Alliance Polarization, Cross-Cutting, and International War, 1815-1964

A MEASUREMENT PROCEDURE AND SOME PRELIMINARY EVIDENCE

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Various authors have posited the relationship between alliance polarization and violent conflict in the global system as positive, negative, and curvilinear. Unfortunately, these hypotheses have not received a thorough test, as previous empirical studies of alliance polarization have tended to neglect (1) the configurational properties of alliance groupings, and (2) the nonmilitary dimensions of alignment. This paper attempts to construct measures of polarization and cross-cutting which take these properties into account. Configurations of alignment patterns are generated by subjecting data on military alliances, diplomatic representation, and intergovernmental organizations to Guttmann-Lingoes Smallest Space Analysis. Several mathematical procedures are developed to measure polarization and cross-cutting within and between these clusters.

Using these new indices, the relationships between and among polarization, cross-cutting, and international war are examined. It was found that both independent variables had only a weak linear relationship to war. However, polynomial regression uncovered a strong curvilinear relationship between military alliance polarization and war; periods in which polarization was extremely low or extremely high were far more likely to be followed by increased war, while a moderate level of polarization apparently reduced the likelihood of violent conflict.

Diplomats and scholars have long assumed a connection between the division of the world's nations into mutually exclusive alliance blocs and the outbreak of war, but there has never been a firm consensus as to how precisely the two are related (Rosecrance, 1966). Recently a major debate has developed in the international relations literature over the relationship between the polarization of the international system and the frequency

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and magnitude of violent international conflict. From one perspective, a strongly bipolar international system such as that existing during the 1950s and early 1960s provides a good deal of stability (Waltz, 1967). The ubiquity of confrontation and crisis prevents aggressive expansion while providing for incremental change without war, and the existence of only two significant powers makes for greater certainty in international dealings.

A more common view, however, holds that highly polarized systems are dangerously unstable and war prone; far better are multipolar systems (for example, that existing between the Napoleonic Wars and World War I) characterized by relatively loose alignments (Deutsch and Singer, 1964; Singer, 1963). Loosely polarized systems provide more interaction opportunities and thus generate competing loyalties which may serve to prevent violent conflict (Coser, 1956: 76-77); by contrast, in "tight bipolar" systems all cleavage is ranged along one axis and hence takes on the character of a zero-sum game. Furthermore, the existence of many power centers means that aggressive actions on the part of anyone are relatively less threatening to the system as a whole.

A third hypothesis has it that the optimal level of polarization is somewhere between tight bipolarity and a loose multipolar system (Rosecrance, 1966). According to this view, a certain degree of polarization provides for the automatic equilibration of the international balance, and serves to dampen conflicts in the remainder of the system. At the same time, the system should be sufficiently multipolar to diffuse some antagonism away from the bipolar axis, and to limit the scope and costs of such crises as do occur.

Thus, the relationship between alliance polarization and war in the international system has variously been asserted to be negative, positive, and curvilinear. Unfortunately, there is insufficient empirical evidence to allow us to evaluate these three contradictory hypotheses with any degree of confidence. There have been only two systematic, data-based studies which touch upon the relationship between system polarization and international war—those by Singer and Small (1968) and Haas (1970)—and these appear to yield partially contradictory findings. Singer and Small found that polarization in the twentieth century international system (as measured by the amount of alliance aggregation) showed a strong positive association with the magnitude and severity of war, but that in the nineteenth century the association was negative. This would seem to suggest that in earlier times alliance polarization had a stabilizing effect on the system, but that in the changed circumstances of the contemporary era it has tended to increase the probability of violent conflict. Haas, on the other hand, found that for 21 historical systems in Europe, Asia, and Hawaii, system polarization as measured by the number of independent power centers exhibited a consistent negative association with the incidence, magnitude, and severity of war.

Quite apart from their findings, it is questionable whether the design of either study permits us to draw any firm conclusions about the relationship between alliance polarization and war. Although system polarization is normally linked conceptually with the number of independent power centers in the system and the tightness with which nations are bound to them (Deutsch and Singer, 1964), the Singer and Small study focuses only on the number of alliance bonds in the system as a whole. While the Haas study does develop an intuitive measure of the number of poles in the system, it employs only a binary measure of the tightness of alignment patterns. Moreover, neither study focuses to any significant degree on the *configuration* of alignment patterns; such factors as the relative distances between and among the various poles and the number of nations clustered outside the major military camps will not necessarily affect their indices.

In addition, both studies concern themselves only with the military aspects of alignment and do not consider the multitude of other pacts, accords, treaties, and commitments which may alternately overlap or cut across military alliance configurations. Many scholars would argue that insofar as these nonmilitary bonds parallel the defense links in the system, they serve to increase the likelihood of war by reinforcing alliance solidarity and exacerbating the cleavage among alliance groupings. Similarly, to the extent that these bonds cut across the structure of military commitments, they tend to reduce the probability of violent conflict by generating competing loyalties linking nations in different or opposing military camps (Coser, 1956; Rae and Taylor, 1970; Deutsch and Singer, 1964).

This paper will propose several indices of alliance polarization which will (1) focus on the neglected configurational properties of the systemwide network of military alignments, and (2) take into account the multidimensional character of alignment patterns by examining two types of nonmilitary bonds. It will then undertake to examine the statistical relationship between these different indices of polarization and cross-cutting, and the magnitude and severity of international war.

The Raw Data

As with most research undertaken in connection with the Correlates of War Project, the temporal domain of this study is the 150-year period from 1815 to 1964. The spatial domain comprises all independent nation-members of the international system as specified by Singer and Small (1966a) and Russett et al. (1968). Data on the dependent variable consist of information on the number of nation-months of war, and the battle deaths accruing from wars begun in the system each year.[1] This basic information will be aggregated in several different ways. First, indices of the amount of interstate war (in which both sides in the conflict are nation-states), as well as indicators measuring the amount of international war (including colonial and imperial conflicts) will be used. Second, the data will be aggregated both annually, and for each five-year period beginning in 1815.

The first step in the construction of indices for the independent variable—the generation of raw data on international alignments—also traverses familiar ground. Three sets of data from the Correlates of War Project will be used. The first is the data on membership in formal military alliances collected by Singer and Small (1969, 1966b). Three classes of alliances are included: defense pacts, committing each signatory to intervene with military force on behalf of the others; neutrality pacts, committing each nation to refrain from intervention against any other signatory; and ententes, providing for consultation upon the outbreak of hostilities. The second data set comprises information on another sort of international commitment: membership in international governmental organizations (Wallace and Singer, 1970). Included here are all organizations established by international treaty and possessing a permanent secretariat, and since these are very few in number during the early nineteenth century, this data set is included only from 1865 to 1964. The final set of data identifies those pairs of nations which have formal diplomatic relations; included is any bilateral exchange of representatives at the chargé d'affaires level or above. The alliance data have been compiled annually; the international organization and diplomatic representation data are compiled at five-year intervals.

1. Following Singer and Small, a war is defined as an armed conflict engaging the armed forces of at least one state-member of the international system for a duration of at least two weeks in which at least 1,000 battle-related fatalities were suffered. For greater detail and the rationale behind these operational procedures, see Singer and Small (1972).

Data Transformation—the Dyadic Scores

If the raw data are to shed light on the configuration of alignment patterns, they must undergo several transformations. The first step is to permute the data so as to yield as much information as possible on the relationship between each pair of nations in the system. This is most easily done by coding it in the form of an n•n proximity matrix, where n represents the number of nations in the system at a given point in time, and the value of cell (i, j) represents the strength of closeness of the bond between nations i and j. There are several possible ways in which this might be done, and since the procedure followed at this stage will have a crucial bearing on the subsequent analyses, it is worthwhile to examine briefly the main alternatives.

The intergovernmental organization (IGO) data set presents us with little difficulty in this respect, reflecting as it does not one nor two but a large and heterogeneous number of internation bonds. Following Russett (1967), the proximity of a pair of nations may be measured using these data as the number of intergovernmental organizations to which both belong, normalized by the total number of organizations in the system (strictly speaking, this normalization is not necessary to the analysis per se, and is done only in order to permit comparability between analyses where the number of organizations varies).

By contrast, the alliance and diplomatic data sets offer no such easy solution. In each case, the raw data almost always represent only a single bond between each nation-pair (or at most two or three in the case of a pair in more than one alliance together). Thus, the simple solution used in the IGO case would yield a matrix with cell entries of 0 or 1, according to whether or not each nation-pair possessed a formal military or diplomatic tie. Such a matrix would have two drawbacks. First, it does not meet the crucial requirement that the cell entries accurately reflect the relative strength of the bonds between and among the nation-pairs, since all aligned pairs are not bonded with the same tightness, nor are all unaligned pairs equally distant. Second, even if this procedure were acceptable in principle, it would create problems when the data matrix was analyzed. As we shall see, the preferred analytic technique cannot handle such dyadic matrices, and the only usable alternative has many drawbacks.

A second possible approach would be to rank or scale the three types of formal alliances and the three types of diplomatic links which make up the raw data. While this procedure would produce more diversified cell entries, it proved impossible even to rank order either set of categories satisfactorily, let alone give them numerical values. For example, one might suppose that defense pacts should be rated above neutrality pacts and ententes, since they imply a much greater degree of formal commitment. Yet this would lead to the classification of such crucial links as those between the Axis powers from 1936 to 1939, or between Britain and France from 1904 to 1914, as less important than such hollow pacts as the Albanian-Italian alliance of 1927-1939. Given that any ordering based upon formal treaty provisions alone creates such anomalies, ranking the direct bonds cannot produce valid results without a great deal more information concerning the pacts themselves. An ordering of the types of diplomatic bonds is easier to justify but unfortunately the number of bonds in the lower two categories (minister resident and chargé d'affaires) undergoes such a sharp relative decline in the twentieth century that the usefulness of this classification is largely obviated.

Given these difficulties in formulating explicit coding rules to rank categories of military alliances, one might expect that a third alternative procedure—the use of an expert panel to rank the importance of the alliances themselves—would be unlikely to produce satisfactory results. And so indeed it proved. Attempting to rank alliance bonds in this fashion, the author quickly discovered that expert consensus simply did not exist; the dimensions of evaluation employed and the relevant information adduced varied widely among respondents, reducing reliability to unacceptable levels. Thus, while a complete or even partial ordering of formal military alliances based upon their relative importance represents a worthwhile goal for further research, it is clearly not something that can be generated from existing data.

Thus, the approach finally adopted proceeds quite differently. The initial assumption is that the tightness of the bond between two nations is a function not only of the direct bond between the pair, but also of the number of other nations with which they are mutually linked. For example, the fact that the United States and Great Britain have alliance and diplomatic ties with many of the same nations is deemed to indicate a closer bond than exists between nations whose only links in common are with each other. Applying this principle to the alliance data we may compute the matrix entries by counting the number of common alliance bonds possessed by each nation-pair (including of course any bond between the nations of the pair themselves) and normalizing by the number of nations in the system. In similar fashion, the diplomatic matrix entries are derived by counting the number of common diplomatic links possessed by a given pair, and dividing by the total number of nations. In either case, this yields a coefficient whose theoretical range is between one and zero and which represents the closeness of the pairwise bond between nations.

It goes without saying that this procedure is not unexceptional. To begin with, some would argue that this coefficient is more a measure of similarity between national alignment and diplomatic patterns than an index of the actual link between nations (Russett, 1967: 99-100). In defense it may be argued that the procedure used here differs from virtually all similarity measures in that it takes into account only those nations with which the pair are *jointly* bonded, and ignores those with which only one or neither member is linked.[2] A second objection might be that this coefficient in effect equates direct and all indirect links, whereas in fact we know that (1) direct bonds are more important than indirect ones, and (2) some indirect bonds—for example, those through a major power—may be more important than others. The point is well taken, but given that there exists no systematic procedure to weight the various links, it seems better to rely on the (admittedly unproven) assumption that the strength of an alliance bond is proportional to the simple *number* of indirect links, rather than to adopt some intuitive weighting procedure which might drastically reduce index reliability.

Data Reduction—the Configurations

Using the above procedures on the entire data set yields 150 derived data matrices corresponding to the annual alliance data from 1815 to 1964, thirty corresponding (approximately) to the quinquennial diplomatic data for the same period, and twenty taken every half-decade from 1865 to 1965 representing the IGO data. The next step is to analyze these 200 matrices so as to make visible the configurations of alignment patterns. Given that most of the matrices are quite large, this requires the

2. For example, the common 0-1 similarity coefficient phi is computed as

$$\phi ij = \frac{\text{(number of cases where i and j are both 1) + (number of cases where they are both 0)} - \text{(number of cases where they disagree)}}{\text{total n}}$$

By contrast, our coefficient alpha is

$$\alpha ij = \frac{\text{number of cases where i and j are both 1}}{\text{total n}}$$

use of some data reduction procedure. The most common analytical technique employed on problems of this type is factor analysis (Russett, 1967; Cattell, 1965b). But despite its widespread use, there are two reasons why it would be inappropriate to employ it here. First, factor analysis requires that the measures of dyadic alignment be in the form of a ratio scale, so that one may say, for example, that a score of twelve is precisely twice as large as a score of six. While the data to be used are in ratio scale form, it may be unwise to presume upon this too much. Since no procedure will be used to weight these formal ties according to their importance, one can hardly insist that twelve bonds represent twice as much alignment as six; it would be preferable to make the less ambitious claim that the twelve bonds merely constitute the greater degree of alignment.

However, the strong assumptions required by the factor analysis model are not limited to the input data, and herein lies the second problem. At several stages in its complex sequence of operations, a priori decisions must be made as to how the algorithm shall proceed. While often masquerading as "merely technical" matters, they have crucial theoretical implications. In deciding whether or not to normalize the factor matrix prior to rotation, one decides in effect whether or not a nation's affiliation with several groupings shall be deemed to attenuate its membership in each (Russett, 1967: 101-102); in choosing the number of factors to be extracted and rotated, one chooses the lower threshold below which a bond is considered "trivial" or "noise" (Cattell, 1965a: 211). The need to make such crucial theoretical decisions at the very outset weighs heavily against the procedure, given the still underdeveloped state of our knowledge.

Thus a different technique will be used here: the method of Smallest Space Analysis (SSA) developed by Guttmann and Lingoes (Guttmann, 1968; Lingoes, 1966; 1965). The chief distinctive feature of SSA vis-à-vis factor analysis is the less stringent demands it makes of the input data. It requires only that the data represent a monotone invariant (ordinal) scale, and not a true metric (ratio or interval) scale.[3] This difference goes a long way toward eliminating the methodological difficulties of factor analysis. For one thing, since this algorithm is only responsive to the rank orderings among the input coefficients and not their actual numeric values, it is

3. Actually there are two additional constraints that must be placed on the coefficients; they must be reflexive ($\alpha_{ij} = \alpha_{ji}$) and nonnegative ($\alpha_{ij} \geqslant 0$, $\alpha_{ii} = 0$). For this reason, Guttmann refers to the coefficients as defining a "semimetric" (Guttmann, 1968: 475).

much less sensitive to the imperfections in the method used to generate a coefficient of alliance bonding. Moreover, we are relieved of the burden of those complex analytic decisions which arise from the strong metric assumed in factor analysis; no new theoretical assumptions are required in order to generate a solution.[4]

SSA has other advantages besides overcoming these traditional bug-bears. For one thing, since the algorithm operates without the restriction of a metric, the resulting solution is generally far less complex. Of particular importance is the fact that the dimensionality of the output configuration (the number of dimensions or factors) is usually much lower with SSA than with factor analysis; in fact, SSA always produces the minimum possible dimensionality with the constraints of a permissible "fit" (Guttmann, 1968: 501).[5] A second and somewhat related advantage is the ease with which the SSA output configuration may be represented spatially. Although the input matrix need not fulfill the requirements of a Euclidean space, the output configuration is transformed to do so by applying Guttmann's principle of rank-images (1968: 479-481); the distances between points in the output configuration will then fulfill all metric requirements while simultaneously preserving the original rank-order among the points to a very close tolerance. Since a good fit to most data can be obtained in very few dimensions, this allows us to represent the underlying relationships in the matrix as real distances in two- or three-dimensional space, greatly facilitating interpretation. The output will in fact constitute a multidimensional map of the international system whose features are the alignment patterns of nations.

Despite these advantages, there will inevitably be those who are leery of the SSA algorithm because of its newness and unfamiliarity. Yet, as noted above, the comparative sense of confidence engendered by the older technique is almost wholly spurious. In using it we are literally forced to make trouble for ourselves. We must make a series of difficult and complex analytic and theoretic decisions at the beginning of the analysis;

4. In principle, the user does have a choice to make with those matrices which violate the monotonicity condition, i.e., those containing ties. In practice, however, the assumption of "semi-strong" monotonicity (which allows the algorithm to break ties wherever possible) produces the most parsimonious solutions (Guttmann, 1968: 477).

5. Of course, the user must decide what tradeoff is to be made between dimensionality and fit. With the data matrices used here however, there was no need for hesitation. In virtually every case, two dimensions gave a good or at least satisfactory fit, and only minor improvements could be obtained with higher dimensionalities.

these return to haunt us by increasing the mathematical difficulties involved in arriving at a solution, and (far more seriously) by generating worrisome problems of interpretation at the end of the process. Thus, SSA should not be considered a still more esoteric substitute for factor analysis, but a welcome surcease from complexity and difficulty.

But the proof of the pudding is in the eating; what hath SSA wrought? It is obviously impossible to present results for all 200 matrices in this paper, so four configurations have been selected as examples. Figures 1 and 2 illustrate two alliance configurations a decade apart; 1953 and 1963. Figure 3 shows the two-dimensional diplomatic configuration for 1920, and Figure 4 the 1930 IGO configuration.

For the 1953 alliance matrix it is possible to obtain an excellent fit (Guttmann-Lingoes Coefficient of Alienation = .033) in only two

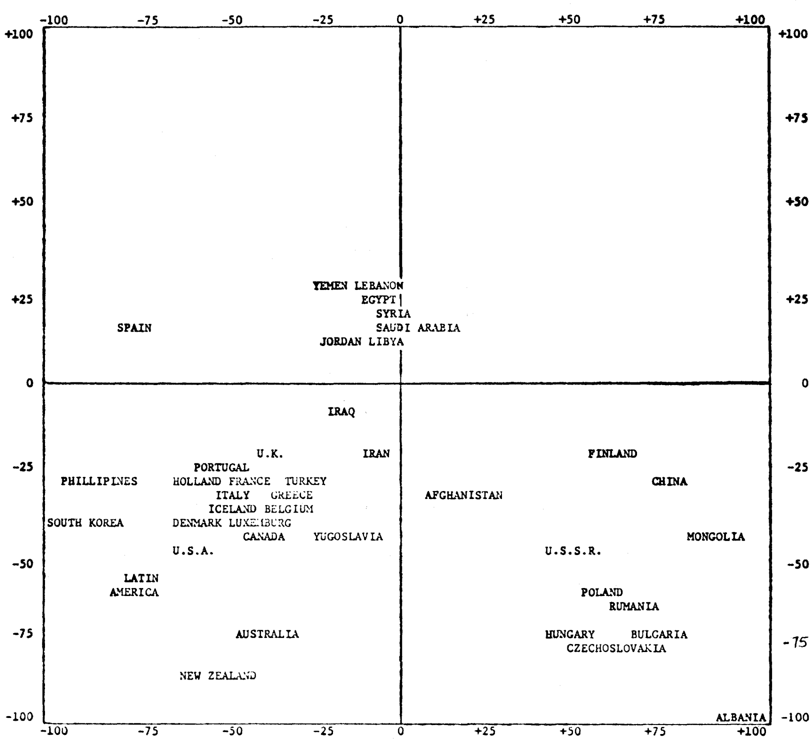


Figure 1: ALLIANCE CONFIGURATION FOR 1953

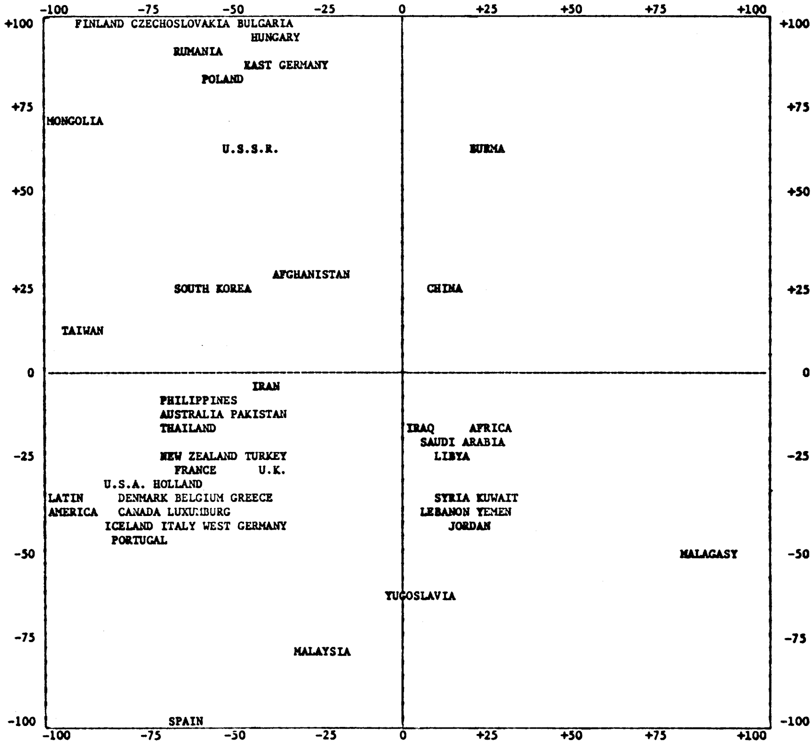


Figure 2: ALLIANCE CONFIGURATION FOR 1963

dimensions. A quick glance at the configuration confirms our intuitive understanding of the alignment patterns at the height of the Cold War. The system is dominated by the two superpowers, each ringed by its allies. There is no other major axis of alignment; indeed, if the solution is forced into a single dimension, the CA only increases to .063, indicating how closely the bipolar model fits this period. The only substantial group of "neutrals" is the Arab bloc, clustered off to one side somewhat closer to the Western than the Soviet camp.

The results for 1963 provide an interesting contrast with the bipolar pattern of a decade earlier. The two-dimensional fit is still excellent (CA = .038) but the mediocre fit in one dimension (CA = .110) indicates that the bipolar axis no longer dominates the system so completely. The two

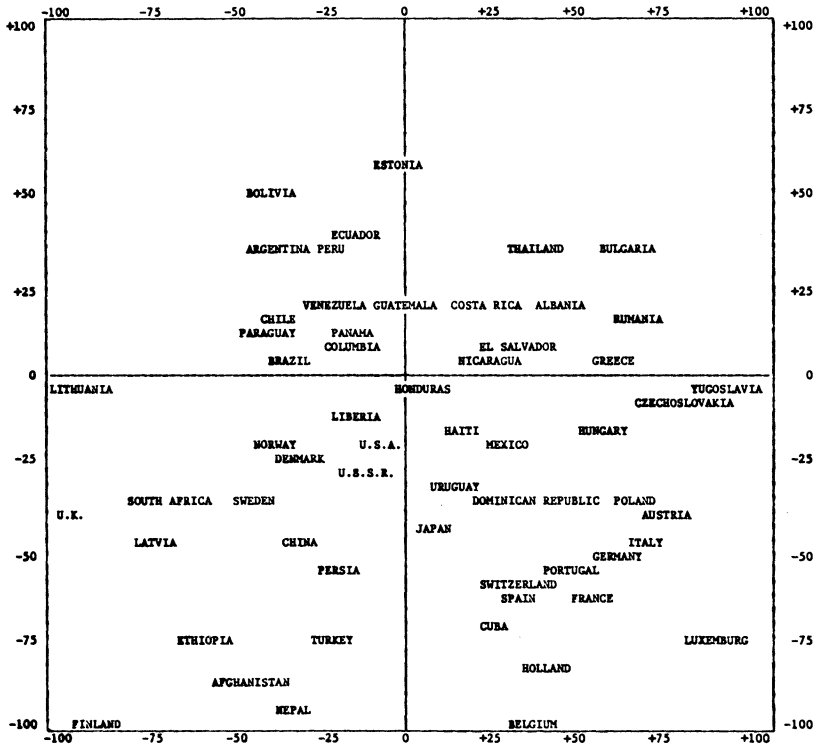


Figure 3: DIPLOMATIC CONFIGURATION FOR 1920

superpower blocs are still distinct, but they are now supplemented by a coterie of Afro-Asian nations lying some distance away from the East-West axis, constituting if you will a "Southern" cluster. This accords well with our intuitive understanding of the impact of the emerging Afro-Asian bloc after 1960.

A still more striking contrast is evident if we turn to the 1920 diplomatic configuration. Tight clusters and poles of any kind are virtually absent, giving way to several rather ill-defined and overlapping regions whose membership may be accounted for chiefly by geographical propinquity. Moreover, the two-dimensional fit is not as good (CA = .260). Taken together, these two results suggest a very complex and somewhat chaotic pattern of internation links, a finding certainly in conformity with

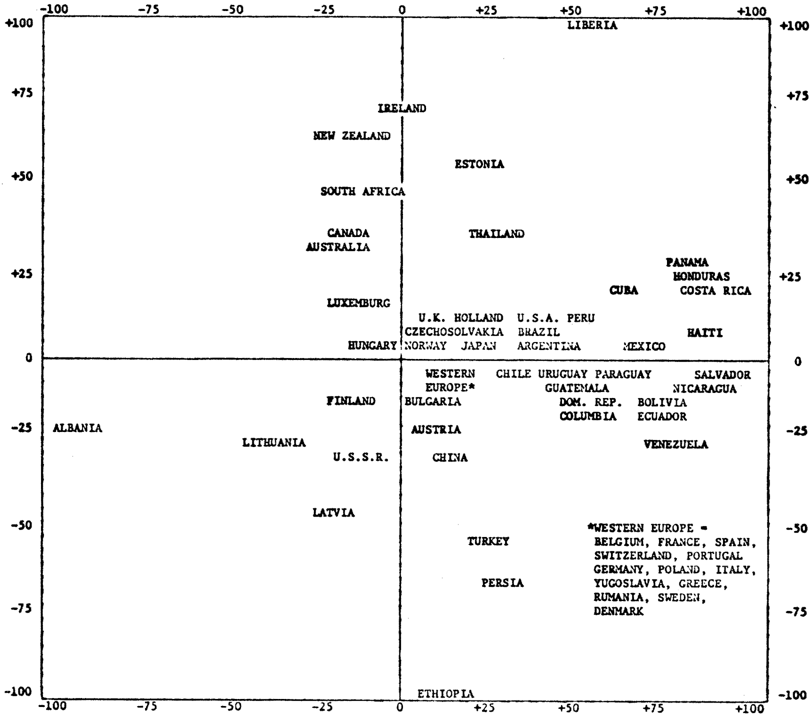
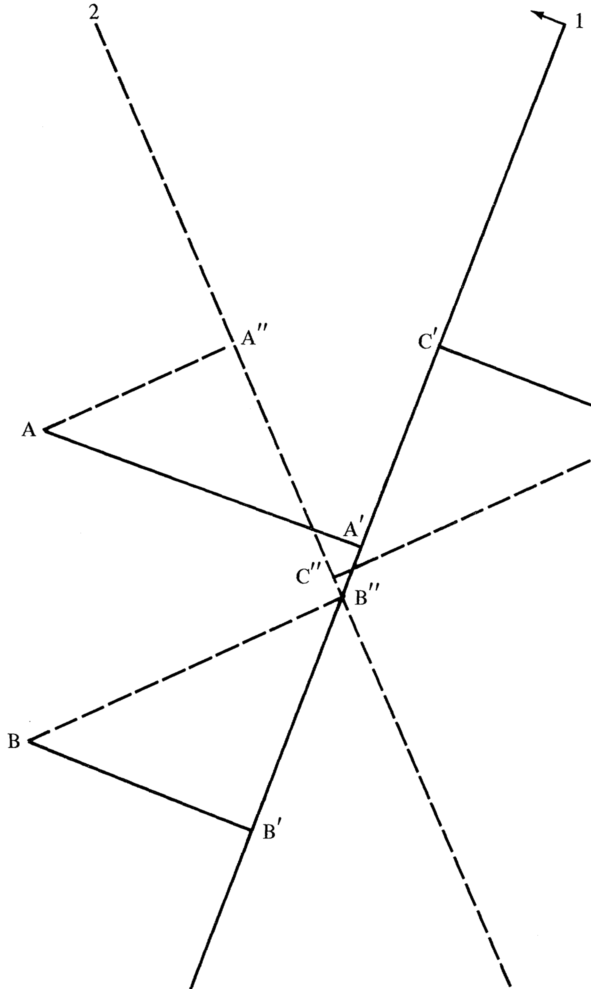


Figure 4: IGO CONFIGURATION FOR 1930

the standard historical description of the international system immediately after World War I.

The configuration produced by the 1930 IGO data stands somewhere midway between the simple structure and tight clusters of the Cold War alliance configurations and the diaphanous complexity of post-World-War-I diplomatic patterns. The system is dominated by two large, tight clusters, the one comprising the European states and Japan, the other the major American states. Unlike the alliance configurations, these groupings are quite close together; the IGO configuration is unipolar rather than bipolar, with the peripheral states of the system scattered loosely around a single, massive core. But despite this apparently simple structure, the two-dimensional fit is not exact (CA = .180), suggesting as in the previous example an underlying complexity not present in the alliance configurations.



$D_1 = AA' + BB' + CC'$
$D_2 = AA'' + BB'' + CC''$

Figure 5: CONSTRUCTING THE POLARIZATION INDEX: A THREE-NATION ILLUSTRATION

From these four examples, it seems clear that SSA does in fact succeed in producing readily interpretable configurations which possess relatively high face validity. Consequently, this method of analysis was used on all 200 derived data matrices. In all cases, the two-dimensional solution was used; while this sometimes results in a loss of detail, such standardization facilitates comparison and is mandatory for the last stage in the construction of indices of polarization and cross-cutting.

Constructing the Polarization Index

As we saw above, some notion of the degree of alliance polarization can be obtained merely by inspection of the SSA output. However, what is needed for the analysis which follows is a mathematical index reflecting precisely the degree of polarization which each configuration represents. Since the relative positions of the nations have been represented geometrically, it is now possible to construct such an index by giving geometric meaning to the concept of polarization. Clearly, where the system is highly polarized, the great majority of nations will be clustered in as few as two tightly knit groups at a considerable distance from one another. On the other hand, where polarization is low, the nations will form many loose clusters, distributed in random fashion throughout the space.

After considerable experimentation, a procedure was devised which allows us to express this visual difference in index form. To begin with, an axis was drawn in an arbitrary direction through the geometric center of the configuration. The second step was to calculate the perpendicular distances from each nation-point in the configuration to this axis, as shown in Figure 5. Third, these distances were summed, and the sum

$$D_1 = \sum_{i=1}^{n} d_{i1}$$

corresponding to the initial axis position, was recorded. The fourth step was to rotate this axis about the center through 180°, recomputing the sum of distances from the nation-points to the axis at intervals of 1°. This yields a series of observations $D_1, D_2, \ldots, D_{180}$.

If we represent these points sequentially on a graph, a relationship between the resulting plot and the degree of polarization in the SSA configuration is immediately apparent. This can best be shown with reference to the two extreme cases illustrated in Figure 6. In the "perfectly" polarized case (where the configuration consists of two points, each representing a cluster of one-half the nations), rotating the axis will produce wide variation in the value of D. Where the axis passes directly through the two point clusters, D will approach zero; where it is perpendicular to a line drawn between them, it will reach a high maximum. It can be shown, in fact, that plotting the series D_1, D_2,. . ., D_{180} will yield a sine wave in this case. On the other hand, in the case of "minimum" polarization (where the nations are randomly scattered

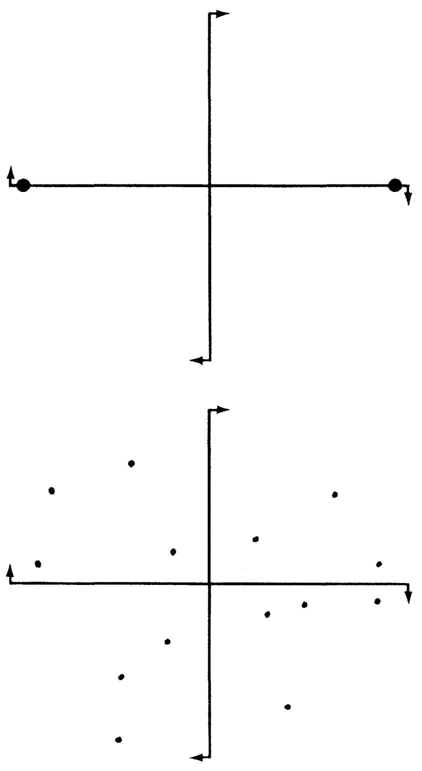


Figure 6: MAXIMUM AND MINIMUM POLARIZATION: AN ILLUSTRATION

throughout the space), D will scarcely vary at all as the axis is rotated; in the limiting case, plotting $D_1, D_2, \ldots, D_{180}$ yields a straight line.

This relationship between variation in D and the properties of the SSA configurations suggests a very simple algebraic representation for alliance polarization. If the value of D varies widely in the highly polarized configurations, but is nearly constant when there is little polarization, we can define an index of polarization

$$P = \frac{\sigma D}{\bar{D}} .$$

Computing this index for each year, we obtain 150 observations.

Refining the Index—The Weighted Values

In computing polarization as described above, each nation was assumed to make an equal contribution to the final score. This represents a distortion of our intuitive notion of polarization in that we normally consider the relative alignments of the larger and more powerful nations to affect system outcomes far more than alignments of smaller states. Moreover, the SSA output demonstrates that the most powerful nations are not always associated with the numerically largest clusters of nations. Thus, the measurement procedure as outlined thus far may tend to underestimate the importance of small poles containing strong nations, while overestimating the influence of weak, populous ones. To compensate for such distortion, it was decided to weight the impact of each nation by some factor reflecting its military capability. The resulting index would then respond to the *relative strength,* as well as the number and tightness of alliance clusters in the system. For this purpose, an additional set of data was adduced: information concerning the number of military effectives possessed by each nation at five-year intervals beginning in 1815 (for the coding rules used to collect these data, see Wallace, 1973).

These data were incorporated into the index by utilizing the physical concept of "moment," or the product of mass times distance from the axis. In computing the sum of the distances of nations from the axis, each distance was multiplied by a weight proportional to the size of the corresponding nation's military effectives. Thus for each position of the axis we obtained the sum of the moments about the axis

$$M = \sum_{i=1}^{n} (d_i \cdot w_i),$$

and as before, $M_1, M_2, \ldots, M_{180}$ were computed, yielding a weighted polarization score

$$P_w = \frac{\sigma M}{\bar{M}} .$$

Since the data on military effectives were only available at five-year intervals, only thirty quinquennial values of the weighted index could be computed.

Constructing Indices of Cross-cutting

In the comparative politics and voting study literature an individual is said to be "cross-pressured" if he or she belongs to several formal or informal groups whose political norms pull in different and often contradictory directions (Lipset, 1960). When there are a large number of such individuals, the political system as a whole is said to be "cross-cut"; this concept is usually defined as the proportion of pairs of individuals who share common loyalties or affiliations on some important systemic cleavages but are in different groupings on others (Rae and Taylor, 1970: 92). In operational terms, the amount of cross-cutting is usually computed either between a single pair of dimensions of affiliation (for example, religion versus race) or, where there are more than two salient cleavages, between each pair of dimensions considered separately. Because of the multitude of different formal links and organizational affiliations to be considered here, such pairwise computations would be far too lengthy and unwieldy. So a simplified procedure will be employed: instead of measuring cross-pressures with reference to pairs of specific links or affiliations, they will be considered a function of the differences among national patterns of allegiance and affiliation on each of the three *classes* of internation links examined in this study. In other words, for our purposes a cross-pressured nation is one whose formal military alignments bond it tightly to a different group of nations than those closely affiliated with it via diplomatic ties or common membership in IGOs.

Thus, when we speak of cross-cutting here it will be in a somewhat limited sense; we have in mind the degree to which the diplomatic and IGO bonds among nations generate patterns of formal allegiance different from those imposed by military alliance ties. Expressed in terms of the SSA configurations, cross-cutting will be said to occur when the geometric structures representing the patterns of diplomatic and IGO links among the nations in the system for a given year are not congruent with the corresponding structure representing the patterns of military alignment. To measure the precise degree of congruence between any pair of configurations, canonical regression analysis is employed. The set of Euclidean coordinates corresponding to each nation's position in a given SSA alliance configuration are regressed against the set of national coordinates derived from the diplomatic and IGO configurations for the same year. A high canonical R^2 between two sets of national coordinates implies a substantial degree of congruence and thus relatively little cross-cutting; conversely, a low canonical R^2 implies little congruence between the two configurations and consequently substantial cross-cutting. Continuing this procedure for all observations, we obtain (1) thirty quinquennial index values of the degree of cross-cutting between patterns of military alignment and those based on formal diplomatic ties, and (2) twenty index values of cross-cutting between military alignments and linkages based on shared IGO memberships. Note that since (a) these are negative indices of cross-cutting (i.e., the greater the index value, the less cross-cutting), and (b) we have posited a negative relationship between cross-cutting and war, the predicted direction of the correlation and regression coefficients will be positive.

Bivariate Relationships Among the Indices

What are the relationships among these measures of alliance polarization, cross-cutting, and the amount of war begun in the international system? Table 1 displays the product-moment correlations between the two indices of the first independent variable—alliance polarization— and the magnitude and severity of war begun in the subsequent annual (or quinquennial) period.[6] It is obvious that the correlations based on the

6. The perceptive reader may ask if the different measurement intervals used by the two indices may not account for many of the differences observed between them. In every case, the values for the unweighted index were reanalyzed on a quinquennial basis for comparison, and no significant differences were uncovered.

TABLE 1

BIVARIATE CORRELATIONS ALLIANCE POLARIZATION AND WAR BEGUN IN THE SYSTEM

Period/ War Index	*Nation-months: Interstate War*	*Battle Deaths: Interstate War*	*Nation-months: International War*	*Battle Deaths: International War*
Unweighted				
1815-1964	.13	.12	.15	.12
1815-1944	.14	.12	.16	.12
1815-1919	.15	.15	.18	.15
1850-1964	.17	.15	.21	.15
Weighted				
1815-1964	–.30	–.41	–.21	–.41
1815-1944	–.34	–.41	–.25	–.41
1815-1919	–.15	–.28	.00	–.27
1850-1964	–.35	–.46	–.26	–.45

unweighted index are negligible; whether we examine the 150-year period as a whole, or look at segments of this era, and regardless of the index of war used, no important relationship is observed. Looking at the weighted polarization scores, we see some improvement; there appears to be a noticeable negative relationship between this index and war. However, only three of the sixteen correlations are significant at the .05 level or better, and the percentage of variance explained never rises above twenty. Consequently, on the basis of these findings we can hardly claim this index shows a marked improvement on those used in other studies.

When we turn to Table 2 and examine the relationship between cross-cutting and war begun, disappointment is compounded by puzzlement. As with polarization the correlations are rather low: using the index

TABLE 2

BIVARIATE CORRELATIONS BETWEEN CROSS-CUTTING AND WAR BEGUN IN THE SYSTEM

Period/ War Index	*Nation-months: Interstate War*	*Battle Deaths: Interstate War*	*Nation-months: International War*	*Battle Deaths: International War*
Alliance-Diplomatic				
1815-1964	–.31	–.39	–.27	–.39
1815-1944	–.36	–.39	–.32	–.39
1815-1919	–.06	–.10	–.02	–.10
1850-1964	–.38	–.43	–.33	–.44
Alliance-IGO				
1865-1964	–.21	–.17	–.16	–.16

measuring alliance-diplomatic cross-cutting, only six of sixteen have less than a .05 probability of occurring by chance, and none of the correlations based on the alliance-IGO index are significant at this level. The results for the earliest (1815-1919) period are particularly poor, as the correlations for that time span are virtually zero. More important, the direction of relationship is opposite from that predicted; as they stand, these findings suggest that the greater the amount of cross-cutting between different types of internation bonds in the system, the greater the amount of lethal conflict that is likely to arise.

Must we conclude, then, that there is indeed no strong relationship between our independent variables and war, and that such as does exist runs counter to the dominant theoretical expectations? Or is it merely that there are flaws somewhere in the complex measurement processes outlined above? Before accepting either of these unpalatable explanations, it would be well to examine empirically other ways of accounting for the observed findings. Two of these suggest themselves immediately.

Multivariate Analysis

The first avenue to be explored is suggested by the strong conceptual links between polarization and cross-cutting. On the one hand, it is not too difficult to surmise a negative empirical relationship between the two variables (Deutsch and Singer, 1964); if the system's alliance structure is strongly polarized, it is more than likely that the opportunities for the construction of cross-cutting ties will be lessened, whereas if alliance polarization is low, such opportunities may well be increased. Thus, the observed positive relationship between cross-cutting and war may be a mere artifact of a strong negative relationship between polarization and these two variables. On the other hand, it is just as easy to hypothesize a strong interaction effect between our two independent variables. It may be that no amount of polarization will have much impact on the amount of war as long as there is sufficient cross-cutting or vice versa. If this were the case, the bivariate relationships between independent and dependent variables would yield misleadingly low results; only by examining the *combined* effect of polarization and cross-cutting would their true importance be apparent.

To test these possibilities, the weighted polarization index was entered into a multiple regression equation with the alliance-diplomatic index of

TABLE 3
WEIGHTED ALLIANCE POLARIZATION AND ALLIANCE-DIPLOMATIC CROSS-CUTTING VERSUS WAR BEGUN IN THE SYSTEM

	Nation-months:			*Battle Deaths:*		
	Beta-Weights for:			*Beta-Weights for:*		
Period/ War Index	*Polari- zation*	*Cross- Cut*	R^2	*Polarip zation*	*Cross- Cut*	R^2
Interstate War						
1815-1964	–.22	–.24	.14	–.33	–.30	.24
1815-1944	–.26	–.28	.19	–.33	–.31	.25
1815-1919	–.14	–.01	.02	–.26	–.00	.08
1850-1964	–.26	–.30	.20	–.37	–.34	.30
International War						
1815-1964	–.14	–.22	.09	–.32	–.30	.24
1815-1944	–.17	–.26	.13	–.33	–.31	.25
1815-1919	.01	–.03	.00	–.26	–.01	.07
1850-1964	–.17	–.27	.14	–.37	–.34	.30

cross-cutting.[7] The regression beta-weights and R^2 values so produced are displayed in Table 3.

The results give little evidence of spurious relationships and virtually none at all of interaction effects. In almost every case, the beta-weights for both independent variables have the same sign as and are only very slightly lower than the zero-order correlations. Only in two rather minor ways do the multivariate findings give us additional information. First, they highlight the differences among time periods and war indices; the joint impact of polarization and cross-cutting appears to be greater on the magnitude than on the severity of war, and far greater in the twentieth and later part of the nineteenth centuries than in the pre-Versailles era. Second, these findings enable us to account for a considerably higher percentage of the variance in the amount of war, as much as 30% in some cases. Nevertheless, they merely compound the main puzzles of the bivariate findings—the low magnitude and unexpected direction of the relationships. To shed light on these, further refinement of the analysis will be necessary.

7. From here on in, only the weighted polarization index and the alliance-diplomatic cross-cutting index are used. These measures yield results which are in the same direction but of greater magnitude than those omitted.

Curvilinear Relationships

As mentioned at the outset, one school of thought holds that the relationship between polarization and conflict is curvilinear, and if this is true, then the strictly linear equations generated thus far will significantly underestimate the magnitude of the relationship. The next avenue to explore, then, is a possible curvilinear relationship, and this may be done by polynomial regression. Higher powers of the weighted polarization index were entered into the equations generated above by a stepwise regression procedure. Table 4 displays the beta-weights for those powers which were statistically significant when entered into the equation, along with the percentage of variance in the amount of war they jointly explain. A number of important results emerge.

First, the curvilinear fit in all cases represents a major improvement; for the 150-year period as a whole, the R^2 ranges as high as a striking .77, and in fact falls below .58 only for the pre-Versailles period. Proportional improvements over the linear fit occur in all of the shorter time periods as well, with the R^2 reaching .78 on two occasions. Thus, Rosecrance (1966) would appear to be correct about the curvilinear nature of the relationship.

Second, the signs of the betas seem to conform roughly with Rosecrance's hypothesis about the shape of the curve as well. In almost all cases, the form of the equation is

$$Y = a - b_1x + b_2x^2 - b_3x^3 + b_4x^4 + e$$

where $b_1 \geqslant b_2 \geqslant b_3 \geqslant b_4$. This suggests that war is more probable both at very low and at very high levels of polarization, while the chances of war are minimized by a moderately polarized alliance configuration. Thus, the finding of a negative linear relationship turns out to have been rather misleading. A negative slope does indeed characterize the relationship at lower levels of polarization, but once a critical threshold has been passed, polarization exerts very strong positive effects; as predicted by Deutsch and Singer (1964), a very highly polarized system is exceptionally war prone.

Third, polarization clearly plays a much more critical role in the later part of the post-Vienna era than in its earliest days. This variable consistently explains three to five times as much variance from 1850 to 1964 as from 1815 to 1919. This finding accords reasonably well with our intuitive expectations; most would agree that the international system in

TABLE 4

WEIGHTED POLARIZATION INDEX VERSUS WAR BEGUN IN THE SYSTEM

Period/	Power of	*Nation-months: Interstate War*		*Battle Deaths: Interstate War*		*Nation-months: International War*		*Battle Deaths: International War*	
War Index	*Polarization*	*beta*	R^2	*beta*	R^2	*beta*	R^2	*beta*	R^2
1815-1964	x	–.61	.61	–.78	.77	–.59	.58	–.78	.77
	x^2	.51		.70		.48		.70	
	x^3	–.41		–.63		–.38		–.63	
	x^4	.34		.57		.31		.57	
1815-1944	x	–.68	.70	–.78	.78	–.67	.70	–.78	.78
	x^2	.58		.69		.56		.70	
	x^3	–.48		–.62		–.47		–.62	
	x^4	.41		.56		.40		.56	
1815-1919	x	–.38	.15	–.34	.16	–.44	.20	–.35	.16
	x^2	.36		.30		.44		.31	
1850-1964	x	–.61	.60	–.77	.77	–.59	.58	–.77	.77
	x^2	.50		.69		.47		.69	
	x^3	–.39		–.61		–.36		–.61	
	x^4	.31		.54		.29		.54	

the twentieth century exhibits far less stability than in the nineteenth on a whole variety of dimensions (Singer et al., 1972) and is thus far more vulnerable to disturbing influences such as a high degree of alliance polarization.

The striking success of polynomial regression applied to the polarization-war relationship suggests that it might clarify the connection between cross-cutting and war as well. A plausible theoretical argument suggesting a curvilinear relationship can be adduced here, as well: it might be that heavily cross-cut international systems generate confusion and uncertainty in the minds of national decision makers about the identity of their respective allies and adversaries. Conceivably, such confusion could lead to less predictable (and consequently more lethal) crisis and conflict behavior. At the same time, systems with little or no criss-cross would lack the stabilizing influence of the countervailing links discussed earlier, and therefore the ideal state of affairs would be a moderate amount of cross-cutting. Turning to Table 5, we see this speculative argument partially confirmed. Apparently, a greater amount of war is associated both with very low and very high levels of cross-cutting, and relatively less war with moderate criss-cross. However, the relationship is by no means as powerful and unambiguous as with polarization; no significant curvilinear relationship exists for the 1815-1919 period, and even for the later periods the R^2 values never exceed a low .26. Furthermore, the indices of cross-cutting do not make a significant contribution to the polarization equation, regardless of the power to which they are raised; their high correlation with the polynomial terms of polarization merely generates a pathological degree of multicollinearity when they are included. Thus, while polynomial regression clarifies the puzzling direction of the linear relationship, it offers no evidence that cross-cutting is an important explanatory variable distinct from polarization.

Some Caveats

Before discussing the implications of these findings, it would be wise to stress their tentative nature. Despite the impressive magnitude of many of the R^2 coefficients, the pitfalls are many and deep. Five of these are worthy of particular note.

To begin with, the raw data used in this study reflect only the more formal and institutional linkages among nations. This author would argue along with others (Singer and Small, 1966b) that the pattern of formal relationships usually reflects, and is often virtually congruent with, the structure of informal links; but nevertheless it would be difficult to make

TABLE 5

POWERS OF THE ALLIANCE-DIPLOMATIC CROSS-CUTTING INDEX VERSUS WAR BEGUN IN THE SYSTEM

Period/	*Power of*	*Nation-months: Interstate War*		*Battle Deaths: Interstate War*		*Nation-months: International War*		*Battle Deaths: International War*	
War Index	*Polarization*	*beta*	R^2	*beta*	R^2	*beta*	R^2	*beta*	R^2
1815-1964	x	–.29	.15	–.41	.26	–.25	.11	–.41	.26
	x^2	.24		.36		.21		.36	
1815-1944	x	–.35	.21	–.41	.26	–.31	.16	–.41	.26
	x^2	.30		.36		.26		.36	
1850-1964	x	–.23	.17	–.37	.26	–.19	.13	–.37	.26
	x^2	.17		.30		.14		.30	

any definitive claims for the findings reported here unless they can be replicated using a broader data base.

Second, the complexity of the process used to measure the independent variables suggests that considerable caution be used in interpreting the results. At the crucial stages in this process—the calculation of a dyadic proximity coefficient, the derivation of a geometric configuration from the matrix, and the measurement of polarization and cross-cutting from the configurations—risky theoretical assumptions have been made. Only if and when these results are reproduced using alternative operational procedures rooted in different measurement hypotheses can they be considered more than tentative. Until that time, great caution should be employed in interpreting the findings.

Third, it is important to recall that the findings reported here apply only to relationships at the level of the system as a whole; one cannot, for example, make inferences from a nation's location in the alliance configuration to the magnitude of its war experience. To make such statements, studies must be undertaken which adduce data on national alliance position and war participation.

Fourth, as with all empirical studies employing only a few independent variables, the findings may be an artifact of the influence of some exogenous variable. As a consequence, these results only suggest—but do not prove—the existence of a strong causal relationship between alliance polarization and war, or the lack of such a relationship between war and the existence of cross-cutting internation bonds. Only further tests which incorporate alliance polarization into a more sophisticated multivariate model can give a definitive answer on this score (Wallace, 1972b).

Finally, this study does not touch upon the origins of alliance polarizations and cross-cutting; until we understand why configurations of formal bonds form and dissolve as they do, we have not discovered a true cause of war, but only one intermediate process leading to it. Once again, what is needed is a multivariate model incorporating the causal sequence of variables whose action eventuates in war.

Interpreting the Results

While important, these caveats should not be allowed to inhibit us from examining the theoretical and practical implications of the findings. This author has argued at length (Wallace, 1973; 1972a) that the paucity of hard evidence about the behavior of the international system, combined with the urgent need for policy-relevant research, gives new meaning to the traditional canons of scientific caution as they apply to our field. It is still important, of course, that tentative results be labelled as such and that we do not claim more than has been demonstrated. But we must exercise equal caution to ensure that no piece of information goes unnoticed. Given the strength, consistency, and direction of the present findings, there is every reason to believe that careful interpretation will produce much of value.

To begin with, the findings clearly vindicate those who have asserted the continuing importance of alliance patterns as an explanatory variable in the international system. Not only have these patterns been closely linked to interstate war over the century and a half from Vienna to Vietnam, but it would appear that their impact has actually been growing steadily. This influence is all the more significant in that it seems to be direct and immediate; unlike certain other factors which are apparently linked to war (Wallace, 1971), there was no need to introduce a long time-lag in order to maximize the statistical effect. In short, it would seem that alliance patterns represent a crucial avenue for exploration in the search for the causes of war.

But if the role of alliances is important, it is also complex. Even this exploratory paper clearly demonstrates that simple indices, bivariate statistics, and linear regression are completely inadequate to deal with the relationships between our independent variables and war. On the one hand, this would indicate that much more research must be done; given the complications unearthed in this one paper, it is likely that a great deal more remains to be discovered. Yet this routine request for further investigation must be tempered with a plea for sophistication. Only carefully designed mathematical procedures, based on sound theoretical reasoning, are likely to prevail in this area.

These findings have two important practical implications. The first concerns the dismantling of tight Cold War alliance groupings which has proceeded apace for almost a decade. If the results are to be believed, it is this change which has been most closely associated with the more temperate relations now existing between superpowers. Yet the decline of the polarization index from its post-World-War-II high in 1954 to its present (1970) value has scarcely been precipitous; it remains at a level which would lead us to "predict" a great deal of violent conflict in the next half decade. Thus, the evidence would suggest that additional "depolarization" would markedly reduce the likelihood of war. For the great powers, this implies that they should strive for accommodation, not on the basis of exclusive control over (and thus, tight alignment bonds with) particular areas of the globe, but rather by permitting and encouraging military guarantees which cross bloc lines. For smaller powers, it suggests that world peace can be better served by maintaining alignment flexibility than by becoming exclusively bound to one alliance grouping. Of course, given the curvilinear nature of the relationship between alliance polarization and war, this process ought not to be allowed to proceed to extremes or the likelihood of war will again rise; perhaps future research can determine the optimal configuration. Nevertheless, it is clear that the ideal level of internation alignment would be much more closely approximated by dismantling or redirecting many existing military pacts.

The second policy implication has to do with the prolonged and patient attempts made by many smaller and middle-rank nations to build diplomatic and organizational bridges across bloc cleavages. The findings presented above suggest that such attempts are, by themselves, unlikely to succeed; such cross-cutting links apparently do not appreciably reduce the likelihood of war unless the military ties themselves are dismantled or rearranged.

Taken together, then, these findings seem to contradict those who argue for the present web of regional and global military security treaties as the best method of maintaining world peace. It would appear, on the contrary, that not only is the present alliance structure likely to increase the probability of violent conflict in the system, but that its war-producing effects are scarcely mitigated by other, more pacific internation links. This is particularly significant in that the structure of Cold War military alliances has come to be accepted as a virtually unalterable fact of life even amongst those who advocate major changes in the foreign and military policies of the superpowers. If the results reported here are correct, we cannot afford such resignation; ways and means of dismantling this structure must be found. Hopefully, the growing spirit of change which pervades the foreign policy process in many countries of both blocs can be harnessed to provide the intellectual and political resources for this vital task.

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