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

VOLUME I

SUMMARY VOLUME

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Principal Investigator:

G. Robert Franco

Prepared by:

Herman M. Weil
Aaron Greenberg
Larry German
Douglas Hartwick
Michael R. Leavitt

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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).

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

This volume of the Interim Technical Report was prepared by:

Dr. G. Robert Franco, Project Director
Dr. Herman M. Weil
Mr. Aaron Greenberg
Mr. Larry German
Mr. Douglas Hartwick
Dr. Michael R. Leavitt*

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* Dr. Michael R. Leavitt is currently Director of the Social Science Computer Center at the Brookings Institution.

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CHAPTER 1: PROJECT TASKS

The major tasks to be performed by CACI in this study are as follows:[1]

Task I: Expand the Number of Long-Range Environmental Descriptor Concepts.

The number of long-range environmental descriptors shall be expanded from three to five to include additional descriptors of special interest to JCS/J5 and other DoD agencies involved in long-range forecasting. Two subtasks are subsumed under Task I:

Subtask A: Selection of Specific Descriptor Concepts

Subtask B: Operationalization of the Selected Descriptor Concepts

Task II: Examine the Interactive Effects Among Central Descriptors.

The interactive effects among the central environmental descriptors shall be described and analyzed, and hypothetical, theoretical, and empirical relationships among these descriptors shall be derived. The single-equation models of international conflict, international alignment, and domestic stability employed in the research to date shall be revised to reflect the complexities introduced by these interactive effects.

Task III: Test the Generality of the Long-Range Environmental Forecasting Models.

Since the international conflict, international alignment, and domestic stability long-term forecasting models have only been applied experimentally to the countries of the Indian Ocean area, the generality of

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[1] See CACI's unsolicited proposal entitled "Quantitative Methods for Long-Range Environmental Forecasting II" (Arlington, Va., January, 1973).

these three models and the additional central-descriptor models selected in Task I shall be tested by systematically applying these models to another region of the world. This application shall include not only postdictions but forecasts of each concept.

Task IV: Forecast the Long-Range Environment for Additional Selected Regions.

The central-descriptor models shall be applied to at least one additional region of the world besides the Indian Ocean. Forecasts shall be made of all of the central descriptors of the long-range environments of each of the selected regions. Postdictions of all concepts for each region shall be made to demonstrate model validity.

Task V: Develop a Long-Range Forecasting Research Guide.

A long-range forecasting Research Guide shall be prepared that shall systematically describe the specific tasks to be performed in developing a long-range environmental forecast. The Guide shall enumerate the major subjects, central concepts, descriptors and predictors of those concepts, the sources of available data for the predictors, and the recommended technique(s) for analyzing the data. This Research Guide shall be based on and supplement the General Handbook for Long-Range Environmental Forecasting[2] previously published.

Task VI: Prepare the Final Report and Disseminate the Results.

The Final Report shall describe all the research and analyses performed under Tasks I through V. The results of the long-range regional environmental forecasts shall be described in detail, as shall the methods,

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[2] CACI, A General Handbook for Long-Range Environmental Forecasting, Vol. I (Arlington, Va., February 1973).

techniques, and data employed in the various analyses. This task shall include disseminating the major findings of the project to potential users in the national security community in the form of briefings, technical reports, or other appropriate means.

Each of these tasks has been addressed and accomplished in the following manner.

Task I. After consulting with various DoD agencies, especially JCS/J5, the number of central environmental descriptors was increased by two to include, besides the original three, national power base and international trade. These two descriptors were picked to satisfy two criteria: users' needs and CACI's belief that the descriptors could be forecast over the long range with some credibility.

Task II. To meet the requirements of this task, a 12-equation simultaneous model was constructed in which the central environmental descriptors or components of the descriptors interact to explain one another. Thus the values of variables in some equations are themselves determined by other forecasting equations. This characteristic of the model was absent in the single-equation Indian Ocean models that simply forecast alignment, conflict, and stability independently of each other.[3]

Tasks III and IV. After consulting with JCS/J5, it was decided that the interactive model called for in Task II would be tested on the European environment of 1985-1995, the period covered by the current

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[3] See CACI, Quantitative Methods for Long-Range Environmental Forecasting.

JLRSS. This area was picked primarily because most of the European countries are fairly well-endowed with data, and because most of them are industrialized, well-developed countries. This is in contrast to the Indian Ocean countries studied in the previous research effort.

Task V. Under the first phase of the contract, CACI published A General Handbook for Long-Range Environmental Forecasting which identified 11 techniques that can be used to generate long-range forecasts.[4] One major criticism made by users of the General Handbook was that it described each forecasting technique fairly accurately, but did not show the analyst how to use it. To correct this problem, A Research Guide for Long-Range Environmental Forecasting has been prepared. This document describes a step-by-step procedure to generate long-range forecasts. The Guide is based on and uses the techniques described in the Handbook and should, therefore, be used in conjunction with it.

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[4] See CACI, A General Handbook for Long-Range Environmental Forecasting, Vols. I and II.

CHAPTER 2: PROJECT PRODUCTS

This project has generated three main products: theoretical models of the five central environmental descriptors; simulation of the models and forecasts of the long-range European environment; and a Research Guide that describes how to generate quantitative long-range environmental forecasts. The output of the research effort has also been disseminated verbally to the user community by regularly scheduled meetings and briefings. A series of briefings on the work as it progressed were presented to the Action Officers for the JLRSS. Furthermore, a paper entitled, "The Use of Quantitative Methods for Long-Range Environmental Forecasting" was presented at the 32nd Session of the Military Operations Research Society.

THE THEORETICAL MODELS

Volume II of this study presents most of the theoretical discussions concerning the development of the models used to generate forecasts of the five central environmental descriptors. Each central environmental descriptor is discussed in detail and indicator and operational measures of each descriptor are chosen. Furthermore, equations that are used to forecast values of the descriptor variables are specified. Owing to the nature of the interactive model, certain descriptor variables are used as predictor variables for other descriptors. For example, international trade, a central environmental descriptor, is an explanatory variable of international alignment, another descriptor variable. Chapter 3 of this volume summarizes the research that has been done on these five central environmental descriptors.

THE COMPUTER SIMULATION

Forecasts of the descriptor variables are generated by a simulation of a dynamic model that examines interactive effects among the five descriptor variables and a set of exogenous variables. The simulation is an on-line model that allows man/machine interaction. By quantitatively or qualitatively reestimating certain parameter values, or by changing some variable values at various points in time, the analyst can alter the forecasts. This simulation is an important part of CACI's integrated approach to forecasting. By interacting with the computer through a terminal, analysts can inject any qualitative inputs they desire into the model. These inputs will, in conjunction with the quantitatively derived inputs, generate new sets of forecasts that can be evaluated for plausibility. The Appendix to Volume II presents the simulation program for the dynamic model.

THE RESEARCH GUIDE

The Research Guide, Volume III of this study, is a four-chapter document that demonstrates how to generate long-range forecasts. It is based on the assumption that the analyst is not well-versed in social science research, but is nevertheless familiar with the forecasting techniques described in A General Handbook for Long-Range Environmental Forecasting. The first chapter of the Guide shows the analyst how to build a conceptual model. The term model, as well as the components of a model, namely, variables, parameters, and functional relationships are defined. Various qualitative techniques that may be used in choosing the variables, parameters, and relationships are described. The use of a cross-impact matrix is suggested as one method of separating endogenous from exogenous variables. Finally,

basic and important functional relationships that relate variables to one another are explained.

The second chapter of the Guide, the "Data Collection Phase," discusses three important phases of data collection--selecting indicators of the variables, operationalizing the variables, and collecting the data. In the data collection phase, the analyst is referred to Volume II of the Handbook in which over 300 data files and 7000 variables are described. Furthermore, the chapter discusses various techniques that are designed to deal with missing data problems.

Chapter 3 of the Research Guide discusses the parameter-estimation phase of the forecast effort and describes ways to derive the functional relationships that relate variables to one another. Once again, the techniques suggested are explained in the General Handbook.

Chapter 4 of the Research Guide presents a hypothetical forecast model. In this model, a hypothetical analyst is assumed to be interested in forecasting the national power base of the People's Republic of China. The example carefully traces each step in generating and evaluating the forecast.

CHAPTER 3: THEORETICAL MODELS

This chapter summarizes the work that has been done on developing models to forecast values of the five central environmental descriptors considered in the analysis: national power base, international alignment, international conflict, internal instability, and international trade. Substantive theoretical and empirical analyses for each descriptor can be found in Volume II of this study. This chapter presents nontechnical summaries of these descriptors, specifying the equation used to forecast values of each descriptor for the European long-range environment, estimates of parameters that were obtained via least squares regression, and postdictions when appropriate. Actual forecasts for each descriptor variable are presented in the next chapter where the simulation of the dynamic model is discussed. The dynamic model examines the interactive effects among the five central environmental descriptors.

NATIONAL POWER BASE [1]

Power has long been recognized by both scholars and practitioners as a central concept in international politics. The meaning of the concept, however, engenders endless debate. In the literature dealing with the term power, two general categories emerge; one that conceptualizes power as a relationship between actors, and a second that links power to the holder. The first category, power characterized as a relationship, suggests that it exists only as influence is achieved and is therefore measureable only after it is exercised. Measurement attempts

[1] For a complete discussion of this descriptor, see Volume II, Chapter 2 of this report.

are usually based on the outcome of the relationship and consequently depend on the issue that gives rise to the power relationship. Since we cannot accurately forecast which issues will be important over the long range or what positions various nations will take on specific issues, power characterized as a relationship is not a useful central environmental descriptor.

The second category, power conceptualized as something possessed, will be used in the long-range environmental forecasting model. To distinguish this concept from the power relationship discussed above, and to suggest the idea of the potential for power, we refer to it as "power base." We define power base as the material and human resources a nation can bring to bear to influence the behavior of other nations. However, while we think of power base as a national attribute, our primary concern in the model is to forecast the power position of nations relative to other nations in the European region. Therefore, our major criterion for evaluation will rest on the ability of the models to rank nations relative to other nations on the power-base descriptor.

National power base is a vital central environmental descriptor for the long-range forecasting model. In its interaction with other central environmental descriptors, it serves as an important predictor variable. For example, power base is linked to domestic instability as an indicator of the resources available to nations to suppress instability. Furthermore, the two dimensions of national power base or their components are used as predictor variables in the international conflict, international alignment, and international trade forecasting models.

Power base is divided into two dimensions, economic power base (EPB) and military power base (MPB). The economic dimension is constructed from four indicators--population (POP), gross national product (GNP), energy consumption (EN CONS), and GNP per capita (GNP/POP). The first three tap the size element that establishes national power as well as specific attributes that contribute to national economic strength. Thus population provides the manpower necessary to establish and maintain a great industrial plant, to field large combat units, and to feed and supply the soldiers and citizenry. Gross national product adds the weight of labor productivity, distinguishing nations with advanced economies from those at subsistence levels. Energy consumption emphasizes the contribution made by the industrial sector of a nation's economy. The fourth indicator, GNP per capita, reflects the quality factors of economic power base and indicates the balance among power elements.

Each of the first three indicators is first transformed into the nation's percentage shares of the total in the region. The three percentages are then averaged. For example, the total population of all the European nations in our model is added together. Then each nation's population is divided by the total, thereby giving the nation's share. 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.

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

The military power-base dimension is composed of military manpower (MIL MANPOW), defense expenditures (DEFEX), and defense expenditures per man in the armed forces ($\frac{DEFEX}{MIL\ MANPOW}$). As with the

economic dimension, manpower and defense expenditures represent the size elements, and defense expenditures per man represent the quality elements such as leadership, training, and firepower. Here again, the size elements are transformed into percentage shares, averaged, and then multiplied by defense expenditures per man.

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

Parameter estimates of the indicators that comprise the two dimensions of national power base are determined via least squares regression techniques. (Parameter estimates are shown in Volume II, Chapter 2 of this report.) Each predictor variable, derived from hypothesized linkages to the indicators of power base, is examined to determine the direction and magnitude of its effect on the power-base measure. The resulting models are used to generate "expected values" for both dimensions of national power base. That is, the models are used to "postdict" economic and military power-base measures for each European nation year by year from 1962 to 1970.

The results indicate that the forecasting models provide quite accurate postdictions of the power-base index and extremely accurate rankings of nations in the European region on each power-base dimension. For the economic dimension, the vast majority of postdictions were within 10 percent of the actual values while on the military dimension most were within 15 percent of the actual values. The major factor that produces somewhat less accurate postdictions on the military dimension compared to the economic dimension is that the military indicators are far more policy-manipulable. Therefore, a much greater range of fluctuation is observed in the actual military power-base dimension.

However, as we noted earlier, our primary concern is with the accuracy of the relative postdictions of power base. The rank-order correlation between actual and postdicted ranks on both power-base dimensions suggests extremely high reliability for the forecasting model. For the economic dimension, the correlation was greater than .990 for each year, indicating almost perfect association between actual and predicted ranks. On the military dimension, the correlation was usually greater than .980 and never fell below .965, again demonstrating the high reliability of the forecasting model.

In sum, the forecasting model provides an excellent tool for predicting relative power base for the nations in the European region. (Power-base forecasts are shown in Volume II, Chapter 7.) Furthermore, while the index value itself does not correspond to observable values, it is suggestive of the magnitude of differences in resources available to the nations of Europe.

INTERNAL INSTABILITY[2]

An important aspect of the international environment is the viability of political regimes. In addition, domestic instability is a factor that can have an effect on the interactions among nations during the long-range future. In the context of the long-range forecasting model, the internal instability descriptor is linked directly to both dimensions of national power base as well as to international conflict.

Consistent with previous theoretical and empirical work, we divide instability into two distinct dimensions--turmoil and revolt. Turmoil

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[2] For a complete discussion of this descriptor, see Volume II, Chapter 3 of this report.

is defined as those 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. The distinctions do not necessarily coincide with the motives of the participants. Rather, they rest upon a relatively well-developed body of theoretical and empirical literature on internal instability.

Five kinds of events are usually used to measure turmoil and revolt. Turmoil has been operationalized with measures of antigovernment demonstrations and antigovernment riots whereas revolt has been measured by occurrences of assassinations, coups d'etat, and armed attacks against public and quasi-public institutions. While we have tried to maintain consistency with these measurement schemata in this analysis, the lack of widespread assassinations and attempted coups d'etat in post-World War II Europe prevented their use as measures of revolt here. Therefore, armed attacks against public and quasi-public institutions were used as a measure of revolutionary activity although this usage is somewhat at odds with the usual conception of revolt as a forceful overthrow of the government. Nevertheless, it would be difficult to imagine a forceful take-over of government institutions that did not involve armed attacks. Thus, armed attacks provide an inclusive operationalization which is particularly relevant in the European context.

The two components of turmoil mentioned above--antigovernment demonstrations and riots--were summed to form a composite measure. Unfortunately, these event counts only indicate the number of times turmoil activities occurred; they suggest nothing about their scope or severity. In order to weight the event counts by their relative severity,

the number of deaths resulting from domestic conflict was used as a weighting factor. Thus, levels of both turmoil and revolt were computed by multiplying transformed event data for each category by transformed death tolls. (See Volume II, Chapter 3 for a discussion of data transformations used.) Since the transformations in both cases adjusted for the expected direction of reporting biases, and those biases were in opposite directions, combining the two measures in a multiplicative manner further offset the effects of these biases. The composite measures of the levels of turmoil and revolt, then, are intended to tap the number and severity of those actions.

A number of variables hypothesized to affect the levels of turmoil and revolt were examined with respect to their linkages with these two measures in the 26 European nations. Multiple regression analysis was the basic technique used to extract two sets of predictor variables from the hypothesized linkages to build forecasting models for the two aspects of internal instability. Six variables--population, past levels of internal instability, alignment distribution, military power base, change in trade, and negative government sanctions--were used in the turmoil forecasting model. Population and military power base proved to have the strongest linkages to turmoil, each explaining nearly a quarter of its variance.

The forecasting model for revolt contained five variables--present levels of turmoil, past levels of revolt, international conflict, military power base, and gross national product per capita. Two of these predictors, military power base and GNP per capita, are country characteristics. The other three--past revolutionary activity, present turmoil, and the level of international conflict with other nations in the European system--are behavioral characteristics. Present turmoil proved to be the most consistent and strongest predictor of revolt.

Descriptive models of turmoil and revolt were developed and estimated with two-stage least squares regression. These models explained 66 percent and 55 percent of the variance in turmoil and revolt, respectively. However, these models could not be used for forecasting purposes because they used turmoil as the primary predictor of revolt while revolt was used as a predictor of turmoil. It was necessary to develop recursive models that allowed 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 were 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 explained 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, economic wealth, 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 forecast the other instability with confidence.

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

that only account for number of riots, demonstrations, armed attacks, and deaths from political violence, miss large and constantly growing components of internal instability. For example, terrorist acts have recently become a major facet of internal instability, even in the European nations; yet these acts are simply not reported in data sources available for analysis.

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, the patterns of reporting are systematically biased so that more of the extant instability is reported for some nations than for others. While we attempted here to construct measures of turmoil and revolt that minimized the effects of these biases, they are certain to affect our results to some extent.

The data available for analyzing patterns of internal instability in the European nations are not reliable enough for forecasting actual levels of turmoil and revolt in those countries. This situation is especially unfortunate because the forecasting methods are most unreliable for nations that experience high levels of instability. Forecasts of turmoil for this group of nations usually underestimate the extent of instability that the nation will experience. For nations that usually have low levels of reported instability, however, the forecasting models developed produce quite accurate and acceptable results.

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 reliable enough to be used to forecast the relative levels of internal instability in the European countries during the period 1985 to 1995. (See Volume II, Chapter 7 of this report.)

It is important to realize that less precise but generally reliable forecasts are 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.

INTERNATIONAL TRADE[3]

International trade is defined as the quantity of goods and services exchanged between two countries per time period. The term does not include capital flows between countries, investment flows, and unilateral transfer payments such as aid and gifts.

International trade has been selected as a central environmental

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[3] For a complete discussion of this descriptor, see Volume II, Chapter 4 of this report.

descriptor of this long-range forecasting study because it is an important predictor variable of other descriptor variables studied in the project. For example, international trade is an important predictor variable of international alignment since countries highly engaged in trade are also likely to be aligned. Furthermore, the degree of a country's dependence on trade will influence its national power base because the power-base component is based partly on the percentage of a nation's GNP which is generated by the foreign sector of its economy. The higher the percentage, the more dependent the nation is on foreign economies and the lower is its national power base. Finally, increased trade dependence increases the vulnerability of the domestic economy to international disturbances and thus may increase the internal instability of a nation.

Thus far, we have suggested that international trade may be a useful variable in explaining international alignment, national power base, and internal instability. In these instances, the linkages between trade and the other three variables are direct. It should be pointed out, however, that international trade may have an indirect impact on international conflict because trade is a predictor variable of alignment and alignment is an explanatory variable of international conflict.

The Elasticity Model

The model used to generate forecasts of international trade is based on the concept of income elasticities of imports. These elasticities measure the responsiveness of the percentage change in imports to percentage changes in GNP, and can be formulated as follows:

$$e = \frac{\%\text{ change in imports}}{\%\text{ change in GNP}}$$

If e = 1.6, then a 1 percent increase in the GNP of the country considered will generate a 1.6 percent increase in its imports. The elasticity of imports can therefore be used to forecast imports, provided future GNP has been forecast. Alternatively, the ratio c .. be written as:

$$\%\text{ change in imports} = (e)\ (\%\text{ change in GNP})$$

An important explanatory variable of imports is pr.ce or the ratio of the price of importables to domestic prices. If this ratio is low for a particular country, then the nation will substitute imports for domestic commodities. If, on the other hand, the ratio is high, then the country will substitute domestic commodities for imports and reduce its level of imports. In either case, prices will influence the quantity of imports. In order to isolate this influence, imports and GNP in the aforementioned equation are deflated or expressed in terms of some base-period prices. In the analysis, 1970 served as the base-period-price index.

Since the goal of this model is to forecast bilateral or dyadic trade, bilateral elasticities had to be estimated. These elasticities tell us by how much the imports of country i from country j will rise when the GNP of i rises by 1 percent. These imports are also the exports of j to i by definition. By estimating bilateral elasticities for all the European dyads, total intra-European trade can be forecast over the desired period. (Actual forecasts of international trade are presented in Volume II, Chapter 7 of this report.)

Twenty-six European countries are considered in the international trade analysis. When taken 2 at a time, 325 dyads are obtained. The elasticity values, however, are not symmetrical for a given pair of countries. This asymmetry means that a total of 650 elasticities, or twice the number of dyads, had to be estimated. (These estimates are presented in Tables 8 through 32 of Chapter 4 , Volume II of this study.)

The elasticities involving Western economies were derived from the 21-year period 1950 to 1970. On the other hand, incomplete data for intra-Communist trade in the 1950's limited the number of observable years and yielded elasticities that were based on 10 years of trade (1961-1970). The criteria for evaluating these estimates are twofold. First, the estimated elasticity 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 has a realistic value, we will repeal the results if the statistical tests tell us that the reliability of the output is questionable. In cases where the empirically determined elasticities are of limited explanatory value or have yielded inconclusive results, we have substituted the empirically determined value by an elasticity equal to 1. 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 this unit elasticity is the actual elasticity value; rather, these substitutes are used so that trade forecasts for all dyads can be generated in keeping with the needs of this study.

Certain overall observations can be made on the empirically derived

estimates of the income elasticities of imports. First, the vast majority of the elasticities generated were intuitively acceptable and reflect the patterns of international trade during the last two decades. Countries that experienced balance of payments deficits, such as the United Kingdom, were found to possess larger elasticities than those of their trading partners. By the same token, 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.

Second, GNP was a more important variable in explaining Western Europe's imports from Eastern Europe than it was 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 40 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 dyadic trade was notably higher. A plausible explanation is that trade initiated by Communist nations with non-Communist economies is often determined by both political and economic considerations, and the effect of simple changes in the GNP of the Communist country is less likely to directly induce change in that country's trade with the West.

Third, 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's of 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 the lack 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.

INTERNATIONAL ALIGNMENT [4]

Since the closing days of the Second World War, alignment with the United States and the Soviet Union has been a crucial variable in the international politics of the European region. Clearly, nations' patterns of alignment with respect to these major powers will continue to be important for public policy purposes, particularly within the national security community. How and to what extent the European countries

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[4] For a complete discussion of this descriptor, see Volume II, Chapter 5 of this study.

tend to cluster around the major powers will have important effects on the international politics of the European region. In the context of this long-range forecasting model, these effects are seen in the role alignment plays as a predictor variable for other central environmental descriptors, particularly internal instability, military power base, and international conflict.

Bipolar alignment schemata are usually one-dimensional; alignments with the United States and the Soviet Union are considered mutually exclusive patterns of behavior. But a single-scale conceptualization cannot differentiate types of nonalignment or multialignment. Thus, the analyst cannot determine whether a nation that lies in the middle of the scale is nonaligned or multialigned.

The long-range environmental forecasting model addresses this problem by employing a modified bipolar schema for determining international alignment in the European region. Essentially, the modification considers each nation's alignment with both major powers. Two aspects of alignment are explicitly described; the extent of major-power alignment; and the manner in which nations distribute their major-power alignment between the United States and the Soviet Union.

The modified bipolar alignment schema is represented on a two-dimensional plane. (See Figure 1.) The extent and distribution of major-power alignment are derived 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 (designated R) serves as a measure of the extent of alignment; the angle of the vector (designated θ) represents the distribution of that alignment between the United States and the Soviet Union. Thus, a nation whose coordinates

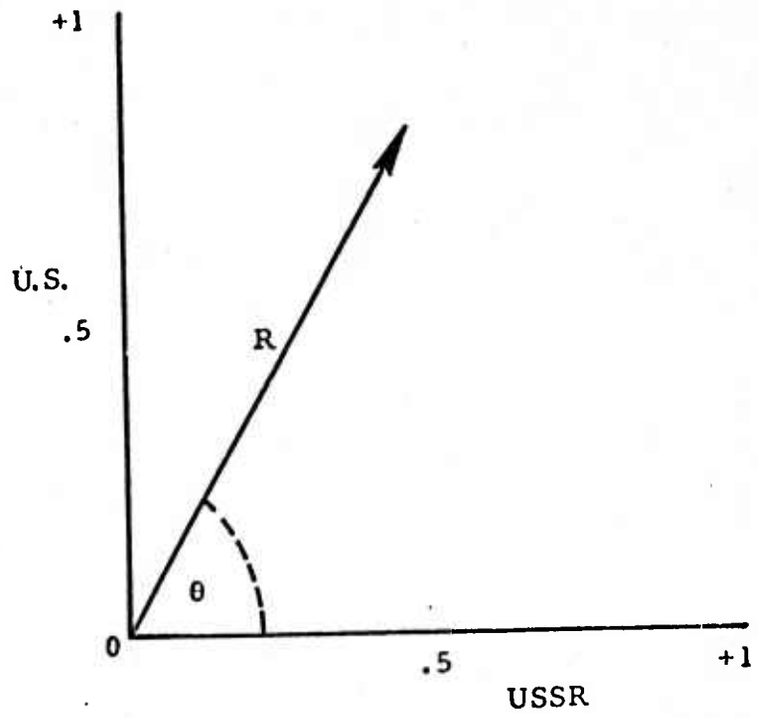

Figure 1. Transformations of Alignment Scores

lie quite close to the point (0.0, 0.0) has a very short vector and is relatively nonaligned with the major powers. 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 totally with the United States. A vector angle of 45^{o} indicates alignment distributed equally with both major powers.

In this way, the analyst can determine whether a nation is highly aligned or nonaligned with a major power based on the length of the vector,

and aligned with one or both major powers based on the angle of the vector. 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.

Two paired components are included in the composite alignment scores for each nation. The first is the percentage of United Nations General Assembly votes in agreement with the United States and with the Soviet Union, respectively. Only those roll-call votes on which the United States or the Soviet Union's position was explicit were used. While a single vote in agreement with one of the major powers may not indicate alignment with that power, United Nations voting patterns over the years do indicate general agreement with one or the other superpower. Furthermore, unlike the policy statements of national leaders which are rarely precise enough to be reduced to quantitative terms, United Nations roll-call votes force a nation to take an identifiable position that can be quantified.

The United Nations roll-call votes may be viewed as the diplomatic dimension of alignment. The second paired component addresses the military dimension of alignment. The percentage of a nation's military treaties with the United States and the Soviet Union, respectively, is used as the measure of the military dimension of alignment. Composite pairs of alignment scores are computed by finding the mean of the scores for the diplomatic and military dimensions.

Multiple regression analysis was the basic technique utilized to generate a forecasting model for each aspect of major-power alignment. Each predictor variable hypothesized to be related to an alignmen

measure was examined to determine its usefulness within the substantive context of Eastern and Western Europe. For those variables that proved useful as predictors, estimates of the direction and magnitude of their linkages with international alignment measures were generated. (See Volume II, Chapter 5 of this report for parameter estimates.)

The forecasting models for the extent and distribution of major-power alignment were used to generate "expected" values for those two aspects of alignment for the European nations in the 1960's. These "postdicted" values were then compared with actual values for both aspects of alignment to determine where the forecasting models were especially accurate and where they were less accurate.

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 ALIGNR, 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 in alignment distribution. 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 postdiction period: 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 to develop nonalignment postures during the 1960's, 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 governments.

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. (See Volume II, Chapter 7 of this report for forecasts of international alignment.) This information is then used to place each of these countries on the two-dimensional major-power-alignment plane. Thus, the clustering of nations in their alignments with the United States and the Soviet Union can be forecast over the long range.

INTERNATIONAL CONFLICT[5]

Conflict is a central descriptor in the Long-Range Environmental

[5] For a complete discussion of this descriptor, see Volume II, Chapter 6 of this report.

Forecasting study because of its major importance in planning long-range U.S. policy toward European nations. The forecasts are intended to provide the policy analyst with information about 1) trends in the amount of stress within the long-range European environment, 2) which European nations are most likely to experience intense conflict, and 3) potential sources of conflict for nations experiencing intense hostility. The extent of a nation's conflict within the region is also an important predictor of other central environmental descriptors. These include the two components of military power base, defense expenditures and manpower; extent of major-power alignment; and level of internal revolt.

Security analysts generally agree that war is the least probable form of conflict in contemporary Europe. Thus a definition of conflict has been chosen that encompasses acts of verbal hostility as well as more severe actions involving physical violence. Verbal conflict includes common diplomatic maneuvers such as threats, warnings, and criticisms whereas physical violence ranges from border skirmishes to military engagements.

Conflictive actions included in this study are nonroutine, newsworthy activities reported by the New York Times. They are divided into three general categories: physical violence, coercion, and pressure. The categories are weighted according to their relative severity, and the weighted conflict acts are summed to obtain measures of conflict for nations and dyads. These measures are not intended to correspond to particular combinations of observable events but rather to indicate relative levels of conflict for the European nations.

Forecasting international conflict is a two-stage process that employs

two closely related indicators of international behavior. The first, monadic conflict, measures the total amount of conflict that a single European nation experiences with the other 25 nations in the region. Dyadic conflict provides more specific information about which pairs of nations are likely to conflict. As a supplement to the monadic forecasts, dyadic-conflict measures locate potential sources of conflict for those countries expected to have relatively high levels of conflict within the region as a whole.

Monadic conflict is a good predictor of dyadic conflict. Thus, we first forecast the European nations' general propensity to conflict, and then use these forecasts to predict the likelihood that conflict will occur between particular pairs or groups of countries. The objective of our study, then, is to develop two distinct forecasting models, one for monadic and one for dyadic conflict.

Multiple regression analysis is the basic technique used to construct forecasting equations for monadic conflict. A set of potentially useful predictors of monadic conflict is extracted from theoretical literature on this subject, and the strength of linkages between these variables and conflict is examined. The predictors include other central environmental descriptors and additional variables exogenous to the integrated model. Our findings indicate that components of each of the four remaining central descriptors--trade, power base, domestic instability, and alignment--are related to conflict. The actual forecasting equation for monadic conflict includes defense expenditures, a combined function of domestic turmoil, the extent of nations' alignments with major powers, past level of trade, and type of regime. (Parameter estimates for these predictors are presented in Volume II, Chapter 6 of this report.)

A similar process is used to construct the forecasting equation for dyadic conflict. As expected, there exists a strong linkage between two nations' past and present levels of conflict within the region and their level of mutual conflict. Other central descriptors that have strong relationships with dyadic conflict are military power base and alignment. Contiguity is an additional factor that affects levels of conflict within dyads. (The forecasting equation for dyadic conflict is specified in Volume II, Chapter 6 of this report.)

The two forecasting models are used to generate expected values or "postdictions" of conflict for the years 1961-1970. Predicted scores are compared with the actual data for this period to determine the accuracy of the models' postdictions. We are particularly interested in the quality of the postdictions for nations and dyads experiencing relatively high levels of conflict during the 1960's. The extent of postdiction error for these "high conflictors" indicates the models' capability to forecast which countries will have high levels of conflict relative to other nations in the region. Generally, the monadic postdictions are low for nations experiencing persistent conflict during the 1960's such as the Soviet Union, West Germany, France, and the United Kingdom. Ordinal-level rank postdictions, however, are extremely accurate for these high conflictors. Rankings closely correspond to the conflict scores in level of precision and are thus the best means for determining the 26 European nations' relative propensities to conflict within the region.

Postdictions for the 20 highest conflicting dyads also tended to be lower than actual scores. They were, however, consistently greater than the average postdicted value generated by the model. Thus, the dyadic forecasting model can be used to forecast relative levels of conflict for the 325 European dyads.

CHAPTER 4: FORECASTS OF THE LONG-RANGE EUROPEAN ENVIRONMENT

The forecasting model developed in the context of this research effort depends upon three sets of theoretical frameworks--substantive social science theory, statistical theory, and cybernetic theory. The assumptions of the model that are expressed in the form of relationships between variables are subjected to validation against each of these three sets of theoretical frameworks. The result of this validation has led to the formulation of a system of 12 equations that constitute the structure 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 (1985-1995). Equations are developed to produce forecasts for population, energy consumption, gross national product, trade, distribution of major-power alignment, extent of major-power alignment, turmoil, defense expenditures, military manpower, monadic conflict, revolt, and dyadic conflict. These variables represent components of the five central environmental descriptors--national power base, internal instability, international trade, international alignment, and international conflict--that are the concern of this research effort.

THE SIMULATION

Naylor has defined simulation as "a technique that involves setting up a model of a real situation and then performing experiments on the model."[1] The model is described in a computer programming language

[1] T.H. Naylor, et al., Computer Simulation Techniques (New York: John Wiley and Sons, Inc., 1966), p. 2.

and is then simulated by executing the program using different sets of values of input variables. It is important to distinguish the simulation model from the forecasting model. The latter specifies the relationships between central environmental descriptors and their components, while the former is the set of computer instructions that generate forecast values of the descriptor variables. (A complete explanation of the simulation model is presented in the Appendix to Volume II of this report.)

Two particular characteristics of the assumptions, or parameters, 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. In short, 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. Thus, a parameter that produces wild fluctuations or unrealistically steep growth curves is unstable, while a parameter that produces 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. Thus, 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.

LONG-RANGE FORECASTS

Forecasts of the various components of each central environmental descriptor are presented in the forthcoming sections.

National Power Base

Table 1 shows the rankings of the 26 countries considered in the forecast on the economic dimension of national power base. Three time periods are given--1985, 1990, and 1995. In Table 2, forecasts for the military power base are presented. These forecasts suggest that the large, wealthy nations will continue to have the bulk of economic power in the long-range future. The only significant change in relative power during the forecast period occurs for Sweden. Examination of two important components of economic power base, GNP and GNP per capita, reveals that Sweden leads the European countries during the forecast period in per capita GNP, while GNP, which reflects country size as well as relative wealth, is dominated by the larger, more traditional powers of Europe. Yet Swedish GNP per capita grows so much faster than the GNP of other countries during the forecast period that, size notwithstanding, its relative economic power increases rather dramatically.

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 2 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

TABLE 1

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.

TABLE 2

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

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 the increased level of wealth in that nation during the long-range future.

Table 3 shows mean military power-base scores by alliance membership and alignment groupings. Of course, the extremely high scores 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

TABLE 3

MEAN MILITARY POWER BASE 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 w/ Soviet Union	1354.88	1562.72	1923.72
Aligned w/ United States	469.22	637.72	949.66
Nonaligned/Multialigned	71.96	94.47	128.15

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. Of particular

interest is the fact that, 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.

Internal Instability

While internal instability was initially conceptualized with 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. 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.

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 distinction 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 are distinctions of intensity rather than form, we use 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 4 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 internal instability at the outset of the forecast period, 1985. This is because 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 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.

TABLE 4

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

Tables 5 through 7 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 nations, but by 1995 Poland experiences more pronounced

TABLE 5

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] $.40 > ALIGN\ \theta \geq 0.0$

strife than the Soviet Union. This result is due to decreases in Soviet domestic unrest that accompany its increasing military capabilities rather than to increases of 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

TABLE 6

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] $.40 > ALIGN\theta \geq 0.0$

to 1995 period. As we noted earlier, France, West Germany, and the United 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.

TABLE 7

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] $1.0 \geq \text{ALIGN}\theta > .55$

[b] $.40 < \text{ALIGN}\theta < .55$

[c] $.40 > \text{ALIGN}\theta \geq 0.0$

The nonaligned and multialigned countries evidence surprising stability 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. Austria and Finland experience the lowest levels of domestic strife of the nonaligned and multialigned group.

Table 8 presents mean domestic-strife scores for the alliance membership and alignment groups for 1985, 1990, and 1995. A comparison of the Warsaw Pact and NATO alliance members suggests that the average difference in levels of strife between these groups of countries remains relatively stable over the forecast period. Furthermore, while domestic unrest is consistently higher in Warsaw Pact nations than in NATO countries, the difference is 30 percent or less. 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 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 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.

TABLE 8

MEAN STRIFE SCORES OF THE 26 EUROPEAN NATIONS BY ALLIANCE MEMBERSHIP AND ALIGNMENT GROUP

	1985	1990	1995
Warsaw Pact	.671	.583	.390
NATO	.609	.403	.324
Nonmembers	.507	.427	.275
Aligned w/ Soviet Union	.671	.583	.390
Aligned w/ United States	.483	.285	.135
Nonaligned/Multialigned	.778	.750	.683

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. By focusing instead upon expected patterns of loyalty to the major powers, however, it appears that Soviet-bloc countries will experience considerably more domestic unrest than will those nations aligned with the United States. Those countries that are presently not members of one of the two alliance groups and 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 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; the elasticity of a given nation's imports with respect to its gross national product typically varies across its trading partners. In terms of the interactions among central environmental descriptors in the forecasting model, however, each nation's total trade, rather than dyadic trade flows, is used as a predictor variable to represent international activity of a transactional nature. The forecasts we present, then, reflect the use of the trade descriptor within the model rather than the manner in which the forecasts were generated.

Table 9 ranks the 26 European nations according to their expected 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

TABLE 9

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

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 economic wealth. Thus, moderate increases in Irish GNP result in substantial increases in that nation's trade with other European countries.

Nations that typically trade very heavily and have large economic power bases are usually those countries with high levels of relative trade. The United Kingdom, of course, remains the most extensive trader of 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-- are also large traders. Not unexpectedly, the smaller and poorer nations are forecast to engage in the least amount of international trade. Bulgaria, Romania, Greece, and Turkey have among the lowest levels of international transactions, while Iceland, the smallest and poorest of the 26 European nations, consistently ranks last in international trade.

International Alignment

In this effort, European nations' alignments with two major powers, 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 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.

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 and ALIGNR are used to identify alignment blocs expected in the long-range future. Tables 10 through 12 present forecast alignment blocs for 1985, 1990, and 1995. Countries forecast to be aligned with the Soviet Union had ALIGNθ 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 during the long-range future.[2] 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 10 through 12 rank the European nations within each of these

[2] These alignment classes were chosen qualitatively, based on the clustering patterns of all the countries studied.

TABLE 10

RANKINGS OF THE 26 EUROPEAN
NATIONS 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

groups according to the extent of their alignment with the respective major power or, in the case of the nonaligned and multialigned group, with the two major powers. Thus, of the Soviet-bloc countries, 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 of this group. Similarly, the relative extent of major-power alignment 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

TABLE 11

RANKINGS OF THE 26 EUROPEAN
NATIONS 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

substantially less aligned with each major power. These nations occupy the borderline between nonalignment and multialignment throughout the 1985 to 1995 period. None of these six nations is unambiguously 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

TABLE 12

RANKINGS OF THE 26 EUROPEAN
NATIONS 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

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 is ranked third. The other important rank change in 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.

Figures 2 through 4 reveal visually the patterns of the European nations' alignments 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

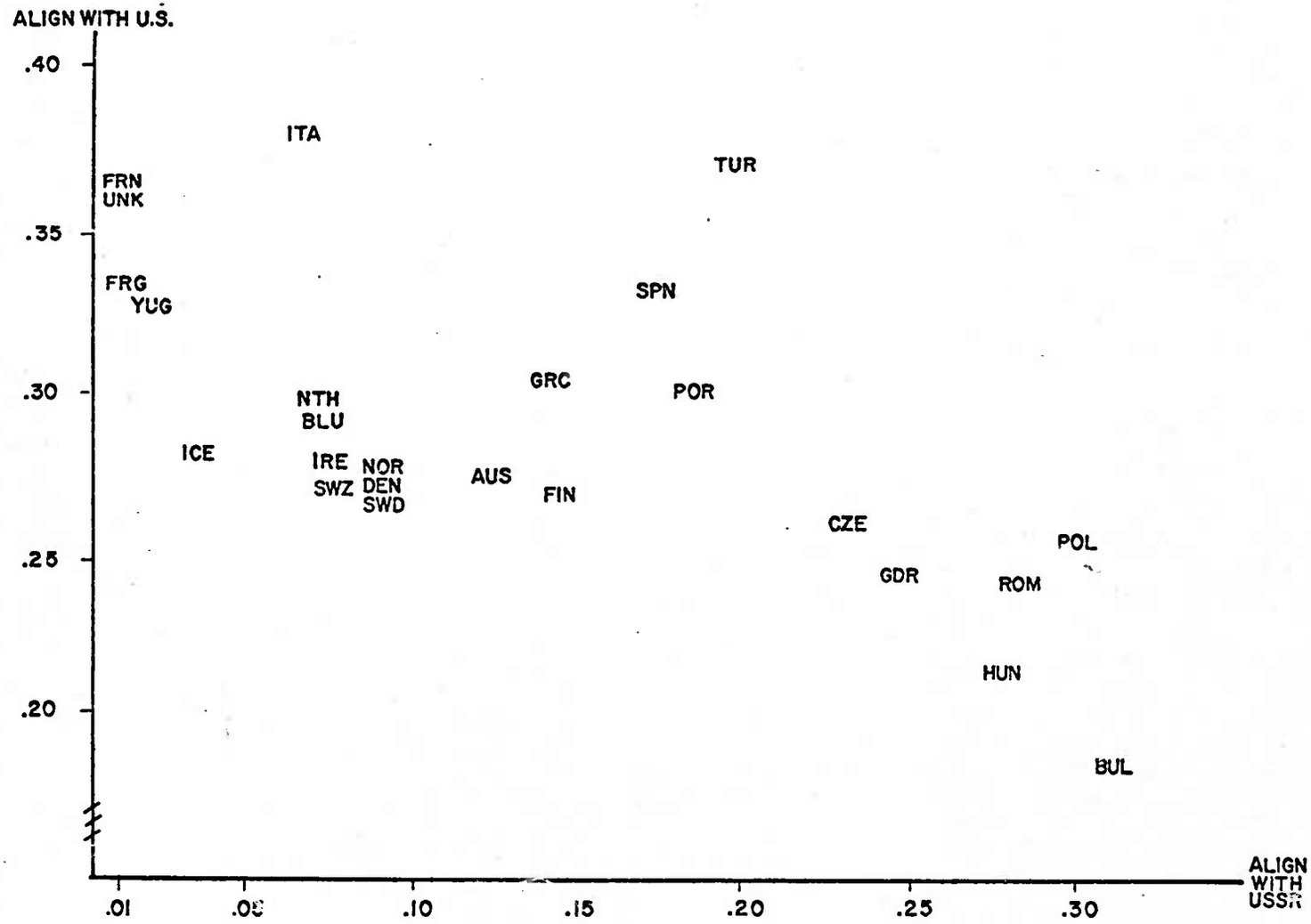

Figure 2. Alignment Distribution, 1985.

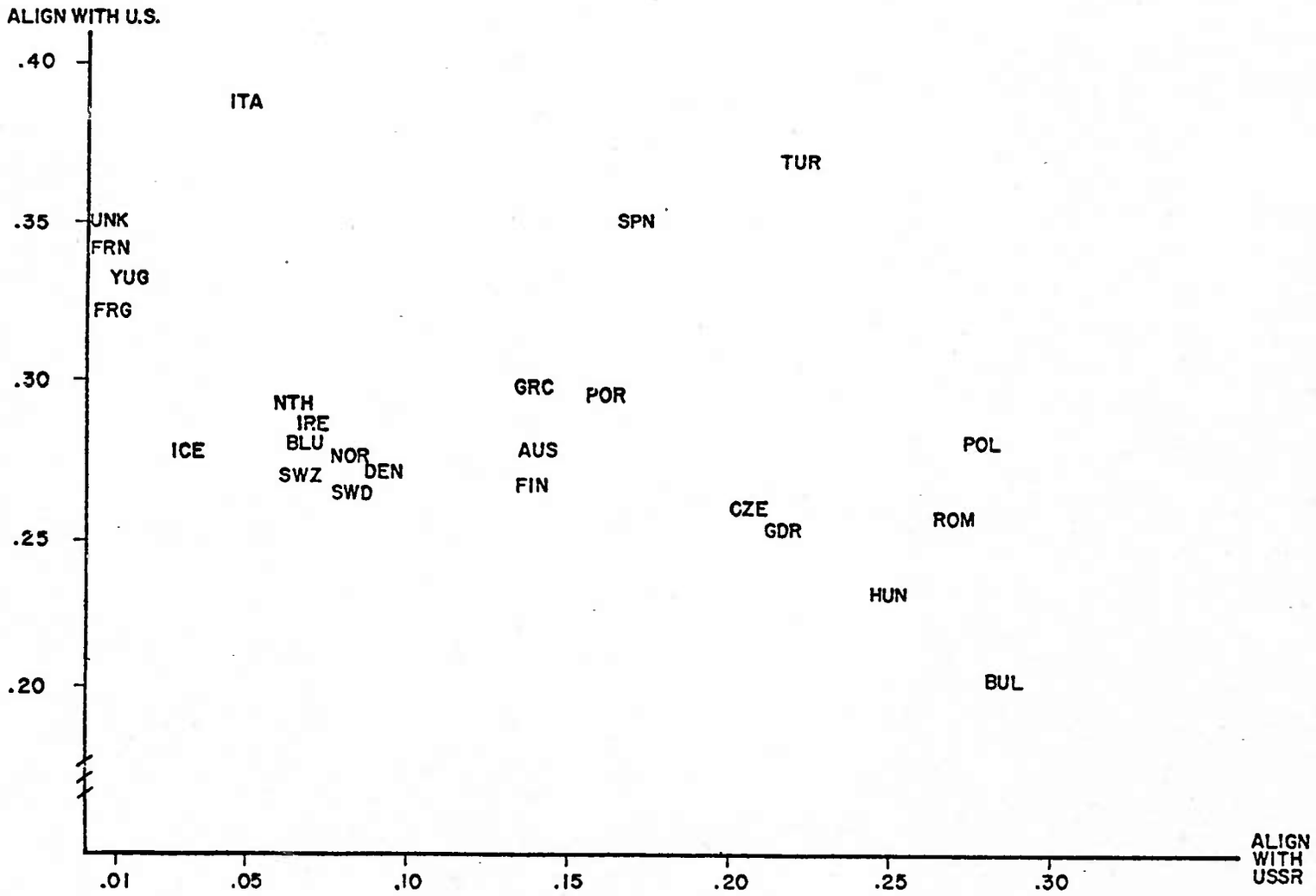

Figure 3. Alignment Distribution, 1990.

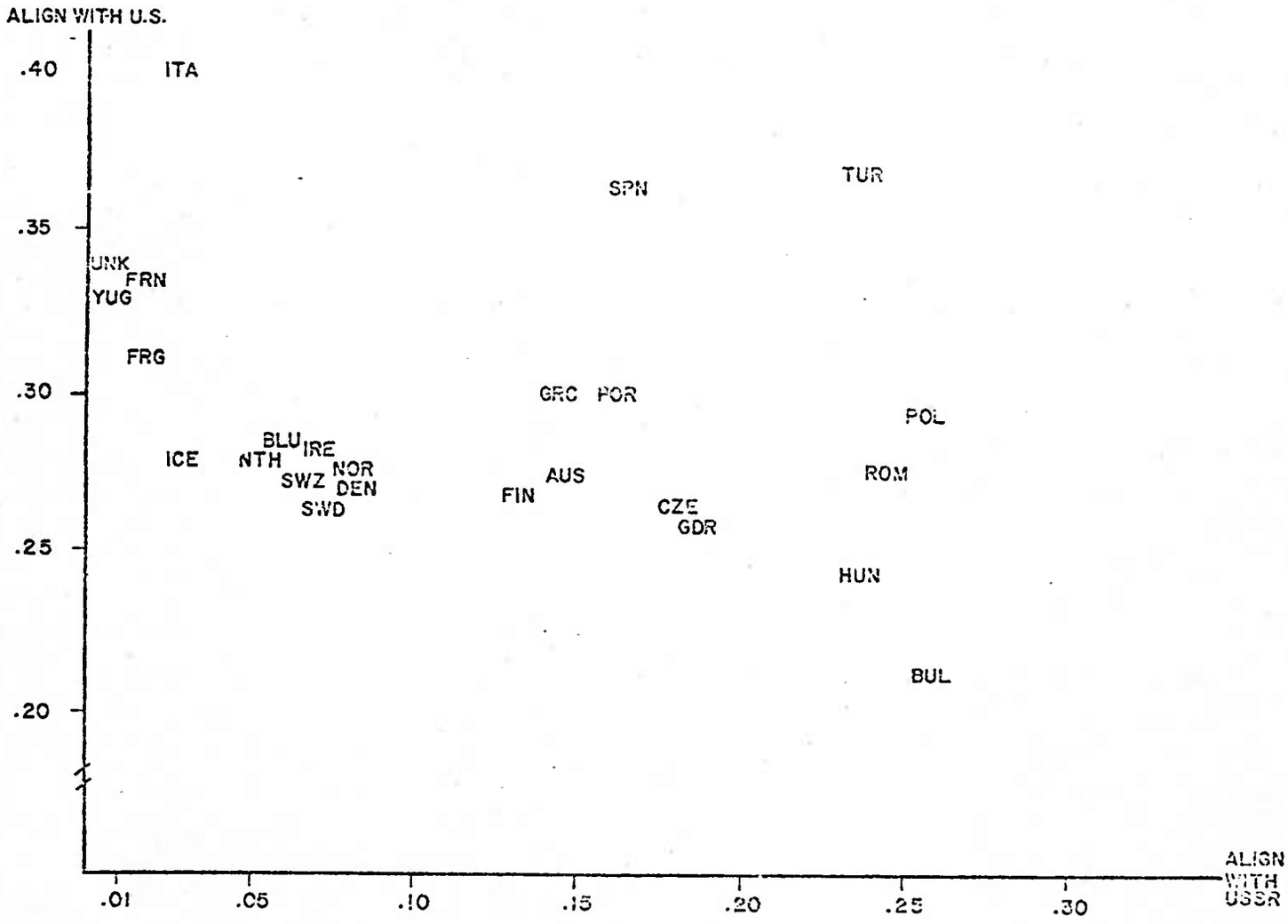

Figure 4. Alignment Distribution, 1995.

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 been traditionally weakly tied to the major powers, but have consistently leaned toward the United States. Iceland, of course, has been a strong ally of the United States in the past.

A third cluster of nations shown in Figures 2 through 4 consists of nonaligned or multialigned nations. 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. 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, of course, also show moderate levels of alignment with the Soviet Union during the 1985 to 1995 period. Greece, Austria, and Finland are nearly 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 in the sense that Turkey, Spain, and perhaps Portugal are, Greece, Austria, and Finland are also not unambiguously nonaligned.

A final group of nations identified in Figures 2 through 4 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 grouping 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 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 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. Thus, a dyadic-conflict score is forecast for each of the 325 European dyads.

Table 13 ranks the European nations according to their forecast levels

TABLE 13

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

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 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, which has traditionally been a low conflictor, is forecast to experience rather extensive conflict during the forecast period because it is expected to show considerable growth in both economic and military power bases.

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 due to 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 14 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 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,

TABLE 14

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

both on the economic and the military dimensions, the Soviet Union has typically been a high conflictor, both within and outside the Soviet bloc. Excluding the Soviet Union from the calculations produces mean conflict scores for the Warsaw Pact nations which are lower than mean conflict scores for NATO members and other Western European allies of the United States.

As Table 14 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 level of international stress experienced within the region. Figure 5 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 sustained 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 correct, these results are

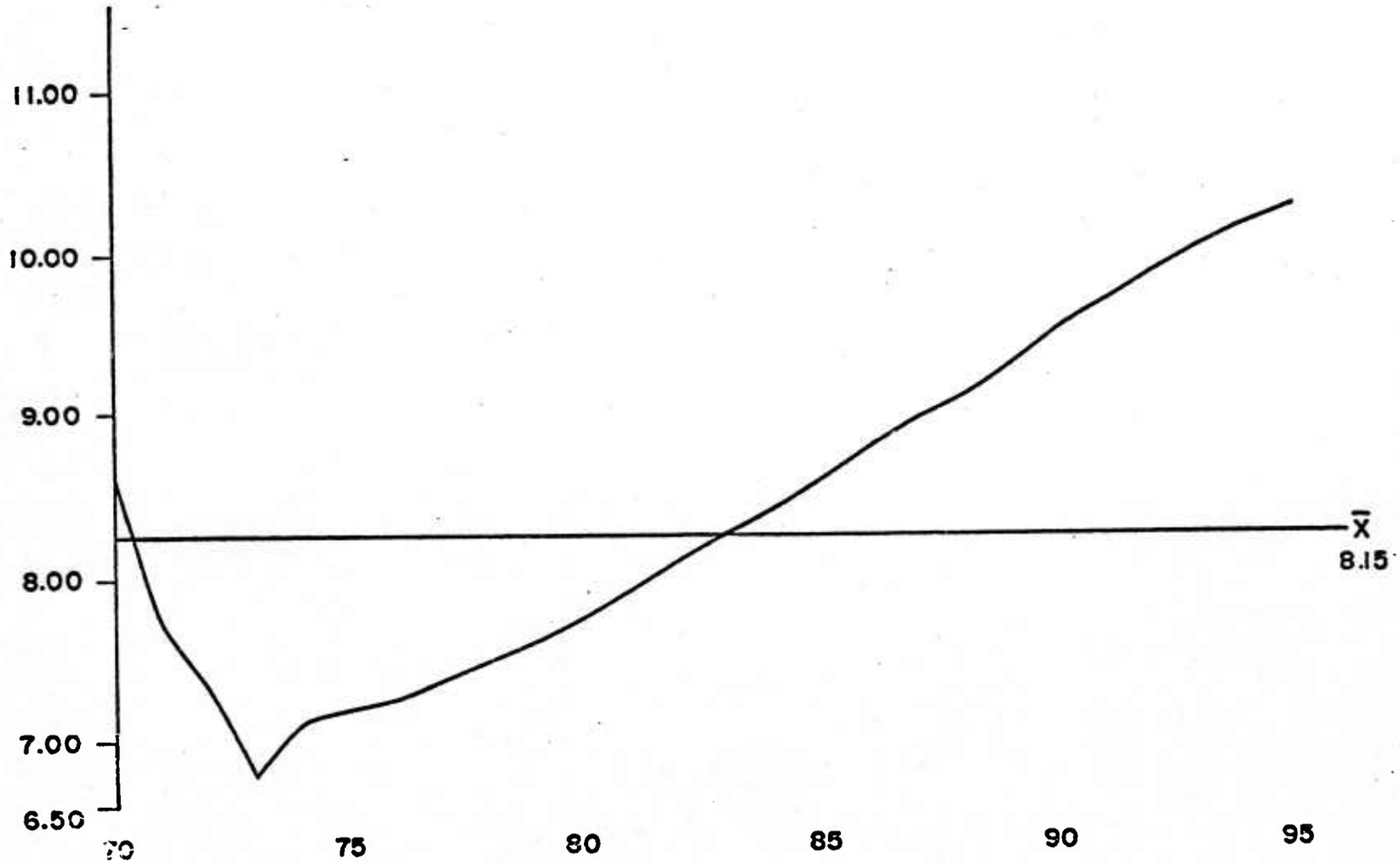

Figure 5. System Stress Scores, 1970-1995.

far from surprising.[3]

It is, however, interesting to note that, as Figure 5 suggests, the level of increase in system stress begins to decelerate during the early 1990's. We suspect that these results are a function of the feedback mechanisms relating defense expenditures to conflict. To the extent that the pressures which 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 persistently 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 15 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 15 suggests, the patterns of conflict among the European nations remain rather stable from 1985 to 1995. Excluding the Soviet

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[3] 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 Donella H. Meadows (Cambridge: Wright-Allen Press, 1973). See also Eugene N. Cameron, ed., The Mineral Position of the United States, 1975-2000 (Madison: University of Wisconsin Press, 1973).

TABLE 15

MEAN INTERBLOC/INTRABLOC
CONFLICT SCORES (EXCLUDING SOVIET UNION)

	Align-US	Align-USSR	Non/Multi
	1985		
Align-US	.28		
Align-USSR	.25	.00	
Non/Multi	.20	.14	.10
	1990		
Align-US	.33		
Align-USSR	.29	.14	
Non/Multi	.24	.18	.10
	1995		
Align-US	.40		
Align-USSR	.33	.20	
Non/Multi	.30	.23	.10

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.

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 chapter of the Summary Volume 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. In the next chapter, areas of further work in long-range environmental forecasting are discussed.

CHAPTER 5: FURTHER WORK IN LONG-RANGE FORECASTING

Approximately two years ago, CACI, Inc. began work on the application of quantitative methods to the problem of long-range environmental forecasting. The overall project objective was to use quantitative methods to improve long-range environmental forecasts. In order to accomplish this goal, three specific objectives were outlined:

- Ascertain what quantitative techniques, methods, and data files have been developed that might be of use in long-range environmental forecasting;
- Develop a method for integrating relevant qualitative techniques and data with existing or newly developed quantitative methods; and
- Experimentally apply the results of the developmental research to identified regions of the world in order to demonstrate, on an operational problem, the applicability of the developmental research.

Work on these objectives and the production of documents required to complete the tasks outlined in the first phase lead the research team into contact with JCS/J5 personnel.[1] The JCS/J5 staff reviewed reports and expressed an interest in employing techniques developed in the course of the research. Preliminary interaction lead to the realization that further theoretical effort was needed before the techniques could be applied to users' problems.

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[1] See CACI, Quantitative Methods for Long-Range Environmental Forecasting.

The contractor continued the first year's effort to accomplish the following three broad objectives which are the subject of this report:

1. Continue efforts to apply quantitative techniques to other relevant regions and to central long-range environmental forecasting concepts of interest.

2. Continue to work with the JCS/J5 staff in interpreting research results and in providing relevant information on data files, techniques, and so forth.

3. Continue and expand the dissemination of research results to interested groups in the national security community.

In continuing the effort to interpret findings and to provide important information to users on the data and techniques relevant to long-range environmental forecasting, emphasis was placed on the search for and demonstration of the relevance of techniques and data to specific user requirements. Thus, placing recommended new methods within the context of the JLRSS and demonstrating their relevance within that context were deemed extremely important in assuring actual implementation by the user agency within the near future.

During the course of the research effort, the work continually shifted from the theoretical to the applied. The stage has been reached when JCS/J5 personnel are anxious to use the model developed for Europe and to expand these techniques to other regions. Further research in this area should strive to accomplish two broad objectives. First, the current simulation should be adapted so that it is user-interactive by easily understood commands. This is required to facilitate the user's ability to operate the model in a "what if" mode which is more attuned to his everyday tasks. Second, the structure of the

existing model should be examined to ascertain whether it can be expanded to include other regions of the world. The simultaneous equation model developed during this phase of the project was subjected to empirical validation on the European region. A major question arose as to whether this forecasting technology could be transferred to other regions. One obvious answer to the question is that the parameter values identified by either ordinary least squares or two-stage least squares would be specific to European data and therefore would have to be reestimated on a country-by-country basis. While this is quite true, the major question deals with the structure of the equations: Does a change in regions maintain a structural homomorphism in the model? Answers to this question rest with the mental images of how countries operate in international affairs. The solution to the question lies not in more analysis but in continued interaction with analysts charged with writing other sections of the JLRSS.

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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 a summary of the technical work that is presented in the second volume of the Report.

The document summarizes the methodology that was developed to forecast values of 5 central environmental descriptors for the European environment of the 1985-1995 period. The descriptors considered were: international conflict, international alignment, national power base, internal instability, and international trade. Forecasts of these descriptor variables are also provided. The document also describes Volume III (the Research Guide) of the Interim Technical Report. The Guide presents a step by step procedure that analysts can use to generate long-range environmental forecasts.

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