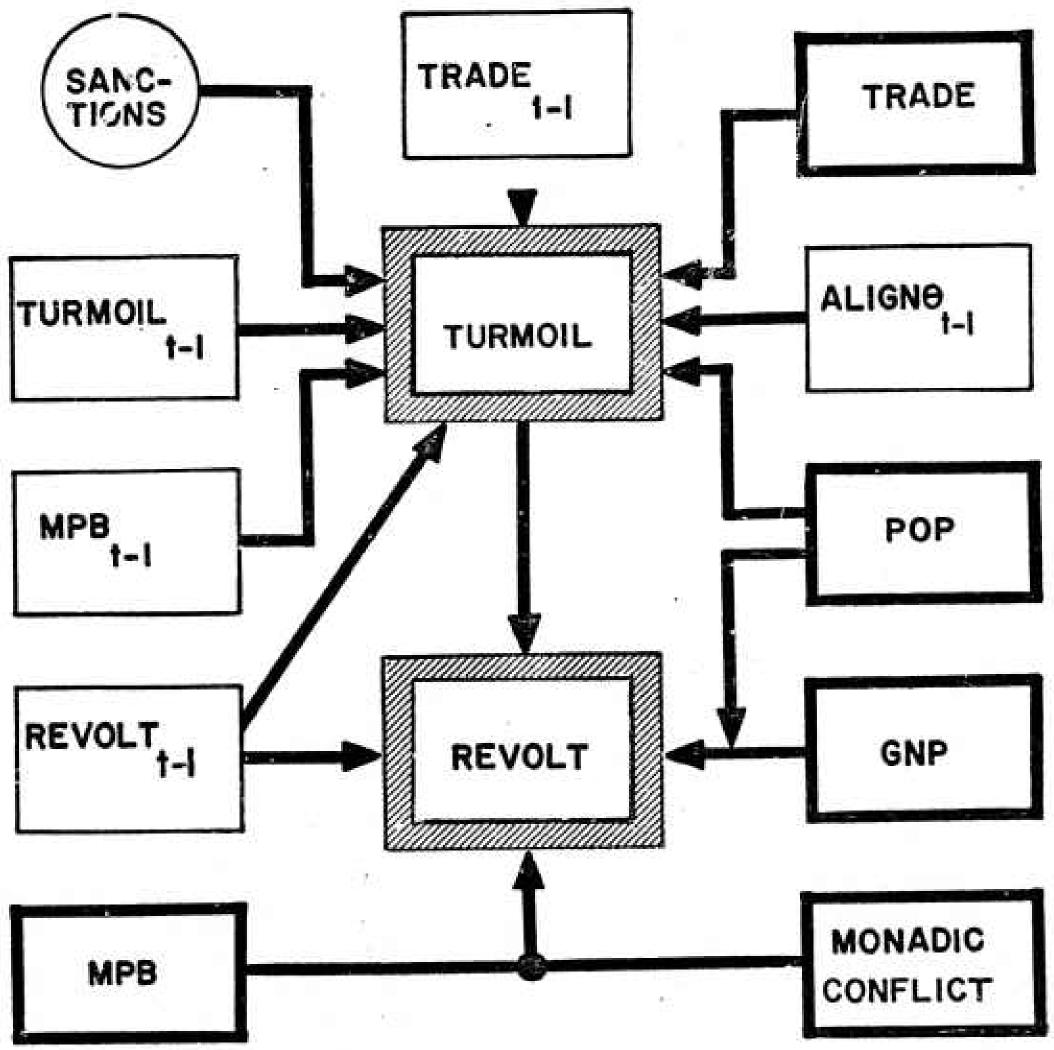

Figure 4. Internal Instability Sector.

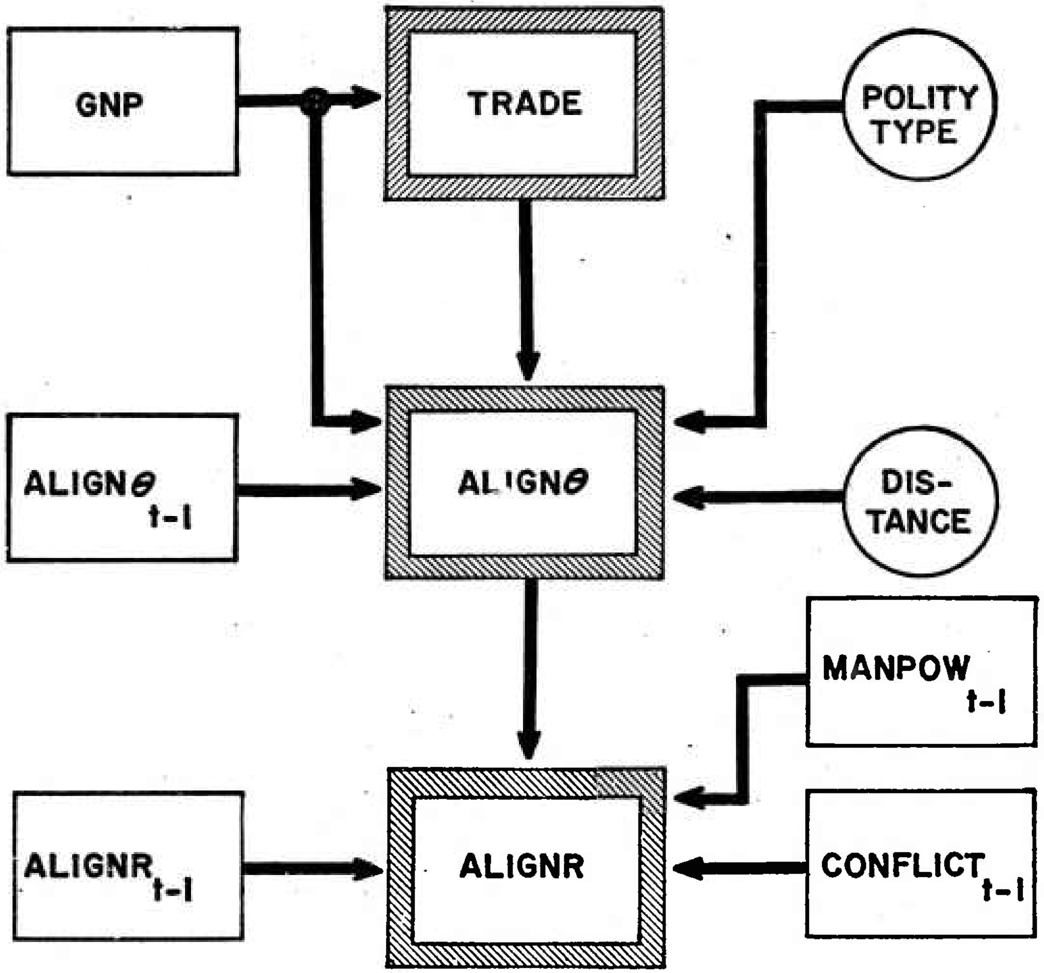

Figure 5. Alignment-trade Sector.

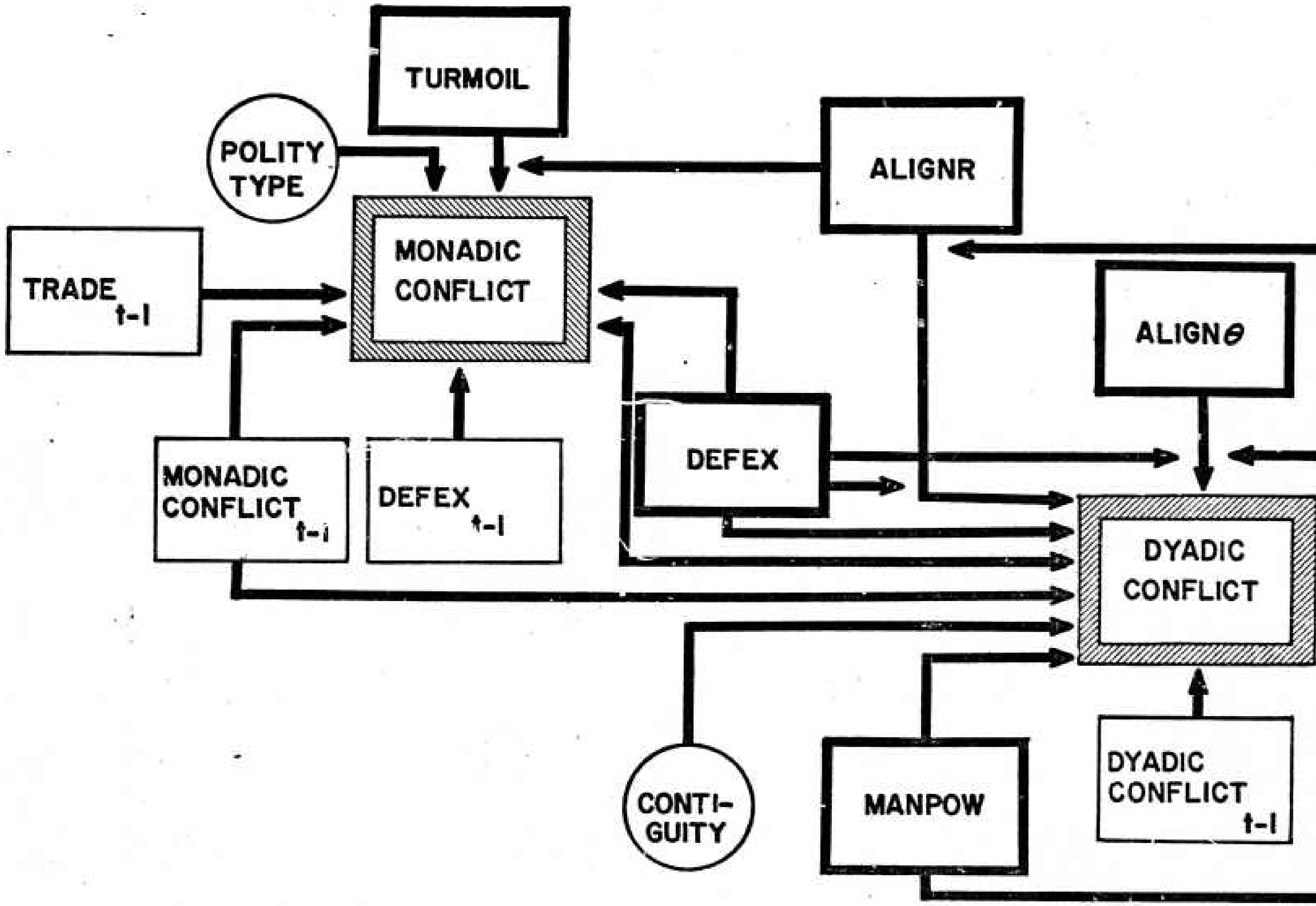

Figure 6. Conflict Sector.

in the European countries, notably GNP, population, and both indicators of military power, combined in this case into the military power index discussed in Chapter 2 of this report. Trade is also an important determinant of turmoil.

Figure 5 shows the relationships among variables extant within the alignment-trade sector of the model. Two power-base indicators, gross national product and manpower, are important influences upon alignment patterns, as is international conflict. GNP is the primary determinant of international trade, as is discussed in Chapter 4 of this report. The international conflict sector of the model is detailed in Figure 6. Components of international alignment, national power base, trade, and internal instability are important predictor variables for both monadic and dyadic conflict.

Data Collection and Statistical Analysis

Once the data are collected for each of the indicators of the central environmental descriptors and for each of the exogenous predictor variables, these various relationships are empirically analyzed and mathematically described. As we noted above, in this phase of the research econometric techniques are especially useful, allowing both statistical tests of the various hypothesized relationships and mathematical descriptions of those found significant. Forecasting models for each descriptor or descriptor component take the form of regression equations relating that descriptor or component to its various predictor variables. The particular hypotheses tests and the resultant mathematical descriptions of the relationships are found in the individual chapters that follow.

Particular attention is given to developing a set of regression equations applicable to forecasting needs. If, for example, GNP serves as a predictor of domestic unrest, the mix of endogenous and exogenous predictors in the set of equations must be structured so as to allow GNP to be forecast before generating forecasts of domestic unrest. In this example, lagged, and therefore exogenous, values of domestic unrest could be used to predict GNP, but present values of domestic unrest could not be used in the GNP forecast because those GNP values were needed prior to forecasting domestic unrest. Once initial hypotheses tests are complete and forecasting equations developed, the equations are ordered to permit their use in a simulation forecasting model, adjustments are made to insure that the equations are in block-recursive form, and the final structual equations are reestimated.

Postdiction

The equations developed are then used to generate data for the years 1960-1970. The results of this process consist of a series of "postdicted" values for each of the forecast descriptors and components for those years. The postdicted values are then compared with actual values for the 10-year period and the extent of error for each forecasting equation is measured. Generally, equations for the economic and military power base indicators are the most accurate, with error consistently below 5 percent. Equations for the two components of international alignment produce postdictions with about 10 percent error, and international trade equations have postdictive results containing about 20 percent error. The two sets of equations with the most extensive error are the equations forecasting internal and external conflict behavior. For those sets of equations, postdictions generally have error in the 40 to 50 percent range. Clearly, forecasts of these sets of variables are likely to be less reliable than forecasts of various national characteristics: economic and military power, trade, and alignment.

It is important to recognize that the kind of error observed in these behavioral regression equations in part reflects the requirements of the forecasting model. Any region-wide regression model will produce postdicted values which are "low" for those countries with high scores on the actual descriptor, and "high" for nations with low values on the descriptor. Thus, postdicted values show a convergence towards the mean when compared with the actual values of the descriptor variable. The critical issue in evaluating the postdictions, then, is the extent to which the regression model discriminates among countries with low, medium, and high scores in a relative sense. Thus we ask whether countries that typically experience little internal instability have lower postdicted values for that descriptor than nations that typically have high levels of internal unrest. While the absolute quantity of error in the regression models is useful for their evaluation, their relative discriminatory power is the best guide to their value in the forecasting context.

CONCLUSION

This chapter has served as an introduction to the substantive and methodological guidelines of this study. We note that forecasting takes on importance as an adjunct to the planning process, and that the needs of planning dictate certain forecasting requirements. In particular, we suggest that forecasts must have maximum credibility and be useful in the examination of the potential implications of changes in important environmental variables. With these needs in mind, multiple theoretical frameworks are used in generating the long-range forecasting model, and corresponding multiple criteria are employed in evaluating the model. Substantively, our research consists of seven basic steps: selecting the variables to be forecast, developing empirical measures of those variables, generating hypotheses relating the variables, collecting data on the empirical measures, testing the hypotheses and mathematically describing the relationships involving the forecast variables, postdicting the forecasting models, and performing simulation experiments on the forecasting model to produce long-range forecasts.

The five chapters that follow discuss the first six steps as they relate to each central environmental descriptor: national power base, internal instability, international trade, international alignment, and international conflict. The last chapter of this report details the simulation experimentation of the forecasting model and presents long-range forecasts of the five descriptors. All computer software used in the simulation is described in the appendix to this volume.

CHAPTER 2: NATIONAL POWER BASE

INTRODUCTION: CONCEPTUALIZATION

> Power is an explanatory concept that is applied with equal facility to physical phenomena and human affairs....In public affairs, both domestic and international, the notion is virtually unchallengeable that the success of a man or an organization depends on the possession of accumulated power greater than the amount of power held by opponents....References to power simply make sense; it is meaningful to speak about a powerful man, a powerful group, or a powerful nation.[1]

Power has long been recognized by scholars and practitioners as an important element in the analysis of international politics. Indeed, Hans Morgenthau defines international politics as a "struggle for power." Regardless of the ultimate policy objectives, "power is always the immediate aim" of statesmen acting in the name of their nations.[2] Karl Deutsch draws an analogy between power as a central concept for politics and money in a similar position with regard to economics. "Just as money is the currency of economic life, so power can be thought of as the currency of politics."[3]

The need for national power springs from the absence of alternatives

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[1] Charles A. McClelland, Theory and the International System (New York: The Macmillan Co., 1966), p. 61.

[2] Hans J. Morgenthau, Politics Among Nations (4th ed.; New York: Alfred A. Knopf, 1973), p. 25.

[3] Karl W. Deutsch, The Analysis of International Relations (Englewood Cliffs, N.J.: Prentice-Hall, Inc. 1968), p. 41.

to self-help in the international arena. In the absence of systemic changes that would eliminate the contest over values among states, power will continue to be an important concept in the analysis of international politics. Conflict is at least as important a reality of the international system as is cooperation; therefore, states are propelled to "make the preservation or improvement of their power position a principle objective of their foreign policy."[4]

The Meaning of Power

The theoretical literature that deals with the power concept can be divided into two categories; one that conceptualizes power in terms of a relationship between actors, and a second that links power to the holder. The first category, power characterized as a relationship, suggests that power "exists only as influence is achieved" and is therefore measureable only after power is exercised.[5] L.S. Shapley and Martin Shubik, James G. March, Robert Dahl, Dorwin Cartwright, and Georg Karlsson[6] have offered formal definitions that treat power as a

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[4] Nicholas J. Spykman, America's Strategy in World Politics: The United States and the Balance of Power (New York: Harcourt, Brace and World Co., 1970), p. 7.

[5] Klaus Knorr, Military Power and Potential (Lexington, Massachusetts: D.C. Heath and Company, 1970), p. 3.

[6] L.S. Shapley and Martin Shubik, "A Method for Evaluating the Distribution of Power in a Committee System," American Political Science Review, Vol. 48 (1954), pp. 787-92; James G. March, "Measurement Concepts in the Theory of Influence," Journal of Politics, Vol. 19 (1957), pp. 202-226; Robert A. Dahl, "The Concept of Power," Behavioral Science, Vol. 2 (1957), pp. 201-215; Dorwin Cartwright, "A Field Theoretical Conception of Power," in Studies in Social Power, ed. by Dorwin Cartwright (Ann Arbor, 1959), pp. 183-220; Georg Karlsson, "Some Aspects of Power in Small

relationship. In all cases, the measurement attempts hinge on the outcome of the relationship. Therefore, the measurement depends not only on the parties in the relationship, but on the issue that gives rise to the power relationship. Since we cannot forecast which specific issues will be important over the long term or the position individual nations will take on given issues, power characterized as a relationship is not a useful central environmental descriptor in this context.

The second category, power conceptualized as something possessed, will be used in the long-range environmental forecasting model. In order to distinguish this concept from the power relationship discussed above and to suggest the notion of potential for power, we will refer to it as "power base." Used in this way, power base represents an important concept for long-range forecasting in the international system in at least three ways. First, it can be used as a variable to predict other important environmental descriptors. Second, power base can define the importance of a situation. For example, when a nation ranked high on the power-base descriptor is involved in conflict, the disruption caused in the international system is usually more dangerous than the disruption caused by conflict involving a nation ranked low on this descriptor. Finally, power defined as a relationship is to a large extent a function of power base.

We define power base as the material and human resources a nation can use to influence the behavior of other nations. Therefore, we think of power base as an attribute of a nation. While we make a sharp distinction between power (the relationship) and power base (the

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Groups," in Mathematical Methods in Small Group Processes, ed. by Joan H. Criswell, Herbert Solomon, and Patrick Suppes (Stanford, 1962), pp. 193-202.

means possessed), the former depends heavily on the latter. Indeed, it is because power base contributes to a nation's ability to influence the behavior of other nations that it is a vital descriptor of the international system.

The Importance of Power Base

Most theoretical discussions of the power concept stress power base as the attribute that allows a state to exercise power. Hans Morgenthau speaks of power as a "psychological relationship between those who exercise it and those over whom it is exercised."[7] But the psychological relationship is based in large measure on the elements of power base that the nation possesses. Raymond Aron defines power as "the capacity of a political unit to impose its will upon other units."[8] He goes on to suggest that a unit's power base (Aron uses the term force) is subject to approximate evaluation, and power can be estimated by reference to the power base available to a state.

A.F.K. Organski's notion of power is "the ability of the nation's representatives to influence the behavior of other nations." However, in order to influence, a nation must possess "the qualities we think of as conferring power--wealth, resources, manpower, arms,..."[9]

We do not suggest that power is totally dependent on power base, that

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7 Morgenthau, Politics Among Nations, p. 27.

8 Raymond Aron, Peace and War (New York: Frederick A. Praeger, 1966), pp. 47-48.

9 A.F.K. Organski, World Politics (New York: Alfred A. Knopf, 1961), pp. 96-98.

is, that a single measure of power base will predict the outcome of all power relationships. Situational determinants, credibility, and relationship to goals are among the factors that condition and modify the weight of a nation's power base and thus its effect on the power relationship. Nevertheless, power base is the foundation from which power or influence is derived. And in its interaction with other environmental descriptors--international conflict, internal instability, international alignment, and international trade--power base takes on some of its situational determinants.

MEASUREMENT

For purposes of the long-range forecasting model, we view the power-base descriptor as the material and human resources available to a nation. Recognizing that resources are the essential elements of a nation's power base, we must still determine which resources most accurately reflect this concept.

We proceeded in this task on the basis of four interrelated steps. Initially we reviewed the literature dealing with national power in search of the elements that scholars consider important determinants of a nation's strength. Second, we sought indicators that would represent these elements. Third, we made a preliminary data search to be sure that data were available for the indicators chosen. Finally, we ranked nations on the basis of several different indicator composites and compared them to rankings developed by others.

Literature Review

The literature that attempts to evaluate a nation's power base is vast.

Here we will discuss only a representative few. Organski[10] examines nations that are known to be powerful by their performance in order to determine which characteristics contribute most to their power base. He includes six elements in his list: geography, resources, population, economic development, political structure, and national morale. Organski then intuitively weights the six elements and suggests interrelationships among them. From there he constructs an empirical index for power base that is based on only two of the six characteristics originally suggested--population size measured directly, and economic development indicated by GNP per capita. These two elements, multiplied together, give a nation's GNP which becomes his final indicator of a nation's power base. Of course gross national product is an important indicator of national power. However, in using GNP alone as the measure of power, too much emphasis is placed upon size and not enough on quality factors and the interrelationship of various power elements.

Morgenthau[11] identifies nine elements of national power base: geography, natural resources, industrial capacity, military preparedness, population, national character, national morale, the quality of diplomacy, and the quality of government. Morgenthau, however, stresses the importance of the interrelatedness of the elements. He argues that merely calculating the amount of an element does not necessarily indicate a nation's relative power. He notes, for example, that India has a very large population and would be ranked number two on the basis of that element alone. But in the case of India, population can in some ways be considered a source of weakness or a drain on power

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10 Organski, World Politics, pp. 116-210.

11 Morgenthau, Politics Among Nations, pp. 106-144.

base because so much of the nation's limited wealth must be allocated to feeding the population.

Knorr[12] focuses his attention on the components of military potential. He divides the elements into three broad categories: economic and technological capacity, administrative skill, and political foundations. Economic and technological capacity include population, resources, productivity, capital equipment, and the stage of economic and technological development. Administrative skill determines the efficiency with which these resources are used, and political foundations refer to the success the regime experiences in allocating resources to producing military capabilities.

Operationalization of the power-base descriptor for the Long-Range Environmental Forecasting project includes Knorr's three major categories, although we distinguish between a military and an economic dimension and we interrelate the categories differently. As the various indicators are discussed, references will be made to the factor that is assessed by that indicator. It should be stated at the outset that skill and, to a greater degree, political will are measured only indirectly.

Indicators

National power base is divided into two dimensions, economic and military. While different forms of power tend to go together,[13] that

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[12] Knorr, Military Power and Potential, pp. 24-30.

[13] Abraham Kaplan and Harold D. Lasswell, Power and Society: A Framework for Political Inquiry (Yale University Press, 1950), p. 97.

is, one form is useful in attaining another form, they are not totally dependent. For example, Japan is a major economic power although it would rank relatively low on a military power-base index. Moreover, within the framework of an integrated long-range forecasting model, it is advantageous to separate these dimensions since each interacts uniquely with other central environmental descriptors.

Economic Power Base (EPB). The economic dimension contributes to a nation's overall power base in two ways. First, it is an indication of the potential for military power in the future. Second, the economic dimension is a basis for exerting influence or exercising power in itself. This discussion will emphasize the second aspect although it should be kept in mind that the economic dimension is a major determinant of the military dimension in the future. For example, a nation's wealth is an important determinant of the resources it can allocate to military spending, and the size of its population is a factor bearing on the number of men in the military establishment.

The economic dimension of the power-base descriptor is composed of four elements: population, GNP, energy consumption, and GNP per capita.

1. Population (POP). Population is an obvious element in a nation's power base. Regardless of the technological level, a certain minimum population is required to exploit the national resources and to make the division of labor profitable.[14] Moreover, people not only

[14] Aron, Peace and War, p. 229.

produce but consume; in their consuming role, they provide a home market upon which industry can be built. Thus, the great American market for automobiles assures the auto industry the full advantages to be derived from mass production. The power advantage conferred by this great industry is obvious.[15]

A large population is also a potential market for other nations, and as such can be turned to relative advantage. As states build their industries to supply the markets of populous nations, they become dependent on those outlet nations to sustain those industries. Japan's relationship with the United States is a case in point. Having penetrated the American market with their industrial products, Japan is now vulnerable to the weapon of American economic policy.

In sum, no nation can become or remain a first-rate power without the large population necessary to establish and maintain a great industrial plant, to field large combat units, and to feed and supply the soldiers and citizenry.[16]

2. Gross National Product (GNP). While a large population is an essential element of national power base, its utility in this regard is diminished if it is producing at only a subsistence level. Furthermore, a populous nation does not constitute a large market if its people cannot consume beyond the bare necessities of life. Indeed, a population at the subsistence level is a source of weakness if increased numbers cannot be absorbed into productive work.[17]

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[15] Organski, World Politics, p. 143.

[16] Morgenthau, Politics Among Nations, p. 119.

[17] Organski, World Politics, p. 143.

Numbers of men and the average-worker productivity are somewhat interdependent due to the efficiency of the division of labor and cooperative activity; but they are not linked in direct causality. Thus, the gross national products of nations with the same size populations do vary. The greater GNP is due to the labor-productivity factor which allows a greater margin of resources above the subsistence level. The productivity of men is increased by the introduction of modern methods and machinery into all economic sectors--agriculture, industry, and service.

GNP size duplicates in part the power element derived from population size; but it also enhances or diminishes the size element by the labor-productivity factor. Thus, the labor-productivity multiplier that distinguishes economically advanced nations is accounted for by the GNP indicator.

3. Energy Consumption (EN CONS). Energy consumption is included as the third element of the economic power base in order to give specific weight to the industrial sector of a nation's economy. The control of resources adds little relative advantage to a nation without the industrial capacity to exploit the resources. Morgenthau points to the example of the Congo with its vast deposits of high-grade uranium.

> ... while this fact [deposits of uranium] has increased the value of that country as a prize of war and, therefore, its importance from the point of view of military strategy, it has not affected the power of the Congo in relation to other nations. For the Congo does not have the industrial plant to put the uranium deposits to industrial and military use.[18]

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[18] Morgenthau, Politics Among Nations, p. 112.

Furthermore, the industrial sector is more readily transformed into military strength in time of need than are the agricultural or service sectors. The industrial sector takes on major importance, especially in the event of major and prolonged mobilization of resources for military purposes, because military supplies are mostly manufactured.[19]

4. GNP Per Capita (GNP/POP). The fourth element, GNP per capita, generally reflects the quality factors of economic power base that enhance the overall operation of a nation's economy. High GNP per capita usually means abundant capital, advanced technology, high labor productivity, ample education and research, and administrative skill. And, as high GNP per capita usually indicates an advanced level of economic and technological development, it is also an index of the ability to produce and use complicated military material.[20]

Moreover, a high gross national product per capita reflects a more favorable balance among power elements. Measuring the population size factor alone neglects the fact that sufficient capital resources for development can come only from earnings over and above those needed for immediate consumption. Fast-rising populations divert national income to the task of providing basic necessities instead of being used for development projects, so essential to modernization and economic growth. Before nations can make appreciable progress toward increased economic power, they must gain a command over consumption which transcends basic food, shelter, and clothing.[21]

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[19] Knorr, Military Power and Potential, p. 68.

[20] Ibid., p. 51.

[21] W. W. Rostow, The Stages of Economic Growth (Cambridge: The University Press, 1965), p. 10.

A measure of a nation's economic power base is constructed from these four elements. The index is based on the nation's average percentage of population, GNP, and energy consumption, weighted by a quality factor GNP per capita. Population, GNP, and energy consumption are converted to percentages to insure computational standardization without sacrificing comparability across countries and over time. For each of the first three elements, we first ascertain how much of the element was present throughout the European interstate system[22] as a whole, and then the percentage share held by each member nation at the time of observation. For example, if the total population in the European system is 700 million persons, and a given nation has a population of 70 million persons, that nation's share would be 10 percent. GNP and energy-consumption shares are derived from similar calculations. The three percentage shares indicating the quantitative elements of economic power base are summed and divided by three to produce an average which is then multiplied by the qualitative factor GNP per capita. This yields the index of economic power base.

$$EPB = \frac{\% \, POP + \% \, GNP + \% \, EN \, CONS}{3} \cdot \frac{GNP}{POP}$$

Rankings on the economic power-base dimension for 1970, calculated in the manner described above, are shown in Table 1.

<u>Military Power Base (MPB)</u>. The military dimension represents a nation's realized military power, that is, its resources and skills available at a given time to be used in military conflict. It is indicated

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22 The European interstate system is defined as the 26 nations considered in the Long-Range Environmental Forecasting project.

TABLE 1

ECONOMIC POWER-BASE RANKINGS
1970

Quintile[a]	Country	Index Scores	Log Index
I	Soviet Union	972.7	6.88
	West Germany	317.7	5.76
II	France	218.6	5.39
	United Kingdom	183.0	5.21
	Italy	104.0	4.64
	East Germany	72.6	4.28
	Czechoslovakia	68.8	4.23
	Sweden	65.3	4.18
	Poland	64.8	4.17
III	Netherlands	47.6	3.86
	BLEU[b]	44.9	3.80
	Switzerland	31.0	3.43
	Romania	30.6	3.42
	Denmark	27.6	3.32
	Spain	26.4	3.27
	Norway	22.9	3.13
	Hungary	22.1	3.10
	Yugoslavia	21.4	3.06
	Austria	17.8	2.88
IV	Bulgaria	15.5	2.74
	Finland	14.0	2.64
	Greece	7.8	2.05
	Turkey	5.0	1.61
	Ireland	4.4	1.48
	Portugal	4.1	1.41
V	Iceland	.7	.36

[a] Quintiles have been created by determining the five equal-interval groups, where the interval is calculated based on the logarithm of the index.

[b] Belgium/Luxembourg. Hereafter BLEU.

by the size of the armed forces, amount of military expenditures, and military expenditures per person in the armed forces.

1. Military Manpower (MIL MANPOW). Military manpower is an obvious element of a military power-base index.

> On the battlefield, number has almost always been an important factor. In particular, within a zone of civilization, when neither arms nor organization were essentially different, it tended to force the decision.[23]

Furthermore, even modern armies equipped with technologically advanced weapons configurations still require vast pools of manpower. Guided missiles, jet aircraft, and atomic artillery all need men to operate, service, transport, and repair them.[24] In short, until the day of "pushbutton" warfare, military manpower will continue to be a required element of military power base. And, ceteris paribus, numbers of men will decide the outcome of combat.

2. Defense Expenditures (DEFEX). Just as manpower is an essential element in establishing and maintaining military power, so too are the funds necessary to feed, clothe, and equip them. Moreover, the "industrialization" of warfare, the critical importance of industrially produced weapons in the fighting ability of modern armies, has received increasing recognition since World War I.[25] These high-technology weapons have substantial cost, and nations seeking a strong military power base must allocate a share of their wealth to defense expenditures if they are to achieve this goal.

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[23] Aron, Peace and War, p. 213.

[24] Organski, World Politics, p. 141.

[25] Knorr, Military Power and Potential, p. 22.

The size of the military establishment (number of people in the armed forces) and the money devoted to its maintenance are both related to a nation's population and wealth. Usually, the greater the population, the greater the number of people under arms. Similarly, the greater the total wealth available, the more that is spent on the military in absolute terms. The correlation between population and armed forces for Europe in 1967 was .98, while the correlation between GNP and military expenditures for the same year was .96.

Less obvious, but nevertheless implicit in the size of armed forces and amount of military expenditures (expressed as relative percentages of population and GNP), is the political will to allocate resources to the military dimension.[26] Japan is a case in point. Both men and money are available to establish a considerable military force in Japan, but the political will to allocate the necessary resources is not now present. This is evident from the average of less than .9 percent of its GNP that Japan has allocated to military expenditures in the period 1961-1970, as compared to a 4.6 percent average for NATO members during the same period.[27] In this sense, then, political will is assessed, though not directly measured, by the manpower and expenditures allocated to the military establishment relative to population and gross national product.

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[26] David Easton distinguishes political interactions from other social interactions by suggesting that they "are predominantly oriented toward the authoritative allocations of values for a society." David Easton, A Framework for Political Analysis (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965), p. 50.

[27] These figures are taken from World Military Expenditures 1971, published by the United States Arms Control and Disarmament Agency (Washington, D.C., 1972).

3. Defense Expenditures Per Person in the Armed Forces $\left(\frac{\text{DEFEX}}{\text{MIL MANPOW}}\right)$.

The third component of a nation's military power base is the expenditures per man in the armed forces. Number of men and amount of expenditures are best associated with the quantitative aspects of the military dimension, while expenditures per man represent the qualitative aspects. Higher expenditures per man are the result of higher living standards, greater allocation to military research and development, more money spent on acquiring weapons and equipment, and greater amounts allocated to training. These qualitative aspects contribute to greater firepower and skill in the use of men and materials, thereby increasing the military dimension of power.

The military power-base index is computed by transforming military manpower and defense expenditures into percentage shares, as was done with population, GNP, and energy consumption in the economic power-base calculation. The two percentages obtained here are averaged and then multiplied by the qualitative factor, defense expenditures per man in the armed forces.

$$\text{MPB} = \frac{\text{\% DEFEX} + \text{\% MIL MANPOW}}{2} \cdot \frac{\text{DEFEX}}{\text{MIL MANPOW}}$$

Table 2 indicates the rankings of European nations in 1970 on the military power-base dimension derived from the calculation described above.

There are, perhaps, several questions that stem from the algebra used in our computation. For example, increasing only the number of men in the armed forces decreases a nation's military power base. While this may at first appear to be counterintuitive, further analysis reveals

TABLE 2

MILITARY POWER-BASE RANKINGS
1970

Quintile[a]	Country	Index Scores	Log Index
I	Soviet Union	9415.0	9.15
II	United Kingdom	755.8	6.63
	West Germany	727.0	6.59
	France	678.1	6.52
III	East Germany	239.9	5.48
	Italy	214.8	5.37
	Poland	212.6	5.36
	Czechoslovakia	159.5	5.07
	Sweden	138.6	4.93
	Netherlands	110.2	4.70
	Spain	89.5	4.49
	BLEU	64.9	4.17
	Switzerland	54.4	4.00
	Yugoslavia	46.3	3.84
	Hungary	42.9	3.76
	Romania	42.5	3.75
	Norway	39.7	3.68
IV	Denmark	35.4	3.57
	Greece	33.8	3.52
	Portugal	29.7	3.39
	Turkey	25.5	3.24
	Bulgaria	20.4	3.02
	Austria	12.0	2.48
	Finland	10.2	2.32
V	Ireland	2.7	.99
	Iceland	0.0	

[a] Quintiles have been created by determining the five equal-interval groups, where the interval is calculated based on the logarithm of the index.

that this is a reasonable expectation. When the number of men under arms is increased without a concomitant increase in defense expenditures, a number of effects are produced that diminish, sometimes dramatically, the nation's military power. Unless the new men can be forced to fight without food, equipment, training, leadership, and so forth, money being used to support the troops already in place will have to be reallocated in part to the increased manpower. As an overall result, the nation's armed forces will be less well-fed, equipped, trained, and led.

On the other hand, increases in defense expenditures, while manpower levels remain constant, produce a significant increase in military power base. Again we find this reasonable in that it reflects the qualitative aspects of military power. The effects of increased defense expenditures can be seen in the advanced technology applied to weapons systems, most notably in modern air power and in nuclear armaments and associated delivery systems. For example, if one were to calculate the relative strengths of the Arab nations vis-a-vis Israel in 1967 based solely on gross money and men, the Israeli victory would have been a rather shocking surprise. However, if one includes the qualitative aspect of this measure, Israeli superiority is clearly reflected. It is just these quality aspects of men and equipment that are of overriding importance in this technological age.

Propensity for Nuclear Weapons (PNW). Nuclear weapons constitute the most powerful means of destruction ever to come under the control of men. Five nations now include nuclear armaments in their military configurations: the United States, the Soviet Union, Great Britain, France, and China. The first three are capable of launching these weapons against any country in the world.

Of equal importance is the fact that an increasing number of nations are becoming financially and technologically capable of building these weapons. Therefore, any forecast of the international environment over the long run must consider the effects of nuclear proliferation.

Although many of the scientific secrets of nuclear explosions have been published by governments, the technology remains extremely advanced. A nation embarking on the construction of nuclear weapons must recognize that such a plan involves building a major modern industry, and makes severe demands on the budget, technicians, and scientific manpower.[28] To some extent these demands are ameliorated by the steady growth of peaceful applications of nuclear power that help recruit skilled men needed to staff a military program. Moreover, because of the similarity of many peaceful and military developments in nuclear-technology outputs from research, peaceful uses of nuclear power often contribute to military nuclear applications.[29]

In contrast to the reduced difficulty of manufacturing nuclear explosives, the provision for a means of delivery requires a continuing commitment to a program of technological development. "For even the most modest of nuclear powers must match its delivery system against those of potential enemies, and these systems are bound to increase in complexity with the years."[30] We refer here not only to the

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[28] Leonard Beaton, "Capabilities of Non-Nuclear Powers," in A World of Nuclear Powers?, ed. by Alastair Buchan (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1966), p. 13.

[29] Leonard Beaton and John Maddox, The Spread of Nuclear Weapons (New York: Frederick A. Praeger Co., 1962), p. 186.

[30] Ibid., p. 4.

launching of a weapon, but more importantly to the requirement of protection so that the nuclear force maintains its effectiveness as a deterrent.

Leonard Beaton has calculated roughly the costs of producing a modest nuclear force including its own delivery system.[31] The force envisioned in these calculations is substantially inferior to those developed by the British and French. However, it at least presents the prospect of leading to a higher level of sophistication. He concludes that a country embarking on this type of program must spend at least $2.3 billion over a 10-year period.

Therefore, it is clear that only the very large or the very developed nations endowed with substantial economic, technological, and manpower resources have the option to embark on a nuclear weapons program. Among those nations so endowed, the decision is a matter of political will. While the incentives to exercise the nuclear option may vary among nations, the major motivation for such a decision is security needs. A nation that feels threatened is likely to seek nuclear weapons unless it feels confident that its major-power ally will provide protection.

The hazards of predicting so momentous a decisionas the acquisition of a military nuclear capability are formidable. Nevertheless, the planner must in some way account for the effect of such weapons. The long-range environmental forecasting model, then, will provide the analyst with a nuclear option by forecasting the propensity of nations to develop nuclear weapons. The forecasts will be based on three other

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[31] Beaton, "Capabilities of Non-Nuclear Powers," pp. 32-33.

central environmental descriptors. The probability that nations will decide to develop military nuclear power is determined by the level of economic and technological capability (economic power base), the level of conflict, and the degree of alignment with a major power. We hypothesize that the probability of developing nuclear weapons will vary directly with economic power base and conflict experience and will vary inversely with degree of alignment with a major power.

The propensity of nations to acquire nuclear capability will be expressed as a probability calculated as follows:

$$(PNW) = (EPB/17.8)^{1.25} \cdot \frac{CONFLICT/(3\text{-}CONFLICT)}{(ALIGNMENT + 1) \cdot 50}$$

The three variables--economic power base, conflict, and alignment--are manipulated to satisfy two criteria. First, does the nation have the economic capacity required to produce nuclear weapons?[32] Second, are the resulting propensities reasonable?

The nuclear index will be constructed by simply multiplying the initial military power-base index by one plus the probability score as determined above. Those nations that have already developed nuclear weapons (in the European system--Soviet Union, Great Britain, and France) are assigned a 100 percent probability. Therefore their military power base is doubled (1 + 1.00 probability = 2).

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[32] 17.8 on the economic power-base index includes all the European nations considered by the Atomic Energy Commission in 1968 to have industrial economies able to support a nuclear weapons program. United States Senate Committee on Foreign Relations, Hearings on the Nonproliferation Treaty, 90th Congress, Second Session (Washington, D.C.: U.S. Government Printing Office, 1968), pp. 30-31.

The nuclear index can be substituted for the military power-base index where the analyst deems it appropriate. Moreover, the analyst can substitute different propensities to develop nuclear weapons derived from expert judgments. In this way, changing conditions can be factored into the model and alternate futures can be forecast.

PREDICTORS OF POWER BASE

This section of the chapter describes the relationships which we believe are important in determining future values of national power base. These relationships are taken primarily from scholarly studies of national power in international relations. Since the forecasting model will be expressed as a set of equations, we need to state the relationships verbally in such a way as to facilitate translation into symbolic terms.

These hypothesized relationships relate specifically to the European interstate system. However, the model has been made as general as possible in order to facilitate its use for other areas of the world.

There are two broad categories of relationships that affect national power base: effects resulting from other environmental descriptors in the forecasting model and effects resulting from external variables. They will be discussed as they relate to the components of each of the power-base dimensions.

Economic Power-Base Dimensions

Three of the four components of the economic power-base dimension--population, GNP, and energy consumption--will be forecast. The fourth component, GNP per capita, is derived from the first two.

Population. Population size is a highly autocorrelated time series; that is, population size at time t predicts population at time t+1. Population is forecast by applying past experienced growth rates to previous population size, resulting in an exponential growth curve.[33] However, population growth rates do not remain static but change over time and are different from place to place. For example, the population growth rate for the developing world is more than twice that of the developed world: 2.4 percent per annum vs. 1.1 percent per annum.[34]

There are, perhaps, a complex set of factors that account for this difference. Although we cannot go into demographic theory here, we do suggest that the population growth of wealthier nations seems to be less than that of poorer nations. Therefore, using GNP per capita as an indicator of wealth, we expect that population growth will vary inversely with this indicator. In the European context this relationship is not expected to be as strong as it would be if many of the less developed countries were included in this study. Nevertheless, GNP per capita should be a significant predictor of population growth.

Gross National Product. Gross national product will be forecast on the basis of previous values of GNP and the rate of GNP growth. GNP at time t-1 is exogenous in that it is already determined at time t. GNP growth, however, is probably affected by additional factors. For example, domestic instability may well cause significant disruption

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33 For an in-depth discussion of the nature and implications of population growth curves, see Jay W. Forrester, World Dynamics (Cambridge, Mass.: Wright-Allen Press, Inc., 1971), pp. 19-23.

34 World Military Expenditures, p. 30.

in a nation's economic system. Investment, both from internal and external sources, is likely to decrease because high levels of revolt and turmoil lead to the expectation of severe losses for investors. The labor force size may be affected as potentially productive workers demonstrate or join in general revolt. Moreover, those workers who remain at their jobs may be subject to harassment and threat. Therefore, we expect that production will decrease as a result of high levels of domestic instability and we hypothesize that GNP will vary inversely with domestic instability.

We believe that the level of military expenditures, too, will have an effect on economic growth. However, it is not clear what the direction of this effect will be. World War II served as an impetus to bring much of America's idle capacity into use, though we must remember that the United States entered the war while still very much in the throes of a depression. A second factor involves the source of increased military spending. Russett[35] suggests that when increases in military spending come at the expense of investment (fixed capital formation) the result will be a smaller productive capacity in future years than if the increases come at the expense of current public consumption. Therefore, it appears that economic growth will be affected by levels of military spending, but the direction of its effect must be empirically determined.

Energy Consumption. Future levels of energy consumption will be exogenously determined via an exponential function.[36] As we previously

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35 Bruce M. Russett, What Price Vigilance? (New Haven: Yale University Press, 1970), pp. 127-156.

36 See Dennis L. Meadows and Donella H. Meadows, eds., Toward Global Equilibrium: Collected Papers (Cambridge, Mass.: Wright-Allen Press, Inc., 1973), p. 293.

noted, energy consumption is an indicator of level of industrialization and in this sense describes the structure of an economy rather than its size. Since an economy's structure usually does not fluctuate greatly within 20-year periods, the impact of the other central environmental descriptors upon energy consumption should be minimal. Therefore, energy consumption will be forecast as an autocorrelated time series, that is, energy consumption at time t-1 predicts energy consumption at time t.

Military Power-Base Dimension

We have defined military power base as the nation's realized military power. The two quantitative indicators of military power base, defense expenditures and military manpower, will be forecast in the long-range environmental forecasting model. The qualitative indicator, defense expenditures per man, is derived from the quantitative indicators.

Defense Expenditures. Defense expenditures are likely to fluctuate somewhat more than the economic power-base indicators because they are more sensitive to policy manipulation. Nonetheless, expenditures on the military establishment rarely vary in the extreme. For the most part, sharp reductions in defense expenditures are associated with demobilization after major conflict. In the absence of sharp fluctuations in the levels of experienced conflict, defense expenditures in any given year should be strongly associated with the level of expenditures in the previous year.

We expect the absolute value of these expenditures to increase if only because of inflationary pressures. However, the proportion of gross national product allocated to military expenditures is likely to fluctuate, depending on other influences.

We noted that although defense expenditures in absolute dollar value are rising, the proportionate share of gross national product devoted to defense may not be increasing. Generally, as GNP rises we expect a smaller portion of it to be allocated to defense. In short, we hypothesize that GNP will grow faster than defense expenditures.

While this is a general statement about the effects of GNP on defense expenditures, there may be an opposite effect for nations aligned with major powers. We hypothesize that the smaller a nation's GNP and the greater its alignment with major powers, the smaller the proportion of GNP it will allocate to the defense establishment. Generally, the defense effort of a state with a small GNP "will vary inversely with its confidence in the big power's guarantee [closeness of alignment] and the disparity in size between the two."[37] This hypothesis is based on the theory of public or collective goods first suggested by Paul Samuelson,[38] a theory that has more recently been applied to alliances[39] by Mancur Olson and Richard Zeckhauser and by Bruce Russett.[40]

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37 Russett, What Price Vigilance?, p. 93.

38 Paul A. Samuelson, "The Pure Theory of Public Expenditure," Review of Economics and Statistics, 36 (1954).

39 In the Long-Range Forecasting project, international alignment with a major power has properties similar to alliances with regard to the theory of public or collective goods.

40 Mancur Olson and Richard Zeckhauser, "An Economic Theory of Alliances," in Economic Theories of International Politics, ed. by Bruce M. Russett (Chicago: Markham Publ. Co., 1968), and Russett, What Price Vigilance?.

The notion of public or collective goods assumes that a voluntary organization, in this case an alliance, serves the common interest of all members. For example, the proclaimed purpose of NATO is to protect its member nations from aggression by a common enemy. From this assumption we define a public or collective good by two properties: 1) all who share the common goal automatically benefit when the goal is achieved, that is, "non-purchasers cannot feasibly be kept from consuming the good,"[41] and 2) when the good is available to one member it is available to all others in the group without decreasing the amount available to any other nation.[42]

Olson and Zeckhauser[43] hypothesized that the larger a nation (measured by the size of its GNP), the more the nation will value the alliance. Therefore, they anticipated a significant positive relationship between the GNP of a nation and the percentage of GNP that the nation spends on defense. Using NATO data for 1961 they found this to be the case. This result is supported by the findings of Ypersele[44] using data for 1955 and 1963, and by Pryor[45] using data for 1956 and 1962. Russett[46] further substantiated the theory for NATO using data for the period 1950-1967. For the Warsaw Treaty Organization he found that

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41 Russett, What Price Vigilance?, p. 94.

42 Ibid., and Olson and Zeckhauser, "An Economic Theory," pp. 26, 27.

43 Ibid., p. 39.

44 Jacques M. Von Ypersele de Strihou, "Sharing the Defense Burden Among Western Allies," Yale Economic Essays, 8 (Spring 1968), pp. 261-320.

45 Frederic L. Pryor, Public Expenditures in Communist and Capitalist Nations (Homewood, Illinois: Richard D. Irwin, Inc., 1969).

46 Russett, What Price Vigilance?, pp. 102-107 and pp. 112-116.

the predicted positive relationship between GNP size and defense share began in the mid 1960's, when, as he suggests, the Warsaw Pact became a voluntary association at least in terms of defense contributions. Based on the theory of collective goods we hypothesize that the percentage of GNP spent on defense will vary with the size of GNP and the degree of major-power alignment.

In addition to public goods, we believe that the notion of private goods in the defense area has an impact on levels of defense spending. Private goods refer to those defense allocations made either as a result of threats outside the situations covered by alliances or when the perception of threat is greater than that within the alliance. We hypothesize that the use of resources for military needs will be affected by the levels of conflict experienced in the past. Specifically, the percentage of gross national product devoted to military spending will vary with conflict.

A further effect, however, is produced by the closeness of alignment with a major power. The more aligned a nation is with a major power, the more confidence it will have in the protective umbrella provided by the major power. Therefore, the share of resources devoted to the defense establishment is likely to vary inversely with the closeness of major-power alignment.

Earlier we noted that major-power alignment would have a positive effect on defense spending. In the present hypothesis, DEFEX/GNP varies with conflict and inversely with major-power alignment. The apparent contradiction can be explained with reference to the previous discussion of the theory of public goods. Simply stated, while major-power alignment does decrease proportionate defense expenditures, the decrease is not as great when GNP is large.

One additional factor is expected to influence the proportion of resources devoted to the military establishment. As the experienced levels of domestic instability increase, we expect a government to allocate more resources to suppress them. Of the two indicators of domestic instability, revolt and turmoil, the former is likely to have the greater influence on defense spending since its objective is "to replace governmental policymakers or alter the structure of the policymaking process itself," rather than simply "alter governmental policies or practices."[47] Clearly, revolts present more formidable challenges to a regime, and the consequent responses are hypothesized to be greater.

The levels of revolt in Europe during the 1960's, however, were not high; thus the expected relationship may be minimized. Therefore, in the estimation phase of the study we will examine the effects of both dimensions of domestic instability, separately and in combination.

Military Manpower. Military manpower levels, like defense spending, are more volatile than economic indicators because they are more easily manipulated. But, like defense expenditures, current manpower levels are significantly correlated with past manpower levels. Here again, major demobilization is associated with past major conflict, when nations long for the "return to normalcy." Europe, in the decade of the sixties, did not experience major war. Rather, it was a period of tension in Europe resulting from opposing, but relatively balanced,

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[47] See Herman Weil, "Internal Instability," Chapter 3, this volume.

power blocs. As tension, based on threat perception, declined, manpower levels also showed a tendency to decline gradually. Similar conditions are expected to exist during the forecast period. Thus we expect a strong relationship to appear between past and current manpower levels.

In addition, several other factors are likely to affect the number of men in the armed forces. As GNP increases, more resources are available; and although the percentage of these resources allocated to defense may decline, the absolute amount will increase. We expect that as more resources are available, materials will be substituted for manpower in the defense establishment. Essentially, this means that greater firepower will replace men in the armed forces. Consequently, we hypothesize that the number of men in the armed forces will vary inversely with gross national product.

Other factors are expected to be positively associated with military manpower levels. First, conflict is likely to result in increases in the number of men in the armed forces. This relationship is obvious because even in the day of technological warfare, more men are needed to operate the increased arsenal of weapons that are required when nations are at war.

Beyond the effects of conflict, population, too, is likely to have a positive influence on manpower. Just as growing wealth allows greater expenditures on defense, a larger population allows more men to be available for the armed services. This is especially true of nations aligned with the two superpowers. The two major powers, the United States and the Soviet Union, seek to provide the high-technology nuclear-weapons systems, while expecting their respective allies to supply military manpower. Therefore, we hypothesize that military manpower levels will vary with population and major-power alignment.

One last factor is expected to affect manpower levels. As in the case of defense expenditures, it is reasonable to assume that regimes will respond with more manpower in order to sustain themselves against revolt and turmoil. Again, revolt should beget the greater response because of its greater danger, although we will also examine the effects of turmoil and the effects of the two instability indicators in combination. Initially, our hypothesis is that manpower will vary positively with levels of revolt.

In this section we have described the relationships that we believe affect the indicators of national power base. In the next section we will translate these hypotheses into symbolic form and present formal power-base models. We will then test the various hypotheses discussed above.

STRUCTURE OF THE POWER-BASE MODEL

Eight variables, including three other central environmental descriptors, have tentatively been selected to forecast power-base rankings for the European interstate system. Hypothesized relationships have been organized into the linkages among the eight variables and the two dimensions of the power-base descriptors. Each predictor variable will be subject to examination to determine the direction and magnitude of its effect on the power-base measure. Parameter estimates generated from the equations will be used to forecast the power-base index of the European nations for the period of the 1980's.

Power-Base Equations

There are five equations that comprise the power-base model, one for each of the five indicators. Each equation includes the relationships discussed in the previous section which are set forth here in symbolic terms:

$$Y_1 = \beta_{10} + \beta_{11} Y_{1_{t-1}} + \beta_{16} Y_{6_{t-1}} + \beta_{14} Y_{4_{t-1}} + \varepsilon_1$$

$$Y_2 = \beta_{20} + \beta_{22} Y_{2_{t-1}} - \beta_{21} \frac{Y_1}{Y_2} + \varepsilon_2$$

$$Y_3 = \beta_{30} + \beta_{33} Y_{3_{t-1}} + \varepsilon_3$$

$$\frac{Y_4}{Y_1} = \beta_{40} + \beta_{44} \frac{Y_{4_{t-1}}}{Y_{1_{t-1}}} + \beta_{48}(Y_1 * Y_8) + \beta_{47} \frac{Y_{7_{t-1}}}{Y_8} + \beta_{46} Y_6 + \beta_{41} Y_1 + \varepsilon_4$$

$$Y_5 = \beta_{50} + \beta_{55} Y_{5_{t-1}} + \beta_{51} Y_1 + \beta_{57} Y_{7_{t-1}} + \beta_{52} (Y_2 * Y_8) + \beta_{56} Y_{6_{t-1}} + \varepsilon_5$$

where:

Y_1 = Gross national product (GNP)

Y_2 = Population (POP)

Y_3 = Energy consumption (EN CONS)

Y_4 = Defense expenditures (DEFEX)

Y_5 = Military manpower (MIL MANPOW)

Y_6 = Turmoil (TURMOIL)

Y_7 = International conflict (CONFLICT)

Y_8 = International alignment (extent of major-power alignment, ALIGNR)

Hypotheses Tests

Estimates for each of the five indicators that comprise the two dimensions of the national power-base descriptor were determined via classical least squares regression techniques. Each dependent variable (indicator) was regressed on the independent variables (predictors) hypothesized to be significant.

Economic Power-Base Dimension

Four indicators comprise the national economic power-base dimension: population, gross national product, energy consumption, and GNP per capita. The results of the estimation for the first three indicators will be discussed in turn. The fourth, GNP per capita, is derived from the first two.

Population. We hypothesized that population is a highly autocorrelated time series. This simply means that a country's population size in one year is a very good predictor of its population size in the following year. This, of course, is borne out by the correlation between population at time t and population at t-1 of 0.9999.

When we regress $population_t$ on $population_{t-1}$ we get a regression coefficient of 1.0093 which essentially means that, barring unforeseen changes within the European nations, their population, on the average, will increase exponentially at approximately 1 percent per year. We noted earlier, however, that world population growth rates are substantially higher, more than twice the 1 percent we attribute to Europe. Visual inspection of world population data shows that the less developed countries account for the higher rates of growth. Consequently, we hypothesized that population growth rates are inversely related to levels of economic development, indicated by GNP per capita. The regression, shown in Table 3, indicates that GNP per capita does have an effect in the expected direction (negative), that is, the higher

TABLE 3

FORECASTING EQUATION FOR POPULATION

Variable	Partial R	Coefficient	t-Statistic
Constant		.038376	.42
POP_{t-1}	.9999	1.012500	1147.30
GNP/POP_{t-1}	-.0736	-.000058	1.18

the GNP per capita, the less population will grow from year to year. However, the partial of .07 indicates that only about .5 percent of the variance in population is explained by GNP per capita when the effects of lagged population are controlled.

Further reflection on the effects that wealth may have on population growth suggested the hypothesis that the relationship is nonlinear.

That is, while we may expect GNP per capita to reduce the rate of population growth, eventually a limit is reached when further increases in wealth no longer affect growth rates, or have only a decreasing impact on those rates. We used a logarithmic model to test this hypothesis. Essentially, using a logarithmic transformation disproportionately reduces large scores (lessens their effect) so that they can be meaningfully interpreted in a linear model. Table 4 displays the revised model.

TABLE 4

FORECASTING EQUATION FOR POPULATION
(with logarithmic transformation)

Variable	Partial R	Coefficient	t-Statistic
Constant		.6900	
POP_{t-1}	.9999	1.0125	1149.20
$GNP/POP_{t-1}LOG$	-.1027	-.2377	1.66

$R^2 = .9998$ $F = 661,940$

The transformed variable shows a negative partial indicating that its effect is in the expected direction. The explained variance, a little more than 1 percent, is twice that of the untransformed variable and the t-statistic is improved to 1.66. Admittedly, the increase in explanation is modest. The most probable explanation for the increment is that the European nations generally are developed, and the linear relationship is stronger in regions with a greater number of developing countries. Nevertheless, the results are at least suggestive, and we include the transformed wealth factor in the population model to increase its applicability to other parts of the world.

Gross National Product. Like population, most of the variance in gross national product is accounted for by GNP in the previous period. The simple correlation between GNP_t and GNP_{t-1} is .9995. The partial R (.995) for GNP_{t-1} in the regression model indicates that 98.9 percent of the variance in GNP_t is explained by the GNP level in the previous period, once the effects of the other independent variables are controlled (see Table 5). The regression coefficient of 1.054 indicates that GNP will grow at approximately 5 percent per year, again controlling for the effects of other independent variables. These other influences, however, may account for variance in GNP growth.

TABLE 5

FORECASTING EQUATION FOR GNP
(with DEFEX)

Variable	Partial R	Coefficient	t-Statistic
Constant		240.840	.994
GNP_{t-1}	.995	1.054	145.890
DEFEX	.287	.302	4.543
$TURMOIL_{t-1}$	-.274	-1512.400	4.316

R^2 = .999 F = 97,609

Earlier we suggested that defense spending affects economic growth. We noted that the increased military spending caused by World War II contributed to the rapid recovery of the American economy. On the other hand, we suggested that military spending at the expense of fixed capital formation might result in smaller productive capacity in future years. Given the limited data at our disposal, we were unable to examine the long-lagged effects of military expenditures. However, we were able to investigate the short-term effects of defense spending on gross national product. Defense spending explains approximately 8 percent of the variance in GNP. The partial is positive indicating that in the short run, increased defense expenditures will increase GNP. This appears reasonable since increased defense spending may bring idle productive capacity into use or increase the productivity of current capacity.

Domestic instability, too, was hypothesized to affect GNP. It seems reasonable to conclude that high levels of instability bring about economic disruption because of the inhibiting effect such instability has on both internal and external investment sources. Moreover, we suggested that worker productivity decreases as a result of harassment and perhaps sabotage of equipment. We examined this relationship by regressing GNP on domestic instability (a composite of TURMOIL and REVOLT) while controlling for the effects of GNP lagged. The effects are statistically significant ($p < .0001$) and the partial R, -.28812, is in the expected direction, explaining more than 8 percent of the variance in GNP.

We then examined revolt and turmoil separately. Conceptually, it seemed unlikely that the European nations we are dealing with would be subject to the levels of revolt that could cause substantial economic disruption. Revolt of this nature usually involves large segments of the population and continues over relatively long time periods. In Europe during the 1960's, revolt generally consisted of sporadic episodes involving individuals or small groups.

In order to investigate this expected relationship, GNP was regressed on the two dimensions of instability separately. The results show (Table 6) that in Europe during the 1960's, turmoil accounted for most of the negative effect on GNP that was originally attributed to the combined descriptor, domestic instability. The partial R for turmoil is -.281 while the partial R for revolt is -.015.

TABLE 6

FORECASTING EQUATION FOR GNP
(with REVOLT)

Variable	Partial R	Coefficient	t-Statistic
Constant		-162.780	-.74
GNP_{t-1}	.999	1.083	530.98
TURMOIL	-.281	-1778.200	4.68
REVOLT	-.015	-95.910	.24

$R^2 = .999$ F = 98,958

In summary, we found that in the European context under study, revolt has a negligible effect on economic growth, unlike demonstrations and riots which do affect the economic health of European nations.

Furthermore, it is reasonable to assume that turmoil, so defined, will continue to exert an influence on the economic growth of European nations. Although it may not be clear what level of turmoil must be reached before investment sources dry up, there is a direct connection between demonstrations and riots on the one hand, and manhours of production on the other. People, when demonstrating and rioting, are not working.

The relationship between conflict and GNP is also conceptually interesting. Certainly it is reasonable to expect that destruction of plants and equipment, which is usually a consequence of military engagements, will decrease GNP. However, in the European context of the 1960's, the long-range environmental forecasting conflict descriptor is essentially measuring verbal conflict. Border incidents involving shooting were relatively rare. Moreover, even in the case when the Soviet Union invaded Czechoslovakia, the resulting economic disruption was minor compared to the destruction of a major war.

The one effect of conflict that is considered important in the forecasting model for Europe is a mediated one. That is, intense verbal conflict influences defense posture. As saber-rattling increases, there is a tendency to build up military capability. The relationship between conflict and GNP, then, is mediated through defense expenditures. Conflict is a predictor of military spending; the greater the past conflict level, the greater the military spending. The latter in turn is a predictor of GNP. Consequently, intense verbal conflict is likely to increase GNP as a result of more government defense spending, at least in the short term.

Energy Consumption. Energy consumption, like the other two indicators of the economic power-base dimension, is a highly autocorrelated time series. Lagged energy consumption explains more than 99.9 percent of the variance in energy consumption. As we noted earlier, energy consumption is an indicator of industrialization in an economy.

Because this is a structural characteristic, it seems appropriate to use past energy-consumption levels alone as a predictor of current energy consumption. Political disruption of an economy is likely to have more immediate effects on gross national product. (See Table 7.)

TABLE 7

FORECASTING EQUATION FOR ENERGY CONSUMPTION

Variable	Partial R	Coefficient	t-Statistic
Constant		-.05397	-.178
EN CONS	.99968	1.05340	633.330

$R^2 = .999$ F = 40.111 + 6

Military Power-Base Dimension

The military power-base dimension is composed of two indicators, defense expenditures and military manpower, which are discussed in turn below.

Defense Expenditures. World military expenditures increased substantially during the decade of the sixties. In absolute dollar value, the average yearly increase in defense expenditures in the period 1961-1970 was 3.2 percent. Concurrently, the world GNP growth averaged 4.8 percent per year.[48] Nations, then, allocate a smaller

[48] World Military Expenditures, p. 2.

proportion of their wealth to defense spending today than they did in 1961. In other words, while government military spending is increasing in absolute terms, it is declining as a percentage of GNP. This statement holds when worldwide totals are considered. However, a distinction should be made between developed and developing nations. The defense burden of the developed nations, as represented by the fraction of GNP spent on defense, has decreased during the period of observation; but for the developing world, defense has become an increasing burden.

The majority of the European nations considered in this forecasting model are part of the developed world. In general, their defense burden is declining, perhaps reflecting a mutually decreasing fear among opposing bloc members of the threat of forceful change in Europe. Moreover, many European leaders have concluded that any war in Europe will result in unacceptable levels of destruction; therefore the best guarantee against war is to rely on unambiguous nuclear deterrence between the superpowers.

Our data for Europe indicate that defense spending, in absolute terms, increased during the sixties by approximately 6 percent per year. Part of the increase is due to inflation. In the same period (including the effects of inflation) GNP increased at an average annual rate of 8.4 percent.[49] Consistent with the experience of more developed nations, the European defense burden declined. While a continued gradual decline is understandable, drastic changes in the future are unlikely. Therefore, the best predictor of the defense burden, defined as defense expenditures divided by GNP (Table 8), is the previous period's

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[49] Ibid., pp., 18, 22.

TABLE 8

FORECASTING EQUATION FOR
DEFENSE EXPENDITURES DIVIDED BY GNP

Variable	Partial R	Coefficient	t-Statistic
Constant		.00084	1.5006
$\frac{DEFEX}{GNP}_{t-1}$	.969	.97300	55.6650
GNP	-.206	$-.355 \times 10^{-7}$	2.9964
GNP·ALIGNR	.189	$.338 \times 10^{-7}$	2.7349
$\frac{CONLOG_{t-1}}{ALIGNR}$	.266	.00074	3.9212
TURMOIL	.130	.00098	1.8640

$R^2 = .97329$ $F = 1472.2$

defense burden. The partial of .969 indicates that the previous period's defense burden explains almost 94 percent of the current defense burden.

As we noted earlier, the GNP of developed nations is growing at a faster rate than their military spending while the opposite is true of developing nations. This suggests that as wealth increases, a smaller share of that wealth is allocated to defense. Conceptually, this means that once "adequate" levels of defense relative to size are reached, those levels are maintained with only minor deviation unless some other factor intervenes. We examined this hypothesis empirically above.

The negative coefficient of GNP indicates that rising GNP is associated with a decreasing defense burden.

While the defense burden varies inversely with GNP, the effect is reversed for highly aligned nations. We hypothesized that the smaller a nation's GNP and the more closely aligned it is with a major power, the less a defense burden it will assume. We based this hypothesis on the work of Olson and Zeckhauser and Russett,[50] who applied the theory of public goods to alliances. Briefly stated, the theory of public or collective goods assumes that an alliance serves the common interest of all members. All who share the common goal including those who do not contribute, benefit when the goal is achieved. Moreover, when the good (in this case defense) is available to one member, it is available to all the others in the group without decreasing the amount available to any one member.

Therefore, we would expect the larger nations in an alliance to carry a relatively larger share of the defense burden than the small ones. That is, defense as a proportion of GNP should vary with GNP multiplied by closeness of alignment. The regression model supports this expectation. The independent variable (GNP·ALIGNR) shows a positive partial R of .189, explaining more than 3.5 percent of the variance in defense spending when the effects of the other variables are controlled. In sum, our research provides additional evidence in support of the prior work done in this area.

Nations spend money for defense in order to deter violence against

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[50] See Russett, What Price Vigilance?, and Olson and Zeckhauser, "An Economic Theory of Alliances."

themselves. In general, the greater the threat they perceive, the more money they are likely to allocate to the defense sector. The perception of threat is largely a function of past conflict experiences, both physical and verbal. Even in a close-knit alliance, different levels of perceived threat are likely. Therefore, defense outlays are partly "private goods." Essentially this refers to the military allocation made either as a result of threats outside of the situations covered by alliances or when one nation perceives a higher degree of threat than do its allies within the alliance.

We hypothesized, then, that the proportion of resources allocated to defense will vary with the past levels of conflict experienced. However, the effect of past conflict is mitigated by the degree of confidence in allies, that is, by the closeness of alignment with a major power. Therefore, while $\frac{DEFEX}{GNP}$ will vary positively with $conflict_{t-1}$, it will vary inversely with major-power alignment. Referring once again to Table 8, we note that the independent variable[51] $\frac{CONLOG_{t-1}}{ALIGNR}$ explains approximately 7 percent of the variance in the defense burden (partial $R = .266$). The partial is positive, indicating that as past conflict increases and as alignment decreases, the defense burden increases. Both effects are consistent with our expectations.

One further factor was expected to influence the share of resources devoted to the defense establishment. As levels of domestic instability

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[51] The reason for using the logarithm of conflict is based on the skewness of that measure which, in part, reflects the differential levels of reporting by the New York Times. This transformation helps to reduce the impact of this differential reporting because it reduces the reporting bias in extremely large scores. See "International Conflict," Chapter 6 of this volume.

increase, governments are likely to spend more on defense in order to sustain themselves. Perhaps this hypothesis holds most strongly in less developed nations where role differentiation (in this case, the distinction between domestic police forces and the military) is less clear than in advanced nations. Nevertheless, the hypothesis proves to be relevant to developed nations as well. One need only remember the use of national troops in the United States during the anti-Vietnam demonstrations to realize that developed nations, too, call on their military when police forces are inadequate for the job.

We noted that of the two components that comprise domestic instability, revolt would probably have a greater impact on defense spending. In other words, we expect armed attacks aimed at replacing the government to be more significantly related to defense expenditures than attempts aimed only at changing government policy. However, we noted the low levels of revolt experienced in Europe in the decade of the sixties. Consequently, we expected the relationship between defense spending and revolt to be minimized. Simple correlations between total defense expenditures and revolt and turmoil are .057 and .143 respectively. Clearly, the stronger relationship is between turmoil and defense expenditures.

As economic well-being improves, governments take on legitimacy. While citizens may have many complaints, there are alternative means to express them short of revolt. Among these are demonstrations and riots, the two elements of turmoil. In short, in Europe during the 1960's, citizens could show their dissatisfaction at the ballot box or through turmoil. Both are practiced at substantial levels in Europe. The latter, turmoil, is often severe enough to require military troops to supplement domestic police forces. The partial correlation of turmoil with defense spending, .130, is somewhat more modest than that of the other independent variables; but it is in the predicted direction.

Military Manpower. The manpower component of national military power base is influenced by the same family of factors as are defense expenditures. Similar to the experience with national defense burden, there appears to have been a general tendency in Europe to reduce military manpower levels during the 1960's. The effort with respect to manpower is perhaps more successful to the extent that nations can substitute expenditures for manpower, that is, more firepower per man.

Generally, the data on military manpower in Europe from 1961 through 1970 indicate decreasing military manpower. West Germany and Portugal are two exceptions to this tendency. During this period, West German manpower levels increased on the average by 3.6 percent[52] each year. This is due primarily to the low levels of German manpower at the outset of the decade, when the legacy of distrust resulting from two world wars prompted fear of a powerful German military establishment. As this fear declined with time, West Germany became more closely tied to the West and was pressured by the United States to contribute her "fair share" to the common defense. As a result, German manpower levels increased. Even in the case of West Germany, however, the rate of increase began to decline in the mid-sixties and there was an absolute drop in manpower levels from 1969 to 1970.

Portuguese manpower increases constitute the most significant

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[52] World Military Expenditures, p. 34.

divergence from the European average. The 10-year period, 1961-1970, shows an average annual increase in Portugal's military manpower of 10.6 percent.[53] This is mainly due to Portugal's colonial involvements. Among the Warsaw Pact nations, East Germany shows the largest divergence from the general trend. Her average annual manpower increase over the 10-year period is 4.2 percent.[54] Here, as with West Germany, the most dramatic increases occurred in the early sixties, followed by a leveling off later in the decade. Factors similar to those suggested with reference to West Germany would also appear to be operative in the East German case.

The decrease in manpower levels for Europe as a whole is shown by the .899 regression coefficient associated with manpower in the previous period (see Table 9). Essentially this means that for every 10 men in the military in a given year, there were about 9 military men the following year, holding the effects of other factors constant.

However, other factors do play a role in establishing military manpower levels. For example, we hypothesized that increasing economic resources allows nations to provide their armies with better equipment and, consequently, fewer men. Therefore, we expect manpower to vary inversely with GNP. The partial correlation for GNP is -.253, substantiating this expectation. The size factor generally associated with GNP, which would lead to expectations of a positive relationship, is accounted for in the regression model by the inclusion of a population variable. Thus, GNP in this use represents a wealth factor, and it is understandable that nations would substitute resources for manpower where they can.

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[53] Ibid.

[54] Ibid., p. 35.

TABLE 9

FORECASTING EQUATION FOR MANPOWER

Variable	Partial R	Coefficient	t-Statistic
Constant		.00269	1.12
$MILMANPOW_{t-1}$	.959	.89900	47.96
GNP	-.253	$.18841 \times 10^{-6}$	3.71
POP·ALIGNR	.498	.00200	8.16
$CONLOG_{t-1}$	.155	.00937	2.20
$TURMOIL_{t-1}$	.271	.01190	4.00

$R^2 = .999$ $F = 37,879$

As we noted above, population is the size variable that helps predict manpower levels. Obviously, ceteris paribus, the larger the population, the more men that are available for military service. Consistent with the theory of public goods, we combined the population variable with major-power alignment (POP·ALIGNR). Thus, the larger the population and the greater the amount of major-power alignment, the higher the military manpower level we expected. The regression model indicates this to be the case. The variable produces a positive partial correlation of .498.

In addition to what may be termed resource variables, GNP and population, two "experience" variables, conflict and turmoil, are related to manpower. We noted earlier that perception of threat is apt to bring increased defense spending. This is no less true of manpower.

Therefore, we included the conflict variable (Table 9) although the partial of .155 indicates that it explains only a little more than 2 percent of the variance in manpower levels.

The second experience variable, turmoil, also has a reasonably strong partial of .271 in the regression model. Furthermore, turmoil explains more of the variance in the manpower model (more than 7 percent) than it does in the defense-burden model (just over 1.5 percent). This is consistent with the view that governments may respond to turmoil with manpower to supplement police forces when the latter are inadequate for the task. While there is cost associated with the use of this manpower, it is unlikely that new, high technology weapons would be required in the effort. Consequently, it is reasonable that turmoil will have a greater impact on military manpower than on defense spending.

In this section we have discussed the parameter estimates generated via least squares regression techniques. Each of the relationships hypothesized to link predictor variables to the indicators that comprise the power-base index was examined to determine their direction and magnitude. In the next section, the resulting model will be applied to postdict the power-base indices for the European nations during the period 1962 through 1970.

POSTDICTIONS OF NATIONAL POWER BASE

The models developed for the components of national economic and military power base were used to generate "expected values" for both dimensions. That is, the five equations were used to "predict" economic and military power-base measures for each European nation year by year from 1962 to 1970. The predicted measures were compared with the actual power-base measures to determine the accuracy of the forecasting models.

Accuracy of the forecasting models can be assessed from two perspectives. First, how closely do the predicted power-base index numbers conform to the actual indices. Here evaluation is based upon the magnitude of difference between actual and predicted values for these indices. A second criterion for evaluating the forecasting models rests on the ability of the models to discriminate between national power bases in a relative sense. That is, if nation A has an actual index of 200 and nation B's actual index is 150, does the forecast index conform to this relationship, A > B, or does it reverse the relative order?

In this section we will deal with both criteria of evaluation. However, our major concern in long-range forecasting is to reflect accurately the relative power-base positions of nations in the European interstate system. The amount of difference as shown by the indices is only suggestive of orders of magnitude. Actual effective power-base differences rest not only on the specific situation, but also on psychological determinants, the most prominent of which is credibility.

Data were available for each of the predictor variables for the period 1961-1970, except for the alignment variable for which 1964 data were missing. Consequently, predictions of military power base exclude 1964.

Economic Power Base

Table 10 lists the European nations ranked by the mean absolute percentage difference between the actual and predicted values of economic power base. (See also Table 12 for year-by-year difference for each country.) An examination of Table 10 indicates that a majority

TABLE 10

ECONOMIC POWER BASE

Country	% Difference
France	1.76
Netherlands	2.43
West Germany	2.62
Hungary	2.71
Soviet Union	2.85
East Germany	2.89
Italy	3.35
Yugoslavia	3.52
Sweden	3.60
Romania	3.67
Austria	3.69
Poland	3.88
BLEU	4.24
Denmark	4.94
Switzerland	5.01
Czechoslovakia	5.02
United Kingdom	5.08
Finland	5.14
Bulgaria	5.91
Spain	6.83
Norway	7.73
Turkey	12.99
Greece	15.55
Ireland	16.10
Portugal	16.94
Iceland	192.89

of the nations, 14, show relatively small differences (less than 5 percent) between predicted and actual power-base measures. An additional seven of the countries are within 10 percent of the actual values. In only five instances do average postdicted values differ from average actual values by more than 10 percent.

A further investigation of the postdiction error reveals a rather clear pattern. Table 11 shows correlations between those errors and the

TABLE 11

SIMPLE CORRELATIONS

Variables	% EPB Variation
GNP_{t-1}	.06
POP_{t-1}	.08
$EN\ CONS_{t-1}$	.06
$DEFEX_{t-1}$	.04
$TURMOIL_{t-1}$	.22
$GNP/POPLOG_{t-1}$	-.20

independent variables used to predict economic power base. The errors have a relatively strong relationship with turmoil in a positive direction and vary inversely with GNP per capita. The positive relationship with turmoil tends to understate the postdicted values while the inverse relationship with GNP per capita overstates the postdicted value of economic power base.

TABLE 12

ECONOMIC POWER-BASE INDEX

United Kingdom

Year	Actual	Predicted	% Difference
1962	187.17	199.05	6
1963	190.31	193.66	2
1964	193.67	198.34	2
1965	193.53	202.80	5
1966	189.79	201.76	6
1967	186.06	198.50	7
1968	186.67	193.94	4
1969	184.56	198.02	7
1970	183.05	194.46	6

Austria

Year	Actual	Predicted	% Difference
1962	13.36	14.09	5
1963	13.83	13.62	2
1964	14.40	14.89	3
1965	14.59	15.50	6
1966	14.96	14.48	3
1967	14.98	16.10	7
1968	15.68	16.13	3
1969	16.45	16.84	2
1970	17.76	17.64	1

TABLE 12 (Cont'd)

ECONOMIC POWER-BASE INDEX

BLEU

Year	Actual	Predicted	% Difference
1962	35.31	30.24	14
1963	36.44	35.27	3
1964	37.38	35.58	5
1965	38.21	39.97	5
1966	37.58	39.20	4
1967	38.36	38.58	1
1968	40.31	39.04	3
1969	42.41	41.49	2
1970	44.87	45.29	1

Denmark

Year	Actual	Predicted	% Difference
1962	20.36	18.33	10
1963	20.26	18.80	7
1964	22.10	22.15	0
1965	22.83	24.10	6
1966	23.44	24.99	7
1967	23.50	24.47	4
1968	24.60	25.74	5
1969	26.78	26.88	0
1970	27.60	29.16	6

TABLE 12 (Cont'd)

ECONOMIC POWER-BASE INDEX

France

Year	Actual	Predicted	% Difference
1962	154.58	148.19	4
1963	162.67	161.53	1
1964	169.71	168.41	1
1965	174.03	176.25	1
1966	179.74	182.85	2
1967	189.13	190.85	1
1968	194.37	197.61	2
1969	209.47	202.52	3
1970	218.64	221.62	1

West Germany

Year	Actual	Predicted	% Difference
1962	247.18	249.67	1
1963	251.23	257.25	2
1964	262.27	263.92	1
1965	271.79	274.45	1
1966	270.50	280.29	4
1967	265.73	281.67	6
1968	285.59	275.57	4
1969	308.20	295.53	4
1970	317.67	322.03	1

TABLE 12 (Cont'd)

ECONOMIC POWER-BASE INDEX

Italy

Year	Actual	Predicted	% Difference
1962	71.00	66.22	7
1963	75.08	71.09	5
1964	75.81	77.36	2
1965	78.10	77.61	1
1966	83.20	80.52	3
1967	90.30	85.07	6
1968	94.95	92.55	3
1969	99.45	98.30	1
1970	104.02	101.21	3

Netherlands

Year	Actual	Predicted	% Difference
1962	32.27	33.13	3
1963	33.33	34.65	4
1964	35.94	35.61	1
1965	37.35	38.38	3
1966	37.39	38.45	3
1967	39.77	38.14	4
1968	42.63	41.63	2
1969	45.58	45.52	0
1970	47.59	48.62	2

TABLE 12 (Cont'd)

ECONOMIC POWER-BASE INDEX

Norway

Year	Actual	Predicted	% Difference
1962	13.59	12.64	7
1963	14.06	15.17	8
1964	14.73	15.59	6
1965	15.44	16.32	6
1966	16.20	17.15	6
1967	16.82	14.16	16
1968	17.53	17.57	0
1969	17.97	19.41	8
1970	22.91	19.86	13

Sweden

Year	Actual	Predicted	% Difference
1962	50.81	52.68	4
1963	52.54	55.06	5
1964	56.10	56.61	1
1965	57.52	60.43	5
1966	59.15	58.46	1
1967	58.49	63.90	9
1968	60.74	61.82	2
1969	63.25	65.48	4
1970	65.34	66.81	2

TABLE 12 (Cont'd)

ECONOMIC POWER-BASE INDEX

Switzerland

Year	Actual	Predicted	% Difference
1962	25.97	25.50	2
1963	27.20	28.31	4
1964	27.43	29.44	7
1965	28.39	28.50	0
1966	28.42	30.78	8
1967	27.40	30.80	12
1968	29.02	29.67	2
1969	30.29	31.32	3
1970	31.04	32.64	5

Finland

Year	Actual	Predicted	% Difference
1962	9.50	10.01	5
1963	9.60	8.56	11
1964	10.20	10 55	3
1965	10.86	11.20	3
1966	11.51	11.92	4
1967	11.20	12.62	13
1968	11.63	12.28	6
1969	12.80	12.72	1
1970	14.05	13.91	1

TABLE 12 (Cont'd)

ECONOMIC POWER-BASE INDEX

Greece

Year	Actual	Predicted	% Difference
1962	4.20	4.50	7
1963	4.50	3.90	13
1964	4.90	3.92	20
1965	5.45	4.92	10
1966	5.85	3.52	40
1967	6.16	5.22	15
1968	6.60	5.08	23
1969	7.10	7.24	2
1970	7.79	7.03	10

Iceland

Year	Actual	Predicted	% Difference
1962	.50	.18	64
1963	.70	1.73	147
1964	.67	.47	30
1965	.66	2.35	257
1966	.85	2.31	172
1967	.81	3.04	275
1968	.59	2.90	391
1969	.72	1.84	155
1970	.73	2.51	244

TABLE 12 (Cont'd)

ECONOMIC POWER-BASE INDEX

Spain

Year	Actual	Predicted	% Difference
1962	15.83	15.36	3
1963	17.52	14.80	16
1964	18.43	18.59	1
1965	19.84	19.53	2
1966	21.51	19.23	11
1967	22.46	20.89	7
1968	23.30	21.14	9
1969	24.81	23.09	7
1970	26.44	24.66	7

Turkey

Year	Actual	Predicted	% Difference
1962	3.31	2.31	30
1963	3.52	3.07	13
1964	3.67	3.54	4
1965	3.80	4.04	6
1966	4.15	3.90	6
1967	4.42	3.81	14
1968	4.69	3.23	31
1969	4.88	4.51	8
1970	5.05	5.34	6

TABLE 12 (Cont'd)

ECONOMIC POWER-BASE INDEX

Yugoslavia

Year	Actual	Predicted	% Difference
1962	13.93	14.74	6
1963	14.28	14.86	4
1964	15.97	15.17	5
1965	17.87	16.99	5
1966	18.69	19.01	2
1967	18.27	18.87	3
1968	18.94	19.41	2
1969	19.96	19.27	3
1970	21.40	21.18	1

Bulgaria

Year	Actual	Predicted	% Difference
1962	6.42	6.33	1
1963	6.89	7.09	3
1964	8.02	6.65	17
1965	8.36	8.13	3
1966	9.72	9.11	6
1967	11.04	10.56	4
1968	11.94	11.95	0
1969	13.24	11.86	10
1970	15.50	14.28	8

TABLE 12 (Cont'd)

ECONOMIC POWER-BASE INDEX

Czechoslovakia

Year	Actual	Predicted	% Difference
1962	45.51	47.86	5
1963	43.42	47.23	9
1964	45.40	43.39	4
1965	46.41	46.99	2
1966	48.56	49.54	2
1967	52.10	51.02	2
1968	57.87	55.88	3
1969	63.36	56.12	11
1970	68.82	64.76	6

East Germany

Year	Actual	Predicted	% Difference
1962	47.63	47.90	1
1963	48.65	50.83	4
1964	47.26	51.74	9
1965	51.29	49.14	4
1966	53.50	53.61	0
1967	58.62	56.94	3
1968	62.04	62.47	1
1969	66.90	66.44	1
1970	72.61	70.57	3

TABLE 12 (Cont'd)

ECONOMIC POWER-BASE INDEX

Hungary

Year	Actual	Predicted	% Difference
1962	12.75	13.50	6
1963	13.98	13.80	1
1964	14.94	15.10	1
1965	14.91	16.09	8
1966	16.23	16.07	1
1967	17.05	17.44	2
1968	18.45	18.29	1
1969	20.07	19.76	2
1970	22.06	21.47	3

Poland

Year	Actual	Predicted	% Difference
1962	35.85	38.61	8
1963	38.12	37.48	2
1964	39.51	39.80	1
1965	41.90	41.28	1
1966	45.40	44.52	2
1967	48.94	45.45	7
1968	55.00	52.02	5
1969	58.30	55.82	4
1970	64.84	61.87	5

TABLE 12 (Cont'd)

ECONOMIC POWER-BASE INDEX

Romania

Year	Actual	Predicted	% Difference
1962	13.89	13.90	0
1963	15.07	14.89	1
1964	17.30	16.06	7
1965	17.73	17.83	1
1966	20.14	18.88	6
1967	22.46	21.40	5
1968	24.57	23.86	3
1969	27.87	26.06	7
1970	30.64	29.51	4

Soviet Union

Year	Actual	Predicted	% Difference
1962	513.20	539.86	5
1963	526.30	551.91	5
1964	577.10	572.16	1
1965	627.06	624.36	0
1966	688.87	677.63	2
1967	753.38	743.44	1
1968	819.19	812.80	1
1969	843.33	885.20	5
1970	972.69	910.31	6

There are 39 individual country years (1[illegible] percent of the total) where the postdicted value varies from the actual by more than 10 percent. Of these, 23 are understatements of the power-base measure. For each case in which there is a greater than 10 percent understatement of economic power base, the data show a significant increase in the level of turmoil during the previous year. We can trace the effect of increased turmoil through the model used to estimate the GNP component of economic power base. Note (in Table 5) that the regression coefficient for turmoil is -1512.4, which means that for each unit of turmoil, GNP is predicted to decrease by $1.5124 billion. It should be evident that the smaller the nation's GNP, the larger the relative effects of high turmoil levels.

Postdictions for three countries--Turkey, Greece, and Portugal--were particularly sensitive to the negative effects of turmoil. In addition, significant increases in turmoil account for the years in which the economic power base of Ireland is understated. (Note that Ireland is also subject to overstatement of its economic power base for reasons discussed below.) All of these nations have small GNP's and consequently their economic power base is less accurately predicted than it is for the other European nations. For the other nations, where turmoil is relatively low, or levels of turmoil are stable, or where the nation has a large GNP, the independent variable turmoil contributes to the overall accuracy of the postdictions.

Two countries, Iceland and Ireland, account for almost all (81 percent) of the 16 country-years in which postdicted economic power base is overstated by more than 10 percent. For both nations, the distorted predictions can be traced to problems of data precision, that is, rounding in the source data. Because these countries are small, the reported size of their gross national products shows no change over several years and then shows a relatively large change. For example, the reported GNP for Iceland in 1961 and 1962 was $300 million. In 1963 it jumped by a third to $400 million, and remained at that level through 1965. For the same period, the reported population figures showed a gradual increase from year to year, so that GNP per capita decreased over the years when GNP was reported as constant. The forecasting model, on the other hand, predicts gradual changes in both gross national product and population. Therefore, the predicted per capita value is larger than the GNP per capita from the source data, and the result is an overstatement of the predicted economic power base. It can be argued that for this type of nation, the predicted values reflect a more precise measure of economic power than does the actual.

In sum, the forecasting model provides rather accurate postdictions of the economic power-base measure for European nations. Only 13 percent of the individual cases show postdicted values that differ from the actual by more than 10 percent.

We now turn to the second evaluation criterion: How well does the forecasting model discriminate among national economic power bases in a relative sense? As we noted at the outset, our primary concern when developing the power-base index was to reflect accurately the resources available to nations relative to other nations with which they interact. As the Sprouts note, "Conclusions regarding the capabilities of nations are always comparative. That is to say, the capabilities of a given state are relative to the capabilities of other states with which it is or may be involved in demand-response relationships."[55]

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[55] Harold and Margaret Sprout, Foundations of International Politics (Princeton, N.J.: D. Van Nostrand Co., Inc., 1962), p. 164.

Measuring power base in an absolute sense without a reference point is meaningless. The resources available to a nation to influence other nations (its power base) are meaningful only in a relational sense.

Moreover, in constructing the power-base indices, the indicators were transformed into percentage shares to give added emphasis to the relational aspect we seek to reflect. Therefore, evaluation of the forecasting model is more importantly based on the accuracy of rankings of nations vis-a-vis other nations.

Table 13 shows the rank-order correlations between actual and postdicted power-base indices for each prediction year. RHO is a measure of association between ordinal-level variables, in this case the actual

TABLE 13

RANK-ORDER CORRELATION BETWEEN ACTUAL AND PREDICTED ECONOMIC POWER BASE

Year	RHO
1962	.9952
1963	.9925
1964	.9966
1965	.9993
1966	.9979
1967	.9971
1968	.9959
1969	.9966
1970	.9973

economic power-base rank and the predicted economic power-base rank. Just as with the correlation coefficient, it can range from -1.0, indicating perfect negative association, to 1.0, indicating perfect positive association. An RHO equal to 0 indicates no association between the rankings.

It is evident from Table 13 that the forecasting model produces accurate rank postdictions for national economic power base. For each year of postdiction, the RHO is greater than .99, indicating almost perfect association between actual and predicted ranks for this dimension of power base.

Table 14 presents the actual and postdicted rankings on the economic power-base dimension for each year 1962-1970. In only one case, Spain in 1963, does the postdicted rank differ from the actual economic power-base rank by as much as three positions. Otherwise rank-position differences are one or two, and in the vast majority of cases postdicted ranks match the actual ranks on the economic power-base dimension.

We conclude, then, that the forecasting model provides an excellent tool for predicting relative economic power base for the nations in the European region. Furthermore, while the index value itself does not reflect anything that one can see in the real world, it suggests the magnitude of difference in resources available to the nations of Europe.

Military Power Base

Table 15 ranks the European nations by the mean absolute percentage difference between their postdicted military power base and their actual

TABLE 14

ECONOMIC POWER BASE

1962

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
West Germany	2	2
United Kingdom	3	3
France	4	4
Italy	5	5
Sweden	6	6
East Germany	7	7
Czechoslovakia	8	8
Poland	9	9
BLEU	10	11
Netherlands	11	10
Switzerland	12	12
Denmark	13	13
Spain	14	14
Yugoslavia	15	15
Romania	16	17
Norway	17	19
Austria	18	16
Hungary	19	18
Finland	20	20
Bulgaria	21	21
Greece	22	22
Ireland	23	23
Turkey	24	25
Portugal	25	24
Iceland	26	26

RHO = .9952

TABLE 14 (Cont'd)

ECONOMIC POWER BASE

1963

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
West Germany	2	2
United Kingdom	3	3
France	4	4
Italy	5	5
Sweden	6	6
East Germany	7	7
Czechoslovakia	8	8
Poland	9	9
BLEU	10	10
Netherlands	11	11
Switzerland	12	12
Denmark	13	13
Spain	14	17
Romania	15	15
Yugoslavia	16	16
Norway	17	14
Hungary	18	18
Austria	19	19
Finland	20	20
Bulgaria	21	21
Greece	22	23
Ireland	23	22
Turkey	24	24
Portugal	25	26
Iceland	26	25

RHO = .9925

TABLE 14 (Cont'd)

ECONOMIC POWER BASE

1964

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
West Germany	2	2
United Kingdom	3	3
France	4	4
Italy	5	5
Sweden	6	6
East Germany	7	7
Czechoslovakia	8	8
Poland	9	9
BLEU	10	11
Netherlands	11	10
Switzerland	12	12
Denmark	13	13
Spain	14	14
Romania	15	15
Yugoslavia	16	17
Hungary	17	18
Norway	18	16
Austria	19	19
Finland	20	20
Bulgaria	21	21
Greece	22	23
Ireland	23	22
Turkey	24	24
Portugal	25	25
Iceland	26	26

RHO = .9966

TABLE 14 (Cont'd)

ECONOMIC POWER BASE

1965

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
West Germany	2	2
United Kingdom	3	3
France	4	4
Italy	5	5
Sweden	6	6
East Germany	7	7
Czechoslovakia	8	8
Poland	9	9
BLEU	10	10
Netherlands	11	11
Switzerland	12	12
Denmark	13	13
Spain	14	14
Yugoslavia	15	16
Romania	16	15
Norway	17	17
Hungary	18	18
Austria	19	19
Finland	20	20
Bulgaria	21	21
Greece	22	22
Ireland	23	23
Turkey	24	24
Portugal	25	25
Iceland	26	26

RHO = .9993

TABLE 14 (Cont'd)

ECONOMIC POWER BASE

1966

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
West Germany	2	2
United Kingdom	3	3
France	4	4
Italy	5	5
Sweden	6	6
East Germany	7	7
Czechoslovakia	8	8
Poland	9	9
BLEU	10	10
Netherlands	11	11
Switzerland	12	17
Denmark	13	13
Spain	14	14
Romania	15	16
Yugoslavia	16	15
Hungary	17	18
Norway	18	17
Austria	19	19
Finland	20	20
Bulgaria	21	21
Greece	22	23
Turkey	23	22
Ireland	24	24
Portugal	25	25
Iceland	26	26

RHO = .9979

TABLE 14 (Cont'd)

ECONOMIC POWER BASE

1967

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
West Germany	2	2
France	3	4
United Kingdom	4	3
Italy	5	5
East Germany	6	7
Sweden	7	6
Czechoslovakia	8	8
Poland	9	9
Netherlands	10	11
BLEU	11	10
Switzerland	12	12
Denmark	13	13
Romania	14	14
Spain	15	15
Yugoslavia	16	16
Hungary	17	17
Norway	18	19
Austria	19	18
Finland	20	20
Bulgaria	21	21
Greece	22	22
Turkey	23	23
Ireland	24	24
Portugal	25	25
Iceland	26	26

RHO = .9971

TABLE 14 (Cont'd)

ECONOMIC POWER BASE

1968

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
West Germany	2	2
France	3	3
United Kingdom	4	4
Italy	5	5
East Germany	6	6
Sweden	7	7
Czechoslovakia	8	8
Poland	9	9
Netherlands	10	10
BLEU	11	11
Switzerland	12	12
Denmark	13	13
Romania	14	14
Spain	15	15
Yugoslavia	16	16
Hungary	17	17
Norway	18	18
Austria	19	19
Bulgaria	20	21
Finland	21	20
Greece	22	22
Turkey	23	24
Ireland	24	26
Portugal	25	23
Iceland	26	25

RHO = .9959

TABLE 14 (Cont'd)

ECONOMIC POWER BASE

1969

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
West Germany	2	2
France	3	3
United Kingdom	4	4
Italy	5	5
East Germany	6	6
Czechoslovakia	7	8
Sweden	8	7
Poland	9	9
Netherlands	10	10
BLEU	11	11
Switzerland	12	12
Romania	13	14
Denmark	14	13
Spain	15	15
Hungary	16	16
Yugoslavia	17	18
Norway	18	17
Austria	19	19
Bulgaria	20	21
Finland	21	20
Greece	22	22
Turkey	23	24
Ireland	24	23
Portugal	25	25
Iceland	26	26

RHO = .9966

TABLE 14 (Cont'd)

ECONOMIC POWER BASE

1970

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
West Germany	2	2
France	3	3
United Kingdom	4	4
Italy	5	5
East Germany	6	6
Czechoslovakia	7	8
Sweden	8	7
Poland	9	9
Netherlands	10	10
BLEU	11	11
Switzerland	12	12
Romania	13	13
Denmark	14	14
Spain	15	15
Norway	16	18
Hungary	17	16
Yugoslavia	18	17
Austria	19	19
Bulgaria	20	20
Finland	21	21
Greece	22	22
Turkey	23	23
Ireland	24	24
Portugal	25	25
Iceland	26	26

RHO = .9973

TABLE 15

MILITARY POWER BASE

Country	% Difference
BLEU	4.50
Poland	4.65
Soviet Union	5.41
Romania	5.86
Italy	5.95
France	6.69
Netherlands	7.72
Czechoslovakia	8.02
United Kingdom	8.94
Sweden	11.12
West Germany	11.57
Denmark	11.60
Yugoslavia	11.64
Bulgaria	12.71
Spain	13.07
Greece	15.30
Norway	15.82
Hungary	17.51
Austria	17.71
Finland	17.77
Portugal	18.71
Switzerland	19.87
Turkey	21.40
East Germany	22.48
Ireland	31.91
Iceland[a]	-

[a] Iceland does not have a military establishment and the actual MPB for this nation is 0 in each year. Therefore, percentage differences between actual and predicted scores cannot be calculated.

military power base. (See also Table 17 for year-by-year difference for each country.)

Table 16 presents the simple correlation between military power-base errors and military power-base predictor variables. In all cases, except for lagged turmoil, the relationship is weak. Putting lagged turmoil aside for a moment, it should be evident that no other independent variable is producing a systematic error in the predictions.

The lagged turmoil variable, which shows the strongest relationship with the MPB errors, influences the military power-base measures through the manpower component (see Table 9) and tends to produce

TABLE 16

SIMPLE CORRELATIONS

MPB Predictors	MPB Errors
DEF/GNP$_{t-1}$	.065
GNP	-.022
CONFLICT LOG/ALIGNR$_{t-1}$	-.015
GNP·ALIGNR	-.003
TURMOIL	.044
MIL MANPOW$_{t-1}$	.013
TURMOIL$_{t-1}$	.308
POP·ALIGNR	.002
CONFLICT LOG$_{t-1}$	.026

TABLE 17

MILITARY POWER-BASE INDEX

United Kingdom

Year	Actual	Predicted	% Difference
1962	724.81	726.45	0
1963	736.98	782.92	6
1965	847.47	896.08	6
1966	874.00	918.43	5
1967	923.55	957.07	4
1968	718.18	962.66	34
1969	700.94	796.59	14
1970	755.75	777.66	3

Austria

Year	Actual	Predicted	% Difference
1962	5.99	7.58	27
1963	7.43	7.39	1
1965	8.84	12.66	43
1966	10.28	9.76	5
1967	10.77	12.65	17
1968	10.91	12.31	13
1969	11.87	13.70	15
1970	12.02	14.49	21

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

BLEU

Year	Actual	Predicted	% Difference
1962	37.09	32.22	13
1963	37.91	39.31	4
1965	44.09	49.75	13
1966	47.18	47.65	1
1967	51.84	52.35	1
1968	54.77	54.65	0
1969	56.43	57.16	1
1970	64.95	63.11	3

Denmark

Year	Actual	Predicted	% Difference
1962	21.24	16.49	22
1963	21.65	18.95	12
1965	26.74	26.97	1
1966	28.63	31.09	9
1967	32.00	30.16	6
1968	32.43	36.84	14
1969	33.78	38.66	14
1970	33.54	38.48	15

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

France

Year	Actual	Predicted	% Difference
1962	475.94	467.48	2
1963	495.09	533.91	8
1965	601.56	595.48	1
1966	665.98	642.77	3
1967	723.13	761.18	5
1968	751.64	801.42	7
1969	741.20	788.58	6
1970	678.13	821.62	21

West Germany

Year	Actual	Predicted	% Difference
1962	639.19	673.95	5
1963	704.89	702.64	0
1965	633.51	747.22	18
1966	636.32	699.23	10
1967	650.11	732.91	13
1968	535.21	737.92	38
1969	621.62	596.74	4
1970	727.05	695.21	4

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

Italy

Year	Actual	Predicted	% Difference
1962	111.30	110.53	1
1963	133.93	115.66	14
1965	162.19	153.05	6
1966	183.90	181.00	2
1967	184.80	197.98	7
1968	189.26	200.06	6
1969	190.33	212.02	11
1970	214.79	210.96	2

Netherlands

Year	Actual	Predicted	% Difference
1962	54.79	56.98	4
1963	56.13	60.58	8
1965	69.86	82.63	18
1966	73.12	75.56	3
1967	85.72	76.40	11
1968	85.96	93.82	9
1969	100.47	94.95	5
1970	110.22	113.19	3

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

Norway

Year	Actual	Predicted	% Difference
1962	19.32	15.67	19
1963	19.71	21.95	11
1965	29.65	24.21	18
1966	29.49	35.45	20
1967	31.31	23.20	26
1968	36.64	31.82	13
1969	36.39	41.38	14
1970	39.67	41.64	5

Sweden

Year	Actual	Predicted	% Difference
1962	82.01	79.40	3
1963	89.70	92.11	3
1965	111.22	121.41	9
1966	131.69	109.65	17
1967	127.16	153.64	21
1968	122.27	135.94	11
1969	152.28	141.52	7
1970	138.63	163.77	18

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

Switzerland

Year	Actual	Predicted	% Difference
1962	39.20	44.36	13
1963	39.59	52.96	34
1965	47.19	55.20	17
1966	53.12	62.46	18
1967	47.97	61.38	28
1968	44.17	55.52	26
1969	51.49	58.67	14
1970	54.44	59.81	10

Finland

Year	Actual	Predicted	% Difference
1962	11.78	9.03	23
1963	9.00	10.72	19
1965	10.61	9.58	10
1966	10.73	12.32	15
1967	11.26	12.84	14
1968	12.21	12.96	6
1969	9.90	13.98	41
1970	10.17	11.57	14

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

Greece

Year	Actual	Predicted	% Difference
1962	11.40	13.67	20
1963	11.70	12.12	4
1965	13.64	15.30	12
1966	15.79	10.26	35
1967	21.39	16.59	22
1968	25.20	19.39	23
1969	29.90	30.17	1
1970	33.79	31.99	5

Ireland

Year	Actual	Predicted	% Difference
1962	2.48	2.66	7
1963	2.48	2.84	14
1965	2.76	6.96	152
1966	3.06	2.32	24
1967	3.11	3.25	5
1968	1.92	1.81	6
1969	2.70	2.35	13
1970	2.67	3.57	34

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

Portugal

Year	Actual	Predicted	% Difference
1962	15.55	13.86	11
1963	14.04	3.88	72
1965	15.46	15.20	2
1966	17.36	13.79	21
1967	23.26	20.22	13
1968	25.08	27.24	9
1969	25.19	25.37	1
1970	29.70	23.24	22

Spain

Year	Actual	Predicted	% Difference
1962	30.50	26.48	13
1963	32.64	29.34	10
1965	39.15	41.46	6
1966	55.00	42.82	22
1967	73.04	62.39	15
1968	66.38	76.29	15
1969	67.96	72.54	7
1970	89.54	74.36	17

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

Turkey

Year	Actual	Predicted	% Difference
1962	21.32	15.12	29
1963	22.00	20.53	7
1965	26.40	28.96	10
1966	27.68	28.93	5
1967	32.14	27.72	14
1968	35.73	25.02	30
1969	37.77	35.49	6
1970	25.47	43.66	71

Yugoslavia

Year	Actual	Predicted	% Difference
1962	14.22	16.13	13
1963	14.54	17.16	18
1965	26.49	31.87	20
1966	26.64	31.40	18
1967	26.00	28.23	9
1968	30.43	29.64	3
1969	40.52	36.27	10
1970	46.33	47.15	2

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

Bulgaria

Year	Actual	Predicted	% Difference
1962	16.55	19.58	18
1963	21.33	19.48	9
1965	13.56	17.02	26
1966	15.70	15.56	1
1967	15.58	17.90	15
1968	16.77	18.05	8
1969	20.43	18.52	9
1970	20.40	23.73	16

Czechoslovakia

Year	Actual	Predicted	% Difference
1962	100.03	92.89	7
1963	104.87	110.25	5
1965	102.90	107.04	4
1966	103.99	116.39	12
1967	119.58	112.80	6
1968	118.28	142.16	20
1969	129.71	128.99	1
1970	159.53	144.33	10

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

East Germany

Year	Actual	Predicted	% Difference
1962	74.45	33.24	55
1963	71.22	98.57	38
1965	81.41	84.65	4
1966	83.81	101.04	21
1967	95.06	104.76	10
1968	185.92	118.56	36
1969	215.51	231.56	7
1970	239.93	258.28	8

Hungary

Year	Actual	Predicted	% Difference
1962	21.43	13.61	36
1963	29.06	23.92	18
1965	26.22	30.56	17
1966	22.62	30.15	33
1967	22.54	26.00	15
1968	26.30	25.87	2
1969	32.61	30.55	6
1970	42.88	37.44	13

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

Poland

Year	Actual	Predicted	% Difference
1962	83.02	87.22	5
1963	91.15	91.55	0
1965	104.70	109.98	5
1966	117.70	121.04	3
1967	127.29	120.02	6
1968	154.70	143.06	8
1969	184.70	166.07	10
1970	212.61	211.48	1

Romania

Year	Actual	Predicted	% Difference
1962	23.01	23.08	0
1963	21.48	25.43	18
1965	22.84	24.43	7
1966	25.13	26.28	5
1967	27.67	29.27	6
1968	32.68	32.03	2
1969	39.29	39.13	0
1970	42.50	46.13	9

TABLE 17 (Cont'd)

MILITARY POWER-BASE INDEX

Soviet Union

Year	Actual	Predicted	% Difference
1962	7046.50	7132.70	1
1963	7016.10	7559.00	8
1965	6511.90	7619.60	17
1966	6602.90	7165.00	9
1967	7109.60	7277.90	2
1968	8121.40	7802.10	4
1969	9054.60	8956.50	1
1970	9415.00	9548.60	1

an understatement of the postdicted value. Similar to our analysis of the economic dimension, the effects of the turmoil variable are most prominent for small nations because of the inordinate influence of turmoil relative to the low values of other components for these nations.

However, the major factor that produces a wider difference between actual and postdicted values on the military dimension than on the economic dimension is the greater range of change associated with a nation's military power base. The components of the military measure, defense expenditures and manpower, are far more subject to policy manipulation than are the elements of the economic dimension. Therefore, the military power-base measure will vary to a greater degree from year to year. Tables 18 and 19 illustrate the greater variation in the military measure vis-a-vis the economic dimension.

TABLE 18

ABSOLUTE PERCENTAGE CHANGE
IN POWER-BASE MEASURES BY YEAR

BLEU

Year	EPB % Change	MPB % Change
1961		
1962	6.3	6.0
1963	3.2	2.2
1964	2.6	14.5
1965	2.2	1.6
1966	1.6	7.0
1967	2.1	9.9
1968	5.1	5.7
1969	5.2	3.0
1970	5.8	15.1
Average	3.8	7.2
Absolute % Range:		
Low	1.6	1.6
High	6.3	15.1

Visual inspection of Table 18 shows the far greater variation in the military power base of BLEU from year to year than in its economic power base. The absolute range of change in MPB ranges from a low of 1.6 percent in 1965 to a high of 15.1 percent in 1970.

The corresponding changes for the economic dimension range from 1.6 percent in 1966 to 6.3 percent in 1962. The average change in the EPB measure is 3.8 percent per year while MPB changes on the average by 7.2 percent, almost twice as much. The same conclusions flow from the data on Portugal (See Table 19).

TABLE 19

ABSOLUTE PERCENTAGE CHANGE
IN POWER-BASE MEASURES BY YEAR

Portugal

Year	EPB % Change	MPB % Change
1961		
1962	4.3	1.6
1963	4.8	9.7
1964	6.8	12.3
1965	6.4	2.0
1966	2.5	12.3
1967	9.2	34.0
1968	6.2	7.8
1969	1.9	0.4
1970	6.8	17.9
Average	5.4	10.9
Absolute % Range:		
Low	1.9	0.4
High	9.2	34.0

As with the economic power-base dimension, however, the accuracy of rank position is the most important criterion for evaluating the military power base. Here again, the military power-base score of any given nation alone is meaningless. The score itself does not translate into anything visible in the real world. Rather it allows nations to be compared in terms of military power and provides meaningful information to the analyst.

Table 20 indicates the accuracy of the forecasting model for predicting rank order on the military power-base dimension. It is noteworthy that even the volatile nature of the military power-base indicators

TABLE 20

RANK-ORDER CORRELATION BETWEEN ACTUAL AND PREDICTED MILITARY POWER BASE

Year[a]	RHO
1962	.9651
1963	.9822
1965	.9815
1966	.9870
1967	.9870
1968	.9768
1969	.9891
1970	.9788

[a] Predictions for 1964 are not included because alignment data are missing for that year. Consequently, a rank-order correlation cannot be calculated.

introduces very little distortion in rank prediction. The degree of association between actual and postdicted military power-base ranks is always above .96 and in most years above .98.

The actual and postdicted ranks for each of the 26 nations from 1962 to 1970 are presented in Table 21. For a large majority of the cases, the postdicted rank is the same as the actual rank. Where there is deviation between actual and postdicted ranks it is usually by one or two rank positions. Moreover, the rank differences that do occur are within groups of nations that are, by any measure, relatively equal in their military potential. Consequently, little if any information distortion is introduced by these minor rank discrepancies.

TABLE 21

MILITARY POWER BASE

1962

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
United Kingdom	2	2
West Germany	3	3
France	4	4
Italy	5	5
Czechoslovakia	6	6
Poland	7	7
Sweden	8	8
East Germany	9	11
Netherlands	10	9
Switzerland	11	10
BLEU	12	12
Spain	13	13
Romania	14	14
Hungary	15	22
Turkey	16	19
Denmark	17	16
Norway	18	18
Bulgaria	19	15
Portugal	20	20
Yugoslavia	21	17
Finland	22	23
Greece	23	21
Austria	24	24
Ireland	25	25
Iceland	26	26

RHO = .9651

TABLE 21 (Cont'd)

MILITARY POWER BASE

1963

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
United Kingdom	2	2
West Germany	3	3
France	4	4
Italy	5	5
Czechoslovakia	6	6
Poland	7	9
Sweden	8	8
East Germany	9	7
Netherlands	10	10
Switzerland	11	11
BLEU	12	12
Spain	13	13
Hungary	14	15
Turkey	15	17
Denmark	16	19
Romania	17	14
Bulgaria	18	18
Norway	19	16
Yugoslavia	20	20
Portugal	21	24
Greece	22	21
Finland	23	22
Austria	24	23
Ireland	25	25
Iceland	26	26

RHO = .9822

TABLE 21 (Cont'd)

MILITARY POWER BASE

1965

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
United Kingdom	2	2
West Germany	3	3
France	4	4
Italy	5	5
Sweden	6	6
Poland	7	7
Czechoslovakia	8	8
East Germany	9	9
Netherlands	10	10
Switzerland	11	11
BLEU	12	12
Spain	13	13
Norway	14	19
Denmark	15	17
Yugoslavia	16	14
Turkey	17	16
Hungary	18	15
Romania	19	18
Portugal	20	22
Greece	21	21
Bulgaria	22	20
Finland	23	24
Austria	24	23
Ireland	25	25
Iceland	26	26

RHO = .9815

TABLE 21 (Cont'd)

MILITARY POWER BASE

1966

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
United Kingdom	2	2
France	3	4
West Germany	4	3
Italy	5	5
Sweden	6	8
Poland	7	6
Czechoslovakia	8	7
East Germany	9	9
Netherlands	10	10
Spain	11	13
Switzerland	12	11
BLEU	13	12
Norway	14	14
Denmark	15	16
Turkey	16	18
Yugoslavia	17	15
Romania	18	19
Hungary	19	17
Portugal	20	21
Greece	21	23
Bulgaria	22	20
Finland	23	22
Austria	24	24
Ireland	25	25
Iceland	26	26

RHO = .9870

TABLE 21 (Cont'd)

MILITARY POWER BASE

1967

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
United Kingdom	2	2
France	3	3
West Germany	4	4
Italy	5	5
Poland	6	7
Sweden	7	6
Czechoslovakia	8	8
East Germany	9	9
Netherlands	10	10
Spain	11	11
BLEU	12	13
Switzerland	13	12
Turkey	14	17
Denmark	15	14
Norway	16	19
Romania	17	15
Yugoslavia	18	16
Portugal	19	20
Hungary	20	18
Greece	21	22
Bulgaria	22	21
Finland	23	23
Austria	24	24
Ireland	25	25
Iceland	26	26

RHO = .9870

TABLE 21 (Cont'd)

MILITARY POWER BASE

1968

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
France	2	3
United Kingdom	3	2
West Germany	4	4
Italy E	5	5
East Germany	6	9
Poland	7	6
Sweden	8	8
Czechoslovakia	9	7
Netherlands	10	10
Spain	11	11
BLEU	12	13
Switzerland	13	12
Norway	14	16
Turkey	15	20
Romania	16	15
Denmark	17	14
Yugoslavia	18	17
Hungary	19	19
Greece	20	21
Portugal	21	18
Bulgaria	22	22
Finland	23	23
Austria	24	24
Ireland	25	25
Iceland	26	26

RHO = .9768

TABLE 21 (Cont'd)

MILITARY POWER BASE

1969

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
France	2	3
United Kingdom	3	2
West Germany	4	4
East Germany	5	5
Italy	6	6
Poland	7	7
Sweden	8	8
Czechoslovakia	9	9
Netherlands	10	10
Spain	11	11
BLEU	12	13
Switzerland	13	12
Yugoslavia	14	17
Romania	15	15
Turkey	16	18
Norway	17	14
Denmark	18	16
Hungary	19	19
Greece	20	20
Portugal	21	21
Bulgaria	22	22
Austria	23	24
Finland	24	23
Ireland	25	25
Iceland	26	26

RHO = .9891

TABLE 21 (Cont'd)

MILITARY POWER BASE

1970

Country	Actual Rank	Predicted Rank
Soviet Union	1	1
United Kingdom	2	3
West Germany	3	4
France	4	2
East Germany	5	5
Italy	6	7
Poland	7	6
Czechoslovakia	8	9
Sweden	9	8
Netherlands	10	10
Spain	11	11
BLEU	12	12
Switzerland	13	13
Yugoslavia	14	14
Hungary	15	19
Romania	16	15
Norway	17	17
Greece	18	20
Denmark	19	18
Portugal	20	22
Turkey	21	16
Bulgaria	22	21
Austria	23	23
Finland	24	24
Ireland	25	25
Iceland	26	26

RHO = .9788

CONCLUSION

We have presented the results of an effort to conceptualize, measure, and forecast national power base as a central environmental descriptor in a long-range forecasting model. We use power base to denote the human and material resources available to a nation to influence the behavior of other nations. At the outset of this research effort we made a sharp distinction between power base as the resources available to influence other nations, that is, attributes of a nation, and power as a relationship, that is, the success a nation realizes in shaping the behavior of other nations.

It is important to remember that while success in a power relationship (winning, or obtaining an objective) may depend heavily on the resources a nation can mobilize, the outcome cannot be predicted with certainty by reference to any composite power-base measure. The limitations on the usefulness of material power are contingent upon many factors, such as the vulnerability of the target nation, the general relationship between the nations involved, and the credibility of the attempt.

For these reasons the conception of power base used in this long-range forecasting model should be interpreted as one factor among many that determines the outcome of a power relationship. For example, it is evident that Japan is a greater economic power than the Arab oil states. Yet the leaders of the Arab world are able to influence Japanese policy toward Israel by capitalizing on Japan's need for oil imports.

Nevertheless, conceptualizing power base as an attribute of nations is an important factor for understanding international politics. A growing quantitative literature substantiates the common-sense hypothesis that a nation's size, and to a lesser extent development, predict its amount of international interaction.[56] Galtung hypothesizes that world interaction patterns are rank dependent.[57] He ranks nations on a number of dimensions such as size, wealth, military power, and degree of development, and suggests that higher ranked nations will engage in more total interaction and more interaction with other highly ranked nations.

In the construction of the power-base descriptor for the long-range forecasting model we have integrated the size, wealth, and development variables into one economic dimension and have considered the military variables as a separate dimension of national power base. Each nation was then ranked on the two dimensions providing a relative power-base index.

The index score itself should not be interpreted as an absolute measure of national power. As we noted, the score does not represent

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[56] Charles F. Hermann, and Maurice A. East, "Do Nation-Types Account for Foreign Policy Behavior?" (paper delivered at American Political Science Association Meeting, Washington, D.C., September 1972); Stephen Salamore and Charles F. Hermann, "The Effect of Size, Development, and Accountability on Foreign Policy Behavior in Dyadic Relationships" (paper presented at International Studies Association Meeting, San Juan, Puerto Rico, March 1971); Johan Galtung, "East-West Interaction Patterns," Journal of Peace Research, No. 2 (1966), pp. 146-174; R.J. Rummel, "Some Dimensions in the Foreign Behavior of Nations," Journal of Peace Research, No. 3 (1966), pp. 201-223.

[57] Galtung says that "rankings have a tendency to be concordant, in the sense that a nation that ranks high on one dimension has a tendency to also rank high on other dimensions." See Galtung, "East-West Interaction Patterns," p. 146. See also Lasswell and Kaplan, Power and Society, p. 94.

anything in the real world although it is suggestive of magnitude of differences between nations. More importantly, the index ranking indicates which nations have greater or lesser national power bases relative tc other nations.

In this context, the power-base descriptor is a useful variable for predicting the level of participation of a state in international interactions. In this respect, national power-base ranks direct the attention of the analyst to those states most likely to be involved in international politics.

The forecasting models for the two dimensions of national power base proved to be quite accurate in ranking the European nations. On the economic dimension, the postdiction results show a degree of association between actual and postdicted rank of better than .99, and on the military dimension at least greater than .96, and usually over .98. It is clear, then, that the models developed represent a reliable means of predicting national power-base rankings over the long range.

INTRODUCTION: THEORETICAL CONSIDERATIONS

During the last decade, the literature of quantitative social science has focused increasingly on various aspects of the performance of political and social systems. Political scientists, in particular, have begun considering the de facto operation of political systems in addition to the de jure organization of those systems. Students of comparative politics have begun relating the nature of outputs to the demands placed upon the systems' decisionmaking structures, and comparing the organization of those structures themselves.

One aspect of a political system's performance that has received considerable attention is the degree to which the system is able to maintain a reasonable degree of internal stability.[1] Theoretical and

[1] See, for example, R.J. Rummel, "Dimensions of Conflict Behavior Within Nations, 1946-59," Journal of Conflict Resolution, Vol. 10 (1966), pp. 65-73; R.J. Rummel, "Dimensions of Conflict Behavior Within and Between Nations," General Systems Yearbook, Vol. 8 (1963), pp. 1-50; Raymond Tanter, "Dimensions of Conflict Behavior Within and Between Nations, 1958-60," Journal of Conflict Resolution, Vol. 10 (1966), pp. 41-64; Douglas P. Bwy, "Political Instability in Latin America: The Cross-Cultural Test of a Causal Model," Latin American Research Review, Vol. 3 (1968), pp. 17-66; Ivo K. Feierabend and Rosalind L. Feierabend, "Aggressive Behaviors Within Polities, 1948-62: A Cross National Study," Journal of Conflict Resolution, Vol. 10 (1966), pp. 249-271; Betty Nesvold, "Scalogram Analysis of Political Violence," Comparative Political Studies, Vol. 2 (1969), pp. 172-194; Ted Robert Gurr with Charles Ruttenberg, The Conditions of Civil Violence: First Tests of a Causal Model (Research Monograph No. 28, Center of International Studies, Woodrow Wilson School of Public and International Affairs, Princeton University, 1967); Ted Robert Gurr, "A Causal Model of

empirical studies of this performance characteristic have, for the most part, studied its absence, that is, internal instability. In that context several terms, among them turmoil, revolt, subversion, internal war, and domestic conflict have been used to characterize internal instability. These terms have taken on rather precise and well-defined meanings in both the theoretical and empirical literature on internal instability, and have been operationalized and measured in surprisingly consistent ways.[2] Such consistency has enabled political theorists to generate and subject to empirical disconfirmation a wide variety of hypotheses about the conditions under which different types of instability are most likely to occur, and to do so in a wide variety of historical and contemporary settings.[3] The existence of this comparatively well-developed body of theoretical and empirical literature allows us to approach the problem of long-range forecasting of these phenomena from a rather substantial base.

Civil Strife: A Comparative Analysis Using New Indices," American Political Science Review, Vol. 62 (1968), pp. 1104-1124; Ted Robert Gurr, Why Men Rebel (Princeton: Princeton University Press, 1970); Ted Robert Gurr, "Sources of Rebellion in Western Societies: Some Quantitative Evidence," Annals of the American Academy of Political and Social Science, Vol. 391 (1970), pp. 128-144; and Ted Robert Gurr and Muriel McCleliand, Political Performance: A Twelve-Nation Study (Beverly Hills: Sage Publications, Inc., 1971).

2 See Rummel, "Dimensions of Conflict Behavior Within Nations"; Tanter, "Dimensions of Conflict Behavior Within and Between Nations"; and Gurr, Why Men Rebel, and "A Causal Model of Civil Strife."

3 See Feierabend and Feierabend, "Aggressive Behaviors Within Polities"; Chalmers Johnson, Revolution and the Social System (Stanford: The Hoover Institution on War, Revolution and Peace, 1964); Charles Tilly and James Rule, Measuring Political Upheaval (Princeton: Center of International Studies, Princeton University, 1965); Harry Eckstein, Internal War: Problems and Approaches (New York: The Free Press, 1966); and Harry Eckstein, "On the Etiology of Internal Wars," History and Theory, Vol. 4 (1965), pp. 133-163.

At the same time, however, we must recognize that previous examinations of internal instability focused upon rather instantaneous explanations of the occurrence of various forms of internal instability where the events or conditions hypothesized to "cause" instability occurred at nearly the same point in time as the instability itself. Models of this sort, while useful in generating hypotheses about short-term determinants of instability, are not appropriate for long-range forecasting purposes. Long-range forecasting requires models that focus upon longer-lagged determinants of instability and allow knowledge about the present state of the world to be used in generating expectations about future levels of instability in nations. This is not to imply that changes in public policies have no immediate or short-term effects on the extent of internal instability in nations, but rather that many such changes cannot themselves be forecast over the long range. Long-range forecasts must generate expectations about future values of internal instability on the basis of present conditions.

Accordingly, we seek to develop a long-range forecasting model of internal instability that considers two basic types of explanatory or predictor variables--those predictors that have a rather long-run impact on instability and whose present values are known to the forecaster, and those predictor variables that, although affecting internal instability almost instantaneously, are themselves subject to forecasting. Long-range forecasts, then, must be based on the known values of the long-lagged predictors as well as on forecasts of short-term predictor variables.

In this chapter of the Long-Range Environmental Forecasting Study we seek to use state-of-the-art forecasting techniques to generate expectations about the levels of internal instability in 26 European nations in the 1980's. Consistent with previous theoretical and empirical work, we consider instability to be composed of two distinct dimensions--turmoil and revolt.[4] We view turmoil as destabilizing activities aimed at altering governmental policies or practices, and revolt as destabilizing actions aimed at replacing governmental policymakers or altering the structure of the policymaking process itself. These distinctions are not intended to impute motives to the actors who participate in various acts of instability. Rather, the distinctions rest upon that relatively well-developed body of theoretical and empirical literature on internal instability mentioned previously.

Few of these research efforts were limited to the European context. Thus, the distinction between turmoil and revolt applied on a global scale may not hold. Such a situation would not prevent the model from producing forecasts of the relative levels of turmoil and revolt in the European nations during the period 1985 to 1995. Elimination of that distinction would, however, limit the applicability of the forecasting model to a single region and remove the present study from that well-developed body of theoretical and empirical literature on internal instability. If turmoil and revolt are found to be significantly related in the European context, the distinction between them will be maintained, but their linkage will be explicitly examined and included in the forecasting model.

OPERATIONALIZING INSTABILITY

Five kinds of events have generally been used to measure turmoil and

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[4] See Rummel, "Dimensions of Conflict Behavior Within Nations"; Tanter, "Dimensions of Conflict Behavior Within and Between Nations"; Gurr, Why Men Rebel, and "A Causal Model of Civil Strife."

revolt. Turmoil has been operationalized with measures of antigovernment demonstrations and antigovernment riots while revolt has been measured by occurrences of assassinations, coups d'etat, and armed attacks against public and quasi-public institutions.[5] We have tried to maintain consistency with these measurement schemata in this analysis. However, the lack of widespread assassinations and attempted coups d'etat in post-World War II Europe has prevented us from using them as measures of revolt here.

In the absence of useful data on assassinations and coups, armed attacks against public and quasi-public institutions are used as a measure of revolt. This usage is somewhat at odds with the normal conception of revolt which involves government take-over by force. However, it would be difficult to imagine a forceful take-over of government institutions that did not involve armed attacks. Thus, using armed attacks as a measure of revolt provides an inclusive operationalization of revolt which is particularly relevant in the European context.

The two previously used components of turmoil mentioned above--antigovernment demonstrations and riots--are summed to form a composite measure of turmoil. Unfortunately, these event counts only indicate the number of times destabilizing activities occur; they suggest nothing about their scope or severity. For example, a riot that involves a relatively small number of people and results in but slight property damage may receive the same event count as another riot that involves thousands of people and results in hundreds of deaths. In order to weight the event counts by their relative severity, the

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[5] Ibid.

number of deaths resulting from domestic conflict is used as a weighting factor.

The event counts for turmoil and revolt are examined and found to be highly skewed. Nations of high interest to the United States which allow relatively free and open reporting on domestic occurrences tend to have high levels of reported turmoil and revolutionary events. Thus, the observed skewness in these measures reflects, in part, differential levels of reporting in the news sources for the various European nations.[6] A log (X + 1) transformation is used to reduce this observed skewness, and results in measures with a lower bound of zero, corresponding to the complete absence of turmoil and revolt. This transformation, then, counteracts the reporting bias in the available data.

The number of deaths resulting from domestic conflict is also found to be a highly skewed measure of the intensity of internal instability. Accordingly, this measure is subjected to a log (X + .10) transformation,

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[6] See Gordon Hilton with Farid Abolfathi, Robert Mahoney, and Herman Weil, "The Role of Customer Expectation in Political Science" (Northwestern University Mimeo: Spring 1972); and Farid Abolfathi "Data Collection in the Civil Strife Project" (Northwestern University Mimeo: Spring 1972). See also Edward Azar, et al., "The Problem of Source Coverage in the Use of International Events Data," International Studies Quarterly (September 1972); Edward Azar, Richard Brody, and Charles McClelland, "International Events Interaction Analysis: Some Research Considerations," International Studies Series No. 02-001 (Beverly Hills: Sage Publications, 1972); Philip M. Burgess and Raymond W. Lawton, "Indicators of International Behavior: An Assessment of Events Data Research," International Studies Series No. 02-010 (Beverly Hills: Sage Publications, 1972). Several investigators have found a consistent relationship between event data counts and levels of reporting of events, both domestic and international.

which results in an intensity measure with a lower bound of 1.0 and, for the 1948-65 time period, an upper bound of approximately 10, limits that are intuitively satisfying for a weighting factor. We suggest that a part of the skewness of deaths from domestic conflict also results from differential levels of newspaper reporting.[7] In this case, however, it is likely that rather exact death tolls are available for nations for which the New York Times provides extensive coverage, while exaggerated body counts are more likely where the newspaper coverage is less intense. The log transformation also provides some reduction of this bias in the deaths from domestic conflict measure.

Of course, we expect some overlap between numbers of events and intensity of internal instability; deaths from domestic violence cannot occur in the absence of domestic-violence events. Nonetheless, the extent of such overlap actually found in the European countries is substantially less than the linkage between the different classes of instability events. As Table 1 suggests, the intensity of instability can be considered distinct from, but related to, the number of instability events; furthermore, differential levels of newspaper coverage in the various European countries may bias these two measures in opposite ways. Past research suggests that both of these statements are true: intensity of instability is an important measure of internal instability in conjunction with the number of destabilizing events. In addition,

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7 The research on biases in event measures taken from news sources cited above suggests this rather complex biasing. In both the event counts and the deaths, the accuracy of the available data is directly related to the thoroughness of news coverage in the various nations. The transformations tended to reduce the impact of the most extreme and inaccurate scores in the distributions. Of course, if non-European nations, for whom news reporting is generally less intense, were included in this study, the news-source bias would have been even more extreme.

TABLE 1

RANKINGS OF NATIONS ON
INTERNAL INSTABILITY EVENT MEASURES
(highest to lowest scores)

Turmoil Events	Revolt Events	Intensity
Italy	Greece	Hungary
France	France	Greece
West Germany	Italy	Poland
United Kingdom	Hungary	Soviet Union
BLEU[a]	East Germany	East Germany
East Germany	West Germany	France
Poland	Poland	Italy
Czechoslovakia	Spain	Czechoslovakia
Spain	Ireland	Turkey
Soviet Union	Soviet Union	Spain
Greece	BLEU	Portugal
Turkey	United Kingdom	Yugoslavia
Austria	Austria	Denmark
Hungary	Romania	BLEU
Portugal	Portugal	United Kingdom
Romania	Yugoslavia	Austria
Denmark	Turkey	West Germany
Finland	Switzerland	Finland
Yugoslavia	Denmark	Ireland
Bulgaria	Czechoslovakia	Bulgaria
Sweden	Sweden	Iceland
Ireland	Finland	Switzerland
Netherlands	Bulgaria	Netherlands
Norway	Norway	Norway
Switzerland	Netherlands	Romania
Iceland	Iceland	Sweden

RANK-ORDER CORRELATIONS

	Turmoil Events	Revolt Events	Intensity
Turmoil Events	1.00		
Revolt Events	.47	1.00	
Intensity	.23	.33	1.00

[a] Belgium/Luxembourg. Hereafter BLEU.

for many nations, particularly those of Eastern Europe, relatively low numbers of turmoil and revolutionary events are reported; yet the numbers of deaths reported are very high and are presented in numbers rounded off to the nearest thousand, a characteristic of gross, estimated, and often exaggerated body counts. Both the low numbers of reported instability events and the exaggerated body counts are partly a function of low intensity reporting, that is, of relatively inaccurate data.

Levels of both turmoil and revolt are computed by multiplying the transformed event data for each category by the intensity weighting factor, the transformed death tolls. Since the transformations in all cases adjust for the expected direction of reporting biases, and those biases are in opposite directions, combining the two measures in a multiplicative manner further offsets the effects of these biases. The composite measures of the levels of turmoil and revolt, then, are intended to tap two dimensions of instability--the number of destabilizing activities of each type that a nation experiences, as well as the relative scope and severity of these actions.

A word of caution is needed, however, concerning the ability to interpret these composite measures. If event data are used without being weighted by an intensity factor, the forecasts generated could be retransformed so that they would constitute predictions about the numbers of riots, demonstrations, and armed attacks expected in the various European nations during the 1980's. Analyses of levels of turmoil and revolt, however, cannot be similarly interpreted. Forecasts generated on the basis of these composite measures must be interpreted in a relative sense since they reflect the levels of instability expected for a nation relative to the other European nations. In short, although these scores have interval properties and can be analyzed using powerful parametric statistical techniques, there are no observable occurrences in the world that correspond exactly to any given unit of turmoil or revolt. Thus, the measures should be interpreted as ordinal and used for comparing the levels of instability among the various European nations. In forecasting instability from these composite measures, the most appropriate kind of output is rankings of the European nations. Rankings suggest comparative levels of expected instability and in no way imply expected absolute event counts.

Table 2 presents rankings of the European nations on the composite measures of the levels of turmoil and revolt for the period 1948-1965. During that time span, these measures were relatively highly correlated with one another, sharing about 29 percent variance in common. Some of this correlation is undoubtedly a function of the use of the intensity weighting factor in both composite measures. An examination of composite event scores, however, reveals a correlation of .47 between turmoil and revolt. In short, only about 8 percent of the overlap between turmoil and revolt is attributable to the weighting factor; most of the observed linkage between turmoil and revolt represents a real relationship between the two types of internal instability in the European nations.

One can think of many reasons why turmoil and revolt are distinct on a global basis and yet highly related within Europe. In many parts of the world, particularly in Latin America and the Middle East, revolution is often caused by personality conflict, disputes over the proper structure of governments, and military leaders. Some theorists have gone so far as to suggest that in those contexts, revolt may be a way of life that is not destabilizing within polities where it is expected.

TABLE 2

RANKINGS OF NATIONS ON COMPOSITE MEASURES OF INTERNAL INSTABILITY (highest to lowest scores)

Level of Turmoil	Level of Revolt
Hungary	Greece
Greece	Hungary
Poland	France
Italy	Poland
France	Italy
Soviet Union	East Germany
East Germany	Soviet Union
Czechoslovakia	Spain
Spain	West Germany
Turkey	BLEU
United Kingdom	United Kingdom
West Germany	Turkey
BLEU	Austria
Portugal	Ireland
Denmark	Portugal
Austria	Yugoslavia
Yugoslavia	Czechoslovakia
Finland	Romania
Romania	Denmark
Bulgaria	Switzerland
Ireland	Finland
Sweden	Bulgaria
Netherlands	Norway
Norway	Netherlands
Switzerland	Sweden
Iceland	Iceland

RANK-ORDER CORRELATIONS

	Level of Turmoil	Level of Revolt
Level of Turmoil	1.00	
Level of Revolt	.55	1.00

Clearly that is not the case in Europe. For the most part, countries of Europe have existed long enough to develop regularized and accepted procedures for investing constitutional authority in leadership groups. Activities that seek to bypass those procedures are unusual, unexpected, and highly destabilizing.

The observation of revolutionary activities in the European context, then, can be usefully viewed as evidence of very serious internal instability. As we shall show later, revolt can be seen in that region as an escalation of turmoil-like behavior, and in fact is found only when turmoil itself reaches high levels.

Are we speaking any longer of two distinct types of internal instability? Or are we instead observing two different levels of internal instability--a relatively low level of protest behavior characterized by demonstrations and riots, and a much more intense and serious escalation of that protest behavior characterized by armed attacks against governmental and quasi-public institutions? We think the latter is a more realistic view for the European countries. We see revolt there as the exacerbation of domestic conflict behavior, an escalation of turmoil. No doubt revolt still has consequences much more serious than turmoil; the very structure of the polity is threatened. But it is a distinction based on level rather than type.

Serious questions need to be raised at this point concerning the validity of these measures of internal instability within the European context. Many scholars[8] view indicators as valid only to the extent that they

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[8] Cronback and Meehl note that, "To make clear the meaning of a concept is to set forth the laws--relationships--within which it occurs," so that validation *is* the examination of these relationships.

behave in accordance with our theoretical expectations and with previous empirical findings. Clearly these indicators do not. Either new indicators must be used for turmoil and revolt that are not in fact linked, or the laws that are used to explain internal instability must be altered, at least as they are applied to the European milieu. We think the latter is a more viable approach. Clearly the indicators selected for use here have been valuable when applied on a worldwide basis; there is no reason to believe that situation has changed. Any extension of this effort to other regions of the world should rely upon those measures and theories that have previously been useful in explaining internal instability. At the same time there are historical circumstances and developments unique to the European context that suggest different patterns of behavior there than in developing regions of the world. If we distinguish between turmoil and revolt while explicitly recognizing the linkages between the two classes of domestic conflict in Europe, we can generalize in the forecasting model and at the same time consider the unique aspects of the European milieu.

PREDICTORS OF INTERNAL INSTABILITY

As the foregoing suggested, the nations that comprise Eastern and Western Europe in many ways constitute a rather unique political system. They represent, at the present time at least, two major military and economic blocs. The nations of Eastern Europe are tied quite closely to the Soviet Union, both in terms of military agreements

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See Lee J. Cronback and Paul E. Meehl, "Construct Validity in Psychological Tests," Psychological Bulletin, Vol. 52 (1955), p. 290. See also T.R. Gurr, Politimetrics (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1972), pp. 47-48; and James A. Caproaso, "Theory and Method in the Study of International Organization," International Organization, Vol. 25 (1971), pp. 228-253.

and in terms of economic interaction patterns. To a more limited extent, the nations of Western Europe are similarly associated with the United States, although the strength of these ties is decreasing. Nonetheless, for the past 20 years, social scientists have viewed these groups of nations as two power blocs. The nations comprising these blocs are often thought to differ greatly on ideological bases, economic transaction patterns, and on the nature of the outcomes of public policies of their respective political systems. Whether or not such differences are in fact real, they present certain obstacles to the social scientist who desires to utilize them as the basis for comparisons.

At the same time, what we are developing here is a general forecasting model for the European nations that permits integrated forecasting of five central environmental descriptors. We will use this model to generate forecasts of the relative extent to which internal instability is expected in the European nations. The model compares nations' levels of turmoil and revolt, and considers the linkages between instability and the other descriptors under examination. Such a model does not ignore the unique aspects of the European context; rather, special consideration of that context is made to insure a truly comparative model. The problem of data comparability between Eastern and Western European nations and the unexpected linkage between turmoil and revolt in those countries exemplify this necessity. This is not to imply that all relevant aspects of the European milieu are being considered in the construction of the system-wide comparative model. We are, however, considering these questions and are generating solutions to the extent that our resources allow.

The goal of this work is to develop an integrated forecasting model for five central environmental descriptors. We are forecasting each of these descriptors in such a way that the linkages among them are used as explicit components of those forecasts. The forecasting model, then, takes the form of a set of simultaneous equations, with one or more equations for each descriptor. Multiple regression analysis is the basic quantitative technique employed in estimating the parameters of each equation. Such estimates, when made for all important linkages between instability and the other descriptors, and for all important relationships between instability and the exogenous variables, provide a viable postdictive model to serve as the basis for forecasting.

Separate multiple regression equations are developed and analyzed for the levels of turmoil and revolt. A series of independent variables drawn from the theoretical and quantitative literature on internal instability serve as the potential predictors of our two dependent variables. Some of these predictors, of course, are other central environmental descriptors. On the basis of their relative explanatory value, a subset of those predictor variables is included in the predictive forecasting model. What follows is a brief description of the potential predictors considered, their conceptual definitions, suggested operationalizations, and the logic behind their initial inclusion in the analysis.

Other Central Environmental Descriptors

Four other central environmental descriptors, or components of central environmental descriptors, are hypothesized to affect the levels of turmoil and revolt in the European countries. These four predictors are trade, national power base, international alignment, and population.

Trade. We suggest that nations that are highly dependent upon the foreign sector for a large proportion of their gross national product are in a more economically precarious position than those not as dependent. This is especially true of any nation whose dependence is upon only one or a few foreign powers because changes in a foreign government's policies that severely reduce or stop the flow of trade can seriously affect the dependent nation's economy.[9] To the extent that such dependence is recognized by the nation in question, and to the extent that the nation's citizens consequently feel economic insecurity, political instability could result. The Cuban economy, for example, was highly dependent upon the production and exportation of cane sugar during the decade of the fifties. Most of the sugar produced in that nation was exported to the United States. In the very early 1960's the United States, for political reasons, stopped importing Cuban cane sugar, and Cuba's economy suffered serious consequences. The threat of economic collapse in Cuba was, in fact, quite real at that point in time, and carried with it the potential for internal instability.

The relationship between the trade descriptor and turmoil and revolt is viewed here as a relative matter. That is, a nation's economy becomes more dependent upon the foreign sector as the percentage of its gross national product associated with that foreign sector increases. Thus, trade values are adjusted to make them relative to nations' GNP. In addition, we noted earlier that concentration of relative trade among one or a few foreign powers is an important part of the linkage between trade and internal instability. Michaely trade concentration ratios, calculated from dyadic trade data, are used as a component of the trade predictor in the internal instability equations. Specifically,

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[9] Gurr, Why Men Rebel.

then, we hypothesize that internal instability varies directly with the quantity of a nation's trade relative to its gross national product, and directly with the concentration ratio of its foreign trade.

<u>National Power Base.</u> The relationships among instability, trade as a percentage of GNP, and trade concentration are, we think, mediated by the value of a nation's power base, particularly the economic component of that power base. A nation can have a large percentage of its economy linked to the foreign sector and its trade can be concentrated among a few nations; but if the nation's economy is very large and very strong, such a situation does not put the nation in such a perilous economic situation. By utilizing the economic power component of the national power-base descriptor, we hypothesize that the relationship between internal instability and trade is inversely mediated by the value of the nation's economic power base.

Moreover, we believe that a nation's power base, both the economic and military components, directly affects the nation's level of internal instability. Gurr,[10] among others, suggests that a government's ability to suppress instability varies inversely with that nation's level of instability. Specifically, he argues that as the relative size of the regime's military forces and internal security forces increases, the level of observed instability in that nation decreases. A regime's capacity to suppress internal instability is perhaps measured best by the level of its military power base within the context of this interactive forecasting model. The work of Gurr and other students of internal instability, then, leads us to hypothesize that the levels of turmoil and revolt in a nation vary inversely with the value of its military power base.

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[10] Gurr, "A Causal Model of Civil Strife."

Several theorists also argue that the extent of a nation's economic development also affects its level of internal instability. Gurr specifically finds that instability is sensitive to the level of a nation's GNP, its GNP growth rate, the level of energy consumption per capita in the country, the extent to which its economy provides technical and professional jobs, and the level of investment in the nation's economy.[11] Taylor[12] suggests that the probability of revolutionary activity decreases with greater GNP per capita, and with greater rates of growth in GNP. The Feierabends[13] also argue that a positive rate of change in income is correlated with increasing internal stability.

This set of variables is best represented by the economic power-base descriptor within the context of our integrated forecasting model. As measures of the level of economic development, these variables are usually highly correlated, and are used here as components of a nation's economic power base. Accordingly, we hypothesize that high values of a nation's economic power base are related to low levels of internal instability in the nation, and vice versa.

International Alignment. It has been suggested that instability is related to the degree to which a nation is aligned with major powers.[14] Since

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[11] Ibid.

[12] Charles L. Taylor, "Turmoil, Economic Development and Organized Political Opposition" (paper delivered at the Annual Meetings of the American Political Science Association, September 1970).

[13] Feierabend and Feierabend, "Aggressive Behaviors Within Polities."

[14] Jonathan Wilkenfeld, "Domestic and Foreign Conflict," Conflict Behavior and Linkage Politics, ed. by Jonathan Wilkenfeld (New York: David McKay Company, Inc. 1973).

nations that are highly aligned with major powers are given added legitimacy by virtue of that alignment, and since, to some extent at least, their military forces are freed from external defense requirements for use in suppressing internal instability, we expect nations so aligned to evidence lower levels of observed instability than would otherwise be expected.

Again, however, the power base at a nation's disposal is expected to modify this relationship; nations that have the economic and military resources to deal with instability on their own need not depend upon alignment with major powers to help them suppress destabilizing activities. In short, we expect nations that are more aligned with major powers to show fewer signs of instability than would otherwise be expected, except when those nations have the resources to suppress that instability without the assistance of alignments.

Specifically, analysis of the international alignment descriptor yields measures of the extent to which nations are aligned with major powers.[15] We hypothesize, then, that internal instability varies inversely with the extent of a nation's major-power alignment, and that this relationship is mediated inversely by the summed value of a nation's economic and military power bases.

<u>Population</u>. Taylor suggests that the size of a nation is an important factor in accounting for its level of internal political disturbance. His hypothesis is that a state with more people has a greater probability of a high level of instability than does one with fewer people simply

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[15] See "International Alignment," Chapter 6 of this volume.

because there are more individuals who may become involved in destabilizing activities.[16] The present population of the nations examined in this study ranges from about 2 to 3 hundred thousand in Iceland and Luxembourg to more than 230 million in the Soviet Union. Such wide variation permits us to consider population as a potentially useful predictor of internal instability in the context of Eastern and Western Europe.

Exogenous Predictors of Internal Instability

In addition to the previously mentioned predictors of internal instability that are, themselves, descriptors of interest here, several predictors of instability will be examined that are exogenous, or outside, the integrated forecasting model. These variables lie outside the forecasting model since their values are predetermined with respect to that model. The exogenous predictors of instability considered here include previous levels of internal instability, negative government sanctions, and regular power transfers.

Previous Levels of Internal Instability. Nearly all empirical research into the causes of internal instability in nations reveals that previous levels of instability are strongly linked to the present level of internal instability.[17] Rubin, in fact, argues that past levels of domestic conflict are the dominant predictors of internal instability at any given

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[16] Charles L. Taylor, "Political Development and Civil Disorder" (paper presented at the Annual Meeting of the American Political Science Association, September 1969), p. 7.

[17] Gurr, "A Causal Model of Civil Strife"; Rummel, "Dimensions of Conflict Behavior Within Nations"; Tanter, "Dimensions of Conflict Behavior Within and Between Nations.".

point in time.[18] Obviously one can see that turmoil or revolutionary activity that began in one time period and continues into the next time frame under analysis produces a strong relationship between instability in the two time frames. Probably more significant, however, is the impact of arguments that justify internal instability on the basis of its past success.[19] That is, if a nation has a history of high levels of instability that has brought changes in governmental policies and practices, or in the governmental structure itself, that history of success provides an impetus for utilizing turmoil or revolt to solve present problems or to relieve present dissatisfactions. In short, successful use of destabilizing activities reinforces their use.

Previous levels of turmoil and revolt are measured in the same manner as the dependent variables under examination here. Event counts of riots and demonstrations are summed and subjected to a log (X + 1) transformation, and event counts of armed attacks are transformed to log (X + 1) as well. Both transformed event scores are then multiplied by the intensity weighting factor, computed by subjecting deaths due to domestic conflict to a log (X + 10) transformation.

Negative Government Sanctions. As noted earlier, we hypothesize that the level of internal instability in a nation is inversely related to the government's resources for suppressing such instability. Also of importance, however, is the government's willingness to employ political violence itself. Negative government sanctions are used as a

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18 Theodore Rubin, "Summary: Environmental Information Service" (Santa Barbara, Calif.: TEMPO), p. xv.

19 Gurr, Why Men Rebel.

measure of a nation's tendency to employ coercive capabilities to suppress perceived threats to the regime.

The two components of the level of negative government sanctions are (a) government executions; and (b) other government sanctions, defined as "...actions taken by the authorities to neutralize, suppress, or eliminate a perceived threat to the security of the government, the regime, or the state itself."[20] Other government sanctions, then, are themselves a summary measure comprised of censorship, restriction of political participation, and espionage activities of the regime in power.

We suggest that a history of high levels of negative government sanctions is directly related to the levels of present turmoil and revolt. That is, a nation with a history of numerous government sanctions is likely to experience a very high level of internal instability. Negative government sanctions are the government's contribution to the overall level of political violence that characterizes a particular society. While such sanctions are probably a reaction to previous levels of turmoil and revolt, we are particularly interested here in the degree to which they serve as a spur to further internal instability.

Consistent with our previous methodological discussion, let us note that negative government sanctions are a long-lagged exogenous variable. That is, the present level of government sanctions is not hypothesized to affect the present level of internal insecurity, but rather a history of government sanctions is expected to serve as a useful predictor of turmoil and revolt.

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[20] Charles L. Taylor and Michael C. Hudson, World Handbook of Political and Social Indicators II (First ICPR ed.; Ann Arbor, Michigan: Inter-University Consortium for Political Research, 1971), p. 15.

Regular Power Transfers. Major and minor regular transfers of power are used here as measures of the legitimacy of a nation's government. Gurr and McClelland suggest that the maintenance of authority, operationally defined as the replacement of governments without disruptive conflict, is a prime component of a regime's legitimacy, and that the degree of internal instability in a nation is negatively related to the degree of legitimacy bestowed upon the national government.[21]

A major regular power transfer is defined as, "...a change in the office of national executive from one leader or ruling group to another that is accomplished through conventional, legal, or customary procedures and unaccompanied by actual or directly threatened physical violence."[22] Minor regular transfers of power subsume events that modify the membership of a national executive body, but do not represent a transfer of formal power from one group or leader to another.[23] Minor transfers can be viewed as one way to adapt to perceived political pressures short of losing formal control of the government. They are similar to major transfers in that both measure the degree to which a government exhibits long-term flexibility and long-term legitimacy. As was the case with negative government sanctions, major and minor power transfers can be either responses to or causes of internal political instability. Again, however, we shall be concentrating our efforts on forecasting internal instability and shall view major and minor regular power transfers as predictors of instability.

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21 Gurr and McClelland, Political Performance: A Twelve-Nation Study.

22 Taylor and Hudson, World Handbook of Political and Social Indicators II.

23 Ibid., pp. 85-86.

Just as negative government sanctions are not expected to have instantaneous impacts on instability, regular power transfers are not viewed as simultaneous causes of internal instability. That is, we do not regard the occurrence of a regular power transfer, or a series of regular power transfers, as predicting relatively low levels of internal instability in the subsequent period. Rather, we view the history of power transfers in a nation as relevant to the forecasting of internal instability. We hypothesize that nations with histories of regular rather than irregular power transfers view their governments as relatively more flexible and are, accordingly, less susceptible to high levels of internal instability. Regular power transfers, then, fit into the category of a long-lagged predictor of internal instability.

ANALYSIS OF THE INSTABILITY MODEL

Nine variables, four of which are other central environmental descriptors, are initially selected as potentially useful predictors of internal instability. These nine are used to construct a postdictive regression model of internal instability. That equation, shown below, takes into account the hypothesized linkages between each of the nine predictors and the level of internal instability in nations. The equation is examined for two dependent variables--the levels of turmoil and revolt in the European nations--and is altered where necessary in accordance with criteria for good estimation.

$$Y_1 = \beta_0 + \gamma_1 Y_{1_{t-1}} + \gamma_2 \frac{(Y_2 X_3)}{Y_3} - \gamma_4 \frac{Y_4}{(Y_3+Y_5)} + \gamma_3 (Y_3+Y_5) + \beta_1 X_1$$

$$- \beta_2 X_2 + \gamma_6 Y_6 + \epsilon_1$$

where:

Y_1 = Strife (TURMOIL and REVOLT)

Y_2 = foreign trade as % GNP (TRADE)

Y_3 = economic power base (EPB)

Y_4 = level of major-power alignment (ALIGNR)

Y_5 = military power base (MPB)

Y_6 = population (POP)

X_1 = negative government sanctions (SANCTION)

X_2 = regular power transfers (POWTRAN)

X_3 = Michaely concentration ratio (MICHAELY)

Those predictors that do not evidence strong linkages with turmoil and revolution are removed from the final forecasting equation. Estimates of the direction and strength of the linkages for the remaining predictors are developed with minimum-information, maximum likelihood methods. These estimates are used to generate forecasts of the levels of turmoil and revolt for the European nations during the 1985-1995 time period.

Predictors with Weak Linkages to Instability

Several of the predictor variables hypothesized to be related to the levels of turmoil and revolt in the European nations are found initially to evidence extremely weak linkages to the level of internal instability in those countries. Those predictors are relative trade $\frac{\text{TRADE (MICHAELY)}}{\text{EPB}}$, national power base (EPB + MPB), international alignment ($\frac{ALIGNR}{EPB + MPB}$), population (POP), and regular power transfers (POWTRAN). Table 3 shows the squared correlation (R^2) of each of these excluded predictors with both turmoil and revolt.

As Table 3 suggests, national power base, international alignment, and regular power transfers appear virtually useless as predictors of either turmoil or revolt. Several reasons can be offered for the deviation of our results from previous findings and hypotheses.

TABLE 3

WEAK PREDICTOR VARIABLES

Predictor	R^2 with TURMOIL	R^2 with REVOLT
$\frac{\text{TRADE (MICHAELY)}}{\text{EPB}}$	.062	.036
EPB + MPB	.022	.004
$\frac{\text{ALIGNR}}{\text{EPB + MPB}}$	.017	.019
POP	.086	.039
POWTRAN	.003	.006

<u>National Power Base and Population</u>. As we noted earlier, national power base is hypothesized to be inversely related to the level of both turmoil and revolt in the European nations. The rationale for this hypothesis is that research has shown that the level of internal instability in nations varies inversely with the nation's ability to suppress

that instability.[24] Thus national power base, both its economic and military components, accurately reflects the resources at a government's disposal for suppressing instability. In short, our hypothesis is based upon the notion that as a nation's economic and military power bases increase, its ability to suppress internal instability also increases, and the level of turmoil and revolt that it in fact experiences decreases.

However, we also noted that larger nations typically experience higher levels of internal instability than do smaller nations because there are many more individuals who may become involved in destabilizing activities. This, in fact, was found to be the case in our analysis of the nations of Eastern and Western Europe.

The construction of the economic and military power-base indices, however, produces measures which are highly colinear with size. The economic power-base index is composed of gross national product, population, and energy consumption, while the military power-base index is composed of defense expenditures and military manpower. The result of this colinearity is that the positive relationship expected between instability and population and the negative relationship hypothesized between instability and power base cancel each other out. Table 4 shows correlation coefficients between the two measures of national power base and population. As these coefficients suggest, population and the two power-base measures are, in fact, highly related, so that colinearity could result in the disappearance of hypothesized relationships.

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[24] Gurr, "A Causal Model of Civil Strife."

TABLE 4

CORRELATIONS BETWEEN
POPULATION AND POWER BASE MEASURES

	EPB	MPB
POP	.946	.953

Table 5 shows the difference between the simple correlation coefficients between turmoil and revolt and population and national power base (EPB + MPB), and the partial correlations where population is controlled for national power base and power base, in turn, is controlled for population. Several things are worth noticing in Table 5.

TABLE 5

COMPARISON OF SIMPLE AND PARTIAL
CORRELATIONS FOR POWER BASE AND POPULATION

Instability Measures	Simple Correlations		Partial Correlations	
	POP	POWER BASE	POP	POWER BASE
TURMOIL	.293	.149	.529	-.479
REVOLT	.196	.065	.468	-.437

To begin, power base was hypothesized to be inversely related to the levels of turmoil and revolt experienced by nations. However, the simple correlations, which contain the colinearity between power base and population, show a positive relationship between power base and internal instability. Once population is controlled, as the partial correlations show, the direction of the relationship between power base and internal instability becomes negative, as hypothesized. The relationships between population and turmoil and revolt remain positive in direction, as hypothesized. Second, the colinearity between population and power base resulted in a depression of the magnitude of the relationships of each of these with turmoil and revolt. By itself, population explained only 8.6 percent of the variance in turmoil and 3.9 percent of the variance in revolt, while power base explained but 2.2 percent and 0.4 percent respectively. When combined into a multiple regression equation, however, these two predictors explain together 29.6 percent of the variance in turmoil and 22.2 percent of the variance in revolt.

Our analyses, then, suggest that both population and national power base affect the level of instability experienced by nations, both in the expected direction and with significant magnitude. Since those predictors are highly related, however, analysis of each of them separately yields inconclusive results; neither shows simple relationships with turmoil and revolt that are consistent with our hypotheses. Once the counteracting influences of population and national power base are pulled apart, however, the hypotheses are confirmed. In short, the larger a nation is in terms of population, the greater the probability that the nation will, in fact, experience high levels of internal instability. At the same time, larger nations possess greater capabilities to suppress such instability. As nations' resources for suppression increase, the probability that they will experience high levels of turmoil and revolt decreases.

<u>Trade.</u> We initially hypothesized that the more nations were

economically linked with other nations, the greater their expected level of instability. Specifically, we suggested that a measure combining the level of a nation's trade relative to its GNP, the concentration ratio of that trade, and its economic power base would be positively related to both turmoil and revolt. That measure, $\frac{\text{TRADE (MICHAELY)}}{\text{EPB}}$, was found to be negatively related to both measures of internal instability. However, when D-TRADE, the difference in a nation's trade from one year to the next, was examined, the relationship with both turmoil and revolt was positive, consistent with our initial hypothesis. It is important to note, however, that the relative trade measure varies inversely with measures of the nation's size, population, energy consumption, and the like. Thus, smaller nations depend upon the foreign sector for a larger part of their national income. And as we pointed our earlier, smaller nations have lower probabilities of internal instability since they have fewer individuals who can become involved in turmoil or revolt. In short, our hypothesis failed to recognize the linkage between trade and nation size, and resulted in misconceptualization of the linkage between trade and internal instability.

D-TRADE, however, is positively related to measures of a nation's size. Table 6 shows correlations of D-TRADE with gross national product, population, energy consumption (EN CONS), defense expenditures (DEFEX), and military manpower (MIL MANPOW). While D-TRADE is consistently and significantly related in a positive manner to these measures of nation size, it exhibits considerable variance (at least 85 percent) independent of nation size. When regressed upon turmoil and revolt controlling for population, the D-TRADE shows the expected positive linkage to both turmoil and revolt, although that linkage is not statistically significant for revolt.

TABLE 6

CORRELATIONS WITH D-TRADE

Components of Power	Correlations
GNP	.370
POP	.267
EN CONS	.329
DEFEX	.185
MIL MANPOW	.171

In short, because the construction of the original relative economic interdependence measure included within it a large component of variance attributable to nation size, that measure did not show expected linkages to turmoil and revolt, and was not particularly useful for forecasting internal instability. A surrogate measure, D-TRADE, proved more useful, particularly when country size was statistically controlled. That surrogate, however, predicted turmoil much more strongly than revolt. Our initial argument linking economic interdependence and internal instability rested upon the notion that as a nation became more economically interdependent with other countries, its economy became more penetrable, more susceptible to disruption from outside powers, and more prone to experience instability. Since turmoil is more likely to result from economic disruption than is revolutionary activity, it is not at all surprising that changes in trade predict turmoil more strongly than revolt.

International Alignment. We hypothesized that the greater a nation's major-power alignment, the lower the level of instability that nation would face. This argument is based upon the observation that more extensive major-power alignments both increase the legitimacy of a nation's government and free that government's political, economic, and military resources from external defense requirements so that they can be used to suppress internal instability. Of course, we expected that this relationship would hold more for relatively weak nations than for stronger nations. The measure constructed to test this hypothesis, $\frac{ALIGNR}{EPB + MPB}$, was intended to reflect this caveat. Frankly, that measure showed nearly zero relationship to either measure of internal instability, TURMOIL or REVOLT. International alignment explained only 1.7 percent of the variance in turmoil and only 1.9 percent of the variance in revolt.

It is important to realize that alignment can be an important determinant of the level of internal instability in a nation only when the level of such instability is very high relative to the nation's resources to suppress it. Thus, nations with typically low levels of turmoil and revolt, or with adequate power-base resources to deal with instability, have no incentive to increase their major-power alignments. For the European nations, only France, Italy, Great Britain, and Spain had consistently high levels of internal instability in the 1960's, and the first three of these nations were certainly able to suppress that instability without the need for extensive major-power alignments. And in Spain, the organization of that nation's resources for suppression maximized their effectiveness in this regard. In short, the conditions under which we would expect this hypothesis to hold simply are not found in Europe during the 1960's.

Regular Power Transfers. Much the same can be said for the hypothesized linkage between regular power transfers and internal instability.

We noted earlier that when a nation has a history of regular, rather than irregular, power transfers, those regular transfers serve as a means of adapting to political pressure, and tend to preclude the necessity for destabilizing activities. Of course, this notion is based on the assumption that, at least in some nations, irregular power transfers such as coups d'etat are the predominant means of transferring governmental power. As we noted above, however, coups are simply an unknown phenomenon in contemporary Europe where the processes of governmental change have become so regularized. In view of that, regular transfers of governmental power probably would not reflect the government's adaptability in the face of political demands and pressures. This is not to say, of course, that regular power transfers are not useful predictors of internal instability in other contexts. Certainly in those regions where coups occur often, namely, the Middle East and Latin America, a history of regular power transfers should predict negative levels of turmoil and revolt.

In fact, regular power transfers explained less than 1 percent of the variance in turmoil and revolt for the European nations. Moreover, the weak linkage that was found between regular power transfers and measures of internal instability was positive in nature; a history of many regular power transfers predicted, although extremely weakly, high levels of turmoil and revolt. This, too, makes sense in the European context where governments faced with high levels of instability are forced to call frequent elections, alter the constitutional schema, and otherwise change in form in response to political pressures.

Five predictors hypothesized to affect the level of internal instability in nations were initially found to exhibit extremely weak linkages with measures of turmoil and revolt. Three of those measures--population, national power base, and trade--are found to have the expected relationships with measures of instability only after the complex relationships between instability measures and predictors are unraveled. Two others--international alignment and regular power transfers--are found to be unrelated to internal instability in the European context because none of the European nations possessed the conditions under which the linkages were hypothesized to hold. What follows is a description of those hypothesized relationships between turmoil and revolt and predictor variables that were found, on initial analysis, to in fact hold.

Predictors with Strong Linkages to Instability

Only two predictor variables--past levels of instability and negative government sanctions--were found to have the strong, hypothesized linkages with measures of internal instability. The nature of the relationships between past instability and negative government sanctions and present levels of turmoil and revolt are discussed in some detail below.

Previous Levels of Internal Instability. As we noted previously, there is a large body of theoretical and empirical work that suggests that past levels of internal instability are strongly and positively related to present levels of turmoil and revolt.[25] Table 7 shows simple correlations of TURMOIL and REVOLT with TURMOIL (t-1) and

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[25] Gurr, "A Causal Model of Civil Strife"; Rummel, "Dimensions of Conflict Behavior Within Nations"; Tanter, "Dimensions of Conflict Behavior Within and Between Nations"; Rubin, "Summary: Environmental Information Service"; Gurr, Why Men Rebel.

REVOLT (t-1), and the simple correlation of TURMOIL with REVOLT. As the table suggests, last year's turmoil explains about 25 percent of

TABLE 7

CORRELATIONS AMONG INSTABILITY MEASURES

	TURMOIL	REVOLT	TURMOIL(t-1)	REVOLT(t-1)
TURMOIL	1.000			
REVOLT	.496	1.000		
TURMOIL(t-1)	.496	.415	1.000	
REVOLT(t-1)	.488	.464	.488	1.000

the variance in present turmoil, while previous levels of revolt explain nearly 22 percent of the variance in present levels of revolt. Nearly as strong is the relationship between previous levels of turmoil and present levels of revolt. High levels of turmoil in the immediate past predict high levels of revolt in the present. When controlling for present levels of turmoil, previous turmoil correlates with present revolt with R = .224. This finding suggests that high levels of turmoil can escalate in such a manner as to encourage revolutionary activity. That is, when a nation's populace engages in destabilizing activity aimed at altering governmental policies or practices, and when that activity continues over some period of time, it may escalate into attempts to replace the governmental policymakers, or alter the policymaking process itself. Not nearly as significant is the relationship between past levels of revolt and present levels of turmoil. When controlling for present revolt, the correlation between past revolt and present turmoil is only .146. This suggests that revolutionary activity, whether successful or unsuccessful, is a culmination of a series of destabilizing activities.

One of the more interesting observed relationships among these measures of internal instability is the strong linkage between levels of turmoil and revolt. The two measures of internal instability used here, TURMOIL and REVOLT, shared about 25 percent of variance in common. Revolt, in fact, is the single strongest predictor of turmoil, and turmoil the strongest and most consistent predictor of revolt. We interpret these results to indicate that one can not usefully view either turmoil or revolt <u>in vacuo</u>. Clearly, when a nation's populace is dissatisfied enough with its government's policies to attempt to replace its policymakers or alter its policymaking process, that populace is also amenable to changes in the present government's policies and practices. Equally likely, if a nation's populace is dissatisfied enough with governmental policies to trigger destabilizing activity, some members of that populace will also favor replacing policymakers or the policymaking process enough to engage in revolutionary activity.

In short, nations that experience one type or level of internal instability are also likely to experience others. Obviously, this is far from an astounding proposition. Nonetheless, it presents certain methodological problems in our analysis of internal instability. If it is possible to explain revolt adequately only with reference to turmoil, then some means of explaining turmoil independently of revolt needs to be found. However, if an adequate explanation of turmoil requires the utilization of revolt, a recursive explanation of revolt itself is not possible. This problem will be discussed in more detail when the descriptive and forecasting models for turmoil and revolt are considered.

Turmoil and revolt, then, tend to occur in conjunction. Moreover, previous levels of both turmoil and revolt affect present levels of revolt while present levels of turmoil are in part a function of previous turmoil. Knowledge about this year's levels of turmoil and revolutionary activity, then, provides a reasonably strong predictor of next year's levels of both types of internal instability.

Negative Government Sanctions. As we noted earlier, negative government sanctions are composed of government executions and other actions taken by government authorities to neutralize, suppress, or eliminate a perceived threat to the internal stability of the nation. Negative government sanctions are a government's contribution to the overall level of political violence in a country. While that contribution can be either a response to previously high levels of turmoil and revolt, or a spur to increased internal instability in the nation, or both, we view negative government sanctions in the context of a predictor variable. That is, we are concerned with the extent to which those sanctions contribute to increased internal instability.

Consistent with this view, and without methodological distinction between short- and long-lagged predictor variables, we regard a nation's historical patterns with respect to the implementation of these sanctions as an important predictor of present levels of turmoil and revolt. That is, we hypothesize that nations that have typically high levels of negative sanctions are more prone to internal instability than are nations with historically lower levels of negative government sanctions. As Table 8 indicates, our analysis suggests that positive and substantial linkages exist between historical levels of negative government sanctions and present levels of both turmoil and revolt for the nations of Eastern and Western Europe. Of course, a history of high levels

TABLE 8

CORRELATIONS WITH
NEGATIVE GOVERNMENT SANCTIONS

	TURMOIL	REVOLT
SANCTION	.272	.318

of negative government sanctions in a nation may, in part, reflect previously high levels of internal instability because such sanctions are often a response to turmoil and revolt. Even when past levels of turmoil and revolt are controlled, sanctions still evidence a .246 correlation with turmoil and a .218 correlation with revolt. In other words, a history of high levels of negative government sanctions contributes to present levels of internal instability independently of the high levels of previous instability that accompanied those sanctions.

Five variables initially hypothesized to be useful predictors of turmoil and revolt were found, indeed, to exhibit substantial linkages to those two measures of internal instability. Those five variables are population, national power base, fluctuations in international trade, previous levels of turmoil and revolt, and histories of negative government sanctions. Additionally, it was found that both types of internal instability, turmoil and revolt, tend to occur simultaneously. That is, a nation experiencing turmoil at the present time is also likely to be experiencing revolutionary activity; revolt is usefully seen as an escalation of turmoil activity.

The next two sections of this chapter will detail the construction of descriptive and forecasting models for both turmoil and revolt, combining these predictors to form viable regression models for those two dimensions of internal instability. The seventh section of the chapter will present postdictive results using the forecasting models for both turmoil and revolt. That will be followed by a concluding section that discusses the more important weaknesses of this effort and suggests improvements in long-range forecasting of domestic unrest.

DESCRIPTIVE MODELS OF INTERNAL INSTABILITY

As we noted earlier, turmoil and revolt tend to occur simultaneously. Describing a situation of that sort requires an analytic model that permits full feedback so that turmoil can be used as a predictor of revolt at the same time that revolt is being used as a predictor of turmoil. Such a model, then, requires simultaneous solution for both turmoil and revolt. Two-stage least squares regression analysis is ideal in this sort of situation since it allows full feedback between equations within a set of equations. If turmoil and revolt are each to be predicted from a multiple regression equation, two-stage least squares regression can be used to allow turmoil to be a predictor in the equation for revolt and revolt to be a predictor in the turmoil equation.

A Descriptive Model for Turmoil.

In addition to the above-mentioned predictors, the distribution of a nation's major-power alignment, ALIGNθ, is used here as a predictor of turmoil. That measure is the cosine of the major-power alignment vector and varies between 0.0 and 1.0, reaching 1.0 when a nation's major-power alignment lies totally with the Soviet Union. Of course, when ALIGNθ equals 0.0 the nation distributes its major-power alignment 100 percent with the United States. Essentially, ALIGNθ is used here as a nondichotomous measure of government type. As nations distribute their major-power alignment more with the Soviet Union, they tend to exhibit higher levels of totalitarian behavior. Thus, the observed strong negative relationship between turmoil and ALIGNθ is not surprising; the more totalitarian a nation's behavior is, the greater the nation's tendency to suppress riots and demonstrations, and the less likely it is that riots and demonstrations that do occur would be known to the outside world. Table 9 shows a ranking of the nations of Eastern Europe on ALIGNθ; all other nations have a score of less than .5 on that measure.

TABLE 9

RANKINGS ON ALIGNθ, 1950-1970

Rank	Country
1	Soviet Union
2	East Germany
3	Bulgaria
4	Hungary
5	Czechoslovakia
6	Romania
7	Poland
8	Yugoslavia

Moreover, theorists' notions concerning the linkages between the external conflict of nations and the level of their internal instability led to the use of a significant predictor in the descriptive equation for turmoil. Simmel, Wright, and Rosecrance[26] are among many social science theorists who argue that foreign conflict behavior of nations and their level of domestic instability are closely related. Some believe that foreign conflict, particularly when extensive, prolonged, and disliked by a nation's populace, can generate rather high rates of internal instability. Several empirical studies,[27] however, found little, if any, relationship between international conflict behavior and domestic instability. More recently, however, Wilkenfeld[28] found that under specified conditions, a very clear relationship does exist between a nation's external conflict and its level of internal instability.

The two-stage least squares equation used to describe turmoil for the nations of Eastern and Western Europe, then, contains ALIGN θ, total external conflict with European nations, revolt, population, military power base, and negative government sanctions. Table 10 shows the predictors of turmoil used in this descriptive model, their regression coefficients resulting from the two-stage least squares regression, the standard errors and t-statistics of those coefficients, and the explained variance of the equation.

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[26] George Simmel, Conflict and the Web of Group-Affiliations (Glencoe, Ill: The Free Press, 1955); Quincy Wright, A Study of War (2nd ed; Chicago: The University of Chicago Press, 1965); Richard Rosecrance, Action and Reaction in World Politics: International Systems in Perspective (Boston: Little, Brown and Co., 1963).

[27] Rummel, "Dimensions of Conflict Behavior Within and Between Nations"; Tanter, "Dimensions of Conflict Behavior Within and Between Nations"; Robert Burrowes and Bertram Spector, "The Strength and Direction of Relationships Between Domestic and External Conflict and Cooperation: Syria 1961-67," Conflict Behavior and Linkage Politics, Jonathan Wilkenfeld, ed. (New York: David McKay Co., Inc., 1973).

[28] Wilkenfeld, "Domestic and Foreign Conflict."

Two of the aforementioned predictors--previous levels of instability and trade--are not included in this final descriptive equation. Previous levels of instability proved to be highly colinear with the combination of present revolt, negative government sanctions, and population, and offered no additional explanatory value once those variables

TABLE 10

DESCRIPTIVE EQUATION FOR TURMOIL

Predictor	Coefficient	Standard Error	t-Statistic
Constant	-.18501	.09192	2.013
REVOLT	.61053	.46392	1.316
ALIGNθ	1.99450	1.26680	1.574
POP	.01348	.00514	2.621
MPB	-.00078	.00033	2.311
CONFLICT	.00344	.00230	1.499
SANCTION	.00138	.00069	1.997

were in the descriptive equation. Trade proved to be highly colinear with a combination of international conflict, ALIGNθ, and national military power base. Its inclusion in the equation in its present form did not improve the descriptive quality of that equation.

As a whole, this descriptive equation for turmoil is quite satisfactory. Each of the regression coefficients is larger than its respective standard error, and each predictor contributes significantly to the overall value of the equation. Moreover, the equation explains more than 65 percent of the variance extant in turmoil for the European nations.

A Descriptive Model for Revolt

Unfortunately, a satisfactory descriptive equation for revolt proved substantially more difficult to construct. This is primarily due, we think, to differences in the characteristics of turmoil and revolt for the European nations. While levels of turmoil in the European nations are reasonably regular from year to year, revolt appears to be a far more sporadic phenomenon. Nearly as important is the fact that the overall level of turmoil in those countries from 1950 to 1970 was about twice as high as the level of revolt during that same time. In short, turmoil is a regularized, recurring phenomenon that varies in scope and intensity from one country to another, but is reasonably consistent over time within nations. Thus, nations' characteristics, which also show wide variation across countries but high consistency over time, can be useful in predicting levels of turmoil. Revolt, on the other hand, exhibits no such temporal consistency. Table 11 shows the number of years during the 1960's in which revolutionary activities were reported for each European nation. Only a few of these nations--Great Britain, France, West Germany, Italy, Greece, Portugal, and Spain--had any reported revolutionary activities in half of the years of the 1960's. Most of the European nations, particularly those of Eastern Europe, had revolutionary events reported for only 1, 2, or perhaps 3 years. This temporal instability of reported revolt makes revolutionary activities difficult to predict from country characteristics.

Accordingly, most predictors of revolt are themselves event data. Four predictors are used in the descriptive equation for revolt, one of which, national military power base, can be classified as a country characteristic. The other three predictors are present levels of turmoil, past levels of revolt, and present levels of international conflict. The strongest of these predictors is present levels of turmoil. As we noted earlier, revolt most often occurs in conjunction with high levels of turmoil and can, in fact, be viewed as an escalation of turmoil

TABLE 11

NUMBER OF YEARS FOR WHICH REVOLUTIONARY ACTIVITIES WERE REPORTED

Nation	No. of Years	Nation	No. of Years
United Kingdom	6	Iceland	0
Austria	1	Ireland	4
BLEU	3	Portugal	7
Denmark	0	Spain	8
France	8	Turkey	3
West Germany	8	Yugoslavia	3
Italy	10	Bulgaria	2
Netherlands	2	Czechoslovakia	3
Norway	1	East Germany	4
Sweden	0	Hungary	1
Switzerland	2	Poland	4
Finland	0	Romania	1
Greece	6	Soviet Union	4

behavior. Table 12 shows the predictors of revolt used in this descriptive model, their regression coefficients resulting from the two-stage least squares regression, the standard errors and t-statistics of those coefficients, and the explained variance of the equation. As Table 12 indicates, each of the predictors of revolt has a coefficient substantially larger than its associated standard error; each regressor is statistically significant. Although the equation explains only about 55 percent of the variance in revolt in the European nations during the 1960's, it is surprisingly strong given the highly unstable nature of those revolutionary activities.

TABLE 12

DESCRIPTIVE EQUATION FOR REVOLT

Predictor	Coefficient	Standard Error	t-Statistic
Constant	-.03819	.03637	1.050
TURMOIL	.41905	.09129	4.590
REVOLT (t-1)	.31835	.07614	4.189
CONFLICT	.09586	.06566	1.460
MPB	-.00003	.00002	1.771

$R^2 = .5463$

FORECASTING MODELS OF INTERNAL INSTABILITY

The descriptive models of turmoil and revolt discussed previously are reasonably good approximations of the levels of these two kinds of internal instability for the European nations. As we alluded to earlier, however, they form a completely closed feedback system which is inappropriate for forecasting purposes. By that we mean simply that since turmoil is used to predict revolt, the level of turmoil in a nation must itself be established before forecasting revolt. However, since the descriptive turmoil model uses revolt as a predictor, the level of revolt must be known to generate a forecast value of turmoil for the European nations. In short, we need to know turmoil to forecast revolt, but we also need to know revolt to generate forecasts of turmoil.

Either turmoil or revolt must be forecast from country characteristics and past event data. That is, if turmoil can be forecast from country characteristics, past turmoil and revolt, and past international conflict, revolt can in turn be forecast partially from turmoil. Alternatively, revolt could first be forecast from these characteristics and lagged event variables, and turmoil forecast on the basis of revolt.

What is needed is to translate the fully simultaneous descriptive models of turmoil and revolt into block-recursive models that can be used for forecasting purposes. One of the types of instability must be forecast before future values for the other can be generated. Since turmoil is temporally more stable than revolt, it is much more strongly linked to country characteristics than is revolt. Furthermore, since revolt is often an escalation of turmoil behavior, we decided to predict turmoil first without using revolt as a predictor variable, and then to forecast revolt using turmoil as a predictor of revolt.

This decision, of course, means that the overall quality of the turmoil equation used for forecasting will be somewhat lower than the descriptive turmoil model while the two models for revolt will be nearly identical. However, since revolt tends to occur only in the presence of high levels of turmoil and since the turmoil equation is initially stronger than the revolt equation, it is in a much better position to withstand the debilitating effects of removing an important predictor variable.

A Forecasting Model for Turmoil

Six variables--population, past levels of internal strife,[29] ALIGNθ (t-1), past national military power base, D-TRADE, and negative government sanctions--are used in the turmoil forecasting model. Population, national military power base, previous strife (turmoil + revolt), and negative government sanctions are among the originally hypothesized predictors of turmoil. As we noted earlier, D-TRADE was utilized as an alternative measure of trade because the original measure, $\frac{\text{TRADE(MICHAELY)}}{\text{EPB}}$, was too highly colinear with nation size to be of value in a forecasting model that also included population. Again, ALIGNθ is used here as a nondichotomous surrogate for government type; the higher a nation's score on this measure the more likely that government will exhibit authoritarian tendencies. And authoritarian governments, clearly, are more prone to actively suppress turmoil.

Note that past national military power base has been substituted for present military power base in the forecasting model. The forecasting process required that turmoil be forecast before generating forecasts for defense expenditures and military manpower because turmoil itself is used as a predictor of those components of military power base. Since military power base is a highly consistent variable over time (the correlation of MPB with MPB(t-1) is .998), this substitution resulted in no substantial harm to the turmoil forecasting equation. Table 13 shows the predictors of turmoil included in this model, their coefficients, the standard errors and t-statistics of those coefficients, and the explained variance for the equation as a whole and its F-statistic.

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[29] Strife is computed by summing the turmoil and revolt scores for each nation. Thus, past strife equals $\text{TURMOIL}_{(t-1)} + \text{REVOLT}_{(t-1)}$.

TABLE 13

FORECASTING EQUATION FOR TURMOIL

Predictor	Coefficient	Standard Error	t-Statistic
Constant	.10479	.07111	1.474
POP	.01980	.00320	6.181
STRIFE(t-1)	.09153	.05528	1.656
ALIGNθ	-.25117	.10001	2.511
MPB(t-1)	-.00063	.00010	6.452
SANCTION	.00190	.00082	2.327
D-TRADE	-.00005	.00002	2.229

$R^2 = .4648$

$F = 17.801$

Each of the coefficients is substantially larger than its respective standard error, and each is statistically significant. Although the F-test of significance for the regression equation as a whole indicates that the regression is highly significant, this forecasting equation explains only 46.5 percent of the variance in turmoil, nearly 20 percent less than the descriptive equation for turmoil.

The reason for this substantial discrepancy in explained variance, of course, is the absence of revolt as a predictor of turmoil. Yet in order to actually generate forecasts of the central environmental descriptors under examination here, it is necessary to eliminate revolt as a predictor of turmoil. Alternatively, turmoil could have been eliminated as a predictor of revolt; but turmoil showed substantially more temporal stability than revolt, was much more strongly linked to country characteristics, and is more theoretically appropriate as a predictor of revolt than revolt is as a predictor of turmoil. Moreover, since the turmoil equation was initially stronger than the revolt equation, the reduction in explained variance in turmoil proved less costly to the overall value of the two internal instability models than would a similar reduction in explained variance in the model for revolt.

Table 14 shows the partial correlation coefficients of each of the six predictors with turmoil. Table 14 can be used to discern the relative

TABLE 14

PARTIAL CORRELATIONS WITH TURMOIL

Predictor	TURMOIL
POP	.487
STRIFE(t-1)	.148
ALIGN θ	-.221
MPB(t-1)	-.503
SANCTION	.205
D-TRADE	-.197

strength of the linkages between these predictors and turmoil, as well as the nature of the relationships between the predictors and levels of turmoil in the European nations. Clearly, population and national military power base have the strongest linkages to turmoil. Each explains about 20 percent of the variance in turmoil.

Three other variables each explain about 4 percent of that variance: ALIGN θ, negative government sanctions, and D-TRADE. Past levels of turmoil and revolt explain only 2 percent of that variance when these other predictors are controlled, far less than previous theoretical work and empirical studies would suggest. Remember, however, that simple correlations between turmoil and past turmoil and past revolt show an R^2 averaging about .25, that is, each of these components of past strife explains about 25 percent of the variance of turmoil. Obviously, some of that common variance is a function of the effects of other predictors included in the model. This is simply to say that the factors that contribute to turmoil in previous time periods also contribute to present levels of turmoil.

Table 14 also reveals that three of these predictor variables--population, past levels of turmoil and revolt, and negative government sanctions--are related positively to present levels of turmoil. That is, as population, previous levels of turmoil and revolt, and negative government sanctions increase, predicted levels of present turmoil also increase. The other three predictors included in the forecasting equation are inversely linked to present levels of turmoil. As nations become more economically interdependent, distribute their major-power alignment more with the Soviet Union, and increase their military power base, their predicted levels of present turmoil decrease.

Of course, with only 46.5 percent of the variance in present turmoil explained by the forecasting equation, that equation is far from absolutely reliable. In the following postdictive analysis, we will try to determine those nations for which it is reasonably accurate, and those for which it is highly inaccurate. That analysis will present means for evaluating the value of this model for forecasting turmoil in the nations of Eastern and Western Europe.

A Forecasting Model for Revolt

Five variables--present levels of turmoil, previous levels of revolt, present levels of international conflict, military power base, and GNP per capita--are used in the predictor equation for revolt. Only two of these predictors, military power base, and gross national product per capita, are country characteristics. The other three are measures of past revolutionary activity in the nation, present turmoil, which we noted earlier was the single most consistent and strongest predictor of revolt, and the level of the nation's present conflict with other actors in the European system.

Several predictor variables originally hypothesized to affect the level of internal instability in the European nations, some of which, in fact, were found to affect nations' levels of turmoil, are not included in the equation for revolt. Each of these variables--population, ALIGN θ, the nation's history of negative government sanctions, and trade--is a predictor of the country characteristic type. Once present levels of turmoil are used to predict present levels of revolt, these variables do not add significant explained variance to the forecasting equation.

In addition to the previously discussed predictor variables, gross national product per capita is used as a predictor of revolt in this forecasting equation. GNP per capita relates inversely to levels of revolt in the European nation; the wealthier a nation, the lower the probability that it will experience high levels of revolutionary activity. If GNP per capita is viewed as an improved relative measure of wealth, it can be seen as a substitute for the hypothesized linkage between instability and GNP. Table 15 lists the predictors of revolt included in this forecasting model, their regression coefficients, the standard

TABLE 15

FORECASTING EQUATION FOR REVOLT

Predictor	Coefficient	Standard Error	t-Statistic
Constant	.05907	.06089	0.970
TURMOIL	.34192	.05225	6.544
REVOLT(t-1)	.36825	.06710	5.488
CONFLICT	.14614	.06077	2.405
MPB	-.00003	.00002	1.607
GNP/POP	-.00004	.00003	1.469

$R^2 = .5270$

$F = 33.419$

errors and t-statistics of those coefficients, and the explained variance for the equation as a whole and its F-statistic. Each of the regression coefficients is substantially larger than its respective standard error, and the regression equation as a whole is quite significant statistically, as indicated by the size of its F-statistic. However, this forecasting model for revolt explains only slightly more than 50 percent of the variance in revolt for the nations of Eastern and Western Europe. Rather obviously, then, the forecasting model developed here is differentially effective for the nations of Europe.

Table 16 shows the partial correlation coefficients of each of these five predictor variables with levels of revolt. These coefficients can be used to discern the relative strength of the linkages between individual predictors and revolt as well as the nature (direction) of those relationships. As Table 16 indicates, present levels of turmoil

TABLE 16

PARTIAL CORRELATIONS WITH REVOLT

Predictor	REVOLT
TURMOIL	.471
REVOLT(t-1)	.409
CONFLICT	.193
MPB	-.130
GNP/POP	-.119

and previous levels of revolt are by far the strongest and most reliable predictors of revolt for the European nations. Not only are the ratios of coefficient size to standard error (their t-statistics) substantially larger for these two predictors than for any others, indicating highly reliable predictors, but together they account for nearly 34 percent of the variance in revolt. The other three predictors--conflict, military power base, and gross national product per capita--each account for between 1 and 4 percent of the variance in revolt. Obviously, if revolt is primarily an escalation of high levels of turmoil, the existence of such turmoil and the past tendency for such escalation to occur in a nation should be the predominant predictors of levels of revolt. That, in fact, seems to be the case.

Each of the predictors included here exhibits the hypothesized linkage with revolt. Present turmoil and past levels of revolt, of course, predict positively to high levels of revolutionary activity. International conflict also predicts positively to levels of revolt; as nations become more embroiled in international-conflict situations while they are already experiencing high levels of turmoil, attempts to replace policy-makers are likely. As was the case for turmoil, military power base exhibits an inverse relationship with levels of revolt. Nations with greater resources for suppressing revolutionary activity are likely to experience lower levels of such activity. As we noted earlier, revolt was also found to vary inversely with GNP per capita. Relatively wealthier nations are rather unlikely to experience revolutionary activity; nations with more vulnerable economies are also more politically vulnerable.

These two equations are utilized within the integrated model to forecast levels of turmoil and revolt for the European nations. Although each of the equations contains coefficients relating predictors to turmoil and revolt which are in the expected directions, neither explains substantially more than 50 percent of the variance in these two types of internal instability. The next section of this analysis contains the results of postdictions using these two forecasting equations. Consideration of those results will yield more precise information concerning the reliability of these forecasting models for the various nations of Eastern and Western Europe.

POSTDICTIONS OF INTERNAL INSTABILITY

Once the forecasting models for turmoil and revolt are developed, they are used to generate "expected" values of those two types of internal instability for the European nations. The two equations are used to "predict" levels of turmoil and revolt for the 1960's. These "predicted" values are then compared with actual levels of turmoil and revolt for that time period to determine for which nations the forecasting models prove especially accurate, and where they may be inadequate. This postdiction process produced information that can be used to determine the reasons for various apparent inadequacies.

Specifically, data on each of the variables are available for the 10 years from 1961 to 1970 inclusive. Thus, turmoil and revolt are postdicted for these 10 years. For each of the 26 nations included in this study, the series of 10 postdicted values of turmoil and revolt is compared with the actual levels of internal instability experienced during that time period.

Postdictions of Turmoil

Table 17 shows the mean of the absolute value of the residual for the turmoil equation for each of the European nations.[30] In addition, the table ranks the 26 European nations according to the size of their mean residuals; the nations with lower ranks are those with the smaller differences between predicted and actual levels of turmoil. The direction of the error in postdiction for the 26 nations is also shown. Thus, a nation whose direction is "high" is one for whom postdicted levels of turmoil are typically higher than actual levels. The direction of error is determined by counting the number of a nation's postdicted values that are "high" and the number that are "low." A nation is classified as having high postdictions if the number of "high" postdictions exceeds its number of "low" postdictions.

As Table 17 shows, there is no apparent pattern to the distribution of

[30] The residual is computed by subtracting the observed from the "predicted" value. Thus, the absolute value of the residual ignores its sign, and measures only its magnitude.

TABLE 17

POSTDICTIVE RESULTS BY COUNTRY

Country	Rank	Residual abs(Actual-Predict)	Direction of Error
Iceland	1	.0738	High
Hungary	2	.0746	High
Finland	3	.0758	High
Bulgaria	4	.1139	High
Sweden	5	.1264	High
Denmark	6	.1346	High
Netherlands	7	.1468	High
Romania	8	.1626	High
Switzerland	9	.1755	High
Norway	10	.1958	High
Yugoslavia	11	.2015	High
Italy	12	.2161	Low
West Germany	13	.2406	High
Austria	14	.2619	High
BLEU	15	.2650	Low
Soviet Union	16	.2794	High
Spain	17	.2998	Low
Portugal	18	.3061	High
Ireland	19	.3391	High
East Germany	20	.3432	High
Greece	21	.3451	Low
United Kingdom	22	.3531	High
Czechoslovakia	23	.3580	Low
Turkey	24	.3827	High
Poland	25	.4243	Low
France	26	.4410	Low

countries by the magnitude of their error in the postdiction of turmoil. Although two of the large Western European nations, the United Kingdom and France, have substantial error, others, including West Germany, Italy, and Sweden, have much smaller error in the turmoil postdiction. The Eastern European nations are also distributed relatively evenly in terms of their turmoil postdiction error, with Bulgaria, Romania, Yugoslavia, and the Soviet Union having fairly small amounts of error, while East Germany, Czechoslovakia, and Poland show rather substantial postdiction error.

An examination of the magnitude of postdiction error with reference to the five central environmental descriptors under study here, however, reveals some interesting patterns. Table 18 shows correlations of the

TABLE 18

CORRELATIONS WITH TURMOIL RESIDUALS

Predictor	Turmoil Residuals abs(Actual-Predict)
EPB	.11
MPB	.06
TURMOIL	.31
REVOLT	.34
ALIGNR	.08
ALIGNθ	-.05
TRADE	.08
CONFLICT	.30

absolute value of turmoil residuals (absolute value of actual minus predicted scores) and the components of the descriptors under examination. Clearly, nations that have high levels of internal instability show larger postdiction error than those that have lower levels of actual domestic unrest. In addition, nations that experience extensive international conflict show larger postdiction error for turmoil. This latter finding suggests that international conflict is related to turmoil in such a manner as to disrupt the regular patterns of relationships among turmoil and its predictors. Since conflict is not found to be related systematically to levels of turmoil within the model, however, this finding is of little use in improving the forecasting model.

Table 19 classifies the 26 European nations according to the accuracy of the postdictions of their levels of turmoil. Thirty-four percent of

TABLE 19

CLASSIFICATIONS BY ACCURACY OF TURMOIL POSTDICTION

Poor (res>.28)	Fair (.28>res>.17)	Excellent (.17>res)
Czechoslovakia	Austria	Bulgaria
East Germany	BLEU	Denmark
France	Italy	Finland
Greece	Norway	Hungary
Ireland	Soviet Union	Iceland
Poland	West Germany	Netherlands
Portugal	Yugoslavia	Romania
Spain		Sweden
Turkey		Switzerland
United Kingdom		

those countries have excellent postdictions, 27 percent have fair postdiction results, while 39 percent have rather poor postdiction results. Unfortunately, several of the more important European nations with high levels of instability are among those with poor postdiction results, namely, East Germany, France, Greece, Spain, and the United Kingdom. The postdiction for Czechoslovakia is poor only because of the aberrant situation there in 1968; generally Czechoslovakia shows rather low levels of internal instability.

Table 20 classifies those 26 European nations according to whether the postdicted values typically lie above the observed levels of turmoil

TABLE 20

DIRECTION OF TURMOIL POSTDICTION ERROR

Low	High
BLEU	Austria
Czechoslovakia	Bulgaria
France	Denmark
Greece	East Germany
Italy	Finland
Poland	Hungary
Spain	Iceland
	Ireland
	Netherlands
	Norway
	Portugal
	Romania
	Sweden
	Switzerland
	Turkey
	Soviet Union
	United Kingdom
	West Germany
	Yugoslavia

for that nation (high), or whether they are generally lower than the actual levels of turmoil (low). For most of the European countries, levels of turmoil are lower than those postdicted by the forecasting model. Several nations which typically experience high levels of turmoil--France, Greece, Italy, and Spain--have postdicted values lower than actual values. In short, the model tends to overestimate turmoil for those nations with low to moderate levels of actual turmoil, and to underestimate turmoil for those nations that typically experience substantial internal instability.

Table 21 shows cross-classifications between the magnitude and direction of postdiction error. As that table suggests, there exists an apparent linkage between the direction and quantity of postdiction error,

TABLE 21

DIRECTION VS. QUANTITY OF POSTDICTION ERROR

Direction of Postdiction Error	Accuracy of Postdiction		
	Poor	Fair	Excellent
High	5	2	0
Low	5	5	9

$X^2 = 6.087 \quad p < .05$

that is, between the nature and quality of forecasts of turmoil. Countries whose forecasts could be classified either "excellent" or "fair" have typically lower postdicted values of turmoil than observed levels; nations with "poor" postdictions are equally divided between low and high postdictions. A chi-square test of significance reveals that there is less than a 5 percent probability that this relationship can be attributed to random factors. In short, nations that typically experience low levels of turmoil have rather accurate postdictions; and to the extent that postdicted values differ from actual values, they fall below actual values. Thus, for nations with typically lo levels of turmoil, the forecasting model is quite accurate; when it does err, it errs on the conservative side. Nations that often experience high levels of turmoil, on the other hand, often have rather poor postdictions, and those postdictions do not show consistent errors. For such countries, the model provides rather inadequate postdiction results. Unfortunately, this latter group includes some of the more important European nations--Czechoslovakia, East Germany, France, Greece, Spain, and the United Kingdom.

Postdictions of Revolt

Table 22 shows the mean of the absolute value of the residuals (predicted minus actual values) of revolt for each of the European nations. In addition, the nations are ranked by their absolute residual; nations with lower ranks show smaller differences between their postdicted and actual levels of revolt than do those nations with larger ranks. Again, the typical direction of the postdiction error, determined by counting "high" and "low" predictions, is also shown for these 26 European nations. Note that, contrary to the turmoil postdictions, the nations are nearly split between those showing high postdictions and those showing low postdictions, with 58 percent of the 26 countries falling into the former category and 42 percent into the latter.

TABLE 22

POSTDICTIVE RESULTS BY COUNTRY

Country	Rank	Residual abs(Actual-Predict)	Direction of Error
Hungary	1	.0313	High
Iceland	2	.0533	Low
Norway	3	.0637	Low
Netherlands	4	.0664	High
Romania	5	.0781	High
Finland	6	.0806	Low
Sweden	7	.0871	Low
Bulgaria	8	.0897	High
Yugoslavia	9	.1033	High
Denmark	10	.1145	Low
Switzerland	11	.1401	Low
Soviet Union	12	.1699	High
Poland	13	.1863	High
Italy	14	.2323	Low
BLEU	15	.2347	High
Czechoslovakia	16	.2456	High
Austria	17	.2486	High
West Germany	18	.2591	High
United Kingdom	19	.2836	High
Turkey	20	.3101	High
Ireland	21	.3131	High
Spain	22	.3513	Low
Greece	23	.3686	Low
Portugal	24	.3687	Low
East Germany	25	.3871	High
France	26	.3911	Low

Table 23 classifies those 26 countries according to whether their postdictive results are excellent (38%), fair (35%), or poor (27%). Although most of these nations evidence excellent or fair postdictive results, and those with poor results are the smallest group, some rather important nations in terms of revolutionary activity do have discouraging postdictions. Among this group are East Germany, France, Greece, and Spain. Note that many of the nations for whom turmoil postdictions are discouraging also have rather poor revolt postdiction results; this is primarily a function of the fact that turmoil is used here as an important predictor of revolt.

TABLE 23

CLASSIFICATIONS BY ACCURACY OF REVOLT POSTDICTION

Poor (res >.30)	Fair (.30 > res >.12)	Excellent (.12 > res)
East Germany	Austria	Bulgaria
France	BLEU	Denmark
Greece	Czechoslovakia	Finland
Ireland	Italy	Hungary
Portugal	Poland	Iceland
Spain	Switzerland	Netherlands
Turkey	Soviet Union	Norway
	United Kingdom	Romania
	West Germany	Sweden
		Yugoslavia

Note that most of the countries that experience "excellent" results on postdictions of turmoil--Bulgaria, Denmark, Finland, Hungary, Iceland, Netherlands, Romania, and Sweden--also show excellent postdiction results for revolt. Table 24 shows a comparison of the ranks of each of the 26 European nations by the magnitude of postdiction error for turmoil and revolt. The striking relationship between rankings of error magnitudes for turmoil and revolt should not, however, be surprising since turmoil is used as an important predictor of revolt. For some of these nations, however, there are substantial differences in these rankings. That group includes Norway, West Germany, Spain,

TABLE 24

COMPARISONS OF RANKS BY MAGNITUDE OF POSTDICTION ERROR

Country	Turmoil	Revolt
Iceland	1	2
Hungary	2	1
Finland	3	6
Bulgaria	4	8
Sweden	5	7
Denmark	6	10
Netherlands	7	4
Romania	8	5
Switzerland	9	11
Norway	10	3
Yugoslavia	11	9
Italy	12	14
West Germany	13	18
Austria	14	17
BLEU	15	15
Soviet Union	16	12
Spain	17	22
Portugal	18	24
Ireland	19	21
East Germany	20	25
Greece	21	23
United Kingdom	22	19
Czechoslovakia	23	16
Turkey	24	20
Poland	25	24
France	26	26

Portugal, East Germany, and Czechoslovakia. This finding suggests that the relationship between turmoil and revolt is not as strong for those nations as for others. Czechoslovakia has a rather high level of revolutionary activity compared to the level of turmoil it typically experiences; the other nations in that group experience comparatively more turmoil than revolt.

Table 25 shows correlations between the absolute value of the revolt residuals (actual revolt minus postdicted revolt) and components of

TABLE 25

CORRELATIONS WITH REVOLT RESIDUALS

Predictor	Revolt Residuals abs (Actual-Predict)
EPB	.04
MPB	-.01
TURMOIL	.32
REVOLT	.50
ALIGNR	.03
ALIGNθ	-.25
TRADE	.30
CONFLICT	.08

the five central environmental descriptors under examination here. As was the case with turmoil, postdictions of revolt are most inaccurate when a country experiences typically high levels of domestic strife, particularly revolutionary activity. In addition, as we noted in the case of turmoil residuals, postdictions of revolt become more inadequate as nations become more involved in international conflict situations, perhaps because such involvement disrupts the regularized relationships among variables that allow adequate prediction of revolt. Again, however, since conflict is not itself systematically related to revolt within the model, this finding is of little value in improving the revolt forecasting model.

In addition to the findings that are similar to, and in part a function of, turmoil postdiction, we notice a significant negative relationship between ALIGNθ and inaccuracies in the revolt postdictions. Since ALIGNθ, the distribution of nations' major-power alignments, essentially measures the extent to which nations align themselves with the Soviet Union, this finding leads us to conclude that postdictions of revolt are more accurate for Eastern European than for Western European nations. Note, however, that Eastern European nations typically experience lower levels of observed revolutionary activity than do the Western European countries. Thus, this linkage may simply reflect the relationship previously observed for both turmoil and revolt; the greater the level of actual internal instability in nations, the less accurate the postdictions of instability.

Table 26 classifies the European countries according to whether the postdictions of revolt are high or low. Unlike the case for turmoil, the 26 countries are fairly evenly split between those whose postdictions are high (58%), and those whose postdictions are low (42%). What is interesting, however, is that the postdictions for all the Eastern European nations are high; these countries consistently experience a lower level of revolutionary activity than is predicted by

TABLE 26

DIRECTION OF REVOLT POSTDICTION ERROR

Low	High
Denmark	Austria
Finland	BLEU
France	Bulgaria
Greece	Czechoslovakia
Iceland	East Germany
Italy	Hungary
Norway	Ireland
Portugal	Netherlands
Spain	Poland
Sweden	Romania
Switzerland	Turkey
	Soviet Union
	United Kingdom
	West Germany
	Yugoslavia

our forecasting model. Again, however, these nations typically experience very low levels of observed revolt. A model that overestimates revolt for countries that experience very little revolt, and underestimates revolt for those nations that actually experience a substantial amount, can be expected to produce these results.

As Table 27 reveals, however, there is no significant relationship between the direction and magnitude of postdiction error. In short, there is no reason to suspect that because forecasts of revolt for any particular nation are inaccurate, they are biased in any specific direction.

Essentially, the forecasting model for revolt provides reliable forecasts

TABLE 27

DIRECTION VS. QUANTITY OF POSTDICTION ERROR

Direction of Postdiction Error	Accuracy of Postdiction		
	Poor	Fair	Excellent
High	3	2	5
Low	4	7	5

$X^2 = 1.622 \quad p > .50$

for nations that typically experience rather low levels of observed revolutionary activity. These include all the Eastern European nations except East Germany and the large, important Western European nations except France, Spain, and Greece. Unfortunately, these four are among the most theoretically interesting and policy-relevant nations in Europe, particularly France and East Germany. This situation, however, is the same as that observed for turmoil, and results in part because turmoil is used, for both strong theoretical and methodological reasons, as an important predictor of levels of revolutionary activity.

CONCLUSION

We have reported here on an effort to develop a quantitative forecasting model for internal instability for 26 nations of Europe. Instability has been forecast as one of five central environmental descriptors, which together form a simultaneous forecasting model so that forecasts of one descriptor can be used in generating forecasts of others. Two models of internal instability were developed here: a fully simultaneous descriptive model that provided a very accurate representation of the generation of internal instability in these nations; and a partially simultaneous, block-recursive model that, although not as accurate in accounting for differential levels of instability among these nations, could be used to generate forecasts for the 1985-1995 time period.

Instability was initially conceptualized with two distinct components: turmoil and revolt. Turmoil was defined as those destabilizing activities aimed at altering governmental policies or practices and was operationalized by antigovernment riots and demonstrations and deaths resulting from political violence. Revolt was defined as those destabilizing activities aimed at replacing governmental policymakers or altering the structure of the policymaking process itself, and was operationalized by antigovernment armed attacks and deaths. These distinctions were not based on the expressed intentions of participants who engage in destabilizing activities, but rather on the large body of theoretical and empirical literature on internal instability. This distinction, however, was found to be rather artificial within the European context. For the nations of that region, turmoil and revolt can be more usefully viewed as two different levels of internal instability rather than different types of instability. Clearly, turmoil and revolt are strongly linked within Europe; nations that experience very high levels of turmoil are likely to experience revolutionary activities. Conversely, revolt is unlikely in the absence of high levels of turmoil.

A number of variables hypothesized to affect the levels of turmoil and revolt in nations are examined with respect to their linkages with these two measures of internal instability in the 26 European nations. Descriptive models of turmoil and revolt are developed which are estimated with the use of two-stage least squares regression. These models explain 66 percent and 55 percent of the variance in turmoil and revolt respectively. However, these models can not be used for forecasting purposes because they use turmoil as the primary predictor of revolt while revolt is used as a predictor of turmoil. It is necessary to develop recursive models which allow one of these types of instability to be forecast from country characteristics and previous levels of instability, utilizing the first as a predominant predictor.

Unfortunately, the recursive models are not nearly as effective in accounting for turmoil and revolt in the European nations as were the fully simultaneous descriptive models The forecasting equations developed explain only 46 percent and 53 percent of the variance in turmoil and revolt respectively. The difference between the descriptive and forecasting models points out clearly the fundamental problem in forecasting internal instability: destabilizing activities occur simultaneously. When a nation experiences very high levels of turmoil it is also likely to experience revolt. However, the linkage between characteristics of the countries and their levels of experienced instability is much weaker. Given knowledge of country size, level of economic wealth, level of military strength, international alignment, and international conflict, the analyst can forecast the nation's level of internal instability only within wide bounds. But once the analyst knows that the nation is experiencing or will experience one kind or level of instability, he can with confidence forecast the existence of other types of instability.

There are several theoretical and methodological reasons for this weak linkage between nations' characteristics and their measured levels of turmoil and revolt. Clearly, measures of turmoil and revolt, which take into account only numbers of riots, demonstrations, armed attacks, and deaths from political violence, miss large and constantly growing components of internal instability. During the last few years terrorist acts have become a major facet of domestic strife, even in the European nations, and these acts are simply not reported in the data sources at our disposal.

Just as important are the reporting biases that characterize all major world newspapers, in our case the New York Times. Because we rely on our primary data source for information, we do not have data on the actual number of destabilizing activities that occurred in the European nations. Obviously, not everything that occurs in every European nation is reported; in fact, there are reasons to believe that the patterns of reporting are systematically biased so that more of the extant instability is reported for some nations than for others. As we noted earlier, we attempt here to construct measures of turmoil and revolt that minimize the effects of these systematic biases. Nonetheless, they are certain to affect our results.

Frankly, the data that we have available for analyzing patterns of internal instability in the European nations are not of sufficient quality to permit reliable forecasting of actual levels of turmoil and revolt in those countries. What makes this situation especially unfortunate is that our forecasting methods are most unreliable precisely for those nations that typically have high levels of reported turmoil and revolt. For nations that usually do not have high levels of reported instability, the forecasting models produce quite accurate and acceptable results;

for those with high levels of reported turmoil and revolt, particularly sporadic reports of instability, the forecasts are much less accurate. In the case of turmoil, forecasts for this group of nations usually underestimate the extent of instability that the nation will experience.

In addition, it is precisely those nations that have the highest levels of turmoil and revolt that are most theoretically interesting and important from a public-policy standpoint. Thus, as the importance of nations increases, the reliability of forecasts of the level of their internal instability decreases.

What we are faced with here is the classic forecasting trade-off between precision and reliability. If we were to attempt to make exact forecasts of expected levels of turmoil and revolt for the European nations, those forecasts would be less than completely reliable. Such an attempt would certainly lack credibility. This does not mean that less precise forecasts would be equally unreliable. In fact, the models developed here are certainly reliable enough to allow forecasts of the relative levels of internal instability in the European countries during the period 1985 to 1995. That is, we can classify those nations according to whether they will experience high or low levels of turmoil and revolt relative to one another with a more than reasonable degree of reliability.

It is important to realize that those are precisely the kind of forecasts most appropriate for policymaking and policy evaluation; expectations about comparative levels of instability can properly focus the attention of policymakers on the development of long-range plans and contingencies. Increasingly precise forecasts about the absolute levels of turmoil and revolt expected for a group of countries are of little marginal use in the policymaking process. For long-range planning and policymaking, the classic forecasting trade-off clearly favors reliability over precision. The models developed here, then, are both reliable and credible in the context of long-range planning and policymaking requirements.

CHAPTER 4: INTERNATIONAL TRADE

Throughout the 20th century the world has witnessed the increasing importance of trade and its influence upon both domestic and foreign policy formulation. There have been marked shifts in evaluating the costs and benefits of this trade, from the protectionist period of the 1930's to the current trade-promoting system ushered in under the Kennedy Round of the General Agreement on Trade and Tariffs (GATT). Recent events such as the rise of the European Community, the devaluation of the dollar, and the increased trade between the United States and the Soviet Union are but a few examples of issues that have generated considerable attention for both scholars and policymakers alike.

The influence of trade in the international environment can be viewed in two ways. International trade may be considered a useful predictor of many international relations phenomena, such as patterns of international alignment and international conflict. In addition, trade may serve as an indicator of economic interdependence among nations, that is, a measure of the extent to which nations depend on international exchanges of goods and services for their economic prosperity. The recent world energy crisis and its linkage to the importance of Middle Eastern oil is a case in point.

Trade may also have a direct impact on the welfare of a nation. The magnitude of present-day trade is 10 times what it was 3 decades ago.[1]

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1 Based upon figures of total world exports. Figures in U.N. Statistical Yearbook, 1971.

This sheer volume of trade itself has numerous implications such as the propensity of a nation to increase its exports and imports, the increased number of social contacts among trading partners, and a general realization of the utility of international trade for the well-being of every nation. Trade, then, has become a determinant of many other important aspects of relations among nations.

We have briefly noted the role that international trade may play in the broader spectrum of international relations. It might be useful at this time to take a closer look at the fundamental economic theories that attempt to explain the occurrence of trade. These theories can be divided into three groups: the classical theories, the Heckscher-Ohlin theory, and the modern theories. According to the classical economists, namely Adam Smith, David Ricardo, John Stuart Mill, and their contemporaries including Marx, international trade occurs when differences in production costs exist among countries.[2] These differences are thought to occur when trading nations employ different production techniques for the same products. Differences in production costs are divided into absolute differences and relative or comparative differences. In the former case, if two countries produce two goods and one country is more efficient in the production of one good while the other country is more efficient in the production of the other good, then trade is said to benefit both. This example is illustrated in Table 1. In this example, the United States is more efficient in food production while Great Britain is more efficient in cloth production.

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[2] For a good discussion of the forces behind international trade, see D. Snider, Introduction to International Economics (5th ed.; New York: Richard D. Irwin, Inc., 1971), pp. 17-27.

TABLE 1

CASE OF ABSOLUTE ADVANTAGE

Country	Food[a]	Cloth[a]
United Kingdom	6	13
United States	10	5

[a] One labor-day produces respective units of food and cloth in each country

Ricardo and Mill refined the theory of absolute advantage and showed that specialization in production and trade would be beneficial even if the United States were more efficient in both food and cloth production. This means that trade would benefit both countries as long as differences in relative or comparative costs exist. This is shown in Table 2.

TABLE 2

CASE OF COMPARATIVE ADVANTAGE

Country	Food[a]	Cloth[a]
United Kingdom	15	10
United States	30	15

[a] One labor-day produces respective units of food and cloth in each country.

The example indicates that the United States could outproduce Great Britain in both food and cloth production. Yet this is not the case since the United States would specialize in the production of food. This phenomenon arises because the price of cloth in terms of food is less in Britain (15/10=1.5) than in the United States (30/15=2). On the other hand, the price of food is less in the United States (15/30= 0.5) than in Great Britain (10/15=0.7). Thus both countries could acquire more food and cloth if they would specialize and trade. For every unit of cloth the United States produces, it must give up 2 units of food; yet the British must give up only 1.5 units of food for every unit of cloth they manufacture. Thus, by specializing in food production, the United States would only need to pay the British 1.5 units of food for each unit of cloth. By trading, the United States would save half a unit of food for every unit of cloth it imports. Similarly, Great Britain would benefit by specializing in cloth production and exchanging cloth for food with the United States.

The classical theory never successfully explained why differences in costs of production arise. It took another 70 years after Ricardo's death before two Swedish economists, Heckscher and his student Ohlin, developed the so-called factor proportion theory of international trade.[3] This theory states that differences in relative prices between countries exist because different countries are endowed with factors of production that are quantitatively and qualitatively distinct. A country tends to export commodities that use its abundant factors intensively and import goods that use its less available factors. These

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[3] For a thorough discussion of the Heckscher-Ohlin theory, see Harry G. Johnson, "Factor Endowments, International Trade and Factor Prices," The Manchester School of Economics and Social Studies (September 1957).

differences reflect differences in production costs because the ratio of the price of capital to the price of labor is high in countries richly endowed with labor. Thus differences in factor endowment are both necessary and sufficient conditions to explain the occurrence of trade. An important difference between the classical theory and the factor proportion theory involves production functions (or techniques of production). The factor proportion theory assumes that production techniques for a particular commodity are similar the world over, though they may differ in factor intensity. The classical theory, on the other hand, assumes that different production functions exist between different countries. The former assertion is a reasonable assumption since multinational corporations have enhanced the transfer of technology between countries.

Modern theories of international trade are more concerned with the types of commodities that are traded given the presence of differences in comparative costs. Kravis, an American economist, believes that the commodity composition of trade is determined by the availability of various commodities at home.[4] Trade tends to be confined to goods that are not available domestically. There are basically two reasons for the absence of certain commodities in certain countries. First, these commodities, which are usually raw materials, may be nonexistent in a particular country. Japan, for example, does not produce petroleum products because it is not endowed with oil deposits. Second, certain commodities that can be produced domestically are nevertheless imported because they can only be produced domestically at very high costs. The United States, for example, could become

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4 I. Kravis, "Availability and Other Influences on the Commodity Composition of Trade," <u>Journal of Political Economy</u> (April 1956).

self-sufficient in banana production. But since banana growing requires a tropical climate, the bananas would have to be grown under controlled climatic conditions in greenhouses. The costs of such an undertaking, in terms of other commodities that would have to be given up, makes banana growing in the United States prohibitive.

In this section, important trade theories have been briefly discussed. These theories were principally designed to explain why trade arises. In order to forecast international trade the concept of import elasticities is developed.

THE SIGNIFICANCE OF THE ELASTICITY CONCEPT

In this section, a procedure to forecast dyadic trade over the long range is presented. This procedure uses the concept of elasticity which measures the responsiveness of changes in imports to changes in GNP.

An example involving the United States, Great Britain, and Japan illustrates the use of elasticities to forecast trade interdependence. In the mid-fifties, United States trade with Great Britain and Japan was $1.6 and $1.1 billion respectively, as is shown in Table 3. By 1968 this trade increased to $4.1 and $7 billion respectively. These trade figures indicate that in the early period, Great Britain was a more important trading partner of the United States (from the United States point of view) than was Japan; but by 1968, the reverse was true. The following question should be asked at this point: Could this reversal in trade interdependence have been forecast? An examination of elasticity values for British and Japanese goods leads us to believe that the answer is yes.

TABLE 3

U.S. TRADE WITH U.K. AND JAPAN[a]

Country	1955			1968		
	Exports	Imports	Total	Exports	Imports	Total
United Kingdom	1,006	616	1,622	2,108	2,048	4,156
Japan	683	432	1,115	2,950	4,057	7,007

[a] in millions of U.S. dollars.

Source: U.S. Statistical Abstract, Washington, D.C. 1969.

In 1955, the income elasticity of imports for Japanese products in the United States was estimated at 3.16. For British goods, on the other hand, this elasticity was calculated to be 1.01. These two values indicate that with increased U.S. GNP, the American economy will eventually be importing larger quantities of Japanese goods than British goods. This in fact happened around 1960.

The Elasticity Approach

In this section, the concept of elasticity is fully developed. Elasticity is a mathematical property of a function. In economics, the concept of elasticity was developed by Alfred Marshall, an English economist of the late 19th century.[5] Marshall was originally concerned with developing a method to compare the responsiveness of buyers to price

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[5] For an excellent discussion of elasticity, see P. Samuelson, Economics (New York: McGraw-Hill, 1961), pp. 411-431.

changes of different commodities. Thus the concept of price elasticity of demand was developed. Elasticity is a relative measure since it is expressed as a ratio of two percentages. The price elasticity (P) of the demand (D) for commodity x was defined by Marshall as follows:

$$\text{(i)} \qquad E_1 = \frac{\% \Delta \text{ in } Dx}{\% \Delta \text{ in } Px}$$

where:

Dx is the demand for commodity X and

Px is its price

Thus, if $E_1 = .5$, then a 1 percent change in the price of commodity x will bring about a .5 percent change in the demand for x. Similarly, a 2 percent change in the price of x will bring about a 1 percent change in the demand for x. Equation (i) is usually written as:

$$\text{(ii)} \qquad E_1 = \frac{\Delta Dx}{\Delta Px} \cdot \frac{Px}{Dx} \cdot$$

The price elasticity concept has been extended by economists to the income (I) elasticity concept which is symbolically written as:

$$\text{(iii)} \qquad E_2 = \frac{\Delta Dx}{\Delta I} \cdot \frac{I}{Dx}$$

E_2 measures the responsiveness of changes in the demand for x, holding the price of x constant, to changes in the income (I) of the individual who is purchasing x. Thus, if $E_2 = .6$, then a 2 percent rise in income will bring about a 1.2 percent rise in the demand for x.

Elasticities in International Trade

Price and income elasticities have often been used by economists to study the impact of price and income changes on the volume of international trade, that is, the quantity of exports and of imports. In international trade, income elasticities of imports have been used to study the effects of economic growth (e.g., growth in GNP) upon a country's balance of trade (exports minus imports). Price elasticities of imports, on the other hand, have been used to study the impact of devaluations on the balance of trade of national economies.[6]

The income elasticity of imports concept is utilized to forecast dyadic trade. Symbolically, the income elasticity of imports is written as:[7]

$$(iv) \qquad E_3 = \frac{\Delta M}{\Delta GNP} \cdot \frac{GNP}{M}$$

where:

M represents imports.

This is equivalent to the percentage change in imports divided by the percentage change in national income or GNP, where M is total imports per time period of the country considered. If $E_3 = .9$, then a 10 percent change in domestic GNP will bring about a 9 percent change in

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6 For a leading article in this area, see H.S. Houthakker and S.P. Magee, "Income and Price Elasticities in World Trade," Review of Economics and Statistics, 51 (May 1969), pp. 111-124.

7 In order to neutralize the impact of price changes on imports and to consider only the impact of changes in GNP on imports, all the variables in equation (iv) are expressed in constant prices.

the imports of the country to which the elasticity refers. Diagrammatically, the income elasticity of imports is drawn as follows:

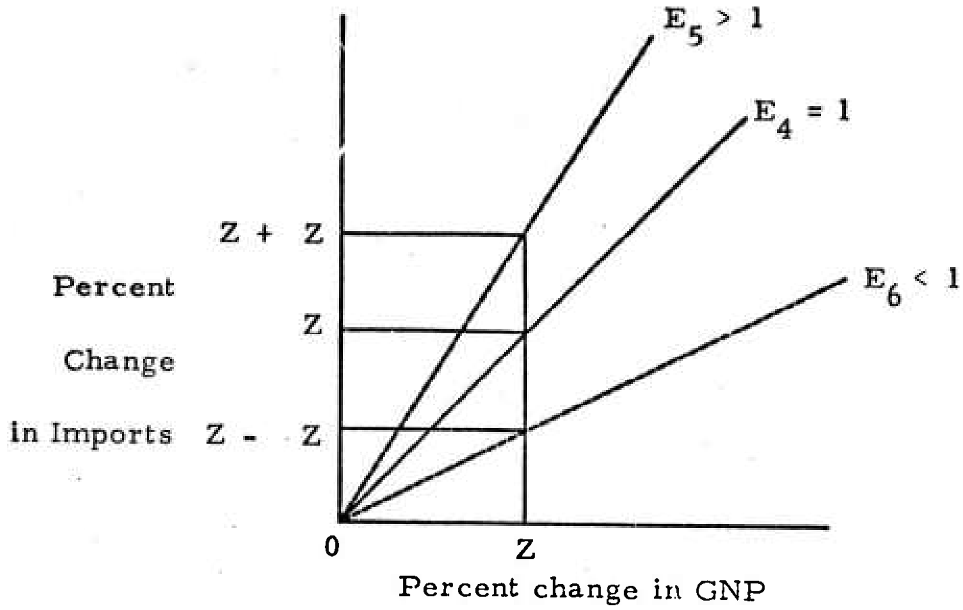

Figure 1. Income Elasticity of Imports

To the left of E_4 the income elasticity of imports is greater than 1 which implies that a Z percent change in GNP will bring about a more than proportional percentage change in imports. To the right of E_4, the percentage change in imports will be less than Z, and on E_4 it will be exactly Z.

<u>Determinants of Import Elasticities.</u> Income elasticities of imports are determined by the composition of a country's trade, that is, the predominant features of a country's exports and imports. Three general categories of traded products can be distinguished: manufactured goods, agricultural products, and raw materials. Industrial countries generally export manufactured goods and import foodstuffs and raw materials. Manufactured goods consist mainly of capital

goods and high standard-of-living consumer goods which tend to have a high income elasticity. Agricultural goods consist mainly of food, the demand for which rises much slower than GNP, and thus have low income elasticities. The supply of raw materials has been declining over the last few decades and the industrial countries will undoubtedly raise their demand for these products. For these reasons, income elasticities for raw materials, which were once thought to be fairly low, are in fact rather high. Tastes of consumers, which are affected by advertising or value judgments, is another factor that influences the value of the income elasticity of imports. If, for example, French products are highly thought of in the United States because of their prestigious reputation, then a rise in income might bring on a larger than proportional increase in the purchase of French products (elasticity >1).

It can be seen, therefore, that the magnitude of the income elasticity of imports is determined by the types of commodities traded and by consumer tastes. Both of these factors are fairly constant over time. Thus, it is reasonable to expect that the Western economies will remain importers of food and raw materials and exporters of manufactured products over the foreseeable future. For example, it is reasonable to assume that France will retain supremacy in perfume and wine manufacturing over the next 20 years. For these reasons, we assume that income elasticities of imports will remain quite constant over time.

Import Elasticities to Forecast Dyadic Trade. We have briefly reviewed the concept of elasticity. We now use a hypothetical numerical example to demonstrate the use of income elasticities to forecast dyadic trade. Consider two countries, i and j. For country i, the income elasticity of imports from j is defined as:

$$\text{(v)} \qquad E_{ij} = \frac{\Delta M^{ij}}{\Delta GNP^{i}} \cdot \frac{GNP^{i}}{M^{ij}}$$

For country j, the income elasticity of imports from i is defined as:

$$\text{(vi)} \qquad E_{ji} = \frac{\Delta M^{ji}}{\Delta GNP^{j}} \cdot \frac{GNP^{j}}{M^{ji}}$$

The first ratio represents the percentage change in the imports of country i from j (i.e., j's exports to i) divided by the percentage change in the GNP of i. The second ratio represents the percentage change in the imports of country j from i (i.e., i's exports to j) divided by the percentage change in the GNP of j. If these elasticities, which are dependent on the composition of trade between i and j, are constant over time, then future values of dyadic trade can be obtained, provided the GNP's of i and j can be forecast.

The following numerical example illustrates how such a forecast of dyadic trade can be generated. Assume the following elasticities to hold for countries i and j:

$$\frac{\Delta M^{ij}}{\Delta GNP^{i}} \cdot \frac{GNP^{i}}{M^{ij}} = 1.5 \text{ and}$$

$$\frac{\Delta M^{ji}}{\Delta GNP^{j}} \cdot \frac{GNP^{j}}{M^{ji}} = 0.9$$

Furthermore, assume that future values of the GNP's of i and j have been obtained. (See Table 4.)

TABLE 4

FUTURE GNP VALUES OF COUNTRIES i AND j[a]

Year	GNP^i	GNP^j
1973	115	51
1974	121	63
1975	138	71
1976	147	79
1977	158	86
1978	163	88

[a] in millions of U.S. dollars.

By calculating the percentage change in the GNP of country i, we can estimate future values of imports of i from j as shown in Table 5.

TABLE 5

FORECAST OF IMPORTS OF COUNTRY i FROM COUNTRY j[a]

Year	GNP^i	$\% \Delta GNP^i$	$\% \Delta M^{ij}$	Imports ij
1973	115	----	----	9.2
1974	121	5.2	7.8	9.9
1975	138	14.0	21.0	12.0
1976	147	6.5	9.7	13.2
1977	158	7.5	11.2	14.6
1978	163	4.6	4.6	15.3

[a] in millions of U.S. dollars.

The table indicates that the imports of i to j will rise from $9.2 million in 1973 to $15.3 million in 1978.

In the same manner, the imports of j from i can be obtained. Table 6 indicates that the imports of country j from i (i.e., i's exports to j) will rise from $5.1 million in 1973 to $8.5 million in 1978.

TABLE 6

FORECAST OF IMPORTS OF COUNTRY j FROM COUNTRY i[a]

Year	GNP^j	$\% \Delta GNP^j$	$\% \Delta M^{ji}$	Imports ji
1973	51	-----	----	5.1
1974	63	23.5	21.2	6.2
1975	71	12.7	11.4	6.9
1976	79	11.3	10.2	7.6
1977	86	8.9	9.8	8.3
1978	88	2.3	2.1	8.5

[a] in millions of U.S. dollars.

By adding M^{ij} to M^{ji} the total trade that will occur between countries i and j over the 1973-1978 period can be obtained. In this manner, the volume of trade between i and j can be compared to other dyads.

In this section the elasticity concept was explained and a numerical example was given to show how it can be used to forecast dyadic trade. This income elasticity of imports is based on an important analytic tool of economic theory, the import function, which relates the quantity of imports to gross national product and to the price of imported commodities.

DEVELOPMENT OF A MODEL

Having briefly reviewed the relevance of income elasticities of imports to the general patterns of international trade, we now turn to conceptualization and operationalization of the model.

Theoretical Considerations

The basic import equation of the model is derived mathematically. In order to fully understand this derivation, some knowledge of calculus and matrix algebra is required. However, a comprehensive grasp of the mathematics is not necessary to understand this chapter.

The import function (a macroeconomic concept) is derived from utility functions (a microeconomic concept) in the following manner. Country i imports goods and services from country j because these yield utility or satisfaction to consumers, businesses, and the government of country i. The demand functions for j's goods by country i are derived from these utility functions. The total import function of country i for country j's products is finally obtained by summing individual demand functions.

The fundamental equation of the model is as follows:

$$\text{(vii)} \quad M^{ij} = h\,(GNP^{i},\ P)$$

where:

M^{ij} represents the level of imports of country i from country j at some time period in current prices,

GNP^i represents the gross national product of country i for the same period in current prices, and

P is an index of the price of importables of country i from j.

The import equation is derived from microeconomic theory. M^{ij} represents the total imports of country i from country j. Alternatively, it represents the consumption by country i of country j's goods. The demand for j's products by i depends on the utility derived by i in consuming j's products. Thus we can write:[8]

$$\text{(viii)} \quad U^i = U(\vec{m}_e^{ij}) \qquad e = 1, 2, \ldots n$$

where:

U^i represents the total utility derived by i in consuming commodities $m_1 \ldots m_e \ldots m_n$, and

$\vec{m}_e^{ij}$ represents a vector of commodities that j exports to i.

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8 By specifying U^i in this manner, we are implicitly assuming interpersonal comparisons of utility. Corporations and consumers in country i derive utility by consuming commodities from country j. U^i represents country i's utility which is derived by consuming j's goods; it therefore represents summed individual utility functions. U^i can be looked upon as a Bergsonian welfare function by i for j's products. U^i is a subset of country i's total welfare function, the arguments of which are also domestic commodities and imports from countries other than j. Another way to derive such a utility index involves employing the Von Neuman-Morgenstern method. For a discussion of this technique, see J. Henderson and R. Quandt, Microeconomic Theory: A Mathematical Approach (New York: McGraw-Hill, 1958), pp. 36-38.

The following assumptions are made regarding U:

$$\frac{\partial U}{\partial \vec{m}_e^{ij}} < 0, \quad \frac{\partial^2 U}{\partial \vec{m}_e^{ij\,2}} > 0.$$

Furthermore, the two are assumed continuous for all values of $\vec{m}_e^{ij}$.

The constraint imposed on the utility function (equation viii) is as follows:

$$\sum_{e=1}^{n} \vec{m}_e^{ij} \vec{p}_e - gnp^i = 0$$

where:

> $\vec{p}_e$ represents a vector of prices of commodities that i can import from j, expressed in i's currency, and
>
> gnp^i represents the portion of i's GNP that is spent on imports from j.

For country i, in its relations with country j, the following constrained optimization problem is stipulated:

$$\text{(ix)} \qquad \text{Max } L = U(\vec{m}_e^{ij}) - \lambda \left[\sum \vec{m}_e^{ij} \vec{p}_e - gnp^i \right].$$

For the simple case in which two commodities can be imported by country i from country j, the Lagrangean function is rewritten as:

$$\text{(x)} \qquad L = f(m_1^{ij}, m_2^{ij}) - \lambda \left[gnp^i - m_1^{ij} p_1 - m_2^{ij} p_2 \right].$$

The first-order conditions are equal to:[9]

(xi) $$\frac{\partial L}{\partial m_1^{ij}} = \frac{\partial f}{\partial m_1^{ij}} - \lambda p_1 = 0$$

(xii) $$\frac{\partial L}{\partial m_2^{ij}} = \frac{\partial f}{\partial m_2^{ij}} - \lambda p_2 = 0$$

(xiii) $$\frac{\partial L}{\partial \lambda} = gnp^i - m_1^{ij} p_1 - m_2^{ij} p_2 = 0.$$

The first-order conditions of the Lagrangean function (x) permit the derivation of the demand functions for commodities 1 and 2, that is, i's imports from j, as a function of p_1, p_2, and gnp^i. Equations (xi), (xii), and (xiii) may be solved for the values of m_1, m_2, and λ such that

$$f\,(m_1^{ij},\ m_2^{ij})$$

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9 The second-order conditions can be obtained by partially differentiating equations (xi) thr..gh (xiii) by p_1, p_2, and gnp^i. For a maximum, the following bordered Hessian has to be positive definite.

$$H = \begin{vmatrix} 0 & -p_1 & -p_2 \\ -p_1 & U_{11} & U_{12} \\ -p_2 & U_{21} & U_{22} \end{vmatrix} > 0.$$

is an extremum subject to

$$gnp^i - m_1^{ij} p_1 - m_2^{ij} p_2 = 0.$$

Under the assumption that

$$\frac{\partial U}{\partial \vec{m}_1^{ij}} < 0$$

and

$$\frac{\partial^2 U}{\partial \vec{m}_2^{ij\,2}} > 0$$

this extremum will be a maximum. Thus the values of m_1 and m_2, determined by the first-order conditions, will be the equilibrium consumption levels of m_1 and m_2 for the given set of prices p_1, p_2, and gnp^i. If we consider that the values of m_1 and m_2 satisfy the first-order conditions as the parameters p_1, p_2, and gnp^i vary, we get the following two equations:

$$\text{(xiv)} \quad m_1^{ij} = m_1^{ij} (p_1, p_2, gnp^i)$$

$$\text{(xv)} \quad m_2^{ij} = m_2^{ij} (p_1, p_2, gnp^i)$$

which are demand functions for imports by country i from country j. For the general case of n commodities, equations (xiv) and (xv) can be summed over all commodities to yield the import demand function by country i for j's products.

Traditionally, in modern international trade theory, the import function is assumed to be a linear function of domestic gross national product and a price index of importables. Thus the function is written as:

$$\text{(xvi)} \quad M^{ij} = \mu_0 + \mu_1 Y^i + \mu_2 P$$

where:

Y^i is the gross national product in current prices per period,

P is the index of the price of importables of i from j,

μ_1 is the marginal propensity for country i to import j's products, and

μ_2 is some price multiplier.

Because of linearity, μ_0, μ_1, and μ_2 are assumed to be constants. This assumption is fairly reasonable in the short run. In the long run, however, these parameters become variables and hence the import function is likely to be nonlinear. Various studies have specified imports as follows:[10]

$$\text{(xvii)} \quad M^{ij} = \alpha_0 Y^{i^{\alpha_1}} P^{\alpha_2}$$

where:

α_1 and α_2 represent the income and price elasticities of imports.

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[10] See, in particular, Houthakker and Magee, "Income and Price Elasticities in World Trade."

To forecast dyadic trade over the long range, it will be necessary to obtain future values of the GNP of country i and future values of prices. The former projection is relatively easy since GNP is probably the economic variable that is forecast most often. Forecasting prices, on the other hand, is extremely difficult over the long range. This involves anticipating inflationary periods, devaluations, tariff policies, and so forth. It is necessary, therefore, to employ a methodology that circumvents the problem of forecasting prices. In order to accomplish this, we respecify equation (xvii) in a manner that holds prices constant. Thus, we have:

$$\text{(xviii)} \quad M_c^{ij} = \beta_0 {Y_c^i}^{\beta_1}$$

where:

M_c^{ij} is the level of imports of country i from country j expressed in some base-period prices,

Y_c^i is the GNP of i expressed in terms of the same base-period prices, and

β_0 and β_1 are constant parameters.

β_1 in this instance represents the income elasticity of imports of i from j purged of the impact of prices. If we assume that the impact of prices on imports remains constant over the long range, then we can obtain future levels of imports by estimating the impact of income on imports.

For estimation purposes, equation (xviii) is linearized by taking the logarithms of both sides of the equation. This transformation yields the following relation:

(xix) $\ln M_c^{ij} = \ln \beta_0 + \beta_1 \ln Y_c^i + e.$

This relation is the basic equation that is used to estimate the elasticities of the dyads considered. The random error term is e.

Data Preparation

Having developed the conceptual framework of the model, the following 26 countries were selected for our analysis:

> United Kingdom, Austria, BLEU (Belgium and Luxembourg), Denmark, France, West Germany, Italy, Netherlands, Norway, Sweden, Switzerland, Finland, Greece, Iceland, Ireland, Portugal, Spain, Turkey, Yugoslavia, Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, Soviet Union.

These countries, taken two at a time, constitute 325 dyads. Since the elasticity values to be estimated are directional, that is, each country pair has an elasticity for country i's imports from country j and for country j's imports from i, a total of 650 elasticities were estimated.

Four sets of data were collected in this phase of the project. In all cases annual data were used. Import figures for all except intra-Communist dyads were obtained from the International Monetary Fund's Direction of Trade Statistics (DOT).[11] Intra-Communist trade data were taken from the United Nations' Yearbook of International Trade

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[11] International Monetary Fund, Direction of Trade Statistics (Washington, D.C., 1950-1972).

Statistics.[12] GNP figures for non-Communist countries were taken from the U.S. Agency for International Development's (AID) Office of Statistics and Reports.[13] Communist GNP figures were taken from the U.S. Arms Control and Disarmament Agency.[14]

Since the purpose of this analysis is to estimate the responsiveness of imports to changes in GNP, unadjusted import values were used.[15] Transportation and insurance costs were excluded. In order to neutralize the impact of price changes on these import values, the following transformation was performed prior to the parameter estimation phase. Where possible, import trade values recorded in current

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[12] United Nations, Yearbook of International Trade Statistics (New York, 1961-1970). Eastern-bloc nations do not report these trade statistics to the IMF. Consequently, the trade values used between Western Europe and Eastern Europe were derived from Western trade figures (e.g., Bulgaria's imports from Austria are derived from Austria's exports to Bulgaria) and were utilized where possible. However, since Communist trade is reported to the United Nations, intra-Communist trade is based on U.N. data.

[13] Agency for International Development, Gross National Product--Growth Rates and Trend Data by Region and Country (Washington, D.C.: Office of Statistics and Reports, 1972).

[14] U.S. Department of State, Arms Control and Disarmament Agency, World Military Expenditures (Washington, D.C., 1971).

[15] Reported import figures generally include miscellaneous costs, insurance, and freight charges. Export figures, however, exclude those additional charges. Import figures are reported CIF (Costs, Insurance, and Freight), while exports are reported FOB (Free On Board). Since country i's exports to country j are country j's imports from country i, and exports exclude the additional costs, we substituted the corresponding dyadic export figures for import figures to obtain our (raw) unadjusted import data.

dollars were multiplied by the import price indices of each country to yield import values in constant dollar terms. The import price indices used are listed in Table 7.[16] Unfortunately, this proved impossible for intra-Communist trade data due to the absence of appropriate price deflators.[17]

Ideally, to eliminate all effects of price changes on dyadic elasticities, dyadic price indices are necessary. For example, in looking at the

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[16] Import price indices were obtained from the International Monetary Fund, International Financial Statistics (Washington, D.C.) Vols. XV, XIX, and XXVI. The import price indices were collected in three time groups and recorded in three different base years depending on the time frame involved. The period 1950-58 was recorded with 1953 as the base year (1953=100). The period 1959-1964 was recorded with 1958 as the base year (1958=100). The period 1965 to the present was recorded with 1963 as the base year (1963=100). The transformation of these data to the base year 1970 was a two-stage process and proceeded as follows:

Step 1. All index numbers were transformed with 1953 as the base year:

a. $$\frac{\text{(index \# for 1958 in 1953 prices)x(index \# for 1959-64 in 1958 prices)}}{100}$$

Taking the 1963 index number in 1953 prices from Step 1. (a) we obtain:

b. $$\frac{\text{(index \# for 1963 transformed to 1953 prices)} \times \text{(index \# for 1965-72 in 1963 prices)}}{100}$$

Step 2. All index numbers transformed to 1953 prices were transformed to a base year 1970 (1970=100):

$$\frac{\text{(index \# for 1970 in 1953 prices)}}{\text{(index \# for 1950-72 in 1970 prices)}}$$

[17] It is the Communists' position that many of the "evils of capitalism" such as inflation or unemployment are nonexistent in a Communist economic system. Price deflators for controlling for inflation do not exist. We assume, therefore, that for the purposes of this model, the Communist trade values are in constant prices.

TABLE 7

IMPORT PRICE INDEXES FOR WESTERN EUROPE 1950-1972 (BASE YEAR = 1970)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Austria	NA	NA	NA	117.8	107.2	103.7	107.2	108.4	101.3	99.3	95.2	95.2	95.2	95.2	88.6	94.3	95.2	93.3	89.5	90.5	100.0	103.8	103.8
Belgium & Luxembourg	86.5	108.4	105.4	99.5	95.5	95.5	98.5	101.4	94.5	92.6	92.6	94.5	92.6	92.6	92.6	93.5	94.4	92.6	93.5	96.3	100.0	100.9	NA
Denmark	80.0	101.6	99.8	89.9	87.2	88.1	91.7	93.5	86.3	84.6	84.6	84.6	83.7	85.5	85.5	87.2	88.0	88.0	93.2	94.9	100.0	106.8	107.7
Finland	66.2	90.8	87.0	77.0	74.6	73.1	76.2	78.5	68.5	67.1	67.1	67.1	67.8	68.5	69.9	70.5	70.5	74.7	89.7	91.8	100.0	106.2	116.4
France	66.6	85.7	84.2	76.5	75.8	75.0	78.1	80.4	75.0	84.8	84.8	82.5	82.5	83.3	94.1	86.3	87.1	87.5	84.8	90.2	100.0	103.3	104.3
Germany, W.	111.0	139.3	128.0	113.0	111.0	113.3	115.5	116.7	106.5	105.4	105.4	102.2	99.0	99.0	93.1	101.8	103.7	102.0	99.0	102.0	100.0	98.9	96.9
Great Britain	67.0	89.3	87.7	79.7	78.9	81.3	82.9	84.5	78.1	77.3	77.3	75.8	75.0	78.1	81.3	81.3	82.8	82.8	91.4	95.3	100.0	103.1	108.6
Greece	NA	104.0	104.9	95.4	93.5	93.5	98.3	101.1	92.5	89.8	87.9	87.0	87.0	89.8	94.0	95.1	94.5	95.1	95.2	99.[illegible]	100.0	NA	NA
Iceland	102.5	118.1	121.4	111.4	106.9	105.8	110.3	114.7	108.0	110.2	111.3	100.5	94.0	96.2	91.3	102.9	104.8	102.9	92.3	96.2	100.0	107.7	NA
Ireland	63.9	76.0	79.4	77.3	75.0	77.2	78.7	83.2	79.4	79.4	79.4	80.2	80.2	81.0	83.5	83.6	83.6	83.1	90.0	93.6	100.0	106.0	NA
Italy	88.1	115.4	111.3	101.2	99.2	101.2	104.3	109.3	98.2	90.3	90.3	88.4	88.4	90.3	84.9	93.6	94.6	95.6	96.0	96.7	100.0	109.5	110.9
Netherlands	84.3	106.1	105.2	94.7	92.9	93.8	96.6	101.4	95.7	92.8	92.8	90.9	90.0	90.9	89.1	93.6	94.5	93.6	90.9	93.6	100.0	104.5	103.6
Norway	85.1	101.4	102.3	95.6	89.9	93.7	99.4	104.2	96.6	94.6	92.7	91.7	90.8	91.7	88.1	92.7	93.6	92.7	90.8	92.7	100.0	104.6	106.4
Portugal	70.2	84.3	85.1	82.6	83.4	80.1	85.1	88.4	95.[illegible]	84.2	82.5	84.2	88.5	88.5	93.8	92.0	95.6	98.2	100.9	100.9	100.0	101.8	104.4
Spain	63.5	66.9	78.2	66.9	63.5	65.5	66.9	68.2	66.2	72.1	72.1	74.1	77.4	79.4	97.7	82.0	84.7	83.7	89.5	93.2	100.0	106.4	NA
Sweden	62.0	78.6	82.4	75.6	78.6	80.9	76.3	75.6	75.6	75.6	76.3	77.1	80.1	79.4	85.7	85.7	86.5	88.1	94.4	100.0	100.0	NA	NA
Switzerland	74.7	89.8	88.1	83.9	83.1	82.2	84.7	86.4	83.9	81.4	81.4	81.4	82.2	84.7	87.3	87.3	89.8	89.8	90.7	93.2	100.0	101.7	105.1
Turkey	25.5	30.1	29.6	29.3	31.9	37.5	38.3	42.1	63.5	85.7	85.7	80.6	80.6	79.4	108.7	96.0	105.6	103.2	100.0	NA	100.0	NA	NA
Yugoslavia	64.4	81.6	78.6	74.9	73.4	76.4	75.6	NA	74.9	74.9	74.1	74.9	79.4	79.4	85.7	87.3	88.1	88.1	88.1	92.9	100.0	NA	NA

Source: International Monetary Fund, International Financial Statistics, Volumes XV, XIX, XXVI.

France/Italy dyad, the price deflator for French imports from Italy is necessary to deflate the prices of French imports from that country. Because dyadic deflators are simply not available, the total import price indices of each country were used as a surrogate deflator.

A second transformation performed on deflated imports was necessary to remove the so-called "zero problem" in the series. As indicated earlier, to estimate the various elasticities the import function had to be linearized in logarithms. This presented mathematical difficulties when trade between two countries was zero for a particular year, as, for example, trade between Bulgaria and Ireland in 1970. To eliminate the presence of zeros, the following transformation on the deflated imports was performed.

$$M^* = M + \frac{1}{M + 1}$$

where:

M^* is the transformed value of imports, and

M is the actual value of imports.

The characteristics of this transformation are as follows:

$$\lim_{M \to 0} M^* = 1$$

$$\lim_{M \to \infty} M^* = M$$

These two limits state that as imports go to zero, the transformed value of imports equals 1; as the value of M grows, however, the transformed value of imports M^* equals M (actual M).

This transformation was performed on equation (xviii) to yield

$$\text{(xix)} \quad M_c^{*ij} = \beta_0^{*} Y_c^{i\,\beta_1^{*}} + e \,.$$

Taking the logarithms of both sides of the equation linearizes the equation as follows:

$$\text{(xx)} \quad \ln M_c^{*ij} = \ln \beta_0^{*} + \beta_1^{*} \ln Y_c^{i} + e$$

where:

β_1^{*} is the income elasticity of imports or $\dfrac{dM_c^{*ij}}{dY_c^{i}} \cdot \dfrac{Y_c^{i}}{M_c^{*ij}}$.

By treating Y_c^{i} as an exogenous variable, ordinary least squares regression will yield best linear unbiased estimates (BLUE) of elasticity of imports.[18] Tables 8 through 32 present values of the estimated elasticities. As stated previously, a total of 650 elasticities were estimated.

RESULTS AND INTERPRETATIONS

The income elasticities of import estimates were derived from the conceptual framework and estimation equations generated for this model. Our criteria for evaluating these estimates and their relative

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18 For a detailed explanation of BLUE, see Ronald and Thomas Wonnacott, Econometrics (New York: John Wiley & Sons, 1970), pp. 21-22, or Arthur S. Goldberger, Econometric Theory (New York: John Wiley & Sons, 1964), pp. 126-128.

explanatory value are in two forms. First, the elasticity generated must be realistic. If, for instance, negative elasticities are produced, they are not used in forecasting dyadic trade since trade, in the long run, will generally increase as income increases. Second, basic statistical theory is used to test the validity of the equations. Thus, even if the elasticity is a realistic value, we will reject the results if the statistical tests tell us that the reliability of the output is questionable.

In cases where the elasticities were in fact of limited explanatory value or yielded inconclusive results, we substituted the value of unit elasticity (E=1.00). Although the reliability of these qualitative estimates is open to question, we feel that this substitute value, where needed, is useful as a working assumption. We do not argue that unit elasticity is the actual elasticity value; rather, these substitutes are used so that trade forecasts for all dyads may be generated in keeping with the needs of this study.

Non-Communist trade elasticities were derived using the 21-year period 1950-1970. Incomplete data for the Communist countries in the 1950's limited the number of observable years to 10--1961 to 1970. In discussing the results we will first make several general observations about the countries studied, and then interpret the results on a country-by-country basis.

General Observations

The vast majority of the elasticities generated are intuitively acceptable since they reflect, for the most part, the patterns of international trade during the last two decades. For example, countries that experienced balance of payments deficits, such as the United Kingdom, were found to possess larger elasticities than those of their trading partners. Similarly, countries that experienced persistent balance of payments surpluses, such as West Germany, were found to possess smaller elasticity values than those of their trading partners.

In addition, GNP is a more important variable in explaining Western Europe's imports from Eastern Europe than it is in explaining Eastern Europe's imports from Western Europe. Thus, for example, approximately 92 percent of the change in imports of the United Kingdom from Romania was explained by changes in the United Kingdom's GNP; but only 49 percent of the change in imports from the United Kingdom to Romania was accounted for by Romania's change in GNP. However, within each Communist and non-Communist political bloc, the variance explained by changes in GNP of intrabloc trade was notably higher. Since trade initiated by a Communist nation with a non-Communist nation is often determined by both political and economic considerations, the effect of simple changes in the GNP of the Communist country is less likely to induce a change in its trade with the non-Communist country.

Furthermore, an examination of the computed elasticities for dyads involving Eastern and Western European countries indicates that elasticities for the non-Communist countries are, for the most part, larger than those describing Communist imports of non-Communist goods. Thus, a 1 percent rise in a non-Communist country's GNP induces proportionally more imports from a Communist nation than does a similar rise in the GNP of a Communist economy. A review of the data offers some explanation. Since Communist elasticities reflect the growth of trade and GNP in the 1960's only, the large percentage growth in absolute terms of West to East trade in the 1950's is not reflected as it is within the non-Communist estimates. Since this "catching up" process of East to West trade is not fully achieved, it is not unrealistic to employ these "inflated" elasticities to forecast East/West trade.

Finally, consistently poor results were obtained for many dyads involving East Germany and Iceland. In reviewing the import trade values of these two nations, it was observed that much of this year-to-year dyadic data exhibited little variance. In addition, there were several instances where missing data or simple absence of trade with another country limited the number of observations to a point where the significance of the output was questionable. Where poor results were obtained, E=1.00 was substituted.

Country-by-Country Analysis

Table 8 presents all cases involving the United Kingdom and its trading partners. The dyadic elasticities assume the magnitude and sign anticipated by the economic theory presented earlier. Percentage changes in GNP are statistically significant (at the 5 percent level) in explaining percentage changes in imports in all cases, with the exception of East German and Soviet imports from the United Kingdom (significant at the 10 percent level).

The United Kingdom's elasticities reflect its serious balance of payments deficits. Except for trade with BLEU (Belgium and Luxembourg), Ireland, and Turkey, British elasticities are higher than those of her trading partners. Thus, for example, the United Kingdom's elasticity

TABLE 8

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING THE UNITED KINGDOM

Country	Elasticity[a]		t-Ratio		R^2	
Austria	3.8700	2.2309	7.1853	20.2840	0.7208	0.9603
BLEU[b]	1.8561	2.1138	5.6976	30.6260	0.6188	0.9791
Denmark	1.6735	1.2634	10.0940	13.1470	0.8359	0.8963
France	2.2867	1.8479	8.2437	19.0930	0.7726	0.9480
West Germany	4.1106	1.5333	14.4300	38.6760	0.9123	0.9868
Italy	2.9286	1.4376	12.0080	14.3950	0.8782	0.9119
Netherlands	2.5240	1.3821	12.5140	17.6350	0.8867	0.9396
Norway	2.9995	0.9984	12.1700	10.4080	0.8810	0.8442
Sweden	2.4674	2.0032	8.8809	19.8910	0.7977	0.9542
Switzerland	4.1724	2.3335	19.6330	15.8320	0.9506	0.9261
Finland	2.3158	1.6074	7.8211	9.2796	0.7536	0.8115
Greece	1.3181	1.0041	6.2565	10.0730	0.6618	0.8493
Iceland	3.1149	0.8430	7.3569	4.4678	0.7302	0.4995
Ireland	2.4254	2.6539	11.2730	16.4200	0.8640	0.9309
Portugal	3.5996	1.6769	8.5794	21.0610	0.7863	0.9569
Spain	2.4544	2.4460	12.0490	22.5260	0.8789	0.9621
Turkey	1.0235	2.3119	4.3319	7.6597	0.4841	0.7652
Yugoslavia	2.5245	2.0814	6.3317	6.1441	0.6676	0.8251
Bulgaria	5.6676	1.8974	24.9260	4.1849	0.9703	0.6864
Czechoslovakia	2.6571	0.5517	9.5852	2.9873	0.8212	0.5273
East Germany	4.9076	1.0115	19.6470	2.0113	0.9554	0.3358
Hungary	5.1853	1.3445	9.8600	8.3415	0.8438	0.8969
Poland	2.3303	1.0432	20.7380	4.3949	0.9556	0.7071
Romania	6.1047	1.2041	14.8710	2.8058	0.9171	0.4960
Soviet Union	2.7984	0.6527	11.0400	1.9503	0.8590	0.3222

[a] The first column in each boxhead represents the response of the United Kingdom imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

[b] Belgium/Luxembourg. Hereafter BLEU.

for Austrian goods is estimated at 3.87, while the latter's elasticity for British goods is estimated at 2.23. These estimates imply that a 1 percent rise in British GNP increases British imports from Austria by 3.87 percent. A 1 percent rise in Austrian GNP, on the other hand, induces an increase in imports from Britain by 2.23 percent. If the difference in these elasticities persists, then regardless of the present state of the trade balance between Britain and Austria, Britain will eventually experience a trade deficit vis-a-vis Austria provided British and Austrian GNP's rise at similar rates.

In Table 9, estimates of elasticities of Austria's trade with its European partners are presented. All estimates exhibit the positive sign anticipated by economic theory with the exception of the elasticity describing Austrian imports from Turkey. In keeping with our assumptions stated previously, we set this dyad's elasticity at E=1.00. Three of the elasticities, imports from Iceland and Greece, and Iceland's imports from Austria, proved to be statistically unreliable and were also set at E=1.00. As the reader will note, the explanatory value of GNP with regard to changes in imports denoted by R^2 is in most cases high. Excluding the exceptions noted above, the equations are statistically significant at the 10 percent level or below.

Estimates of the elasticities for dyads involving BLEU are given in Table 10. It is interesting to note that the magnitude of the elasticities between BLEU and the other European Community (EC) members is significantly larger than that of the dyads involving BLEU and non-EC countries. This is some indication of the trade-promoting environment that has grown among its members. The t-ratios suggest statistical significance in all dyads with the exception of BLEU/Czechoslovakia whose elasticity was set at 1.00.

TABLE 9

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING AUSTRIA[a]

Country	Elasticity[b]		t-Ratio		R^2	
BLEU	1.5216	1.6852	13.3570	8.5395	0.9130	0.7848
Denmark	2.8960	3.4012	13.7260	24.5630	0.9172	0.9679
France	1.7161	1.5101	16.2560	16.2560	0.9396	0.7474
West Germany	2.1060	1.7151	32.1220	21.9600	0.9838	0.9602
Italy	1.6155	1.2577	18.5320	8.1680	0.9528	0.7694
Netherlands	2.1660	1.6702	37.4380	15.3900	0.9880	0.9221
Norway	1.1841	2.9778	6.6094	19.7050	0.7199	0.9510
Sweden	2.8994	3.8943	17.0550	29.2530	0.9448	0.9783
Switzerland	2.4755	3.2046	16.8970	20.9940	0.9438	0.9566
Finland	3.1681	3.2859	12.7580	17.8090	0.9054	0.9407
Greece	0.0889	1.0876	0.3860	10.5910	0.0088	0.8617
	(1.0000)		NA		NA	
Iceland	0.2109	0.3247	1.7791	0.6553	0.3114	0.0211
	(1.0000)	(1.0000)	NA	NA	NA	NA
Ireland	0.2998	3.6432	6.9668	10.0520	0.7406	0.8348
Portugal	2.8519	2.2560	12.3410	8.6194	0.8996	0.7879
Spain	0.9315	2.4855	3.2672	11.3110	0.3857	0.8648
Turkey	-0.2208	2.0758	-0.7131	9.2071	0.0291	0.8248
	(1.0000)		NA		NA	
Yugoslavia	1.3582	3.0965	10.9690	5.0327	0.8762	0.7599
Bulgaria	1.0884	1.0214	4.7239	4.7721	0.5675	0.7400
Czechoslovakia	1.9213	1.3428	3.1615	9.3794	0.7315	0.9166
East Germany	1.1101	0.6183	2.0151	1.8159	0.6152	0.2918
Hungary	1.7254	1.5002	9.3527	9.0740	0.8373	0.9114
Poland	0.8194	0.9726	7.4016	4.8236	0.7632	0.7441
Romania	1.9263	1.6705	6.6380	7.5496	0.7216	0.8769
Soviet Union	4.0671	0.6074	8.4822	4.8263	0.8089	0.7444

[a] Except all dyads previously considered. (See Table 8)

[b] The first column in each boxhead represents the response of Austrian imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 10

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING BLEU (Belgium/Luxembourg)[a]

Country	Elasticity[b]		t-Ratio		R^2	
Denmark	1.7143	1.2649	7.8847	6.8331	0.7566	0.7001
France	2.9502	2.8625	42.0080	25.9450	0.9888	0.9711
West Germany	3.2677	2.3462	25.4600	18.4450	0.9701	0.9445
Italy	3.9996	2.0839	37.4140	13.8830	0.9859	0.9059
Netherlands	2.3997	1.8712	22.1870	24.3780	0.9609	0.9674
Norway	1.2730	1.1174	4.4715	5.3058	0.4999	0.5846
Sweden	1.5733	1.3646	12.5310	5.7235	0.8870	0.6329
Switzerland	0.9018	1.5267	9.7848	10.7260	0.8272	0.8519
Finland	1.2437	1.0292	7.2298	5.3032	0.7233	0.5844
Greece	3.7962	1.1197	13.3960	9.3775	0.8997	0.8301
Iceland	0.5904	1.1627	2.8349	4.6502	0.3647	0.5195
Ireland	2.1433	2.0735	7.0769	8.6574	0.7146	0.7894
Portugal	0.6973	0.5112	9.4747	3.3831	0.8178	0.3640
Spain	1.7285	2.2082	6.8928	23.3310	0.2037	0.9646
Turkey	2.7551	1.9380	10.4970	6.6568	0.8464	0.7111
Yugoslavia	1.5061	4.1675	6.8879	6.0233	0.7035	0.8193
Bulgaria	1.8753	1.1547	8.3396	2.3039	0.7767	0.3986
Czechoslovakia	1.2727	-0.5600	7.7919	-0.2182	0.7522	0.0059
		(1.0000)		NA		NA
East Germany	2.6892	0.7057	14.5480	2.3289	0.9216	0.1808
Hungary	1.9763	0.8376	10.5600	3.8876	0.8479	0.6540
Poland	2.0437	1.7397	10.2070	8.0353	0.8389	0.8898
Romania	2.7892	2.2511	9.2224	5.5072	0.8096	0.7913
Soviet Union	2.1718	1.6696	11.3040	3.8653	0.8647	0.6513

[a] Except all dyads previously considered. (See Tables 8 and 9).

[b] The first column in each boxhead represents the response of BLEU imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

In Table 11, elasticities of Denmark and its trading partners are presented. All elasticities estimated have the expected positive sign. For certain Communist trading partners--the Soviet Union, Romania, and East Germany--the R^2 value, which reflects the change in the variance of imports explained by the change in the variance of GNP, is markedly low. This suggests that factors other than economic play an influential role in the changes in trade between Denmark and these countries.

In Table 12, income elasticities for dyads involving France are presented. The t-ratios indicate statistical significance at the 5 percent level for all elasticities except East German imports from France (t=1.60).

In Table 13, elasticities for West Germany and its trading partners are presented. In general, the vast majority of the estimated elasticities are statistically significant. However, owing to the small sample sizes of West Germany (N=7) and East Germany (N=9) some elasticities were difficult to estimate and consequently were set at E=1.00.

Italy's estimated elasticities and those of its trading partners, presented in Table 14, are excellent, except for Italy's imports from Iceland, where only a small percentage of the variance is explained by GNP. The results of estimating elasticities between Italian trade and Communist countries suggest that trade between the Italians and East Europe is largely dependent on GNP. This is unlike other Western countries where the t-ratios and R^2 for East-West trade are low, suggesting important noneconomic influences on trade. In the last decade, Italy, more than any other Western nation, has successfully expanded its trade with East Europe, particularly with the USSR. This is reflected by the statistical significance of the elasticities generated.

TABLE 11

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING DENMARK[a]

Country	Elasticity[b]		t-Ratio		R^2	
France	1.8392	1.6371	12.4320	8.9151	0.8854	0.7989
West Germany	2.2172	0.8863	15.0980	12.1570	0.9193	0.8808
Italy	2.8466	1.4900	31.2330	8.4262	0.9799	0.7802
Netherlands	1.7965	1.8720	8.6085	14.8880	0.7875	0.9172
Norway	2.2725	2.5487	25.1000	24.5200	0.9692	0.9678
Sweden	2.7691	3.7286	29.1100	41.3350	0.9769	0.9890
Switzerland	2.3629	2.5004	20.1030	13.7990	0.9528	0.9049
Finland	1.7395	1.6517	9.7106	6.3864	0.8250	0.6709
Greece	0.7433	1.5698	6.4735	13.7850	0.6769	0.9135
Iceland	1.9917	1.5560	6.6223	4.7643	0.6868	0.5316
Ireland	0.9405	3.6384	8.0950	11.1530	0.7662	0.8615
Portugal	2.9174	2.3209	21.5640	13.1460	0.9588	0.8963
Spain	1.3221	2.0292	7.0465	11.2470	0.7129	0.8635
Turkey	1.3238	1.8564	4.8727	8.2087	0.5428	0.7892
Yugoslavia	1.9758	2.1850	8.1341	3.5000	0.7679	0.6171
Bulgaria	1.2961	1.3940	6.9867	3.0114	0.7771	0.5313
Czechoslovakia	2.2741	0.9476	11.2021	2.8819	0.8625	0.5094
East Germany	0.7797	4.1481	6.9259	1.0965	0.7271	0.1306
Hungary	2.4152	1.8623	20.0550	5.1233	0.9526	0.7664
Poland	1.5313	1.3085	5.9334	3.5051	0.6377	0.6056
Romania	1.1139	1.8200	4.4496	2.3832	0.5031	0.4152
Soviet Union	2.0273	0.5373	8.1135	0.7094	0.7669	0.0592
		(1.0000)		NA		NA

[a]Except all dyads previously considered. (See Tables 8, 9, and 10)

[b]The first column in each boxhead represents the response of Danish imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 12

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING FRANCE[a]

Country	Elasticity[b]		t-Ratio		R^2	
West Germany	3.1770	2.3061	36.5420	26.9150	0.9852	0.9731
Italy	3.4822	2.8022	21.9760	27.8360	0.9602	0.9748
Netherlands	3.1118	2.6510	41.2420	16.9330	0.9884	0.9348
Norway	1.5201	1.3206	8.8721	11.8320	0.7974	0.8749
Sweden	1.8125	2.0476	12.5870	14.1400	0.8879	0.9132
Switzerland	2.0236	2.3534	26.4880	22.3860	0.9723	0.9616
Finland	1.2740	1.1633	8.2329	5.5021	0.7722	0.6022
Greece	1.7113	1.6498	6.2630	10.7920	0.6623	0.8661
Iceland	0.3716	0.9626	3.5016	4.9323	0.3801	0.5488
Ireland	2.9675	4.1368	10.6060	17.7040	0.8490	0.9400
Portugal	1.7991	2.1923	13.8220	18.6810	0.9052	0.9458
Spain	2.3943	2.7122	12.1760	21.2530	0.8811	0.9576
Turkey	0.8312	1.8140	3.0659	8.9405	0.3197	0.8162
Yugoslavia	2.2271	3.4239	9.9533	6.9634	0.8320	0.8584
Bulgaria	2.9601	1.7382	18.4410	4.6485	0.9444	0.7298
Czechoslovakia	1.9367	1.6009	11.5970	3.1679	0.8705	0.5564
East Germany	3.3044	1.3714	16.5280	1.6015	0.9349	0.2428
Hungary	2.9185	0.8226	23.5730	2.2648	0.9653	0.3906
Poland	1.7885	1.9248	7.3112	6.3623	0.7277	0.8349
Romania	3.4739	1.8724	13.3040	5.7410	0.9076	0.8047
Soviet Union	3.0420	1.8273	9.7982	3.0629	0.8275	0.5397

[a]Except all dyads previously considered. (See Tables 8, 9, 10, and 11)

[b]The first column in each boxhead represents the response of French imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 13

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING WEST GERMANY[a]

Country	Elasticity[b]		t-Ratio		R^2	
Italy	2.6486	2.5838	27.7610	25.2090	0.9747	0.9695
Netherlands	2.0802	2.5847	18.0220	41.1560	0.9419	0.9883
Norway	1.5866	2.1675	15.7720	7.4704	0.9255	0.7361
Sweden	1.1788	2.5476	17.5090	12.4740	0.9387	0.8912
Switzerland	1.6156	2.9191	38.5450	23.9930	0.9867	0.9664
Finland	1.3664	2.6915	10.1670	11.3080	0.8378	0.8647
Greece	1.1182	1.7697	8.1382	21.9650	0.7680	0.9640
Iceland	1.2781	1.9789	7.8241	8.8586	0.7537	0.7969
Ireland	1.9574	4.4855	13.0600	13.5810	0.8950	0.9021
Portugal	1.2377	2.5223	12.8810	10.6450	0.8924	0.8499
Spain	1.8704	3.0530	10.3100	18.1120	0.8416	0.9425
Turkey	0.2136	2.2891	1.1937	10.6770	0.0665	0.8636
	(1.0000)		NA		NA	
Yugoslavia	1.3530	3.9810	7.5358	5.8478	0.7395	0.8104
Bulgaria	2.7315	1.7868	23.8570	3.7089	0.9660	0.6322
Czechoslovakia	1.8341	2.4219	11.2120	15.9880	0.8627	0.9696
East Germany	(1.0000)	(1.0000)	NA	NA	NA	NA
Hungary	1.6162	(1.0000)	10.1180	NA	0.8365	NA
Poland	2.0782	1.5880	14.0880	17.3520	0.9084	0.9741
Romania	3.7423	1.6414	16.5550	5.7482	0.9319	0.8050
Soviet Union	4.3859	1.1526	11.0680	2.7578	0.8596	0.4873

[a] Except all dyads previously considered. (See Tables 3 through 12)

[b] The first column in each boxhead represents the response of West German imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 14

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING ITALY[a]

Country	Elasticity[b]		t-Ratio		R^2	
Netherlands	2.8419	3.7173	26.3330	29.5980	0.9719	0.9776
Norway	1.3283	2.1644	8.4653	18.0470	0.7818	0.9421
Sweden	1.6289	2.5849	14.8650	24.0450	0.9170	0.9681
Switzerland	1.4223	2.4747	12.9270	37.0740	0.8931	0.9856
Finland	1.9292	2.3383	10.6520	10.4230	0.8501	0.8445
Greece	1.5397	1.2684	4.8732	7.4194	0.5428	0.7536
Iceland	0.4279	0.7238	1.9829	6.6452	0.1643	0.6882
Ireland	1.9417	4.1526	8.2547	21.0940	0.7730	0.9569
Portugal	1.2612	2.9152	8.1578	28.8770	0.7689	0.9765
Spain	2.8946	3.8743	11.9770	20.0900	0.8776	0.9527
Turkey	1.2543	2.6027	2.5593	14.8600	0.2467	0.9246
Yugoslavia	2.3433	3.1546	22.2660	6.5534	0.9612	0.8429
Bulgaria	3.7514	2.1070	24.6200	6.3131	0.9680	0.8328
Czechoslovakia	1.9039	1.7676	11.0730	7.1513	0.8597	0.8673
East Germany	2.5335	2.9341	9.9648	3.3613	0.8465	0.5854
Hungary	2.8663	2.2429	13.2700	19.6880	0.8980	0.9797
Poland	2.1214	1.8270	7.1617	6.8811	0.7194	0.8554
Romania	3.7341	1.4426	18.9180	6.2629	0.9470	0.8305
Soviet Union	2.9157	1.6875	13.0270	4.7085	0.8945	0.7348

[a] Except all dyads previously considered. (See Tables 8 through 13)

[b] The first column in each boxhead represents the response of Italian imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

In Table 15, elasticities for the Netherlands are presented. In all instances, except for Dutch imports from Iceland, the estimates exhibit high statistical significance and produce signs anticipated by economic theory. Furthermore, GNP explains a good portion of the variance of most Dutch imports. For the case involving Iceland and Holland noted above, however, the elasticity was necessarily set at E=1.00.

Elasticities of dyads involving Norway and its trading partners are presented in Table 16. The results concerning non-Communist trade are statistically significant. Estimated elasticities involving Communist nations, however, do not fare as well. Poor statistical significance and negative elasticities of Norwegian exports to Bulgaria, Czechoslovakia, Romania, and East Germany necessitated replacing the results with E=1.00. It is interesting to note that in the elasticity of imports for Norway with Iceland, Turkey, and Bulgaria, the amount of variance in the change in imports explained by changes in Norwegian GNP is relatively small when compared with the remaining dyads. A review of the data used for these specific regressions reveals that the absolute amount of goods imported by Norway from these three countries is very small in the period considered. It may be suggested, then, that in these cases the types of goods imported are generally income inelastic.

Table 17 presents elasticities involving Sweden. The results generated are statistically acceptable with the exception of Turkey, whose elasticity was set at E=1.00. The regressions involving elasticities of Swedish exports to Bulgaria, Czechoslovakia, East Germany, Poland, Hungary, and Romania produce R^2 values that are notably higher than the R^2 values corresponding to equations of Communist elasticities with other Western nations. This suggests that Swedish/Communist

TABLE 15

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING NETHERLANDS[a]

Country	Elasticity[b]		t-Ratio		R^2	
Norway	1.4068	1.2957	11.0560	9.4637	0.8593	0.8174
Sweden	1.3910	1.9841	14.6670	11.5590	0.9149	0.8755
Switzerland	1.4417	1.9582	14.4440	17.4440	0.9125	0.9383
Finland	1.4663	0.9821	10.0000	4.7684	0.8333	0.5320
Greece	2.6223	1.7626	14.6760	21.1450	0.9150	0.9613
Iceland	0.0310	1.3894	0.0842	8.5574	0.0004	0.7854
	(1.0000)		NA		NA	
Ireland	2.1359	2.5145	6.4744	10.5050	0.6769	0.8465
Portugal	1.8025	1.7093	12.0710	21.1700	0.8793	0.9572
Spain	2.1733	2.7442	9.9556	33.6400	0.8320	0.9826
Turkey	1.5061	2.3691	5.9775	8.4166	0.6411	0.7973
Yugoslavia	1.5196	3.2792	6.9060	7.5496	0.7045	0.8769
Bulgaria	1.9168	2.1722	10.7190	2.6601	0.8517	0.4693
Czechoslovakia	1.0270	1.9295	6.0852	5.5647	0.6493	0.7946
East Germany	1.9134	2.3722	16.4490	5.6639	0.9376	0.8004
Hungary	2.4327	1.6773	7.8239	4.1115	0.7537	0.6787
Poland	2.2964	1.9028	8.6414	12.4910	0.7887	0.9512
Romania	2.7784	2.9525	11.1920	7.4589	0.8682	0.8742
Soviet Union	1.5657	1.4729	4.2294	3.0816	0.4721	0.5427

[a] Except all dyads previously considered. (See Tables 8 through 14)

[b] The first column in each boxhead represents the response of Dutch imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 16

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING NORWAY[a]

Country	Elasticity[b]		t-Ratio		R^2	
Sweden	2.1999	3.3099	27.4430	20.7250	0.9741	0.9576
Switzerland	2.4403	2.3602	18.9370	14.0980	0.9471	0.9085
Finland	2.8340	2.2209	7.3775	9.0143	0.7312	0.8024
Greece	0.5552	3.0276	4.7371	10.2190	0.5287	0.8529
Iceland	0.8078	2.2902	2.4747	10.6700	0.2344	0.8505
Ireland	1.2117	3.1174	6.1704	14.9170	0.6671	0.9175
Portugal	1.9999	1.4305	12.4290	6.7060	0.8853	0.6922
Spain	0.8767	1.3629	6.9415	11.7390	0.7066	0.8732
Turkey	0.5544	1.4501	2.8829	5.2413	0.2935	0.6041
Yugoslavia	2.4512	2.2387	5.2745	2.8446	0.5817	0.5028
Bulgaria	1.4516	-0.3509	3.3984	-0.4353	0.3908	0.0231
		(1.0000)		NA		NA
Czechoslovakia	0.9250	-0.5513	7.2948	-4.4791	0.7268	0.7149
		(1.0000)		NA		NA
East Germany	0.5604	0.1008	2.1042	0.1803	0.1975	0.0040
		(1.0000)		NA		NA
Hungary	2.0864	1.0361	14.6760	2.8899	0.9150	0.5107
Poland	1.7225	1.2788	5.2468	4.2400	0.5792	0.6920
Romania	-0.0683	-0.7217	-0.0205	-3.3557	0.0023	0.5846
	(1.0000)	(1.0000)	NA	NA	NA	NA
Soviet Union	1.2192	0.8330	6.8778	3.6848	0.7028	0.6292

[a]Except all dyads previously considered. (See Tables 8 through 15)

[b]The first column in each boxhead represents the response of Norwegian imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 17

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING SWEDEN[a]

Country	Elasticity[b]		t-Ratio		R^2	
Switzerland	2.6056	2.8378	12.7020	14.0340	.8946	.9678
Finland	4.2903	3.2534	13.0250	20.3850	.8992	.9540
Greece	1.8798	0.8641	6.9180	6.5533	.7158	.7046
Iceland	2.5860	1.5229	15.3060	7.6293	.9249	.7442
Ireland	1.6903	2.5633	8.0493	9.8900	.7732	.8302
Portugal	3.5103	2.0511	14.5240	16.8810	.9173	.9344
Spain	2.1191	2.4498	6.6936	13.7850	.7022	.9047
Turkey	0.0599	1.9197	.1523	6.0617	.0012	.6712
	(1.0000)		NA		NA	
Yugoslavia	3.0830	3.1612	10.6700	5.4021	.8569	.7848
Bulgaria	1.5261	2.6469	5.7680	5.2622	.6489	.7758
Czechoslovakia	1.5163	1.2224	4.1828	4.5995	.4793	.7256
East Germany	2.0078	2.0361	8.7486	9.7729	.8182	.9227
Hungary	3.3670	1.9769	28.8600	7.0827	.9777	.8624
Poland	0.8032	1.0251	2.0834	8.7448	.1859	.9052
Romania	2.5951	2.0006	6.1726	5.5471	.6672	.7936
Soviet Union	3.4661	0.9931	11.1100	2.1054	.8666	.3565

[a] Except all dyads previously considered. (See Tables 8 through 16)

[b] The first column in each boxhead represents the response of Swedish imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

trade is more dependent on economic factors than is most of West Europe's trade with East Europe. It could be hypothesized that Sweden's neutral stance in world affairs has lowered the need for political considerations in these Communist countries' trade relations vis-a-vis Sweden.

In Table 18, elasticities of Switzerland and its trading partners are presented. All the statistical results involving this country are good, giving rise to reliable estimates of bilateral elasticities. Here again it is useful to point out that the R^2 values for Communist elasticities of Swiss exports, like those involving Sweden, are generally high. This lends some credence to our hypothesis that economic factors play a key role in determining changes in trade among Communist and nonaligned countries.

In Table 19 we review the results of elasticity estimates involving Finland. The elasticities with the large Western nations prove to be the most reliable statistically. In addition, the two elasticities produced for the Finland/USSR dyad yield high R^2 values indicating the important role that GNP plays with regard to changes in their trade. In view of their close commercial relations, this observation seems intuitively justified. With regard to the remaining Communist countries, however, data-related problems yield statistical results that are of marginal value. In cases with poor statistical results unitary elasticity estimates were substituted.

Table 20 presents dyadic elasticities involving Greece that have not been listed in the earlier tables. With the exception of Poland's elasticity of imports for Greek goods, the elasticities involving Greece and the Communist nations are consistently reliable and reflect our

TABLE 18

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING SWITZERLAND[a]

Country	Elasticity[b]		t-Ratio		R^2	
Finland	2.4476	2.8235	5.9683	20.6920	.6404	.9553
Greece	1.1794	2.0102	6.0019	25.0540	.6430	.9721
Iceland	0.6715	0.9861	2.7363	6.0449	.3187	.6462
Ireland	1.5274	2.6775	3.4991	9.2113	.6019	.8092
Portugal	2.4687	2.0824	10.5790	37.9690	.8484	.9863
Spain	1.5776	2.1539	8.0652	30.0210	.7648	.9782
Turkey	3.0122	2.4528	14.3430	11.4460	.9114	.8792
Yugoslavia	2.3261	3.3269	8.0704	6.1274	.7650	.8243
Bulgaria	1.4357	2.4675	9.1322	7.0571	.8065	.8616
Czechoslovakia	1.0634	1.8618	5.5429	13.6800	.6057	.9590
East Germany	1.0658	2.9761	4.1838	10.7960	.5073	.9357
Hungary	1.9459	1.9155	8.0454	11.4470	.7639	.9424
Poland	1.1393	1.4375	9.4456	6.3872	.8168	.8360
Romania	2.3195	1.2426	12.1680	4.1492	.8810	.6827
Soviet Union	2.0433	2.5939	7.3395	12.5610	.7292	.9517

[a]Except all dyads previously considered. (See Tables 8 through 17)

[b]The first column in each boxhead represents the response of Swiss imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 19

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING FINLAND[a]

Country	Elasticity[b]		t-Ratio		R^2	
Greece	-0.3378	1.4201	-2.8574	13.3860	0.2898	0.9087
	(1.0000)		NA		NA	
Iceland	0.4433	0.2789	3.0591	1.2866	0.3187	0.0764
		(1.0000)		NA		NA
Ireland	0.1557	2.4099	1.8181	13.6520	0.1551	0.9030
	(1.0000)		NA		NA	
Portugal	2.7960	1.9202	8.9662	10.0470	0.8007	0.8346
Spain	0.9363	2.2085	2.8188	9.7701	0.2843	0.8267
Turkey	-0.8897	0.5890	-2.5433	2.3071	0.2443	0.2282
	(1.0000)		NA		NA	
Yugoslavia	0.9970	-0.5582	2.7849	-0.4346	0.2794	0.0230
		(1.0000)		NA		NA
Bulgaria	0.9908	1.0894	5.0374	1.4143	0.5592	0.2000
Czechoslovakia	0.0484	0.4040	0.1817	1.0348	0.0016	0.1180
	(1.0000)		NA		NA	
East Germany	0.2713	0.2782	1.2781	0.9518	0.0832	0.1017
	(1.0000)	(1.0000)	NA	NA	NA	NA
Hungary	1.2593	1.1913	4.9843	2.9832	0.5540	0.5266
Poland	0.0822	0.2993	0.3262	1.1011	0.0052	0.1316
	(1.0000)	(1.0000)	NA	NA	NA	NA
Romania	-0.6662	0.5765	-1.2200	2.3464	0.0692	0.4076
	(1.0000)		NA		NA	
Soviet Union	2.2024	0.9464	11.0340	4.9221	0.8589	0.7517

[a] Except all dyads previously considered. (See Tables 8 through 18)

[b] The first column in each boxhead represents the response of Finnish imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 20

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING GREECE[a]

Country	Elasticity[b]		t-Ratio		R^2	
Iceland	0.1538	-0.0149	1.5910	-4.5346	0.1296	0.6728
	(1.0000)	(1.0000)	NA	NA	NA	NA
Ireland	0.2821	0.0500	3.5454	0.3869	0.4399	0.0074
		(1.0000)		NA		NA
Portugal	0.8478	1.2588	10.2180	5.2755	0.8529	0.5818
Spain	1.8509	2.3550	7.0010	8.2888	0.7314	0.7924
Turkey	0.0729	-0.0014	0.2231	-0.0117	0.0027	0.0000
	(1.0000)	(1.0000)	NA	NA	NA	NA
Yugoslavia	1.9378	3.1970	8.5595	5.0469	0.8027	0.7609
Bulgaria	2.4372	2.1634	8.3946	4.9476	0.8245	0.7536
Czechoslovakia	2.0349	0.8369	7.8387	3.6311	0.7734	0.6223
East Germany	1.7462	1.1475	8.9880	3.0880	0.8346	0.5437
Hungary	2.2087	0.8242	12.7300	2.9508	0.9050	0.5211
Poland	2.2788	0.5706	9.1473	1.3539	0.8394	0.1864
		(1.0000)		NA		NA
Romania	1.5286	1.3501	5.5028	5.8581	0.6542	0.8109
Soviet Union	2.7732	0.7280	6.4696	5.2132	0.7234	0.7725

[a] Except all dyads previously considered. (See Tables 8 through 19)

[b] The first column in each boxhead represents the response of Greek imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

expectations regarding their trade relations. Greek imports of Communist goods are more income responsive, that is, a change in Greek GNP explains a larger portion in the variance of its Eastern European imports than do Communist imports of Greek goods. This is in keeping with the statistical results of most of the non-Communist dyads. Poor statistical results involving Greece with Iceland, Ireland, Poland, and Turkey necessitated the use of unit elasticity estimates.

The results listed in Table 21 describing the elasticity estimates involving Iceland reflect the data problems encountered as previously mentioned. Little substantive evaluation is possible in this case.

Dyads involving Ireland are presented in Table 22. As the table indicates, several problems were encountered for many of the elasticities estimated. For Yugoslavia, Bulgaria, Czechoslovakia, East Germany, Romania, and the Soviet Union, the statistical results are of limited utility in describing changes in dyadic imports. It is likely that irregular changes in dyadic imports and irregular GNP growth patterns combined to yield poor statistical results.

In Table 23, elasticities for Portugal and its trading partners are presented. The magnitude of the elasticities indicate that Portugal is more economically interdependent with Spain than with any other country considered in the table. Specifically, a 1 percent increase in Portugal's GNP brings forth a 3.71 percent increase in its imports from Spain, while a 1 percent increase in Spain's GNP brings forth a 2.18 percent increase in its imports from Portugal. Given the consistent growth of these nations' GNP's and the large amount of trade between them, their future economic interdependence should greatly increase. The surrogate value of E=1.00 was necessary because of

TABLE 21

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING ICELAND[a]

Country	Elasticity[b]		t-Ratio		R^2	
Ireland	0.0019	0.1026	-0.5829	0.9937	0.0254	0.0470
	(1.0000)	(0.5500)	NA	NA	NA	NA
Portugal	0.3286	1.4415	2.8523	7.7429	0.3849	0.7498
Spain	-0.5847	0.6626	-3.1324	4.5906	0.3291	0.5130
	(1.0000)		NA		NA	
Turkey	0.0026	NA	0.1366	NA	0.0026	NA
	(1.0000)	(1.0000)	NA	NA	NA	NA
Yugoslavia	NA	-0.0086	NA	-0.1285	NA	0.0054
	(1.0000)	(1.0000)	NA	NA	NA	NA
Bulgaria	NA	-0.0133	NA	-1.4304	NA	0.5057
	(1.0000)	(1.0000)	NA	NA	NA	
Czechoslovakia	0.1752	-1.1971	0.6484	-3.7923	0.0205	0.6425
	(1.0000)	(1.0000)	NA	NA	NA	NA
East Germany	-0.4958	-0.4251	-1.1987	-1.0050	0.0779	0.1121
	(1.0000)	(1.0000)	NA	NA	NA	NA
Hungary	0.0345	0.3899	0.3650	1.3710	0.0088	0.2385
	(1.0000)	(1.0000)	NA	NA	NA	NA
Poland	0.1379	0.2845	1.3578	0.8698	0.0844	0.0864
	(1.0000)	(1.0000)	NA	NA	NA	NA
Romania	-0.1484	0.0394	-0.3886	0.1983	0.0165	0.0055
	(1.0000)	(1.0000)	NA	NA	NA	NA
Soviet Union	0.5680	0.3050	1.5611	0.9115	0.1253	0.0940
	(1.0000)	(1.0000)	NA	NA	NA	NA

[a] Except all dyads previously considered. (See Tables 8 through 20)

[b] The first column in each boxhead represents the response of Icelandic imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 22

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING IRELAND[a]

Country	Elasticity[b]		t-Ratio		R^2	
Portugal	1.2922	0.2515	4.6017	3.9054	0.5142	0.4326
Spain	2.4647	1.5178	11.3810	7.8539	0.8662	0.7551
Turkey	2.3352	0.1078	0.4161	2.4824	0.2142	0.3812
Yugoslavia	0.1172	0.7468	1.1398	0.8483	0.0797	0.1524
	(1.0000)	(1.0000)	NA	NA	NA	NA
Bulgaria	0.3531	NA	2.7891	NA	0.4142	NA
		(1.0000)	NA		NA	
Czechoslovakia	1.5900	-0.1187	5.7574	-0.5120	0.6236	0.0317
		(1.0000)		NA		NA
East Germany	1.6000	-0.7010	4.0270	-2.8400	0.4738	0.5734
		(1.0000)		NA		NA
Hungary	0.5098	0.9406	7.0844	2.5230	0.7818	0.5600
Poland	4.5242	1.7880	9.1150	4.3535	0.8219	0.7031
Romania	0.8076	0.0285	2.0186	1.3723	0.2254	0.3856
	(1.0000)	(1.0000)	NA	NA	NA	NA
Soviet Union	0.5681	-0.0646	1.5611	-0.1343	0.1253	0.0025
	(1.0000)	(1.0000)	NA	NA	NA	NA

[a] Except all dyads previously considered. (See Tables 8 through 21)

[b] The first column in each boxhead represents the response of Irish imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 23

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING PORTUGAL[a]

Country	Elasticity[b]		t-Ratio		R^2	
Spain	3.7072	2.1766	14.5920	9.9513	0.9141	0.8319
Turkey	2.1937	1.4554	4.3508	7.3221	0.5928	0.7592
Yugoslavia	NA	0.7328	NA	1.4949	NA	0.2183
	(1.0000)		NA		NA	
Bulgaria	0.2237	0.1677	0.9596	0.6361	0.0661	0.0481
	(1.0000)	(1.0000)	NA	NA	NA	NA
Czechoslovakia	0.8587	0.9755	6.1855	2.4725	0.6567	0.4331
East Germany	0.0544	0.1935	0.4155	1.7918	0.0131	0.3485
	(1.0000)	(1.0000)	NA	NA	NA	NA
Hungary	0.0475	0.1450	0.7032	0.6745	0.0319	0.0538
	(1.0000)	(1.0000)	NA	NA	NA	NA
Poland	2.1995	0.4060	8.0924	1.5409	0.7751	0.2288
Romania	1.2504	0.7002	2.9696	3.1034	0.4041	0.5462
Soviet Union	0.1306	NA	0.4157	NA	0.0121	NA
	(1.0000)	(1.0000)	NA	NA	NA	NA

[a]Except all dyads previously considered. (See Tables 8 through 22)

[b]The first column in each boxhead represents the response of Portuguese imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

poor empirical estimates or the absence of data with regard to most dyads with Communist nations.

Table 24 presents estimated elasticities involving Spain and the Eastern European countries. Elasticity estimates of Spain with non-Communist countries have been listed in earlier tables. Changes in GNP are of limited explanatory value with regard to Spain/Turkey. It is interesting to note that fairly consistent results are obtained for elasticities describing Spain's trade with Communist economies. High R^2 values are obtained for the two elasticities involving trade between Spain and Czechoslovakia (R^2=.86 and .79) and trade between Spain and Romania (R^2=.92 and .88). With the exception of Spain/East Germany, the remaining dyads generally exhibit similar statistical patterns with R^2's ranging between .5 and .8 in describing the explanatory value of changes in GNP to changes in dyadic imports. The elasticity value of Yugoslav imports from Spain (5.20) suggests a rapid expansion of trade over the period considered. The elasticity for Spanish imports from East Germany could not be estimated because of insufficient data and was set at E=1.00.

Table 25 describes the results obtained for dyads involving Turkey and the Communist nations. In general, the R^2 values for the equations describing elasticities of dyadic Turkish imports are consistently higher than the corresponding R^2 values that describe a Communist nation's elasticity of imports from Turkey. This suggests that economic factors are somewhat more important in determining Turkish imports than they are in determining Communist imports from Turkey. The explanatory value of changes in GNP as a predictor of changes in dyadic trade between the USSR and Turkey, however, is high (R^2=.95 and .88), indicating the dominant role changes in GNP play in both

TABLE 24

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING SPAIN[a]

Country	Elasticity[b]		t-Ratio		R^2	
Turkey	1.0044	1.1194	2.7677	3.6720	0.2769	0.4282
Yugoslavia	2.0891	5.1952	7.4369	3.4294	0.8096	0.5951
Bulgaria	1.9899	2.5501	5.0792	4.4285	0.6825	0.7102
Czechoslovakia	2.0171	2.6231	10.1090	5.5449	0.8646	0.7935
East Germany	NA (1.0000)	2.5619	NA NA	3.2979	NA NA	0.5761
Hungary	1.9503	3.6741	6.3933	5.4515	0.7587	0.7879
Poland	2.6370	1.6190	6.4117	2.6702	0.7597	0.4712
Romania	3.3388	2.5497	12.2240	7.5732	0.9199	0.8775
Soviet Union	2.7676	2.5718	5.0274	2.9289	0.6603	0.5174

[a] Except all dyads previously considered. (See Tables 8 through 23)

[b] The first column in each boxhead represents the response of Spanish imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 25

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING TURKEY[a]

Country	Elasticity[b]		t-Ratio		R^2	
Yugoslavia	1.3910	2.7710	3.3275	2.8528	0.3808	0.5042
Bulgaria	1.8989	1.5079	8.8258	4.1196	0.8122	0.6796
Czechoslovakia	1.3474	0.6488	6.4382	2.8796	0.6972	0.5089
East Germany	NA	2.3598	NA	2.8169	NA	0.4979
	(1.0000)		NA		NA	
Hungary	2.1508	2.5709	8.8386	4.1709	0.8127	0.6850
Poland	2.4780	0.8448	7.0563	2.6337	0.7344	0.4643
Romania	2.1192	2.1176	6.4356	3.9931	0.7089	0.6659
Soviet Union	3.7284	2.9103	15.5330	7.6547	0.9451	0.8798

[a]Except all dyads previously considered. (See Tables 8 through 24)

[b]The first column in each boxhead represents the response of Turkish imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

countries with regard to changes in imports. In addition, it is interesting to note the magnitude of the elasticities in the dyad. Consistent growth of the GNP's of both nations would suggest increased economic interdependence between them in future time periods.

Tables 26 through 32 present the estimates of elasticities for all intra-Communist dyads. For the majority of cases, the resulting high R^2's suggest that trade among the Communist countries appears to be explained by economic factors. In those cases where the results are poor the surrogate value E=1.00 was substituted.

It is interesting to point out that for East Germany's elasticities of imports with other Communist nations (Table 29), the statistical reliability is high, unlike most of the non-Communist dyads involving East Germany. It may be that the consistency of the data and moderate variance in the levels of imports themselves with regard to intra-Communist trade were important factors.

CONCLUSION

The following four general points can be made regarding the empirically derived elasticities.

1. By and large, countries that traditionally experience surpluses in their trade balance consistently display elasticities that are lower in value than those of their trading partners. Conversely, countries that are net debtors exhibit elasticities of higher magnitude than those of their trading partners.

2. The statistical estimates of elasticities derived from intra-West European trade were good. While the estimates derived from intra-East European trade were weaker,

TABLE 27

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING BULGARIA[a]

Country	Elasticity[b]		t-Ratio		R^2	
Czechoslovakia	0.6475	0.3162	2.8353	0.3885	0.5345	0.0211
		(1.0000)		NA		NA
East Germany	1.2417	1.7046	5.6321	15.8490	0.8192	0.9728
Hungary	1.6349	1.9337	10.3830	4.7932	0.9390	0.7664
Poland	1.9946	1.4942	9.1408	5.9772	0.9227	0.8361
Romania	1.4952	1.2629	2.9039	3.7147	0.5464	0.6634
Soviet Union	1.6762	1.7665	19.9110	16.3750	0.9826	0.9745

[a]Except all dyads previously considered. (See Tables 8 through 26)

[b]The first column in each boxhead represents the response of Bulgarian imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 28

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING CZECHOSLOVAKIA[a]

Country	Elasticity[b]		t-Ratio		R^2	
East Germany	1.3572	1.2251	14.3500	12.1760	0.9671	0.9549
Hungary	0.7017	0.4707	4.4742	1.9359	0.7409	0.3486
Poland	1.2273	0.5659	5.5009	3.4593	0.8121	0.6309
Romania	1.8435	0.3002	6.6703	1.1485	0.8640	0.1585
		(1.0000)		NA		NA
Soviet Union	0.7929	0.4935	4.2377	3.0377	0.7191	0.5686

[a] Except all dyads previously considered. (See Tables 8 through 27)

[b] The first column in each boxhead represents the response of Czechoslovakian imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 29

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING EAST GERMANY[a]

Country	Elasticity[b]		t-Ratio		R^2	
Hungary	1.7206	1.3117	9.2162	8.4555	0.9238	0.9108
Poland	1.9986	0.6663	8.8456	6.1812	0.9178	0.8451
Romania	1.8293	0.7988	4.3924	5.2951	0.7337	0.8002
Soviet Union	0.9035	0.7904	7.6268	4.4390	0.8925	0.7378

[a] Except all dyads previously considered. (See Tables 8 through 28)

[b] The first column in each boxhead represents the response of East German imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 30

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING HUNGARY

Country	Elasticity[b]		t-Ratio		R^2	
Poland	1.3415	1.0161	7.0197	4.4890	0.8756	0.7421
Romania	0.3732	0.2283	1.1345	0.9598	0.1553	0.1163
	(1.0000)	(1.0000)	NA	NA	NA	NA
Soviet Union	1.2691	1.1928	9.5133	11.4990	0.9282	0.9497

[a] Except all dyads previously considered. (See Tables 8 through 29)

[b] The first column in each boxhead represents the response of Hungarian imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 31

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING POLAND[a]

Country	Elasticity[b]		t-Ratio		R^2	
Romania	1.2082	1.0411	3.1237	8.2302	0.5822	0.9063
Soviet Union	1.4229	1.3031	13.1670	10.7280	0.9611	0.9426

[a]Except all dyads previously considered. (See Tables 8 through 30)

[b]The first column in each boxhead represents the response of Polish imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

TABLE 32

ESTIMATES OF ELASTICITIES FOR ALL DYADS INVOLVING ROMANIA[a]

Country	Elasticity[b]		t-Ratio		R^2	
Soviet Union	0.3835	0.4040	1.9638	3.6063	0.3552	0.6501

[a]Except all dyads previously considered. (See Tables 8 through 31)

[b]The first column in each boxhead represents the response of Romanian imports while the second represents the response of the partner's imports to changes in their respective GNP's. The elasticity values are expressed in percentages.

they were superior to the ones derived from East-West trade. It appears that trade is very much a function of income within West Europe and within East Europe. For East-West trade, however, there are indications that trade is based more on political than economic factors. This was more often the case in the fifties and early sixties than it is today or probably will be in the future. Undoubtedly, inaccuracies will arise in using elasticities derived from misspecified equations, that is, equations in which imports are expressed as a function of GNP where in fact they are a function of political factors. In these instances an arbitrary unit elasticity is adopted.

3. The magnitude of the elasticities among member nations of trade blocs (such as the EC and the COMECON) tends to be larger than with nonmember countries. Thus, a given increase in France's GNP tends to bring more imports from other EC members than from non-EC members.

4. Poor empirical results were consistently obtained for dyads involving Iceland and East Germany. In these instances, the reasons are found in the missing data or in the absence of variance in the data. In such cases, unitary elasticity was substituted for the empirically derived estimates.

CHAPTER 5: INTERNATIONAL ALIGNMENT

INTRODUCTION: MODELS OF INTERNATIONAL ALIGNMENT

Although popular literature often equates alignment with alliance, theoretical social scientists have taken great pains to differentiate the two concepts. Sullivan notes:

> Alignments in no way share the permanency of formal alliances nor are they as global. Alignments refer to specific behaviors engaged in by groups of nations which are directed toward a common set of objects. They involve the coordination of behaviors in response to a particular issue in the same time period and involve either some form of explicit agreement and coordination or acting in a similar manner in an attempt to deal with some problem[1]

Thus alignments may either cause or result from formal alliances; at the same time, they can be distinguished from alliances and thus be analyzed differently.[2] Such a distinction, however, does little to define alignment in any complete sense. Nonetheless, the concept of alignment among nation states is an important subject in both the traditional and quantitative literature of international relations.

Our objective here is to describe and forecast the alignment patterns

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1 John D. Sullivan, "The Dimensions of United States Alignments in the Third World" (paper presented at the International Studies Association meetings, Pittsburgh, Pennsylvania, April 2-4, 1970), p. 1.

2 Ibid., p. 2.

of selected European nations for the 1985-1995 time period. In this respect, we will measure and predict the alignment patterns of European nations with two major powers, the United States and the Soviet Union. Such an objective requires two basic research steps. First, we must develop adequate quantitative measuring instruments for describing international alignment. Second, we must search for means to forecast patterns of major-power alignments in the European context during this time period.

Bipolar Alignment Models

The popular press often describes alignment patterns as a bipolar phenomenon; nations are considered either aligned with the United States or with the Soviet Union, or nonaligned with these major powers. Clearly nations' patterns of alignment with respect to these major powers are important for public policy purposes, particularly within the national security community. The manner and the extent to which the European countries tend to cluster themselves around the major powers can be of great value in understanding the nature and the importance of alignments in that region.

Usually bipolar alignment schemata are one-dimensional; alignments with the United States and with the Soviet Union are considered mutually exclusive patterns of behavior. Such a conceptualization, however, does not differentiate types of nonalignment or multialignment. When using a single scale, the analyst cannot determine whether a nation that lies in the middle of the scale is nonaligned, that is, has no ties to either major power, or is aligned to some extent with both, perhaps with respect to different issue areas. France, for example, could be closely tied to the United States on mutual security matters and still find itself in close agreement with the Soviet Union on issues involving such Third World areas as Southeast Asia and the Middle East.

Thus, we suggest using a modified bipolar alignment schema to determine whether the nations of Eastern and Western Europe align themselves with the most important major powers in the area, the United States and the Soviet Union. In this way, nonaligned nations can be easily distinguished from multialigned countries, and the patterns of nations' alignments with the major powers, the clustering of countries around those powers, can be more subtly represented. This modification entails considering each nation's alignment with both major powers. Thus, two aspects of major-power alignment can be explicitly described: the extent to which these countries align themselves with the major powers, and the manner in which they distribute their major-power alignment between the United States and the Soviet Union. This enables the analyst to determine the nature and the significance of the clustering of countries around these two major powers.

Hostility-Friendship vs. Cognitive Dissonance Alignment Models

So far we have implicitly assumed that alignments with major powers are most usefully viewed in terms of the direct relationships between each of the European countries and the two major powers. Leavitt[3] notes that this approach, the hostility-friendship alignment model, considers two nations aligned when they behave in a relatively friendly or cooperative manner toward each other. Teune and Synnestvedt[4] utilize

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3 Michael R. Leavitt, "A Framework for Examining the Causes of International Alliance" (Madison, Wisconsin: University of Wisconsin, July 1972). (Mimeographed.)

4 Henry Teune and Sig Synnestvedt, "Measuring International Alignments"

the hostility-friendship alignment model in their empirical examination of international alignments. This model requires indicators of alignment that represent only interactions between the two nations for which alignment is considered. Thus Teune and Synnestvedt use military alliances, visits by heads of state and other important dignitaries, protests and/or expulsions of diplomatic personnel, and educational and cultural exchanges as measures of alignment.

An alternative alignment model identified by Leavitt is the cognitive dissonance model which considers two nations aligned if they behave similarly toward one or more mutually salient third nations. Sullivan[5] uses such a conceptualization in his examination of United States alignments with developing nations in the Third World. The indicators of alignment for this model are measures of the total patterns of nations' actions in the international system. The degree to which two nations act in a friendly or hostile manner toward one another is essentially irrelevant as a measure of their alignment, except as that behavior is part of their total activity in the international system. Positions taken with respect to third nations, actions toward third nations, or the systemwide distribution of a nation's formal alliances are appropriate indicators of alignment within the context of the cognitive dissonance model.

For our purposes, the hostility-friendship model seems quite satisfactory. There are periods, of course, when highly aligned nations express

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(Philadelphia, Pennsylvania: University of Pennsylvania Foreign Policy Research Monograph Series No. 5, 1965).

5 Sullivan, "The Dimensions of United States Alignments in the Third World."

hostility toward one another, as with the Soviet Union and Czechoslovakia in 1968. On the whole, however, aligned nations are more friendly toward one another than are nonaligned nations. The major drawback of this model is that it does not consider alignment between nations that do not interact. The cognitive dissonance model, on the other hand, is able to measure alignment between noninteracting nations. If nations are considered aligned when they behave similarly toward one or more mutually salient third nations, the mutual salience of the third nation(s) assures a level of interaction sufficient for measuring behavioral patterns. Thus, the cognitive dissonance model can be usefully viewed as a hostility-friendship model that introduces explicit controls for the levels of interaction between countries.

In the context of our problem, this control is unnecessary. Since we are dealing with two superpowers, each of which is the subject of a large number of policies and actions by the European countries, we can expect a level of interaction that will enable us to compare alignment patterns. Consequently, we will use the hostility-friendship conceptualization to develop a well-grounded forecasting model of alignment for the Eastern and Western European nations.

MEASURING INTERNATIONAL ALIGNMENT

We represent alignment on a two-dimensional plane, thus moving away from the single-dimensionality of most bipolar alignment schemata. Two scores are produced for each nation to indicate its alignment with the United States and with the Soviet Union respectively. The two scores are coordinates that define a given point on the plane shown below. The letters mapped onto the plane represent hypothetical nations, A to J, and indicate visually their alignment with each of the major powers.

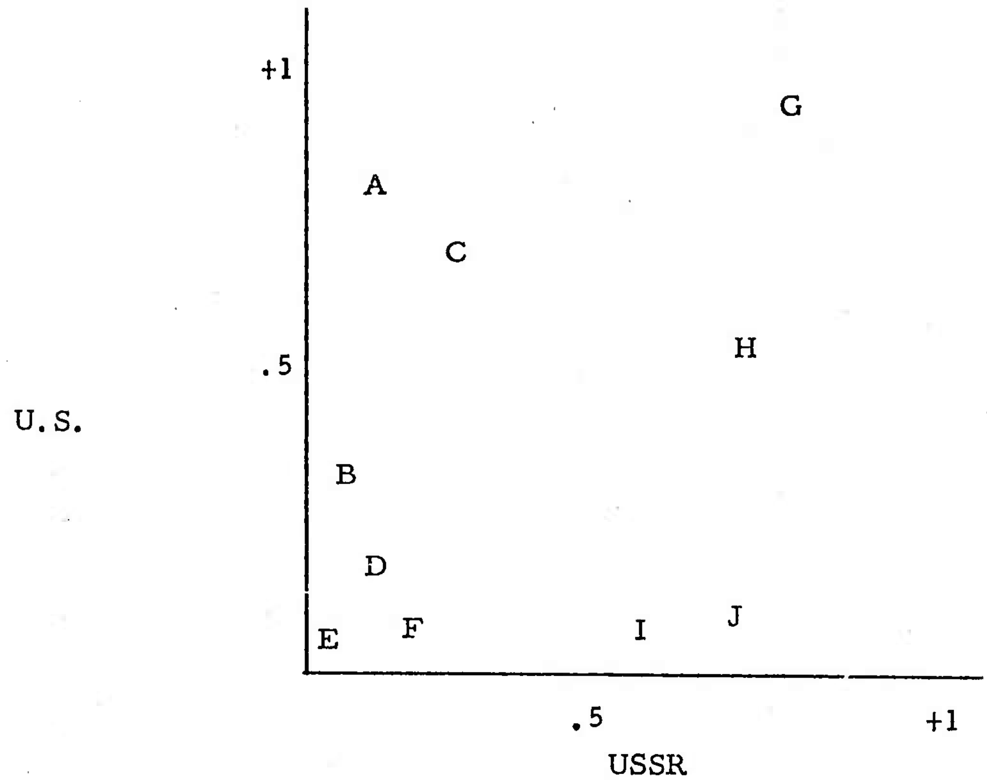

Figure 1. Hypothetical Display of Alignment Scores

Thus, the score for nation E (0.0, 0.0) suggests that the nation is not aligned with either of the powers; nation G's score of (1.0, 1.0) suggests that it is completely aligned with both major powers, while a score of (1.0, 0.0) suggests complete alignment with the Soviet Union and no alignment with the United States. Needless to say, this model can be logically extended to accommodate any number of major powers with which one might want to measure a nation's alignment. The use of two dimensions here is appropriate for Eastern and Western Europe since the United States and the Soviet Union are clearly the two most important major powers for all European nations.

U.N. Votes as a Measure of Alignment

We include two paired components in the composite alignment scores for each nation. The first set of components is the percentage of United Nations General Assembly votes in agreement with the United States and with the Soviet Union respectively. United Nations votes are aggregated here according to the year in which they were cast. Since the General Assembly sessions normally begin in the fall and adjourn the following spring, the voting computed for a given year may actually come from two different General Assembly sessions. Although this treatment of United Nations roll call data differs somewhat from normal practice, it is necessary to insure comparability between the roll call data and other data sets that are aggregated by calendar year. Of course, only roll call votes could actually be considered in the construction of this part of the alignment scores since voice votes or hand votes do not identify the position taken by a given nation. Furthermore, only those roll calls on which the United States or the Soviet Union took an identifiable position were used to determine whether a given nation's voting was in agreement with either or both of them.

There are shortcomings in using United Nations voting data as a measure of international alignment. A single vote in agreement with the United States may not indicate alignment with the United States. Nonetheless, the patterns of United Nations voting over the years do indicate the degrees to which nations are in agreement with the major powers. Since policy statements by national leaders are rarely precise enough to be reduced to quantitative terms or to be compared with other leaders' statements, United Nations votes are particularly important as a public forum where nations take clearly identifiable and comparable policy positions. Thus, Russett notes:

> Roll-call votes provide an especially useful means of identifying states' attitudes. They occur on a very wide

variety of issues, they are numerous, and they force a state to take a position.[6]

There are several specific difficulties with the use of United Nations roll call votes as an indicator of international alignment, not the least of which is that we have no satisfactory way to decide which roll calls are most and which are least "important." Nor have we any means to measure the intensity of a particular nation's position.[7] There are, in addition, particularly severe difficulties in using United Nations votes for African and perhaps for Latin American nations.[8] There is, however, some evidence to suggest that these roll calls can be a useful measure of alignment patterns with the major powers, especially in the context of Eastern and Western Europe.

In a 1965 project undertaken by Henry Teune and Sig Synnestvedt,[9] a group of 126 political scientists, including both "area specialists" and international relations "generalists," were asked to rate the degrees of alignment of 119 nations with the United States and with the Soviet Union. Teune and Synnestvedt then examined those issues in the 1963 United Nations sessions on which the United States and the Soviet Union disagreed and found that the countries considered most aligned with the United States cast 95 percent of their votes with the United States while

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6 Bruce Russett, Trends in World Politics (New York: Macmillan & Co., Inc., 1965), p. 67.

7 Ibid.

8 African countries, in particular, often agree with the USSR on issues that involve Third World nations. That agreement is limited to that specific set of issues, however, and does not suggest overall alignment tendencies.

9 Teune and Synnestvedt, "Measuring International Alignments."

countries thought to be most aligned with the Soviet Union voted with it 94 percent of the time. This study suggests that United Nations voting data are a useful, readily obtainable indicator of international alignment, at least with respect to these major powers.

Other Components of the Alignment Scores

Teune and Synnestvedt maintain, however, that international alignments are composed of two rather distinct dimensions--the diplomatic dimension and the military dimension. While they regard United Nations roll calls as a quite useful measure of the diplomatic dimension of alignment, they maintain that the military dimension requires a measure of the degree to which nations collectively view their national security.[10] Accordingly, the percentage of a nation's military treaties with the United States and the Soviet Union respectively is used as the pair of measures of the military dimension of alignment.

In the context of Eastern and Western Europe this pair of measures is often mutually exclusive; that is, nations that have military treaties with the United States do not have such commitments with the Soviet Union, and vice versa. However, for some of the European nations--Czechoslovakia, Finland, Hungary, Italy, Romania, and Yugoslavia--this condition does not hold.

Composite pairs of alignment scores were computed for each European nation by finding the mean of the alignment scores for the diplomatic and military dimensions. These composites are used in the following analyses.

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[10] Ibid.

Composite Alignment Measures

Once the economic and military dimensions of alignment were combined into composite alignment scores, the composite measures could be used to describe the relative degree to which the various nations of Eastern and Western Europe are aligned with the United States and with the Soviet Union. Tables 1 and 2 show mean composite alignment scores for each of the 26 nations included in this study for the period 1961 to 1970 inclusive. These means were calculated by summing each nation's composite alignment scores over the 10-year period and dividing that sum by 10. Table 1 also shows ranks of the various European nations by the degree of their alignment with the United States, while Table 2 ranks these countries by their alignment with the Soviet Union.

As Table 1 suggests, these composite scores show that 16 of the 26 countries have high levels of alignment with the United States. Two others, West Germany and Yugoslavia, evidence moderate levels of alignment with the United States. West Germany is, of course, highly aligned with the United States; but since it has few military treaties and until recently did not belong to the United Nations, its alignment score with the United States is not as high as that of other Western European nations. The same is true of East Germany's alignment with the Soviet Union. East Germany's low score is also a function of its lack of military treaties and its nonmembership in the U.N. However, East Germany is the least aligned of the European nations with the United States, while West Germany is the least aligned with the Soviet Union. This fact places East and West Germany on the extremes of a modified bipolar alignment schema. Seven European nations are clearly not aligned with the United States: Poland, Romania, Switzerland, Czechoslovakia, Hungary, Bulgaria, and East Germany. Each of these

TABLE 1

COMPOSITE ALIGNMENT WITH
THE UNITED STATES, 1961-1970

Country	Rank	Score
Iceland	1	.4693
United Kingdom	2	.4150
Italy	3	.4145
Spain	4	.3999
France	5	.3980
BLEU[a]	6	.3974
Netherlands	7	.3957
Turkey	8	.3799
Ireland	9	.3533
Greece	10	.3524
Portugal	11	.3507
Austria	12	.3441
Norway	13	.3414
Denmark	14	.3367
Finland	15	.3012
Sweden	16	.3000
West Germany	17	.2775
Yugoslavia	18	.1627
Poland	19	.0970
Romania	20	.0902
Switzerland	21	.0795
Czechoslovakia	22	.0683
Hungary	23	.0624
Bulgaria	24	.0599
East Germany	25	.0000

[a]Belgium/Luxembourg. Hereafter BLEU.

nations, except Switzerland, is relatively highly aligned with the Soviet Union; Switzerland is aligned with neither major power. Note that Yugoslavia, the other nation moderately aligned with the United States, is also highly aligned with the Soviet Union. Yugoslavia can be

TABLE 2

COMPOSITE ALIGNMENT WITH THE SOVIET UNION, 1961-1970

Country	Rank	Score
Hungary	1	.4620
Poland	2	.4572
Bulgaria	3	.4532
Czechoslovakia	4	.4373
Romania	5	.4366
Yugoslavia	6	.3478
East Germany	7	.2155
Finland	8	.1828
Turkey	9	.1667
Greece	10	.1420
Spain	11	.1365
Norway	12	.1341
Denmark	13	.1239
Sweden	14	.1221
Ireland	15	.1215
Austria	16	.1089
France	17	.1081
Iceland	18	.0873
Italy	19	.0866
Netherlands	20	.0797
BLEU	21	.0765
United Kingdom	22	.0745
Portugal	23	.0737
Switzerland	24	.0170
West Germany	25	.0045

characterized as a multialigned nation with reasonably strong ties to both the United States and the Soviet Union.

In addition to East Germany, Finland and Turkey also show moderate levels of alignment with the Soviet Union. Finland has been viewed as a multialigned nation with respect to the United States and the Soviet Union for several years. Turkey, too, has recently demonstrated more flexibility in its relationships with the two superpowers. Our measures reflect these dual alignment patterns.

Figure 2 depicts the composite alignment scores for the European countries on the two-dimensional plane shown previously. There are three important facets of this figure that bear upon the value of these alignment measures. The first is the clustering of Western European nations in the upper-left of the figure. As is evident, 14 of these countries are primarily aligned with the United States: Iceland, Britain, Italy, BLEU, France, Spain, Netherlands, Portugal, Ireland, Greece, Austria, Norway, West Germany, and Denmark. A similar clustering of Eastern European countries is found in the lower-right of the figure. Six nations--Romania, Poland, Czechoslovakia, Hungary, Bulgaria, and East Germany--are primarily aligned with the Soviet Union. Four nations--Turkey, Sweden, Finland, and Yugoslavia--are multialigned and one country, Switzerland, is unaligned. The pattern represented in Figure 2 accords with our intuitive notions about alignment in the European context; the Eastern and Western blocs are clearly defined, while countries usually considered multialigned or nonaligned remain outside the bipolar pattern.

USES OF THE MEASURES

We have so far considered only the components of the raw alignment measures. We now direct our attention to the way these measures can be utilized to produce two kinds of information about the alignments of the European nations: information about the <u>extent</u> or level to which the

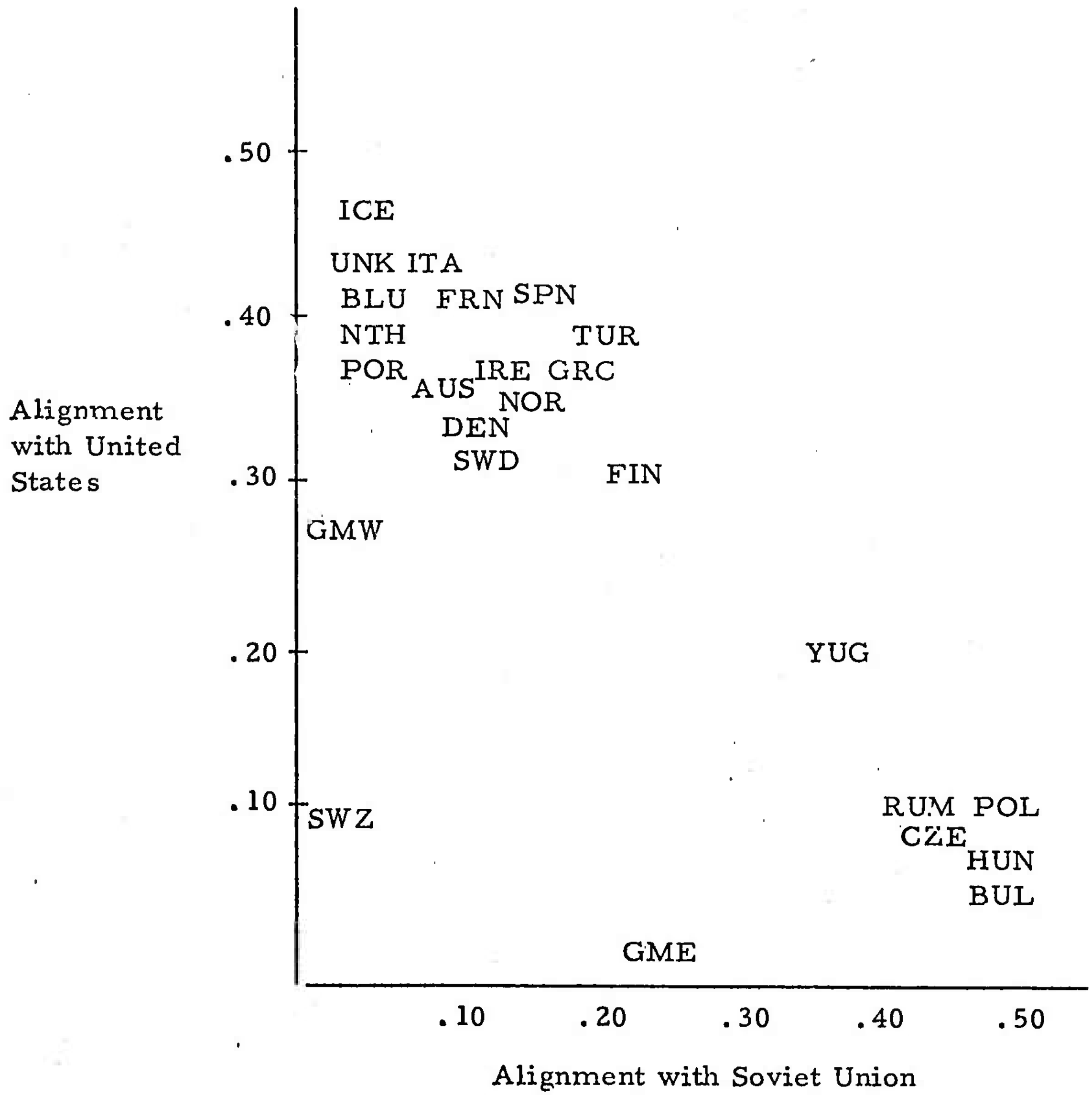

Figure 2. Alignment Scores for the European Countries 1960-1970.

nations are aligned with major powers, and information about the <u>distribution</u> of their major-power alignments between the United States and the Soviet Union.

In Figure 3 we derive the <u>extent</u> and <u>distribution</u> of major-power alignments by considering the characteristics of a vector that originates at the point (0.0, 0.0) and ends at a given nation's coordinates. The length of this vector, R, serves as a measure of the <u>extent</u> of the nation's major-power alignment; the angle of the vector, θ, represents the <u>distribution</u> of that alignment between the United States and the Soviet Union.

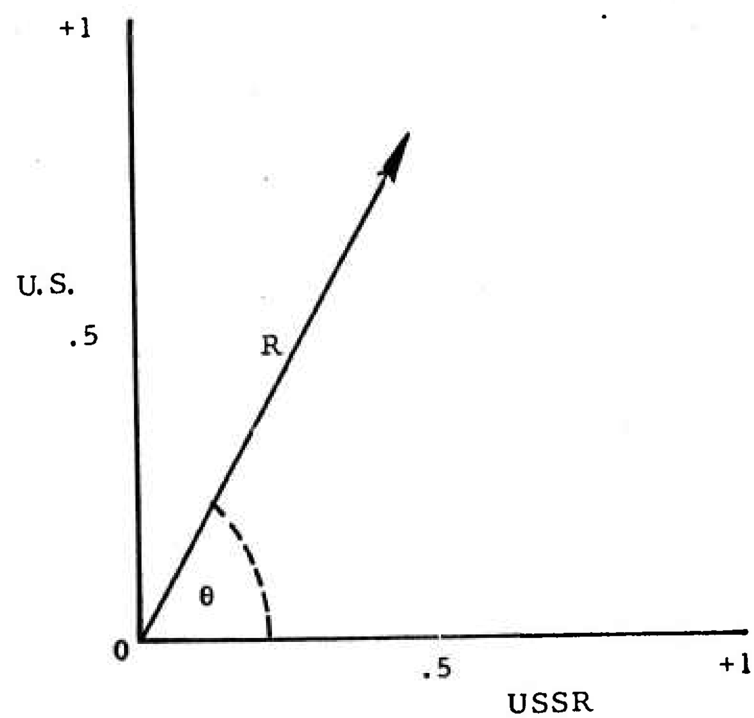

Figure 3. Transformations of Alignment Scores

Thus, a nation whose coordinates lie quite close to the point (0.0, 0.0) has a very short vector and is relatively nonaligned with the major powers. In a similar manner, a nation whose vector has an angle of 0^{o} from the horizontal axis is completely aligned with the Soviet Union, while a nation whose vector has an angle of 90^{o} from the horizontal axis distributes its major-power alignment completely with the United States. A nation whose vector has an angle of 45^{o} is equally aligned with both major powers.

The length of the vector, R, has a range from 0 to approximately 1.414. The cosine of the vector angle has a range of 0.0 to 1.0. The cosine of the angle will equal 1.0 when the vector lies along the horizontal axis, and 0.0 when it lies along the vertical axis. Thus, when the cosine equals 1.0, a nation apportions its major-power alignment completely with the Soviet Union; when the cosine equals 0.0, the nation apportions its major-power alignment completely with the United States.

Nations' scores on ALIGN θ, the distribution of their alignments between the United States and the Soviet Union, are shown in Table 3. The scores reveal that the nations of Western Europe consistently distribute their major-power alignment toward the United States while Soviet-bloc nations show high degrees of alignment with the Soviet Union.

Note that Finland is clearly aligned with both major powers, distributing its major-power alignment about equally with the United States and the Soviet Union. To a more limited extent, Turkey and Yugoslavia can also be viewed as multialigned nations. Though Turkey is

TABLE 3

DISTRIBUTION OF NATIONS'
MAJOR-POWER ALIGNMENTS 1960-1970

	Country	Rank	ALIGNθ
Aligned with U.S.	West Germany	1	.0162
	United Kingdom	2	.1284
	Portugal	3	.1359
	BLEU	4	.1405
	Iceland	5	.1476
	Netherlands	6	.1480
	Italy	7	.1622
	Switzerland	8	.2084
	France	9	.2232
	Austria	10	.2542
	Ireland	11	.2886
	Denmark	12	.3038
	Spain	13	.3042
	Norway	14	.3220
	Sweden	15	.3280
	Greece	16	.3547
	Turkey	17	.3959
Multiply Aligned	Finland	18	.4882
Aligned With USSR	Yugoslavia	19	.9094
	Poland	20	.9658
	Romania	20	.9658
	Czechoslovakia	22	.9708
	Hungary	23	.9733
	Bulgaria	24	.9734
	East Germany	25	1.0000

primarily aligned with the United States, it is ranked below Yugoslavia and Finland on alignment with the Soviet Union (see Table 2). Yugoslavia, on the other hand, is primarily aligned with the Soviet Union. Nonetheless, it shows substantially higher alignment with the United States than does any other Eastern European country.

West Germany, the United Kingdom, Portugal, Iceland, and the Netherlands are among those nations that have the most extensive alignment with the United States. East Germany, Bulgaria, Hungary, and Czechoslovakia are the nations most highly aligned with the Soviet Union during the 1960 to 1970 period.

Nations' scores on ALIGNR, the <u>extent</u> of their alignments with either major power, are shown in Table 4. In addition, this table ranks each of the European nations by the <u>extent</u> of their major-power alignments. The Soviet Union is not included among the group of nations ranked here because it was used as one of the referents in constructing alignment scores for the various European nations. Analytically, we set the Soviet Union's ALIGNR value equal to 1.0 and its ALIGNθ value equal to 1.0 which simply means that the Soviet Union is completely aligned with itself. An examination of Table 4 reveals that 13 European nations are highly aligned with the 2 major powers, the United States and the Soviet Union. Five of those 13 countries are Eastern European nations, while the other 8 include most major Western European countries--the United Kingdom, Italy, France, Spain, and the Netherlands. Only two Eastern European countries--Yugoslavia and East Germany--are not among those highly aligned with the major powers. More will be said on this point later. Switzerland clearly shows lack of alignment with either major power.

TABLE 4

EXTENT OF NATIONS'
MAJOR-POWER ALIGNMENTS 1960-1970

Country	Rank	ALIGNR
Hungary	1	.4519
Poland	2	.4499
Iceland	3	.4475
Bulgaria	4	.4424
Czechoslovakia	5	.4274
Romania	6	.4265
United Kingdom	7	.4006
Italy	8	.3977
Spain	9	.3913
Turkey	10	.3866
BLEU	11	.3824
France	12	.3808
Netherlands	13	.3796
Yugoslavia	14	.3500
Greece	15	.3495
Ireland	16	.3413
Norway	17	.3312
Denmark	18	.3245
Austria	19	.3244
Portugal	20	.3220
Finland	21	.3068
Sweden	22	.2874
West Germany	23	.2754
East Germany	24	.2157
Switzerland	25	.0818

It is especially interesting to note that East and West Germany show relatively low scores as to the extent of their major-power alignment. As we noted above, this result stems from the relatively few military treaties to which these two powers are signatories. Moreover, until very recently, they did not belong to the United Nations; hence no roll call data that included them were available. At first glance, these results are counterintuitive. However, an examination of Table 3, which shows nations' scores on ALIGNθ, reveals that these two countries evidence extreme scores on this aspect of alignment. This suggests that, to the extent that East and West Germany are aligned with the two major powers, they distribute their major-power alignment exclusively with the Soviet Union and the United States respectively.

How does information about the extent of nations' major-power alignments help us understand international alignment? Information about the distribution of major-power alignment tells us whether a nation is aligned with the United States, the Soviet Union, or lies somewhere in the middle of a single-dimensional alignment continuum. That distribution says nothing, however, about the importance or significance of a nation's major-power alignment. Clearly, a nation may distribute its alignment toward one or the other superpower, yet have few and weak ties to that power. In that case, its tendency to align with that particular major power would assume less importance than if its ties with the superpower were strong and extensive. Thus, for example, the distribution of major-power alignment of Switzerland and France is quite similar; both lean substantially toward the U.S. Switzerland's alignment is far less important than that of France since the extent of its alignment is neither as strong nor as extensive. For public policy and planning purposes, then, ALIGNR serves as a valuable adjunct to ALIGNθ in determining nations' major-power alignments.

In addition, consideration of both aspects of nations' major-power alignments helps us distinguish patterns of nonalignment and multialignment with the major powers. As we suggested earlier, the inability to make these distinctions limited the usefulness of many bipolar alignment schemata. The two-dimensional modification allows Switzerland, for example, to be characterized as a nonaligned nation because of the very short length of its alignment vector. Finland, and to some extent Turkey and Yugoslavia, are viewed as multialigned. For these three nations, the angle of the alignment vector approaches 45°, but the length of the alignment vector is substantial.

As we noted before, nations that show high scores on ALIGNθ and distribute their major-power alignment toward the Soviet Union also tend to have very high scores on ALIGNR. Table 5 shows cross-classifications of the extent and distribution of major-power alignment for 24 of these European countries; Finland is excluded because it

TABLE 5

EXTENT VS. DISTRIBUTION OF MAJOR-POWER ALIGNMENT, 1960-1970

ALIGNθ	ALIGNR	
	High	Moderate
With U. S.	8	10
With USSR	5	1

$X^2 = 3.050$ $p < .07$

shows an almost even distribution of its major-power alignment between the United States and the Soviet Union. The table shows a clear link between ALIGN θ and ALIGNR. That linkage is positive; the higher a nation's value on ALIGNθ, the greater its value on ALIGNR. In short, nations aligned with the Soviet Union are closely aligned with the Soviet Union; nations aligned with the United States are not consistently so closely aligned with the United States. Given the hegemony the Soviet Union has attempted to extend over its Eastern European allies, our results are far from surprising.

Thus, we have modified the traditional bipolar alignment schema to permit a more complex, and hopefully meaningful, description and understanding of the alignments of the European countries. The two-dimensional modification helps us identify the major power with which a country is aligned and the level or significance of that alignment. These two aspects of major-power alignment, although distinct, are explicitly related. Together they enable us to describe and forecast clusters of nations aligned with the United States or with the Soviet Union, as well as clusters of nonaligned and multialigned nations.

PREDICTORS OF INTERNATIONAL ALIGNMENT

Two types of predictor variables are used in constructing the alignment forecasting model. The first type consists of other central environmental descriptors under consideration in the Long-Range Environmental Forecasting project. In addition, exogenous predictors, variables whose values are predetermined with respect to the long-range environmental forecasting model, are used in forecasting international alignment.

Other Central Environmental Descriptors

Four other central environmental descriptors are included in the international alignment forecasting model. These are internal instability, national power base, international trade, and international conflict.

Internal Instability and National Power Base. Liska[11] has suggested that nations facing internal instability seek alignments with major powers for two primary reasons. First, major-power alignments give the nation's government additional legitimacy within the nation. The notion here is that as a nation's regime becomes more aligned with major powers, it is viewed as a more legitimate government by those powers. This additional legitimacy is translated into the domestic arena so that more of the nation's citizens also view the regime as legitimate. In addition, alignments free resources, especially military resources, from external defense requirements so that they can be used to suppress internal instability. Consequently, a nation is likely to seek alignments that allow this reallocation of military resources for that purpose. However, this relationship is probably mediated by the level of a nation's power base. Nations with large military resources, and large economic power bases that can be transformed into military resources, are more able to maintain large external defense forces and large internal suppression forces simultaneously. Thus, instability is hypothesized to be directly related to the extent to which a nation is aligned with major powers; but this relationship is hypothesized to be important primarily for nations with relatively small national power bases.

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[11] George Liska, Nations in Alliance (Baltimore: The Johns Hopkins Press, 1962).

Trade. Several theorists[12] have linked patterns of international alignment to patterns of trade among nations. Sullivan,[13] in particular, notes that, aside from past patterns of alignment, international trade patterns are the most important predictors of international alignment. We suggest that the distribution of a nation's major-power alignment between the United States and the Soviet Union wi. vary directly with the proportion of its trade with each of the two nations. Since the cosine of the angle of the alignment vector is to be forecast, and since the cosine of an angle varies inversely with the size of the angle itself, we hypothesize that

$$\cos \theta = f \left(\frac{\text{proportion of trade with USSR}}{\text{proportion of trade with U.S.}} \right)$$

that is, the greater the proportion of trade with the Soviet Union, the smaller the angle, θ, and the greater the cosine of that angle. Proportion of trade with the Soviet Union relative to trade with the United States, then, is hypothesized to vary directly with the distribution of a nation's major-power alignment.

International Conflict. The remaining central environmental descriptor, international conflict, is hypothesized to affect both the extent to which nations align with major powers and the distribution of nations' major-power alignments between the United States and the Soviet Union. Liska[14]

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12 See Russett and Lamb, "Global Patterns"; Russett, International Regions and the International System; and Teune and Synnestvedt, "Measuring International Alignments."

13 Sullivan, "Cooperating to Conflict."

14 Liska, Nations in Alliance.

suggests that intense international conflict is the primary determinant of whether nations seek international alignments, although much empirical research disputes this hypothesis.[15] The thrust of the familiar argument here is that nations that are engaged in international conflict attempt to supplement their abilities to deal with that conflict by aligning themselves with major powers. This hypothesis requires qualification, however, and the lack of this qualification in previous empirical research may account for weak observed linkages between conflict and alignment tendencies. Specifically, we suggest that it is likely that nations involved in new conflicts will seek such alignments since new conflicts involve great uncertainties. Nations involved in conflicts for an extended period of time, however, will not seek major-power alignments because the level of uncertainty is much lower. We regard this as one way to incorporate Leavitt's[16] hypothesis that threats constitute the most important cause of alignment formation.

A measure was constructed to test this hypothesis by controlling the level of present conflict by the level of previous conflict. Specifically,

$$\frac{\text{conflict at time } t}{\text{conflict at time } t-1}$$

is hypothesized to be positively related to the <u>extent</u> of a nation's major-power alignment.

The <u>distribution</u> of a nation's major-power alignment between the United

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15 Sullivan, "Cooperating to Conflict."

16 Leavitt, "A Framework for Examining the Causes of International Alliance."

States and the Soviet Union is also viewed as a function of conflict. Specifically, a nation's distribution of major-power alignment is regarded as a function of the level of its conflict with the Soviet Union relative to its level of conflict with the United States. Again, the cosine of an angle is inversely proportional to the size of that angle in degrees,

$$\cos \theta = f \left(\frac{\text{conflict with U.S.}}{\text{conflict with USSR}} \right)$$

Thus, as a nation has proportionately more conflict with the United States than with the Soviet Union, it is expected to align more with the Soviet Union than with the United States. Conversely, a nation that has more conflict with the Soviet Union than with the United States is expected to align more with the United States.

Exogenous Predictors of International Alignment

We include two types of predictor variables in our integrated forecasting model. The first type is predictors hypothesized to affect the measures of alignment more or less instantaneously. This type includes other central environmental descriptors, for which values will be forecast at the same time that international alignment measures are forecast. In addition, we include a class of lagged exogenous predictors whose impact on alignment is observed some time after their values occur. Three lagged exogenous variables are initially examined as potentially useful predictors of alignment--previous alignment, proximity, and polity-type similarity.

Previous Alignment Patterns. Several theorists have suggested that patterns of international alignment are primarily a function of previous international alignments.[17] Specifically we suggest that the extent of a nation's major-power alignment is determined in part by its previous level of major-power alignment, and that the distribution of a nation's major-power alignment is a function of its previous distribution of major-power alignment.

Proximity. Sullivan and Russett[18] have argued that geographical proximity plays a role in determining the alignments of nations. The argument is based upon the notion that nations physically near one another share common regional problems; these common problems lead to the search for common solutions, or common positions, which constitute indicators of alignment. Specifically, Sullivan utilized air miles between capitals as a measure of the proximity of nations and found that nations are more likely to be aligned with one another as that distance decreases.[19] Consistent with Sullivan's usage, we suggest that the distribution of a nation's major-power alignment is positively related

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[17] See John D. Sullivan, "Cooperating to Conflict: Sources of Informal Alignments," in Peace, War, and Numbers, ed. by Bruce M. Russett (Beverly Hills: Sage Publications, Inc., 1972), pp. 115-138; Bruce M. Russett, "Components of an Operational Theory of International Alliance Formation," Journal of Conflict Resolution, Vol. 12 (1968), pp. 285-301; Norman J. Padelford and George A. Lincoln, The Dynamics of International Politics (New York: The Macmillan Co., 1962); Bruce M. Russett and W.C. Lamb, "Global Patterns of Diplomatic Exchange," Journal of Peace Research, Vol. 3 (1969), pp. 37-55; and Bruce M. Russett, International Regions and the International System (Chicago: Rand McNally and Co., 1967).

[18] Sullivan, "Cooperating to Conflict," and Russett, International Regions and the International System.

[19] Sullivan, "Cooperating to Conflict," p. 127.

to the relative distance from that nation to the United States and to the Soviet Union, respectively, as measured by air miles between capitals. That is, the longer the distance from a nation to the Soviet Union relative to its distance to the United States, the more likely it is that the nation is aligned with the United States. Conversely, nations closer to the Soviet Union relative to their distance to the United States are more likely to be aligned with the Soviet Union. Again, since the cosine of an angle is inversely related to the size of that angle in degrees, and since an angle of zero degrees in a nation's alignment vector corresponds to that nation's allocation of all its major-power alignment to the Soviet Union, we hypothesize that the measure,

$$\frac{\text{distance from U.S.}}{\text{distance from USSR}}$$

will be positively covariant with the cosine of the angle of the nation's major-power alignment vector, where distance is measured by air miles between capitals.[20]

Polity-Type Similarity. Several theorists[21] have argued that nations

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[20] Since the universe of nations is limited to Europe, we, of course, expect all nations to be closer geographically to the Soviet Union than to the United States (thus this ratio will always be greater than 1.0). However, since we are concerned here with the relative distances, the universal proximity to the Soviet Union will not be important.

[21] Russett and Lamb, "Global Patterns"; Russett, International Regions and the International System; Russett, "Components of an Operational Theory"; H.S. Dinerstein, "The Transformation of Alliance Systems," American Political Science Review, Vol. 54 (1965), pp. 589-601; William A. Gamson, "A Theory of Coalition Formation," American Sociological Review, Vol. 26 (1961), pp. 373-382; and Sullivan, "Cooperating to Conflict," p. 127.

with similar polity types are more likely to be aligned with one another. Consistent with previous usage, we will utilize Banks and Gregg's[22] polity-characteristic typology, in which all the European nations are identified as either "centrist" or "polyarchic." Since the Soviet Union and the United States are identified as centrist and polyarchic respectively, we suggest that centrist nations are more likely to align with the Soviet Union and polyarchic nations are more likely to align with the United States. By creating a polity-type dummy variable and scoring centrist nations "1" and polyarchic nations "0," this theory can be tested by relating the polity-type dummy variable to the cosine power-alignment vector. Specifically, then, we hypothesize that the cosine of a nation's alignment vector is positively related to its score on the Banks and Gregg polity-type measure.

STRUCTURE OF THE ALIGNMENT MODELS

Multiple regression analysis is the basic technique utilized to generate a postdictive model for both aspects of major-power alignment--the <u>extent</u> of nations' major-power alignments, and the <u>distribution</u> of those alignments between the United States and the Soviet Union. Each of the predictor variables discussed above is examined to determine if it is useful within the context of Eastern and Western Europe. For those variables that prove useful as predictors, estimates of the direction and magnitude of their linkages with international alignment measures are generated. Those estimates are used, along with known values

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22 Arthur S. Banks and Phillip M. Gregg, "Grouping Political Systems: Q-Factor Analysis of a Cross Polity Survey," <u>The American Behavioral Scientist,</u> Vol. 9 (1965), pp. 3-6.

of the lagged exogenous predictors and forecast values of the other central environmental descriptors, to generate forecasts of the alignment measures for the 1985-1995 time period.

Seven predictor variables, four of which are other central environmental descriptors, are used to forecast international alignment patterns. These seven variables are used in two alignment equations, one equation for the <u>extent</u> of nations' major-power alignments and the other for the <u>distribution</u> of their major-power alignments between the United States and the Soviet Union. The equations are then evaluated for explanatory power, and are altered, where necessary, to be consistent with criteria for good estimation. Parameter estimates developed from the final equations are utilized to generate forecasts of the length and cosine of the angle of nations' alignment vectors for the 1985-1995 period.

$$Y_1 = \beta_{10} + \beta_{11} Y_{1_{t-1}} + \beta_{17} \frac{Y_7(\text{USSR})}{Y_7(\text{U.S.})} + \beta_{16} \frac{Y_6(\text{U.S.})}{Y_6(\text{USSR})} + \beta_{12} \frac{X_1}{X_2} + \beta_{13} X_3 + \xi_1$$

and,

$$Y_2 = \beta_{20} + \beta_{22} Y_{2_{t-1}} + \beta_{23} \frac{Y_3}{Y_4 + Y_5} + \beta_{26} \frac{Y_{6_t}}{Y_{6_{t-1}}} + \xi_2$$

where:

Y_1 = cosine vector angle (<u>distribution</u> of alignment)

Y_2 = vector length (<u>extent</u> of alignment)

Y_3 = internal instability (TURMOIL and REVOLT)

Y_4 = military power base (MPB)

Y_5 = economic power base (EPB)

Y_6 = international conflict (CONFLICT)

Y_7 = trade

X_1 = distance from U.S.

X_2 = distance from USSR

X_3 = dummy indicating polity type

In short, we evaluate these equations for the length and cosine of the angle of nations' alignment vectors with a view toward removing those predictors that do not, in fact, evidence strong linkages with the characteristics of the nations' alignment patterns. Estimates of the direction and strength of the linkages for the remaining predictors are developed with minimum-information, maximum-likelihood methods.

Predictors of ALIGN θ

Five variables--previous distribution of major-power alignment, international trade, international conflict, distance, and polity-type similarity--are initially hypothesized to be useful predictors of the distribution of nations' major-power alignment. Each of the five variables relates to ALIGN θ in the expected manner, although only four are used in the forecasting model for ALIGN θ. (Conflict is excluded because it merely reflects variance also attributable to combinations of the other four variables.) In the sections that follow, each of these five potential predictors is discussed, and their linkages with the distribution of nations' major-power alignments are analyzed.

Previous Distribution of Major-Power Alignment. Previous distribution of nations' major-power alignments is expected to relate strongly to their present distribution. Clearly, these expectations are based on our belief that alignment represents the recurring aspects of nations' behaviors, as well as on the empirical and theoretical work of many international relations scholars.

In fact, we observe a .885 correlation between ALIGNθ and $ALIGN\theta_{t-1}$ for the European nations during the period 1960-1970. ALIGNθ and $ALIGN\theta_{t-1}$, then, had nearly 80 percent of their variance in common.

Previous distribution of major-power alignment is by far the predominant predictor in the forecasting model. This suggests that the distribution of nations' major-power alignments can be predicted by knowing the nations' previous distribution of major-power alignments, and the peculiar conditions that may have affected those nations in the recent past. Given the absence of unusual conditions, then, previous alignment patterns become the predominant determinants of present alignment patterns.

Trade. Several international relations scholars[23] have linked patterns of international alignment to patterns of trade among nations, and in fact have suggested that aside from past patterns of alignment, international trade is the most important predictor of international alignment. Since our interest here is in forecasting the distribution of nations' major-power alignments between the United States and the Soviet Union, we would expect a measure of the relative quantity of trade a nation has with these two powers to be a strong and useful predictor variable. Since higher ALIGNθ scores represent greater alignment

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23 See John D. Sullivan, "Cooperating to Conflict." See also Russett and Lamb, "Global Patterns"; Russett, International Regions and the International System; and Teune and Synnestvedt, "Measuring International Alignments."

with the Soviet Union relative to alignment with the United States, we hypothesize that ALIGNθ is positively related to trade with the Soviet Union, inversely related to trade with the United States, and positively related to a measure representing trade with the Soviet Union relative to trade with the United States (TRADE (USSR))/(TRADE (U. S.)).

Table 6 shows correlations of ALIGNθ with each of the three measures of trade, and partial correlations controlling for previous distribution of major-power alignment. These correlations reveal that much of the

TABLE 6

CORRELATIONS WITH MEASURES OF TRADE

Trade	ALIGNθ	Controlling for $ALIGN\theta_{t-1}$
With USSR	.747	.340
With U.S.	-.640	-.303
USSR/U.S.	.322	.148

linkage between alignment and trade is a part of the long-term and recurring aspect of international alignment patterns, not surprising considering the relative stability of trade patterns over time. Additional and substantial variance in ALIGN θ is attributable to trade patterns, however, even when previous distribution of major-power alignment is controlled. This finding suggests that deviations in the long-term patterns of international alignments are in part related to changes in international trade patterns. Trade, then, can be used as a predictor of major-power alignment distribution in conjunction with previous distribution of major-power alignment.

International Conflict. Much the same can be said of international conflict as was said of international trade patterns. We hypothesize that ALIGN θ relates strongly to the relative quantity of nations' conflict with the United States and the Soviet Union. Again, since ALIGNθ is a measure of a nation's alignment with the USSR relative to its alignment with the United States, we expect the distribution of a nation's major-power alignment to relate positively to conflict with the United States, inversely to conflict with the Soviet Union, and positively to a measure representing conflict with the United States relative to conflict with the Soviet Union (CONFLICT (U.S.))/(CONFLICT (USSR)).

Table 7 shows simple correlations of ALIGN θ with each of these three measures of international conflict with major powers, and partial correlations controlling for previous distribution of major-power alignment.

TABLE 7

CORRELATIONS WITH
MEASURES OF INTERNATIONAL CONFLICT

Conflict	ALIGN θ	Controlling for ALIGNθ_{t-1}
With U.S.	.241	.071
With USSR	-.102	-.026
U.S./USSR	.183	.147

Although international conflict measures evidence the expected relationships with nations' distribution of major-power alignment, these correlations reveal that those relationships disappear once previous

ALIGN θ is controlled. Fluctuations in long-term trends of international alignment patterns, then, are not as sensitive to conflict between nations as we had expected.

It is important to remember, however, that patterns of alignment and conflict with major powers remained fairly stable during the decade of the 1960's. Nations that were highly aligned with the Soviet Union in 1960--Bulgaria, Hungary, East Germany, Poland, and Czechoslovakia--were also highly aligned with Russia in 1970. Those same countries continued to act in a conflictual manner toward the United States during that entire time span. And although the ties between the United States and its Western European allies began to weaken somewhat during that time period, this was accompanied by a lessening of the level of conflict between those countries and the Soviet Union. These events did not, certainly, occur overnight. They proceeded gradually, with alignment ties decreasing year by year and conflict with the Soviet Union lessening year by year. As a result, when the long-term trend of major-power alignment <u>distribution</u> is accounted for, little variance remains to be explained by the accompanying changes in nations' patterns of international conflict. And in the case of the Eastern European countries, little change was evident in either <u>distribution</u> of major-power alignment or conflict with the United States. As Table 8 shows, alignment <u>distribution</u> scores for those five Eastern European countries remained relatively constant from 1960 to 1970, while those for major Western European nations showed slight, but perceptible, increases, indicating movement away from alignment with the United States. Yugoslavia is shown as an example of an Eastern European country that moved away from the Soviet Union and toward the United States during that time period. Note that major-power conflict scores for those Eastern European countries do not show a consistent trend

TABLE 8

CHANGES IN ALIGN θ AND CONFLICT DURING THE 1960's

Country	ALIGN θ			Conflict (with U.S. or USSR)		
	1960	1965	1970	1960	1965	1970
United Kingdom	.071	.076	.080	1.14	.95	.95
France	.085	.176	.207	1.15	.60	.69
West Germany	.017	.017	.020	1.42	1.15	1.17
Italy	.036	.143	.183	.70	.48	.49
Denmark	.127	.242	.230	.60	.30	.30
Greece	.028	.298	.545	.70	.60	.48
Spain	.079	.159	.232	.48	.30	.30
Bulgaria	.999	.999	.999	.60	.77	.60
Czechoslovakia	.999	.999	.999	.70	.48	.95
East Germany	.999	.999	.999	1.34	1.11	1.30
Hungary	.999	.999	.999	.30	.30	.47
Poland	.996	.995	.990	.47	.30	.30
Yugoslavia	.938	.879	.867			

during the 1960's. These countries had about as much conflict with the United States in 1970 as they did in 1960, while Western European allies of the United States had consistently and substantially less conflict with the Soviet Union in 1970 than they did in 1960.

It comes as no surprise, then, that conflict has little marginal relationship with the distribution of nations' major-power alignments once the long-term trends and recurring patterns in ALIGN θ are controlled. Thus, although conflict exhibits the hypothesized relationships with measures of nations' major-power alignment distribution, it does not prove to be a useful predictor variable in a forecasting model that includes several other predictors of the distribution of major-power alignment, particularly ALIGNθ_{t-1}.

Proximity and Polity-Type Similarity. Several international relations scholars[24] have argued that geographical proximity plays a role in determining the alignment of nations. As stated previously, their notions are often based upon the idea that nations that are near one another share common problems, and that the existence of these common problems leads to a search for common solutions. Drawing upon these ideas we suggest that ALIGN θ will vary positively with the distance of nations from the United States relative to their distance from the Soviet Union (see Table 9).

TABLE 9

CORRELATIONS WITH PROXIMITY AND POLITY TYPE

	ALIGNθ	Controlling for ALIGNθ_{t-1}
Distance (U.S.)/ Distance (USSR)	.520	.149
Polity Type	.742	.274

Similarly, several theorists[25] have suggested that nations with the

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24 John D. Sullivan, "Cooperating to Conflict," and Bruce M. Russett, International Regions and the International System.

25 Russett and Lamb, "Global Patterns"; Russett, International Regions and the International System; Russett, "Components of an Operational Theory"; Dinerstein, "Transformation of Alliance System"; and others.

same governmental types are more likely to be aligned than nations with different organizational schemata.[3] Specifically, we hypothesize that nations that are identified as polyarchic tend to align with the United States while those that are viewed as centrist tend to align more with the Soviet Union. In fact, as can be seen in Table 9, both proximity and polity type evidence the expected relationships with ALIGN θ; proximity shares more than 25 percent of its variance with major-power alignment distribution, and polity type more than 50 percent.[26]

As with international conflict, however, the relationships between ALIGN θ and proximity and polity-type similarity diminish once controls are introduced for previous distribution of major-power alignment. Even so, however, proximity, and particularly polity-type similarity, have enough variance in common with the distribution of a nation's major-power alignment to be included in the forecasting model.

ALIGNR and Gross National Product. We noted earlier that the two aspects of nations' major-power alignments, their extent and their distribution, are related in the European context. Thus, one of these two alignment measures can be used as a predictor of the other. If the distribution of a nation's major-power alignment is used to forecast the extent of that alignment, forecast values of ALIGN θ must be known prior to forecasting ALIGNR. That is, ALIGN θ must be forecast before ALIGNR can be forecast.

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[26] Polity type is measured here by a dummy variable scored "1" if the country has a centrist government and "0" for polyarchic governmental structures. Since ALIGN θ increases as nations become more aligned with the Soviet Union relative to the United States, and since the Soviet Union is centrist while the United States is considered polyarchic, the polity-type similarity argument suggests a positive relationship between the dummy variable and ALIGN θ.

It could be argued that the forecasting process could proceed in the reverse direction--that forecasts could be generated for ALIGNR, and ALIGNR could subsequently be used to forecast ALIGNθ. We can see no theoretical grounds to postulate a causal connection in either direction. The historical situation in Eastern Europe, however, suggests that nations aligned with the Soviet Union are forced to align closely with that major power because of the Soviet desire for extensive control over its satellites. It is implausible, however, to say that countries strongly aligned with a major power tend to align themselves with the Soviet Union rather than with the United States. The historical situation, then, suggests that ALIGN θ is more properly viewed as a predictor of ALIGNR than is ALIGNR as a predictor of the distribution of nations' major-power alignments.

We also found a strong relationship between ALIGN θ and GNP, one component of a nation's economic power base. This relationship stems from the historically higher level of wealth in the Western European nations than in the Soviet satellite countries. In order to utilize this relationship in a forecasting model, it is necessary to assume that Eastern European countries will not surpass U.S. allies in Western Europe in terms of economic wealth. Given that growth in GNP depends in part on previous levels of GNP, and that, until this point at least, major Western European economies have sustained their high rates of growth relative to Eastern European countries, it seems reasonable to use GNP in the forecasting model for nations' distribution of major-power alignment.

Five variables--previous distribution of major-power alignment, relative trade with the major powers, polity-type similarity, relative proximity with the major powers, and GNP--have been identified as useful components of a forecasting model for the distribution of nations' major-power alignments. Of course, the value of some of these components depends on the validity of certain assumptions concerning the continuation of specified historical sequences. These assumptions, however, are certainly reasonable enough to allow the inclusion of each of these predictors in the ALIGNθ model.

Predictors of ALIGNR

Six variables are initially hypothesized to be useful predictors of the extent of nations' major-power alignments--previous extent of major-power alignment, internal instability (TURMOIL and REVOLT), economic power base (EPB), military power base (MPB), and international conflict. Each of these variables does in fact significantly affect the extent of nations' major-power alignments, but in some cases in rather unexpected ways. In the following sections, we discuss each of these predictors and their relationships with ALIGNR.

Previous Extent of Major-Power Alignment. As we noted before, alignment patterns represent the long-term and recurring aspects of nations' behaviors. Thus, we expect that the previous extent of nations' major-power alignments strongly predicts the present extent of their alignments. In fact, several researchers[27] have identified past patterns of alignment as the strongest predictors of present alignments of nations.

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27 See John D. Sullivan, "Cooperating to Conflict: Sources of Informal Alignments"; Bruce M. Russett and W.C. Lamb, "Global Patterns of Diplomatic Exchange"; and Bruce M. Russett, "Components of an Operational Theory of International Alliance Formation."

Our analysis of the European milieu from 1950 to 1970 confirms these ideas. The observed correlation between ALIGNR and $ALIGNR_{t-1}$ for the European nations during that time span is .537; this means that nearly 30 percent of the variance of ALIGNR can be attributed to previous extent of nations' major-power alignments. Moreover, even when the other five descriptors hypothesized to affect the extent of nations' major-power alignments are controlled, $ALIGNR_{t-1}$ still explains a substantial portion of the variance in present extent of major-power alignments.

It is especially interesting to note that in the final predictor equation utilized for forecasting ALIGNR, previous extent of nations' major-power alignments is by far the predominant predictor, explaining fully 65 percent of the variance in the forecast variable. This finding suggests that the extent of nations' major-power alignments can be predicted by knowing the nations' previous extent of major-power alignments and the peculiar conditions that occurred in those nations in the recent past. Given the absence of unsettling conditions, as was the case in Europe during much of the 1950's and 1960's, previous alignment patterns become predominant.

Internal Instability and National Power Base. Several theorists[28] have suggested that nations that face high levels of internal instability seek alignments with major powers, both to endow the nations' governments with added legitimacy and to free economic and military resources to suppress that instability. We hypothesize that this relationship is especially strong for those nations that do not have sufficient economic and military resources of their own to defend themselves and control internal instability. Thus, ALIGNR is hypothesized

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[28] See George Liska, Nations in Alliance.

to be positively linked to levels of turmoil and revolutionary activity in nations, and to be inversely related to the size of nations' economic and military power bases.

When controlling for nations' previous extent of major-power alignments, however, neither turmoil nor revolt evidences significant linkages with ALIGNR. Table 10 shows partial correlations between measures of internal instability and ALIGNR, controlling for past levels of major-power alignments. As these correlations indicate, once the long-term, recurring patterns of alignment are taken into account, internal instability has virtually no effect on the tendency of nations to

TABLE 10

PARTIAL CORRELATIONS WITH ALIGNR (Controlling for $ALIGNR_{t-1}$)

Instability Measure	ALIGNR
TURMOIL	-.006
REVOLT	.046

align with major powers. Moreover, the relationship between turmoil and ALIGNR is actually in a negative direction, contrary to our initial hypothesis.

Table 11 shows that a strong, simple relationship does, in fact, exist between ALIGNR and these two measures of internal instability. At the same time, both measures of internal instability are positively

TABLE 11

CORRELATIONS AMONG
ALIGNR AND PREDICTOR VARIABLES

	ALIGNR	TURMOIL	REVOLT	EPB	MPB
ALIGNR	1.000				
TURMOIL	.176	1.000			
REVOLT	.115	.496	1.000		
EPB	.672	.228	.121	1.000	
MPB	.790	.141	.048	.932	1.000

related to the size, wealth, and military strength of the nations. Since larger and wealthier nations tend to take part in extensive international interactions and consequently align themselves strongly with the major powers, the apparent relationship between measures of internal instability and ALIGNR is a function of the fact that both are related to nation size and wealth. That is, the relationship between internal instability and the level of major-power alignment is part of the long-term and recurring aspect of alignment; large countries have a greater tendency to become involved in international alignments than do small countries. Once this is taken into account in controlling for previous levels of major-power alignment, the correlation between measures of internal stability and ALIGNR approaches zero. Internal instability, in short, is of little value in explaining deviations from these normal and recurring patterns.

Nations' economic and military power bases, on the other hand, were hypothesized to be inversely related to the extent of their alignment with major powers. It was thought that in order to achieve internal stability, smaller and weaker nations would turn to major powers, and consequently become more aligned with those major powers. In fact, as Table 11 shows, both economic power base and military power base are strongly and positively related to the extent of nations' major-power alignments. Clearly, it is the larger and wealthier nations, and not, as we had hypothesized, the smaller, weaker powers that are most prone to become highly aligned with these major powers. Since these larger and wealthier countries are the major international actors, we infer that alignment levels are partly a function of the level of nations' international activities. It is especially interesting to note that the relationship between military power base and ALIGNR is even stronger than that for economic power base; nations that transform extensive economic resources into military resources are most prone to major-power alignments.

Table 12 shows correlations between economic power base and three major components of economic power base, and ALIGNR. As

TABLE 12

CORRELATIONS WITH
ECONOMIC POWER-BASE COMPONENTS

Economic Power-Base Component	ALIGNR
EPB	.672
GNP	.340
POP	.406
GNP/POP	-.128

that table suggests, both economic power base and two of its primary components, GNP and population (POP), relate positively to the level of nations' major-power alignments. However, GNP per capita is inversely related to ALIGNR, suggesting that a complex relationship exists between ALIGNR and these two components of economic power base. In fact, the correlation of ALIGNR with POP controlling for GNP is .279, while the correlation of ALIGNR with GNP controlling for POP is -.254. This suggests that moderately large nations and small but wealthy nations tend to align strongly with major powers, while the very large and very wealthy countries do not. This result is a function of the fact that the largest and wealthiest European nation, the Soviet Union, was analytically scored as being unaligned with the United States because the Soviet Union, itself, was used as a point of reference in determining major-power alignment. This caveat aside, it is clear that the relationships we expected to find between the level of nations' major-power alignments and their size and wealth are simply not extant in the European milieu. The larger and wealthier countries--the United Kingdom, West Germany, and France in Western Europe, and East Germany in Eastern Europe--are the most strongly aligned countries with the major powers. Major-power alignment, in short, does not serve solely as a prop for the small and weak powers in Europe.

It is certainly not surprising, then, that the complex relationship we expected to find between ALIGNR and internal instability and national power base is simply not evident in the available data. As we noted earlier, the complex measure (TURMOIL + REVOLT)/(EPB + MPB) was expected to relate strongly and positively to ALIGNR. In fact, the correlation between ALIGNR and this complex measure was -.032, neither strong nor positive. This correlation lacks the expected strength because both measures of internal instability, TURMOIL and REVOLT, were found to be unrelated to deviations in levels of nations' major-power alignments. The correlation was negative because nations' economic and military power bases, which we expected to relate inversely to the extent of nations' major-power alignments, were in fact positively related to their tendency to align with major powers.

International Conflict. As we noted earlier, many scholars have found that intense international conflict has a substantial effect on the tendency of nations to align with major powers.[29] In fact, nations that experience high levels of international conflict align more closely with major powers than do nations that experience little, if any, international conflict. This hypothesis is based on the idea that nations that experience high levels of conflict with other countries, particularly new and intense conflict, attempt to supplement their ability to deal with that conflict by aligning with major powers. We hypothesize, then, that a nation's level of international conflict relates positively to its level of major-power alignment, and that ALIGNR also relates positively to the complex measure $(CONFLICT_t)/(CONFLICT_{t-1})$ which taps the increasing conflict that threatens nations.

Table 13 shows partial correlations between ALIGNR, and international conflict and the complex measure discussed above, controlling for past levels of major-power alignment. As that table shows, neither conflict, nor lagged conflict, nor the complex measure relates significantly to levels of nations' major-power alignments. These findings suggest that neither conflict, nor expressly new conflict, accounts for the

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[29] See Liska, Nations in Alliance, and John D. Sullivan, "Cooperating to Conflict."

TABLE 13

PARTIAL CORRELATIONS WITH CONFLICT MEASURES (Controlling for $ALIGNR_{t-1}$)

Conflict Measure	ALIGNR
$CONFLICT_t$	-.021
$CONFLICT_{t-1}$	-.072
$CONFLICT_t/CONFLICT_{t-1}$	.039

deviations in the long-term, regularized patterns of international alignment. Without controlling for $ALIGNR_{t-1}$, however, the correlation between CONFLICT and ALIGNR increases to .290, suggesting a significant positive relationship, as hypothesized. However, that relationship is clearly a function of the ongoing patterns that contribute to both alignment tendencies and international conflict levels. Table 14 shows correlations between conflict and measures of national power-base size.

TABLE 14

CORRELATIONS BETWEEN POWER-BASE MEASURES AND CONFLICT

Power-Base Measure	CONFLICT
EPB	.606
MPB	.465

As we noted in the case of measures of internal instability, it is clearly the large and wealthy nations that are usually involved in high levels of international conflict. Smaller and poorer powers simply do not interact extensively in the international arena. And the relationship between power base and extent of major-power alignment, discussed earlier, is attributable to the same phenomenon: small countries are not active participants in the international system. Since it is the same countries that participate in all kinds of international actions, it is of little surprise that a simple relationship is found between conflict and ALIGNR. However, that relationship is essentially a function of the long-term, recurring pattern of action in the international system, the domination of that system by the large and wealthy countries. Once that pattern is accounted for by controlling for $ALIGNR_{t-1}$, conflict is of marginal value in explaining the deviations in levels of major-power alignment.

Distribution of Major-Power Alignment. We did not initially hypothesize a significant relationship between the extent and the distribution of nations' major-power alignments. As we noted previously, there is a clear and substantial relationship between these two aspects of nations' major-power alignments. The higher a nation scores on ALIGNθ, that is, the more it is aligned with the Soviet Union relative to the United States, the greater its level of major-power alignment. Nations that are aligned with the Soviet Union are relatively highly aligned with that nation; nations aligned with the United States, on the other hand, are not so highly aligned with it. This finding is certainly consistent with expectations generated by the Soviet Union's attempt to maintain strong ties with its satellite nations in Eastern Europe.

However, in the absence of this historical fact, we can find little theoretical reason to expect a consistent relationship between the <u>extent</u> and the <u>distribution</u> of nations' major-power alignments. An examination of Figure 2 reveals that the composite alignment scores constructed here divide the European nations into two major blocs, with very few nations independent of these blocs. These groupings are quite consistent with our perceptions of the loyalties of the various European nations. Any schema that clusters nations into two such groups, however, will produce a relationship between the various aspects of the clustering (in this case two aspects, the length and the angle of the alignment vector) unless both clusters lie the same distance from the origin. In this case, of course, the cluster of Eastern European nations lies further from the origin than does the cluster of Western European countries (see Figure 2).

The relationship between ALIGN θ and ALIGNR is strong, and partially independent of the long-term and recurring patterns that account for much of the variance in nations' levels of major-power alignment. Table 15 shows the simple correlation between these two measures during the period 1960 to 1970, and the partial correlation between ALIGN θ and ALIGNR when controlling for $ALIGNR_{t-1}$. As the table

TABLE 15

CORRELATIONS WITH ALIGNθ

	ALIGNR
ALIGN θ	.317
Controlling for $ALIGNR_{t-1}$	.275

indicates, these two aspects of nations' major-power alignments share about 10 percent common variance, and even when the recurring aspects of nations' levels of major-power alignment are controlled, there is about an 8 percent overlap.

The use of major-power alignment distribution as a predictor of the extent of nations' major-power alignments in a forecasting model requires the assumption that the Soviet Union will continue to require stronger allegiance from its satellites in Eastern Europe than does the United States from its Western European allies. If the Czechoslovakian stiuation during 1968 and 1969, and the more recent interactions between Romania and the Soviet Union are indicative of the general patterns of behavior of the Soviet Union vis-a-vis its allies, this assumption is plausible.

Four variables--previous levels of major-power alignment, national power base, international conflict, and the distribution of nations' major-power alignments--have been identified as useful predictors of ALIGNR. Although the value of some of those predictors is contingent upon certain basic assumptions about the patterns of international behavior in the European milieu, these assumptions are far from unreasonable. Each of these four variables, or components of them, are used, then, in the forecasting model for ALIGNR.

FORECASTING MODELS OF MAJOR-POWER ALIGNMENT

This section contains a description of two forecasting models, one each for the extent and the distribution of nations' major-power alignments. Each forecasting model takes the form of a multiple regression equation relating the respective aspect of alignment to some set of predictor variables drawn from the preceding analysis. In each case, the relative contribution of each predictor variable is presented, the nature of the relationship between each predictor and the respective aspect of alignment is considered, and the forecasting model as a whole is evaluated. Some predictors that relate in the hypothesized manner to alignment are not used in the forecasting models. The excluded predictors are those shown to be highly colinear, or related, with one or some group of the other predictors and that, within the context of the forecasting model, contribute little to the multiple regression equation. In each case where one or more variables are to be eliminated from the forecasting model for this reason, a conscious attempt is made to retain those variables for which the best, most precise, and reliable measurements are available.

A Forecasting Model for ALIGN θ

After empirical examination, five variables appeared to be useful predictors of ALIGN θ: previous distribution of major-power alignment, relative trade with major powers, polity-type similarity, relative proximity with the major powers, and GNP. Table 16 shows the coefficients of each of these predictor variables, the standard errors and t-statistics of those coefficients, and the explained variance for the equation as a whole and its F-statistic. Each of the coefficients is substantially larger than its respective standard error, and each is highly significant statistically. The F-test of significance for the regression equation indicates that this forecasting model for ALIGN θ is, as a whole, highly significant. The equation accounts for more than 82 percent of the variance in the distribution of nations' major-power alignments during the 1960's.

TABLE 16

FORECASTING EQUATION FOR ALIGN θ

Predictor	Coefficient	Standard Error	t-Statistic
Constant	.07299	.03543	2.060
$ALIGN\theta_{t-1}$	.49960	.05305	9.418
REL-TRADE	.36998	.08105	4.565
PROXIMITY	.0000384	.0000116	3.302
POLITY TYPE	.14253	.03374	4.225
GNP	-.000000546	.000000149	3.650

$R^2 = .8258$

$F = 239.89$

Table 17 shows partial correlation coefficients between each of these five predictors and the distribution of nations' major-power alignments. Table 17 can be used to discover the relative strength of each of the various predictor variables and the nature of their respective linkages with ALIGN θ. $ALIGN\theta_{t-1}$ is the strongest of the five predictors, but it is not nearly as predominant here as past extent of alignment is in the ALIGNR equation. Past distribution accounts for but 25 percent of the variance in present values of ALIGNθ. Each of the other predictors accounts for about 8 percent of the variance in the distribution of major-power alignment. Three of the variables, REL-TRADE, PROXIMITY, and POLITY TYPE, show a positive relationship with ALIGN θ.

TABLE 17

PARTIAL CORRELATIONS WITH ALIGNθ

Predictor	ALIGNθ
$ALIGN\theta_{t-1}$	.509
REL-TRADE	.276
PROXIMITY	.203
POLITY TYPE	.257
GNP	-.224

REL-TRADE and PROXIMITY are constructed by dividing the trade with and the distance from one of the major powers by the trade with and distance from the other power respectively. Previous distribution has a positive relationship with present distribution of major-power alignment; the more closely aligned a nation was with the Soviet Union in the past, the more likely it is to be closely aligned with that power at the present. GNP, on the other hand, exhibits an inverse relationship with ALIGNθ; wealthier nations are less likely to be highly aligned with the Soviet Union than less wealthy, less economically developed countries. Each of these relationships between individual predictors and the distribution of major-power alignments is, of course, in the predicted direction, and had the predicted relative magnitudes: past distribution is the most important predictor; relative trade the next most important; with polity type, GNP, and proximity following. Well over 80 percent of the variance in the distribution of major-power alignment is accounted for by this multiple regression equation. In short, this forecasting model promises to be of value for long-range forecasting if the assumptions upon which the equation rests continue to hold during that 15-20 year period.

A Forecasting Model for ALIGNR

As we noted earlier, four variables--previous extent of major power alignment, distribution of major-power alignment, national power base, and international conflict--proved to be useful predictors of ALIGNR. In fact, one particular component of national power base, military manpower (MIL MANPOW), seemed to be the most useful in the multiple regression equation. However, since the forecasting requirements necessitated that military manpower be forecast after ALIGNR was forecast, MIL $MANPOW_{t-1}$ was actually utilized in the multiple regression. Of course, military manpower is a highly autocorrelated time series; generally a nation's level of manpower does not vary widely from year to year. Thus, the need to use past levels of manpower did not detract significantly from the equation for ALIGNR.

Table 18 shows the predictors of nations' extent of major-power alignment included in this model, their coefficients, the standard errors and t-statistics of those coefficients, and the explained variance for the equation as a whole and its F-statistic. Each of the coefficients is larger than its respective standard error. The F-test of significance for the regression equation as a whole indicates that this forecasting model is highly significant statistically. In fact, this forecasting model explains more than 92 percent of the variance in the extent of nations' major-power alignments during the period 1960 to 1970.

Table 19 shows partial correlation coefficients for each of the four predictors with levels of nations' major-power alignments. Table 19 can be used to discern the relative strength of the various linkages

TABLE 18

FORECASTING EQUATION FOR ALIGNR

Predictor	Coefficient	Standard Error	t-Statistic
Constant	.05194	.01355	3.833
$ALIGNR_{t-1}$	.80657	.03789	21.285
ALIGN θ	.01234	.00880	1.402
$CONFLICT_{t-1}$	-.01247	.00814	1.532
$MIL\ MANPOW_{t-1}$	.04424	.01017	4.351

$R^2 = .9218$

F = 521.25

between each of the predictors and ALIGNR, as well as the nature of those relationships. Clearly, previous levels of major-power alignment is the predominant predictor of present ALIGNR, accounting for more than 70 percent of the variance in the forecast variable. Previous levels of military manpower explain another 10 percent of the variance in ALIGNR, while previous conflict and the distribution of major-power alignment explain smaller amounts of variance in the forecast variable.

Table 19 also reveals that three of the four predictor variables--previous levels of major-power alignment, distribution of major-power alignment, and previous levels of manpower--are positively related

TABLE 19

PARTIAL CORRELATIONS WITH ALIGNR

Predictor	ALIGNR
$ALIGNR_{t-1}$	.848
ALIGN θ	.105
$CONFLICT_{t-1}$	-.114
$MIL\ MANPOW_{t-1}$	.311

to present levels of alignment. That is, as previous levels of alignment increase, and as nations become more aligned with the Soviet Union relative to the United States, they are more likely to align strongly with one or more major powers. Manpower levels prove to be directly related to ALIGNR; militarily stronger nations tend to be more strongly aligned with the major powers than nations with smaller military forces.

As with the ALIGNθ model, this equation explains most variations in the levels of major-power alignments. Well over 90 percent of the variance in that forecast variable is accounted for by the multiple regression. To the extent that the assumptions upon which the equation rests continue to hold during the next 20 years, this forecasting model should be useful for long-range forecasting of ALIGNR.

These two equations are used within the integrated model to produce forecasts of the <u>extent</u> and <u>distribution</u> of the European nations' major-power alignments during the period 1985 to 1995. Both equations are quite strong since they explain most of the variance in the dependent variables, contain coefficients of the approximate magnitude and direction hypothesized, and utilize statistically significant predictor variables. In the next section of this analysis, postdiction results from these two equations are presented. Consideration of those results enables the analyst to judge more effectively the reliability of the two forecasting models for particular nations of Eastern and Western Europe.

POSTDICTIONS OF MAJOR-POWER ALIGNMENT

Once the forecasting models for the extent and distribution of major-power alignment are developed, they are used to generate "expected" values for those two aspects of alignment for the European nations. The two equations are used to "predict" the extent and distribution of nations' major-power alignments for the 1960's. These "predicted" values are then compared with actual values for both aspects of alignment for that time period to determine where the forecasting models are are especially accurate, and where they are less than adequate.

Specifically, data on each of the variables included in the two forecasting models--both measures of major-power alignment as well as the various predictor variables--were available for the 10 years from 1961 to 1970 inclusive. Thus, the extent and distribution of nations' major-power alignments were "predicted" for these 10 years. For each of the 25 nations included in this analysis (the Soviet Union was excluded because it was used as a reference nation--a major power), the series of "predicted" values for the two aspects of alignment were compared with actual values experienced during those 10 years.

Postdictions of ALIGNR

Table 20 shows the mean of the absolute value of the residual from the equation forecasting the extent of major-power alignment for each of

TABLE 20

POSTDICTION RESULTS BY COUNTRY FOR ALIGNR

Country	Rank	Residual abs(Actual-Predict)	Direction of Error
Romania	1	.0104	Low
West Germany	2	.0121	High
East Germany	3	.0150	High
Poland	4	.0201	Low
Czechoslovakia	5	.0249	Low
Hungary	6	.0268	Low
Yugoslavia	7	.0273	Low
Bulgaria	8	.0274	Low
Finland	9	.0290	High
United Kingdom	10	.0299	Low
Sweden	11	.0301	Low
Denmark	12	.0319	High
Netherlands	13	.0333	Low
Greece	14	.0337	High
France	15	.0355	Low
Norway	16	.0356	High
Switzerland	17	.0362	High
Turkey	18	.0365	High
Ireland	19	.0408	Low
BLEU	20	.0422	High
Austria	21	.0439	Low
Portugal	22	.0460	Low
Spain	23	.0509	Low
Italy	24	.0536	Low
Iceland	25	.0730	Low

the 25 European countries.[30] In addition, Table 20 ranks the 25 European nations according to the size of their mean residuals; the nations with the lower ranks have smaller differences between postdicted and actual values of ALIGNR. The direction of error in postdiction for each country is also shown. Thus, a nation whose direction is "high" is one for whom the postdicted extent of major-power alignment typically exceeds the actual level of such alignment. The direction of error is determined by counting the number of a nation's postdicted values that are "high," and the number that are "low." (A nation is classified as having "high" postdiction if the number of those postdictions exceeds its number of "low" postdictions.)

As Table 20 suggests, there is an apparent pattern to the distribution of countries by the magnitude of their error in the postdiction of ALIGNR. Of the top eight countries on the list, all but West Germany are Eastern European satellites of the Soviet Union. This suggests that this group of nations is more accurately predicted in terms of extent of major-power alignment than are the Western European allies of the United States. As we noted earlier, however, this group of countries also shows greater temporal stability in their alignment patterns than do the Western European nations. Thus, previous alignment measures are stronger predictors of present alignment for the Eastern European countries, and the overall quality of those predictions is correspondingly higher. Spain, Italy, and Iceland round out the bottom of the list and evidence, in absolute terms, the least accurate of the postdictions. These three countries are among the Western European nations most

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[30] The residual is computed by subtracting the observed from the "predicted" value. Thus, the absolute value of the residual ignores its sign, and measures only its magnitude.

closely aligned with major powers since they have some of the highest ALIGNR scores. In proportional terms, their postdictions are not nearly as weak as their rankings suggest.

Table 21 classifies these 25 countries according to the magnitude of their postdiction error. For 60 percent of the European nations, the mean magnitude of postdiction error is less than 10 percent of their mean ALIGNR score. For another 36 percent, mean error is between

TABLE 21

CLASSIFICATIONS BY
MAGNITUDE OF POSTDICTION ERROR FOR ALIGNR

Less than 10%	10% to 15%	More than 15%
Romania	Sweden	Switzerland
West Germany	Norway	
East Germany	Ireland	
Poland	BLEU	
Czechoslovakia	Austria	
Hungary	Portugal	
Yugoslavia	Spain	
Bulgaria	Italy	
Finland	Iceland	
United Kingdom		
Denmark		
Netherlands		
Greece		
France		
Turkey		

10 and 15 percent of the mean ALIGNR score. For only 1 of the 25 nations, Switzerland, is the postdiction error substantial compared to actual ALIGNR values. The absolute quantity of postdiction error

for Switzerland, however, is actually very moderate; but since Switzerland is virtually unaligned with the major powers, and has an extremely low score on ALIGNR, error as a percentage of that score approaches 50 percent.

Table 22 classifies the various nations according to the direction of their postdiction error. Note that only one of the East European countries, East Germany, has postdicted values typically larger than actual ALIGNR scores, while the Western European nations are about evenly

TABLE 22

CLASSIFICATIONS BY DIRECTION OF POSTDICTION ERROR FOR ALIGNR

High	Low
West Germany	Romania
East Germany	Poland
Finland	Czechoslovakia
Denmark	Hungary
Greece	Yugoslavia
Norway	Bulgaria
Switzerland	United Kingdom
Turkey	Sweden
BLEU	Netherlands
	France
	Ireland
	Austria
	Portugal
	Spain
	Italy
	Iceland

split between those with "high" and those with "low" postdictions. A comparison of the direction of nations' postdiction errors with the size of their actual ALIGNR scores reveals a strong inverse relationship between the two. As Table 23 shows, nations that are closely aligned with major powers and have high ALIGNR scores have typically lower

TABLE 23

DIRECTION OF POSTDICTION
ERROR VS. SIZE OF ALIGNR SCORES

Direction of Error	Size of ALIGNR Scores	
	Low	High
Low	2	11
High	7	5

$X^2 = 4.996 \quad p < .05$

postdictions than actual scores. Nations with low actual scores, however, usually have higher postdicted values. This result is far from unexpected; the model, developed for a group of countries with substantial differences in actual scores, tends to produce a postdiction somewhere between the nation's actual score and the mean of all nations' scores. The model, in short, underestimates the extent of alignment for highly aligned nations and overestimates the level of alignment for unaligned countries. The extent of alignment is typically underestimated for the Eastern European countries, then, because they tend to have rather large ALIGNR scores. Nonetheless, the magnitude of postdiction error is quite small for all nations, and particularly small for those Eastern European countries. Although the forecasting model for ALIGNR is biased, the magnitude of the bias is so small as to make the model quite acceptable, particularly for forecasting relative levels of major-power alignment for these 25 countries.

Postdictions of ALIGNθ

Table 24 shows the mean of the absolute value of the residuals (predicted minus actual values) of ALIGN θ for each of the European nations. In addition, the 25 nations are ranked by their absolute residual; nations with lower ranks show smaller differences between postdicted and actual distributions of major-power alignment than do those nations with larger ranks. Again, the typical direction of the postdiction error, determined by counting "high" and "low" postdictions, is also shown for the various countries.

Table 24 reveals some rather interesting patterns. Aside from Switzerland and West Germany, the most accurate postdictive results are obtained for Eastern European countries highly aligned with the Soviet Union. As we noted in the case of ALIGNR postdiction, these results are due to the extreme temporal stability of alignment scores for these countries caused by the Soviet Union's maintenance of strong ties with its satellite allies. Both Switzerland and West Germany also have extreme scores.

Although Switzerland shows very little major-power alignment, what alignment it does have is exclusively with the United States. West Germany also aligns exclusively with the United States, though its level of major-power alignment is rather substantial. Following this initial

TABLE 24

POSTDICTION RESULTS BY COUNTRY FOR ALIGN θ

Country	Rank	Residual abs(Actual-Predict)	Direction of Error
Switzerland	1	.0220	High
East Germany	2	.0325	Low
West Germany	3	.0478	High
Hungary	4	.0660	Low
Romania	5	.0688	Low
Bulgaria	6	.0797	High
Poland	7	.0826	Low
Czechoslovakia	8	.0888	Low
Norway	9	.1020	High
Iceland	10	.1061	High
Sweden	10	.1061	High
Denmark	12	.1075	High
Finland	13	.1148	Low
United Kingdom	14	.1151	High
France	15	.1216	Low
Turkey	16	.1293	Low
Italy	17	.1307	High
Netherlands	18	.1453	High
BLEU	19	.1461	High
Greece	20	.1487	Low
Austria	21	.1505	High
Ireland	22	.1554	Low
Yugoslavia	23	.1686	Low
Spain	24	.1760	High
Portugal	25	.2317	High

group are the Scandinavian nations--Norway, Sweden, Denmark, Finland, and Iceland. The large Western European allies of the United States follow this second group.

Table 25 classifies these countries according to the magnitude of their postdiction errors. Thirty-two percent of the countries evidence very low postdiction error (residual less than .10), and 48 percent have moderate error in the postdiction (residual between .10 and .15). Only

TABLE 25

CLASSIFICATIONS BY MAGNITUDE OF POSTDICTION ERROR FOR ALIGN θ

Low	Medium	High
Switzerland	Norway	Austria
East Germany	Iceland	Ireland
West Germany	Sweden	Yugoslavia
Hungary	Denmark	Spain
Romania	Finland	Portugal
Bulgaria	United Kingdom	
Poland	France	
Czechoslovakia	Turkey	
	Italy	
	Netherlands	
	BLEU	
	Greece	

five countries--Austria, Ireland, Yugoslavia, Spain, and Portugal--have high postdiction error (residual greater than .15). Spain and Portugal fall into this group because of the use of polity-type similarity as a predictor of ALIGN θ; these are the only two European countries with centrist governments that are not aligned strongly with the Soviet Union. Yugoslavia appears here because, although it is strictly a Communist government and maintains strong formal ties with the Soviet Union, it has, during the 1960's, decreased the degree to which it is aligned with the Soviet Union.

Table 26 shows classifications of the 25 countries according to the typical direction of their postdiction error. Again, note that most of the

TABLE 26

CLASSIFICATIONS BY DIRECTION OF POSTDICTION ERROR FOR ALIGN θ

High	Low
Switzerland	East Germany
West Germany	Hungary
Norway	Romania
Iceland	Poland
Sweden	Czechoslovakia
Denmark	Yugoslavia
United Kingdom	Finland
Italy	France
Netherlands	Turkey
BLEU	Greece
Austria	Ireland
Spain	
Portugal	
Bulgaria	

Eastern European countries have postdicted values lower than their actual ALIGN θ scores. Comparing the direction of postdiction error with the size of ALIGN θ scores reveals the reason for these results. As Table 27 shows, there is again a statistically significant inverse relationship between direction of postdiction error and size of actual scores. Nations with low ALIGN θ scores (strong alignment with the United States) have typically higher postdicted values than actual values. Nations with moderate to high actual scores (more aligned with the Soviet Union) have postdicted values typically lower than actual

TABLE 27

DIRECTION OF POSTDICTION
ERROR VS. SIZE OF ALIGNθ SCORES

Direction of Error	Size of ALIGNθ Scores		
	Low	Medium	High
Low	2	4	5
High	13	0	1

$X^2 = 16.131 \quad p < .05$

distributions of major-power alignment. Again, the model tends to produce forecast values that lie somewhere between actual values and the mean value for all nations. The model, in short, underestimates alignment for nations that are highly aligned with the Soviet Union, and overestimates alignment for nations that are highly aligned with the United States. This is, however, a bias that is minimally harmful inasmuch as it affects nearly all nations' scores in a similar manner and because it has no effect on the clustering aspect of the model.

CONCLUSION

We have reported here on an effort to develop a quantitative forecasting model for two aspects of the international alignment patterns of 25 European countries. These two aspects of alignment, the extent and the distribution of nations' major-power alignments, are forecast as a part of a simultaneous forecasting model in which five central environmental descriptors are simultaneously forecast. Thus, forecasts of each descriptor are used to generate forecasts of others. Three other central environmental descriptors were used to forecast the extent and distribution of major-power alignment: national power base, trade, and international conflict.

Our specific focus has been on these two aspects of nations' major-power alignments with the United States and with the Soviet Union: the extent to which 25 European nations are aligned with these two major powers, and the distribution of that major-power alignment. Forecasting equations were developed for each of these two aspects of major-power alignment: ALIGNR, the extent of major-power alignment; and ALIGNθ, the distribution of that alignment between the United States and the Soviet Union.

A number of variables hypothesized to affect the extent and distribution of nations' major-power alignments, some of which were other central environmental descriptors or components of central environmental descriptors, were examined with respect to their observed linkages with these two aspects of major-power alignment. Nearly all of these predictors were found to affect the two aspects in the hypothesized manner, although some of the predictors had extensive overlapping variance and thus could not be used independently in the forecasting model. In addition, use of some predictors for forecasting necessitated specific assumptions which, although certainly reasonable in the European milieu, limit the applicability of the forecasting model.

The forecasting equations developed for ALIGNR and ALIGN θ are more than adequate quantitative representations of these two aspects of nations' international alignment patterns. The equation for ALIGNR explained well over 90 percent of the variance in that variable, with each predictor contributing significantly to the overall model. In postdicting the extent of major-power alignment, we found that only one country, Switzerland, showed substantial postdiction error. For the other 24 countries, the level of postdiction error was below 15 percent, and for 60 percent of the nations, it was below 10 percent.

The forecasting equation for ALIGN θ was nearly as successful in explaining variations among nations in the distribution of major-power alignment. The equation as a whole explained more than 80 percent of the variance in that variable, and again each of the predictors contributed significantly to the model. Postdiction results were especially accurate for nations that experienced rather stable alignment patterns during the period 1961 to 1970: Switzerland, West Germany, and the Eastern European allies of the Soviet Union. Postdiction was nearly as good for the larger Western European allies of the United States: the United Kingdom, France. Italy, Netherlands, Sweden, Denmark, and Turkey. Only five nations evidenced disappointing postdiction results: Austria, Yugoslavia, Spain, Portugal, and Ireland. Austria and Yugoslavia, of course, attempted during the 1960's to develop nonalignment postures, contrary to their previous behavior. Spain and Portugal evidenced disappointing results because of their anomalous characteristics; they are the only U.S. allies in Western Europe to have centrist government types.

Both forecasting models relied primarily on the temporal continuity of international alignment patterns. Each was developed with an eye toward describing those recurring patterns and then explaining deviations from those long-term patterns. Of course, nations that experience wild fluctuations in alignment patterns are less susceptible to accurate forecasting than are nations that show some continuity and pattern.

The models developed are used to generate long-range forecasts of the extent and distribution of major-power alignments for the European nations. This information is then used to place each of these countries on the two-dimensional major-power alignment plane discussed above (see Figure 3). Thus, the clustering of nations in their alignments with the United States and the Soviet Union can be forecast over the long range.

INTRODUCTION

Conflict is often regarded as the most typical form of behavior in the international political system. Relationships of tension and violence set the pace of world affairs and thus are of major concern to both the policymaker and the scholar of international relations. Conflicts among nations may be expressed in many forms. War, the most dramatic and destructive expression of international hostility, has traditionally received widespread attention in both governmental and nongovernmental circles. Recently, however, observers have become increasingly attentive to the more subtle forms of diplomatic conflict that are an important part of international behavior.

This chapter focuses on conflict among the nations of Eastern and Western Europe. Europe has provided the historical setting for many studies of the nature and causes of war. The works of Clausewitz, Aron, and Hoffman[1] are among the more well-known efforts to develop a theory based on the experiences of the European nations. However, this rich body of theoretical literature has produced little consensus regarding the causes of diplomatic or military conflict in the European

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[1] Karl von Clausewitz, On War, ed. by Anatol Rapoport (Baltimore: Penguin Books, 1968); Raymond Aron, Peace and War: A Theory of International Relations (New York: Praeger, 1966); Stanley Hoffman, The State of War (New York: Praeger, 1965). For a good summary of much of the traditional theory of the causes of war, see Kenneth N. Waltz, Man, the State and War (New York: Columbia University Press, 1959).

context. Some observers attribute conflict to dissimilarities in cultures, clashes of interests, or faulty perceptions of the international environment. Others argue that aggressive tendencies inherent in human nature and the decentralized anarchic nature of the international system inevitably lead to competition and hostility among nations. Aron and Hoffman[2] conclude that international conflict can be understood only within the unique social, economic, and political context in which it occurs.

The objective here is to develop an explanatory model of conflict for the European region that can be used to forecast conflict over the long range. During the recent past, relations among the European states were structured by the postwar division of the continent into Communist and non-Communist blocs. Tensions between East and West reached their height in the Berlin crisis of the early 1960's but have remained an important element of European relations since then. Conflicts between East and West took place under the perpetual threat of nuclear confrontation between the United States and the Soviet Union, adding an element of restraint often absent in the past history of the continent. There were also important elements of conflict within blocs; the Soviet invasion of Czechoslovakia, the growing hostility between France and other members of the Western bloc, and the struggle involving Greece and Turkey over Cyprus are but a few examples.

This chapter seeks to identify patterns of causal relationships underlying conflict within Europe. An attempt is made to build upon preexisting theories of conflict by subjecting relevant hypotheses taken from traditional and quantitative conflict literature to empirical

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[2] Aron, Peace and War; Hoffman, The State of War.

examination in the context of contemporary Europe. Factors that are found to have an important influence upon European conflict are used to construct a postdictive model. This model is subsequently used to generate forecasts of European conflict for the period 1985-1995. A major task of this chapter is to evaluate the model's precision and reliability in predicting conflict for the 26 European nations.

THE DEPENDENT VARIABLE

For the purposes of this study, conflict is conceptualized as a component of the flow of interactions among nations. International interactions are defined as "single action items of a nonroutine, extraordinary, or newsworthy character that in some sense are directed across a national boundary and have, in most instances, a specific foreign target."[3] Conflictual actions are a subset of international interactions that indicate a degree of hostility among nations. They include both verbal actions such as protests, warnings, and threats, and acts of a physical nature such as armed attacks or military engagements. Acts of conflict vary in degree of intensity and cover a wide variety of issue areas. This conceptualization differs from those

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3 The conceptualization of interaction is taken from previous research related to the World Event/Interaction Survey. The term event is often used interchangeably with interaction. An important distinction has been drawn between events, or interactions, and transactions which are "items of action that have at some point in time become so numerous, so commonplace, and so normal to their situation that they are accounted for conventionally in an aggregated form, usually by some unit other than item frequency." See Charles McClelland and Gary Hoggard, "Conflict Patterns in the Interactions Among Nations," International Politics and Foreign Policy, ed. by James N. Rosenau (New York: The Free Press, 1969), pp. 711-724.

employed in much of the theoretical literature on conflict in that it encompasses both verbal and physical conflict actions.

Most of the traditional theorists previously mentioned limited their area of study to the nature and causes of war. Similarly, many well-known quantitative studies treat conflict as synonymous with armed combat. Richardson[4] measured the intensity of conflict by the number of war dead. Singer and Small[5] improved upon this approach by adding the total number of violent conflicts in which a nation became involved. Similarly, Wright concerned himself with "the legal condition which equally permits two or more hostile groups to carry on a conflict by armed force."[6] All four men accumulated vast amounts of data for numerous variables in the hope of uncovering relationships that would reveal the genesis of violent conflict.

Yet a war model that deals only with the extreme form of conflict is of limited explanatory value in the contemporary international environment. The establishment of integrative economic and military federations and the introduction of nuclear deterrents all help to promote a nonwar environment.[7] Furthermore, a relatively tranquil period has prevailed in Europe since World War II, culminating in the recent

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4 Lewis Richardson, Statistics of Deadly Quarrels (Pittsburgh: Boxwood, 1960).

5 J. David Singer and M. Small, The Wages of War 1816-1965: A Statistical Handbook (New York: John Wiley & Sons, 1972). See also J. David Singer, "The Correlates of War Project: Interim Report and Rationale," World Politics, XXIV (January 1972).

6 Quincy Wright, A Study of War (2nd ed.; Chicago: The University of Chicago Press, 1965).

7 Aron, Peace and War.

East-West detente. Thus, a war-oriented paradigm is far too restrictive for the present study.

In the broadest sense, then, conflict includes other forms of interaction--economic, diplomatic or social, as well as military. In certain cases a measure of economic confrontations is more appropriate than military encounters in determining the "true" level of conflict. Thus, the absence of military conflict does not mean that conflict does not exist nor does it imply that the occurrence of war should be underplayed. It simply means that various forms of conflict should be known to the decisionmakers who must formulate viable long-run policy. Consequently, we favor a model that will consider war as a subset of many conflict types.

An additional assumption of our study is that international conflict is a unidimensional phenomenon. That is, a conflict continuum can be developed utilizing event data. At the lower end fall smaller scale disruptions or negative verbal interactions that are limited in scope and marginal in impact. Between the two poles fall conflict relations of increasing intensity and magnitude.[8] At the upper extremes fall military or violent conflict. We view a unidimensional conceptualization as more applicable to the needs of the policymaker than a more complex, multidimensional construct.[9] The unidimensional approach requires the acceptance of two assumptions. First, the various

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[8] Leo A. Hazlewood, "Externalizing Systemic Stresses: Internal Conflict as Adaptive Behavior," Conflict Behavior and Linkage Politics, ed. by J. Wilkenfeld (New York: David McKay Co., Inc., 1973), p. 160.

[9] There is evidence suggesting that conflict may (in fact) be viewed as (be) a multidimensional phenomenon. Rummel's research indicates the existence of "three independent continua of foreign conflict

conflict events must be manifestations of the same phenomenon and, second, they must represent different intensities. These assumptions provide the basis for a monotonic framework comprised of heterogeneous types of conflict.

Two measures of international conflict are employed in our study. The first, monadic conflict, measures the total conflict each nation experiences in the context of the European system. This requires the use of the individual nation-state as the central unit of analysis. The second, dyadic conflict, measures the conflict behavior of pairs of nations. Here, of course, the dyad or nation-pair is the appropriate unit of analysis.[10]

We attempt to combine monadic and dyadic forecasts to provide analysts with the greatest possible amount of relevant information. In simple terms, we first intend to develop a model for predicting the total amount of conflict that each European nation will experience

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behavior:...a war dimension; a nonviolent, foreign conflict behavior, diplomatic dimension; and an actively hostile, belligerent dimension." Weede's conclusions are similar. If conflict is in fact multidimensional, events should not simply be placed on a single conflict continuum, but should first be located on the proper individual continuum, then further pinpointed within it. See R. J. Rummel, "Dimensions of Conflict Behavior Within and Between Nations." <u>Conflict Behavior and Linkage Politics</u>, ed. by J. Wilkenfeld (New York: David McKay Co., Inc., 1973), p. 83, and Erich Weede, "Conflict Behavior of Nation-States," <u>Journal of Peace Research</u>, No. 3 (1970), pp. 229-35.

[10] For a discussion of the important conceptual differences between monadic and dyadic conflict, see R. A. Skinner and C. W. Kegley, "The Use of the Direct Dyad for the Analysis of Interstate Behavior: Conceptual and Methodological Issues," (paper presented at the Southern Section of the Peace Science Society International, April 1973).

within the regional system. These predictions are intended to identify the "high conflictors," or nations most likely to become involved in major conflict situations. Then we attempt to overcome several serious limitations in dyadic conflict theory by using combined monadic scores as a predictor of levels of hostility among members. Dyadic forecasts are intended to be useful supplements to the monadic predictions, indicating with whom high conflicting countries are likely to interact.

A measure of international conflict is developed in the following section. Following this, the forecasting model for monadic conflict is discussed and evaluated. This includes explanation of the theoretical underpinnings of the model, tests of individual hypotheses relating predictors to the conflict descriptor, and a discussion of postdiction results. Then a similar process is undertaken for dyadic conflict; the monadic descriptor is used in conjunction with other exogenous and endogenous predictors to construct a forecasting model for predicting conflict between pairs of nations.

OPERATIONALIZATION: EVENT ANALYSIS

Operationalization of international conflict involves selecting measurable indicators that reflect the level of conflict among nations. Our definition suggests that conflict refers to that subset of international interactions that are of a hostile or negative nature. International interaction analysis thus provides an appropriate operational framework for our study.

Recent efforts to obtain data on international interaction have focused on the mass media. McClelland and Hoggard discuss the use of the media in studying patterns of international behavior:

> For more than a generation, academic journalism and communication research have been accumulating systematic findings about the mass media. We have now the benefit of a body of knowledge, much of it based on statistical analyses, about the characteristics of public communication. There is a growing body of reliable knowledge about the flow of the news and about communication behavior. International communication is an important aspect of this expanding field of knowledge, albeit there is a lag in the study of international political behavior from the perspective of the communication approach. There is no question, however, that such an approach can be taken to the analysis of the way in which the countries of the world act toward one another.[11]

Here we are specifically interested in a subset of interactions called events. "An event is defined as an activity undertaken by an actor in the political system in order to affect the behavior of the recipient of the act."[12] Reports of these events can be obtained from the media (usually newspapers and journals). Event codings generally have four components: an actor (initiator of action), target (recipient of action),

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[11] McClelland and Hoggard, "Conflict Patterns in the Interactions Among Nations." For a good discussion of communications theory, see John W. Burton, Conflict and Communication (New York: The Free Press, 1969).

[12] For a good, concise explanation of event analysis and its uses, see Mark Wynn and Mary F. Smith, The International and Domestic Event Coding System: INDECS (Arlington, Va.: CACI, Inc., 1973). For a more in-depth discussion of event analysis and a general discussion of transaction analysis, see Charles A. McClelland, "International Interaction Analysis: Basic Research and Some Practical Applications," Technical Report #2, World Event/Interaction Survey (1968).

issue area, and event type. Thus, "the U.S. issues a verbal warning to the North Vietnamese to cease infiltrating South Vietnam," is an event in the formal sense.

Event data will be used in the Long-Range Environmental Forecasting project to measure monadic and dyadic conflict. Event interactions include both verbal and physical exchanges between nations and thus provide a means for operationalizing and combining these two important aspects of international behavior. The World Event/Interaction Survey (WEIS) has been chosen as the source of a large portion of the conflict data. Events contained in the WEIS file are taken from the New York Times and coded into 1 of 63 event categories. Categories of verbal and physical conflict employed in the present study are listed in Table 1. Because the scope of WEIS is limited to the period 1966-73, additional data collection for the years 1961-1965 was necessary. Events for these years were taken from the New York Times Index and coded according to the WEIS scheme presented in Table 1.

The limitations of the event data approach warrant careful consideration. An obvious drawback of the WEIS collection is its restricted source coverage. Since the New York Times is the single source of events, only those items that it deems newsworthy are entered. Though the New York Times covers more events than any other single source, it does not report all international behavior and may omit significant occurrences in the international arena.[13] This shortcoming

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[13] Edward Azar, et al., "The Problem of Source Coverage in the Use of International Event Data," International Studies Quarterly (September 1972). See also Edward Azar, Richard Brody, and Charles McClelland, "International Events Interaction Analysis: Some Research Considerations," International Studies Series, Vol. 1,

TABLE 1

WEIS CONFLICT CATEGORIES

Number	Category
1	sieze position or possessions
2	military engagement
3	issue order, insist on compliance
4	give warning
5	threat without specific negative sanctions
6	threat with specific nonmilitary negative sanctions
7	threat with force specified
8	ultimatum, time limit specified
9	military mobilization, exercise, or display
10	break diplomatic relations
11	order personnel out of country
12	expel organization or group
13	detail or arrest persons
14	turn down proposal, reject protest, etc.
15	refuse, oppose, refuse to allow
16	charge, criticize, blame
17	denounce, denigrate, abuse
18	informal complaint
19	formal complaint or protest
20	deny an accusation
21	deny an attributed policy, action, or position
22	cancel or postpone planned event
23	reduce routine international activity
24	reduce or halt aid
25	halt negotiations

is further compounded by the exclusion of certain actors and action types from the WEIS file. The coding procedure for WEIS recognizes only interactions among governments or their representatives.[14] This excludes many important nongovernmental actors such as the International Red Cross and multinational corporations, and ignores some important forms of international behavior.[15]

No. 02-001 (Beverly Hills: Sage Publications, 1972); Philip M. Burgess and Raymond W. Lawton, "Indicators of International Behavior: An Assessment of Events Data Research," International Studies Series, Vol. 1, No. 02-001 (Beverly Hills, Sage Publications, 1972).

[14] The scope of WEIS is specific: the reported event must be (1) a single and discrete event-interaction, i.e., a specific action or statement; (2) international (a national boundary is crossed); (3) official governmental--reported by and concerning official government sources such as: a) an executive officer of high rank (President, Premier, Minister); b) an executive agency (defense department secretary and spokesman); c) persons acting in an official role (negotiators, ambassadors, representatives); d) a party related to a nation's international relations in military, guerrilla actions and demonstrations (Israeli forces, Swedish protestors, Pathet Lao guerrillas); e) an international body and its official heads, committees, representatives; f) an official government news service, radio publication (Tass, Al Ahram, Neues Deutschland). For a complete discussion of WEIS coding procedures see Trysha Truesdell, "World Event/Interaction Survey (WEIS) History and Codebook " (Arlington, Va.: CACI, Inc., 1973). (Unpublished paper).

[15] Furthermore, certain external and internal behavior is not represented in WEIS. These include: (1) nongovernmental, unofficial acts (informal access) that are ignored for pragmatic reasons; (2) routine transaction flows (e.g., exchange of goods and services); (3) international administrative activity carried on in the low, middle levels of bureaucracy such as the day-to-day business of embassies, consulates, and agencies. For further discussion of the weaknesses of event analysis, see Charles A. McClelland, "Some Effects on Theory from the International Event Analysis Movement," International Studies Series, Vol. 1, No. 02-001 (Beverly Hills: Sage Publications, 1972), pp. 37-39.

These observations lead us to conclude that WEIS events collection does not readily lend itself to measures of the absolute amount or magnitude of conflict among nations. However, we feel that the data employed in this study provide a reasonable indication of the relative intensity of conflict for the European nations.[16] That is, events reported in the New York Times are representative of the nations and dyads involved in serious conflict relative to other nations in the system. This relative, as opposed to absolute, operationalization of conflict has important implications for the interpretation of our forecasts. Predictions should not be interpreted as precise measures of international hostility; instead, they should be examined as sources of information concerning which actors have the greatest potential for engaging in conflict.

Event Scaling

Another problem in event analysis is that of accurately representing the intensity of interactions among nations. The task of weighting events has critical implications for a measure of conflict that attempts to discern the intensity as well as frequency of activity. Clearly, physical conflict events such as border skirmishes or full-scale war imply a higher level of conflict than do verbal protests, accusations, and threats. By weighting, we assign numerical values to events in such a way that larger values are given to events of greater intensity.

The categories of conflict events listed in Table 1 vary considerably

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[16] This assertion is more valid for Europe than for other world regions. The problems of source coverage are minimized in the European context due to the relatively keen interest the U.S. media has in the politics of the region.

in intensity, ranging from mild verbal criticism to violent encounters. If a realistic measure of international conflict is to be obtained, a series of weightings reflecting these important differences must be assigned to the events. However, since our objective is to create an index measure of relative rather than absolute levels of conflict, an elaborate schem defining a separate weight for each individual WEIS category is probably inappropriate. Instead we employ a scaling and weighting scheme defining three general classes of event categories that reflect our a priori notions about the most fundamental differences among the conflictual interactions. Table 2 shows those three event classes: (1) military incidents, (2) coercion, and (3) pressure; the WEIS categories included within each class; and the weightings assigned to the events. Military incidents include both violent military engagements and seizure of foreign property, coercion consists of intense verbal conflict such as threats, warnings, and detainment or expulsion of diplomatic personnel, while pressure includes milder forms of negative verbal interaction. Military incidents are considered to be the most severe form of conflict and are weighted 1.0. Coercive acts are weighted 0.5, while the less severe acts of pressure are given a weight of 0.35.[17]

Conflict Scores

Monadic and dyadic conflict scores are computed by summing the

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[17] See Theodore J. Rubin and Gary A. Hill, Experiments in the Scaling and Weighting of International Event Data (Arlington, Va.: CACI, Inc., January 1973). The event classes presented in Table 2 are a slightly modified version of those developed by Rubin and Hill, with the category "seize position or possessions" added to the military incidents category. Weightings are those suggested by CACI coders working on the WEIS project and reflect a general consensus among many who have attempted to use WEIS events to operationalize conflict.

TABLE 2

RELATIONSHIP BETWEEN WEIS
EVENT CATEGORIES AND AGGREGATED CLASSES

Aggregated Classes	WEIS Event Categories
1. Physical Conflict Weight = 1.0	seize position or possessions military engagement
2. Coercion Weight = 0.5	issue order, insist on compliance give warning threat without specific negative sanctions threat with specific military negative sanctions threat with force specified ultimatum, time limit specified military mobilization, exercise, or display break diplomatic relations order personnel out of country expel organization or group detail or arrest persons
3. Pressure Weight = 0.35	turn down proposal, reject protest, etc. refuse, oppose, refuse to allow charge, criticize, blame denounce, denigrate, abuse informal complaint formal complaint or protest deny an accusation deny an attributed policy, action, or position cancel or postpone planned event reduce routine international activity reduce or halt aid halt negotiations

weighted events for each nation and dyad. The monadic score for a given European nation equals the sum of its total weighted conflict events with all other nations in the European region. A dyadic conflict score is equal to the sum of the weighted conflict events between two nations; for dyad AB, the conflict score equals the number of weighted actions A directs at B plus the number B directs at A. Mean conflict scores and rankings of the 26 European nations and the 20 highest conflicting dyads for the period 1969-1970 are shown in Tables 3 and 4.

The conflict scores in Tables 3 and 4 are generally consistent with our a priori expectations regarding conflict among the European countries. Relatively large, powerful countries which we expect to dominate interaction in the region do in fact have the highest levels of monadic conflict. Smaller countries which assume a less influential role in European affairs, and thus seldom become involved in conflict, tend to have much lower scores. Furthermore, dyads which are known to have experienced severe conflict during the 1960's such as Russia/Greece, West Germany/East Germany, and Greece/Turkey exhibit the highest dyadic conflict scores. These observations support our contention that the event-based scores are valid indicators of relative levels of conflict among the European nations.

An examination of the monadic conflict scores in Table 3 reveals that the distribution is highly skewed. We contend that this skewness is in part a reflection of differential levels of reporting by the New York Times. To reduce the skewness and counteract the effects of bias in source coverage, the monadic scores are subject to a logarithmic transformation. The effect of the transformation is to reduce the

TABLE 3

MEANS AND RANKINGS ON MONADIC CONFLICT
1961-1970

Country	Mean Level of Conflict	Rank
Soviet Union	1.3320	1
West Germany	1.3152	2
United Kingdom	1.1371	3
East Germany	1.1238	4
France	.9603	5
Greece	.7247	6
Czechoslovakia	.5178	7
Turkey	.4749	8
Italy	.4556	9
Spain	.4016	10
Poland	.4004	11
Romania	.3907	12
Yugoslavia	.3732	13
Austria	.2857	14
Bulgaria	.2584	15
Netherlands	.2335	16
Hungary	.2283	17
Switzerland	.2158	18
Denmark	.1806	19
Ireland	.1204	20
Iceland	.1079	21
Finland	.1079	21
Sweden	.1079	21
Norway	.1079	21
Belgium	.0903	25
Portugal	.0477	26

range, and thus the total variance of the distribution, while having minimal substantive impact on the scores themselves.

Table 4 suggests that the distribution of dyadic conflict scores is also highly skewed. However, the range of the dyadic scores is considerably less than that of monadic conflict scores, implying that a transformation having a less drastic impact upon the variance is preferable. Accordingly, dyadic scores are subjected to the transformation $\sqrt{X + 1}$. The effect of this transformation is to reduce the skewness while preserving more of the original variance.

Methodological Considerations

The goal of the Long-Range Environmental Forecasting project is to build an integrated forecasting model for five central environmental descriptors--internal instability, national power base, international alignment, international trade, and international conflict. The forecasting model takes the form of a set of simultaneous linear regression equations, with one or more equations for each descriptor. Linkages among the five descriptors play an important role in generating the forecasts. That is to say, the set of independent variables used to predict each descriptor includes other central environmental descriptors and exogenous variables that are not forecast by the model.

The present effort is concerned with developing separate regression equations for monadic and dyadic conflict. Sets of potentially useful predictors for the two dependent variables are taken from theoretical literature on international conflict. In keeping with the project's integrated approach to forecasting, these predictors include other

TABLE 4

MEANS AND RANKINGS FOR TOP 20 DYADS
1961-1970

Dyad	Mean Conflict	Rank
West Germany - East Germany	3.259	1
West Germany - Soviet Union	2.518	2
United Kingdom - Soviet Union	2.516	3
France - Soviet Union	1.974	4
Greece - Turkey	1.678	5
Czechoslovakia - Soviet Union	1.648	6
United Kingdom - France	1.582	7
France - West Germany	1.545	8
United Kingdom - East Germany	1.467	9
United Kingdom - Spain	1.466	10
Romania - Soviet Union	1.394	11
France - East Germany	1.371	12
Greece - Soviet Union	1.339	13
United Kingdom - West Germany	1.290	14
West Germany - Poland	1.290	14
Turkey - Soviet Union	1.229	16
Italy - Soviet Union	1.197	17
Yugoslavia - Soviet Union	1.165	18
Greece - Bulgaria	1.156	19
West Germany - Yugoslavia	1.124	20

central environmental descriptors as well as additional exogenous variables. The strength and direction of the relationship between each predictor and conflict is empirically determined using data from Eastern and Western Europe for the period 1961-1970. Then, based upon their relative explanatory value, the most useful predictors are included in the final forecasting equations.

Forecasting models for both monadic and dyadic conflict are system-wide rather than case-specific. That is, we present 2 separate equations, one to predict levels of monadic conflict for all 26 European nations, and the other to forecast dyadic conflict for the 325 dyads in the region. Such an approach might be criticized on the grounds that it ignores crucial determinants of conflict behavior that are unique to the individual nation or dyad. Though we recognize the importance of such factors, we maintain that regionwide trends underlie much of the serious conflict among the nations of Eastern and Western Europe. Consequently, we feel that the more general approach is appropriate for forecasting conflict in the context of Europe, particularly over the long range.

Finally, we reemphasize that our models are intended to forecast relative rather than absolute levels of conflict. We do not attempt to predict the occurrence of verbal or physical conflict events; instead, we employ event data to indicate the relative intensity of underlying conflict conditions. The forecasts, then, reflect the potential level of conflict that can be expected for a particular nation or dyad.

FORECASTING MONADIC CONFLICT

The search for causes of international conflict has uncovered a wide variety of social, economic, and political variables that are believed to affect the behavior of nations. Among these are psychological factors that influence the perceptions and behavior of individual decisionmakers, the attributes of individual societies, the similarities and differences among nations and the nature of their interactions, and the characteristics of the international system itself. The models that have been developed for the Long-Range Environmental Forecasting project combine variables from several of these categories to forecast both monadic and dyadic conflict. In keeping with the integrated approach to forecasting, these predictor variables include variables that are both exogenous and endogenous to our system. In the following section, a brief description of each of the six initial predictors and their hypothesized linkages with monadic conflict is presented.

Previous Levels of Foreign Conflict

There is considerable evidence that suggests that there exists a strong link between a nation's past and present conflict behavior. Wright and Richardson[18] maintain that past wars are an important factor in determining the likelihood of future violence among countries. Wilkenfeld and Zinnes[19] extend the investigation to include verbal hostility, and conclude that a nation's foreign conflict during a given year is positively related to its level of verbal and physical conflict during the previous year. These analyses note that nations' interactions within their environment are in part an extension of their past behavior. Therefore, countries with high levels of present conflict have a high propensity for conflict in the future.

Internal Instability

Simmel, Wright, and Rosecrance[20] are among the many theorists

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[18] Wright, A Study of War; Richardson, Statistics of Deadly Quarrels.

[19] Dina Zinnes and Jonathan Wilkenfeld, "An Analysis of Foreign Conflict Behavior of Nations," in Comparative Foreign Policy: Theoretical Essays, ed. by Wolfram Hanrieder (New York: David McKay Co., Inc., 1971), pp. 167-213.

[20] George Simmel, Conflict and the Web of Group-Affiliations Glencoe, Ill.: Free Press, 1955); Wright, A Study of War; Richard Rosecrance, Action and Reaction in World Politics: International Systems in Perspective (Boston: Little, Brown and Co., 1963).

who argue that domestic and foreign conflict of nations are closely interrelated. They reason that a nation's leader, faced with domestic instability, will attempt to increase national unity and the stability of his political position by diverting attention to foreign affairs. Thus, involvement in international conflict can be expected to accompany or follow periods in which nations experience serious internal stress.

Early quantitative research concerning the relationship between domestic and foreign conflict cast doubt upon the validity of this argument. Rummel's factor analyses of variables measuring both kinds of conflict yielded no significant relationship between the two domains.[21] Tanter and Burrowes[22] offered further support for Rummel's findings, concluding that the two forms of conflict tend to operate independently of each other. However, Rummel's findings have been qualified by Wilkenfeld,[23] who found a clear relationship between domestic and foreign conflict when he controlled for type of governmental structure and introduced time lags. Specifically, Wilkenfeld concluded that nations with centrist[24] governments tend to become involved in

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[21] Rummel, "Dimensions of Conflict Behavior Within and Between Nations."

[22] Raymond Tanter, "Dimensions of Conflict Behavior Within and Between Nations, 1958-1960," Journal of Conflict Resolution, 10 (March 1966), pp. 41-64; Robert Burrowes and Bertram Spector, "The Strength and Direction of Relationships Between Domestic and External Conflict and Cooperation: Syria 1961-1967," Conflict Behavior and Linkage Politics, ed. by J. Wilkenfeld (New York: David McKay Co., Inc., 1973).

[23] Jonathan Wilkenfeld, "Domestic and Foreign Conflict," in Conflict Behavior and Linkage Politics, ed. by J. Wilkenfeld (New York: David McKay Co., Inc., 1973).

[24] For a definition of these government types, see Arthur Banks and Robert B. Textor, A Cross Polity Survey (Mass.: MIT Press, 1963).

international conflict in some time period subsequent to that in which they experienced internal instability. Nations with personalist governments, on the other hand, tend to experience internal instability and international conflict in the same time period. Wilkenfeld found no clear relationship between international conflict and internal instability for polyarchic countries. Furthermore, for extremely high levels of internal instability, he found that the relationship between instability and conflict appears to become negative for all government types. This seems to be a logical conclusion since a nation experiencing high levels of internal conflict may reallocate its military resources to promote domestic stability. Wilkenfeld also found that time is an important factor affecting the relationship between instability and conflict; past instability tends to have a stronger linkage to conflict than present instability.

In addition to polity type, we suggest that alignment with major powers mediates the relationship between instability and international conflict. Highly aligned nations can rely upon their allies for protection from external threats, thus freeing their own military forces for use in controlling domestic disorder. High levels of alignment may also increase the legitimacy of a nation's government, thus lessening the danger of open revolt.[25] Therefore, alignment is expected to both increase a nation's capacity to deal with instability and reduce the probability that domestic strife will seriously threaten the existence of a national government. The effect of alignment then is to reduce internal stress. That is, nations with high levels of instability are expected to have high levels of international conflict if they have a low

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[25] Wilkenfeld, "Domestic and Foreign Conflict," and Herman Weil, "Internal Instability," Chapter 3 of this volume.

level of alignment with major powers.

Alignment with Major Powers

An additional hypothesis links the extent of a nation's alignment with major powers to its propensity for international conflict. We expect alignment to be closely related to a nation's overall involvement in international politics and thus indirectly related to conflict. With regard to the first point, Louis Terrell[26] found that high levels of involvement in international behavior tend to be associated with relatively large amounts of monadic conflict. That is, highly aligned nations that assume active roles in international affairs will experience more conflict than less prominent countries that have low levels of interaction (with other states).

A nation's total alignment should also be an important determinant of the extent to which it becomes involved in interbloc competition and conflict. We suspect that highly aligned countries are more apt to "take sides" in these bipolar struggles, and thus be drawn into conflict with members of the opposing bloc.[27]

Power Base

The relationship between power capabilities and the propensity of

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26 Louis M. Terrell, "Patterns of International Involvement and International Violence," International Studies Quarterly (June 1972), pp. 167-186.

27 This is assuming, of course, that a nation is not highly aligned with both major powers and that high major-power alignment indirectly taps bloc identification.

nations to become involved in foreign conflict has also attracted wide scholarly, as well as journalistic, attention. Singer[28] noted that major powers tend to become involved in international military conflict more often than weaker nations. Rummel[29] reached a similar conclusion when he observed that bloc prominence, a variable very closely related to power, correlates rather strongly with all forms of foreign conflict. Galtung[30] observed that powerful nations tend to participate more frequently in all forms of interaction in the international system, and since some portion of this interaction is of a conflictual nature, major powers will be more involved in conflict as a function of their higher level of international activity. In short, theorists suggest that there exists a positive linkage between absolute levels of power and levels of foreign conflict; the larger and more powerful a given nation, the higher the level of conflict we should expect it to experience.

The power-base descriptor developed for the Long-Range Environmental Forecasting project includes two dimensions, military and economic. Whether military or economic power base is the better predictor of conflict remains an empirical question. Large military capabilities are often associated with a high propensity for involvement in conflict. Economic power base may be an important determinant of a nation's role in international affairs and thus may affect its patterns of conflict behavior. Therefore, hypotheses relating both military

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[28] Singer, "The Correlates of War Project," pp. 243-270.

[29] Rudolph Rummel, "The Relationship Between National Attributes and Foreign Conflict Behavior," in Quantitative International Politics, ed. by J. D. Singer (New York: The Free Press, 1968).

[30] Johan Galtung, "A Structural Theory of Aggression," Journal of Peace Research, No. 2 (1964), pp. 15-38.

and economic power base to conflict are tested.

Trade

Although we feel that economic relations among the nations of Europe are integrally related to conflict within the region, the specific nature of the relationship between these two variables remains unclear. Many scholars[31] have equated trade with integration, suggesting that economic interaction indicates a high level of cooperation among nations. Others[32] argue that economic transactions create a number of potential conflict situations that may lead to increased hostility in the long run. Consequently we test two competing hypotheses relating conflict to economic interactions, the first positing a positive relationship and the latter a negative relationship between them. Additional mediating factors may be added if empirical study reveals that the relationship is heavily influenced by other variables.

Level of Defense Expenditures

A number of scholars have used defense expenditures as an index of the degree to which nations are preoccupied with military affairs and

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31 See Hayward Alker and Donald Puchala, "Trends in Economic Partnership in the North Atlantic Area, 1928-1963," Quantitative International Politics, ed. by J. D. Singer (New York: The Free Press, 1967); Richard Chadwick and Karl Deutsch, "International Trade and Economic Integration: Further Developments in Trade Matrix Analysis," Comparative Political Studies (April 1973).

32 Andrew M. Scott, The Functioning of the International Political System (New York: The Macmillan Co., 1967).

defense-related matters. Haas[33] found a strong positive relationship between defense as a percentage of GNP and the tendency of nations to engage in physical warfare. Weede[34] similarly used the defense/GNP ratio as an indicator of the degree of militarization, and concluded that more militarized nations tend to become involved in more verbal and physical conflict. These conclusions suggest that nations which allocate a large portion of their resources to defense tend to be more aggressive in their relations with other nations and therefore have a greater propensity to become involved in conflict than nations little concerned with military affairs.

We test three hypotheses that relate monadic conflict to the defense/GNP ratio, to the absolute level of defense expenditures, and to changes in defense expenditures. It is important to recognize the conceptual distinctions among these three predictors. The level of defense expenditures indicates the gross amount of a nation's resources allocated to defense. Because the expenditure level is heavily contingent upon the size of a nation's economy, this variable is clearly related to economic power base, another endogenous predictor. A change in the level of defense expenditures is indicative of whether a country is increasing or decreasing its allocation of resources to defense, and thus, whether it is becoming more or less militarized. Defense as a percentage of GNP, in contrast, reveals the importance a nation attaches to defense relative to other areas of expenditure, and thus suggests how "military minded" the country is.

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33 Michael Haas, "Societal Development and International Conflict," in Conflict Behavior and Linkage Politics, ed. by J. Wilkenfeld (New York: David McKay Co., Inc., 1973).

34 Weede, "Conflict Behavior of Nation-States."

INITIAL EQUATION FOR MONADIC CONFLICT

The forecasting model for monadic conflict will take the form of a multivariable equation transformed to linearity. As discussed earlier, we are using a general model to describe conflict for the entire area of study. Our initial equation, presented below, takes into account each of the hypothesized linkages between predictors and monadic conflict discussed in the preceding section.[35]

$$Y_1 = \beta_0 + \beta_1 Y_{1(t-1)} + \beta_4 Y_4 + \beta_5 Y_5 + \beta_6 Y_6 \pm \beta_7 Y_7 + \beta_9 \left(Y_9 \cdot X_1\right) +$$

$$\beta_{10} Y_{10} + \beta_{11} \left(Y_{10} / Y_{11}\right) + \beta_{10} \left(Y_{10(t)} - Y_{10(t-1)}\right)$$

where:

- Y_1 = level of monadic conflict (CONFLICT)
- Y_4 = level of major-power alignment (ALIGNR)
- Y_5 = military power base (MPB)
- Y_6 = economic power base (EPB)
- Y_7 = total foreign trade (TRADE)
- Y_9 = internal instability (TURMOIL + REVOLT)
- Y_{10} = level of defense expenditure (DEFEX)
- Y_{11} = GNP
- X_1 = Polity type dummy; value of 1 if centrist, value of 0 for all other types

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35 Lagged variables, or variables at t-1, are exogenous to the simultaneous forecasting model because their values are predetermined as the forecast is generated.

The list of explanatory variables in our regression equation is obviously incomplete. Numerous other variables could be included and their addition might add to the accuracy of the model. However, the variables that we have chosen are among the most important predictors discussed in theories of international conflict. Additional variables contribute less to overall accuracy and add more to complexity. The model as it now stands maintains a balance between accuracy and simplicity.

TESTS OF HYPOTHESES

The next step in constructing our forecasting model is to test the hypothesized linkages between the predictors and the monadic conflict descriptor. The objective of these analyses is to remove the independent variables that have weak linkages to conflict and to isolate the subset of variables that is best able to explain the variance in the dependent variable. We now turn to the tests of the hypotheses outlined in the previous discussion.

Past Conflict

Our initial equation suggests a positive relationship between past and present monadic conflict. Wright, Wilkenfeld, and Zinnes[36] are among the many writers who argue that behavior in the international system is in part an extension of past behavior. Consistent with this view, a simple correlation of .74 is found between past and present conflict. This high correlation indicates that there is a strong

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[36] Wright, A Study of War; Wilkenfeld and Zinnes, "An Analysis of Foreign Conflict Behavior of Nations."

tendency for nations with high levels of conflict within their environment during the past year to have high levels of conflict during the present year. Past conflict is a relatively strong predictor, accounting for roughly 55 percent of the variance in monadic conflict.

The strong linkage between past and present conflict is in accordance with our intuitive notion of the consistency in nations' patterns of behavior over time. A nation's propensity to engage in conflict is in part contingent upon its previous experience in using verbal pressure, coercion, and military force. That is, European nations most likely to conflict with other countries in the region are those for which pressure, coercion, and military force are an integral part of their general foreign policy behavior.

Internal Instability

The hypothesis linking domestic instability and international conflict suggests a positive relationship between these two descriptors. The rationale here is that governments confronted with domestic disorder frequently attempt to reduce internal stress by precipitating conflict with other nations in order to divert national attention to foreign affairs. Our initial findings indicate that in the European context there is a moderate relationship between instability and conflict. Table 5 presents simple correlations between conflict and measures of turmoil, revolt, and strife; each accounts for about 14 percent of the variance in conflict.

The relatively strong linkage between turmoil and conflict suggests that diverting attention to external conflicts is a strategy often used when

TABLE 5

SIMPLE CORRELATIONS WITH INSTABILITY MEASURES

	TURMOIL	REVOLT	STRIFE (TURMOIL + REVOLT)
CONFLICT	.383	.264	.376

nations are faced with the milder forms of domestic instability such as riots, antigovernment demonstrations, and strikes. This finding is intuitively acceptable since governments can realistically divert the public's attention from these types of occurrences whereas external threats usually do not take precedence over open revolt. A weaker linkage between conflict and revolt was somewhat expected given Wilkenfeld's observation that nations confronted with the most extreme forms of instability tend to retreat from international involvements.[37] However, we do not find the negative relationship implied by Wilkenfeld; there is a slight tendency for European countries with high levels of revolt to have high levels of international conflict.

The results of our analyses do not support the contention that time is an important factor affecting the relationship between instability and conflict.[38] Correlations between conflict and past turmoil, revolt, and strife are shown in Table 6. Comparing these results with the correlations in Table 5, we find that lagging the instability indicators

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37 Wilkenfeld, "Domestic and Foreign Conflict."

38 Ibid.

produces weaker relationships. Therefore, we conclude that present instability is a more potent determinant of a nation's conflict behavior than its past levels of domestic disorder.

TABLE 6

CORRELATIONS WITH PAST INSTABILITY

	PAST TURMOIL	PAST REVOLT	PAST STRIFE (TURMOIL + REVOLT)
CONFLICT	.317	.239	.325

Wilkenfeld also found that polity type mediates the relationship between instability and conflict. When faced with internal instability, centrist regimes have a greater tendency to become involved in international conflict that polyarchic regimes. Controlling for polity types slightly enhances the explanatory value of turmoil, which has a partial correlation of .392.[39] Turmoil and polity type together account for slightly over 16 percent of the variance in conflict, compared to 14 percent for turmoil alone. We conclude that nations with high levels of turmoil are likely to have high levels of international conflict if they have centrist regimes.

An additional argument suggests that alignment has a mediating impact

[39] Polity type is treated as a dichotomous variable, with 0 indicating polyarchic regimes and 1 representing centrist regimes. Revolt was not considered because it was shown to be a weaker predictor of conflict than turmoil.

on the relationship between instability and conflict. A high level of alignment is expected to decrease the tendency for a nation experiencing internal stress to become involved in international conflicts. To test this hypothesis a third variable, TURMOIL/ALIGNR, is constructed. The effect of this ratio is to decrease the level of turmoil proportionate to the level of alignment, thus introducing the expected mediating impact of alignment with the major powers.

A single correlation of .37 between TURMOIL/ALIGNR and conflict is observed. This correlation is slightly lower than that for turmoil alone, suggesting that the addition of ALIGNR does not have the expected mediating effect. However, when polity type is controlled, the partial correlation between TURMOIL/ALIGNR and conflict is about .40. Together, TURMOIL/ALIGNR and polity type explain 17 percent of the variance in the conflict descriptor. This result is slightly better than the multiple correlation for turmoil and polity type. indicating that major-power alignment and regime type have a joint mediating effect upon the relationship between turmoil and international conflict.

Major-Power Alignment

As discussed earlier, nations strongly aligned with major powers are expected to have relatively high levels of conflict within the European region. This assertion is based on the rationale that the greater a nation's major-power alignment, the more active it is in international affairs and the more likely it is to participate in bipolar struggles; hence, its expected level of conflict is greater. Consistent with this hypothesis, a positive correlation of .29 is observed between major-power alignment and conflict. This finding suggests, however, that alignment is a relatively weak predictor of conflict, accounting for only 8 percent of its variance. This weak linkage indicates that it is common for a European nation to align itself with one or both major powers and yet avoid becoming overly involved in interbloc conflicts. Therefore, we conclude that in the European context there is only a slight tendency for nations highly aligned with major powers to have high levels of conflict within the region.

Power Base

Several theorists maintain that there is a strong positive relationship between nations' power capabilities and their propensity to engage in conflict with other states. Nations with large military and economic power bases are expected to experience high levels of conflict relative to small, less powerful countries. Correlations between monadic conflict and the military and economic power-base indicators, shown in Table 7, support this argument. Both military and economic power bases have relatively strong positive relationships with monadic conflict. Military power base explains about 22 percent of the variance in conflict. Economic power base, however, proved to be the superior predictor, accounting for 37 percent of the total variance.

TABLE 7

SIMPLE CORRELATIONS
FOR POWER-BASE MEASURES

	MPB	EPB
CONFLICT	.466	.606

The finding that powerful nations tend to have relatively high levels of conflict is far from surprising. A large proportion of the conflict in Europe is in the form of verbal statements from one nation intended to influence the behavior of another such as threats, warnings, and criticisms. Countries relying heavily on verbal coercion and pressure to achieve their international objectives are usually those countries that have power capabilities sufficient to make these actions credible. Less powerful countries, lacking the capabilities to coerce other nations successfully, will likely turn to persuasion and cooperation to influence other states. Therefore, it is reasonable to expect that powerful European countries will engage in conflict more frequently than smaller nations.

The fact that both the military and economic dimensions of power are related to conflict is also not surprising, particularly since there is a strong tendency for different kinds of power to be interdependent.[40] The finding that economic power has a stronger linkage to conflict may be partly explained by referring to our earlier argument linking power, status, and involvement to conflict. Briefly, powerful nations tend to dominate international interaction and experience high levels of conflict as a result of their active role in the system. We suspect that in the context of Europe, a large percentage of interstate interaction is verbal discussion of economic issues; much of the conflict, then, arises over these issues. The countries most involved in economic interaction are those with large economies and extensive economic involvements within the region. Thus, it logically follows that economic power is an important determinant of a nation's level of conflict.

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[40] See Harold D. Lasswell and Abraham Kaplan, Power and Society, (New Haven: Yale University Press, 1950).

Trade

An additional hypothesis links the extent of a nation's trade with other nations in its environment to the amount of conflict it experiences. We are reluctant to specify a priori the direction of this relationship due to inconsistencies in the theoretical literature. The results of our empirical investigation indicate that there is a distinct tendency for nations with large amounts of trade also to have high levels of conflict. This positive relationship is shown by the positive correlations between past and present trade and conflict presented in Table 8. Substantial relationships are observed in both cases, with past trade a slightly better predictor explaining 29.4 percent of the variance. (Past and present trade are highly colinear, correlating at the .99 level).

TABLE 8

CORRELATIONS BETWEEN TRADE AND CONFLICT

	TRADE	PAST TRADE
CONFLICT	.529	.542

One might suspect that the relationship between trade and conflict is spurious because a substantial part of the variance in both variables can be attributed to nation size. That is, large nations with sizable economies are likely to have high levels of trade and, as shown previously, high levels of conflict within their environment. Controlling for both economic power base and GNP, however, did not completely obliterate the relationship. Partial correlations for both present and past trade decreased to about the .30 level, with past trade remaining a slightly stronger predictor. From these analyses, we conclude that the relationship between past and present trade and conflict is partly, but not totally, a function of nation size; level of trade has a genuine impact upon a nation's propensity to engage in international conflict.

Our findings support the contention that high levels of economic interaction tend to increase the potential for nations to become involved in conflict situations. This is especially interesting in the context of Europe where many observers have argued that increased trade is a vital first step toward the eventual political integration of the Eastern and Western blocs. Clearly, disagreements arising over international monetary issues, tariff questions, and payments of debts are important elements of international conflict. Hence, we would be in error to assume that increased trade will always improve the relations among countries.

However, we would be equally mistaken to conclude, on the basis of these findings, that trade has a wholly negative impact on the international environment. Intuitively, we suspect that trade is positively related to both the cooperative and conflictual dimensions of international political behavior. That is to say, nations with high levels of trade are expected to have high levels of both conflict and cooperation within their environment. Because the scope of our study does not include cooperation among the European nations, this must remain an open question subject to future empirical research.

Defense Expenditures

Our findings offer support for propositions put forward by Weede, Hazelwood, and Haas[41] relating defense expenditures to international conflict. As discussed earlier, gross defense expenditures are considered an indication of a nation's belligerence or degree of militarization and thus its propensity to engage in conflict. Change in defense expenditures (D-DEFEX) indicates whether a nation is increasing or decreasing its extent of militarization; we hypothesize that the greater the increase in defense expenditures, the higher the expected level of conflict. Defense expenditures as a percentage of GNP (DEFEX/GNP) signify the extent to which nations stress defense relative to other areas of expenditure.[42] Here again, we expect a positive relationship between the defense-spending measure and conflict.

Correlations of each of these three predictors with conflict are shown in Table 9.

TABLE 9

SIMPLE CORRELATIONS FOR DEFENSE EXPENDITURES

Predictor	CONFLICT
DEFEX	.475
D-DEFEX	.404
DEFEX/GNP	.483

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41 Weede, "Conflict Behavior of Nation-States"; Hazelwood, "Externalizing Systemic Stresses"; and Haas, "Societal Development and International Conflict."

42 The effect of using the DEFEX/GNP ratio is essentially the same as controlling for GNP: the nations with small economies and high

DEFEX/GNP is the most potent predictor of conflict, explaining 23 percent of the total variance. Slightly weaker linkages exist between DEFEX and D-DEFEX and monadic conflict.

The possibility of a spurious relationship between defense expenditures and conflict is suggested by the fact that both are functions of past conflict.[43] Controlling for past conflict reduces, but does not completely eliminate, the relationships discussed above. Table 10 shows that the partial correlations for DEFEX, D-DEFEX, and DEFEX/GNP decline to the .2 level when $CONFLICT_{(t-1)}$ is held constant. These findings indicate that the relationships are partly, but not wholly, caused by the influence of past conflict on both defense expenditures and present conflict.

TABLE 10

PARTIAL CORRELATIONS FOR DEFENSE EXPENDITURES CONTROLLING FOR PAST CONFLICT

Predictor	CONFLICT
DEFEX	.209
D-DEFEX	.200
DEFEX/GNP	.221

levels of defense expenditures are expected to have the highest levels of conflict within the region.

[43] See Aaron Greenberg, "National Power Base," Chapter 2 of this volume.

Military capabilities are vital to the credibility of verbal coercion and pressure as tactics in international diplomacy. We conclude that the relative size and importance of a nation's defense budget reflect its propensity to use such tactics to influence the behavior of other nations. The greater the size, rate of increase, and relative importance of a European nation's defense spending, the more we expect its leaders to rely upon their ability to coerce other European nations to obtain their objectives.

FORECASTING MODEL FOR MONADIC CONFLICT

In the preceding section of this chapter, the individual linkages between our initial set of predictors and conflict were examined. The present discussion will present and evaluate the multivariate regression model to be used in forecasting monadic conflict. Construction of the model involves selecting an optimal set of predictor variables that maximize the amount of explained variance in conflict while preserving the statistical significance of the regression model as a whole. Once those predictors that make only marginal contributions to the explained variance are eliminated, the parameters are reestimated to yield the best possible results.

Five of the original predictors--past conflict ($MCONFLICT_{t-1}$), past trade ($TRADE_{t-1}$), change in defense expenditures (D-DEFEX), turmoil mediated by alignment (TURMOIL/ALIGNR), and polity type (POLTYPE)--are included in the final equation. Revolt and strife are not included because of their weak linkages relative to turmoil. Military and economic power base were previously shown to be highly colinear with past conflict and thus add little to the total explained variance. Furthermore, D-DEFEX has a stronger linkage to conflict than either level of defense expenditures or defense expenditures as a percentage of GNP when other major predictors are controlled. Consequently, the latter two variables, which are highly correlated with D-DEFEX, are also excluded from the forecasting model.

Table 11 shows the five predictors, their partial correlations, regression coefficients, the t-statistics of the coefficients, and the F-statistic and total explained variance of the equation.

TABLE 11

FORECASTING MODEL FOR MONADIC CONFLICT

Predictor	Partial Correlation	Coefficient	t-Statistic
Constant		.02736	.75548
$MCONFLICT_{t-1}$	.533	.48857	8.35210
D-DEFEX	.233	.00009	3.18120
TURMOIL/ALIGNR	.226	.04902	3.07630
$TRADE_{t-1}$	.274	.00001	3.78020
POLTYPE	.150	.09785	2.01850

$R^2 = .6543$

$F = 66.63$

The R^2 of .6543 indicates that the five predictor variables explain about 65 percent of the variance in monadic conflict. The large F-statistic implies that as a whole the model is highly statistically significant, that is, there is a low probability that the relationships occur by chance. On the basis of these results, we conclude that the forecasting model is satisfactory; it can reliably account for about two-thirds of the variance in conflict. However, there remains a substantial error component which must be attributed to random measurement error, the linearization of nonlinear relationships by the transformation, and additional causal factors not included in the present equation.

The substantial error in the monadic equation can also be partly attributed to the volatile, somewhat irregular nature of international conflict behavior. That is to say, we expect random factors and situationally specific variables to have a particularly strong impact on conflict, and consequently, to reduce the precision of the forecasts. Such elements, of course, have an especially strong influence on verbal conflict interactions of a rather incidental nature. These random elements reduce the extent to which patterns of conflict are consistent over time, and thus limit the level of precision that can reasonably be expected of our predictive model.

Partial correlations indicate the relative strength and direction of the linkage between each predictor and the conflict descriptor. Clearly, past conflict has the strongest relationship, explaining 28 percent of the total variance in conflict. As originally hypothesized, the relationship between these two variables is positive; nations with high levels of past conflict within the region tend to have high levels of present conflict. Three additional predictors--change in defense expenditures, level of turmoil mediated by alignment with major powers, and level of past trade--each have a moderately strong positive relationship to the conflict descriptor. The higher the level of trade, the larger the increase in defense expenditures, and the more domestic turmoil (given low levels of major-power alignment), the higher the level of expected conflict. Finally, polity type exhibits a weak positive linkage, suggesting that centrist regimes tend to experience more conflict than polyarchic regimes.

The t-statistic is used to evaluate the statistical significance of each coefficient, and thus, the reliability of the five predictors. Each of the five coefficients is shown to be significant, with past conflict once again having the highest level of reliability. Therefore, we conclude that there is a low probability that there do not exist genuine relationships between the individual predictors and conflict.

These results suggest that the model is sound from both a statistical and a theoretical perspective. That is to say, the relationships between the variables are probably not mere products of chance, and are consistent with our intuitive notions about which factors should tend to increase and decrease international conflict. Our findings indicate that the extent to which a European nation engages in conflict with other nations in its regional environment is largely a function of that nation's past behavior within the region. A nation's present level of conflict is primarily determined by its level of conflict during the previous year and strongly influenced by its past level of trade with other European countries. Additional factors that have a significant but less important influence on conflict are increasing defense expenditures, domestic turmoil, major-power alignment, and polity type.

This equation, which will be used to forecast monadic conflict, can reliably account for 65 percent of its total variance. The presence of a 35 percent error raises questions concerning the precision of the individual forecasts. Specifically, we wish to know if the forecasts tend to be more or less precise for particular European countries. To answer this question, we now turn to the analyses of postdictions of monadic conflict for the countries of Eastern and Western Europe.

POSTDICTIONS OF MONADIC CONFLICT

The forecasting model for monadic conflict is used to compute postdicted conflict scores and rankings. Postdiction involves "predicting" levels of conflict for the years included in our study, 1961-1970. Comparisons of these postdicted values with our original data provide a means for evaluating the reliability of the forecasts for each of the European countries.

We are interested in the degree to which the model accurately postdicts rankings as well as conflict scores for the 26 nations in our study. The use of rankings is consistent with our argument that we are forecasting relative and not absolute levels of conflict. Rankings are ordinal measures and are thus somewhat less precise than the actual conflict scores. However, we suspect that rankings may be more reliable for some European countries than the postdicted conflict scores. It is especially important to determine the accuracy of the postdictions for nations with the highest levels of conflict. These high conflictors are of central interest to policymakers who attempt to anticipate future conflict situations. Earlier, we pointed out that a relatively small subset of the European states are involved in a large proportion of the conflict within the region. Table 12 groups the countries by the mean level of conflict each experienced during the 10-year period under study. The high conflictors are the large, important nations that consistently experienced relatively high levels of conflict. Nations in the moderate category intermittently engaged in conflict, while the low conflictors seldom if ever experienced intense hostility. The analyses of postdictions attempt to show how our forecasting model can best be used to obtain reliable forecasts for those countries in the high and moderate categories.

TABLE 12

CLASSIFICATION OF COUNTRIES BY AVERAGE LEVEL OF CONFLICT, 1961-1970

High Conflictors (Mean >.9)	Moderate Conflictors (.9 > Mean > .3)	Low Conflictors (Mean < .3)
Soviet Union	Czechoslovakia	Austria
West Germany	Greece	Bulgaria
United Kingdom	Turkey	Netherlands
East Germany	Italy	Hungary
France	Spain	Switzerland
	Poland	Denmark
	Romania	Ireland
	Yugoslavia	Iceland
		Sweden
		Finland
		Norway
		BLEU
		Portugal

Table 13 presents the standard deviation of the residuals and rank differences for each of the European nations. Residuals, or errors, are the differences between postdicted and actual conflict scores. Large standard deviations of the residuals indicate substantial error and fluctuation in error in the postdicted conflict scores.[44] Similarly,

[44] Standard deviation is computed by the formula $\sqrt{\frac{X^2}{N}}$ Squaring the residual thus indicates the extent of total error, regardless of whether the residuals are positive or negative.

standard deviations of the differences between nations' actual and postdicted rankings, shown in column two, indicate the degree of inaccuracy in the postdicted rankings.

TABLE 13

POSTDICTION RESULTS BY COUNTRY

Country	Standard Deviation of Residuals	Standard Deviation of Rank Differences
Soviet Union	.25147	.9234
West Germany	.18369	.6512
United Kingdom	.17822	.7990
East Germany	.23566	1.6637
France	.22584	1.9261
Czechoslovakia	.51123	4.8214
Greece	.29070	5.3281
Turkey	.28463	8.4068
Italy	.19870	5.3050
Spain	.26272	5.0000
Poland	.44544	7.8533
Romania	.20955	2.6424
Yugoslavia	.36048	6.7493
Austria	.20347	5.5662
Bulgaria	.28909	5.2982
Netherlands	.33285	9.4508
Hungary	.16018	4.1036
Switzerland	.19189	4.7616
Denmark	.22823	7.4150
Ireland	.26032	6.5941
Iceland	.11435	1.7678
Sweden	.27347	7.3630
Finland	.19302	5.4248
Norway	.15460	3.9182
BLEU	.17329	4.7790
Portugal	.13328	4.7505

These results suggest that the postdicted conflict scores are most accurate for nations with either relatively high or low levels of conflict and least accurate for those intermittently involved in serious conflict. This pattern is shown more clearly in Table 14 where the 26 nations are classified according to the accuracy of their postdicted conflict scores.

TABLE 14

CLASSIFICATION BY ACCURACY
OF POSTDICTED CONFLICT SCORES

Excellent (S.D. < .2)	Fair (.2 < S.D. < .28)	Poor (S.D. > .28)
Iceland	Austria	Turkey
Portugal	Romania	Bulgaria
Norway	France	Greece
Hungary	Denmark	Netherlands
BLEU	East Germany	Yugoslavia
United Kingdom	Soviet Union	Poland
West Germany	Ireland	Czechoslovakia
Switzerland	Spain	
Finland	Sweden	
Italy		

Two of the high conflictors, the United Kingdom and West Germany, are among those countries with little postdiction error; the remaining countries in this category--France, the Soviet Union, and East Germany--each showed moderate postdiction error. Of the 13 countries with low levels of conflict during the 1960's, 11 are about evenly distributed between the "excellent" and "fair" categories. Bulgaria and the Netherlands are the only low conflictors shown to have extremely inaccurate postdictions. The most striking pattern shown in Table 14 is the inaccuracy of the postdictions for those nations intermittently involved in serious conflict. With the exceptions of Italy, Spain, and Romania, postdictions for each of the moderate conflictors exhibit substantial error.

It is not surprising that our forecasts of levels of conflict are most accurate for nations that have consistent levels of conflict behavior over time. Such regularity implies that stable patterns of causal relationships are the primary determinants of the extent to which these countries conflict with other nations in their environment. The methods used to generate our forecasts are based upon these kinds of causal relationships. In contrast, countries intermittently involved in hostilities are those most susceptible to the influence of random occurrences and situation-specific factors that are not accounted for by our model.

Table 15 classifies the 26 nations according to the accuracy of postdicted rankings. Clearly, the rankings are more accurate for the high and moderate conflictors than are the predicted conflict scores. Rankings for each of the five high conflictors are extremely accurate.

Yugoslavia, Poland, and Turkey are the only moderate conflictors with substantial error in their rankings, while the remainder of the countries in this category exhibit fair to excellent postdicted rankings. However, for many of the countries with little conflict during the 1950's, rank postdictions were less accurate than the predicted conflict scores.

TABLE 15

CLASSIFICATION BY ACCURACY OF RANK POSTDICTION

Excellent (3.0>S.D.)	Fair (3.0<S.D.<6.0)	Poor (S.D.>6.0)
West Germany	Norway	Ireland
United Kingdom	Hungary	Yugoslavia
Soviet Union	Portugal	Sweden
East Germany	Switzerland	Denmark
Iceland	BLEU	Poland
France	Czechoslovakia	Turkey
Romania	Spain	Netherlands
	Bulgaria	
	Italy	
	Greece	
	Finland	
	Austria	

Therefore, rank forecasts are more reliable for the high and moderate conflictors than the predicted conflict scores. The ordinal-level rankings are nearly as precise as the interval-level conflict data, given the relative nature of the conflict scores. Thus, the analyst loses little information by shifting his focus to rank forecasts.

In addition to degrees of inaccuracy, it is also important to determine whether the postdictions tend to be high or low for each European nation. Table 16 classifies nations with regard to direction of error in the postdicted conflict scores. Direction is determined by counting the number of positive versus negative residuals for each nation to determine which group is larger.

TABLE 16

CLASSIFICATION BY DIRECTION OF RANK POSTDICTION

High	Low
BLEU	United Kingdom
Denmark	Austria
Italy	France
Netherlands	West Germany
Norway	Greece
Sweden	Turkey
Switzerland	East Germany
Finland	Romania
Portugal	Soviet Union
Spain	
Yugoslavia	
Bulgaria	
Hungary	
Poland	
Iceland	
Ireland	
Czechoslovakia	

A clear pattern emerges from these observations. The postdicted conflict scores tend to be higher than real scores for nations with relatively low levels of actual conflict. For nations that frequently experience conflict within the region, postdictions are generally low. This outcome is certainly not unexpected given the systemwide model used to generate forecasts. A model intended to offer forecasts for both high and low conflicting nations will tend toward a mean value for all nations in the system. Thus, the model naturally tends to underestimate conflict for nations at the upper end of the conflict spectrum and overestimate those with lower levels of conflict.

In summary, the analyses of postdictions suggest that the model should offer reasonably accurate forecasts of the relative levels of monadic conflict for the 26 European countries. These analyses indicate that the combined usage of predicted conflict scores and ranks provides fairly reliable information about conflict in Europe. Predicted conflict scores are accurate for countries with low levels of conflict and thus may be used to determine which nations are least likely to be involved in major hostilities. Rank forecasts tend to be more reliable for nations with higher or moderate conflict, and thus provide a better indication of which countries are most likely to become involved in conflict situations.

FORECASTING DYADIC CONFLICT

The remainder of this chapter concerns the development of a forecasting model for dyadic conflict. As discussed earlier, we are forecasting European conflict in two stages. In the first stage, we dealt with the general context of monadic conflict and developed a model for predicting the total conflict of nations within their environment. We now move to the more specific context of the nation-dyad. The monadic conflict values are used in conjunction with other variables to construct a second forecasting model to predict which pairs of European countries are most likely to engage in conflict.

The absence of a large body of theoretical literature on dyadic conflict limits the number of potentially useful predictors of our dependent variable. Consequently, we borrow several hypotheses from monadic conflict theory and modify them to apply to the dyadic context. However, we would be mistaken to assume a priori that predictors strongly related to monadic conflict have equally strong linkages to dyadic conflict. From a theoretical standpoint, we expect that there are fundamental differences between the causal patterns affecting a single nation's conflict behavior and those influencing the extent to which two nations are in conflict. Substantial differences between the patterns of variance in the two dependent variables perhaps arise from the fact that the dyadic data contain 3250 observations, many of which are zero-cells. This will certainly influence the strength and direction of relationships. Therefore, it is necessary to repeat the process of formulating and testing hypotheses before constructing the dyadic conflict model.

Our purpose in considering dyadic conflict is to provide the policymaker with forecasts that contain more exact information about the location of potential conflict situations. In developing the dyadic model, we stress the predictive more than the explanatory value of the linkages among the variables. That is to say, we place less emphasis on finding linkages that have a strong theoretical basis and instead stress those that are statistically the strongest and most reliable.

Six sets of variables are hypothesized to affect the level of conflict between dyads. Four of these--monadic conflict, trade, national power base, and alignment--are themselves forecast in the interactive model.

<u>Combined Monadic Conflict</u>

The first hypothesis links the total conflict two nations experience within their environment to the level of conflict between them. We suggest that the greater the level of conflict for two nations within the region as a whole, the greater the level of conflict between them. The rationale behind this hypothesis seems intuitively obvious. Two European nations with high levels of conflict within the region are more likely to conflict with one another than nations seldom involved in hostility with any European country.

The hypothesis as stated implies that the expected level of dyadic conflict is highest in cases where both members of a dyad are high conflictors; moderate levels of dyadic conflict are expected where one member has a large monadic score, while the lowest levels should occur where neither member experiences substantial conflict within the region. Summing the monadic scores for dyad members will, therefore, produce the desired measure of regionwide conflict for each pair of European countries.

Previous Levels of Dyadic Conflict

In our earlier discussion of monadic conflict, we developed and tested the hypothesis that past conflict is an important determinant of present conflict.[45] The logic of that argument is now extended to the dyadic context. There is considerable evidence to support the proposition that the magnitude of conflict behavior between members of a dyad is in part a function of their previous experiences. Phillips' study of dyadic conflict concludes that two nations' future dealings with one another are essentially extensions of the chain of interaction sequences preceding them.[46] This implies that the nature of the

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45 See Wright, Wilkenfeld, and Zinnes, "An Analysis of Foreign Conflict Behavior of Nations."

46 Warren Phillips, "A Mathematical Theory of Conflict Dynamics," The Dimensionality of Nations Project, Research Report No. 39

ongoing interaction between two nations is thus an important determinant of the way they will interact at a given point in time. Therefore, we expect those dyads with high levels of past conflict also to have high levels of present conflict.

Trade

As discussed earlier, there is considerable disagreement among students of international relations regarding the impact of trade upon conflict behavior. Some argue that trade facilitates regional cooperation and may be a prerequisite to political integration. Others insist that economic interaction, like other forms of involvement in international affairs, increases the number of potential conflict situations arising among countries. Therefore, we hypothesize a relationship between dyadic trade and dyadic as well as monadic conflict, but leave open the question of the direction of the relationship between these variables.[47]

Power Base, Alignment

Power base is another endogenous central environmental descriptor that may have an impact upon the occurrence of dyadic as well as monadic conflict. One plausible argument suggests a positive relationship between the combined military power base of a dyad and its level of conflict. The rationale here is similar to that linking power and monadic conflict; large, powerful nations generally tend to

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(Department of Political Science, University of Hawaii, Honolulu, June 1970).

47 Dyadic trade is measured by summing the total trade between each pair of European nations.

be more active in international affairs and are thus the nations most likely to be drawn into international conflicts. That is to say, the greater the level of combined power in a dyad, the higher its level of participation in the international system; hence its expected level of conflict is higher.

We would add to this assertion the possible mediating impact of alignment. Two nations with large power bases are likely to conflict if the differences between their alignment status are large. A nation's alignment status, or its tendency to align with major powers, is investigated with respect to two salient major powers, the United States and the Soviet Union. Alignment scores for each European nation are represented as points on a two-dimensional plane. The distance vector between two points on the plane is used to measure the degree of similarity between two nations' behavior patterns; the greater the distance vector, the less the similarity in behavior or alignment status. Consequently, a positive relationship between alignment distance, power base, and conflict is expected; the greater the distance between two nations' alignment scores, and the larger their combined power bases, the greater the expected level of conflict between them.

A second hypothesis links the differences between two nations' power bases to the level of conflict between them. Organski[48] points out that when nations become similar in power and status, they are drawn into more competitive situations and are thus more prone to become involved in conflict with each other. Consequently, the difference in power bases of two nations should relate in a negative manner to the

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[48] A. F. K. Organski, World Politics (New York: Alfred A. Knopf, 1958).

level of dyadic conflict they experience.

We do not intend to imply that only those nations with similar levels of military power are likely to become involved in conflict with each other; but we do regard the case of conflict between a very powerful nation and a rather weak nation as a special case of the Organski hypothesis. Specifically, we think this linkage is mediated by the level of alignment between those nations. Thus when a small nation begins to decrease its alignment ties to the large nation, the more powerful nation tends to utilize military, economic, and diplomatic pressure to preserve the status quo. That is, conflict is viewed as a joint function of the power difference between nations and the difference in the level of their alignment from the last time frame to the present.

We suggest that the difference in power between two nations is inversely linked to the level of conflict between them. That is, as the level of their military power bases becomes more nearly similar, they are more likely to experience conflict. This relationship is modified by the level of their alignment at time t relative to the level of their alignment at time t-1. Nations with great differences in their power bases are likely to become involved in conflict when they are less aligned than in the last time frame. This mediated relationship can be expressed by the function

$$C_{ij} = h\left(\left| P_i - P_j \right| \left(\text{Align}_{ijt-1} - \text{Align}_{ijt}\right)\right)$$

where:

C_{ij} = the level of conflict between the members of the dyad,

$\left| P_i - P_j \right|$ = the absolute value of the difference in military power between them, and

$\left(Align_{ijt-1} - Align_{ijt} \right)$ is an inverse measure of the degree of alignment between the two nations at time t relative to the degree of their alignment at time t-1.

The functional relationship hypothesizes that conflict will be inversely related to the difference in two nations' military power bases, except when those nations become less aligned from time t-1 to time t.

Geographic Proximity/Contiguity

Studies of the causes of war have found that geographic relationships among nations are an important determinant of their conflict behavior. Lewis Richardson[49] emphasized this, concluding that states become involved in wars in proportion to the number of states with which they have common frontiers. Singer, Denton, and Weede[50] tested similar hypotheses relating contiguity to war. Rummel[51] used both geographic distance and contiguity as predictors of conflict

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[49] Richardson, Statistics of Deadly Quarrels.

[50] Singer, "The Correlates of War Project," pp. 243-270; Frank Denton, "Some Regularities in International Conflict 1820-1949" (Santa Monica, California: RAND Corporation, 1965); Weede, "Conflict Behavior of Nation-States."

[51] Rudolph Rummel, "Field Theory and Indicators of International Behavior," The Dimensionality of Nations Project, Research Report No. 29 (July 1969).

between nation-pairs and discovered some relationship between these factors and both verbal and physical conflict. The rationale underlying these conclusions is that geographically proximate nations, particularly those sharing common boundaries, tend to be faced with large numbers of potential conflict situations and are thus frequently drawn into conflict.

Therefore, we hypothesize a positive relationship between proximity and contiguity and the amount of conflict within dyads. Geographic proximity can be measured by using airline or steamship indices of the spatial distance between nation-pairs. These crude distance measures are supplemented by a dichotomous index of contiguity indicating the existence or nonexistence of a common land boundary between dyad members. A value of 1 for this variable indicates that the members share a common boundary, while the number 0 indicates that they do not share a common boundary.

Number of Past Treaties

Earlier we hypothesized that the history of conflict between nations is a predictor of their subsequent conflict behavior. Similarly, it can be argued that previous experiences of mutual agreement and cooperation reduce the potential for international conflict. The number of treaties between members of each dyad is used here as an indicator of their history of cooperation. Treaties have an important impact upon dyadic relations in that they establish a precedent of peaceful agreement that can counteract future hostility. They create mutual constraints and lasting guidelines for problem-solving that may prevent the occurrence of the more violent forms of conflict. It should be clear that the number of treaties between dyad members will be a long-lagged predictor in the conflict model; a single value will be used for each dyad. The data will include all United Nations registered treaties recorded up to 1970, and are intended to represent the history of cooperation between dyad members in the long run. Though a more accurate predictor of conflict during a given time period may be the number of treaties existing during that same period, it is unrealistic to attempt to predict the signing of future treaties. Thus we hypothesize that there exists a negative relationship between the number of past treaties between dyad members and their propensity to become involved in conflict (with one another).

STRUCTURE OF THE DYADIC CONFLICT EQUATION

The six hypotheses discussed above are used to construct our initial regression equation for dyadic conflict. (Nine predictors, including six central environmental descriptors and three additional variables, are contained in the equation.) As discussed earlier, we are attempting to develop a general model to describe and forecast dyadic conflict for the entire European environment. Estimates are based on data taken from 325 possible dyadic combinations per year for the period 1961-1970. The general form of the regression equation is as follows:

$$
\begin{aligned}
Y_2(i,j) = \; & \beta_0 + \beta_1 \left(Y_1(i) + Y_1(j) \right) + \beta_2 Y_{2_{t-1}}(i,j) \\
& - \beta_5 \left(\left| Y_5(i) - Y_5(j) \right| \Big/ \left(Y_{3_t}(i,j) - Y_{3_{t-1}}(i,j) \right) \right) \\
& + \beta_3 \left(Y_3(i,j) * \left(Y_5(i) + Y_5(j) \right) \right) + \beta_1 \left(Y_{1_{t-1}}(i) + Y_{1_{t-1}}(j) \right) \\
& \pm \beta_8 \left(Y_8(i,j) - \beta_1 X_2(i,j) \right) + \beta_3 X_3(i,j) - \beta_4 X_4(i,j)
\end{aligned}
$$

where:

$Y_2(i,j)$ = Conflict between countries i and j

$Y_1(i)$ = Monadic conflict for country i

$Y_{2_{t-1}}(i,j)$ = Past conflict between countries i and j

$Y_3(i,j)$ = Level of dyadic alignment for countries i and j

$Y_5(i)$ = Military power base of country i

$Y_8(i,j)$ = Level of trade between countries i and j

$X_2(i,j)$ = Proximity (distance between capitals)

$X_3(i,j)$ = Contiguity

$X_4(i,j)$ = Number of treaties.

Combined Monadic Conflict

Our initial equation posits a relationship between the level of conflict two nations have within the regional system as a whole and the amount of conflict between them. We reason that dyads in which both members experience high levels of conflict with other European countries are most likely to have high levels of dyadic conflict. A measure of a dyad's propensity for conflict is constructed by summing the two members' monadic conflict scores. As expected, this measure shows a strong relationship with dyadic conflict. The two variables correlate at the .637 level, indicating that the combined monadic scores explain 41 percent of the variance in dyadic conflict. This finding suggests that if one or both members of a dyad are involved in major conflict within the European region, a high level of conflict between the members can be expected.

The strong relationship between the summed monadic scores and dyadic conflict is, of course, partly an artifact of the inclusion of the dyadic conflict events in the monadic measure. That is to say, the sum of two nations' monadic scores includes their level of conflict with one another as well as their conflict with all other European nations. As discussed earlier, we employed this "built in" relationship to increase the predictive value of our model. Given the present level of development of conflict theory, it is necessary to know first the total extent of a nation's conflict before attempting to determine with which nation it is most likely to experience conflict.

An additional finding was that past levels of regionwide conflict influence levels of dyadic conflict. The correlation between the two variables is .27, indicating that past conflict explains about 7 percent of the variance in present dyadic conflict. Thus we conclude that the greater two nations' past level of conflict within their environment, the greater the expected level of conflict between them.

<u>Past Dyadic Conflict</u>

We hypothesize that the level of conflict between two nations is partly determined by their previous behavior toward one another. Dyads that had high levels of conflict during the previous time period are expected to have high levels during the present time frame.

Consistent with this expectation, our empirical investigation reveals a substantial correlation of .565 between past and present conflict. This finding indicates a strong linkage between the two variables, with 32 percent of the variance in present conflict explained by past conflict.

Trade

As stated earlier, we expect that there exists a relationship between dyadic trade and conflict but are uncertain of the direction of the relationship. Our findings, however, suggest that the two variables are unrelated. A simple correlation of the two variables yields an R of only .07, indicating a very slight tendency for high levels of trade to be associated with high levels of conflict. As a predictor of dyadic conflict, then, trade is able to explain only .5 percent of its total variance.

Power Base Alignment

Our initial model for dyadic conflict suggests that there is a positive relationship between the sum of two nations' power bases and their level of conflict. Here again our findings support the original hypothesis. Military power base has a correlation of .28 with conflict, thus suggesting a moderately strong relationship between the two variables. Power base explains about 8 percent of the variance in the dependent variable.

We also hypothesize that the difference between two nations' alignment status (ALIGN) mediates the relationship between power base and conflict. That is, the greater the sum of two nations' power bases and the greater the dissimilarity between their behavior toward the United States and the Soviet Union, the higher their expected level of conflict.[52] To test this hypothesis, the measure (MPB·ALIGN) is

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[52] See Herman Weil, "International Alignment," Chapter 5 of this volume.

constructed by multiplying the summed power base measure by the degree of dissimilarity in alignment.[53] A correlation of .29 between (MPB·ALIGN) and conflict is obtained, suggesting that our hypothesis is correct. There is, however, only a slightly greater tendency for power base to be more strongly related to dyadic conflict when dyad members are unaligned.

An additional hypothesis links the difference between two nations' military power bases (D-MPB) to their level of conflict. Nations similar in power capabilities are expected to compete for status and prominence in the international system and thus tend to have relatively high levels of conflict. Our initial findings, however, do not support this contention. A positive correlation of .24 between the difference in two nations' military power bases and their level of conflict is observed. This suggests that large differences in power tend to have a positive effect upon levels of dyadic conflict.

Controlling for change in alignment did not produce a significant change in the previously observed relationship. Thus, our hypothesis that alignment mediates the relationship between difference in power base and conflict is not supported. Controlling for past dyadic conflict and combined monadic conflict, however, reverses the direction of the relationship to that initially hypothesized. A partial correlation of -.02 is observed for D-MPB, suggesting that small differences in power base tend to have a positive effect on conflict when dyad members' overall propensity for conflict and past level of mutual conflict are low.

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[53] Multiplying these two variables increases the size of the power-base measure proportionate to the degree of difference between the nations' alignment status.

Proximity, Contiguity

The argument linking geographic proximity to dyadic conflict (DCONFLICT) suggests that the closer two nations are to one another, the greater their mutual salience and involvement, and thus, the greater their propensity for conflict. Contiguous nations have an especially strong tendency toward high levels of conflict inasmuch as boundary and territorial issues may become major areas of disagreement.[54] Table 17 presents simple correlations between contiguity, proximity, and dyadic conflict. Contiguity has the strongest relationship, accounting for 2.3 percent of the variance in conflict. The inverse relationship between proximity and conflict is consistent with our initial expectations; the greater the distance between two nations, the lower the level of conflict between them. However, proximity is an extremely weak predictor, explaining only a negligible portion of the variance in the dependent variable. Therefore, our primary substantive conclusion is that if two nations share common boundaries, they will tend to have higher levels of conflict than noncontiguous dyads.

TABLE 17

CORRELATIONS FOR CONTIGUITY AND PROXIMITY

	Proximity	Contiguity
DCONFLICT	-.049	.146

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[54] Contiguity was operationalized as a dichotomous variable (1, 0) with 1 indicating presence of a common boundary between dyad members. Proximity was measured by the number of miles between nations' capitals.

Past Treaties

The number of treaties between nation-pairs was initially hypothesized to be inversely related to levels of dyadic conflict. Treaties were considered indicators of a history of cooperation and agreement between nations which served to facilitate conflict resolution and abatement. As a "long lagged predictor" in our model, the number of treaties for each dyad is held constant over time. This avoids the need to make separate forecasts for this predictor variable.

Contrary to our initial hypothesis, the linkage between treaties and conflict proved to be extremely weak. The simple correlation between these two variables is only .05, indicating that treaties account for very little of the variance in conflict.

FORECASTING MODEL FOR DYADIC CONFLICT

The construction of a forecasting model for dyadic conflict first involves eliminating those predictors variables that evidence weak linkages to the descriptor. These predictors include the number of treaties between dyad members, the level of dyadic trade, proximity, economic power base, and change in alignment. Each of these predictors explains less than 10 percent of the variance in the dependent variable, and thus makes only marginal contributions to our predictive model.

The six variables included in the final forecasting equation are listed with their partial correlations, coefficients, and t-statistics in Table 18. Five of the predictors--combined monadic conflict (MCONFLICT), past dyadic conflict ($DCONFLICT_{t-1}$), alignment times military power base

(ALIGN·MPB), contiguity (CONTIG), and difference in military power base (D-MPB)--were part of our original hypothesized model. Past regional conflict ($MCONFLICT_{t-1}$) was found to be negatively related to dyadic conflict when present combined mon.dic conflict is controlled.[55]

TABLE 18

FORECASTING MODEL FOR DYADIC CONFLICT

Predictor	Partial Correlation	Coefficient	t-Statistic
Constant		.57884	46.569
$MCONFLICT_{t-1}$	.616	.00111	46.703
$DCONFLICT_{t-1}$	.497	.42818	34.225
CONTIG	.096	.04939	5.7589
$MCONFLICT_{t-1}$	-.062	-.01864	-3.7243
D-MPB	-.124	-.00002	-7.4754
ALIGN·MPB	.159	.00004	9.6259

$R^2 = .588$

$F = 848.20$

Table 13 shows that the six predictors explain about 59 percent of the total variance in dyadic conflict. The extremely large F-statistic indicates that the equation as a whol- is highly statistically significant. From these results we conclude that the model is satisfactory in that

[55] Controlling for present monadic conflict eliminates cases where dyad members have high levels of conflict within the region. This leaves dyads which had high levels of past over.ll conflict which no longer persists, suggesting that some form of conflict resolution processes are operating for one or both dyad members.

it reliably explains a substantial portion of the total variance in conflict. As we pointed out earlier, random factors and situationally specific variables have a strong influence on international conflict behavior and can be expected to reduce the precision of our explanatory models. Moreover, the 41 percent error must be partly attributed to the extremely large data base of 3,250 observations which was used to obtain parameter estimates.

As suggested by the partial correlations, regional conflict and past dyadic conflict have the strongest linkages to present dyadic conflict. These two variables also have extremely large t-statistics indicating they are highly reliable predictors. The remaining four predictors account for only about 4 percent of the variance in conflict, though the coefficient for each is statistically significant below the .005 level.[56]

Generally, the individual relationships exhibit the direction hypothesized by our original theoretical model. Regional conflict and past dyadic conflict are both positively associated with dyadic conflict; the greater the two nations' present conflict within the region and past conflict with one another, the greater the expected level of conflict between them. Morever, dyads with the highest levels of conflict are those that are contiguous and those in which members have large military power bases and are not aligned. The remaining two predictors--difference in military power base and past regional conflict--are shown to be inversely related to conflict. This implies that the less

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[56] These predictors, however, were previously shown to have moderate to strong linkages to conflict, suggesting that a considerable portion of the variance they can explain is taken into account by the two dominant predictors.

often two nations experienced conflict with other European countries during the previous year, and the smaller the difference between their military power bases, the greater the expected level of conflict between them.

The dyadic forecasting model, then, conforms to both the substantive theoretical and statistical criteria used in selecting reliable forecasting models. Further evaluation of the usefulness of the forecasting model requires examination of postdicted values of dyadic conflict. As discussed previously, our purpose in forecasting dyadic conflict is to supplement the monadic predictions and provide the analyst with more specific information about which pairs of European nations are most likely to engage in conflict. Thus we are primarily interested in the accuracy of postdictions for those dyads with the highest levels of conflict during the period 1961-1970. We now turn to the comparisons of postdicted and actual conflict for these high conflicting dyads.

POSTDICTIONS OF DYADIC CONFLICT

Postdicted conflict scores for the 325 European dyads were computed for the years 1961-1970. Table 19 presents the mean actual and mean predicted conflict scores and rankings for the 20 dyads having the most actual conflict over the 10-year period. Generally, the mean predicted scores are lower than the average level of actual conflict, suggesting that the model tends to underestimate the severity of conflict for most high conflicting dyads. This finding is far from surprising, considering the large number of nonconflicting dyads included in our sample. Therefore, we should expect our forecasts to be somewhat low for the set of high conflicting dyads.

TABLE 19

COMPARISON OF ACTUAL AND PREDICTED DYADIC CONFLICT

Dyad	Mean Actual Conflict	(Rank)	Mean Predicted Conflict	(Rank)
West Germany - East Germany	3.259	1	2.377	2
West Germany - Soviet Union	2.518	2	2.397	1
United Kingdom - Soviet Union	2.516	3	2.131	3
France - Soviet Union	1.974	4	1.701	5
Greece - Turkey	1.678	5	1.441	7
Czechoslovakia - Soviet Union	1.648	6	1.766	4
United Kingdom - France	1.582	7	1.355	10
France - West Germany	1.545	8	1.494	6
United Kingdom - East Germany	1.467	9	1.414	9
United Kingdom - Spain	1.466	10	1.220	15
Romania - Soviet Union	1.394	11	1.137	16
France - East Germany	1.371	12	1.318	12
Greece - Soviet Union	1.339	13	1.328	11
United Kingdom - West Germany	1.290	14	1.427	8
West Germany - Poland	1.290	14	1.239	14
Turkey - Soviet Union	1.229	16	1.248	13
Italy - Soviet Union	1.197	17	1.069	20
Yugoslavia - Soviet Union	1.165	18	1.087	19
Greece - Bulgaria	1.156	19	1.120	18
West Germany - Yugoslavia	1.124	20	1.124	17

Although the actual and predicted conflict rankings differ somewhat, they indicate that the model adequately forecasts relative conflict for the high conflicting dyads. For most of the 20 dyads, predicted and actual ranks differed by 1 rank or less. For only three dyads--United Kingdom/Spain, United Kingdom/West Germany, and Romania/Soviet Union--were the predicted and actual ranks different by more than three.

Further evidence that the dyadic forecasts are good relative indicators of conflict is the fact that mean conflict scores for each of the high

TABLE 20

POSTDICTION RESULTS BY DYAD

Dyad	Mean Absolute Error	Standard Deviation of Error
West Germany - East Germany	1.03	.64
West Germany - Soviet Union	.58	.68
United Kingdom - Soviet Union	.44	.30
France - Soviet Union	.36	.44
Greece - Turkey	.63	1.06
Czechoslovakia - Soviet Union	.19	.36
United Kingdom - France	.34	.38
France - West Germany	.47	.65
United Kingdom - East Germany	.32	.37
United Kingdom - Spain	.39	.55
Romania - Soviet Union	.31	.27
France - East Germany	.28	.35
Greece - Soviet Union	.27	.36
United Kingdom - West Germany	.25	.31
West Germany - Poland	.17	.20
Turkey - Soviet Union	.30	.38
Italy - Soviet Union	.13	.17
Yugoslavia - Soviet Union	.16	.23
Greece - Bulgaria	.17	.27
West Germany - Yugoslavia	.17	.23

conflicting dyads are substantially larger than the average predicted dyadic scores for each year during the 1960's. Postdictions for the great majority of dyads range between .98 and 1.05, averaging 1.025, while for the 20 high conflictors, the lowest mean score is 1.069. Dyads having substantial conflict will probably have forecast values well above the average for the European region. An appropriate strategy for using the dyadic scores, then, is to select the subset of dyads with large predicted scores as an indication of which nation-pairs are likely to experience future conflict.

Table 20 shows the mean of the absolute value of the error and the standard deviation of the error for the 20 highest conflicting dyads. The former indicates the total amount of error in the postdictions, while the standard deviation suggests the extent of fluctuation in the error. Clearly, dyads with the highest conflict over the period 1961-1970 tend to have large postdiction error. That is, the higher the level of conflict for a particular dyad, the more error can be expected in the forecasts. Generally, the mean error ranges between 10 and 20 percent of the actual conflict score; West Germany/East Germany has by far the greatest overall error, approaching 30 percent of its average yearly conflict.

Standard deviations tend to be largest for dyads with the highest levels of actual conflict and the highest overall error. Greece/Turkey has by far the greatest fluctuation in postdiction error, which is not surprising when considering the intense but erratic nature of conflict that occurred between these countries during the 1960's.

Postdictions of dyadic conflict, then, suggest that we may expect the predicted conflict scores to have substantial error, tending to be somewhat low for most high conflicting dyads. The analyst should be extremely cautious in interpreting these scores as indicators of absolute magnitudes of conflict between European nations. However, the dyadic forecasts are primarily intended to provide an indication of which dyads are most likely to experience conflict in a particular time period. They are best interpreted as relative measures, suggesting which dyads have the greatest potential for future conflict.

CONCLUSION

This study has sought to develop a technology for forecasting international conflict for 26 European nations over the long-range. Two regression models were constructed to generate forecasts for the period 1985 through 1995. These equations are part of a larger simultaneous forecasting model in which international conflict is only one of five central environmental descriptors. The predictive model is based upon an integrated approach to forecasting; linkages among the five descriptors, as well as among other exogenous predictors, are used to generate (obtain) forecasts of the European economic and political environment.

International conflict was conceptualized as that subset of interactions between countries that evidences a degree of hostility. Conflictual interactions include both physical violence and verbal coercion or pressure. The interactions form a weighted continuum, the upper end of which is composed of physical violence and the remainder of which includes verbal actions. Conflict was operationalized using events reported in the New York Times. The event-based measures were interpreted as indicative of relative as opposed to absolute levels of international hostility.

We approached the forecasting of international conflict as a two-stage process. First we developed a model to represent levels of monadic conflict--the total amount of conflict experienced by European nations within their environment. Then, a second model incorporating the monadic forecasts was constructed to forecast levels of conflict for nation dyads. In the context of policy analysis, the monadic and dyadic forecasts were intended to complement one another. Monadic forecasts provide a general indication of which nations are most likely to become involved in serious conflict. Dyadic forecasts provide more specific information, indicating which pairs of nations are likely to experience high levels of hostility.

In the process of selecting predictors of monadic and dyadic conflict, a number of hypotheses taken from theoretical literature were examined using data from the European context. To summarize briefly the major empirical findings, our study suggests that monadic conflict in Europe is strongly related to nations' behavior in the international system. A country's present level of conflict within its environment is strongly related to its past level of conflict and its past and present level of trade. There is also evidence that a nation's attributes are associated with conflict; countries with large economic and military power bases as well as high levels of defense expenditures tend to experience high levels of conflict. Additional evidence indicates that domestic instability tends to affect a nation's propensity to engage in conflict. This is particularly true of centrist polities, but is generally true in the European context.

CHAPTER 7: FORECASTS OF THE LONG-RANGE EUROPEAN ENVIRONMENT

STRUCTURE OF THE FORECASTING MODEL

The forecasting model developed here depends upon three sets of theoretical frameworks: substantive social science theory, statistical theory, and cybernetic theory. The assumptions of the model, that is, the relationships among variables within it, are subjected to validation against each of these three sets of theoretical frameworks as they are integrated into a general systems paradigm. The result is a set of 12 equations that describe the interrelationships among descripto· components over time and relate those components to exogenous predictor variables.

These 12 equations, then, constitute the heart of the forecasting model. Application of the equations to a set of initial data (for the year 1970) produces a forecast for the long-range European environment (in this case, 1985-1995). Equations are developed to produce forecasts for population (Y_1), energy consumption (Y_2), gross national product (Y_3), trade (Y_4), distribution of major-power alignment (Y_5), extent of major-power alignment (Y_6), turmoil (Y_7), defense expenditures (Y_8), military manpower (Y_9), monadic conflict (Y_{10}), revolt (Y_{11}), and dyadic conflict (Y_{12}).

$$Y_1 = \beta_{10} * Y_{t-1}^{\beta_{11}} * \left(\frac{Y_{3_{t-1}}}{Y_{1_{t-1}}} \right)^{\beta_{13}}$$

$$Y_2 = \beta_{20} + \beta_{22} Y_{2_{t-1}}$$

$$Y_3 = \beta_{30} * \left(Y_{3_{t-1}}\right)^{\beta_{33}} * \left(Y_{8_{t-1}} + 1\right)^{\beta_{38}} * \left(Y_{7_{t-1}} + 1\right)^{\beta_{37}}$$

$$Y_4 = Y_{4_{t-1}} * \left(\frac{Y_3 - Y_{3_{t-1}}}{Y_{3_{t-1}}} + 1 \quad * \quad \beta_{43} \right)$$

$$Y_5 = \beta_{50} + \beta_{53} Y_3 + \beta_{54} Y_4 + \beta_{55} Y_{5_{t-1}} + \beta_{513} X_{13} + \beta_{514} X_{14}$$

$$Y_6 = \beta_{60} + \beta_{66} Y_{6_{t-1}} + \beta_{65} Y_5 + \beta_{69} Y_{9_{t-1}} + \beta_{610} Y_{10_{t-1}}$$

$$Y_7 = \beta_{70} + \beta_{71} Y_1 + \beta_{77}\left(Y_{7_{t-1}} + Y_{11_{t-1}}\right) + \beta_{75} Y_{5_{t-1}} + \beta_{715} X_{15} +$$

$$\beta_{78}\left(f\left(\left(Y_{8_{t-1}} + Y_{9_{t-1}}\right) \frac{Y_{8_{t-1}}}{Y_{9_{t-1}}}\right)\right) + \beta_{74}\left(Y_4 - Y_{4_{t-1}}\right)$$

$$Y_8 = Y_3 * \left(\beta_{80} + \beta_{86} Y_6 + \beta_{810}\left(Y_{10_{t-1}} * Y_6\right) + \beta_{83} Y_3 + \beta_{87} Y_7 + \right.$$

$$\left. \beta_{88} \frac{Y_{8_{t-1}}}{Y_{3_{t-1}}} \right)$$

$$Y_9 = \beta_{90} + \beta_{99} Y_{9_{t-1}} + \beta_{93} Y_3 + \beta_{91}\left(Y_1 * Y_6\right) + \beta_{910} Y_{10_{t-1}} + \beta_{97} Y_{7_{t-1}} +$$

$$Y_{10} = \beta_{100} + \beta_{1010} Y_{10_{t-1}} + \beta_{107}\left(Y_7 - Y_{7_{t-1}}\right) + \beta_{108}\left(Y_8 - Y_{8_{t-1}}\right) +$$

$$\beta_{104} Y_{4_{t-1}} + \beta_{1013} X_{13}$$

where:

X_{13} = polity type (0 = polyarchic, 1 = centrist)

X_{14} = proximity to major powers

X_{15} = negative government sanctions

X_{16} = contiguity score

$$Y_{11} = \left(\beta_{110} + \beta_{117} Y_7 + \beta_{1111} Y_{11_{t-1}} + \beta_{1110} Y_{10} + \beta_{118}\left(f\left(\left(Y_8 + Y_9\right)\frac{Y_8}{Y_9}\right)\right) + \beta_{113}\left(\frac{Y_3}{Y_1}\right)\right)^2$$

$$Y_{12}^{ij} = \beta_{120} + \beta_{1210}\left(Y_{10}^{i} + Y_{10}^{j}\right) + \beta_{1211}\left(Y_{10_{t-1}}^{i} + Y_{10_{t-1}}^{j}\right) +$$

$$\beta_{1212} Y_{12_{t-1}}^{ij} + \beta_{128}\left|\left(f\left(\left(Y_8^{i} + Y_9^{i}\right)\frac{Y_8^{i}}{Y_9^{i}}\right)\right) - \left(f\left(\left(Y_8^{j} + Y_9^{j}\right)\frac{Y_8^{j}}{Y_9^{j}}\right)\right)\right| + \beta_{1216} X_{16}^{ij} +$$

$$\beta_{126}\left(\left(Y_6^{i}\left(f\left(\left(Y_8^{i} + Y_9^{i}\right)\frac{Y_8^{i}}{Y_9^{i}}\right)\right)\right) + \left(Y_6^{j}\left(f\left(\left(Y_8^{j} + Y_9^{j}\right)\frac{Y_8^{j}}{Y_9^{j}}\right)\right)\right)\right)$$

where:

i and j constitute a dyad of nation-states.

Two general points are particularly important with regard to the set of equations comprising the forecasting model. The first concerns the use of endogenous variables, other central environmental descriptors, in the forecasting equations. Strictly speaking, the use of endogenous variables as predictors in a system of equations requires an estimation technique capable of removing the error component of those variables when their coefficients are estimated. Failure to remove this stochastic component will result in biased and inconsistent estimates of the parameters, or assumptions, of the forecasting model. At the same time, however, use of such an estimating technique, two- or three-stage least squares regression for example, requires concomitant use of a simultaneous modeling technique where the forecasting process is iterated until a converging, though not exact, solution is found. In both the estimation of model assumptions and the generation of forecast values, then, such an approach increases substantially the complexity of the forecasting process. Moreover, both the statistical and modeling techniques place great demands upon the exogenous variables in the system and upon the structure of the forecasting model. That is, the tolerance for error in the exogenous variables and misspecification in the equations themselves is extremely low. In our view, these requirements are excessive in light of the relatively poor quality of data at our disposal and macro-level concepts included in the model. To be sure, these concepts are of critical importance to policymakers in the national security community; equally likely, they are not simply a function of a few other macro-level variables.

This is not to say, of course, that a model focusing upon purely macro-level political and economic variables cannot approximate the causal structure underlying those important environmental factors. But such a model does require statistical and modeling methods that are relatively forgiving in terms of error and misspecification tolerance. Combined with appropriate statistical and model-construction tools, macro-level concepts are probably the most useful and credible for forecasting over the long range.

Therefore, a system of equations that is amenable to ordinary least squares parameter estimation is required. This requirement is met by structuring the equations in a recursive manner so that predictor variables in equations at the end of the forecast process are themselves forecast prior to being utilized as predictors, while equations at the beginning of the set depend upon exogenous, or lagged endogenous, predictors. Thus, the value of a variable will already be determined at the time it is used in forecasting another variable.

The second general point concerning the set of forecasting equations is that while most of the equations take a linear form, those for population, gross national product, international trade, and defense expenditures do not. We suggested in Chapter 1 that, generally speaking, the concepts with which we are concerned are not developed enough conceptually to permit nonlinear modeling techniques. Furthermore, we suggested that nonlinear models with multiplicative and exponential functions exaggerate the effects of data errors more than do linear models which contain only additive relationships. Except for defense expenditures, these variables have been subjected to a great deal of theoretical and empirical analysis in the fields of economics, demography, and political science. These variables generally are well conceptualized and have accepted operational procedures and reliable data bases associated with them, particularly for the more well-developed countries in the European region. Thus, the nonlinear models most appropriate for long-range forecasting can be used in these cases with some credibility. For those variables that have been studied to only a limited extent previously, however, traditional linear methods prove more useful.

Table 1 shows the confidence intervals for the parameter estimates of the equations that constitute the forecasting model. Each row in the table contains the estimated parameter ranges for a single forecasting equation. The first row consists of the parameter estimates for Y_1 (population), the second for Y_2 (energy consumption), the third for Y_3 (gross national product), and so on. The columns of Table 1 contain the parameters associated with a particular variable in the model as that variable is used as a predictor. Thus β_1 is associated with the first variable in the model, population; reading down the first column we note that population, or lagged population, is used as a predictor for population (Y_1), turmoil (Y_7), and military manpower (Y_9). Any particular estimated parameter range can be found in Table 1 by locating the intersection of the row of the central descriptor component and the column of the particular predictor variable.

Each cell in Table 1 is either blank or contains two numbers. If a cell is blank, no important relationship was found between that particular central environmental descriptor and predictor variable for either substantive theoretical or statistical reasons. Where a theoretically important and statistically significant relationship was found, the two numbers in the cell denote the ranges of the 95 percent confidence interval for the parameter of that relationship. Therefore, if the assumptions of the statistical theory by which these estimates were generated

TABLE 1

LEAST SQUARES COEFFICIENT RANGE ESTIMATES AT 95 PERCENT CONFIDENCE LEVEL

Equation	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	β_9	β_{10}	β_{11}	β_{12}	β_{13}	β_{14}	β_{15}	β_{16}
Y_1	2.0702 -.6901	1.0301 1.0107		.0495 -.5249													
Y_2	.5520 -.6600		1.0501 1.0567														
Y_3	725.36 -243.42			1.0683 1.0395				-807.64 -2217.16	.4353 .1693								
Y_4																	
Y_5	.1439 .0021			-.000000248 -.000000844	.5321 .2079	.6057 .3953								.2100 .0750	.0000616 .0000152		
Y_6	.0790 .0243					.0299 -.0053	.8824 .7308			.0646 .0238	.0038 -.0288						
Y_7	.2470 -.0374	.0262 .0134			-.00001 -.00009	-.0512 -.4512		.2021 -.0190	-.00043 -.00063							.00354 .00026	
Y_8	.0019 -.0003			-.000000059 -.000000011			.000000059 .000000009	.00200 -.00007	1.0082 .9383		.0011 .0004						
Y_9	.0075 -.0021	.0025 .0015		-.00000020 -.00000018				.0178 .0060		.9367 .8617	.0178 .0010						
Y_{10}	.1307 -.0455				.000015 .000005			.0809 .0171	.00015 .00004		.6058 .3716			.1948 .0001			
Y_{11}	.1807 -.0708			.00002 -.00010				.4464 .2374	.00001 -.00007		.2676 .0246	.5025 .2341					
Y_{12}	.6037 .5539						.000047 .000031		-.0000155 -.0000269		.0012 .0011	-.0086 -.0286	.4532 .4032				.0666 .0322

*Bidirectional elasticities of Imports with respect to GNP for the 325 European dyads are presented in Chapter 4 of this report, "International Trade."

do in fact hold, there is a 95 percent certainty that the true parameter estimates lie within those ranges.

Of course, there is some certainty that those assumptions of statistical theory are actually violated in the analysis of this particular problem. Since the estimates were derived from data for 1950 to 1970 and are used to generate forecasts up to 1995, an important implicit assumption is that the relevant phenomena occurring during the 1950-1970 period can be treated as a random sample of the phenomena occurring in the 1950 to 1995 time frame. Although this assumption is probably invalid for most of the variables under examination here, in most cases we have little knowledge or intuition upon which to base "guesses" about the direction of bias in the associated parameters. For a few of the variables, however, estimates of the direction of parameter bias are possible. For example, the gross national product of European countries, particularly of Western European nations, rose dramatically during the period 1950-1970 as postwar reconstruction resulted in nearly constantly booming economies. As the industrial bases of the European countries were rebuilt following the devastation of World War II, energy consumption also increased substantially. It seems unlikely that these high rates of growth will continue indefinitely, particularly as energy and raw material shortages begin to have greater impacts on the economies of highly industrialized nations. We suggest, then, that the "true" parameter value relating GNP to previous gross national product levels lies toward the lower end of the estimated parameter range. Future growth rates in energy consumption will probably also lie near the bottom of the estimated range for the β_{22} parameter.

During the 1950-1970 period, the European nations relied to a great extent upon the United States and the Soviet Union for assistance in defense matters. With few exceptions, their defense establishments are inconsistent with the levels of conflict experienced in Europe during that period and with the presently declining willingness of the superpowers to absorb the bulk of the defense burden. We would expect, then, that the rate of growth in European defense budgets and manpower levels will be somewhat higher in the long-range future than previous experience would suggest. Given this assumption, the parameters relating defense spending to previous levels of defense expenditures and manpower levels to previous manpower levels probably lie toward the upper end of the estimated parameter ranges.

Of course, these few examples constitute but a small portion of the nearly 60 parameter estimates included in this forecasting model. For most of the others, intuition provides little guide as to the expected position of the true parameter value within the estimated range. The value of simulation experimentation lies in its ability to approach this question in a more systematic manner. That experimentation allows the use of alternative parameters within the estimated ranges to produce alternative forecasts. Evaluation of the various forecasts can be used to judge the credibility of the parameter estimates of the associated forecasting model.

SIMULATING THE FORECASTING MODEL

We noted that two particular characteristics of the assumptions of a forecasting model are evaluated in the simulation process: their sensitivity and their stability. Sensitivity refers to the quantity of change in the central environmental descriptor produced by a given parameter and its associated predictor variable. While parameters should produce some effect on the descriptor variables, that effect should be less than unity with respect to the descriptor variable. That is, a single parameter should not produce a greater than 100 percent change in the value of a descriptor in a single time period.

Stability, on the other hand, refers to the patterns of change produced by parameters. A parameter that produces wild fluctuations or unrealistically steep growth curves is unstable, while a parameter producing monotonically increasing growth or decline in the descriptor value is extremely stable. Depending on the particular substantive consideration, most parameters should lie somewhere between these conditions. For example, population growth should be rather stable, but not without some fluctuation, while levels of international conflict should fluctuate substantially more from one time period to the next. Each of these characteristics is examined in more detail below with respect to the particular parameter estimates generated in this effort.

Sensitivity

None of the parameters shown in Table 1 produces a greater than 100 percent change in the value of a central environmental descriptor in a single time period. Although the parameter relating turmoil to gross national product is rather large, turmoil values typically fall at or below 1.0 while GNP values are in millions of dollars. Thus, even the extreme of the estimated parameter range (-2217.16) will produce no more than a 60 percent decrease in GNP. On the other end of the spectrum, many parameter estimates appear so small as to effect virtually no change in the associated central environmental descriptor. Parameters relating gross national product to distribution of major-power alignment (-.000000844 to -.000000248), defense spending as a percentage of GNP (-.000000011 to -.000000059), and military manpower levels (-.00000018 to -.00000020) fall into this category, as does the parameter relating extent of major-power alignment to defense spending as a percentage of GNP (.000000009 to .000000059). Except for the last of these, the small values are artifacts of the scaling of the variables in the relationships, where GNP is expressed in millions of dollars and the predicted descriptor components fall within the range 0.0 to 1.0.

Since the extent of nations' major-power alignments varies between 0.0 and 1.414, the parameter linking extent of alignment to defense spending as a percentage of GNP must have a value of at least .015 (assuming a defense spending of 5 percent of GNP and an alignment score of .70). The actual maximum of this parameter range estimate, .000000059, is far less than that required for maximum acceptable sensitivity. It is low enough, in fact, that this parameter can be viewed as nearly insensitive. That is, the tendency for nations to align themselves with major powers has little substantive impact on their levels of defense spending, despite the fact that the relationship between these variables has been previously regarded as theoretically important and is, for the European region, statistically significant.

There are many possible substantive and statistical explanations for the negligible effect of major-power alignment upon defense spending. Transforming the defense-spending variable into another scale would, of course, increase the size of this parameter; yet we are evaluating the parameter size relative to the scaling of the two variables. A transformation of this sort, then, would not change the relative potence of the parameter relating alignment to defense expenditures. A second possible explanation for this small parameter is that the variance in common between alignment and defense expenditures is also shared by one of the other predictors in the defense-spending equation--gross national product, turmoil, conflict, or some combination of those predictors. Analysis of Table 1, however, reveals that extent of major-power alignment was not significantly related, in a predictor equation, to either of these three central environmental descriptor components. However, conflict and defense spending are both predictors of extent of alignment. The size of a nation's military establishment combined with the level of its experienced international conflict help determine the extent of its alignment with the United States and the Soviet Union.

Of course, the substantive interpretation of these relationships could run in either direction: alignment and conflict could cause defense spending or defense expenditures and conflict could cause alignment. While high levels of experienced conflict are likely to drive up defense spending, military expenditures are unlikely to be systematically related to alignment in the absence of conflict, or controlling for conflict. It seems more likely that those nations experiencing intense conflict, and consequently increasing the size of their military establishments, will look for allies to strengthen their positions in those conflictual situations.

Analyses of the sensitivity of the parameters of the long-range forecasting model, then, reveal that nearly all the parameter estimates have acceptable levels of sensitivity. Only the parameter relating gross national product to turmoil appears potentially too sensitive, and in this case the scalings of the gross national product and turmoil variables allow that large parameter estimate without producing an overly sensitive equation with respect to turmoil levels. Three parameter estimates relating gross national product to the distribution of major-power alignments, defense spending as a percentage of gross national product, and military manpower were so small as to appear potentially insensitive. In these cases, the size of the parameters was a result of vast differences in the scalings between GNP and these three components of the central environmental descriptors. In only one case, the parameter estimate relating extent of major-power alignment to defense spending as a percentage of GNP, is a parameter potentially insensitive. Although the relationship between these variables is theoretically important and statistically significant, extent of alignment is a rather weak determinant of military spending over the long range.

Stability

Analyses of parameter stability are directed at the form of the relationships included within the forecasting model. A parameter that produces wild fluctuations or unrealistically sharp growth or decline in the values of a descriptor component is viewed as too unstable for use in a forecasting model that must undergo numerous iterations to produce long-range forecasts. On the other hand, parameters producing monotonically increasing growth or decline in the values of a descriptor component may be too stable, depending on the substantive role of the descriptor component within the forecasting model.

One equation in the model, the equation for energy consumption (Y_2), approaches perfect stability. Future values of energy consumption are forecast solely on the basis of previous levels of energy consumption. Once initialized values of energy consumption are input into the model for the 26 European countries, their relative levels of consumption of nonhuman energy sources are fixed over the long range. We view energy consumption, however, as a variable describing the structure, rather than the process, of economic life in the European countries. Energy consumption reflects the extent to which an economy is industrialized and the extent to which its agricultural sector is mechanized. Although energy consumption also reflects nation size and the level of economic activity in a country, these characteristics are tapped by the population and gross national product components of the economic dimension of national power base. To the extent that energy consumption does in fact tap a residual factor that reflects the structure of nations' economies, we expect rather constant relative levels of energy consumption among the European countries. That is, while all nations are expected to experience both increased levels of economic activity and population growth, hence increasing the demands for energy, the relative industrialization and agricultural mechanization of the European economies are expected to remain rather constant. Thus, the extreme stability of the energy consumption equation is particularly desirable given the structural conceptualization of that variable.

A second equation, that for population, is nearly as stable as the energy consumption equation. Population is forecast as a function of previous population size and changes in per capita gross national product. Nations are expected to show slower population growth rates as their levels of economic wealth increase. Of course, in the absence of catastrophic events, population is extremely unlikely to shift dramatically from one year to the next. Although rising wealth will produce lower rates of population growth, the effect of this change on forecasts of population size will be rather slow. Thus, the stable nature of this equation seems rather desirable in terms of actual fluctuations in population size in developed countries.

When simulating the interactive forecasting model, two equations produce forecasts that suggest that those equations are highly unstable. The first of these, the equation for defense expenditures, produces widely fluctuating values because of its nonlinearity. We noted earlier the nonlinear equations were used for three variables--population, gross national product, and international trade--about which a great deal of social science theory and empirical research exists. In these cases, the conceptualizations and operationalizations of the descriptor components and the specification of their forecasting equations are strong and well accepted. In addition, data on gross national product, population, and trade are accurate enough so that nonlinear models can be used with some credibility. With regard to defense expenditures, however, there is a notable lack of the theory needed for strong conceptualization and operationalization, particularly in the distinction between external defense forces and internal security forces directed at population control. Additionally, data on defense expenditures are generally less reliable than economic and demographic data, due in part to the desire of many governments to withhold specific information for national security reasons. Accordingly, the defense expenditure forecasting equation was respecified in a linear form such that,

$$Y_8 = \beta_{80} + \beta_{88} Y_{8_{t-1}} + \beta_{810}\left(Y_{10_{t-1}} * Y_6\right) + \beta_{83} Y_3 + \beta_{81}\left(\frac{Y_3}{Y_1}\right)$$

where:

$\beta_{80} = 5.92390$

$\beta_{88} = .91530$

$\beta_{810} = 22.05700$

$\beta_{83} = .00445$

$\beta_{81} = -.00596$

and:

Y_8 = Defense Expenditures (DEFEX)

Y_{10} = Monadic Conflict (MCONFLICT)

Y_6 = Extent of Alignment (ALIGNR)

Y_3 = Gross National Product (GNP)

Y_1 = Population (POP)

Each parameter estimate in this revised equation is significant at the $p < .05$ level, the F-statistic for the equation as a whole is 5311.0 (significant at the $p < .0001$ level), and the equation accounts for more than 99 percent of the observed variance in defense spending among the 26 European countries. Substitution of this equation into the forecasting model in place of the initial defense-spending equation results in forecasts with much greater year-to-year continuity, a characteristic reflecting the incrementalism that often pervades the budget-making process, particularly in Western nations, and tends to offset the impact of poor data for Eastern European countries as well.

The second equation in the forecasting model that exhibits high instability is the monadic conflict equation. The difficulty in this case is that all of the estimated parameter ranges are positive. Thus, the lack of any restraining influence in the conflict equation results in extremely steep and uncontrolled growth in the levels of conflict for the European nations. An alternative equation, also acceptable on theoretical and statistical grounds, was substituted into the forecasting model so that:

$$Y_{10} = \beta_{100} + \beta_{1010} Y_{10_{t-1}} + \beta_{108} \left(f \left(\left(Y_8 + Y_9 \right) \frac{Y_8}{Y_9} \right) \right) +$$

$$\beta_{103} \left(f \left(\left(Y_{3_{t-1}} + Y_{2_{t-1}} + Y_{1_{t-1}} \right) \frac{Y_{3_{t-1}}}{Y_{1_{t-1}}} \right) \right)$$

where:

β_{100} = .103300

β_{1010} = .512600

β_{108} = -.000125

β_{103} = .002300

and:

Y_{10} = Monadic Conflict (MCONFLICT)

Y_8 = Defense Expenditures (DEFEX)

Y_9 = Military Manpower (MIL MANPOW)

Y_3 = Gross National Product (GNP)

Y_2 = Energy Consumption (EN CONS)

Y_1 = Population (POP)

For this substitute equation, each parameter estimate is significant at the $p < .05$ level, the F-statistic equals 133.24 (significant at the $p < .001$ level), and the explained variance in monadic conflict is over 60 percent. The substitute conflict equation contains parameter estimates that are both positive and negative. Thus, amplifying and attenuating influences are placed upon monadic conflict in the forecasting process. If monadic conflict, unlike country characteristics, is assumed to fluctuate in response to situational changes and to be dominated by negative feedback controls, this substitute equation is a more realistic representation of conflict patterns.

In addition, several parameter estimates relating military manpower, defense expenditures, gross national product, and international trade as predictors of other central environmental descriptors were adjusted within their confidence intervals to offset the effects of known biases in the data sample used for estimation. As we noted above, those estimates were obtained from data for 1950 to 1970 which, for those variables, cannot be considered a random sample of the 1950-1995 time period. The growth patterns of these variables over the 1950-1970 period are known and reasonable expectations about future growth patterns are generated. Thus, the parameters that relate these variables to others can, in certain cases, be adjusted in accordance with these expectations to produce forecasts with more reliable boundaries than would result simply from the application of the results of statistical analysis of past data. Table 2 shows the nine parameter estimates that were adjusted within the boundaries of their 95 percent confidence intervals.

With these structural changes and parameter estimate adjustments, the long-range environmental forecasting model exhibits stability appropriate to the conceptualizations of the variables included within it and is consistent with our broad expectations about the future behavior of these variables.

TABLE 2

ADJUSTMENTS IN PARAMETER ESTIMATES

Parameter	Initial Estimate	Adjusted Value
β_{99}	.8992	.9367
β_{93}	-.000000188	-.000000087
β_{108}	-.000125	-.000196
β_{103}	.0023	.0014
β_{70}	.1048	.2470
β_{78}	-.00063	-.00053
β_{74}	-.00005	-.0000054
β_{97}	.0119	.0089
β_{100}	.1033	.0774

Summary

The initial model is derived from substantive social science theory and previous empirical analyses in the social sciences, and its parameters, or assumptions, are estimated in a manner consistent with statistical theory. This initial model is then simulated and additional validation criteria, drawn from cybernetic theory, are applied to it. The resulting forecasting model is based upon five sets of interrelated assumptions, each set detailing the determinants of a central environmental descriptor.

1. A nation's national power base can best be viewed as composed of two dimensions: economic and military. The economic dimension of national power base, measured by population, GNP, and energy consumption, is largely

self-contained; economic variables are, by and large, influenced by other economic variables. Defense spending, however, contributes to growth in GNP while domestic instability drains a nation's economy. The military dimension of national power base is much more sensitive to the situations a nation experiences in the international environment. Defense spending and military manpower are affected by international conflict. In addition, a nation's military establishment responds to the domestic conditions experienced by a country: both measures of military power base respond to changes in the level of a country's income, or GNP, and to changes in domestic unrest within the nation.

2. A nation's international trade is best viewed as a result of its general level of economic activity. Large and wealthy countries are consistently the world's most extensive traders. As nations' levels of GNP increase, their levels of international trade also increase.

3. International alignment with major powers can be considered a rather stable and persistent pattern of behavior for nation-states. Nations' levels of wealth and their patterns of international trade affect their alignment patterns. Moreover, nations that have large military establishments are also most strongly aligned with the major powers in the European region.

4. In contrast to alignment patterns, domestic instability within nations is heavily influenced by peculiar situations and personalities. Nonetheless, there exist some rather potent determinants of the potential for internal unrest within nations. International trade and international alignment both reduce the potential for internal instability in the European nations. As nations become more closely tied together economically and politically, the likelihood of extreme internal dissension decreases. Moreover, as nations' military establishments increase in size and sophistication, their ability to suppress domestic unrest increases. Internal instability decreases when suppression capabilities rise substantially. High levels of international conflict, particularly as they persist over time, contribute to internal strife within nations. Unrest within countries is in part a reaction to the strains created by continued high levels of conflict between nations. Finally, patterns of behavior

within nations are, to a limited extent, rigid over time. Some nations typically experience internal instability under conditions of strain while others traditionally resolve these problems by more formal means. Knowledge about the past patterns of behavior in a country and the expected conditions within that country in the future can be used to forecast effectively the potential for internal unrest within the nation.

5. Finally, international conflict, like internal instability, depends in part upon the effects of unique situations and personalities. The potential for high levels of international conflict, however, is affected by other international and domestic processes. Nations that are large and wealthy and which traditionally have been active in international politics have the greatest potential for engaging in international conflict. However, as the size and sophistication of those nations' military establishments increase, they will exhibit restraint in their international interactions and the intensity of their conflict experiences will decrease. The potential for destruction acts as a moderating force in international affairs.

These five sets of assumptions about the relationships among important environmental variables were used to forecast five central environmental descriptors for the European region for the period 1985 through 1995. Those forecasts are presented in the next section of this chapter.

ENVIRONMENTAL FORECASTS FOR THE EUROPEAN REGION

This section of the chapter presents forecasts of the long-range European environment. The presentation of those forecasts takes an ordinal form because we view the concepts and methodologies utilized in this effort as most appropriate for comparing the European countries in terms of the components of the central environmental descriptors. Forecasts are presented for three time points during the long-range future: 1985, 1990, and 1995. The presentation is divided into five subsections, one for each central environmental descriptor.

National Power Base

Table 3 shows rankings of the 26 European nations on the economic dimension of national power base (EPB) for 1985, 1990, and 1995. These forecasts suggest that the large, wealthy nations will continue to have the bulk of economic power in Europe during the long-range future. As Table 3 suggests, the only significant change in relative economic power during the forecast period occurs for Sweden. Examination of two important components of economic power base, gross national product (Table 4) and GNP per capita (Table 5), reveals that Sweden leads the European countries during the forecast period in per capita GNP, while gross national product, which reflects country size as well as relative wealth, is dominated by the larger powers of Europe. In fact, Swedish per capita GNP grows so much faster than that of other countries during the forecast period that, size notwithstanding, its relative economic power should be expected to increase rather dramatically.

Rank values of gross national product (see Table 4) remain nearly constant over the long-range forecast period. Only four countries--Yugoslavia, Switzerland, Hungary, and Denmark--show any change in rank during that 11-year period, and those changes are limited to a single rank. Those countries that today are the largest and strongest economic powers--the Soviet Union, West Germany, France, the United Kingdom, and Italy--retain the top five ranks in gross national product during the forecast period.

TABLE 3

RANKINGS OF THE 26 EUROPEAN NATIONS ON ECONOMIC POWER BASE

1985	1990	1995
Soviet Union	Soviet Union	Soviet Union
West Germany	West Germany	West Germany
France	France	France
United Kingdom	United Kingdom	United Kingdom
Italy	Italy	Sweden
East Germany	East Germany	East Germany
Czechoslovakia	Sweden	Italy
Sweden	Czechoslovakia	Czechoslovakia
Poland	Poland	Poland
Netherlands	Netherlands	Netherlands
BLEU[a]	BLEU	BLEU
Switzerland	Switzerland	Switzerland
Romania	Denmark	Denmark
Denmark	Romania	Romania
Norway	Norway	Norway
Spain	Hungary	Hungary
Hungary	Spain	Spain
Yugoslavia	Yugoslavia	Yugoslavia
Austria	Austria	Austria
Bulgaria	Bulgaria	Bulgaria
Finland	Finland	Finland
Greece	Greece	Greece
Turkey	Turkey	Portugal
Portugal	Portugal	Turkey
Ireland	Ireland	Ireland
Iceland	Iceland	Iceland

[a] Belgium/Luxembourg. Hereafter BLEU.

Per capita GNP, however, is dominated by the Scandinavian countries--Sweden, Norway, and Denmark-- and by Switzerland. Although these four nations shift some rank positions during the forecast period,

TABLE 4

RANKINGS OF THE 26
EUROPEAN NATIONS ON GNP

1985	1990	1995
Soviet Union	Soviet Union	Soviet Union
West Germany	West Germany	West Germany
France	France	France
United Kingdom	United Kingdom	United Kingdom
Italy	Italy	Italy
Poland	Poland	Poland
East Germany	East Germany	East Germany
Czechoslovakia	Czechoslovakia	Czechoslovakia
Sweden	Sweden	Sweden
Netherlands	Netherlands	Netherlands
Spain	Spain	Spain
Romania	Romania	Romania
BLEU	BLEU	BLEU
Yugoslavia	Yugoslavia	Switzerland
Switzerland	Switzerland	Yugoslavia
Hungary	Hungary	Denmark
Denmark	Denmark	Hungary
Austria	Austria	Austria
Norway	Norway	Norway
Bulgaria	Bulgaria	Bulgaria
Finland	Finland	Finland
Greece	Greece	Greece
Turkey	Turkey	Turkey
Portugal	Portugal	Portugal
Ireland	Ireland	Ireland
Iceland	Iceland	Iceland

they retain the top four ranks in GNP per capita from 1985 until 1995. Two other aspects of the distribution of per capita GNP also deserve special attention. First, throughout the forecast period, East German wealth is higher than West German GNP per capita. This, of course,

TABLE 5

RANKINGS OF THE 26
EUROPEAN NATIONS ON GNP/POP

1985	1990	1995
Sweden	Sweden	Sweden
Norway	Norway	Norway
Switzerland	Denmark	Denmark
Denmark	Switzerland	Switzerland
Czechoslovakia	Czechoslovakia	Czechoslovakia
BLEU	BLEU	BLEU
East Germany	East Germany	East Germany
West Germany	West Germany	West Germany
France	France	France
Netherlands	Netherlands	Netherlands
Soviet Union	Finland	Finland
Finland	Soviet Union	Soviet Union
United Kingdom	Austria	Austria
Austria	Hungary	Hungary
Hungary	United Kingdom	United Kingdom
Iceland	Iceland	Bulgaria
Bulgaria	Bulgaria	Ireland
Poland	Ireland	Iceland
Italy	Poland	Poland
Ireland	Italy	Romania
Romania	Romania	Italy
Yugoslavia	Greece	Greece
Greece	Yugoslavia	Yugoslavia
Spain	Spain	Spain
Portugal	Portugal	Portugal
Turkey	Turkey	Turkey

differs substantially from the present situation in which West Germany has a considerably higher standard of living than East Germany. Second, two of the larger European powers, the Soviet Union and the United Kingdom, show consistent decreases in relative levels of wealth during the forecast period. Relative to their size, then, these nations' economies are not expanding as rapidly as are smaller European powers, particularly the Scandinavian countries.

Table 6 shows mean economic power-base scores by alliance membership and alignment group.[1] Although the mean EPB score for Soviet-bloc countries is more than twice that of the Western European nations, the bulk of that is a function of the size and strength of the Soviet Union

TABLE 6

MEAN ECONOMIC POWER-BASE SCORES BY ALLIANCE MEMBERSHIP AND ALIGNMENT GROUP

	1985	1990	1995
Warsaw Pact	341.98	407.05	488.02
NATO	141.81	177.83	227.45
Nonmembers	63.10	82.48	92.31
Aligned with Soviet Union	341.98	407.05	488.02
Aligned with United States	158.86	200.39	257.27
Nonaligned/Multialigned	26.15	33.60	43.07

itself. Excluding the Soviet Union, Warsaw Pact EPB mean scores are 98.22 for 1985, 125.90 for 1990, and 160.90 for 1995, barely two-thirds of the mean scores for the Western European nations.

[1] Nonmembers of alliances are those nations that belong to neither the Warsaw Pact nor the North Atlantic Treaty Organization. This group includes Austria, Sweden, Switzerland, Finland, Spain, and Yugoslavia. Alignment groups were determined according to nations' scores

One rather interesting aspect of the economic power-base forecasts is the difference in growth in economic power base between the Soviet-bloc countries and the Western European nations aligned with the United States. Including the Soviet Union, the Warsaw Pact countries possessed 52 percent of the economic power in Europe during 1985 while the NATO countries had 40 percent. By 1995, this difference had been reduced to 6 percent, 49 percent versus 43 percent. In 1970, the relative distribution of economic power within Europe mirrored the 1985 situation; the dramatic changes, then, occur during the long-range forecast period. Of course, this set of changes is a function of differential growth rates in economic power base for the two alliance groups. While the Warsaw Pact countries experience a 1.9 percent rate of growth of economic power base from 1985 to 1995, the NATO nations' growth rate is a substantially higher 2.6 percent. Nonmembers of alliance groups, in contrast, experience a 2.1 percent rate of growth in economic power, very similar to the rates for the Warsaw Pact.

A second particularly interesting aspect of the relative rates of change in economic power base between alliance groups is the impact of the Soviet Union's growth rate upon the mean scores for the Warsaw Pact countries. Including the Soviet Union, these nations show a growth rate of about 1.9 percent in economic power during the 10 years. If the Soviet economy is excluded from the calculations, the rate of growth for the Warsaw Pact countries jumps to 2.8 percent during that same time period.

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on ALIGN θ during the forecast period. Countries with scores greater than .55 were classified as aligned with the Soviet Union. This includes Poland, Romania, East Germany, Hungary, Bulgaria, Czechoslovakia, and, of course, the Soviet Union. Countries with scores between .40 and .55 were classified as nonaligned or multialigned. This group includes Turkey, Spain, Greece, Portugal, Austria, and Finland. The other 13 nations included in this study had scores of less than .40 and were classified as aligned with the United States.

Thus, the Soviet economy tends to stagnate somewhat during the long-range forecast period while the economies of its Eastern European allies evidence rather extensive expansion.

Examination of the alignment groupings reveals that the pattern of distribution of economic power during the long-range future is quite similar to that of alliance groupings. Of course, there exists an extensive overlap between these two classifications, with all Warsaw Pact members retaining alignments with the Soviet Union during the forecast period. Moreover, very few present NATO members become nonaligned or multialigned by 1995, and only two current nonmembers of the alliances, Sweden and Yugoslavia, become allies of the United States. The patterns for alignment groupings, then, are very similar to those evidenced by the alliance groups.

Military power-base rankings for the 1985 to 1995 forecast period show the same kind, and nearly the same degree, of stability as do the economic power-base rankings. As Table 7 shows, the Soviet Union, West Germany, France, the United Kingdom, and Italy retain the top five positions in military power for the entire 11-year period. Sweden, in fact, is the only nation evidencing dramatic shifts in its military power-base ranking from 1985 to 1995, moving from ninth rank in 1985 to sixth rank in 1995. The Swedish increase is due to increasing levels of defense spending relative to manpower levels; the level of training and equipment available to the Swedish armed forces, always high, is expected to increase rather dramatically, partly because of that nation's increased level of income during the long-range future.

Table 8 shows mean military power-base scores by alliance membership and alignment groupings. Of course, the extremely high scores

TABLE 7

RANKINGS OF THE 26 EUROPEAN NATIONS ON MILITARY POWER BASE

1985	1990	1995
Soviet Union	Soviet Union	Soviet Union
West Germany	West Germany	West Germany
France	France	France
United Kingdom	United Kingdom	United Kingdom
Italy	Italy	Italy
East Germany	East Germany	Sweden
Poland	Sweden	East Germany
Czechoslovakia	Czechoslovakia	Czechoslovakia
Sweden	Poland	Poland
Netherlands	Netherlands	Netherlands
BLEU	BLEU	BLEU
Spain	Romania	Romania
Romania	Spain	Spain
Switzerland	Switzerland	Switzerland
Yugoslavia	Yugoslavia	Yugoslavia
Hungary	Hungary	Hungary
Denmark	Denmark	Denmark
Austria	Austria	Austria
Norway	Bulgaria	Bulgaria
Bulgaria	Norway	Norway
Greece	Greece	Finland
Finland	Finland	Greece
Turkey	Turkey	Turkey
Portugal	Portugal	Portugal
Ireland	Ireland	Ireland
Iceland	Iceland	Iceland

for the Warsaw Pact countries and those nations aligned with the Soviet Union result from the inclusion of the Soviet Union in that group. Excluding the Soviet Union, the mean military power-base scores for the Warsaw Pact group and those nations aligned with the Soviet Union are 230.19 in 1985, 307.98 in 1990, and 429.68 in 1995.

TABLE 8

MEAN MILITARY POWER-BASE SCORES BY ALLIANCE MEMBERSHIP AND ALIGNMENT GROUP

	1985	1990	1995
Warsaw Pact	1354.88	1562.72	1923.72
NATO	434.67	587.06	870.23
Nonmembers	146.82	204.23	300.27
Aligned with Soviet Union	1354.88	1562.72	1923.72
Aligned with United States	469.22	637.72	949.66
Nonaligned/Multialigned	71.96	94.47	128.15

Even with the inclusion of the Soviet military establishment, the gap between Warsaw Pact nations and NATO countries decreases substantially during the forecast period. In 1985, the Warsaw Pact countries possess 59 percent of the total military power in the European region while the NATO nations have but 35 percent. (The U.S. military establishment is not included in the NATO calculations.) By 1995, the gap between these two groups narrows to 9 percent, with the Warsaw Pact countries possessing 51 percent of the military power in the European region and the NATO nations 42 percent. Nonmembers of the two alliance groups have 7 percent of the military power by 1995.

An examination of the forecast alignment groupings reveals the same general patterns. At the beginning of the forecast period those nations aligned with the Soviet Union (including the Soviet Union) possess 59 percent of the region's military power while those nations aligned with the United States possess 38 percent. This gap closes even more than the NATO/Warsaw Pact gap during the forecast period, with the difference in military power between the two groups being 51 percent and 46 percent respectively by 1995. The primary reason for this difference is that Sweden, which is not a member of NATO, is forecast to be aligned with the United States during the long-range future and experiences considerable growth in its military establishment relative to other European nations.

Table 9 shows estimated propensities to develop nuclear weapons for the European nations during the 1985 to 1995 time period. These estimates are based on the assumption that a non-nuclear country will develop its own weapons rather than acquire them from a nuclear power. The capabilities for nuclear weapons development were measured using the economic power-base score, while the impetus for development was measured with international conflict and major-power alignment scores. Thus, these estimates are tied to the long-range forecasts of three central environmental descriptors: national power base, international alignment, and international conflict.

As Table 9 suggests, West Germany is the only European nation likely to develop nuclear weapons during the long-range future examined in this forecasting effort. The rather high, and dramatically increasing, West German propensity to develop nuclear weapons is fundamentally a function of its large and growing economic power base. Between 1985 and 1990, West Germany's propensity to develop nuclear weapons increases from 52 to 77 percent. During that time, the West German economic power base increases by 24 percent while West German conflict increases by only 8 percent and extent of major-power alignment continues to show a 3 percent decline. The increased propensity to

TABLE 9

PROPENSITY TO DEVELOP NUCLEAR WEAPONS

Country	Percent		
	1985	1990	1995
United Kingdom[a]	100.0	100.0	100.C
Austria	0.3	0.5	0.7
BLEU	1.7	2.9	4.6
Denmark	0.8	1.3	2.1
France[a]	100.0	100.0	100.0
West Germany	51.7	76.5	99.6
Italy	4.3	6.1	8.3
Netherlands	1.8	2.9	4.8
Norway	0.6	1.0	1.6
Sweden	3.9	6.6	11.5
Switzerland	0.8	1.4	2.2
Finland	0.2	0.4	0.6
Greece	0.1	0.1	0.2
Iceland	0.0	0.0	0.0
Ireland	0.0	0.1	0.1
Portugal	0.0	0.1	0.1
Spain	0.4	0.6	0.9
Turkey	0.0	0.0	0.1
Yugoslavia	0.4	0.5	0.8
Bulgaria	0.3	0.4	0.7
Czechoslovakia	3.8	6.5	10.7
East Germany	4.1	6.8	11.3
Hungary	0.5	0.8	1.2
Poland	2.4	3.6	5.5
Romania	0.7	1.0	1.5
Soviet Union[a]	100.0	100.0	100.0

[a] For countries already possessing nuclear weapons, the propensity is set to 100 percent.

develop nuclear weapons, from 77 percent in 1990 to 99 percent in 1995, reflects the 50 percent growth in economic power base experienced by West Germany during that period.

Only three other nations evidence a greater than 10 percent propensity to develop nuclear weapons during the forecast period. By 1995, the Swedish propensity to develop nuclear weapons is 11.5 percent while Czechoslovakia shows a 10.7 percent score and East Germany an 11.3 percent nuclear propensity. For most European countries, the propensity to develop nuclear weapons during the long-range future stays at or below 1 percent. Only West Germany, then, is likely to become a member of the nuclear club by 1995.

Clearly, the distribution of economic and military power in the European region remains, during the long range, quite similar to presently observed distributions of national power. The Soviet Union remains the overwhelming power in the region, followed by West Germany, France, the United Kingdom, and Italy. During the forecast period, Sweden's economic and military power increase dramatically so that by 1995 that nation ranks fifth in economic power (ahead of East Germany and Italy) and sixth in military power (below the five nations listed above). One rather interesting and important change does occur in the distribution of economic and military power between alignment blocs. In 1985, the Soviet-bloc countries, including the Soviet Union itself, possess the preponderance of both economic and military power in the European region. By 1995, however, economic and military power are shared nearly equally among those countries and the Western European allies of the United States.

Internal Instability

While internal instability was initially conceptualized as involving two distinct, though related, dimensions, our findings suggest that turmoil (riots and demonstrations) and revolt (armed attacks against public institutions) reflect the same kind of domestic unrest but with different intensity. In fact, the relationship between these two sets of phenomena is so strong that each is the most potent predictor of the other. As we noted in Chapter 3 of this volume, one form of instability is very likely to be accompanied by the other; revolt, in the European context, is an exacerbated form of turmoil that, under particular economic, social, and political conditions, is likely to develop out of turmoil.

We also noted in Chapter 3 that the distinction between turmoil and revolt rested upon a rather well-developed body of theoretical and empirical analysis of domestic unrest. We suggested that the generalizability of this forecasting model is enhanced by retaining the theoretical and analytic distinctions between the two, and by generating forecasting models for each level of domestic unrest. Since the empirical analyses undertaken in this effort suggested that the distinctions between turmoil and revolt were distinctions of intensity rather than form, we report here on a combined measure of internal instability, domestic strife. Domestic-strife scores are generated by summing the turmoil and revolt scores forecast for each nation during the long-range future.

Table 10 presents rankings of the 26 European countries on domestic strife scores for 1985, 1990, and 1995. Of particular interest is the fact that four large European powers--the Soviet Union, the United Kingdom, France, and West Germany--have rather high levels of instability at the initiation of the forecast period, 1985. This is because

TABLE 10

RANKINGS OF THE 26
EUROPEAN NATIONS ON DOMESTIC STRIFE

1985	1990	1995
Soviet Union	Soviet Union	Turkey
Italy	Turkey	Spain
Turkey	Spain	Italy
Spain	Italy	Poland
United Kingdom	Poland	Greece
Poland	Greece	Soviet Union
Greece	Yugoslavia	Romania
Yugoslavia	Portugal	Portugal
West Germany	Romania	East Germany
France	East Germany	Hungary
Portugal	United Kingdom	Iceland
Romania	Hungary	Yugoslavia
East Germany	Iceland	Bulgaria
Hungary	Austria	Norway
Czechoslovakia	Czechoslovakia	Austria
Switzerland	Ireland	Czechoslovakia
Austria	Bulgaria	Finland
Netherlands	Norway	Denmark
Ireland	Switzerland	Ireland
Iceland	Denmark	Switzerland
Norway	Finland	United Kingdom
Denmark	West Germany	BLEU
Finland	France	France
Bulgaria	Netherlands	West Germany
BLEU	BLEU	Netherlands
Sweden	Sweden	Sweden

these are large countries with histories of extensive domestic unrest. Between 1985 and 1995, however, the military power bases of these four nations increase substantially, in part as a response to external conflict pressures. As military capabilities rise, internal strife in these four countries decreases accordingly. Thus by 1995 the Soviet

Union ranks sixth on internal strife scores while France, West Germany, and the United Kingdom are among those European nations with the least domestic unrest.

Two smaller European countries, Iceland and Bulgaria, have rather low levels of internal strife at the beginning of the forecast period. This is primarily because they are small and typically peaceful nations. Relative to other European nations, however, their military power bases stagnate between 1985 and 1995. As a result, they evidence substantially higher relative levels of domestic unrest in 1995 than they did previously. By 1995, both countries have average, as opposed to low, levels of domestic unrest.

Tables 11 through 13 rank nations on domestic strife within alignment groups: nations aligned with the Soviet Union, nations aligned with the United States, and nonaligned and multialigned countries. Within the Soviet-bloc countries, relative rankings on domestic strife remain rather stable during the forecast period. The important exception to this, of course, involves the Soviet Union and Poland. In 1985 and 1990, the Soviet Union has the most extensive domestic unrest of that group of nation ; but by 1995, Poland experiences more pronounced strife than the Soviet Union. This result is due to decreases in Soviet domestic unrest that accompany its increasing military capabilities rather than increases in internal strife in Poland.

Within the group of nations aligned with the United States, Italy experiences the most persistent and pervasive domestic unrest while Sweden is the most free of internal strife. Several nations, however, show marked changes in relative levels of instability during the 1985 to 1995 period. As we noted earlier, France, West Germany, and the United

TABLE 11

RANKINGS OF THE 26 EUROPEAN NATIONS ON DOMESTIC STRIFE BY ALIGNMENT GROUP, 1985

Aligned with Soviet Union[a]	Nonaligned/ Multialigned[b]	Aligned with United States[c]
Soviet Union	Turkey	Italy
Poland	Spain	United Kingdom
Romania	Greece	Yugoslavia
East Germany	Portugal	West Germany
Hungary	Austria	France
Czechoslovakia	Finland	Switzerland
Bulgaria		Netherlands
		Ireland
		Iceland
		Norway
		Denmark
		BLEU
		Sweden

a $1.0 \geq ALIGN\theta > .55$

b $.40 < ALIGN\theta < .55$

c $.40 > ALIGN\theta \geq 0.0$

Kingdom evidence substantial decreases in relative levels of strife between 1985 and 1995, due primarily to increased military capabilities. Iceland, and to some extent Norway, become substantially more strife-ridden during the forecast period as a function of stagnant military establishments. The relative positions of the other Western European allies of the United States remain rather constant over the 10-year period.

The nonaligned and multialigned countries evidence surprising stability

TABLE 12

RANKINGS OF THE 26 EUROPEAN NATIONS
ON DOMESTIC STRIFE BY ALIGNMENT GROUP, 1990

Aligned with Soviet Union[a]	Nonaligned/ Multialigned[b]	Aligned with United States[c]
Soviet Union	Turkey	Italy
Poland	Spain	Yugoslavia
Romania	Greece	United Kingdom
East Germany	Portugal	Iceland
Hungary	Austria	Ireland
Czechoslovakia	Finland	Norway
Bulgaria		Switzerland
		Denmark
		West Germany
		France
		Netherlands
		BLEU
		Sweden

a $1.0 \geq ALIGN\theta > .55$

b $.40 \leq ALIGN\theta \leq .55$

c $.40 > ALIGN\theta \geq 0.0$

in their relative levels of internal strife between 1985 and 1995. Turkey and Spain, with histories of substantial unrest and forecasts of consistently low economic development, remain the most unstable nations within this group. Of the nonaligned and multialigned group, Austria and Finland experience the lowest levels of domestic strife throughout the forecast period.

Table 14 presents mean domestic-strife scores for the alliance membership and alignment groups for 1985, 1990, and 1995. A comparison

TABLE 13

RANKINGS OF THE 26 EUROPEAN NATIONS ON DOMESTIC STRIFE BY ALIGNMENT GROUP, 1995

Aligned with Soviet Union[a]	Nonaligned/ Multialigned[b]	Aligned with United States[c]
Poland	Turkey	Italy
Soviet Union	Spain	Iceland
Romania	Greece	Yugoslavia
East Germany	Portugal	Norway
Hungary	Austria	Denmark
Bulgaria	Finland	Ireland
Czechoslovakia		Switzerland
		United Kingdom
		BLEU
		France
		West Germany
		Netherlands
		Sweden

[a] $1.0 \geq ALIGN\theta > .55$

[b] $.40 < ALIGN\theta < .55$

[c] $.40 > ALIGN\theta \geq 0.0$

of the Warsaw Pact and NATO alliance members suggests that the average difference in levels of strife between those groups of countries remains relatively stable over the forecast period. Furthermore, while domestic unrest in Warsaw Pact nations is consistently higher than that in NATO countries, this difference is never greater than 30 percent. Thus, marked differences between these groups in terms of domestic instability are not expected. An examination of the alignment groups, however, reveals a strikingly different pattern. The difference in mean domestic-strife scores between the group of countries

TABLE 14

MEAN STRIFE SCORES BY
ALLIANCE MEMBERSHIP AND ALIGNMENT GROUP

	1985	1990	1995
Warsaw Pact	.671	.583	.390
NATO	.609	.403	.324
Nonmembers	.507	.427	.275
Aligned with Soviet Union	.671	.583	.390
Aligned with United States	.483	.285	.135
Nonaligned/Multialigned	.778	.750	.683

aligned with the Soviet Union and the group aligned with the United States widens considerably between 1985 and 1995. Western European allies of the United States have about 30 percent less domestic unrest than Soviet-bloc countries in 1985, 50 percent as much by 1990, and nearly 70 percent less internal instability by 1995. The reason for these differences between alliance groups and alignment formations, of course, lies in the fact that Turkey, Greece, and Portugal, three countries presently members of NATO which are forecast to experience rather extensive internal strife in the long-range future, are also expected to move into the nonaligned and multialigned group of nations. The result is reflected in a comparison of strife scores of nonmembers of the two alliances with the scores of the nonaligned and multialigned countries. In 1985 and 1990, the latter group experiences nearly 35 percent more strife than the nonmembers of present alliances. By 1995, this gap widens to 60 percent as Turkish and Greek domestic unrest increase considerably.

In short, an analysis of expected levels of domestic strife between present alliance groupings suggests little difference in forecasts of internal instability between the Soviet-bloc nations and the Western European allies of the United States. Focusing instead upon expected patterns of loyalty to the major powers, however, suggests that Soviet-bloc countries will experience considerably more domestic unrest than will those nations aligned with the United States. Nonmembers of the two alliances which tend to become more closely aligned with the United States are forecast to experience rather low levels of internal unrest. Present NATO members that move into a nonaligned or multialigned position with respect to the United States and the Soviet Union are also those Western European nations expected to have high levels of internal instability in the long-range future.

International Trade

In constructing a forecasting model of international trade, dyadic elasticities are estimated to relate changes in income, or gross national product, to changes in levels of imports. Thus, the estimated elasticity of imports of country X from country Y with respect to country X's GNP is used to forecast the flow of goods from Y to X. Conversely, Y's elasticity of imports of country X with respect to its own GNP is used to forecast the flow of goods from X to Y. These combined flows of trade constitute the total trade between the two nations. Dyadic elasticities are estimated for maximum accuracy. As expected, the elasticity of a given nation's imports with respect to its gross national product typically varies across its trading partners, reflecting different needs and tastes for the goods produced by various trading partners. In terms of the interactions among central environmental descriptors in the forecasting model, however, each nation's total trade is used as a predictor variable to represent international activity of a transactional nature. The forecasts we present, then, are of each nation's total trade with other European countries.

Table 15 ranks the 26 European nations according to their expected

TABLE 15

RANKINGS OF THE 26 EUROPEAN NATIONS ON TRADE

1985	1990	1995
United Kingdom	United Kingdom	United Kingdom
France	France	BLEU
West Germany	BLEU	France
BLEU	West Germany	Sweden
Netherlands	Sweden	West Germany
Sweden	Netherlands	Netherlands
Italy	Italy	Yugoslavia
Switzerland	Switzerland	Italy
Yugoslavia	Yugoslavia	Switzerland
Soviet Union	Spain	Spain
Spain	Soviet Union	Ireland
Denmark	Denmark	Denmark
East Germany	Ireland	Finland
Czechoslovakia	East Germany	Austria
Austria	Finland	Soviet Union
Norway	Austria	East Germany
Finland	Czechoslovakia	Norway
Ireland	Norway	Czechoslovakia
Portugal	Portugal	Portugal
Poland	Hungary	Hungary
Hungary	Bulgaria	Bulgaria
Bulgaria	Poland	Poland
Romania	Romania	Turkey
Greece	Turkey	Romania
Turkey	Greece	Greece
Iceland	Iceland	Iceland

levels of total trade in 1985, 1990, and 1995. The temporal stability of relative levels of trade for the European countries reflects the stability observed in forecasts of the GNP component of economic power base. Substantial changes in relative trade for two nations, however, do appear in these forecasts. Between 1990 and 1995, the Soviet Union's trade decreases substantially relative to other European nations. Although Soviet GNP remains the largest of the European countries during this period, the rate of growth of the Soviet economy is expected to decrease considerably. The decline in relative quantity of trade observed for that nation reflects this economic stagnation. Ireland, on the other hand, shows marked increases in relative trade from 1985 to 1995. This results from the high propensity to trade exhibited by the Irish relative to their level of income. Thus, moderate increases in Irish GNP result in substantial increases in that nation's trade with other European countries.

By and large, nations that historically trade very heavily, and that are forecast to have large economic power bases, are those countries with high levels of relative trade. The United Kingdom, of course, retains its leadership in international trade among the European countries since it depends on imports for most raw materials and on exports for balance of trade. Other large members of the European Community--France, West Germany, and BLEU (Belgium/Luxembourg)-- also trade extensively. Not unexpectedly, the smaller and poorer nations are forecast to engage in the least international trade. Bulgaria, Romania, Greece, and Turkey have among the lowest levels of international transactions, while Iceland, the smallest of the 26 European nations, consistently ranks last in international trade.

International Alignment

In this effort European nations' alignments with the United States and the Soviet Union have been investigated. In contrast to most bipolar alignment schemata, a two-dimensional measurement model has been developed to forecast major-power alignments. The first of these dimensions, the extent of nations' major-power alignments, taps the propensity of the European nations to align with one or both of the major powers. The second dimension, the distribution of the countries' major-power alignments, concerns how those countries divide their major-power alignments between the United States and the Soviet Union. In this effort, two alignment variables are forecast, ALIGNR and ALIGNθ, corresponding respectively to the extent and distribution of the European nations' major-power alignments. An examination of these forecasts in conjunction can allow differentiation of nonaligned and multialigned nations and identification of the clustering tendencies of the European nations with respect to their patterns of international alignment.

As we noted in discussing the construction of alignment scores,[2] initial measures were developed on each nation's alignment with each major power. These scores were then transformed to produce measures of the extent and distribution of each nation's major-power alignment. Forecasts of ALIGNθ are used here in conjunction with ALIGNR forecasts to identify alignment blocs expected in the long-range future. Tables 16 through 18 present forecast alignment blocs for 1985, 1990, and 1995. Countries forecast to be aligned with the Soviet Union have

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[2] See Chapter 5 of this volume, "International Alignment," for a complete description of the transformations linking alignment with the United States and alignment with the Soviet Union scores to extent and distribution of major-power alignment scores.

TABLE 16

RANKINGS OF THE 26 EUROPEAN COUNTRIES WITHIN ALIGNMENT GROUPS, 1985

Aligned with Soviet Union	Nonaligned/ Multialigned	Aligned with United States
Bulgaria	Turkey	Italy
Poland	Spain	France
Romania	Portugal	United Kingdom
Hungary	Greece	West Germany
East Germany	Austria	Yugoslavia
Czechoslovakia	Finland	Netherlands
		BLEU
		Iceland
		Ireland
		Switzerland
		Norway
		Denmark
		Sweden

ALIGN θ greater than .55. Nations with ALIGNθ scores between .40 and .55 are expected to be nonaligned or multialigned during the forecast period, while countries with scores less than .40 are expected to be aligned with the United States. It is not at all surprising that the memberships of these three groups remain constant during the forecast period; international alignment, after all, is conceptualized as a rather stable and persistent aspect of politics in the international system.

Tables 16 through 18 rank the European nations within each of these groups according to the extent of their alignment with the respective major power or, in the case of the nonaligned and multialigned group,

TABLE 17

RANKINGS OF THE 26 EUROPEAN COUNTRIES WITHIN ALIGNMENT GROUPS, 1990

Aligned with Soviet Union	Nonaligned / Multialigned	Aligned with United States
Bulgaria	Turkey	Italy
Poland	Spain	United Kingdom
Romania	Portugal	France
Hungary	Greece	Yugoslavia
East Germany	Austria	West Germany
Czechoslovakia	Finland	Netherlands
		BLEU
		Ireland
		Iceland
		Norway
		Denmark
		Switzerland
		Sweden

with the two major powers. Bulgaria is consistently the strongest ally of the Soviet Union, followed by Poland, Romania, and Hungary. Czechoslovakia remains the least aligned with the Soviet Union. Similarly, the relative extent of major-power alignments of the nonaligned and multialigned group is constant during the forecast period. Turkey and Spain are clearly aligned with both major powers, although they do lean slightly toward the United States. Portugal is also multialigned, but distributes its major-power alignment more or less equally between the United States and the Soviet Union. Greece, Austria, and Finland are substantially less aligned with both major powers. These nations occupy the borderline between nonalignment and multialignment throughout the 1985 to 1995 period. None of these six nations is unambiguously

TABLE 18

RANKINGS OF THE 26 EUROPEAN COUNTRIES WITHIN ALIGNMENT GROUPS, 1995

Aligned with Soviet Union	Nonaligned/ Multialigned	Aligned with United States
Bulgaria	Turkey	Italy
Poland	Spain	United Kingdom
Romania	Portugal	Yugoslavia
Hungary	Greece	France
East Germany	Austria	West Germany
Czechoslovakia	Finland	Netherlands
		BLEU
		Ireland
		Iceland
		Norway
		Denmark
		Switzerland
		Sweden

nonaligned; yet Greece, Austria, and Finland are far less tied to the major powers, as indicated by their substantially lower ALIGNR scores.

Within the group of Western European nations forecast to be aligned with the United States there is some fluctuation in relative levels of alignment throughout the forecast period. While the two most aligned nations, Italy and the United Kingdom, maintain their relative positions from 1985 to 1995, Yugoslavia increases its alignment with the United States rather substantially during that period. Yugoslavia begins the forecast period as the fifth most aligned European nation with the United States; by 1995 it overtakes both West Germany and France and ranks third. Of course, it is difficult to really expect Yugoslavia to be an extremely strong ally of the United States by 1995. Yet the predictors of alignment distribution included in this model, GNP and trade patterns most prominently, point to strong pressures for decreased Yugoslavian alignment with the Soviet Union and increased ties with the United States. Diplomatic and military policies implemented by the Soviet Union to counteract these pressures are explicitly not included in these forecasts, and policies of this sort would undoubtedly be considered once the magnitude of potential change in Yugoslavian alignment was realized. The forecasts we show here, then, are what is expected in the absence of policy changes on the part of significant and affected governments; those changes, on the other hand, are likewise to be expected. The other important change in rankings of alignment with the United States involves Switzerland. That nation shows a two-rank decrease in alignment with the United States between 1985 and 1990, and then stabilizes its level of alignment with the United States.

Figures 1 through 3 reveal visually the alignment patterns of the European nations with the major powers. Levels of alignment with the Soviet Union are measured on the horizontal axes of the graphs, while levels of alignment with the United States are measured on the vertical axes. Four distinct clusters of countries appear on the graphs and maintain their relative positions throughout the forecast period. The first group, composed of Italy, France, the United Kingdom, West Germany, and Yugoslavia, is quite highly aligned with the United States and evidences little, if any, alignment with the Soviet Union. The second group is not as strongly aligned with the United States but still shows very little alignment with the Soviet Union. This cluster of nations includes Norway, Denmark, Sweden, the Netherlands, BLEU, Switzerland, Ireland, and Iceland. With the exception of Iceland, these nations have

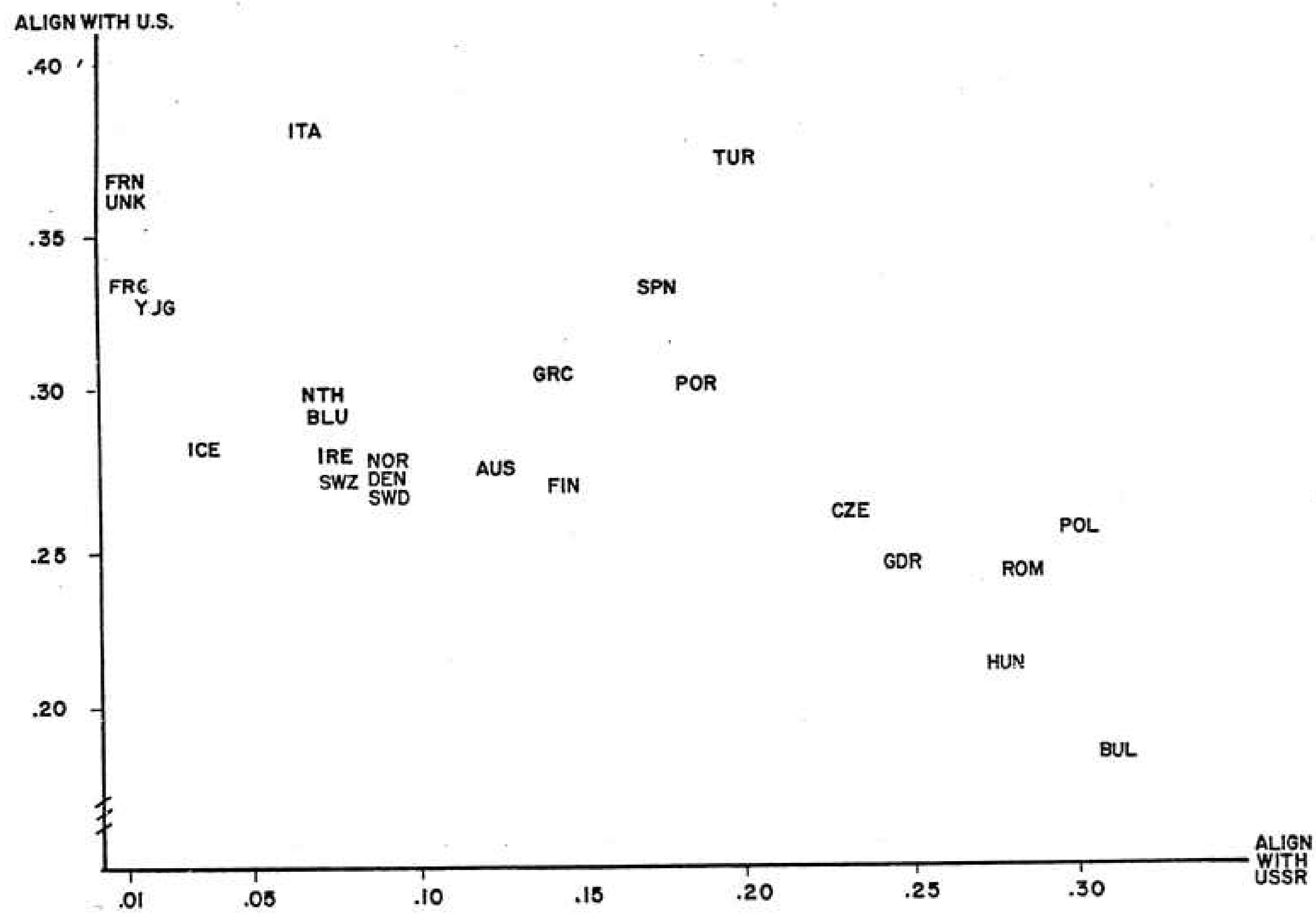

Figure I. Alignment Distribution, 1985.

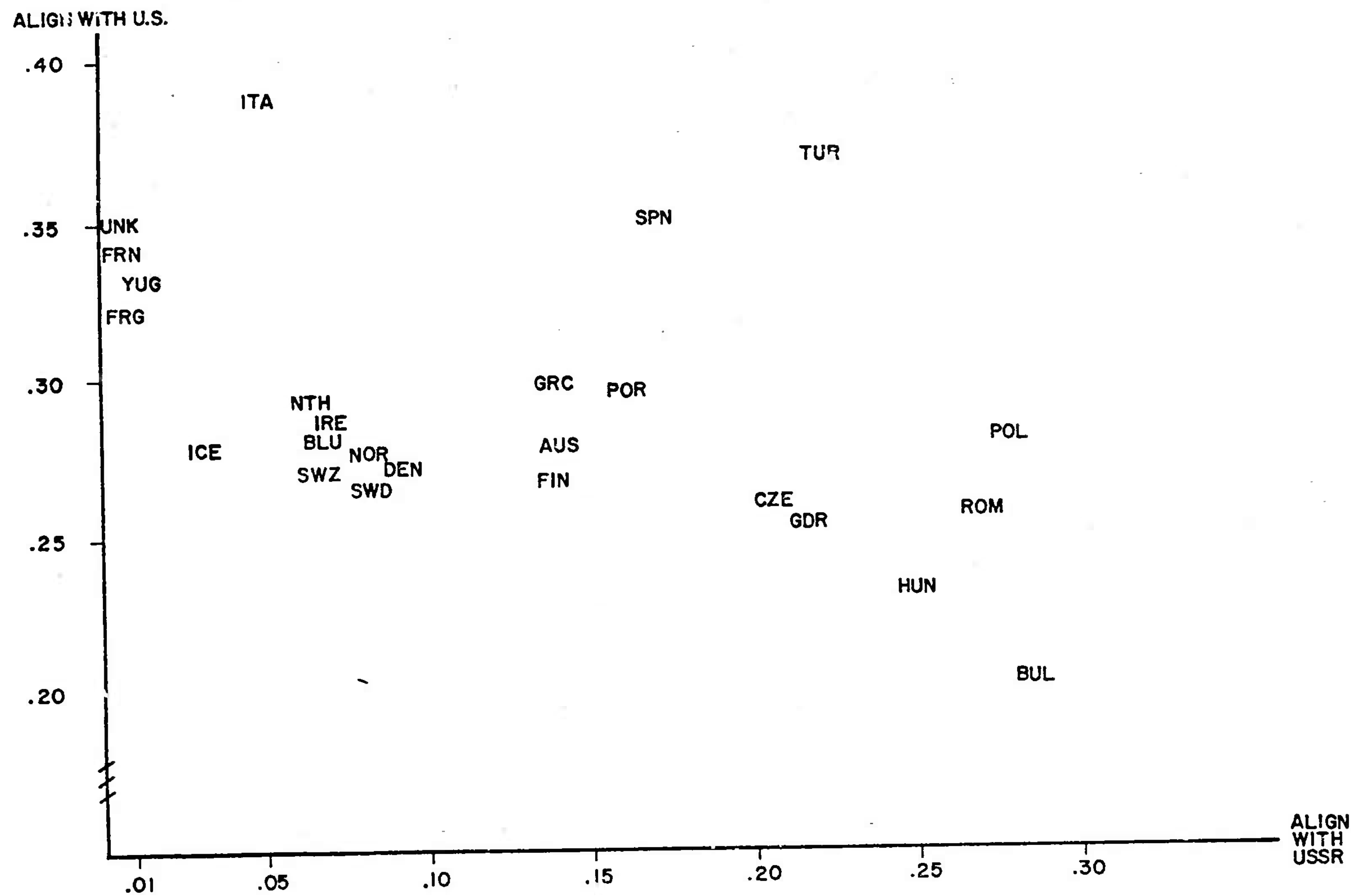

Figure 2. Alignment Distribution, 1990.

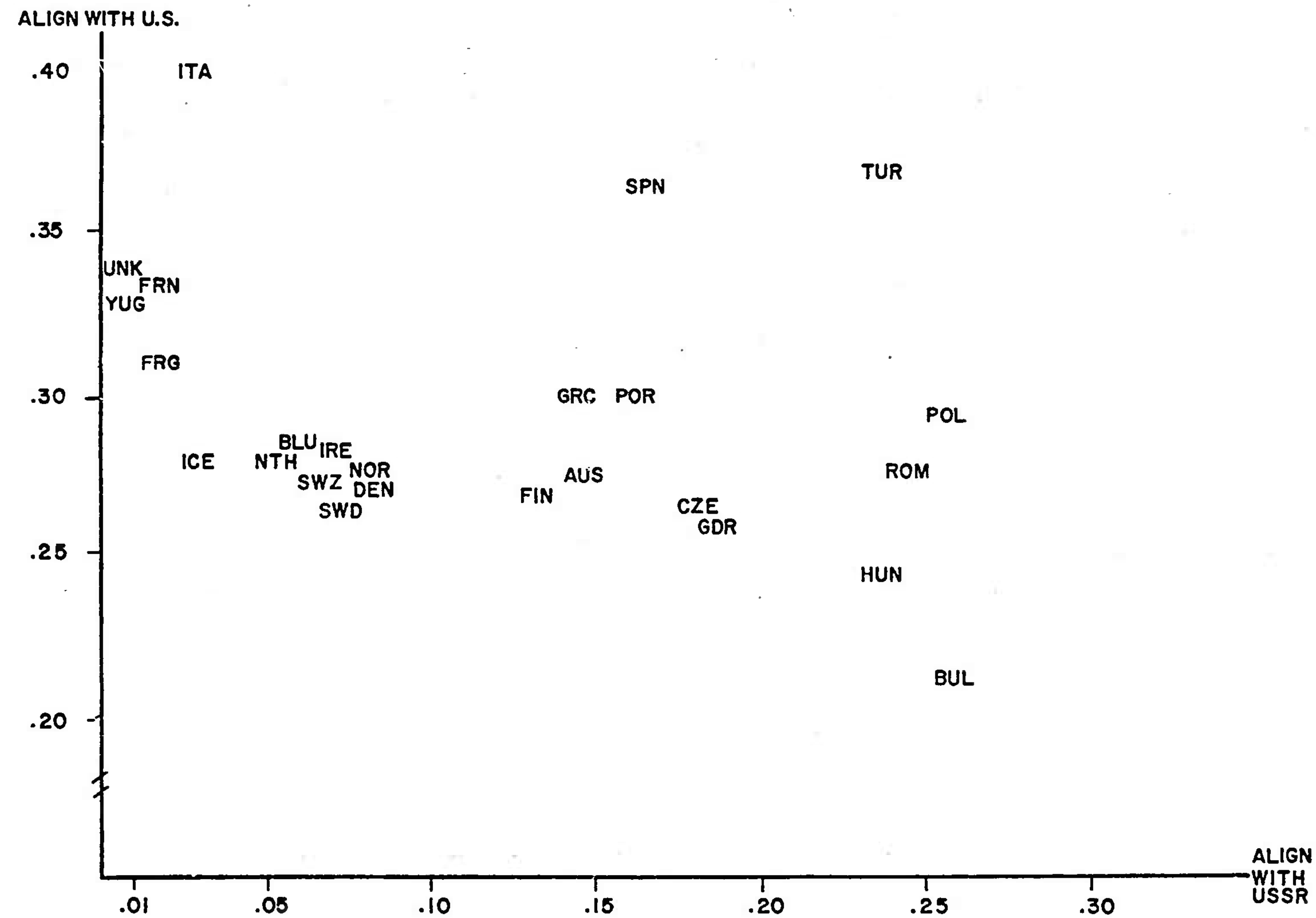

Figure 3. Alignment Distribution, 1995.

traditionally been weakly tied to the major powers, but have consistently leaned toward the United States. Iceland, of course, has in the past been a strong ally of the United States.

A third cluster of nations shown in Figures 1 through 3 consists of those nations identified as nonaligned or multialigned. This group includes Austria, Finland, Greece, Portugal, Spain, and Turkey. As the figures suggest, Turkey has the strongest ties of any of these countries to the two major powers. Turkish alignment with the United States is as strong as British and French alignment with this country; at the same time, Turkey is nearly as strongly aligned with the Soviet Union as Czechoslovakia, a nation identified as a member of the Soviet bloc during the long-range future. Spain and Portugal are much less aligned with the major powers than is Turkey; yet their alignment scores are still higher than those of many nations aligned with the United States. These two nations also show moderate levels of alignment with the Soviet Union during the 1985 to 1995 period. Greece, Austria, and Finland border on being nonaligned nations although their levels of alignment with the United States are as high as those of many weak U.S. allies and they evidence moderate levels of alignment with the Soviet Union as well. Though clearly not multialigned, Greece, Austria, and Finland are also not unambiguously nonaligned.

A final group of nations identified in Figures 1 through 3 consists of the Soviet-bloc countries--Czechoslovakia, East Germany, Poland, Romania, Hungary, and Bulgaria. Of this group, Czechoslovakia and East Germany are the most weakly aligned with the Soviet Union, Bulgaria shows by far the strongest alignment with the Soviet Union, while Poland, Romania, and Hungary lie between these two groups. These relative positions within the bloc remain quite stable during the entire forecast period.

Alignment with the major powers, then, evidences the sort of stability and persistence during the forecast period that theoretical consideration of international alignment suggests. The basic groupings of nations--strongly and weakly aligned with the United States, nonaligned or multi-aligned, and aligned with the Soviet Union--retain their memberships intact throughout the forecast period. Moreover, within-group fluctuations, though at some points noticeable, do not disrupt the basic patterns of ties between the European nations and these two major powers.

International Conflict

In this effort two distinct, yet related, conflict measures are developed. The first, monadic conflict, indicates the total level of conflict experienced by a given nation during a given time period within the entire European region. Thus, the French monadic-conflict score measures total French conflict with the other 25 European countries included in this analysis. The second measure of conflict, dyadic conflict, indicates with whom a given nation is experiencing conflict.[3] Thus, a dyadic-conflict score is forecast for each of the 325 European dyads.

Table 19 ranks the European nations according to their forecast levels of monadic conflict in 1985, 1990, and 1995. Two points are of special interest with respect to these results. First, the distribution of nations on measures of monadic conflict reflects, to a large extent, their relative levels of national power base. This is because conflict is best understood as a component of nations' general patterns of behavior in the international system, and large, wealthy, and powerful nations are

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[3] See Chapter 6 of this volume, "International Conflict," for a discussion of the distinctions and linkages between monadic and dyadic conflict.

TABLE 19

RANKINGS OF THE 26 EUROPEAN NATIONS ON MONADIC CONFLICT

1985	1990	1995
Soviet Union	Soviet Union	Soviet Union
West Germany	West Germany	West Germany
France	France	United Kingdom
United Kingdom	United Kingdom	France
East Germany	East Germany	East Germany
Czechoslovakia	Czechoslovakia	Czechoslovakia
Sweden	Sweden	Sweden
Italy	Italy	Italy
Poland	Poland	Poland
BLEU	BLEU	BLEU
Netherlands	Netherlands	Netherlands
Denmark	Denmark	Denmark
Switzerland	Switzerland	Switzerland
Norway	Norway	Norway
Romania	Romania	Romania
Hungary	Hungary	Hungary
Austria	Austria	Austria
Spain	Bulgaria	Bulgaria
Bulgaria	Spain	Finland
Yugoslavia	Finland	Spain
Finland	Yugoslavia	Yugoslavia
Greece	Greece	Greece
Ireland	Ireland	Ireland
Portugal	Portugal	Portugal
Turkey	Turkey	Turkey
Iceland	Iceland	Iceland

typically those countries that interact extensively with others. Smaller and poorer nations seldom take part in international interactions since they have neither the resources nor the motivation to become major actors in the international system. Thus, the Soviet Union, West Germany, France, the United Kingdom, and East Germany lead the list of nations in terms of monadic conflict, a situation that is quite consistent with the patterns of conflict observed during the 1960's. Sweden, traditionally a low conflictor, is forecast to experience rather extensive conflict during the forecast period because Sweden is forecast to show considerable growth in both economic and military power bases, contributing to that country's increasing involvement in international affairs. Usually, some portion of those involvements is of a conflictual nature, although not all conflict is of a violent, military form. Much conflict, as measured here, consists of diplomatic and economic pressures.

The second major point to be made here concerns the stability of these rankings throughout the forecast period. Between 1985 and 1995 only two nations, Finland and Spain, show any significant change in rank on monadic-conflict forecasts. The increase in Finland's conflict during the period is a result of its common border with the Soviet Union. Since Finland is not aligned solely with the Soviet Union, the potential for conflict between these nations is high, particularly in the absence of restraint in the interactions between these two countries. Spain, on the other hand, evidences a decline in total conflict throughout the forecast period. As we noted earlier, Spanish economic and military power show a decline relative to other European countries between 1985 and 1995. Concomitantly, Spain's level of conflict within the European region decreases relative to other nations' conflict experiences.

Table 20 shows mean conflict scores for the three alliance groups and three forecast alignment groupings. Clearly, the Soviet-bloc nations experience consistently more conflict in the European region than do NATO members and other Western European nations forecast to be aligned with the United States. Interestingly, the Soviet-bloc share of total within-region European conflict increases during the forecast period. In 1985, the Warsaw Pact nations experience 46 percent of

TABLE 20

MEAN MONADIC CONFLICT SCORES
BY ALLIANCE MEMBERSHIP AND ALIGNMENT GROUP

	1985	1990	1995
Warsaw Pact	.56	.67	.75
NATO	.38	.42	.44
Nonmembers	.27	.30	.33
Aligned w/ Soviet Union	.56	.67	.75
Aligned w/ United States	.41	.46	.49
Nonaligned/Multialigned	.20	.21	.22

the intra-European conflict, compared to 31 percent for the NATO nations. By 1995, the Warsaw Pact share increases to 49 percent while the NATO share decreases to 29 percent. Of course, the initial difference in conflict experience itself, as well as the relative increase in experienced conflict between 1985 and 1995, can be attributed to the Soviet Union. In addition to being the largest power in the European region, both on the economic and the military dimension, the Soviet Union has typically been a high conflictor within the region. Excluding the Soviet Union from the calculations produces mean conflict scores for the Warsaw Pact nations that are lower than mean conflict scores for NATO members and other Western European allies of the United States.

As Table 20 suggests, the overall level of conflict in the European region increases substantially during the forecast period. In fact, intra-European conflict levels increase by 15 percent between 1985 and 1990 and by another 9 percent between 1990 and 1995. Combining the monadic-conflict scores for all 26 European nations for each year gives an indication of the expected levels of internation stress experienced within the region. Figure 4 graphs system stress scores, or the sum of all nations' monadic-conflict scores, from 1970 until 1995. As the figure suggests, stress within the European region declines in the early 1970's, using 1970 as the base year for the forecast. These results correspond closely to the impact of detente between the United States and the Soviet Union. However, the forecasts also suggest that the effects of detente are rather short-lived; conflict levels within Europe begin to increase after 1973 and evidence a nearly monotonic increase until the early 1990's. The increased level of stress within the region during this period could result from many factors. Yet conflict over internation transactions, competition between these industrialized nations for raw materials from Third World countries, and the accompanying competition for export markets to pay for these raw materials could dominate the politics of the European region in the long-range future. If the projections of many analysts of future patterns of energy and raw material production and consumption are valid,[4] these results are far from surprising.

It is, however, interesting to note that, as Figure 4 suggests, the level of increase in system stress begins to decelerate during the early 1990's.

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4 See, for example, William W. Behrens, III, "The Dynamics of Natural Resource Utilization," and William W. Behrens, III, and Dennis L. Meadows, "Determinants of Long-Term Resource Availability," Toward a Global Equilibrium, ed. by Dennis L. Meadows and Donnella H. Meadows (Cambridge: Wright-Allen Press, Inc., 1973). See also Eugene N. Cameron, ed., The Mineral Position of the United States, 1975-2000 (Madison: University of Wisconsin Press, 1973).

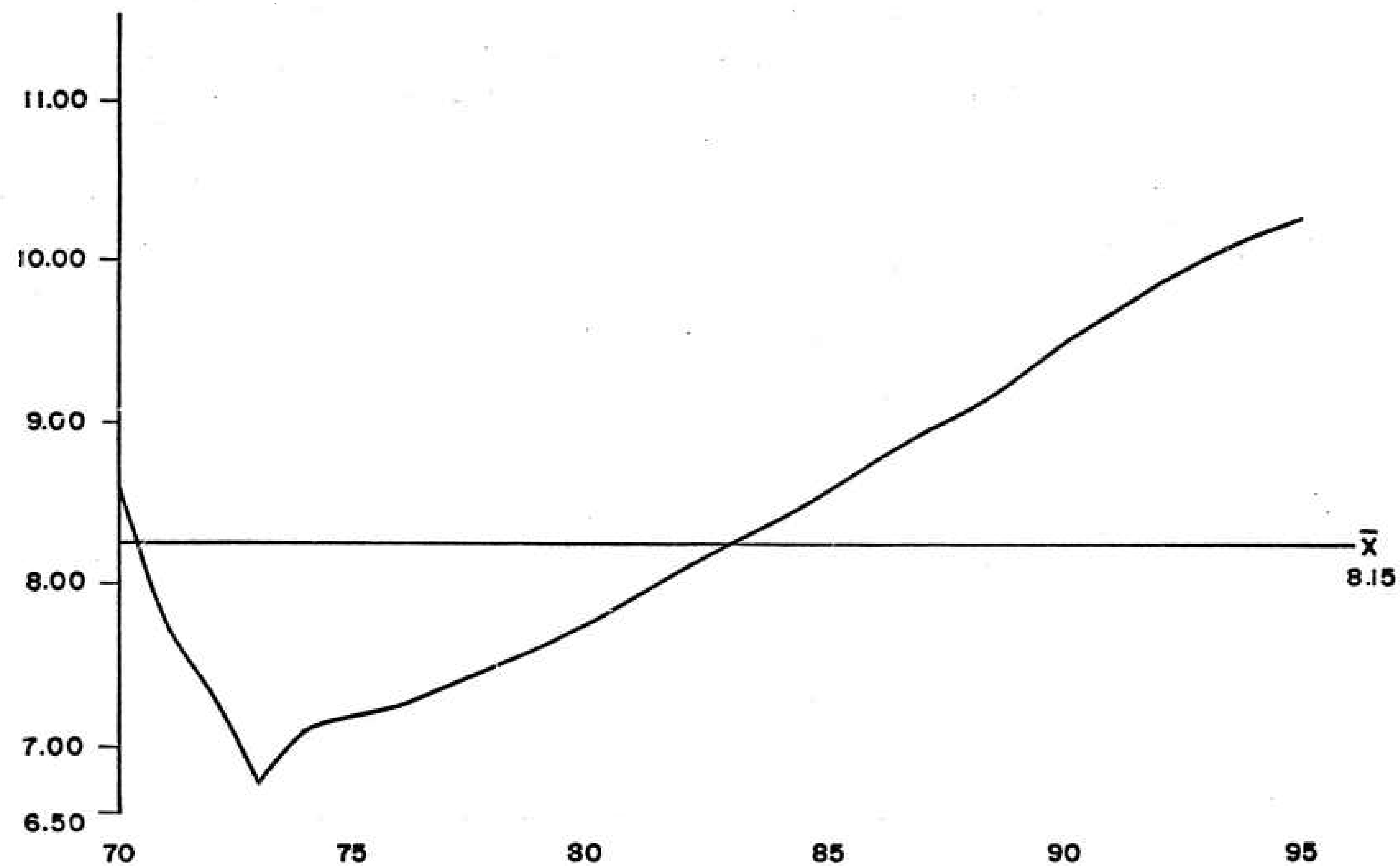

Figure 4. System Stress Scores, 1970-1995.

We suspect that these results are a function of the feedback mechanisms relating defense expenditures to conflict. To the extent that the pressures that provoked increases in system stress persist, it is doubtful that the curve would evidence any significant decrease in slope. Clearly, if those pressures are a function of the transactional needs alluded to above, they are likely to be potent over the long range. Thus, the level of internation stress within the European region can realistically be expected to rise continuously during the long-range future.

Dyadic conflict forecasts are used here to identify the patterns of conflict expected between the European nations during the 1985 to 1995 time period. Table 21 shows mean dyadic-conflict scores within and between the three forecast alignment groups previously identified. The Soviet Union is excluded from this analysis because its levels of conflict tend to overshadow all other conflict patterns. Suffice it to say here that the Soviet Union experiences extensive conflict with nations in all three alignment blocs during the entire forecasting period.

As Table 21 suggests, the patterns of conflict among the European nations remain rather stable from 1985 to 1995. Excluding the Soviet Union from these figures, the Western European allies of the United States consistently experience the highest levels of conflict during the forecast period. Interestingly enough, the levels of conflict among these nations are higher than levels of conflict between this group of nations and either the Soviet-bloc countries or the nonaligned and multialigned nations. In addition, those nonaligned and multialigned nations tend to experience more conflict with the U.S. allies than they do with Soviet-bloc countries. Conflict among Soviet-bloc nations remains at a relatively low level throughout the forecast period.

TABLE 21

MEAN INTERBLOC/INTRABLOC CONFLICT SCORES
(excluding Soviet Union)

	Align w/ U.S.	Align w/ USSR	Nonaligned/ Multialigned
	1985		
Align w/ U.S.	.28		
Align w/ USSR	.25	.00	
Nonaligned/ Multialigned	.20	.14	.10
	1990		
Align w/ U.S.	.33		
Align w/ USSR	.29	.14	
Nonaligned/ Multialigned	.24	.18	.10
	1995		
Align w/ U.S.	.40		
Align w/ USSR	.33	.20	
Nonaligned/ Multialigned	.30	.23	.10

In short, the overall level of conflict within the European region is expected to increase rather substantially during the long-range future. For the most part, the major conflictors and the countries showing the largest increases in conflictual interactions are the large, wealthy, and powerful nations within the region. With the exception of the Soviet Union, these are mainly Western European nations forecast to be aligned with the United States. Conflict levels are especially high for the Soviet Union, and that nation conflicts extensively with members of all three alignment blocs during the long-range future. Aside from the Soviet Union, much of the European conflict involves major European allies of the United States, and a surprising amount of their conflict is with one another.

Summary

This section of the chapter has presented forecasts of the long-range European environment. The forecasts were presented in such a manner as to maximize both their reliability and their usefulness within the long-range planning context. Thus, unnecessary precision was avoided and the presentation concentrated on comparing the European nations in terms of five central environmental descriptors--national power base, internal instability, international trade, international alignment, and international conflict--for the years 1985, 1990, and 1995.

CONCLUSION: DIRECTIONS IN LONG-RANGE FORECASTING

This report has described an effort to develop and implement new long-range environmental forecasting technologies. This volume has provided a rather detailed technical description of the processes whereby these efforts were satisfied. The first chapter of this volume described the context in which long-range forecasting is a valuable tool in policy planning and development, detailed the requirements of a forecasting model in terms of its value in the planning process, and suggested the linkage between the methods used in this effort and those requirements. Specifically, we noted that an environmental forecasting model is valuable to the planner to the extent that the concepts examined within it are related to the implementation and evaluation of policy. At the same time, however, we suggested that the credibility of forecasts of a concept depends in part on the generality of those concepts. Thus, concept selection often hinges on the trade-off between planners' needs, typically specific, and forecasters' capabilities.

We suggested in Chapter 1 that a forecasting model is credible or valid to the extent that it is subject to being disverified and failed of disverification. We noted that the most powerful validation technique available is to subject the model to multiple validation tests, each resting upon fundamentally different, yet complementary, criteria. Thus, we sought to integrate substantive social science theory, statistical theory, and cybernetic theory into a generalized framework by subjecting the forecasting model to validation tests based upon each. These are, then, the three stages in the development of this forecasting model:

1) Generate hypotheses relating central environmental descriptors to one another and to exogenous predictors using extant theoretical and empirical social science analysis as the source of the hypotheses.

2) Examine those hypotheses within the contemporary European context using statistical theory as the source of criteria for their acceptance or rejection.

3) Simulate the through-time effects of the accepted hypotheses and interpret the results of the simulation in terms of expectations generated from both substantive social science theory and cybernetic theory.

In this manner, three sets of validation criteria were applied to the forecasting model, with each set of criteria drawn from a distinct theoretical framework. Chapters 2 through 7 of this volume provide detailed descriptions of the application of these multiple validation criteria to specified sectors of the forecasting model.

At the same time, however, we noted that no model is ever validated in any absolute sense, but rather is compared for usefulness against some finite number of specific alternatives. We suggested that, while in relative terms the reliability of the model is high, in absolute terms we are unable to evaluate the reliability of this forecasting model. Faced with the classic forecasting trade-off between precision and reliability of forecasts, we selected the latter. We noted that excessive precision is of little marginal value to the planner, especially when considering long-range plans, while reliability is extremely important in the policy-planning process. In presenting forecasts of the long-range European environment, then, we utilized a format that maximized the reliability of the forecasts at the cost of eliminating unnecessary precision.

In the course of generating a long-range forecasting model which explicitly accounted for the interactions among the central environmental descriptors under examination, we found that the role of theory was extremely prominent. Specifically, interactive models of this sort require strong theoretical bases for high reliability. Thus, sectors of the model that are based on rather strong theory and extensive previous empirical examination such as population, energy consumption, GNP, and trade, proved to be quite reliable. Those sectors based on rather undeveloped theory and for which little previous empirical research was available--international conflict, internal instability, and international alignment--proved more difficult to forecast with a similar degree of reliability.

In addition, we found that models of this sort tend to become increasingly region-specific as they are progressively developed. When the operationalization of the central environmental descriptors and the selection of predictor variables are done within the substantive content of the region under examination, the reliability of the forecasting model is improved, but the generality of that model to other regions of the world is decreased. Clearly, methods for assessing the equivalence of concepts in various regions, and of evaluating the equivalence of measurement models of those concepts, must be applied to these forecasting methodologies if they are to be used on a worldwide basis simultaneously. We also found that the reliability of interactive models of the sort developed here is highly dependent upon the quality of data upon which that model is based. While data for the European nations are, for the most part, both plentiful and of reasonable quality, this is certainly not the case for many parts of the world, particularly those regions composed of developing countries. Some methods must be employed, then, to reduce the sensitivity of the forecasting model to its associated data base when forecasts of Third World nations are undertaken.

More importantly, we return for a moment to the role of forecasting in the planning process. If forecasting is to be a valuable adjunct to policy planning, the particular needs of planners must be given greater consideration. We see four specific ways in which forecasting can be more freely integrated with the policy-planning process. First, new conceptualizations of important environmental variables that map more closely onto the planners' requisites are required. We noted earlier that the present state of theory in the social sciences requires that concepts be selected for forecasting which are often more general than the concepts of particular interest to the planner, that is, there often exists a trade-off between the planner's needs and the reliability of a forecasting model. Thus, bridging this gap from the forecasting standpoint requires that new concepts be developed or refined and then used in theoretical and empirical social science analyses. In short, we suggest that the application of new and advanced methodologies requires the concomitant development of new and better substantive theory and that basic research on the conceptualization of important environmental variables is more urgently needed than ever before.

The second way in which forecasting can be made more useful is by including more manipulable exogenous variables into the forecasting models utilized. For example, in considering the alignment posture of Third World nations, an important and, from the United States standpoint, manipulable exogenous predictor might be the level of U.S. military and economic aid to these nations. If aid is, in fact, a potent predictor of alignment, U.S. planners can use a forecasting model that includes that variable to develop long-range plans and policies designed to maximize their goals with respect to the alignment postures of selected countries. Essentially, then, the forecaster must give the planner an entry into the forecasting model, that is, a realistic way of introducing controlled change into the model and observing its effects in terms of important aspects of the international environment.

In addition to allowing the planner entry into the forecasting model through manipulable exogenous variables, the forecaster must develop technologies for interpreting international events in terms of the process variables explicitly included in the model. The planner may want to assess the impact of the death of a particular political leader on the level of internal instability within a nation and on its degree of alignment with the United States. To permit such an evaluation, the forecaster must develop methods for translating such an event into changes in the levels of the variables in the model. Once this capability is obtained, the planner can observe the impact of these changes on the long-range values of important central environmental descriptors and interpret the effects of the event.

Finally, the forecaster must impress upon the planner the limited scope of any forecasting model and urge that greatest consideration be given to the selection of the concepts of interest. Clearly, any model can provide a realistic view of the world only to the extent that the concepts included within the model are both key environmental variables and cover a broad spectrum of the environment of interest. Of crucial importance in making forecasting a useful adjunct to planning, then, is the planner's understanding that the concepts he selects for inclusion into the forecasting model determine the scope of his forecasts of the long-range future.

APPENDIX: COMPUTER SOFTWARE

INTRODUCTION

This appendix describes the three major computer programs and their associated data files that are used to produce the long-range environmental forecasts. Program FORECAST generates forecast output files that are used by PRINT and RANK for display.

The programs are designed to be used interactively via terminals, although batch operation is possible. They have been written for Control Data Corporation 6400 computers in FORTRAN IV. Conversion to other systems should proceed in a fairly straightforward manner; difficulties would appear primarily in the input-output operations.

PROGRAM FORECAST

FORECAST reads two files of data and generates forecasts based on a model of international relations formulated by standard econometric techniques. The first portion of the program describes the arrays that are used; initialization of arrays and input of starting information follows; the calculations are then performed for each year for which forecasts are desired. In addition, there are two subroutines for locating items in arrays.

Program Declarations and Array Structures

Lines 100 through 490 define the arrays used in the model. These include 17 pairs of vectors representing the monadic endogenous variables (see Table 1) and 2 pairs of dyadic endogenous variables. The arrays are suffixed by the numbers 1 and 2. For example, GNP1 refers to current values of gross national product, while GNP2 refers to the previous year's gross national product. Exogenous variables have one array each; these values do not change over the time period considered.

Each variable has 27 values: one for the 26 countries in the study, and one "extra" for future expansion. The names of the countries are stored in variable CNAM (line 200), and are assigned values at the appropriate data statements (lines 430-450). For display purposes, each variable has a name--variable VNAM (line 200)--where appropriate values are assigned (lines 460-490).

Model parameters are stored as constants--variable A--and coefficients--variable B. There is room for 13 equations in the model although only 11 are used (numbers 5 and 13 are excluded). There is room for up to six coefficients in each equation (line 210).

For each data transfer, FORTRAN EQUIVALENCE structures have been established between the endogenous variables and the arrays X1, X2, and Y. X1 and X2 are equivalent to the list of all endogenous variables in Table 1, where X1 represents current values and X2 represents previous values. They have been used to facilitate the transfer of "current" to "previous" at the start of each cycle, as well as the transfer of each year's "current" to external storage for retrieval by other programs. Y is used as an equivalence for the monadic endogenous variables to facilitate changing their values during a run. This will be explained below in the computations cycle.

TABLE 1

CORRESPONDENCE OF FORTRAN
VARIABLE NAME AND SUBSTANTIVE VARIABLE NAME

FORTRAN Name	Substantive Name
Endogenous	
GNP1, GNP2	Gross National Product
POP1, POP2	Population
ENE1, ENE2	Energy Consumption
TRD1, TRD2	Total (world) Trade
GTD1, GTD2	Great Power Trade
ALT1, ALT2	Direction of Alignment
ALN1, ALN2	Amount of Alignment
TML1, TML2	Turmoil
DEX1, DEX2	Defense Expenditures
MAN1, MAN2	Military Manpower
CNF1, CNF2	Log (international conflict)
CON1, CON2	International Conflict
REV1, REV2	Revolutionary Activity
STR1, STR2	Strife
EPB1, EPB2	Economic Power Base
MPB1, MPB2	Military Power Base
GPC1, GPC2	Gross National Product per Capita
DTD1, DTD2	Dyadic Trade
DCF1, DCF2	Dyadic Conflict
Exogenous	
POL	Polity Type
DST	Geographical Distance USSR/US
SAN	History of Sanctions
CTG	Contiguity (dyadic)
ELA	Trade Elasticity (dyadic)

Initialization

Figure 1 presents the flow chart for the initialization phase of the program, and accompanies lines 491-738. The first three lines establish the file into which the forecast output is stored. This is followed by three statements which establish the INDEX array (used later to manipulate dyadic data). INDEX is given the locations of the beginning items corresponding to each country in DCF and CTG. Lines 560 and 570 define the names of the data files to be read by the programs: IN for initial data, and AB for parameters. The initial data are read from file IN at line 580. Trade conversion (from world to European) initialization is done at lines 590-655, during which TPERC, the fraction of each nation's world trade devoted to Europe, is calculated. Lines 660-700 read the parameters from file AB. A descriptive title for each run is read at lines 703 and 706. Lines 710 and 712 modify constants which are later used in logarithmic equations. SQR2 is assigned the value of $\sqrt{2}$ at line 714.

Lines 720-735 establish the run parameters read on line 730: IS is the first year, IE is the last year, and KC is the interval (in years) between display/changes. IS and IE may be expressed in any desired numbers (e.g., 1, 25; 1971, 1995; etc.), although the initial date is assumed to be 1970 (line 736). Line 738 prints the appropriate heading (according to the format in lines 742-750).

Calculations Loop

The body of the forecast is found at lines 740-1580 and displayed in Figure 2. Basically, these statements perform the actual calculations which form the forecast. These lines are executed once for each

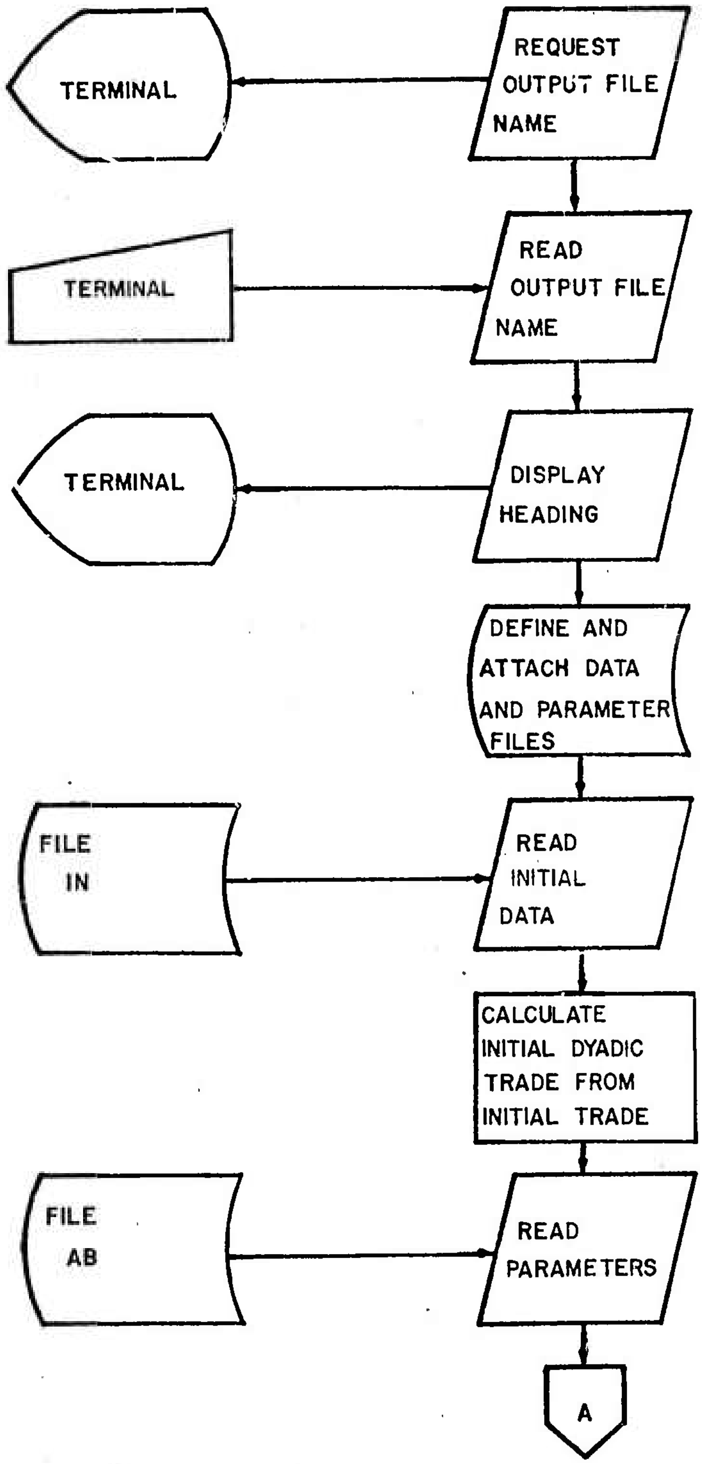

Figure I. Program FORECAST Initialization Flow Chart.

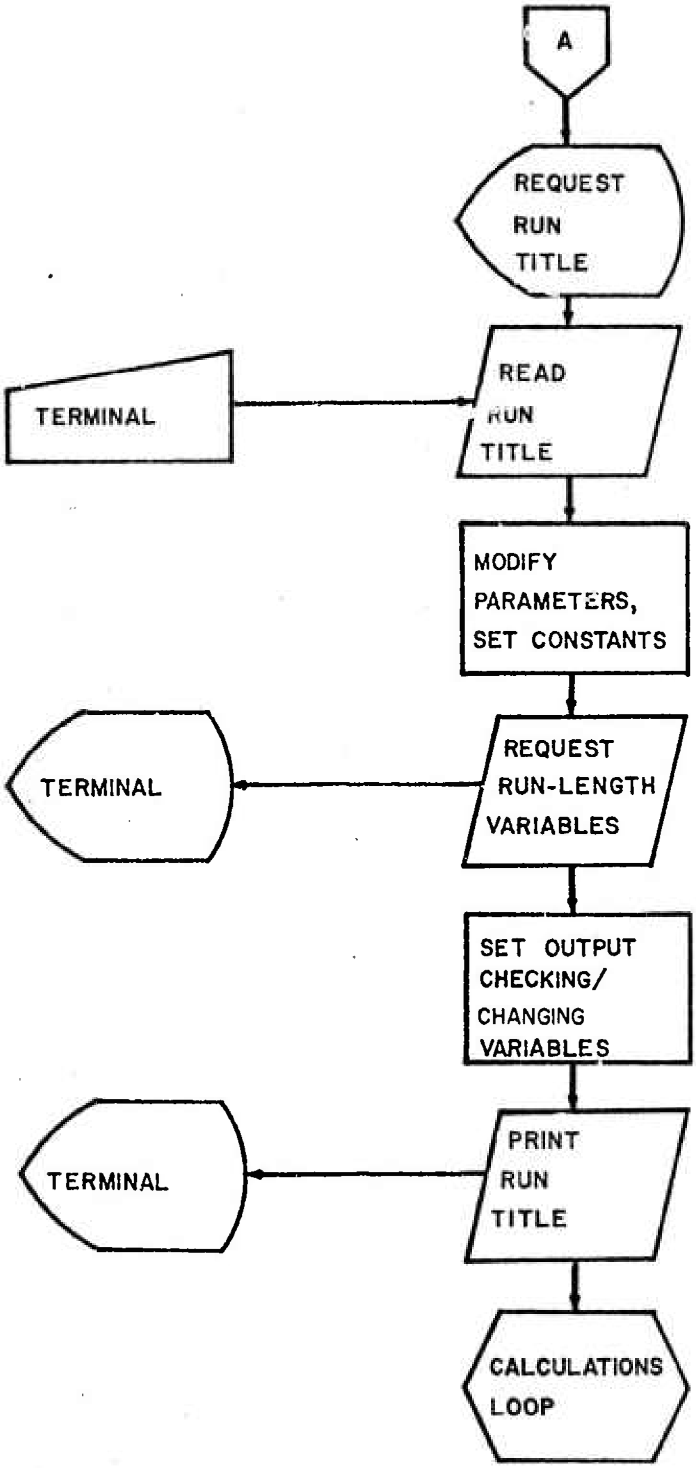

Figure I (continued).

LOOP OCCURS FOR EVERY YEAR PER RUN-LENGTH VARIABLES

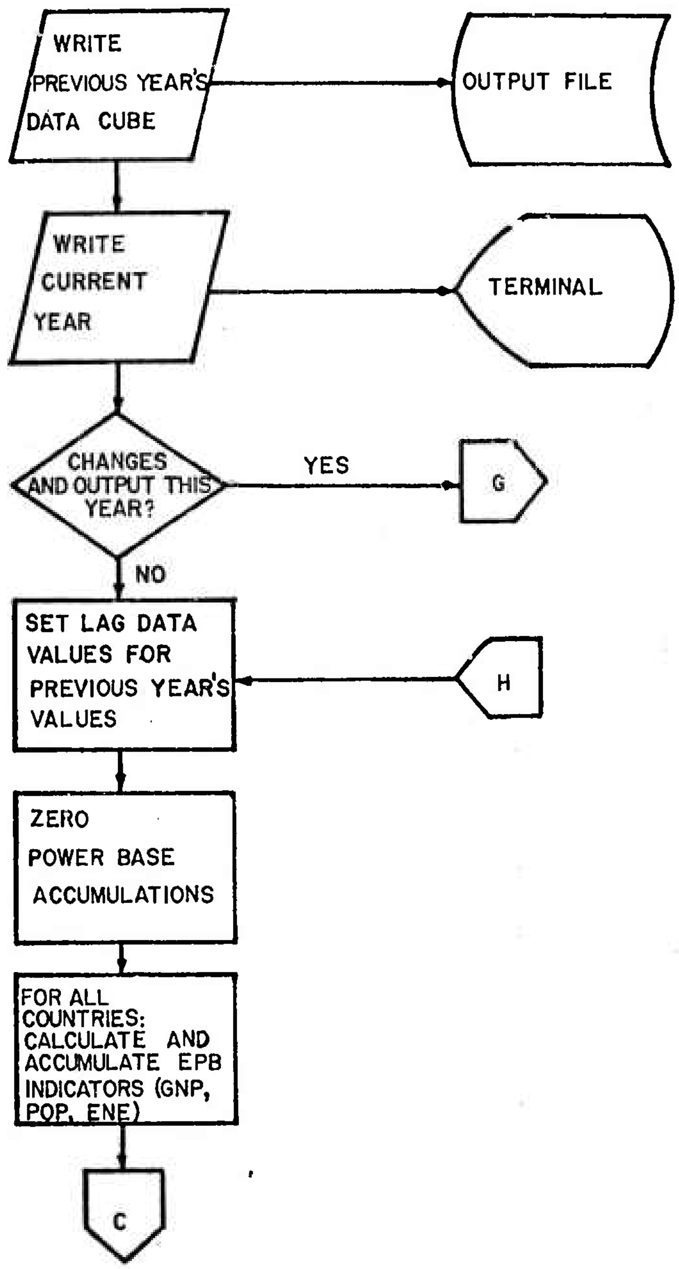

Figure 2. Program FORECAST Calculations Loop Flow Chart.

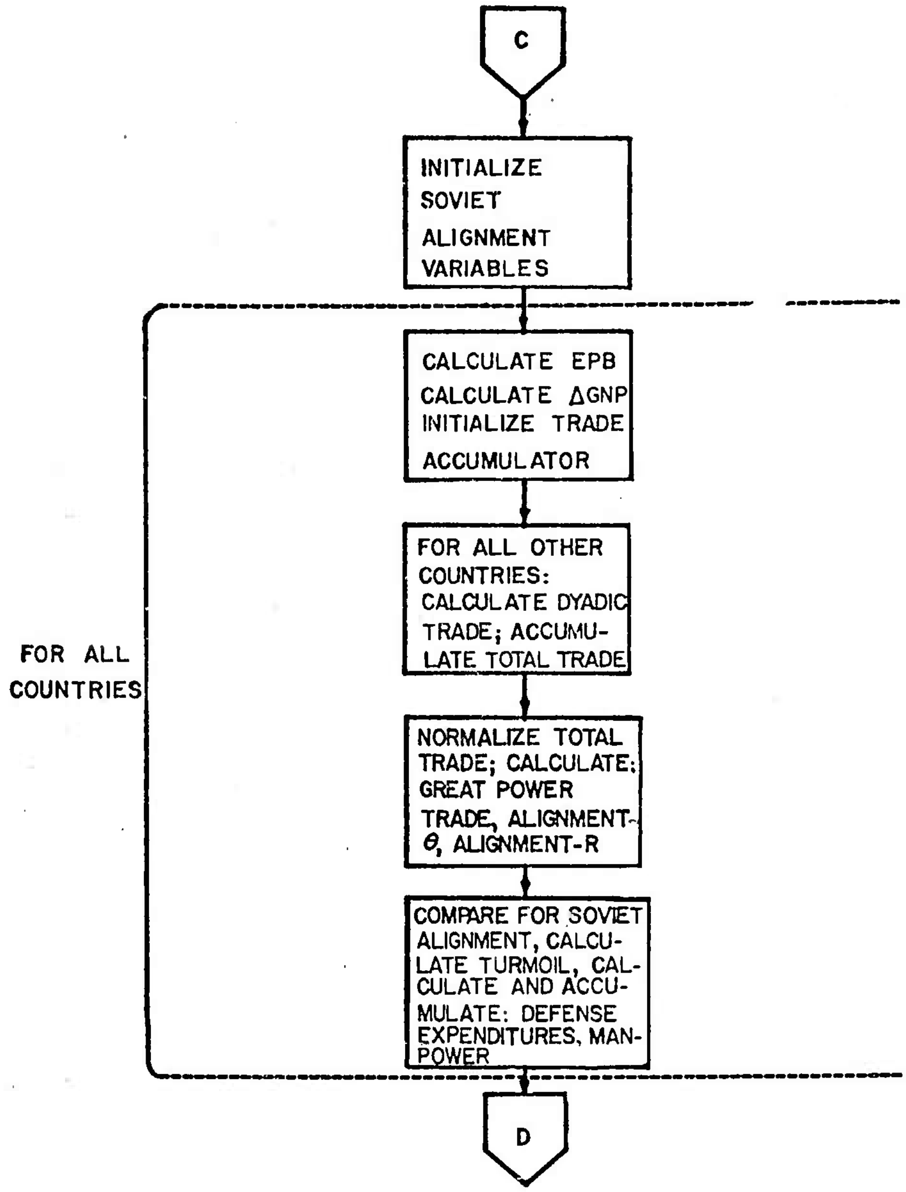

Figure 2 (continued).

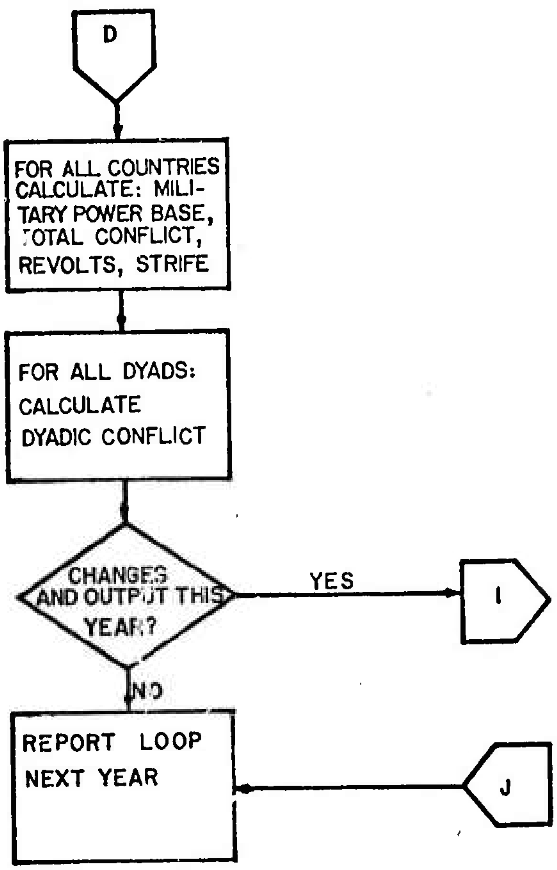

Figure 2 (continued).

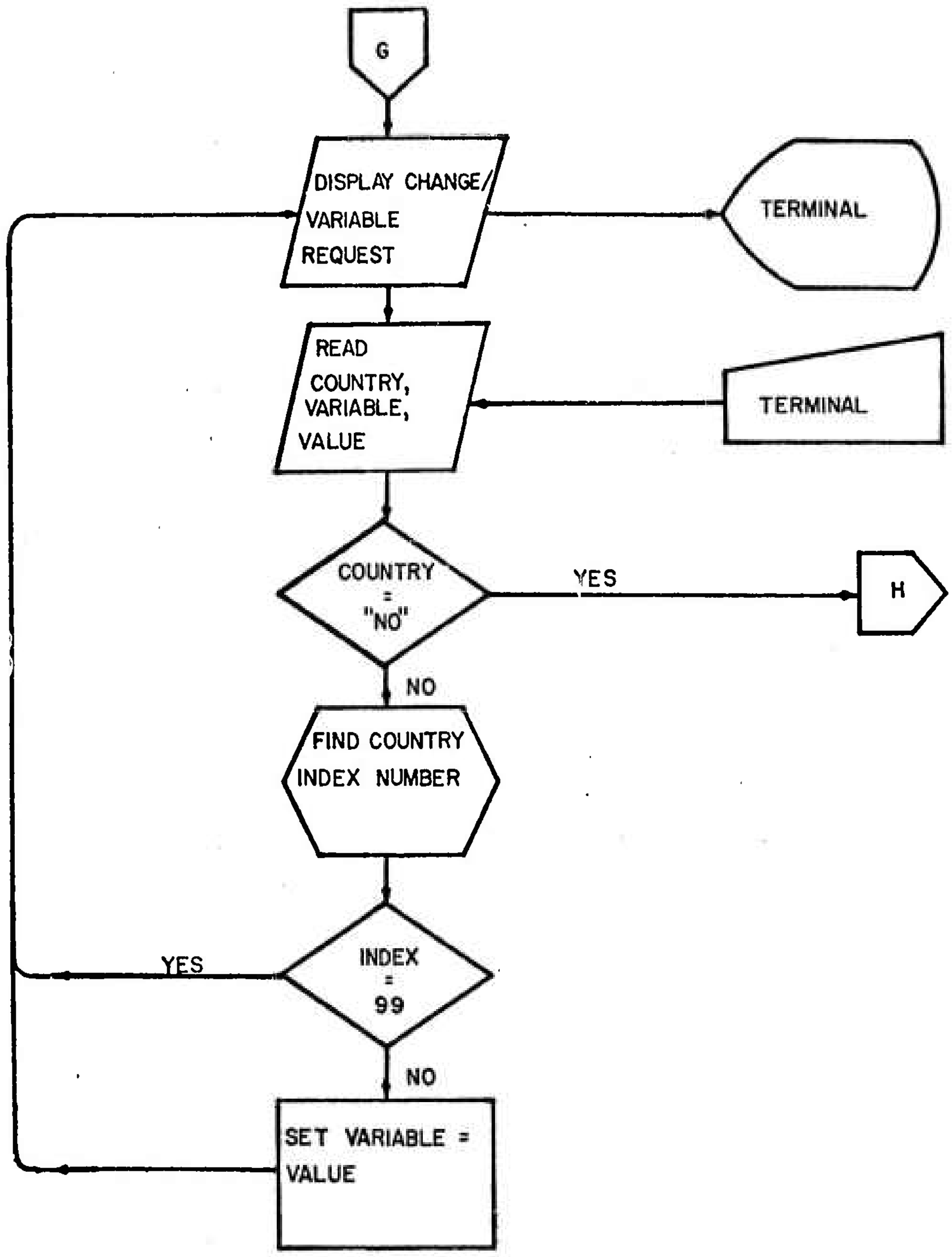

Figure 2 (continued).

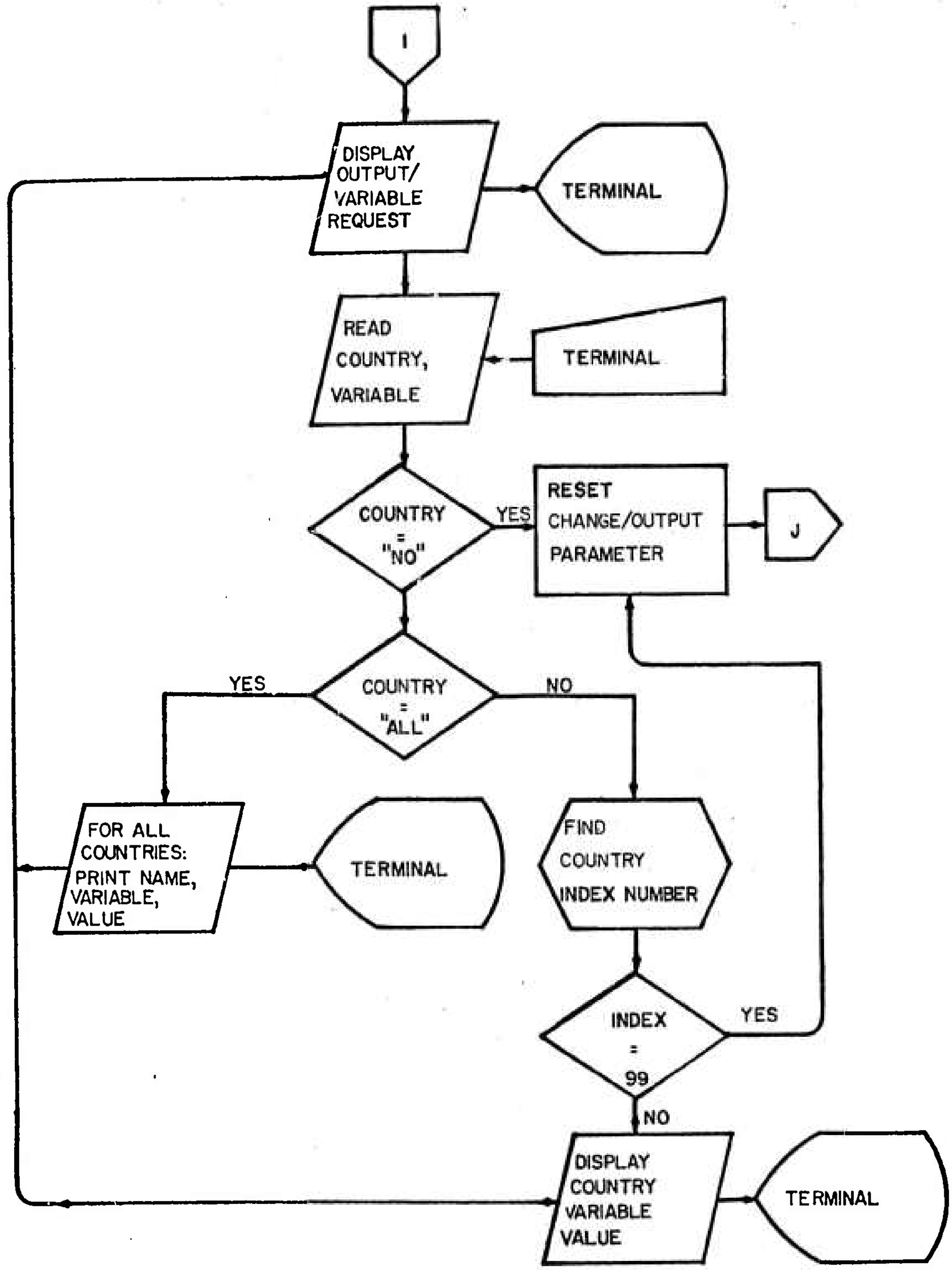

Figure 2 (continued).

forecasted year. The first step is storing the previous year's calculated values (or initial values for the first year), and printing the current year at the terminal. If the current year (IT) is "scheduled" for updating or changing information, the user is asked to enter a country name, a variable number (1-17) and the new value of that variable for that country. Modifications continue (lines 744-747) until the user types "NO" as a country name.

At lines 750 through 800, the previous year's "current" values are set to this year's "previous" values. Line 810 initializes all accumulated variables. Lines 830 through 930 calculate current values of population, energy consumption, gross national product, gross national product per capita, and accumulate the economic power base components. Line 940 initializes values of Soviet alignment. Line 960 calculates economic power base according to procedures described in Chapter 2.

Lines 970 through 1040 calculate dyadic trade and accumulate values of European trade, the latter of which is modified in line 1045 to create a total trade figure. Lines 1050 through 1126 are calculated for all countries except the Soviet Union. Lines 1070 and 1080 calculate the great power trade value; lines 1090 through 1115 calculate alignment components; and lines 1122 and 1124 assign Soviet alignment the maximum of the calculated values for the other countries.

Lines 1130-1142 calculate turmoil; defense expenditures are calculated in lines 1150-1170 and accumulated (for military power base) in line 1180. Similarly, military manpower is calculated at lines 1190-1210 and accumulated in line 1220. Military power base is actually calculated in lines 1270 through 1320.

Monadic conflict is calculated in lines 1325 through 1350. Revolution and strife are calculated in lines 1360 through 1390. Finally, dyadic conflict scores are generated in lines 1438 through 1512.

At the conclusion of the calculation cycle, the user is given the opportunity to examine values of variables for the purpose of changing them at the beginning of the next year. Lines 1527 through 1540 perform this function.

Termination and Subroutines

Termination of the program occurs after the final year's calculations are performed. At line 1590 the final year's values are stored and the file on which they are stored is closed at line 1600.

Subroutine INDEX1 (lines 1620-1710 and Figure 3) is used during the calculation of dyadic conflict. It simply returns the appropriate "dyad number" for a given pair of "country numbers." Subroutine INDEXC (lines 1800-1880 and Figure 4) is used in updating and examining values to convert a country name to a country number for internal use. Neither subroutine has substantive significance.

PROGRAMS PRINT AND RANK

Both of these programs display information about a forecast to the user at a terminal. They are identical except that one (PRINT) presents the actual data, while the other (RANK) converts the data to ranked values.

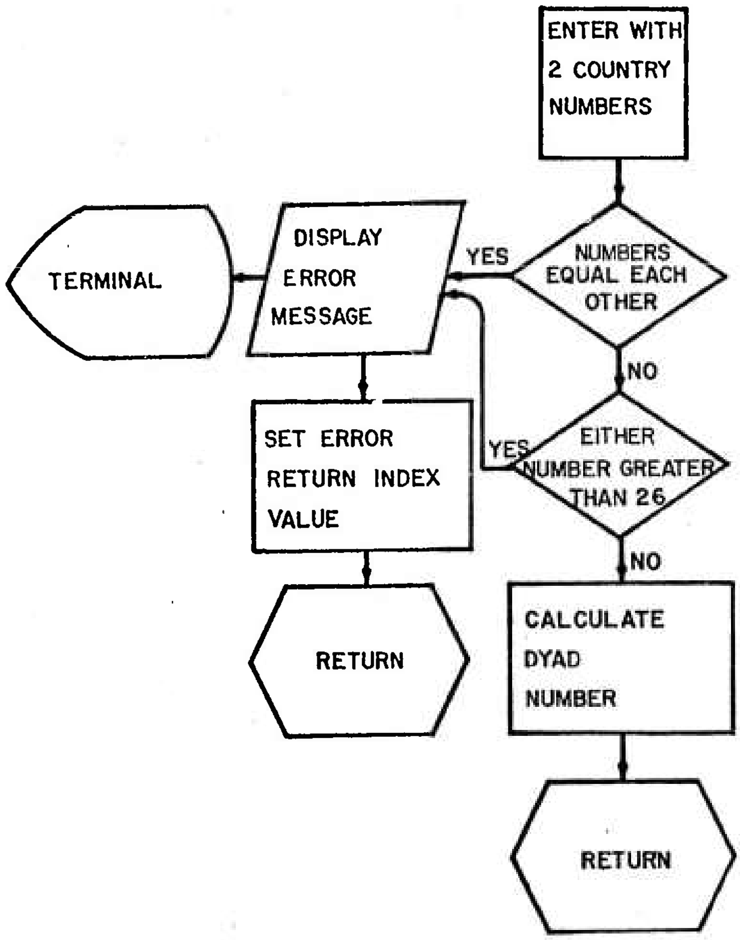

Figure 3. Program FORECAST Subroutine INDEXI Flow Chart.

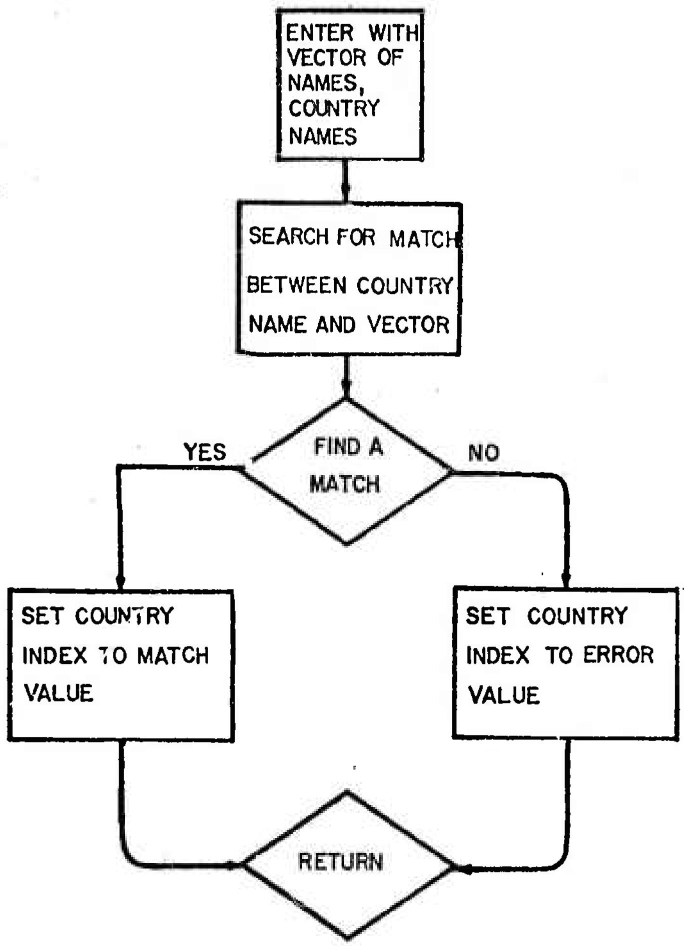

Figure 4. Program FORECAST Subroutine INDEXC Flow Chart.

Declarations and Initialization

The programs are identical in this phase. The 17 monadic variables which are output by program FORECAST are organized into a single list--X--corresponding to X1 in program FORECAST, and an array--Y--with a similar correspondence. In addition, the country names are stored in vector NC, variable names in NM and variable group names (to be described below) in NG. Line 150 presents the values of the six group names--G1, G2, G3, G4, G5, and G6 (see Figure 5).

Actual country and variable names are stored in a file called DICT, which is defined at line 170 and read in lines 172-178. Lines 180-184 request from the user the file in which forecast values have been stored, read that file name, and make that file available to the program. Lines 220 through 313 establish a list of countries for which forecast values are to be displayed. Country names are read until the user types "END." The vector KODE is set to 1 for each country designated. Alternatively, the user may type "ALL" if all countries' values are to be displayed.

Yearly Operation

Each year, the program reads forecast values as stored by the FORECAST program (line 315). Program RANK converts those values to ranks (in lines 1050-1190). Program PRINT proceeds directly to displaying the values. RANK simply creates ranks for each of the 17 variables by comparing each nation's score with each other nation's score, and adding 1.0 to the value of the smaller country's location in vector RANK. If the two are tied, 0.5 is added to each country's value. Otherwise RANK and PRINT are identical.

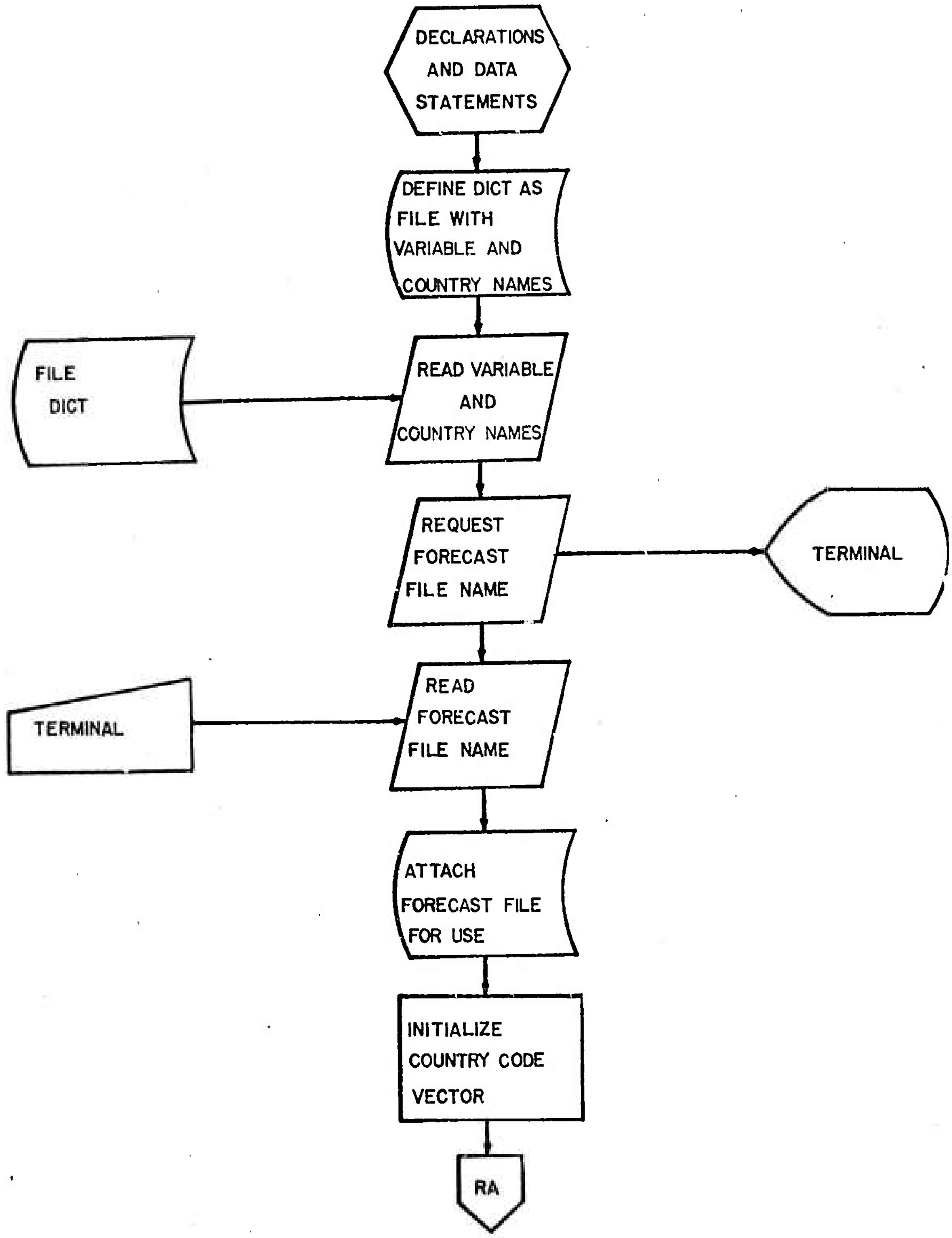

Figure 5. Program PRINT/RANK Flow Chart.

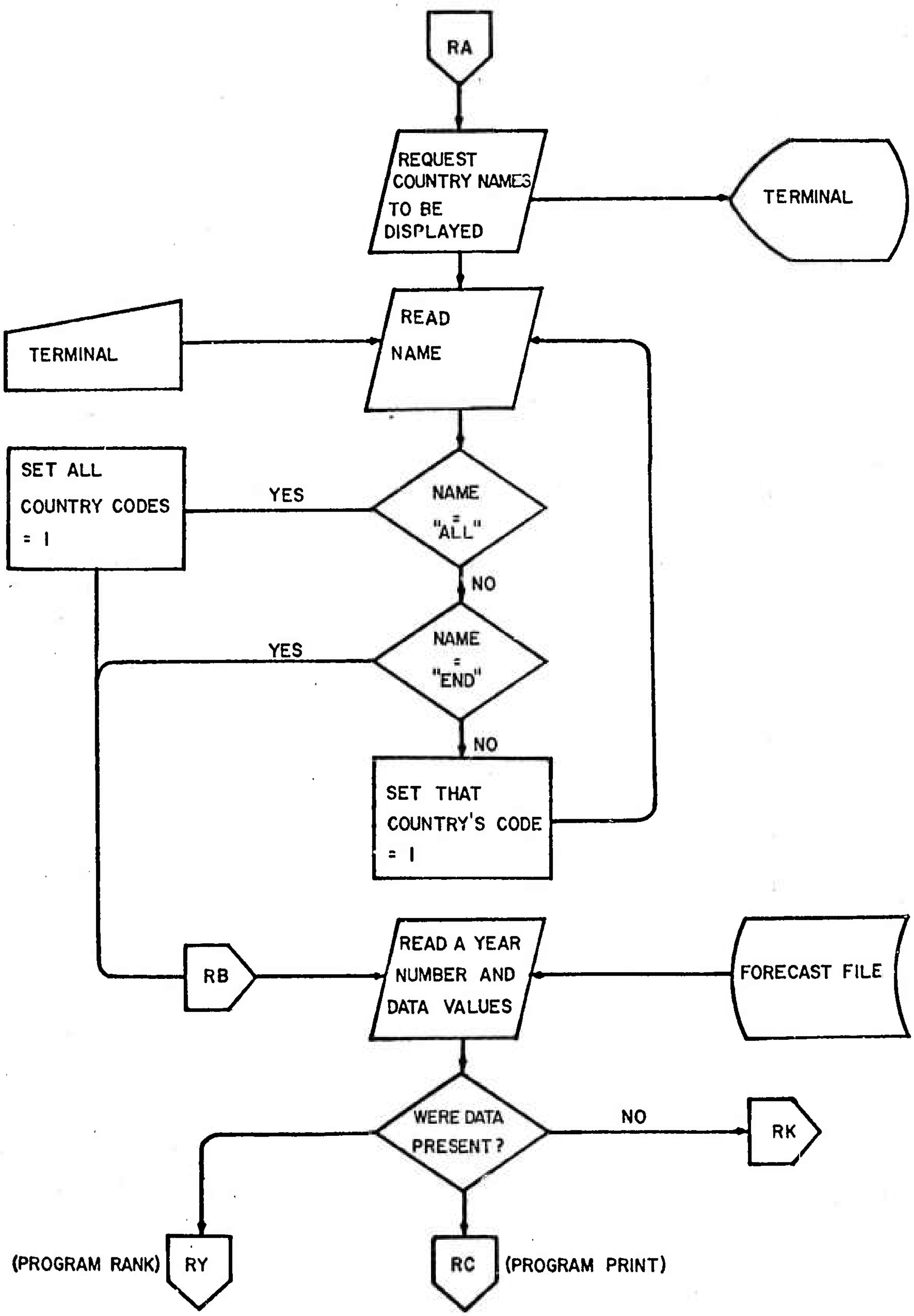

Figure 5 (continued).

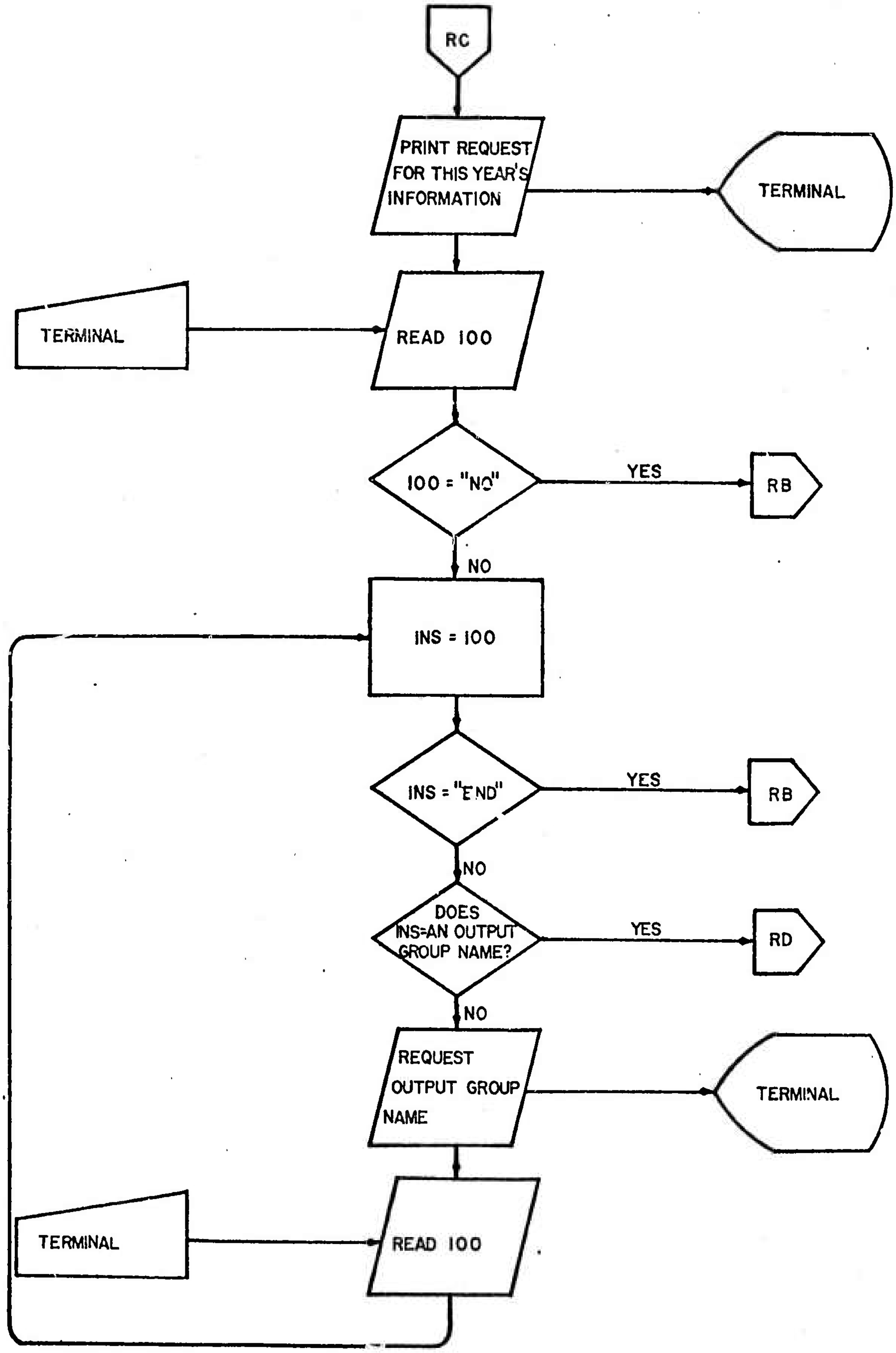

Figure 5 (continued).

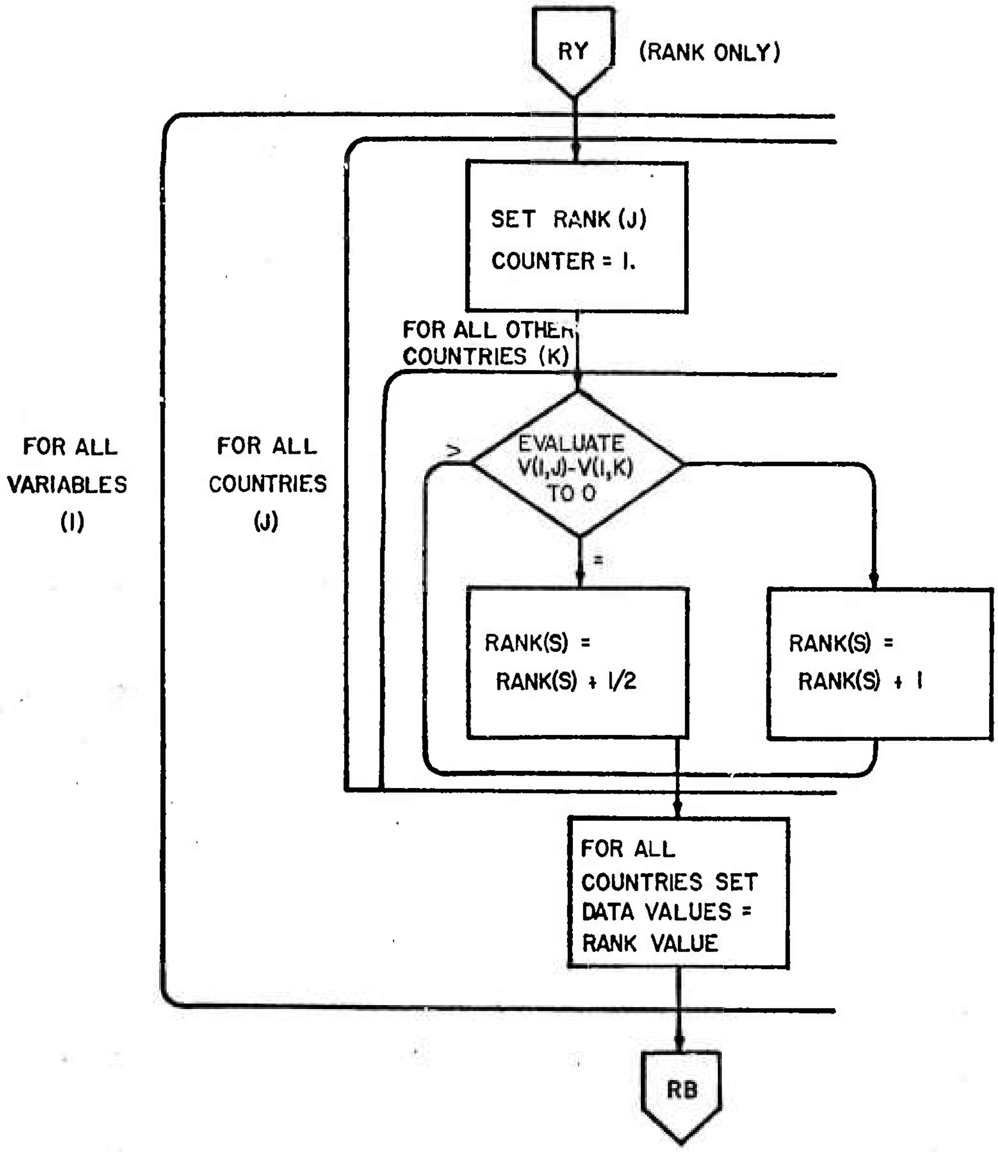

Figure 5 (continued).

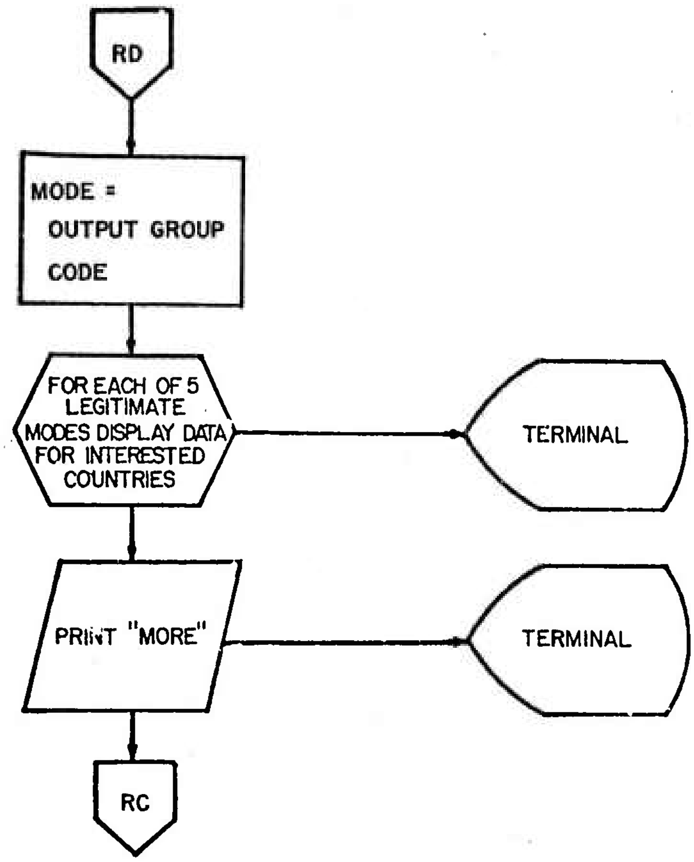

Figure 5 (continued).

The year is printed at the user's terminal as a part of the question:

OUTPUT FOR YEAR nnnn.

The user may answer "NO" at which point the computer circles back to reading the next year's information. If the user responds "YES," the the program asks for an "OUTPUT GROUP." This must be answered by one of the "group names" described above. Alternatively, the user may give a group name as the answer to the "OUTPUT FOR YEAR nnnn" question. Each group name tells the program to print out values for a particular set of variables for the countries specified. The variables in the six groups are shown in Table 2.

TABLE 2

VARIABLES IN OUTPUT DISPLAY GROUPS

Group	Variables
G1	MPB, EPB, STR, CON, ALN, ALR
G2	EPB, POP, ENE, GNP, GPC, TRD
G3	MPB, DFX, MAN
G4	ALN, ALR, GTD
G5	TML, REV, CNF
G6	None

Thus, if a user responds with "G2," this is determined (at lines 350-370) to be the second group, and from line 400 the program transfers to the second item on the list, statement 21 (line 490). At this point the variable names (NM) corresponding to the variables in G2 are printed (lines 490-500), followed by values (or ranks) of each variable for the selected countries (lines 510-540). This procedure is identical for each group. The program then transfers to line 1000, where the word "MORE" is typed, followed by a transfer back to line 323 where "OUTPUT FOR YEAR nnnn" is typed and the user is given the opportunity to respond "NO" (and transfer to the next year) or to request a new group of output.

After the final year's output, the program transfers to line 1500 and stops. Programs RANK and PRINT can be run any number of times for the same forecast data with different combinations of countries and groups.

```
00100 PROGRAM MIKE(INPUT,TAPE1,TAPE2,TAPE3,OUTPUT)
00110 DIMENSION POP1(27),POP2(27),ENG1(27),ENG2(27),GNP1(27)
00112+,Y(27,17)
00120+,          GNP2(27),TRD1(27),TRD2(27),GTD1(27),GTD2(27)
00130+,          ALT1(27),ALT2(27),ALN1(27),ALN2(27),TML1(27)
00140+,          TML2(27),DEX1(27),DEX2(27),MAN1(27),MAN2(27)
00150+,          CNF1(27),CNF2(27),CON1(27),CON2(27),REV1(27)
00160+,          REV2(27),STR1(27),STR2(27),EPB1(27),EPB2(27)
00170+,          MPB1(27),MPB2(27),GPC1(27),GPC2(27),POL(27)
00180+,          DST(27),SAN(27),DTD1(26,26),DTD2(26,26)
00190+,          DCF1(333),DCF2(333),CTG(325),ELA(26,26)
00200+,          CNAM(26),VNAM(26)
00210+,          A(13),B(13,6)
00220+,          TITLE(7),INDEX(26)
00230+,          X1(792),X2(792)
00240+,YY(6),DD(325)
00242+,TPERC(27)
00250 REAL MAN1,MAN2
00260 REAL MPB1,MPB2
00270 INTEGER TITLE,CNAM,VNAM
00280 EQUIVALENCE (X1(1),POP1(1)),(X2(1),POP2(1)),(X1(28),ENG1(1))
00290+,(X2(28),ENG2(1)),(X1(55),GNP1(1)),(X2(55),GNP2(1))
00300+,(X1(82),GPC1(1)),(X2(82),GPC2(1)),(X1(109),TRD1(1))
00310+,(X2(109),TRD2(1)),(X1(136),GTD1(1)),(X2(136),GTD2(1))
00320+,(X1(163),ALT1(1)),(X2(163),ALT2(1)),(X1(190),ALN1(1))
00330+,(X2(190),ALN2(1)),(X1(217),TML1(1)),(X2(217),TML2(1))
00340+,(X1(244),DEX1(1)),(X2(244),DEX2(1)),(X1(271),MAN1(1))
00350+,(X2(271),MAN2(1)),(X1(298),CNF1(1)),(X2(298),CNF2(1))
00360+,(X1(325),CON1(1)),(X2(325),CON2(1)),(X1(352),REV1(1))
00370+,(X2(352),REV2(1)),(X1(379),STR1(1)),(X2(379),STR2(1))
00380+,(X1(406),EPB1(1)),(X2(406),EPB2(1)),(X1(433),MPB1(1))
00390+,(X2(433),MPB2(1)),(X1(460),DCF(1)),(X2(460),DCF2(1))
00392 EQUIVALENCE (X1(1),Y(1,1))
00394 DATA NO/2HNO/
00395 INTEGER ALL
00396 DATA ALL/3HALL/
00400 DATA NC/26/
00410 DATA LIMA/792/
00422 DATA GFAC/.5/
00430 DATA CNAM/3HUNK,3HAUS,3HBLU,3HDEN,3HFRN,3HFRG,3HITA,3HNTH,
00440+3HNOR,3HSWD,3HSWZ,3HFIN,3HGRC,3HICE,3HIRE,3HPOR,3HSPN,
00450+3HTUR,3HYUG,3HBUL,3HCZE,3HGDR,3HHUN,3HPOL,3HROM,3HUSR/
00460 DATA VNAM/3HPOP,6HENERGY,3HGNP,7HGNPPCAP,5HTRADE,4HDGNP,
00470+5HTHETA,5HALIGN,6HT'MOIL,5HDEFEX,6HMANPOW,4HCLOG,
00480+4HCONF,6HREVOLT,6HSTRIFE,3HEPB,3HMPB,7HPOLTYPE,5HDDIST,
00490+8HSANCTION,6HCONTIG,4HELAS,6HDYTRAD,6HDYCONF,1HA,1HB/
00491 PRINT,*OUTPUT FILE*
00492 READ,IOUT
00493 CALL DEFINE(5HTAPE3,IOUT,0,0,1HW) $ REWIND 2
00500 INDEX(1)=1
00510 DO 8  K=2,NC
```

```
8 INDEX(K)=INDEX(K-1)+NC-K+1
100 FORMAT(///13X,◆C A C I  L O N G  R A N G E  ◆
+◆F O R E C A S T◆//5X,7A10)
CALL ATTACH(5HTAPE1,2HIN,0,0,0) $ REWIND 1
CALL GET(5HTAPE2,2HAB,0,0) $ REWIND 2
READ (1) X1,DD,POL,DST,SAN,CTG,ELA
DO 2000 I=1,NC
TPERC(I)=0.
DO 4  J=1,NC
IF (I.NE.J) GO TO 3
DTD1(I,J)=0. $ GO TO 4
3 CALL INDEX1(INDEX,I,J,K)
DTD1(I,J)=DD(K)
TPERC(I)=TPERC(I)+DTD1(I,J)
4 CONTINUE
2000 TPERC(I)=TPERC(I)/TRD1(I)
DO 6  I=1,13
READ (2,) N,A(I),YY
DO 5  J=1,6
5 B(I,J)=YY(J)
6 CONTINUE
PRINT,◆RUN TITLE:◆
READ,TITLE
A(1)=10.◆◆A(1)
A(3)=10.◆◆A(3)
SQR2=2.◆◆0.5
PRINT,◆FIRST,LAST YEARS, INCREMENT?◆
READ,IS,IE,KC
IP=KC $ KC=IS
IY=1970
PRINT 100,TITLE
DO 90  IT=IS,IE
WRITE (3) IY,X1 $ IY=IY+1 $ PRINT 605,IY
605 FORMAT(I4)
IF (KC.NE.IT) GO TO 20
17 PRINT,◆FOR CHANGES,ENTER COUNTRY,VARIABLE,NEW VALUE◆
18 READ,LC,LV,Z $ IF (LC.EQ.NO) GO TO 20
CALL INDEXC(CNAM,LC,IC) $ IF (IC.EQ.99) GO TO 17
Y(IC,LV)=Z $ GO TO 18
20 DO 10  K=1,LIMA
10 X2(K)=X1(K)
DO 7  I=1,NC
DO 7  J=1,NC
DTD2(I,J)=DTD1(I,J)
7 CONTINUE
200 SUMP=SUME=SUMG=SUMD=SUMM=0.
DO 250  I=1,NC
POP1(I)=A(1)◆
+POP2(I)◆◆B(1,1)◆
```

```
00841+GPC2(I)**B(1,2)
00842 IF (POP1(I).LE.0.) POP1(I)=0.
00850 ENG1(I)=A(2)+B(2,1)*ENG2(I)
00852 IF (ENG1(I).LE.0.) ENG1(I)=0.
00860 GNP1(I)=A(3)*GNP2(I)**B(3,1)*
00861+(DEX2(I)+1.)**B(3,2)*(TML2(I)+1.)**B(3,3)
00862 IF (GNP1(I).LE.GFAC*GNP2(I)) GNP1(I)=GFAC*GNP2(I)
00870 GPC1(I)=GNP1(I)/POP1(I)
00880 SUMP=SUMP+POP1(I)
00890 SUME=SUME+ENG1(I)
00910 SUMG=SUMG+GNP1(I)
00930 250 CONTINUE
00940 SDVALR=0. $ SDVALT=0.
00950 DO 300  I=1,NC
00960 EPB1(I)=GPC1(I)*(POP1(I)/SUMP+GNP1(I)/SUMG+ENG1(I)/SUME)/3.
00970 TRD1(I)=0.
00980 DGNP=(GNP1(I)-GNP2(I))/GNP2(I)
00990 DO 260  J=1,NC
01000 IF (I.EQ.J) GO TO 260
01020 DTD1(I,J)=(ELA(I,J)*DGNP+1.)*DTD2(I,J)
01030 TRD1(I)=TRD1(I)+DTD1(I,J)
01040 260 CONTINUE
01045 TRD1(I)=TRD1(I)/TPERC(I)
01050 IF (I.EQ.26) GO TO 262
01070 Q=DTD1(I,26)-(DGNP+1.)*(DTD2(I,26)-GTD2(I)*TRD2(I))
01080 GTD1(I)=Q/TRD1(I)
01090 ALT1(I)=A(5)+B(5,1)*GNP1(I)+B(5,2)*GTD1(I)+B(5,3)*POL(I)
01100++B(5,4)*ALT2(I)+B(5,5)*DST(I)
01102 IF (ALT1(I).LE.0.) ALT1(I)=0.
01104 IF (ALT1(I).GE.1.) ALT1(I)=1.
01110 ALN1(I)=A(6)+B(6,1)*ALT1(I)+B(6,2)*MAN2(I)+B(6,3)*CNF2(I)
01112+          + B(6,4)*ALN2(I)
01115 IF (ALN1(I).LT.0.) ALN1(I)=0. $ IF(ALN1(I).GT.SQR2) ALN1(I)=SQR2
01122 IF(ALT1(I).GT.SDVALT)SDVALT=ALT1(I)
01124 IF(ALN1(I).GT.SDVALR)SDVALR=ALN1(I)
01126 GO TO 264
01128 262 ALN1(26)=SDVALR $ ALT1(26)=SDVALT
01129 264 CONTINUE
01130 TML1(I)=A(7)+B(7,1)*POP1(I)+B(7,2)*STR2(I)+B(7,3)*ALT2(I)
01140++B(7,4)*MPB2(I)+B(7,5)*SAN(I)+B(7,6)*(TRD1(I)-TRD2(I))
01142 IF (TML1(I).LE.0.) TML1(I)=0.
1150 DEX1(I)=A(8)+B(8,1)*DEX2(I)+B(8,2)*CNF2(I)*ALN1(I)   +
1155+          B(8,3)*GNP1(I)+B(8,4)*GNP1(I)/POP1(I)
01170 IF (DEX1(I).LE.0.) DEX1(I)=0.
01180 SUMD=SUMD+DEX1(I)
01190 MAN1(I)=A(9)+B(9,1)*MAN2(I)+B(9,2)*GNP1(I)+B(9,3)*POP1(I)*ALN1(I)  +
01200+          B(9,4)*CNF2(I)+B(9,5)*TML2(I)
01210 IF (MAN1(I).LE.0.) MAN1(I)=0.
01220 SUMM=SUMM+MAN1(I)
01250 300 CONTINUE
```

```
DO 400  I=1,NC
MPB1(I)=0.
IF (MAN1(I).LE.0.) GO TO 270
MPB1(I)=DEX1(I)*(DEX1(I)/SUMD+MAN1(I)/SUMM)/2.
+/MAN1(I)
270 CONTINUE
CNF1(I)=A(10)+B(10,1)*CNF2(I)+B(10,2)*MPB1(I)+B(10,3)*EPB2(I)
IF (CNF1(I).LE.0.) CNF1(I)=0.
CON1(I)=10.**CNF1(I)-1.
RR=(A(11)+B(11,1)*TML1(I)+B(11,2)*REV2(I)
++B(11,3)*CNF1(I)+B(11,4)*MPB1(I)+B(11,5)*GPC1(I))
IF (RR.LE.0.) RR=0.
REV1(I)=RR*RR
STR1(I)=REV1(I)+TML1(I)
400 CONTINUE
410 IMAX=NC-1
DO 500  I=1,IMAX
JMIN=I+1
DO 498  J=JMIN,NC
CALL INDEX1(INDEX,I,J,K)
C1=CON1(I)+CON1(J) $ C2=CON2(I)+CON2(J)
DM=ABS(MPB1(I)-MPB1(J)) $ SM=MPB1(I)+MPB1(J)
Z=SQRT(DCF2(K))+B(12,2)*C1+B(12,3)*CYG(K)+B(12,4)*C2
++B(12,5)*DM
Q2=ALT1(I) $ Q1=SQRT(1.-Q2*Q2)
Q4=ALT1(J) $ Q3=SQRT(1.-Q4*Q4)
R=Q1*ALN1(I)-Q3*ALN1(J)
S=Q2*ALN1(I)-Q4*ALN1(J)
Q=B(12,6)*SQRT(R*R+S*S)
DYC=A(12)+B(12,1)*Z+B(12,6)*Q*SM
DCF1(K)=DYC*DYC
498 CONTINUE
500 CONTINUE
IF (KC.NE.IT) GO TO 90
PRINT,*FOR OUTPUT,ENTER COUNTRY,VARIABLE*
88 READ,LC,LV
IF (LC.EQ.NO) GO TO 79
IF (LC.EQ.ALL) GO TO 87
CALL INDEXC(CNAM,LC,IC) $ IF (IC.EQ.99) GO TO 79
PRINT 606,LC,VNAM(LV),Y(IC,LV)
GO TO 88
606 FORMAT(A3,1X,A8,1X,F12.3)
87 DO 89  IJ=1,NC
89 PRINT 606,CNAM(IJ),VNAM(LV),Y(IJ,LV)
GO TO 88
79 IF (KC.EQ.IT) KC=KC+IP
90 CONTINUE
999 WRITE (3) IY,X1
ENDFILE 3 $ REWIND 3
STOP
```

```
SUBROUTINE INDEX1(IN,K,L,IX)
DIMENSION IN(26)
IF (K.NE.L.AND.K.LE.26.AND.L.LE.26) GO TO 14
PRINT,◆ERROR IN INDEX◆
IX=1 $ GO TO 99
14 IF (K.LT.L) GO TO 16
I=L $ J=K $ GO TO 18
16 I=K $ J=L
18 IX=IN(I)+J-I-1
99 RETURN $ END
SUBROUTINE INDEXC(NAM,J,I)
DIMENSION NAM(26)
DATA NC/26/
DO 10  K=1,NC
IF (J.EQ.NAM(K)) GO TO 12
10 CONTINUE
I=99 $ GO TO 99
12 I=K
99 RETURN
END
```

```
.011084 1.0006 -.002592 0. 0. 0. 0.
-.053971 1.0539 0. 0. 0. 0. 0.
.06314 .98311 .013243 -.013727 0. 0. 0.
0 0 0 0 0 0 0
.072994 -.00000054555 .36998 .14253 .4996 .000038362 0.
.051939 .01234 .044239  -.012471 .80657 0. 0.
.247002 .019801 .091529 -.25117 -.000532909 .0019031 -.000005388
5.9239 .9153 22.057 .0044468 -.0059573 0. 0.
.00269 .936696 -.000000086974 .002 .00937 .0089289 0.
.077398 .51264 -.000195928 .00143624 0. 0. 0.
.059074 .34192 .36825 .14614 -.00002925 -.00004203 0.
.57884 .42818 .001105 .049389 -.018635 -.000021248  .000038961
1 1 1 1 1 1 1
```

```
00100    55.73   7.39  10.02    4.93  50.77  59.43  53.67  13.03   3.88
00110     8.04   6.25   4.69    8.79   0.20   2.94   9.65  33.78  35.33
00120    20.37   8.49  14.47   15.97  10.31  32.47  20.65 242.77   0.
00130   299.14  25.35  59.65   28.85 193.04 317.05 144.10  66.19  18.67
00140    50.72  21.36 19.61   11.20    0.85   8.81   6.62  49.94  16.87
00150    29.34  34.14  90.77 102.75   32.72 138.85  56.881076.86
00160  121000. 14300. 26700. 15600.147500.186300. 93200. 31200. 13400.
00170   32600. 20500. 10200.  9500.    500.  4100.  6200. 32300.  9000.
00180   24700. 12700. 39700. 42000. 18600. 51200. 29000.646100.
00190  2171.181935.052664.673164.302905.263134.781736.542394.473453.61
00200  4054.733280.002174.841080.772500.001394.56 642.49 956.19 254.74
00210  1212.571495.882743.612629.931804.071576.841404.362661.37
00220  41083.0 6405.422955.5 7760.937049.464175.528121.025160.3 6152.7
00230  13786.311641.1 4944.1 2603.6  304.5 2604.1 2502.9 7136.9 1476.9
00240   4558.5 3824.0 7653.0 9428.0 4822.0 7150.0 3811.024539.0
00250   -0.10  -0.01  -0.07  -0.07  -0.06 -0.09  -0.08  -0.07  -0.06
00260   -0.05 -0.08   0.07  -0.04  -0.12  -0.08  -0.00  -0.17  -0.11
00270     0.04   0.53   0.31   0.39   0.33   0.34   0.25   0.99
00280    0.07   0.26   0.16   0.23   0.16   0.02   0.14   0.11   0.28
00290     0.23   0.22   0.40   0.54   0.16   0.33   0.05   0.23   0.52
00300     0.87   1.00   1.00   1.00   1.00   0.99   0.98   1.00
00310     0.37   0.30   0.33  0.30   0.39   0.26   0.36   0.35   0.30
00320     0.28   0.09   0.29   0.31   0.34   0.30   0.36   0.38   0.36
00330     0.34   0.43   0.42   0.22   0.40   0.[illegible]   0.38   1.00
00340     0.49   0.0    0.0    0.0    0.70   0.7[illegible]   1.24   0.30   0.0
00350     0.0    0.0    0.0    0.32   0.0    0.0    0.31   0.95   0.69
00355     0.0    0.0    0.48   0.0    0.0    1.19   0.0    0.0    0.0
00360   5865.0  165.0  705.0 368.0 5977.0 6167.0 2499.0 1098.0  388.0
00370   1129.0  422.0  140.0  474.0    0.0   36.0  435.0 1165.0  416.0
00380    667.0  310.0 1660.0 2200.0  560.0 2250.0  610.065000.0
00390     0.39   0.05   0.10   0.04   0.51   0.48   0.41   0.12   0.04
00400     0.08   0.03  0.04   0.16   0.0    0.01   0.18   0.28   0.48
00410     0.26   0.17   0.20   0.20  0.14   0.29   0.23   3.53
00420     0.95   0.0    0.30   0.30   0.70   1.26   0.60   0.30   0.30
00430     0.0    0.0    0.0    0.48   0.0    0.30   0.0    0.30   0.48
00440     0.30   0.0    0.30   1.15   0.0    0.30   0.30   1.20
00450    15.00   1.00   0.0    0.0    8.00  21.00   4.00   0.0    1.00
00455    0.0    0.0    0.0    2.0    0.0    3.0    0.0    2.0    0.0
00460     2.00   1.00   8.00  15.00   1.00   1.00   3.00  24.00
00470     0.0    0.0    0.0    0.0    0.48   0.30   0.34   0.0    0.0
```

00480	0.0	0.0	0.0	0.32	0.0	0.0	0.31	0.0	0.0
00490	0.0	0.0	0.0	0.0	0.0	0.75	0.0	0.0	
00500	0.49	0.0	0.0	0.0	1.18	1.00	1.58	0.30	0.0
00510	0.0	0.0	0.0	0.65	0.0	0.0	0.63	0.95	0.69
00515	0.0	0.0	0.48	0.0	0.0	1.94	0.0	0.0	0.0
00520	183.05	17.76	44.87	27.60	218.64	317.67	104.02	47.59	22.91
00530	65.34	31.04	14.05	7.79	0.73	4.44	4.10	26.44	5.05
00540	21.40	15.50	68.82	72.61	22.06	64.84	30.64	972.69	
00550	755.75	12.02	64.95	33.54	678.13	727.05	214.79	110.22	39.67
00560	138.63	54.44	10.17	33.79	0.0	2.67	29.70	89.54	25.47
00570	46.33	20.40	159.53	239.93	42.88	212.61	42.509415.03		
00580	0.0	0.0	0.0	0.63	0.14	0.0	0.0	0.0	0.0
00590	0.0	0.0	0.0	0.0	1.00	0.0	0.0	0.0	0.0
00600	0.0	0.0	0.84	0.0	0.0	0.0	4.00	0.0	0.0
00610	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00620	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00630	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00640	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00650	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.84
00660	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00670	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00680	0.0	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00690	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00700	0.0	0.0	0.0	0.0	0.0	0.0	0.97	0.0	0.0
00710	0.0	0.0	0.0	0.0	1.00	0.0	0.0	0.0	1.00
00720	0.0	0.0	0.0	0.0	9.64	0.0	0.0	0.0	0.32
00730	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00740	0.0	0.0	1.00	0.0	1. 0	0.0	0.0	0.0	0.0
00750	0.95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00760	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00770	1.00	0.0	0.0	0.0	1.00	0.0	0.0	0.0	0.0
00780	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00790	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00810	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00820	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00830	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00840	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00850	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00860	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00870	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00880	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00890	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.81
00910	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00920	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00930	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00940	0.57								

00950	392.8	1125.2	1151.5	1543.0	2425.1	1076.5	1730.2	857.4	1721.2
00960	871.1	711.7	175.6	41.6	1596.3	405.6	553.1	119.9	206.2
00970	46.6	103.6	79.2	71.1	294.6	125.5	773.2	102.4	110.9
00980	184.3	2221.5	505.5	186.0	53.6	226.5	564.1	55.6	38.7
00990	1.5	4.0	39.7	34.1	18.5	183.0	37.6	129.2	54.0
01000	140.0	102.5	75.6	161.6	160.2	4266.1	5677.0	1039.4	3893.6
01010	150.2	440.8	355.3	93.6	88.8	10.6	36.8	59.4	160.4
01020	52.5	64.8	14.8	40.6	47.9	29.7	51.1	31.9	131.3
01030	252.9	1220.0	245.3	244.3	412.2	1220.8	180.6	171.3	17.1
01040	29.0	20.7	42.0	48.4	14.2	20.2	4.6	38.6	38.8
01050	24.8	82.5	9.5	62.1	7919.1	3686.6	2180.9	183.6	599.8
01060	1266.5	173.0	178.3	4.3	73.6	178.6	689.0	87.0	187.1
01070	66.6	96.7	101.9	73.8	149.2	135.3	476.5	5902.2	7479.9
01075	947.9	2077.4	2863.1	661.6	489.9	39.4	134.0	328.1	880.8
01080	378.8	832.2	130.3	487.7	0.0	276.4	383.2	355.7	764.8
01090	1257.8	131.9	405.5	1106.7	106.6	241.5	7.0	42.6	124.3
01095	389.3	156.7	654.9	104.0	150.0	61.7	213.8	192.8	213.8
01100	589.4	192.8	598.8	367.2	177.7	105.7	9.8	60.5	64.5
01110	250.1	46.1	82.6	16.5	67.1	84.7	58.9	57.5	36.1
01120	103.6	1133.0	97.2	145.5	63.5	10.6	11.7	25.8	42.2
01130	4.7	17.5	3.8	21.9	15.4	11.2	32.4	2.6	55.6
01140	369.0	774.3	31.8	17.1	30.9	93.2	137.4	15.2	62.9
01150	12.6	67.9	124.3	47.2	96.7	32.4	287.1	99.4	39.4
01160	5.7	12.8	79.8	163.8	71.6	116.2	16.5	76.5	39.4
01170	56.5	43.9	35.2	76.8	20.9	6.0	18.2	26.6	34.0
01180	5.8	9.5	9.5	26.1	35.8	21.0	66.8	13.6	613.8
01190	1.1	2.2	4.6	15.5	4.6	74.4	24.3	26.3	18.9
01200	21.3	19.3	26.8	70.7	0.3	6.5	2.7	0.1	0.1
01210	0.0	3.5	1.5	1.3	4.1	0.6	21.1	4.3	14.7
01220	1.3	0.5	0.7	4.1	1.7	2.4	23.4	2.0	3.8
01230	85.1	5.3	0.7	0.9	4.5	0.8	0.7	5.5	3.2
01240	1.0	9.2	31.3	13.0	21.3	12.7	14.5	34.5	22.1
01250	15.6	19.2	9.2	24.5	21.1	27.2	36.4	12.3	68.1
01260	55.0	240.7	125.3	96.9	108.5	65.4	434.7	-9.9	-9.9
01270	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9
01280	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9
01290	-9.9								
01300	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
01310	0.0	0.0	0.0	0.0	0.0	0.0	1.00	1.00	0.0
01320	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
01330	1917.00	3194.00	2279.00	2886.00	2088.00	2598.00	2816.00	2277.00	2647.00
01340	3171.00	2366.00	3572.00	3551.00	514.00	1366.00	944.00	1456.00	3935.00
01350	-5540.0	3556.00	3044.00	2979.00	3338.00	3555.00	3770.00	4680.00	
01360	59.00	8.00	7.00	3.00	65.00	80.00	32.00	12.00	7.00
01370	7.00	44.00	4.00	169.00	0.0	7.00	63.00	138.00	36.00
01380	32.00	10.00	37.00	132.00	42.00	83.00	5.00	166.00	

01400	1.00	2.23	2.11	1.26	1.85	1.53	1.44	1.38	1.90
01410	2.00	2.33	1.61	1.00	.84	2.65	1.68	2.45	2.31
01420	2.08	1.80	.55	1.01	1.34	1.04	1.20	.65	1.00
01430	1.00	1.69	3.40	1.51	1.72	1.26	1.67	2.98	3.89
01440	3.21	3.29	1.09	1.00	3.64	2.26	2.49	2.08	3.10
01450	1.02	1.34	.62	1.50	.97	1.67	.61	1.86	1.52
01460	1.00	1.26	2.86	2.35	2.08	1.87	1.12	1.36	1.53
01470	1.03	1.12	1.16	2.07	.51	2.21	1.94	4.17	1.15
01480	1.00	.71	.84	1.74	2.25	1.67	1.67	2.90	1.71
01490	1.00	1.64	0.88	1.49	1.87	2.55	3.73	2.50	1.65
01500	1.57	1.56	3.64	2.32	2.03	1.86	2.19	1.39	0.95
01510	0.41	1.86	1.31	1.18	1.00	2.29	1.72	2.95	1.84
01520	1.00	2.31	2.80	2.65	1.32	2.05	2.35	1.16	1.65
01530	0.96	4.14	2.19	2.71	1.81	3.42	1.74	1.60	1.37
01540	0.82	1.92	1.87	1.83	4.11	2.11	3.27	2.22	3.18
01550	1.00	2.58	2.58	2.17	2.55	2.92	2.69	1.77	1.98
01560	4.49	2.52	3.05	2.29	3.98	1.79	2.42	1.00	1.00
01570	1.59	1.64	1.15	2.93	1.62	4.00	2.85	3.48	2.65
01580	1.00	3.72	2.16	2.58	2.47	2.32	1.27	0.72	4.15
01590	2.92	3.87	2.60	3.15	2.11	1.77	2.93	2.24	1.83
01600	1.44	1.69	2.52	2.17	2.40	1.80	3.11	2.08	2.84
01610	1.00	1.30	1.98	1.96	0.98	1.76	1.39	2.51	1.71
01620	2.74	2.37	3.28	2.17	1.93	2.37	1.68	1.90	2.95
01630	1.47	3.00	1.18	1.27	2.27	1.52	1.59	1.33	1.41
01640	1.00	3.31	2.36	2.22	3.03	2.29	3.12	1.43	1.36
01650	1.45	2.24	1.00	1.00	1.00	1.04	1.28	1.00	0.83
01660	2.47	2.90	1.57	2.80	1.81	1.18	1.63	1.39	2.20
01670	1.00	2.84	3.25	0.86	1.52	2.57	2.05	2.45	1.92
01680	3.16	2.65	1.22	2.04	1.98	1.03	2.00	0.99	4.17
01690	2.48	0.90	2.36	2.02	1.62	1.42	1.44	2.44	2.61
01700	1.00	2.82	2.01	0.99	2.68	2.08	2.15	2.45	3.33
01710	2.47	1.86	2.98	1.92	1.44	1.24	2.59	2.32	3.17
01720	1.24	1.74	1.27	1.37	1.93	1.47	2.83	4.29	2.45
01730	1.00	1.42	1.00	2.41	1.92	2.21	0.59	1.00	1.09
01740	1.00	1.00	1.19	1.00	0.58	0.95	1.32	1.00	3.80
01750	0.74	1.71	1.12	1.54	2.62	0.55	1.88	1.18	1.00
01760	1.00	1.00	1.00	1.26	2.36	1.00	3.20	2.16	0.84
01770	1.15	0.82	1.00	1.35	0.73	3.12	1.00	0.59	1.99
01780	0.37	1.28	0.43	1.00	0.81	2.59	0.67	1.00	1.00
01790	1.00	1.00	1.44	0.66	1.00	1.00	1.00	1.00	1.00
01800	1.00	1.00	1.00	1.00	2.43	0.30	2.14	0.94	2.97
01810	1.96	1.94	2.14	1.21	1.69	1.53	1.00	0.28	1.00
01820	1.00	0.25	1.52	0.11	1.00	1.00	1.00	1.00	0.78
01830	1.79	1.00	1.00	3.60	2.85	0.70	2.92	1.80	1.24
01840	1.26	1.80	2.00	3.51	2.48	2.80	0.85	0.33	1.29
01850	1.00	2.18	1.46	0.73	1.00	0.98	1.00	1.00	0.41
01860	0.70	1.00	2.45	1.00	1.93	1.32	2.39	1.87	2.89
01870	2.17	0.88	2.12	1.58	0.94	1.85	1.00	2.46	3.71
01880	1.00	1.12	5.20	2.55	2.62	2.56	3.67	1.62	2.55
01890	2.57	1.02	1.00	2.76	1.32	0.83	1.00	1.25	1.51
01900	0.55	1.00	3.01	1.00	1.00	1.00	2.33	2.19	1.00

[illegible]10	1.00	2.77	1.51	0.65	2.36	2.57	0.84	2.12	2.91
01920	2.52	1.36	1.51	1.98	2.23	1.35	2.34	1.52	2.45
01930	3.08	2.33	1.00	1.94	1.00	1.00	1.00	2.09	1.39
01940	1.00	1.66	2.14	1.00	2.01	1.00	1.83	2.36	5.67
01950	1.09	1.88	1.30	2.96	2.73	3.75	1.92	1.45	1.53
01960	1.44	0.99	2.44	1.00	0.35	0.86	1.99	1.89	3.31
01970	1.00	1.00	1.70	1.93	1.49	1.26	1.77	2.66	1.00
01980	1.27	2.27	1.94	1.83	1.90	1.03	0.92	1.52	1.06
01990	1.00	2.03	1.00	1.59	1.00	2.02	1.35	4.56	0.64
02000	1.00	1.23	0.47	0.57	1.00	0.49	4.91	1.00	2.69
02010	0.78	3.30	1.00	2.53	1.91	0.60	2.01	1.07	1.00
02020	1.75	1.00	1.60	1.00	1.00	1.00	2.21	1.24	1.36
02030	1.00	1.31	0.67	0.80	0.79	5.18	1.73	1.98	2.42
02040	2.92	1.62	2.87	2.43	2.09	3.37	1.95	1.26	2.21
02050	1.00	0.51	1.00	1.95	2.15	1.96	1.63	0.70	1.72
02060	1.00	1.02	1.00	1.19	2.33	0.82	2.04	1.53	1.79
02070	2.08	2.12	2.30	1.72	1.00	1.14	1.00	2.28	1.00
02080	4.52	2.20	2.64	2.48	1.00	1.99	1.23	2.00	1.34
02090	1.00	1.04	1.30	6.10	1.93	2.79	1.11	3.47	3.74
02100	3.73	2.78	1.00	2.60	2.32	1.00	1.53	1.00	1.00
02110	1.25	3.34	2.12	4.70	1.50	1.84	1.83	1.00	1.21
02120	1.00	0.40	2.80	4.07	2.17	2.03	3.04	4.39	2.92
02130	1.57	1.22	3.47	2.04	2.22	2.77	1.00	1.00	1.00
02140	2.77	3.73	4.05	1.68	0.79	0.90	1.27	1.42	0.38
02145	1.00								
[illegible]50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02160	0.0	0.0	0.0	0.0	1.0	0.0	0.	0.0	0.0
02170	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02180	0.0	1.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0
02190	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0
02200	1.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	1.0
02210	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02220	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02230	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02240	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02250	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0
02260	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
02270	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
02280	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
02290	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0
02300	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
02310	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
02320	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02330	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02340	0.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
02350	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
02360	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02370	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02380	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02390	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
[illegible]00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

```
PROGRAM RANK(INPUT,TAPE1,TAPE2,OUTPUT)
DIMENSION X(742),Y(27,17),RANK(27)
+,NC(26),KODE(26)
+,NM(17)
+,NG(6)
INTEGER ALL,END
DATA NG/2HG1,2HG2,2HG3,2HG4,2HG5,2HG6/
DATA NUMC/26/
DATA ALL,END,NO/3HALL,3HEND,2HNO/
EQUIVALENCE (X(1),Y(1,1))
CALL GET(5HTAPE1,4HDICT,0,0) $ REWIND 1
READ (1,100) NM
100 FORMAT(5X,8(1X,A6))
READ (1,102) NC
102 FORMAT(5X,14(1X,A3))
PRINT,*FILE*
READ,NAME
CALL ATTACH(5HTAPE2,NAME,0,0,0) $ REWIND 2
199 FORMAT(A3,6(1X,F10.2))
2 DO 3  K=1,NUMC
3 KODE(K)=0
PRINT,*COUNTRIES*
4 READ,ICC
IF (ICC.EQ.ALL) GO TO 6
IF (ICC.EQ.END) GO TO 1
DO 5  K=1,NUMC
NXX=NC(K)
IF (ICC.NE.NXX) GO TO 5
KODE(K)=1 $ GO TO 4
5 CONTINUE
PRINT,*ERROR IN COUNTRY CODE*
GO TO 4
6 DO 7  K=1,NUMC
7 KODE(K)=1
1 READ(2)IY,X
IF(ENDFILE2)99,14
14 PRINT 104,IY
104 FORMAT(*OUTPUT FOR YEAR *,I4)
READ,IOO
IF (IOO.EQ.NO) GO TO 1
200 INS=IOO
IF (INS.EQ.END) GO TO 1
DO 8  K=1,6
IF (INS.EQ.NG(K)) GO TO 10
8 CONTINUE
PRINT,*OUTPUT GROUP*,
READ,IOO
GO TO 200
10 MODE=K
13 GO TO (11,21,31,51,61,71) MODE
```

```
11 PRINT 121,NM(17),NM(16),NM(15),NM(13),NM(8),NM(7)
DO 12  K=1,NUMC
IF (KODE(K).EQ.0) GO TO 12
PRINT 199,NC(K),Y(K,17),Y(K,16),Y(K,15),Y(K,13),Y(K,8)
+,Y(K,7)
112 FORMAT(A3,6F9.3)
12 CONTINUE
GO TO 80
21 PRINT 121,NM(16),(NM(L),L=1,5)
121 FORMAT(◆NAT◆,6(4X,A6,1X))
DO 22  K=1,NUMC
IF (KODE(K).EQ.0) GO TO 22
PRINT 199,NC(K),Y(K,16),(Y(K,L),L=1,5)
22 CONTINUE
GO TO 80
31 PRINT 121,NM(17),NM(10),NM(11)
DO 32  K=1,NUMC
IF (KODE(K).EQ.0) GO TO 32
PRINT 199,NC(K),Y(K,17),Y(K,10),Y(K,11)
32 CONTINUE
GO TO 80
51 PRINT 121,NM(8),NM(7),NM(6)
DO 52  K=1,NUMC
IF (KODE(K).EQ.0) GO TO 52
PRINT 199,NC(K),Y(K,8),Y(K,7),Y(K,6)
52 CONTINUE
GO TO 80
61 PRINT 121,NM(9),NM(14),NM(12)
DO 62  K=1,NUMC
IF (KODE(K).EQ.0) GO TO 62
PRINT 199,NC(K),Y(K,9),Y(K,14),Y(K,12)
62 CONTINUE
GO TO 80
71 CONTINUE
80 PRINT,◆MORE ◆,
GO TO 14
500 DO 600 I=1,17
DO 550 J=1,NUMC
RANK(J)=1.
DO 530 K=1,NUMC
IF(J.EQ.K)GO TO 530
IF (Y(J,I)-Y(K,I))520,510,530
510 RANK(J)=RANK(J)+.5
GO TO 530
520 RANK(J)=RANK(J)+1.
530 CONTINUE
550 CONTINUE
DO 580 J=1,NUMC
580 Y(J,I)=RANK(J)
600 CONTINUE
GO TO 14
99 STOP $ END
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13. ABSTRACT

The overall purpose of this Interim Technical Report is to provide a basis for the improvement of long-range environmental forecasting through the use of quantitative methods. This volume provides the technical discussion of the model that was developed to forecast values of five central environmental descriptors for the European environment of the 1985-1995 period. The descriptor variables considered were international conflict, international alignment, national power base, internal instability, and international trade.

The structure of the model consists of 12 equations which specify the various components of the descriptor variables. The coefficients of the model which is block-recursive are estimated using the least squares method. Forecasts of the five central environmental descriptors are provided by a simulation of the model.

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