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INTERNATIONAL INVOLVEMENT: STEPS TOWARD THE QUANTITATIVE MEASUREMENT AND EXPLANATION OF INTERNATIONAL POLICIES

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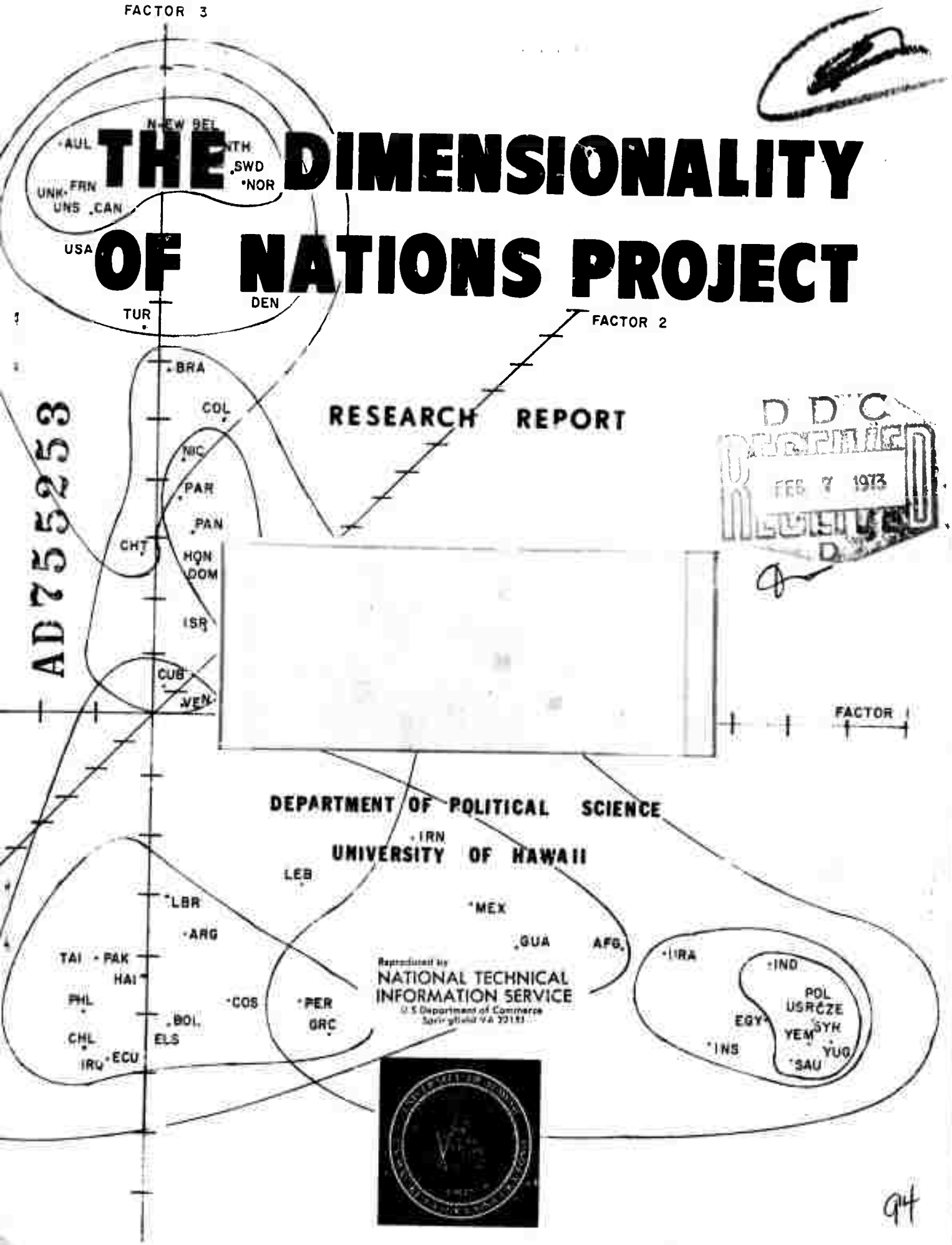

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13. ABSTRACT

The effects of policy decisions on international behavior are not adequately separated from the effects of social ecology (e.g., power, development, type of political system) in traditional behavioral research. ~~Far~~ deeper incursions can be made into policy analysis by behavioral science methods (as distinguished from logical abstractions such as game theory) if the latter will explicitly include concepts of goal, drift, and actual states of the international system in research designs, and carefully analyze gaps between predicted and actual behavior patterns ("residuals" in regression analyses, for example). Here I apply the above orientation to a very crude data analysis within the general context of international field theory. This report is not designed to have any immediate applied significance, but may be of use to researchers interested in this problem.

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INTERNATIONAL INVOLVEMENT: STEPS TOWARD THE QUANTITATIVE MEASUREMENT AND EXPLANATION OF INTERNATIONAL POLICIES[1]

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Introduction

Conflict, cooperation, cold war, balance of power, balance of terror, "brinksmanship," imperialism, neo-colonialism, gunboat diplomacy, containment, peaceful coexistence; these and many others have been coined as terms to distinguish governmental strategies in international politics. They have also been used as terms to describe, in some objective sense, the actual behavior patterns of nations in international systems.

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[1]The research for this paper was supported by the Dimensionality of Nations Project, University of Hawaii, and completion of the manuscript by the Cambridge Project, Massachusetts Institute of Technology, on a sub-grant through the Center for International Affairs; both projects are supported by the Advanced Research Projects Agency (Behavioral Sciences Division) of the Department of Defense. I wish to thank R. J. Rummel and Karl W. Deutsch for the assistance they provided through these projects, and Dennis Hall who faithfully executed the computer analyses with care and diligence. For their substantive criticisms of an earlier draft of this manuscript, I wish to thank Joseph M. Firestone and R. J. Rummel.

The distinction between a strategy and a behavior pattern is not a trivial one. Strategy refers to a plan of action designed to achieve some goal. Behavior pattern refers to an inferred regularity in a stream of observed behaviors. Traditionally, the study of strategies has focused on the memoirs of and precedents set by statesmen; and explanations are sought (for international behavior) which are consistent with these data. Often, hypotheses about the future (or alternative futures) begin as speculations about who will succeed whom to power, what values and ambitions will be represented at the head of government, and what lessons will have been learned from the past.[2]

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[2]In epitomizing this approach, one immediately thinks of diplomatic histories and policy analyses, such as the works of Gar Alperovitz, among which are Atomic Diplomacy: Hiroshima and Potsdam (New York: Simon and Schuster, Inc., 1965) and Cold War Essays (forward by Christopher Lasch) (New York: Doubleday & Company, Inc., 1970); or John Spanier's American Foreign Policy Since World War II (New York: Frederick A. Praeger, Publisher, 1962). Future oriented policy discussions, such as George W. Ball's The Discipline of Power: Essentials of a Modern World Structure (Boston: Little, Brown & Company (Canada) Limited, 1968) and Martin C. McGuire's Secrecy and the Arms Race: A Theory of the Accumulation of Strategic Weapons and How Secrecy Affects It (Cambridge: Harvard University Press, 1965), are essentially of the same genre notwithstanding the formalism introduced by game theoretic and econometric methodologies in the latter work. More general works, drawing upon the social ecology subsystem only in the sense of its contribution of capabilities and alternatives to the human factors making decisions in international politics, may be epitomized by W. W. Kulski's International Politics in a Revolutionary Age (New York: J. B. Lippincott Company, 1964) and Hans J. Morgenthau's Politics Among Nations: The Struggle for Power and Peace (New York: Alfred A. Knopf, Inc., 1967). McClelland's chapters on system analysis and international communication (Charles A. McClelland, Theory and the International System; New York: The Macmillan Company, 1966) present a theoretical abstraction of this approach; and an orientation toward international behavior which is entirely interactive (i.e., devoid of socio-ecological considerations influencing policy) may be found in Warren R. Phillips', "The Dynamics of Behavioral Action and Reaction in International Conflict," Research Report No. 49, Dimensionality of Nations Project, University of Hawaii, 1970, a quantitative study of the "stimulus-environmental response" type.

This orientation towards the phenomena of international relations is essentially cybernetic, and its content ranges from traditional diplomatic histories to the analysis of alternative strategies in the context of game theories.

By contrast, the study of behavior patterns focuses on social, cultural, demographic, geological, and geographic factors which characterize not the governments of nations but the socio-ecological structures of the nation-states or socio-physical regions putatively under the control of governments. The social ecology of nation-states is then presumed to provide both opportunities for and constraints upon the behavior of nations and regions within the total international system. Thus, both the magnitude of national behaviors and their distribution or mix in interactions among dyads (pairs of nations) and larger groupings are expected to be predictable from socio-ecological information.[3]

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[3]This approach underlies several of the major cross-national data collection efforts, those of the Yale Political Data Program and the Dimensionality of Nations Project (see descriptions by Deutsch, et al., and Rummel in Richard L. Merritt and Stein Rokkan, Comparing Nations; New Haven, Conn.: Yale University Press, 1966). Rummel's field theory and its various models, and Galtung's rank theory and its various models, represent the most sweeping generalizations about the effects of socio-ecological conditions on international behavior today. R. J. Rummel: "Field Theory and Indicators of International Behavior," Research Report No. 29, Dimensionality of Nations Project, University of Hawaii, 1969; "A Field Theory of Social Action with Application of Political Conflict within Nations," General Systems, Vol. 10, 1965, 183-211; Richard Van Atta and R. J. Rummel, "Testing Field Theory on the 1963 Behavior Space of Nations," Research Report No. 43, Dimensionality of Nations Project, 1970. For an excellent summary of Galtung's rank theory, and a comparison and critique of Rummel's field theory, see Nils Petter Gleditsch, "Rank Theory, Field Theory, and Attribute Theory: Three Approaches to Interaction in the International System," Research Report No. 47, Dimensionality of Nations Project, University of Hawaii, 1970.

(Continued)

Note that the distinction between the cybernetic and social ecological orientations towards the study of international relations lies in the theory, not necessarily in the data, that is used. Socio-ecological data is often used by those with a cybernetic orientation; in the hands of the policy analyst, the opportunities and constraints represented by these data become "tools of statecraft," used within the context of specific values and ambitions of statesmen. And the data on intentions and ambitions of statesmen may be used as part of

3(continued)
See also Johan Galtung, "A Structural Theory of Aggression," Journal of Peace Research, Vol. 1, No. 2, 1964, 15-38.

To my knowledge, the most comprehensive socio-ecological study of international behavior yet conducted through quantitative techniques is Roger W. Cobb and Charles Elder's International Community: A Regional and Global Study (New York: Holt, Rinehart and Winston, Inc., 1970), which makes operational the concepts and hypotheses summarized by Jacob and Teune, "The Integrative Process: Guidelines for Analyses of the Bases of Political Integration," in P. Jacob and J. Toscano (eds.), The Integration of Political Communities (Philadelphia: Lippincott, 1964). Despite their inclusion of values and attitudes in the hypotheses, Cobb and Elder's work belongs to this genre because the values and attitudes measured index global properties of the nations in their samples, not the values and attitudes putatively ascribed to subpopulations actively engaged in the pursuit of goals in the international arena

While the above theories aspire to explain interaction among pairs of actors, socio-ecological models have also been constructed to explain only volumes of each nations external behavior -- a less ambitious task in that no effort is made to predict the direction of the activity, only its magnitude. A 17-variable causal model leading to the explanation of volumes of threats, accusations and protests was evaluated and revised in Richard W. Chadwick, "A Partial Model of National Political-Economic Systems: Evaluation by Causal Inference Methods," Journal of Peace Research, No. 2, 1970.

Rapoport has noted that the arms race models he discusses (primarily Richardson's) are models "devoid of rational goals" (Anatol Rapoport, Fights, Games and Debates; Ann Arbor, Michigan: The University of Michigan Press, 1967, p. 358). Such models, therefore, belong to this genre, despite the inclusion of such psychological variables in them as "grievances." As I interpret it, "grievances" condition the magnitude and direction of response (or more precisely, change in the magnitude per some unit time), quite apart from any ratiocination about the effectiveness of the response in reducing "grievances" or accomplishing some other goal.

the cultural characteristics of a nation-state system by a social ecologist. But the former looks at international relations in terms of plans and strategies, while the latter looks at the same phenomena from the viewpoint of behaviors and interaction networks. Since both of these viewpoints have established their value as explanatory frameworks, and since both have significant drawbacks in application, it is likely that the more exclusively cybernetic or socio-ecological research is, the less likely it is to relate to the whole of the international system, to offer a well-rounded explanatory framework, or to be of general value to participants in the real world of international politics.[4]

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[4]The ambiguity of classification of some research into cybernetic or social ecology types may be underscored by observing that while Phillips' dynamic interaction study (op. cit.) ignores any explicit socio-ecological variable, his stimulus-response model is totally devoid of rational goal-attainment behavior or policy considerations. And many quantitative studies of national attributes and international behavior are purely descriptive of systemic properties, including no causal model whatsoever. Cf. Bruce M. Russett, International Regions and the International System: A Study in Political Ecology (Chicago: Rand-McNally & Company, 1967); R. J. Rummel, "Indicators of Cross-National and International Patterns," American Political Science Review, LXIII (March, 1969), 127-147; Frank H. Denton and Warren R. Phillips, "Some Patterns in the History of Violence," Journal of Conflict Resolution, Vol. XII, No. 2 (June, 1968), 182-195.

It should be noted in passing that this distinction is not a "levels-of-analysis" type; both the cybernetic and social ecology subsystems are analytic, global subsystems which have in common all "unit-level" distinctions made, for example, by J. David Singer in Qualitative International Politics: Insights and Evidence (New York: The Free Press, 1968), and by James Rosenau in Linkage Politics: Essays on the Convergence of National and International Systems (New York: The Free Press, 1969). There is an unfortunate tendency to view national attributes of the social ecology variety as "lower level" phenomena acting as background conditions on the "higher level" phenomena of international politics, and to view this higher level as

(Continued)

It is no accident, however, that measurement and systematic analysis of large quantities of data have characterized the social ecology orientation. The national accountants of the world have provided reams of data; and the public news media provide a ready source of event data for cumulating and typologizing "behavior." It is also no accident that the cybernetic orientation works with and communicates through information in common language form, and that those practicing this orientation have found it exceptionally difficult, if not impossible, to quantify information.[5] Only with the application of game theory have we seen the rise of a methodology which may be capable of translating policies and strategies into quantitative terminology; and as yet no corps of graduate students has been trained to attack memoirs with as much diligence and reliability as statistically

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4(continued)
the domain of cybernetic explanation and feedback modeling. (Cf. Gleditsch's discussion of attribute theories; Gleditsch, op. cit.) By so doing, the obvious impact of international behavior on socio-ecological conditions becomes lost as a modeling problem. Similarly, the impact of cybernetic activity at "lower" levels on the international system also tends to become ignored, as national "attributes" do not typically include such operating characteristics of goal-attaining behavior as values, attitudes, or situational orientations. These omissions are significant, and stem -- in my opinion -- from the nation-state ideologies within which social scientists are embedded.

[5]The development of content analysis in general (see, for example, Philip J. Stone, Dexter C. Dunphy, Marshall S. Smith, and Daniel M. Ogilvie, The General Inquirer: A Computer Approach to Content Analysis, Cambridge, Mass.: The M.I.T. Press, 1966) bodes well for making verbal material quantitatively tractable.

trained students attack national account statistics and the New York Times.[6]

One purpose of this paper is to begin the analysis of behavior in international relations in a manner making the analytic output more amenable to policy analysis or the cybernetic orientation. In a sense, the analytic output of behavioral studies has been captured by (become the exclusive domain of) social ecology; for while social ecology factors may be used as partial explanations within a total systems framework, the "unexplained variance" of behavior need not be attributed to more ecological variables that just happen to be absent from a particular study. Thus, it is proposed here to treat the residuals from a behavioral, statistical study as being indicative of policy inputs, i.e., cybernetic inputs rather than just more "blind fate."

Another purpose of this paper is to show how behavior may be analyzed in a manner suggestive of policy inputs. By permitting the encroachment of a policy orientation on behavioral data and statistical methods, new questions may be put to the data, questions less amenable to social ecology answers and more amenable to cybernetic explanations.

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[6]The Dimensionality of Nations Project (currently at the University of Hawaii; principal investigator, R. J. Rummel) has been collecting conflict data from primarily the New York Times, for example, since 1962, and Rummel has developed a standardized code sheet ["A Foreign Conflict Code Sheet," World Politics, Vol. XVIII, No. 2 (April, 1967), 196-206]. But no such similar developments characterize the systematic retrieval of data from, say, memoirs, biographies, and histories. The development of game theory techniques, for example, might serve a content analysis function, for example, such that students analyze historical materials from this perspective. I have seen such efforts applied by students under Professor Glenn Snyder's tutelage at the State University of New York at Buffalo.

A third purpose is more methodological and pedagogical aimed at those who like to test theories with statistical tools, which includes myself.[7] Theories can often be quite complex. The question thus often arises: does a tester desire a gross or a fine test? A gross test may generate one statistic, such as a multiple correlation coefficient, upon which some decision will hinge. A fine test may generate many statistics, no one of which is sufficient to reject any but a small part of a general theory. Typically, gross tests are employed. The methodology employed in this paper is meant to indicate how relatively fine tests may be usefully developed from a general theory, in this case an early version of R. J. Rummel's "field theory" of international behavior.[8]

To achieve these objectives, a general model will be put forth in outline terms, one capable of incorporating both cybernetic and social ecology explanations explicitly, one that leads to the analysis of residuals from a policy viewpoint. Within this model, Rummel's field theory will be located, and given a policy interpretation wholly consistent with both the mathematics of the theory and Rummel's goals in formulating it, but from a substantively different perspective. Third, this interpretation will be used in a simplified test of a

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[7] See Chadwick, 1970, op. cit.

[8] R. J. Rummel, "A Social Field Theory of Foreign Conflict Behavior," Peace Research Society: Papers, IV, Cracow Conference, 1965 (published 1966), 197-208.

portion of Rummel's field theory. Fourth, an analysis of the patterning of nations' residuals will be conducted in terms of substantive speculations, i.e., policy effects.

I. A General Model of International Systems

We may think of the real world of international behavior as deriving from two broad systems, which we may paraphrase as the "nerves of government"[9] and the flesh of government: (1) the cybernetic, political, or decision-making network; (2) the social ecology "backup" of social, economic, cultural, geological, and geographical attributes of each nation within a global system.[10] The former may be construed as manipulating the resources available in the latter, for more or less coherent (though often conflicting) purposes.

Much of the model hinges upon what one means by coherence, as regards the special implications of coherence for patterning in the behavior of nations in the international system. One can presume that individuals always have purposes and that national leaders must at least give the impression of purpose in their role as leaders. How

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[9] From the title, The Nerves of Government: Models of Political Communication and Control, by Karl W. Deutsch (New York: The Free Press, 1966, 1963).

[10] Paul Smoker has strongly emphasized the need for working within a global system context, and taking seriously the effects of large multi-national corporations in the system. The present work should not be construed to implicitly leave out such entities or inter-governmental or non-governmental international organizations. See Paul Smoker, "International Relations Simulations: A Summary," copyright by Paul Smoker, 1970.

and whether purposes translate into measurable behavior patterns remains a key question in international relations theories, and one to which the present model expressly addresses itself.

If behavior is purposive, we must necessarily include the concept of feedback explicitly in a model, or, more to the point, the existence of learning or something like it at the organizational level of analysis.[11] Even the simple notion of reinforcement learning, and its implications for increasing or decreasing a behavior as the distance to a goal state changes, gives rise to definite expectations for changes in the behavior of statesmen, assuming we can quantify a goal-matrix or "ideal" behavior system to which they aspire to achieve. Having said this, we can now draw a crude sketch of what our general model of international systems should look like.

Real behavior is assumed to be the result of dynamic interaction between social ecology and cybernetic forces, purposive man against the elements and his own habits, as it were. (We may regard as habit the institutional bases of social organization, as distinct from definite efforts at redirecting activity, which may involve the use of some habits to alter others, or some institutions to alter others, for the purpose of attaining some goal.) Thus, social ecology gives rise to a behavior prediction, explained in terms of institutions, the use made of geological and geographical resources by institutionalized human

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[11] See Deutsch, The Nerves of Government, op. cit., esp. Ch. 11, for a general treatment of the feedback concept and learning phenomena at the organizational level of analysis.

behavior, and the making of "habitual" decisions at the lowest level of cybernetic processes. Cybernetic processes give rise to "ideal" or "goal" behavior, that is, those behavior patterns which are desired to attain over some time period, and are explained in terms of the values, attitudes, and situational orientations of decision-makers typically (but not necessarily) occupying institutional positions with the authority to alter habitual patterns of resource allocations. As decision-makers usually attempt to implement a strategy for altering habitual patterns of resource allocation, they contribute to the stream of "real" behavior indicated in Figure 1. Their contribution may not be precisely what they intended it to be; thus the loop connecting "real" behavior to the decision-makers' values, attitudes and situational orientations is drawn to reflect the impact of this potential discrepancy. Similarly, the very act of reaching a decision and attempting to implement it is presumed to affect values, attitudes and situational orientations to some degree, hence the "feedback" loop connecting decision to "memory."

"Memory" is, in a sense, a black box; for we can hardly hope to sufficiently map the values, attitudes, and situational orientations of decision-makers on a global scale, as those who work with memoirs, biographies, and the substance of political history are well aware. For theoretical and some applied purposes, however, it may be possible

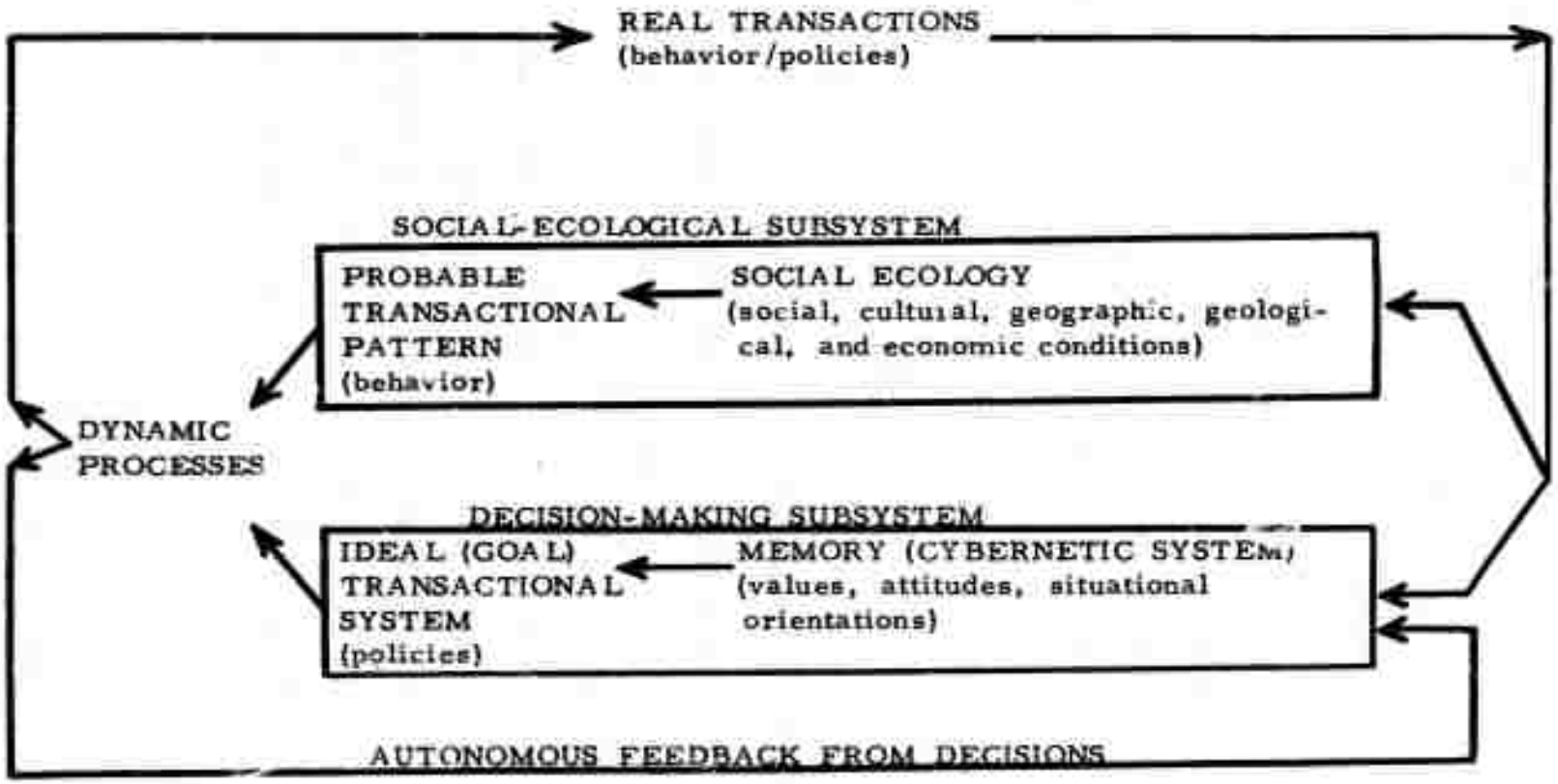

Figure 1. A Simple Sketch of a General International Relations System.

to simulate the decision-making pattern of values, attitudes, and situational orientations to a sufficient degree to be useful.[12]

Let us suppose now that we had a true model of the impact of social ecology on behavior, instead of a mere sketch, and some relevant data on real transactions which to some extent reflect the the combined effects of socio-ecological and decision-making subsystems. Let us refer to a real quantity of some type of transactions from nation i to nation j as t_{ij}, and to the behavioral expectation from the social ecology model as b_{ij}. For the ideal or goal, which is in some as yet undefined sense a product of the (global) decision-making subsystem, let us write g_{ij} (goal-quantity of transactions to occur from i to j). We may express the relations between these three variables as follows (see Figure 2).

We have simplified international transactions, for expository purposes, into two categories, cooperation and conflict. In this instance, we will also consider but one dyad (i,j). Note that the difference between the socio-ecological expectation (b_{ij}) and actual behavior (t_{ij}) may be represented by a vector α (alpha); and the gap between b_{ij} and t_{ij} may be indicated in a variety of ways: (1) by

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[12] Cf. Charles Hermann, Crises in Foreign Policy (New York: The Bobbs-Merrill Company, Inc., 1969), and Paul Smoker, "International Processes Simulation: An Evaluation," forthcoming, Journal of Peace Research. The question may be raised in simulations of the man-machine type -- as the studies reported in these works were -- as to whether the "decision-making system" they evolve is more "captured" by the model than are corresponding real-world decision-makers by their environments or social ecology. The question of relative autonomy of simulation and "referent system" decision-makers may not be as abstruse as it might appear; for it is precisely the degree of autonomy possessed by decision-makers in either real or simulated system that permits them to control the direction of events through time, in accord with their own purposes.

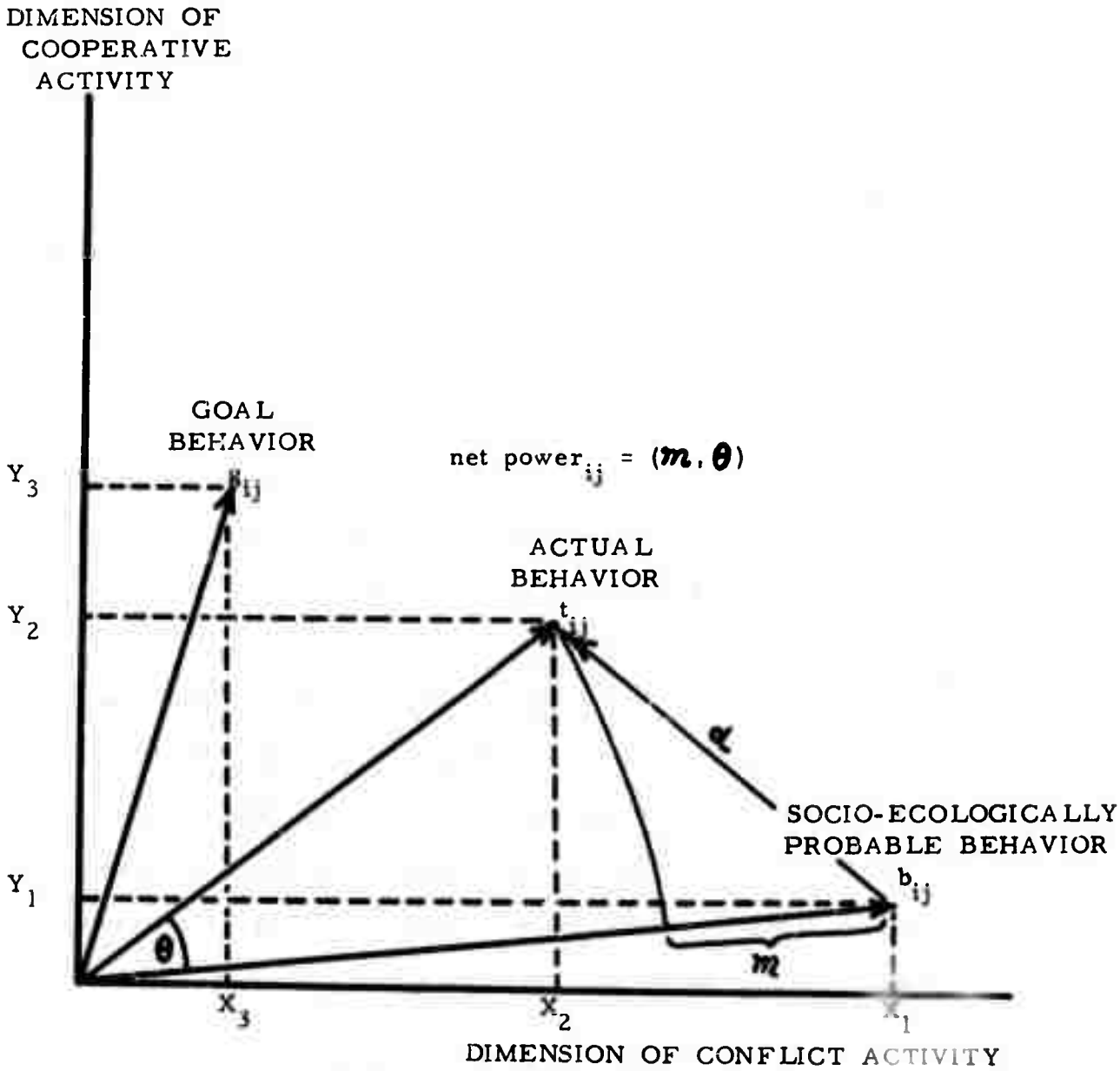

Figure 2. A Simple Concept of Net Power over Transactions.

the Euclidean distance representing the length of the vector α, given by the square root of the sum of squared distances y_2-y_1 and x_2-x_1; (2) by the numerical distance vector (d_y, d_x) where the d_y and d_x are the differences y_2-y_1 and x_2-x_1, respectively; (3) by the differences in the magnitude (length) of the b_{ij} and t_{ij} vectors, given by m, and the difference in their direction, given by θ (theta). We will temporarily use the third interpretation because of its heuristic value from a substantive viewpoint.

Assuming that discrepancy between b_{ij} and t_{ij} is due to g_{ij} (the goal-condition of the actors i and j), this discrepancy may be referred to as the net power or control of i and j, written: net power$_{ij}$ = (m,θ). We may use the cybernetic term, control, because, according to the model sketched in Figure 1, a decision-making (cybernetic) effort was required to move the system (i,j) away from b_{ij} towards g_{ij}, and a measure of that effort is (m,θ).[13] Furthermore, θ and m are amenable to the following substantive interpretations. θ represents a change in the mix of cooperative/conflict strategy characterizing (i,j); and m represents a change in the magnitude of total activity characterizing (i,j), both, in theory, brought about by an effort to attain the activity magnitude/mix condition represented by g_{ij}.

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[13]For a discussion and analysis of the concepts of power in an international relations conceptual framework, see Richard W. Chadwick, "Steps toward a Probabilistic Systems Theory of Political Behavior, with Special Reference to Integration Theory," a paper delivered at the International Political Science Association Congress, September, 1970, Munich, Germany. For a more general discussion of power and control, see Chadwick, Power, Control, Social Entropy, and the Concept of Causation in Social Science," presented at the Albany Symposium on Power and Influence, State University of New York at Albany, Albany, N.Y., 1971.

These remarks lead to the important conclusion that, assuming we have a respectable theory of social ecology, we can measure the net power$_{ij}$ in a system by examining the unexplained residuals or deviations from expectations according to such a theory.

What do we do with this measurement of net power? Without further speculation as to the nature and distribution of the goal conditions g_{ij}, very little. However, if we assume that, over the short run, the goal conditions g_{ij} do not vary much, it would be possible to trace out the apparent effect of other actors on any given net power measurement on (i,j). For instance, it would be possible to develop meanin fully the following (heuristic) differential "equation," and elaborate a testing strategy to determine which actors influenced which other actors' (and their own), (m,θ)s.

$$\frac{d(\text{net power}_{ij})}{dt} = \sum_{\substack{i=1,\\ j=1}}^{N} (\text{net power}_{ij})a_{ij}, \qquad (1)$$

where the a_{ij} terms are unknowns to be determined. In plain English, it would be possible to measure the policy impact of the actions of all actors at some previous point in time on the net power of any given pair of actors (i,j) at a later point in time. If substantive information were available on the goals of actors in the international system, then it would be possible through an expansion of such analyses as (1) to infer the impact of goals, social ecology, and actual transactions upon each other.

For the present, it is sufficient to note that international transactions may be quantitatively specified in terms of the magnitude of total activity, or involvement, of one actor with another; and in terms of the mix of activities composing this total magnitude. These two aspects of transactions may be further distinguished in terms of their deviations from a substantive model predicting behavior in terms of a social ecology subsystem. The deviations may be analyzed in a number of ways, each consistent with a vector representation of transactions; and the patterning in these deviations over time may shed some light on the power of one nation over the transactions of others, and *vice versa*.

II. Rummel's Field Theory: A Social Ecology Subsystem Model

In 1965, Rummel put forth a social field theory of international relations.[14] While the core of this theory is an assumption that differences in the attributes of nations cause the magnitude and direction of international behaviors between each pair of nations, its most fundamental innovation lies in the manner in which it formalizes relations between attributes and behavior. Both behavior and attributes are cast into the form of matrices, the columns of which represent either different types of behavior or national attributes, and the rows of which represent *directed dyads*, identifying the sender and the receiver of each specified type of behavior, or some dyad-dependent

[14] R. J. Rummel, "A Field Theory of Social Action with Application to Political Conflict within Nations," *General Systems*, Vol. 10, 1965, 183-211.

attribute. This simple innovation now makes possible the analysis of directed behavior and its causes through the powerful tools of matrix algebra and vector analysis (see Figure 3).

An examination of the substantive variables actually used to derive basic dimensions of national attributes (see Appendix I) clearly places the relevance of the theory in the category of social ecology. (The 94 variables listed in Appendix I were part of a larger set of 235; many were discarded because they did not seem to add to the number of relevant dimensions on which to characterize nations and predict their behavior. (See, for example, Rummel's treatment of foreign conflict in the Singer book of readings cited in footnote three, for 1968.) Most variables relate to social, demographic, geological, or geographic properties. There are no specifications of values, attitudes, situational orientations, goals or ideals, of either national leadership or in the general populations. There is an exception to this statement; McClelland's need-power, affiliation and achievement measurements are among the ninety-four variables; but it has been shown that they are more relevant as generational variables and require time-lagging to become relevant.[15] Even not considering this argument, before the field theory could be said to have a cybernetic component, both the

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[15] For some interesting findings relating the McClelland variables to rates for economic development, see Joseph M. Firestone and Gary Oliva, "National Motives and Domestic Planned Violence: An Examination of Time-Lagged Correlational Trends in Cross-Time Regressions," General Systems Yearbook, 1971.

The work from which the data were obtained is David C. McClelland's The Achieving Society (New York: Van Nostrand, 1961).

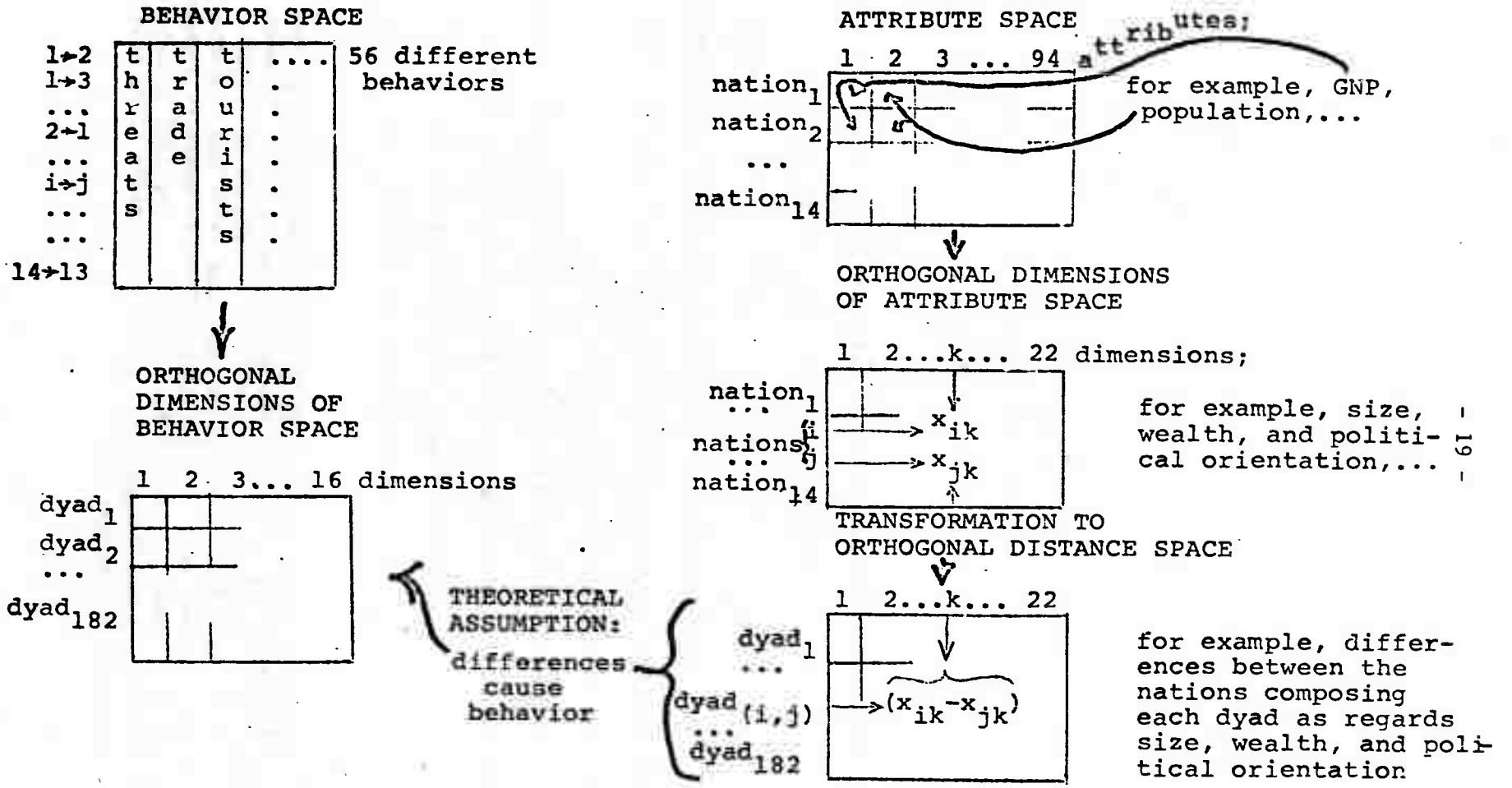

Figure 3. A Simple Sketch of Rummel's Social Field Theory in Application

specific substantive assumption within the theory and the scope of the theory (for example, the adding on of feedback loops as indicated in Figure 1) would have to be enlarged upon.

Because of the location of Rummel's theory of international behavior in the domain of social ecology, and because of the breadth of coverage in the social ecology of nations, which is represented by his twenty-two orthogonal dimensions (obtained through a factor analysis of the ninety-four variable attribute space), the theory is ideally suited for the analysis of residuals outlined in section one of this paper.

We will select but one aspect of the net $power_{ij}$ residuals, defined earlier as (m,θ) (see Figure 2), for discussion, namely m, the magnitude of involvement or activity unexplained by social ecology. We will reserve discussion of m for the next section, and concentrate here instead on the relevance of Rummel's theoretical assumption for estimating the magnitude of behavior, b_{ij}.

One of Rummel's early field theory equations (since discarded) is ideally suited for demonstrating both a testing approach for evaluating different aspects of Rummel's theory, and for making operational the concept of m with the available data.[16] Let us

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[16] Rummel, op. cit., fn. 8. The equations developed below begin with his presentation of the field theory model shown there. Rummel, however, has developed and explored several new forms of the field theory which he feels should replace the one used here; see, however, fn. 18, infra. A major test of these later models is given in Richard Van Atta and R. J. Rummel, "Testing Field Theory on the 1963 Behavior Space of Nations," Research Report No. 43, Dimensionality of Nations Project, University of Hawaii, 1970.

consider a dyad behavior vector b_{ij} consisting of i's behavior towards j, as represented on some sixteen behavior dimensions derived from a large number of actually observed behaviors (fifty-six in the 1963 data collection by the Dimensionality of Nations Project; for a specific enumeration of these behaviors, see Appendix II). We may denote this b_{ij} vector by $(b_{ij1}, b_{ij2}, \ldots, b_{ij16})$. Similarly, we may consider dyad (i,j)'s attribute space of differences. If x_{ik} is i's score on an attribute dimension k, and x_{jk} is j's score on the same attribute dimension k, then we may define the difference score d_{ijk} as $d_{ijk} = x_{ik} - x_{jk}$. In the version of the early field theory under discussion, b_{ij} and the d_{ijk}s were related as follows (in matrix notation):

$$\begin{bmatrix} b_{ij1} \\ b_{ij2} \\ \cdots \\ b_{ijk} \\ \cdots \\ b_{ijn} \end{bmatrix} = a_1 \begin{bmatrix} d_{ij1} \\ 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix} + \ldots + a_k \begin{bmatrix} 0 \\ \vdots \\ 0 \\ d_{ijk} \\ 0 \\ \vdots \\ 0 \end{bmatrix} + \ldots + a_n \begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \\ d_{ijn} \end{bmatrix}$$

which we can express simply as $B_n = D_{nn}A_n$, where n is the number of orthogonal attribute and behavior dimensions.[17] This formulation has the disadvantages that the dimensionality of the behavior and attribute spaces must be identical, and that each behavior dimension must be a function of a single attribute dimension. These constraints have been removed by Rummel, but the simplicity of the model permits some obvious and interesting deductions concerning the prediction of the magnitude of a given dyad's behavior vector. Assuming conformability in the equation B=DA, we may premultiply both sides of the equation by their respective transposes, thusly

$$B'B = A'D'DA,$$

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[17] Note that when the attribute dimensions for nations are defined to be orthogonal, the difference dimensions corresponding to them are also orthogonal. The proof of this is simple. If the attributes are expressed in standard form, then orthogonality implies that

$$x_{ik} = bx_{ih}, \text{ where } b = 0,$$

that is, that i's score on dimension h is unrelated to its score on dimension k. Consider now the derivation of d_{ijk} and d_{ijh} in the light of the above, thus:

$$\left.\begin{array}{ll} & x_{ik} = bx_{ih} \\ \text{subtract} & x_{jk} = bx_{jh} \\ \hline & (x_{ik}-x_{jk}) = b(x_{ih}-x_{jh}) \\ \text{or,} & d_{ijk} = bd_{ijh}, \end{array}\right\} \quad b = 0$$

thus, each of the difference vectors k and h are also orthogonal.

which will give us on the left-hand side the square of the length of the given dyad's behavior vector. Define $m_{ij}^2 =_{def} B'B$ and then expand in scalar algebra notation the right-hand side, to obtain

$$m_{ij}^2 = \sum_{k=1}^{n} a_k^2 d_{ijk}^2, \qquad (2)$$

which is to say, the square of the magnitude (length) of the behavior vector, b_{ij}, is equal to the sum of the squares of the weighted attribute differences, d_{ijk}. Notice how that (2) as a testing equation (for empirical research) does <u>not</u> formally require that the <u>empirical</u> behavior and attribute vector spaces be of equal dimensionality. This is a reasonable consequence; it is more than likely that <u>empirical</u> dimensionality will differ from theoretical dimensionality due to a variety of causes such as insufficient data, inadequate typology of data types, atypical sampling in time and space of dyads, coding error, and so on. Notice also that the right-hand side of (2) <u>no longer implies a one-to-one correspondence between each behavior dimension and each attribute dimension</u>. What is now implied is that the magnitude of the behavior vector is a weighted sum of all the differences between a given dyad in attribute space.[18]

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[18] Rummel's later formulations define B_{nm} as an n-dyad by m-behavior dimensions matrix, D_{np} as an n-dyad by p-attribute difference dimensions with $p \geq m$, and A_{pm} as a matrix of empirical coefficients. Not only does this change entail eliminating an arbitrary restriction on the dimensionality of B; it also permits a non-orthogonal transformation of D into the B-space -- a transformation technique first developed and theoretically justificed by Ahmavaara (see Yrjö Ahmavaara and Touko Markkanen, <u>The Unified Factor Model</u>; Stockholm: Almquist and Wiksell, 1958, esp. section IV, pp. 74-88

(Continued)

Suppose we now expand algebraically (2), taking note of the identity $d_{ijk} = x_{ik}-x_{jk}$, as follows:

$$m_{ij}^2 = \sum_{k=1}^{n} a_k^2(x_{ik}-x_{jk})^2 = \sum_{k=1}^{n} a_k^2(x_{ik}^2-2x_{ik}x_{jk}+x_{jk}^2)$$

$$= \sum_{k=1}^{n} (a_k^2x_{ik}^2 - 2a_k^2x_{ik}x_{jk} + a_k^2x_{jk}^2) \qquad (3)$$

While (2) and (3) are formally identical, their implications for estimating m_{ij}^2 from real data are not; for by using (2), the test will hinge simply upon how much of real transaction vectors t_{ij} (see Figure 3) one expects to be composed of behavior b_{ij}, and how much one expects to be a function of the efforts of statesmen to achieve goal-states g_{ij}. By using (3), we can simultaneously test the theoretical assumption embedded in the field theory; for now <u>three</u> coefficients representing a_k^2 and $-2a_k^2$ will be generated, and they may empirically not stand in the expected relationship to one another.

18(continued)
<u>passim</u>). With this change in the definition of the matrices B, D, and A, I believe that the corresponding equation to (2) would be, for dyad (ij),

$$m_{ij}^2 = \sum_{k=1}^{m} \left(\left(\sum_{q=1}^{p} d_{ijq} a_{ak} \right)^2 \right)$$

where m_{ij}^2 is the scalar result of the v_{ij}-th row of B being post-multiplied by the ij-th column of B' [the functional equivalent of the previous pre-multiplication B'B when B was only a vector in eq. (2)]; and the right-handed term is the corresponding element in DAA'D' in the new notation. It will be observed that if we were to attempt a similar expansion of (3) and (4) with the above formulation, testing the implications of the field theory model would involve estimating $m \cdot p^2$ coefficients, i.e., $16 \cdot 22^2$ -- a number far in excess of the degrees of freedom (181) available in the data collected.

To clarify the point, let us rewrite (3) as a standard regression model:

$$m_{ij}^2 = a + \sum_{k=1}^{n} (b_{1k}x_{ik}^2 + b_{2k}x_{ik}x_{jk} + b_{3k}x_{jk}^2). \qquad (4)$$

From (3), the relationships between the b_{1k}, b_{2k} and b_{3k} coefficients and the a_k^2 and $-2a_k^2$ coefficients is apparent. If this version of the theoretical assumption that <u>differences</u> in national attribute dimensions predict the magnitude (as well as direction) of behavior vectors b_{ij}, then the b_{1k}, b_{2k} and b_{3k} coefficients should stand in relation to each other as 1:-2:1. (It will be recalled from footnote 18 that the present model does not have an unambiguous interpretation in terms of the direction of the b_{ij} vectors; <u>thus results from this particular test have no direct bearing on any other subsequent developments of field theory</u> or empirical models).

The test of this little bit of the field theory is executed by carrying out both the regression suggested by (2) and the regression suggested by (4). The estimated a_k^2 coefficients will be used as best estimates of the b_{1k} and b_{3k} coefficients, and $-2a_k^2$ will be used as the best estimate of the b_{2k} corresponding terms. The actual b_{1k}, b_{2k} and b_{3k} terms will then be computed directly; and standard statistical tests will be used to determine whether differences between them are attributable to "chance."[19]

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[19] Strictly speaking, the sample which should have been used for purposes of test generalization in this test was Rummel's "random sample" (continued)

In addition to the test with regard to coefficients, note will be taken of the difference in the per cent of variance in the squared magnitude of actual transaction vectors t_{ij} which was accounted for. Strictly speaking, this is not necessary, for if the coefficients are not as predicted, it is highly probable that (4) will do a better job in estimation than (2). Nevertheless, one may be interested in just how much better (4) could be than (3), and just why it might be that this could occur. For example, it may be that interaction terms, $x_{ik}x_{jk}$, are vastly more relevant than the squared terms individually. If so, this would give rise to a straightforward probabilistic interpretation of the impact of attribute dimensions on behavior.[20] Alternatively, if the separate x_{ik} and x_{jk} terms are of greatest significance (explain the most variance), a model of the form $(x_{ik}+x_{jk})$ $(x_{ik}-x_{jk})$ might emerge by inference, which would indicate that both combined and distinguishing aspects of nations on each dimension determine their aggregate behavioral

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19(continued)
of dyads (some nations were added because of substantive interest) from the 1963 universe of 107 nation-states. Van Atta and Rummel (op. cit., p. 15) have assured us, however, that factor scores for both the random and selected sample are reasonably similar and that results of analyses of interrelations among variables are virtually identical (p. 22); so I have picked the selected sample instead, because the dyads it contains are more interesting.

[20]See Chadwick (1970), op. cit., fn. 13 supra, for treatment of this point in some detail.

exchange, or involvement.[21] These and many other substantive possibilities might emerge from this test, essentially because it does not assume without proof that the difference formula is the only one by which the field theory, more broadly taken, might prove valuable.[22]

By way of pedagogical commentary, we may note that this particular strategy of theory testing, under usual circumstances, will tend to raise more questions than it answers. It will not give a simple yes or no to (3), and leave it to the researcher or theorist to create another formula out of his intuition. It isolates a piece of a puzzle and studies its implications for the whole, so to speak. It provides detailed information on likely new avenues to explore. The strategy is simply to break down a general model into its least-subdivisible ("atomic") units, draw some empirical inferences, and examine them. No one piece of the total testing procedure will cause one to reject the entire model, or to accept it. Each piece will simply cause one to conclude that this or that particular area of potential application is in fact empirically substantiated. If enough bits and pieces are inapplicable, the theory will eventually be passed by, as inferences

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[21] See Nils Petter Gleditsch, "Rank Theory, Field Theory, and Attribute Theory: Three Approaches to Interaction in the International System," Research Report No. 47, Dimensionality of Nations Project, 1970, for a treatment of both these expressions in terms of rank disequilibrium theory.

[22] Indeed, Rummel (1965, op. cit., fn. 8) has found a mix of $(x_{ik}-x_{jk})$ and $(x_{ih}+x_{jh})$, $k \neq h$, terms to be most useful in accounting for foreign conflict behavior.

built up along the testing path suggest new formulations and cumulate into a countervailing theory. Conversely, if the bits and pieces of empirical inference support the theoretical deductions, the detailed work will build up a backlog of applied significance (now lacking in most international relations theories because they are far too gross and non-operational in form)[23] and confidence in the generality of the theory.

III. Estimating the Magnitude of Probable Dyadic Transactions

While Figure 3 sketches Rummel's present model for making operational his field theory, and the indicated factor analyses were actually performed, only the results of the attribute space factor analysis were used. On the behavior side, the behavior of these fourteen nations toward each other in 1963 was factor analyzed, and the fifty-six variables were reduced to a sixteen-dimensional space. However, it was reasoned that the full variance of behavior space, not the 81.6 per cent included in the sixteen factors, should be allowed to define (measure) the magnitudes of dyadic interaction; for there was no substantial reason for excluding unique (non-common) variance from contributing to magnitude variance. (See Appendix III for further discussion.) The sample of dyads

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[23] Rummel's own theory stands in this relation to the field theory of Quincy Wright's, put forth in The Study of International Relations (New York: Appleton-Century-Crofts, 1955). Wright's work was, despite the data collection meant to suggest operational aspects, non-operational. The references to factor analysis were without support in terms of moving from data to factors or dimensions such as energy-lethargy; and precisely how attributes affected behavior was never made clear by him. Wright's insight was monumental; his ability to quantify his insight moderate: his testing operations non-existent.

selected by Rummel in terms of representativeness on a number of criteria, consisted of the following nations: Brazil, Burma, China, Cuba, Egypt, India, Indonesia, Israel, Jordan, Netherlands, Poland, Russia, United Kingdom, and the United States.[24] Within this space, the behavior of each directed pair (dyad of nations, e.g., Brazil→Burma, is represented by a single vector with two attributes: length, and direction. We considered only the length property in this test, as discussed in section two, above. Equations (2,4) were thus made operational, with the following results.

Following the general regression model shown in (4), only one of the factors produced a statistically significant contribution on all three of its component scores [the two squared terms and the product term shown in (4)]. While this factor is also the best predictor of national involvement; using (2), it turns out that two of the three b-coefficients estimated by (2) are significantly different from those estimated by (4), which was to be expected since the differences in per cent variance accounted for are substantial. The factor component that had "not been incorrectly" predicted was for the sender and accounted for only 3.46 per cent of the variance in involvement. (The .05 level of significance test was performed in all analyses reported on in this study; for details see Appendix III.)

[24] See Van Atta and Rummel, op. cit., fn. 16, for a more complete description of the data and sample, as well as the technical details of the factor analysis.

The factor that produced these results had two attributes which characterizes it (i.e., of which it is predominantly composed): number of foreign students present in the country, and a measure of distance between the capital of a country and all other capitals of other countries (indicating how far, on the average so to speak, one country's capital is from all the others). Their factor loadings were .78 and .64, respectively, and their correlation .44. At first glance, it seems inconsistent that nations with relatively large capital-to-capital distances should have relatively many foreign students. The explanation may lie in both the relative weakness of the correlation (implying that many substantive exceptions to the general pattern exist) and in the relatively great distances between major powers and countries within their spheres of influence (as compared with each other). Of the fourteen countries in this study, the top five (in order) on this factor were the United States, the Netherlands, Egypt, the Soviet Union and the United Kingdom -- a group not inconsistent with this speculation. While two of these five cannot be regarded as global powers, the Netherlands does have a colonial power past, and Egypt is a major power in the Middle East.

We shall give the above factor a name for further reference, consistent with its importance for estimating the magnitude of dyadic behavior: educational influence. In order to further justify this description, it may be noted that it implies asymmetry in influence. From (4), it will be observed that it was represented by three terms: x_i^2, $x_i x_j$, and x_j^2, where x_i and x_j are the original factor scores for

each i and j country. The receiver score, x_j, should be by far the strongest, that is, account for most of the variance. It does: twenty-one per cent of the variance in the magnitude of dyadic international activity was accounted for by it, as compared with three per cent by the x_i term, and one per cent by the $x_i x_j$ term.

The only other factor to explain a substantial proportion of variance in behavioral involvement, within the context of (4), was one labeled by Van Atta and Rummel linguistic-ethnic diversity, characterized by such variables as numbers of language, religious and ethnic groups.[25] As might be expected given the substantive asymmetry in educational influence, the receiver component of the substantive asymmetry in educational influence, the receiver component of the factor accounted for eleven per cent of the variance, the interaction term but two per cent, and the sender term nothing significant; though just why diversity should seem to attract activity is obscure. In a faint, probabilistic way, it may be that such cultural diversity is attractive for the relatively wide variety of cultural opportunities for external transactions, presuming that each subculture within the nation has counterpart cultures abroad. Thus a nation with many subcultures would have more opportunities to offer for interaction than others.

There were eight other factors with one term each which contributed significantly to estimating the magnitude of dyadic

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[25]Van Atta and Rummel, op. cit.

behavior, but they each accounted for two per cent or less of the total variance, hence are not worth the bother to conjecture about. A grand total of fifty per cent of the variance in involvement was accounted for by ten factors with one or more significant terms, within the context of (4). Forty per cent was accounted for by the first two factors alone, as discussed above. Thirty-five per cent was accounted for by receiver or destination component terms (the s_j^2 terms) -- thirty-three per cent from the first two factors alone. Since our object is not to account for all of the involvement of nations with one another, but just that due to social ecology, this may be considered a very satisfactory set of figures. From a substantive viewpoint, these are also very heartening results for the "humanist" scholars in political science and international relations. For the factors that turned out to do the best job of prediction were cultural and intellectual, not economic or geographic or geological. The results indicate the predominance of the properties of people, not what they do (e.g., make GNP) or what they do it with. The results emphasize the social in social ecology. Another interesting aspect of these results is that they underscore the passive nature of social ecology. It was not the sender or origin properties, but the recipient or destination properties that were most important. It would seem consistent with these data to say that social ecology provides opportunities but not drives or conations towards action. Indeed, the fact that one has students from abroad could hardly be explained any other way.

We will now turn to an examination of the results of applying (2) in and of itself. While some ten factors had at least significant

coefficients, and accounted altogether for thirty-five per cent of the variance in dyadic national involvement, eight of them accounted for only two per cent or less variance each, and therefore have little substantive significance. The first, educational influence, has already been discussed; it accounted for nineteen per cent of the variance explained by (2). The second, accounting for six per cent of the variance, is surprising. It was the 19th factor extracted by Van Atta and Rummel, and was left unnamed. It had only one meaningfully loaded variable (say, loadings greater than .3 or so), which was domestic killed (number killed in domestic violence in 1963), with a loading of .767. Since its b-coefficient is positive, this implies that a nation with large numbers of domestic killed relative to another nation (i.e., large positive difference in a directed dyad), will tend slightly to have more involvement with the other nation. Moreover, since the domestic conflict factor did not contribute significantly to involvement, this finding is restricted to numbers killed; it is not generalizable to domestic conflict in general. This is a curious finding, and bears extremely careful examination, and should be replicated using other data. So far, the general lack of relationship between domestic conflict and external national behavior has been characteristic of field theory tests; moreover, domestic killed has usually been associated with domestic conflict in general. Future research on this relationship is strongly urged.

We have found sufficient substantive relevance in applying the field theoretic perspective developed by Rummel to consider the analysis

of residuals generated by (4). The specific difference-model embedded within the early version of field theory examined above, however, has not been supported. This suggests that further, more detailed testing and exploration is vital, not that the difference model should be rejected, even as regards its implications for predicting the magnitude of dyadic interaction. One test on one set of data, in the context of one inferential argument, executed by a few fallible individuals, is hardly a sufficient basis for reaching a final decision. Nevertheless, the results argue strongly for more detailed substantive analysis, the Van Atta and Rummel tests on the same data with a different model notwithstanding.

IV. Some National Patterns of Policy Involvement: A First Approximation Exercise.

This section presents a first approximation to measuring relative policy involvement between nations, through application of (4), the equation through which one of Rummel's field theory models was tested. The value of this analysis, given its limitations, is primarily as a heuristic demonstration of a policy analysis method for future, more substantive, applications.

The essential feature of what we have done has been to take the "expected" values of the magnitude of dyadic interaction as baselines against which to measure relative deviations of real interactions. Because the "expected" values have been obtained by using a model through which (it is hoped) all relevant socio-ecological national

attributes have been properly considered, the deviations from "expectations" are presumed to indicate the amount of "over-involvement" or "under-involvement" due to the global decision-making system within which each nation is embedded. Put in the words of section one of this paper, it is hoped that those national attributes which contribute to routinized, habitual behavior and alternatives have been controlled, so that what remains for observation is the net impact of cybernetic or control efforts to achieve goals or attain valued or "ideal" conditions.

It is important to make clear at the outset the limitations on this essentially heuristic application, which are as follows:

(1) Some fifty-six coded types of national interaction were compressed into a single index of the magnitude of involvement each nation with another. Substantive applications should not be so universal in scope. It is vital that at least conflict and cooperation be analytically distinguished (after the manner suggested by figure two), through some weighting and combining process (as suggested, for example, by Rummel's use of factor analysis, indicated in figure three). If the specific interactions representing certain types of policies could be isolated, and a weighted summary index determined for each, still greater value could be obtained.

(2) The data are collected for 1963 (from the DON Project), hence any substantive interpretations of observed patterns need to be executed in the global policy context of that year.

(3) The "expected" values are in theory the squares of the magnitude of interactions between each pair of nations (directed dyad). The particular model used requires that we use these theoretically

"squared" (see equation four) terms as some of the "expected" values from the socio-ecological model are negative, giving rise to imaginary numbers if square roots were taken (see Appendix IV).

(4) Since the measurement units are not of substantive significance in this study (the data having been standardized at various points), but since there exists a meaningful zero point (as all values were squared and as the mean location is still represented by the constant zero), relative involvement (RI_{ij}) indices have been constructed, defined as

$$RI_{ij} = (I^2_{ij} - \hat{I}^2_{ij})/\hat{I}^2_{ij} ,$$

where I^2_{ij} stands for the square of the interaction index compiled from measured transactions from i to j, and $\hat{I}^2_{ij}$ is the "expected" level of such transactions from the socio-ecological model (4). RI_{ij} is thus the proportion above or below expectation; it is the deviation per unit expectation. Such an index is valuable even when meaningful measurement units exist because the deviations ($I^2_{ij} - \hat{I}^2_{ij}$) themselves can be expected to be larger, the larger is the expectation; by norming for the expectation, we can easily note where the interaction level is in proportion to where we expected it to be. (In the case where I^2_{ij} is a negative number, the following index is substituted:

$$RI'_{ij} = (\hat{I}^2_{ij} - I^2_{ij})/\hat{I}^2_{ij} . \qquad (5')$$

This reversal in the direction in which the difference is taken permits an identical interpretation of the index when negative expectations are present. In the future, these and other Rube Goldberg arrangements of the data should be minimized.)[26]

(5) The model used is, after all, but the first manipulated to indicate quantitatively the relative policy involvement of nations in their interactions. It clearly has a high probability of being successfully replaced by more sophisticated and fundamental concepts, data sets, and methodologies. Thus this exercise can best be labeled "pioneering," and valuable only as a direction sign.

By way of appreciation to balance the above list of limitations, it should be noted that:

(1) This method essentially begins where classic regression analyses end, and as such underscores just how far away a true policy science (as distinguished from the art of policy making and the art of policy analysis) really is;

(2) By differentiating the magnitude of involvement of each nation with another, from the mix of activities characterizing the given level of involvement, a crucial distinction in policy science can now be made operational in a systematic, quantitative manner;

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[26] See Chadwick, op. cit., fn. 13 supra, for discussion of such indices in general. The specific application here was originally conceived when I noted that the Savage-Deutsch model was essentially controlling for but two types of national attributes, as they conceived them, viz., total exports and total imports of each nation. This point is discussed at some length in the manuscript referred to above. See also I. Richard Savage and Karl W. Deutsch, "A Model for the Gross Analysis of Transaction Flows," Econometrica, 28(3), July, 1960, 551-579.

(3) It would now be possible to analyze RI_{ij} indices in terms of their dynamic interrelationships over time to arrive at measures of the power which each actor has over every other national actor in the global international system, and on the effects of cybernetic behavior on national attributes and on itself;

(4) It would now be possible to speculate in a quantitative manner about the goals or ideal condition of transactions and national attributes to which each national subsystem seems to aspire, and to project the interplays of the goal, socio-ecologically probable, and real transaction systems over time -- not for the purpose of prediction in the usual sense of that term, but for the purpose of more clearly defining and selecting among alternative futures to attempt to attain.[27]

While the present application is clearly but a first faltering step in terms of the above possibilities, it is only by making such trial applications that new, detailed questions for future research and application can be developed.

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[27] Social science still needs to develop paradigms for the use of the concept of causation, upon which policy futures can be developed. The traditional concept of "forecasting" and the use of the term "prediction" in regression analysis contexts clearly indicate how inadequate our present paradigm is. For further treatment of this subject, see Chadwick (1972, op. cit., fn. 13, supra). One of the key ideas discussed there is that social systems must be viewed as designed systems; thus their behavioral regularities are a function of how policy makers and policy-making processes in general direct the formation of social change. Contrariwise, social ecology models have the same status as Savage and Deutsch's "null model," (op. cit.), that is, a hypothetical condition of the social system's transaction flows is predicted under the assumption that transactions are statistically independent -- not governed by coherent policy processes. The need for suitable application of the concept of causation to social ecology models is vital, so that we do not presume that their "predictions" are in fact high-probability "forecasts" in the usual sense.

A. A General Overview of Fourteen National Involvement Patterns: Some Criteria for Evaluation

There are a number of features of RI_{ij} indices which for general theoretical reasons it would be desirable to work with when making preliminary examinations. These are: (1) general goodness of fit of the socio-ecological model to actual transactions (implying small deviations from expectations, relative to the magnitude of expectations); (2) relative symmetry or asymmetry to the RI_{ij} indices, implying instability in the relationships between i and j (i.e., RI_{ij} and RI_{ji} being markedly different); (3) relative number of positive or negative RI_{ij}s, indicating relative activity or isolation of a nation in the world. We will develop these concepts further below, in the context of their application.

A.1. Goodness of Fit to the Socio-Ecological Model

To the extent that a nation exhibits relatively small deviations [i.e., relative to its estimated (predicted) values] from behavior patterns inferred from the socio-ecologically expected, it may be said to have relatively little desire or capability to alter the magnitude of its involvement with other nations. (This statement could be generalized to the mix of activities as well if such inferences were made; the present socio-ecological model does not make such inferences.)

The application of this generalization to the data at hand indicates that, of the fourteen nations, the United States has probably the least control of the magnitude of its involvement with the other nations. All nations have been shown graphically in Appendix V, in terms of their RI_{ij}s and RI_{ji}s. Figure 17 of Appendix V plots the RI_{ij} of the United States (i = U.S.A.) on the horizontal axis and the RI_{ji}s on the vertical axis. When the United States is compared with the other thirteen countries in the set (Figures 4 through 16), it will be noted that it has the smallest range of RI_{ij}s. It also has the smallest range of RI_{ji}s (others to U.S.A.), indicating that others are just as unable or unwilling to alter their magnitude of involvment with the United States as it is with them.

Upon making this observation, one is tempted to reconsider explanations which are socio-ecological in nature. For example, noting that the United Kingdom and the Soviet Union (Figures 16 and 15) also have relatively small graphs, it might be inferred that restrictions on the range of the RI_{ij}s is a function of the level of expectations: large powers, having greater magnitudes of involvement in international affairs, would tend to require relatively larger "efforts" to alter their magnitudes of relative involvement with other nations. But if this were so, then countries such as Israel and the Netherlands would require additional explanations, for, with one exception each, their RI_{ij}s are also comparably small. Furthermore, other large nations such as China and India have relatively large graphs. Ultimately, the fact that size and development variables were already tried (in section three

of this paper) as control variables for inferring the magnitude of dyadic behavior, and found irrelevant, should dissuade us from this line of inquiry.

A possibly more fruitful and exciting line of inquiry lies in the cybernetic or policy approach, which this analysis is designed to lead into. The exceptions in the Israel and Netherlands graphs (Israel to Jordan, and Netherlands to Cuba; and both vice-versa as they are fairly symmetric) in 1963 may be properly indicating the relative amounts of "special attention" these countries were paying to their respective "deviants." In the case of Israel, the reason almost surely lies in the intense propaganda campaign and intense hostilities within which they were mutually embroiled. In the case of the Netherlands, Cuba found an outlet for her sugar and source of trade, against the will of the U.S.A. It would be necessary to develop the analysis in more detail, as suggested earlier, in terms of conflict and cooperation dimensions, and even in more detail on the actual types of coded behavior. But that is beyond the scope of the present paper.

In terms of the development of more quantitative indicators of goodness of fit of national behavior to a socio-ecological model, several statistics may be suggested. First, the per cent discrepancy statistic could be calculated, which measures how much of the observed magnitudes of transactions would have to be redistributed to equal the expected magnitude from the socio-ecological model (measuring this discrepancy as a percentage of the maximum possible discrepancy).[28]

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[28]This statistic has been used with good results in another context by Steven J. Brams, "Transaction Flows in the International System," American Political Science Review, Vol. LX, No. 4 (December, 1966), 880-898, esp. p. 886.

Second, a measure of the patterning of the deviations (the RI_{ij}s), such as a correlation, might be calculated. But this would probably be more relevant for indicating the strength of symmetry or asymmetry in the RI_{ij}-RI_{ji}s, as discussed below.

A. 2. Symmetry and Asymmetry in the Magnitude of Involvement

To the extent two nations exhibit symmetry in their relative magnitudes of involvement ($RI_{ij} \doteq RI_{ji}$), their relationship is characterized by a mutuality of concern. Asymmetry suggests one-sided dependencies, which may indicate rapidly changing relationships. To interpret relative degrees of symmetry really requires detailed data and analysis; and it would be worthwhile to conduct such analyses for the information which they would conveniently summarize.

The most asymmetric patterns (by visual inspection) in the data seem to be the United Kingdom and Egypt, for fully eight of their thirteen RI_{ij}-RI_{ji}s were mixed positive and negative, and each had only one positive-positive combination of RI_{ij}-RI_{ji}s, and these were no where near the line of symmetry (the diagonal line at 45° in Figures 8 and 16). In Egypt's case, in 1963 she seemed far more involved with Burma, Israel, Indonesia, and Cuba than they with her; and the U.S.S.R. seemed far more involved with Egypt than vice versa. The particular patterning here defies simple inferences, indicating even more strongly the need for detailed breakdown of behavior. But it is clear that Soviet involvement in Egypt, unmatched by Egypt in the U.S.S.R., is easily explained in terms of Soviet interests in

supporting the Egyptian government against Israel. And while we might have expected a mutuality of attention between Egypt and Israel, Israel's relatively low RI with Egypt may be explained by her preoccupation in 1963 with the Fedayeen raiders across the Jordanian border. Details in the data could be used to test these speculations.

The United Kingdom's graph is relatively uninteresting because of the relatively small range of its RI_{ij}s and RI_{ji}s. Yet one finds oneself asking: does the general pattern not suggest a weakness and instability in her foreign policy? Only three of the thirteen countries showed an excess of transactions above those socio-ecological inferred (the Netherlands, the U.S.A., and Indonesia). While the same could be said of Egypt, there was a tendency for the Egyptian RIs to be larger.

Israel's graph is somewhat similar in its pattern of asymmetry to the others, with only one positive-positive association -- with Jordan, as described earlier. In fact, only Jordan and the U.S.A. seem singled out for attention as these are the only two with whom she appeared excessively involved. On the other hand, many nations seemed involved with her -- India, Cuba, Egypt, Poland, being those relatively more involved.

Somewhat similar patterns of asymmetry are to be found in the Cuba and Indonesia graphs, though in Indonesia's case, there are two relatively strong symmetric relationships, with Burma and Brazil. If we reflect on this set of nations with relatively strong asymmetries (Egypt, the United Kingdom, Israel, Cuba and Indonesia), with the exception of the United Kingdom (because of its small magnitudes of RIs), it would probably be fair to say that they were

under great effective stress -- either of their own will or by others -- to alter their national policies and place in world politics. With the decline of her colonial empire, this could also be said of the United Kingdom; but the graph indicates that such stress is relatively weak as compared with that laid on Egypt and the others. The fact that the graphs accord well with historical reflections simply means that the quantitative analysis is doing the job it was designed to do. Nevertheless, despite the results, Jordan ought also to be subject to the same generalization, which indicates once again the need for greater refinements in the data analysis.

As mentioned in the discussion of goodness of fit, one way of quantifying the notion of asymmetry more systematically than counting numbers of positive-negative RI pairs and positive-positive pairs (or equivalently negative-negative pairs) is through correlation and regression analysis. Symmetry implies a perfect linear correlation with a b-coefficient of 1.0, i.e., $RI_{ij} = 0 + 1.0RI_{ji}$. Asymmetry thus departs in terms of both the strength of the correlation and the direction of the association. In the asymmetric graphs discussed, we might expect a negative b-coefficient; but a weak correlation coupled with such a negative b-value would indicate neither symmetry nor asymmetry but rather the absence of any pattern at all.

Assuming that the strength and magnitude of asymmetry adequately measure the effective stress toward change in national policy, we would expect nations exhibiting most stress to be centers of domestic and international conflict. Furthermore, we would project two long-term trends in such nations' behavior and socio-ecological systems:

(1) the relatively asymmetric nations either alter others or their own behavior towards symmetry; (2) they alter others or their own socio-ecological systems gradually to bring about a balance between socio-ecological and policy-directing forces, or alter their overall patterns of involvement in the direction of the socio-ecologically expected. These generalizations will be discussed in the summary to this section.

A. 3. Activity and Isolation

In terms of their action towards others, the U.S.A., India, and the Netherlands seem the least active of the fourteen nations selected for study, with 9-10 negative RI_{ij}s. While the Netherlands also has the distinction in this sample of having the most negative-negative RIs (7), the behavior of the U.S.A. and India suggests similar features. All three of them have only three positive-positive RI_{ij}-RI_{ji} pairs each. Relative to its socio-ecological expectations, the U.S.A. has mutually greater -- though not by much -- involvements with India, the U.S.S.R., and the Netherlands. The first two are understandable in terms of global strategy; but the latter evades a simple reflection. We have noted that the Cuba-Netherlands RIs are positive and reasonably symmetric, as well as the U.S.A.-Netherlands RIs. It is conceivable that the Netherlands is providing an indirect linkage between the U.S.A. and Cuba, but this speculation requires detailed data to confirm. India's other positive RIs are with Jordan and China, and most strongly with Israel (though this is not reciprocated for Israel's RI to India

is negative). India was indeed stirred to action by Indian-Chinese border disputes, as by the continuing Mid-East turmoil. In general, the few positive RIs which these relatively underactive nations have seem amenable to explanation.

Israel, though it has but two positive RIs toward others, clearly requires separate treatment. It is highly likely that Israel shows this pattern because of her intense military and diplomatic efforts directed towards Jordan and the other Mid-East states. Because of the great imbalance in her diplomatic activity, the general summing without special weighting of all types of international activity probably causes her graph (Figure 11) to be ill-represented in the extreme.

On the positive side, Burma and China show the largest number of positive RIs (and among the largest; see Figures 5 and 6). The graphs seem quite different, however, for while it appears that the large RIs are towards Burma, China's large RIs are self-generated, towards others. This contrasts with a nation, Burma, which generates interest but has relatively little interest in others, though the comparison should not be overdrawn.

Though the China and Burma patterns do not describe asymmetries in the sense of many positive-negative RI_{ij}-RI_{ji} combinations, they do have the largest asymmetries (in magnitude) in the graphs. In particular, the China-Burma, China-Jordan and Burma-Brazil asymmetries are truly extreme. The Chinese interest in Burma certainly includes

the presence historically of trade ties [which in 1963 had very large Savage-Deutsch relative acceptance (RA) indices; but as these ties were fairly symmetric, at least supplementary explanations are required].[29] The China-Jordan asymmetry may essentially consist of propaganda, but detailed data would be necessary to confirm this. Similarly, in the absence of any recorded trade between Burma and Brazil, precisely what transactions caused the strong Burma-Brazil relative involvement indices and the strong asymmetry in them remains to be uncovered.

B. Theoretical Problems Related to Relative Involvement Indices

We have examined a few national patterns of global involvement; and throughout the need for more precision was made manifest. More detailed studies of international behavior should go a long way to making the usefulness of this method far greater. However, more fundamental developments in the method itself can also be suggested. Among these developments, the following should be investigated: (1) developing purely theoretical models of the potential impact of socio-ecological conditions on behavioral patterns; (2) relations between relative and absolute magnitude of deviations in behavior from expectations; and (3) policy dynamics.

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[29] The China-Burma RA was 12.4 and Burma-China, 10.0. For further discussion, see Chadwick, Deutsch, and Savage, Regionalism, Trade, and International Community (forthcoming).

B.1. Socio-Ecological Models

We may be underrating the impact of policy on international transaction patterns through the present approach. It is perfectly possible that ethnic diversity and foreign students, as variables characterizing in part the makeup of national populations, did so well in estimating the magnitude of national involvement because (1) policy defines the borders of nations and can alter the ethnic composition of nations, (2) international policy activity certainly alters the number of foreign students in any given nation. Certainly the number and composition of foreign students in the United States and the Soviet Union reflect their pattern of cooperative activities (or, indirectly, their coercive activities) in world politics. And Israel certainly has affected her own ethnic composition. Thus, it may be that these variables effectively act as surrogates for the policy activity itself -- at least to some extent.

In this context, we should also ask: has the impact of other national attributes on behavior been masked by the relative grossness of the magnitude index? In the study of trade flows, for example, Linnemann has found he could account for international trade, or sixty-four per cent of its variance, in terms of gross national product, population size, and port-to-port distances between trading partners.[30] Trade was a component of the m^2_{ij} and the variables Linneman used were effectively included, even in their multiplicative

[30] Hans J. Linnemann, An Econometric Study of International Trade Flows (Amsterdam: North-Holland Publishing Company, 1966).

form,[31] yet they showed no significant association to the m_{ij}^2 terms. Similarly, Rummel found size ("power") measures and the distance to be associated with the magnitude of conflict,[32] and these also were included in the m_{ij}^2 terms. It may be that the grossness of the m_{ij}^2 terms themselves accent the effect of those attributes most sensitive to policy decisions. If so, then the more detailed sorts of analyses (such as Van Atta and Rummel's[33]) point in the correct analytic direction, though not with an optimal model.

These observations lead to the conclusion that far more effort should be undertaken to devise specific substantive models linking subsets of national attributes to subsets of national behavior, both as regards the implications for the relative magnitudes of involvement and as regards the mix of specific activities for which the set of attributes are relevant. Similarly, we must come to grips in an empirical fashion with the problem of analytically representing concrete policy systems -- not idealized as in game theory or idealized through the myopia of inside-dopesterism, or idealized

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[31] Linnemann, ibid. Both Linnemann and Rummel have used such variables as GNP in their logarithmic form, Linnemann to linearize his multiplicative model with unknown exponents, and Rummel to normalize data distributions (bring in extreme outliers such as the U.S.A.). While the data were not put into logarithmic form in the present study (following current DON Project usage), the multiplicative components in (4), the $x_i x_j$ products, are present for each of the attribute factors; and one of the factors covered ("size") had GNP and population loaded heavily on it. Thus the regression coefficient associated with that factor could be (roughly) interpreted as an average exponent coefficient for these specific attributes.

[32] Rummel, 1965 (op. cit.).

[33] Van Atta and Rummel, op. cit.

through the stimulus-deprived environments of two or three variable experiments. The results obtained through the socio-ecological model in section three are in fact, compared with the empirical studies already cited, not especially outstanding, but about on a par in terms of variance accounted for. The only claim to attention which the present empirical work has lies within the self-evaluative and self-correcting context of the general cybernetic orientation shown in Figure 1, above. For this cybernetic orientation directs us to examining as critically the methods and substance of the modeling context as the testing context. The need for further development of socio-ecological models, for example, is not stressed by the apparently good results achieved in the regression analysis conducted; but from the quality of the results, i.e., the specific variables which turned out to account for behavior, as compared with those which did not (which should have, given others' empirical studies). Until such time as the questions raised here are investigated with dynamic models (with regard to the time-lagged relationships between specific behaviors and such attributes as foreign student population and ethnic composition) and more detailed exploration of specific types of behavior (such as threats, measured in terms of their relative magnitude as well as frequency), the development of a true policy science of international behavior can hardly be said to have begun. If this seems a harsh remark to non-quantitative policy scientists or to quantitative behavioral scientists, it need only

be noted that there are few whose work could be characterized as quantitative behavioral policy science.[34]

B.2. Relative and Absolute Departures from Socio-Ecologically Expected Behavior.

To characterize policy effects in terms of relative departures for the socio-ecologically probable behavior may not be adequate. We have taken deviations from expectations per unit expectation because of the intuitive appeal of the relativistic argument. This argument is simply that a small absolute departure in transactions from a behavioral expectation that is small may represent a more significant policy decision than a small departure from a large expectation. Consider the case of international trade and the impact of a policy decision as regards a tariff. Two large powers may not be as significantly affected by such a decision, say on a commodity such as rice, as two small powers.

This viewpoint of relative effect of a policy decision has its disadvantages, however. For one, it treats each nation as an individual analytic unit. Thus the fact that a large power may contain a small faction as much affected by a tariff decision as the large faction in a small power is not considered. Furthermore, that the large power may act in a decision arena with no greater or lesser magnitude than appropriate to the absolute size of the relevant faction is not

[34] A first approximation to such a policy science is exemplified by Bruce M. Russett, What Price Vigilance? The Burdens of National Defense, New Haven: Yale University Press, 1970.

considered. It has in fact been suggested by Firestone[35] to treat each nation in this manner; that is, to weight it within a behavioral arena according to the relative sizes of their subpopulations actively interested in the policy implications of the behavior. Performing these operations on population and other relevant national attributes, and then examining the implications of these attributes for national behavior taken in absolute quantities, might make the absolute deviations from these quantities the most interesting statistics for policy analysis. Moreover, Van Atta and Rummel's finding that they were able to substantially improve their prediction of behavior through the field theory by taking separate regressions on each nation's specific dyads might be accounted for by this explanation. For what they did was control for each nation's "uniqueness" as regards their distribution of national attributes, and then examined each behavioral factor through a series of canonical regressions.[36] Thus we see, as through a glass darkly, the probability of fruitfully pursuing substantive models of "linkage politics" and "permeability" concepts through more substantively quantitative models.

Another sort of norming might be fruitfully investigated: dividing a difference between a behavioral expectation and actual level of transactions by the absolute magnitude of all the deviations associated with a given sender, receiver, or both in a global system. The point to carrying out yet another such data manipulation is to arrive at an index of relative policy effect or relative coordination.[37] The deviations from

[35] Firestone, personal communication, Summer, 1968.

[36] Van Atta and Rummel, op. cit.

[37] Chadwick, 1970 (op. cit.).

socio-ecological expectation may be summed (taken in their absolute values) for any nation's received or sent behavior (or both simultaneously), which would indicate the total magnitude of effect of its own and others efforts to alter behavior from socio-ecological expectations. By taking the proportion of this magnitude accounted for by any one interaction partner, we arrive at a measure of relative impact or coordination of a policy type, either imposed by others or by the specific sender or receiver of the transactions. In fact, if done in conjunction with re-evaluating attributes relative to specific policy arenas, such indices of relative policy effect would have fairly direct interpretations of the most substantive sort.

B.3. Policy Dynamics

With the discussion of suitable modifications of the methodology for policy analysis, we have reached the point where most future research should, in this cybernetic viewpoint, be directed. The theoretical scaffolding roughly developed in this paper has one fundamental goal: to initiate a far deeper quantitative and empirical incursion into applied and theoretical policy science literature, than has heretofore taken place. If social scientists are to make useful their empirical research to policy planning and development in a manner that is not intrinsically biased in favor of one or another policy decision, it is vital that socio-ecological effects be analytically distinguished from policy effects in observable transactions, communications and other interaction matrices. The development of socio-ecological models can

not occur without simultaneous development of models of policy dynamics, i.e., about the self-regulatory, autonomous feedback processes represented in Figure 1. While the "cerebral" viewpoint has often been taken in the policy literature, the sad fact is that hardly a shred of quantified empirical data has been systematically analyzed to provide people on the applied policy firing line with the fundamental equivalent of engineering tools and information. The term "social engineer" has more in common with Asimov's "psycho-historians" than any real consultants or advisors to any government on Earth.[38] It is, therefore, no wonder that in our age of massive and rapid social experimentation and large-scale socio-ecological problems, the very science from which should come the intellectual tools for application, is among the least able or willing to do so. In fact, in their haste to become relevant, some avant garde social scientists have mistaken insignificant scientific development of a policy science for inevitable impossibility and become openly anti-scientific.[39] This orientation can have but one effect if eventually overpowering: to cause social science as an entire discipline to become pure and simple political advocacy.

We have proposed in this paper some simple analytic distinctions and concepts to be made operational, and suggested in a practice-application

[38] Isaac Asimov, Foundation (New York: Doubleday and Company, 1951).

[39] See, for example, Marvin Surkin, "Sense and Nonsense in Politics," PS, Vol. II, No. 4 (Fall, 1969), pp. 573-581, esp. p. 577, last two paragraphs. While I find Surkin's discontent with the state of political scientists' political behavior justifiable, I believe he took a giant step in the wrong direction by confusing scientific objectivity in social systems modeling and validation norms with the traditional mind/body, rational/irrational, and subjective/objective dualistic philosophical concepts. For an alternative view, see Chadwick, 1971 (op. cit).

how specific model development may be undertaken. We have not indicated in a similar empirical vein the outlines of a model of policy dynamics. That is a next and most difficult step in future research.

APPENDIX ONE

LIST OF 94 NATIONAL ATTRIBUTES, CIRCA 1963, FROM THE DIMENSIONALITY OF NATIONS PROJECT

VARIABLE CODES & PROBLEM NUMBERS
1963 ATTRIBUTE SPACE

Analysis Number	Variable Name	Variable Code	Variable List Number*
1	telephones/population	TEL-PC	(11)
2	agricultural population/population	%A-POP	(3)
3	energy consumption/population	ENC-PC	(83)
4	illiterates/population 10 years of age or older	ILLITE	(10)
5	GNP/population	GNP-PC	(23)
6	population x energy production	EXPP	(63)
7	national income	NI	(29a)
8	population	POPULA	(18)
9	UN assessment/total UN assessment	%CT-UN	(190)
10	defense expenditure	DEFEXP	(60)
11	English titles translated/foreign titles translated	E/TRSL	(204)
12	bloc membership	BLOC	(198)
13	US aid received/USSR and US aid received	US/AID	(202)
14	freedom of opposition	TOTALI	(65)
15	IFC and IBRD subscription/(GNP)$^{.4}$ per capita	IFC/GP	(162)
16	accusations	ACCUSA	(156)
17	killed in foreign violence	F-KILL	(157)
18	military action or not	MILACT	(152)
19	protests	PROTST	(147)
20	killed in domestic violence	D-KILL	(144)
21	riots	RIOTS	(141)
22	purges		(140)
23	demonstrations	DEMONS	(143)
24	Roman Catholics/population	%CATH	(123)
25	air distance from U.S.	US-DIS	(210)
26	medicine NGO/NGO	MED/NG	(195)
27	ambassadors expelled or recalled	ER-AMB	(149)
28	divorces/marriages	DIV-MR	(104)
29	population/national land area	DNSITY	(17)
30	arable land/total land area	%ARABL	(43)
31	national area	AREA	(41)
32	road length/national area	RDS-KM	(108)
33	railroad length/national area	RR-KM	(110)
34	religions	RELGRP	(90)
35	immigrants/migrants	IM/I+E	(216)
36	average rainfall	RAIN	(45)
37	membership of largest religion/population	RGRP/P	(91)
38	dwellings with running water/dwellings	%D-WTR	(103)
39	foreign college students/college students	FST/ST	(222)
40	membership in Neutral bloc	NEUTRL	(200)

*These numbers refer to the "236 Variable Revised List of Variables and Indices," Dimensionality of Nations Project, 1963.

Analysis Number	Variable Name	Variable Code	Variable List Number
41	age of country	NATAGE	(59)
42	religious titles published/book titles	REL/TI	(120)
43	% increase in national income/% increase in population	%NI/P	(31)
44	emigrants/population	EMG/PP	(215)
45	seaborne goods/GNP	SG/GNP	(118)
46	law NGO/NGO	LAW/NG	(192)
47	unemployed/economically active population	%UNEMP	(33)
48	leading export/exports	EX/EPT	(229)
49	languages	LANGRP	(94)
50	membership of largest language group/population	LGRP/P	(95)
51	ethnic groups	ETHGRP	(92)
52	economic aid received	AIDRVD	(160)
53	technical assistance received	D-TR	(168)
54	government education expenditures/government expenditures	%E-GVT	(37)
55	percent population with 50% of land	P-50%	(35)
56	desire for affiliation	N-AFFI	(133)
57	female workers/economically active	FM/WKS	(127)
58	military treaties/treaties	MT/TRE	(172)
59	exports/GNP	EP/GNP	(228)
60	desire for achievement	N-ACHV	(132)
61	foreign mail sent/foreign mail	MSNT/M	(180)
62	imports/trade	IP/TRD	(225)
63	cost of living index	P-INDX	(28)
64	calories consumed minus calories required/calories required	CAL-PC	(50)
65	proteins/calories	PR/CAL	(49)
66	Russian titles translated/foreign titles translated	R/TRSL	(205)
67	military personnel/population	MIL/PP	(62)
68	balance of investment/gold stock	BOT/GO	(234)
69	political parties	PARTYS	(78)
70	arts and culture NGO/NGO	ART/NG	(188)
71	communist party membership/population	COM/PP	(130)
72	government expenditure/GNP	GUT-PC	(76)
73	monarchy or not	MONARC	(129)
74	primacy (of largest city) measure	PRIMCY	(21)
75	pupils in primary school/primary school teachers	PUP-PT	(38)
76	legality of government change	LAWTRA	(72)
77	largest ethnic group membership/population	EGRP/P	(93)
78	UN delinquencies/assessment	UNDE/C	(189)
79	balance of payments/gold stock	BOP/GO	(227)
80	balance of investments	INVBAL	(233)
81	system style (0 = non-mobilizational; 1 = limited mobilizational; 2 = mobilizational)	STYLE	
82	constitutional status (0 = totalitarian; 1 = authoritarian; 2 = constitutional)	CONSTI	
		ELECTO	

Analysis Number	Variable Name	Variable Code	Variable List Number
83	electoral system (0 = non-competitive; 1 = partially competitive; 2 = competitive)	ELECTO	
84	political leadership (0 = elitist; 1 = moderately elitist; 2 = non-elitist)	LEADER	
85	horizontal power distribution (0 = negligible; 1 = limited; 2 = significant)	POWDIS	
86	military participation (0 = neutral; 1 = supportive 2 = interventive)	MILPAR	
87	bureaucracy (0 = traditional; 1 = semi-modern; 2 = modern)	BUREAU	
88	factor scores on first 1963 UN voting dimension	UNF_1	
89	factor scores on second 1963 UN voting dimension	UNF_2	
90	factor scores on third 1963 UN voting dimension	UNF_3	
91	censorship score	CENSOR	
92	radial measure of nation's capital	GEOG X	
93	latitudinal measure of nation's capital	GEOG Y	
94	longitudinal measure of nation's capital	GEOG Z	

APPENDIX TWO

LIST OF 56 NATIONAL BEHAVIORS, CIRCA 1963, FROM THE DIMENSIONALITY OF NATIONS PROJECT

RANDOM SAMPLE LIST 1963

Analysis Number	Variable Name	Variable Code	Variable List Number
1	Economic Aid A→B		(1)
2	Relative Economic Aid A→B		(2)
3	Treaties A↔B		(3)
4	Relative Treaties A↔B		(4)
5	Official Visits A→B		(5)
6	Co-participation in Intl. Conferences A↔B		(6)
7	Export of Books and Magazines A→B		(10)
8	Relative Export of Books and Magazines A→B		(11)
9	Book Translations A of B		(12)
10	Relative Book Translations A of B		(13)
11	Military Violence F_3 A↔B		(15)
12	Negative Communications F_1 A→B		(16)
13	Negative Sanctions F_5 A→B		(17)
14	Anti-Foreign Violence F_2		(18)
15	Warning and Defensive Beh. F_4		(19)
16	Total Conflict A→B		(20)
17	Conflict Incidence A→B		(21)
18	Conflict Allies A→B		(26)
19	Military Treaties A↔B		(29)
20	Relative Military Treaties A B		(30)
21	Weighted Distance on Major Related Dimensions of UN Voting A↔B		(31)
22	Unweighted Distance on Major Rotated Dimensions of UN Voting A↔B		(32)
23	Distance on First Rotated Dimension UN Voting A↔B		(33)
24	Distance on Second Rotated Dimension of UN Voting A↔B		(34)
25	Distance on Third Rotated Dimension of UN Voting A↔B		(35)
26	Tourists A→B		(38)
27	Relative Tourists A→B		(39)
28	Tourists (A→B)/A's population, A→B		(40)
29	Emigrants A→B		(41)
30	Relative Emigrants A→B		(42)
31	Emigrants (A→B)/A's population, A→B		(43)
32	Students A→B		(44)
33	Relative Students A→B		(45)
34	Exports A→B		(46)
35	Relative Exports A→B		(47)
36	Exports (A→B)/A's GNP		(48)
37	Largest Commodity Export A→B/A's Export, A→B		(49)
38	Ingergovtl. Organizations (IGO) A↔B		(50)
39	Relative IGO A↔B		(51)
40	Nongovtl. International Organizations (NGO) A↔B		(52)
41	Relative NGO A↔B		(53)

Analysis Number	Variable Name	Variable Code	Variable List Number
42	N-IGO = IGO/Total of A's Comemberships		(54)
43	N-NGO = NGO/Total of A's Comembership		(55)
44	Embassy and Legation A→B = 1, non = 0		(58)
45	Relative Diplomatic Representation (Embassy or Legation A→B)		(59)
46	Diplomats Sent A→B		(60)
47	Relative Diplomats A→B		(61)
48	Telephone Communication Linkages A↔B		(63)
49	Time Since on Opposite Sides of War A↔B		(66)
50	Time Since on Same Side of War A↔B		(67)
51	A has lost, and not regained territory to B since 1900 = 1, no = 0, A→B		(68)
52	A once a colony, territory, or part of homeland of B		(69)
53	Joint independence (Independence of A and B predates 1946 = 1, no = 0)		(70)
54	Common Bloc Membership A↔B = 2; Different = 1; Opposing = 0		(71)
55	Bloc Position Index A↔B		(72)
56	Military Alliances A↔B = 1, no = 0		(73)

APPENDIX THREE

TESTS OF THE ESTIMATION OF NATIONAL BEHAVIOR BETWEEN NATION-PAIRS (DYADS) FROM INFERENCES FROM A VERSION OF RUMMEL'S FIELD THEORY OF INTERNATIONAL RELATIONS

Outline of Procedure

Instead of the procedure outlined in Figure 3 of the text, the alternative procedure was followed. The variables were standardized, i.e., each of the 56 dyadic behavior measurements listed in Appendix Two. In this 56 dimensional space, the square of the magnitude of each directed dyad (i,j) was computed, according to the following formula:

$$m_{ij}^2 = s_{ij1}^2 + s_{ij2}^2 + \dots s_{ij56}^2 ,$$

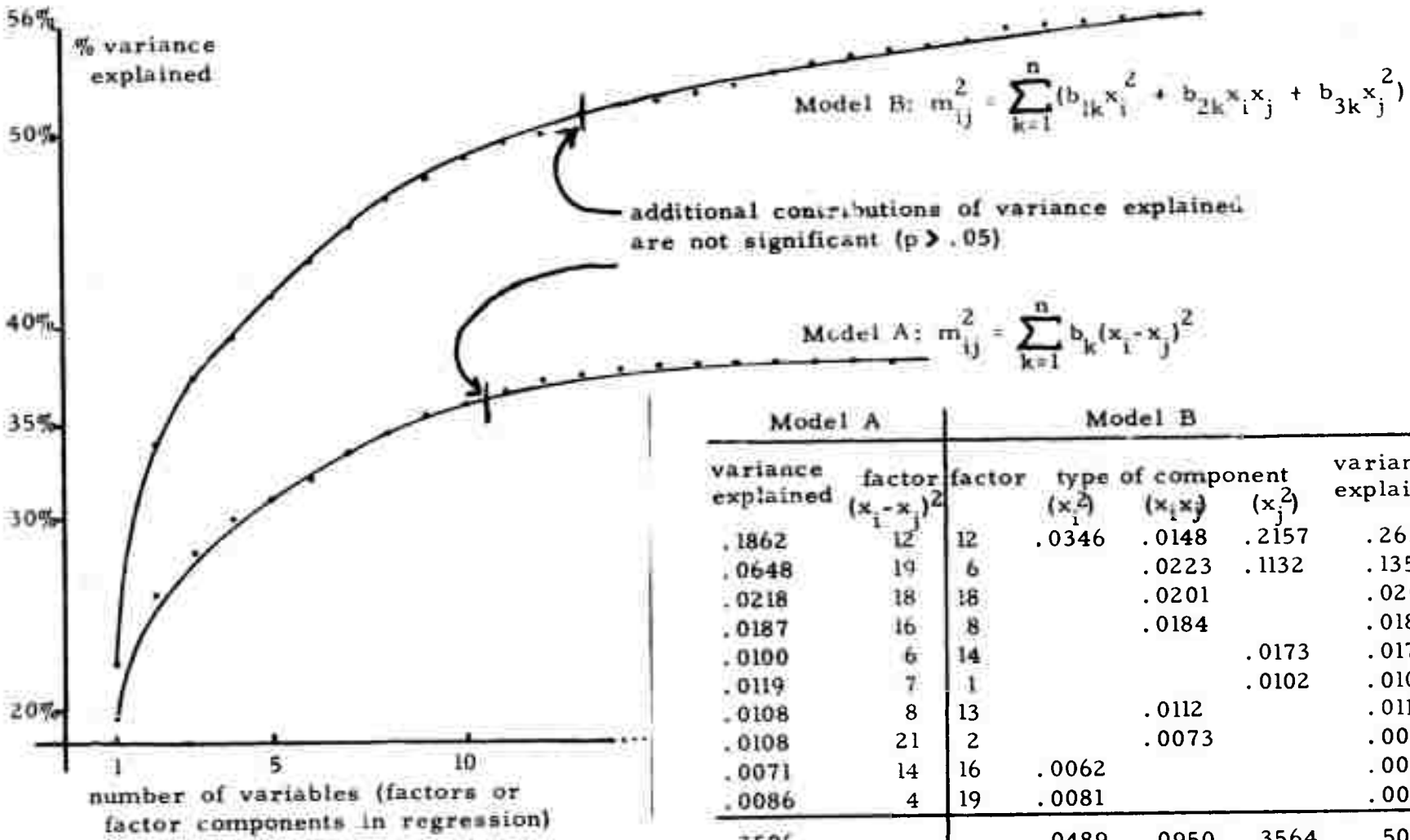
where s_{ijk} is the standard score of i's behavior to j with respect to variable k, k=1,2,...,56.

This method was used in preference to the procedure of calculating an intermediate factor solution because the intermediate steps at best reproduce the m_{ij}^2 terms, and at worst remove much of the variance in behavior from its possible contribution to the net magnitude of activity. For example, using the varimax criterion for rotation in conjunction with

an eigenvalue in the vicinity of unity (though not precisely; see Van Atta and Rummel, cited in the notes to the text), two effects emerge which are undesirable in this context: (1) the variance not in common (1-communality$_k$, k=1,2,...,56) is removed altogether from its contribution to m_{ij}^2; (2) unless each factor score is effectively weighted by the contribution made by the factor to accounting for the common variance, the m_{ij}^2 values would become over much a function of the behaviors in the smallest clusters (factors accounting for the least variance).

Once the selection of the derived data had taken place, the regressions using the models described in (2) and (4) of the text were made. Diagram 1 shows the results in terms of per cent variance cumulatively explained in the step-wise regression process used (number of variables entered against cumulative per cent variance explained, showing cut-off points for F-ratio test of significant contribution in addition to the amount of variance already explained). As can be seen, the results are substantially different.

The regression coefficients for the significant factors contributing to the m_{ij}^2 dependent variable were then checked for consistency with the field theory prediction, as explained in the text (section two). These results are shown in Table 1; and as can be seen were, with some unimportant exceptions, not supportive of the theory.



Model A		Model B				
variance explained	factor $(x_i-x_j)^2$	factor	type of component (x_i^2)	(x_ix_j)	(x_j^2)	variance explained
.1862	12	12	.0346	.0148	.2157	.2651
.0648	19	6		.0223	.1132	.1355
.0218	18	18		.0201		.0201
.0187	16	8		.0184		.0184
.0100	6	14			.0173	.0173
.0119	7	1			.0102	.0102
.0108	8	13		.0112		.0112
.0108	21	2		.0073		.0073
.0071	14	16	.0062			.0062
.0086	4	19	.0081			.0081
.3506			.0489	.0950	.3564	.5003

*only those factors or factor components are shown which contributed significantly ($p < .05$, F-test) to prediction

Diagram 1. Cumulative Percent Variance Explained in Magnitude of Behavior

Table 1. Tests of Model A Estimates of Model B Coefficients

Model B: Factor Component Data					Model A b-estimate of Model B		
Factor[1]	% Variance[2]	b-coefficient[3]	standard error[4]	critical b-value[5]	Factor[6]	b-estimate[7]	b=b-estimate?[8]
36	21.57%	5.30	0.59	4.14	12	2.51	NO
18	11.32	11.09	1.76	7.64	6	-4.29	NO
34	3.46	1.97	0.60	3.14	12	2.51	YES
53	2.10	4.82	1.14	2.58	18	1.26	NO[9]
17	2.23	11.06	3.83	3.55	6	8.58	YES[9]
23	1.84	-11.71	4.21	-3.46	8	-7.66	YES[9]
42	1.73	-7.42	2.61	-2.30	14	-1.57	NO
35	1.48	-2.31	1.13	-4.52	12	-5.03	NO[9]
3	1.02	5.57	2.52	--not applicable[10]--			
38	1.12	11.47	5.61	--not applicable[10]--			
5	0.73	3.79	2.61	--not applicable[10]--			
46	0.62	2.57	1.47	-0.21	16	1.20	YES
55	0.81	2.7)	1.69	6.10	19	8.04	NO
	1.19	--not applicable[11]--			7	-1.25	--
	1.08	--not applicable[11]--			21	0.96	--
	0.86	--not applicable[11]--			4	-0.76	--

Notes to Table 1

1. Factors in Model B refer to the hypothetical factor components of Model A. These are related to each other as follows:

$(x_i - x_j)^2$	x_i^2	$x_i x_j$	x_j^2
1	1	2	3
2	4	5	6
3	7	8	9
4	10	11	12
5	13	14	15
6	16	17	18
7	19	20	21
8	22	23	24
9	25	26	27
10	28	29	30
11	31	32	33
12	34	35	36
13	37	38	39
14	40	41	42
15	43	44	45
16	46	47	48
17	49	50	51
18	52	53	54
19	55	56	57
20	58	59	60
21	61	62	63
22	64	65	66
Model A	----Model B--------		

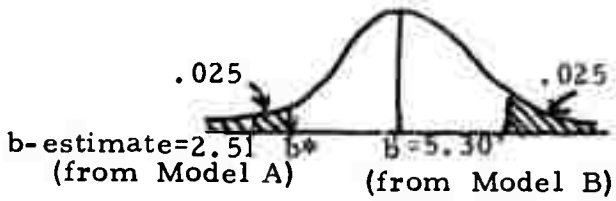
where the x_i and x_j refer to factor scores of nation i and j on the factors given by the factor analysis of 107 nations and 94 attributes for 1963, which generated twenty-two factors. The factors underline are those which made a significant contribution (F-test $\leq .05$) to the variance explained in separate regressions using first the 22 factor in their Model A representation, then the 66 factor components in their Model B representation. Thus Model A factor 12 accounted for a significant amount of variance in the squared magnitude of behavior, and in each of its three component representations (Model B 34, 35, 36).

2. This is the percent variance contributed by each factor component of Model B, as previously diagrammed in Diagram 1 of this appendix.

3. This is the b-coefficient of the corresponding Model B factor, obtained from the Model B regression; the estimate shown is the one from the 13th step, i.e., the one at which no more additional explained variance could be added above the .05 "noise" level.

4. This is the standard error of the corresponding b-coefficient.

5. This is the critical value (b*) relevant for testing whether Model A produced an estimate of Model B within the .05 "noise" level. For example:



here Model B factor 36 has a b-coefficient of 5.30 with a standard error of 0.59; Model A produced a b-estimate of 2.51. Was model A right in its prediction? We ask ourself the traditional question of whether it is "not false," and apply the traditional criterion of .05, i.e., whether the probability of it having come from the same population as the Model B coefficient is greater than .05. If it is less, we reject it. Model B (our "null" model) gives us a b=5.30 and s.e.=0.59. We use a two-tail test on the probable sampling distribution of the b-coefficient because Model A may give us a sample value either greater or less than the Model B coefficient, thus we must find a b* (actually two b*s, one for either side of the b-coefficient of Model B; only one is shown as we know Model A results already) such that the probability to the left is half of .05, i.e., .025. Using the normal distribution, a b* must have an associated $z_{.025}=1.96$, thus:

$$4.41 = b^* = 5.30 - 1.96(0.59) = b - z_{.05}s.e.$$

As the b-estimate of Model A (2.51) is less than b* (4.14), Model A is rejected as having correctly estimated Model B's b-coefficient.

6. This is the factor number from the factor analysis of 94 attributes across 107 nations for 1963; see Diagram 1 of this appendix for percents of variance accounted for by each of magnitude of involvement.

7. This is the b-coefficient derived from the multiple regression (step-wise) of the Model A factors (in their squared difference form) against squared magnitudes of involvement, as discussed in the text.

8. This is the result of tests described in fn. 5, supra. Thus, since Model A's estimate of the Model B coefficient for factor component 36 fell short of the critical b-value of 4.14, it was rejected.

9. The factor comparable to this Model A factor was composed of factor score products (i.e., $x_i x_j$), hence, following the implications of equations (3) and (4) in the text, the Model A coefficient was multiplied by two and its sign reversed. Thus, for example, the Model A coefficient estimate shown for Model A factor o is minus two times that used in comparison with factor 18 (i.e., -4.29 became +8.58).

10. As the corresponding Model A factors did not contribute significantly to the variance accounted for by the Model B factors, these comparisons were judged not useful or particularly important to make.

11. As the corresponding Model B factors did not contribute to a significant amount of additional explained variance in magnitude of involvement, a comparison with Model A factors was was judged not useful or important to make. It should also be noted that the Model A factors which made "significant" contributions to variance explained in these instances did not contribute to more than about one percent of variance each (as can also be said about the Model B factors which contributed "significant" amounts of variance explained where Model A did not); thus these judgments to compare or not to compare are themselves of no substantial interest.

APPENDIX FOUR

TABLE OF DYADIC EXPECTED, ACTUAL, AND RESIDUAL VALUES FROM APPLICATION OF EQ. (4)

Table 2. List of Residuals and Relative Involvement (RI_{ij}) Indices

Case			m^2_{ij} Actual	$\hat{m}^2_{ij}$ Estimated	$m^2_{ij} - \hat{m}^2_{ij}$ Residual	RI_{ij} Index
(1)	BRA→	1 BUR	6.07	-0.42	6.49	15.54
		2 CHN	7.80	15.32	-7.52	-0.49
		3 CUB	7.07	5.49	1.57	0.29
		4 EGP	3.96	15.98	-12.03	-0.75
		5 IND	2.30	11.75	-9.45	-0.81
		6 INS	5.17	-3.81	8.98	2.35
		7 ISR	4.77	7.62	-2.85	-0.37
		8 JOR	7.34	8.34	-1.00	-0.12
		9 NTH	7.55	7.97	-0.42	-0.05
		10 POL	3.15	2.22	0.93	0.42
		11 USR	9.31	17.07	-7.76	-0.45
		12 UNK	9.04	17.42	-8.37	-0.48
		13 USA	82.83	52.60	30.24	0.57
(2)	BUR→	14 BRA	4.58	-1.32	5.90	4.48
		15 CHN	7.70	4.27	3.42	0.80
		16 CUB	5.39	6.18	-0.79	-0.13
		17 EGP	8.42	9.41	-0.99	-0.10
		18 IND	13.32	10.96	2.35	0.21
		19 INS	9.32	-4.56	13.88	3.04
		20 ISR	7.24	6.04	1.20	0.20
		21 JOR	6.81	-4.57	11.38	2.49
		22 NTH	5.44	3.61	1.82	0.50
		23 POL	5.23	0.82	4.41	5.36
		24 USR	6.21	15.09	-8.88	-0.59
		25 UNK	43.45	35.73	7.72	0.22
		26 USA	13.61	54.95	-41.34	-0.75
(3)	CHN→	27 BRA	6.74	10.52	-3.78	-0.36
		28 BUR	6.00	0.37	5.63	15.05
		29 CUB	7.40	3.67	3.73	1.02
		30 EGP	18.58	11.58	7.00	0.60
		31 IND	18.30	9.97	8.33	0.84
		32 INS	6.89	2.40	4.49	1.87
		33 ISR	2.55	7.74	-5.19	-0.67
		34 JOR	5.53	0.50	5.03	10.15
		35 NTH	6.57	4.45	2.12	0.48
		36 POL	6.04	4.36	1.68	0.39
		37 USR	31.62	11.46	20.16	1.76
		38 UNK	6.38	22.66	-16.28	-0.72
		39 USA	24.70	57.24	-32.55	-0.57
(4)	CUB→	40 BRA	8.13	5.33	2.80	0.53
		41 BUR	5.67	6.92	-1.24	-0.18
		42 CHN	10.54	8.31	2.23	0.27
		43 EGP	3.04	5.44	-2.39	-0.44

Case		m^2_{ij} Actual	$\hat{m}^2_{ij}$ Estimated	$m^2_{ij} - \hat{m}^2_{ij}$ Residual	RI_{ij} Index
	44 IND	3.89	15.05	-11.16	-0.74
	45 INS	5.10	8.66	-3.56	-0.41
	46 ISR	2.32	0.52	1.80	3.48
	47 JOR	5.12	5.99	-0.87	-0.15
	48 NTH	7.95	-2.19	10.14	4.64
	49 POL	3.26	9.95	-1.70	-0.17
	50 USR	31.30	12.18	19.12	1.57
	51 UNK	9.58	27.75	-18.18	-0.65
	52 USA	65.36	62.41	2.94	0.05
(5) EGP→	53 BRA	4.31	4.83	-0.52	-0.11
	54 BUR	5.46	-0.84	6.31	7.64
	55 CHN	4.11	5.23	-1.12	-0.21
	56 CUB	2.16	-5.55	7.72	1.39
	57 IND	5.77	5.30	0.47	0.09
	58 INS	4.47	-4.58	9.05	1.98
	59 ISR	33.23	7.73	25.49	3.30
	60 JOR	7.44	14.01	-6.57	-0.47
	61 NTH	5.06	7.35	-2.29	-0.31
	62 POL	2.04	1.94	0.10	0.05
	63 USR	13.81	13.39	0.42	0.03
	64 UNK	15.36	25.86	-10.50	-0.41
	65 USA	16.14	44.89	-28.75	-0.64
(6) IND→	66 BRA	2.55	6.71	-4.16	-0.62
	67 BUR	6.78	6.83	-0.05	-0.01
	68 CHN	32.66	9.73	22.92	2.35
	69 CUB	2.63	10.18	-7.55	-0.74
	70 EGP	3.86	11.42	-8.56	-0.66
	71 INS	6.57	19.77	-13.20	-0.67
	72 ISR	7.67	1.51	6.16	4.08
	73 JOR	3.43	1.98	1.44	0.73
	74 NTH	5.06	12.12	-7.06	-0.58
	75 POL	3.51	5.49	-1.98	-0.36
	76 USR	3.54	13.04	-9.49	-0.73
	77 UNK	16.97	26.61	-9.64	-0.36
	78 USA	97.39	67.27	30.12	0.45
(7) INS→	79 BRA	5.41	-2.09	7.50	3.59
	80 BUR	4.11	-1.94	6.05	3.12
	81 CHN	6.45	8.93	-2.48	-0.28
	82 CUB	8.42	10.55	-2.13	-0.20
	83 EGP	4.91	8.30	-3.38	-0.41
	84 IND	10.22	26.53	-16.31	-0.61
	85 ISR	7.60	5.76	1.84	0.32
	86 JOR	4.86	15.98	-11.13	-0.70
	87 NTH	68.69	36.82	31.87	0.87
	88 POL	4.72	4.05	0.67	0.17
	89 USR	8.78	10.72	-1.93	-0.18
	90 UNK	96.78	72.11	24.67	0.34
	91 USA	14.42	49.65	-35.23	-0.71

	Case		m^2_{ij} Actual	$\hat{m}^2_{ij}$ Estimated	$m^2_{ij} - \hat{m}^2_{ij}$ Residual	RI_{ij} Index
(8)	ISR→ 92	BRA	3.73	13.88	-10.15	-0.73
	93	BUR	6.19	13.19	-7.01	-0.53
	94	CHN	4.27	18.79	-14.52	-0.77
	95	CUB	1.65	6.94	-5.29	-0.76
	96	EGP	10.83	25.14	-14.31	-0.57
	97	IND	7.82	12.80	-4.98	-0.39
	98	INS	8.58	10.29	-1.72	-0.17
	99	JOR	49.41	13.30	36.11	2.72
	100	NTH	9.19	23.04	-13.85	-0.60
	101	POL	2.64	4.17	-1.52	-0.37
	102	USR	1.56	27.67	-26.11	-0.94
	103	UNK	48.00	54.98	-6.98	-0.13
	104	USA	146.93	76.30	70.63	0.93
(9)	JOR→105	BRA	7.37	6.16	1.22	0.20
	106	BUR	6.26	-5.85	12.10	2.07
	107	CHN	4.28	3.11	1.19	0.38
	108	CUB	4.27	3.98	0.29	0.74
	109	EGP	44.12	22.98	21.13	0.92
	110	IND	7.31	4.84	2.47	0.51
	111	INS	6.71	12.08	-5.37	-0.44
	112	ISR	18.83	4.86	13.97	2.87
	113	NTH	4.98	18.33	-13.35	-0.73
	114	POL	4.79	3.59	1.20	0.34
	115	USR	4.97	21.18	-16.21	-0.77
	116	UNK	15.01	29.00	-13.99	-0.48
	117	USA	48.53	52.98	-4.45	-0.08
(10)	NTH→118	BRA	5.16	7.83	-2.67	-0.34
	119	BUR	3.67	4.37	-0.70	-0.16
	120	CHN	7.13	9.11	-1.98	-0.22
	121	CUB	5.31	-2.17	7.48	3.45
	122	EGP	2.30	18.36	-16.06	-0.87
	123	IND	2.34	17.02	-14.67	-0.86
	124	INS	34.49	34.95	-0.46	-0.01
	125	ISR	5.61	16.64	-11.03	-0.66
	126	JOR	4.19	20.36	-16.18	-0.79
	127	POL	4.14	23.33	-19.18	-0.82
	128	USR	5.56	19.76	-14.19	-0.72
	129	UNK	113.09	49.10	63.98	1.30
	130	USA	75.98	49.12	26.85	0.55
(11)	POL→131	BRA	4.25	1.38	2.87	2.08
	132	BUR	6.12	0.89	5.24	5.91
	133	CHN	7.07	8.32	-1.25	-0.15
	134	CUB	9.21	9.28	-0.07	-0.01
	135	EGP	2.17	12.26	-10.09	-0.82
	136	IND	6.77	9.69	-2.92	-0.30
	137	INS	4.59	1.49	3.10	2.08
	138	ISR	3.17	-2.93	6.10	2.08
	139	JOR	4.97	4.93	0.04	0.01

	Case	m^2_{ij} Actual	$\hat{m}^2_{ij}$ Estimated	$m^2_{ij} - \hat{m}^2_{ij}$ Residual	RI_{ij} Index
	140 NTH	10.10	22.63	-12.53	-0.55
	141 USR	49.62	16.15	33.47	2.07
	142 UNK	9.32	13.97	-4.64	-0.33
	143 USA	26.50	46.12	-19.62	-0.43
(12)	USR→144 BRA	6.67	15.41	-8.74	-0.57
	145 BUR	3.71	14.33	-10.62	-0.74
	146 CHI	26.22	14.60	11.62	0.80
	147 CUB	12.56	10.69	1.88	0.18
	148 EGP	78.22	22.89	55.33	2.42
	149 IND	33.78	16.41	17.37	1.06
	150 INS	8.43	7.33	1.10	0.15
	151 ISR	2.43	19.76	-17.33	-0.88
	152 JOR	5.32	21.70	-16.38	-0.76
	153 NTH	8.78	18.24	-9.46	-0.52
	154 POL	18.22	15.33	2.90	0.19
	155 UNK	11.97	49.47	-37.50	-0.76
	156 USA	77.31	67.47	9.84	0.15
(13)	UNK→157 BRA	7.60	-6.58	14.18	2.15
	158 BUR	6.58	12.63	-6.05	-0.48
	159 CHI	7.12	3.45	3.67	1.06
	160 CUB	7.29	3.92	3.38	0.86
	161 EGP	9.48	13.01	-3.53	-0.27
	162 IND	13.99	7.64	6.34	0.83
	163 INS	31.10	46.39	-15.29	-0.33
	164 ISR	16.31	24.73	-8.42	-0.34
	165 JOR	16.50	7.18	9.32	1.30
	166 NTH	27.05	25.24	1.81	0.07
	167 POL	8.15	-9.20	17.34	1.89
	168 USR	13.18	27.13	-13.95	-0.51
	169 USA	65.07	73.77	-8.70	-0.12
(14)	USA→170 BRA	12.55	16.98	-4.43	-0.26
	171 BUR	4.10	20.23	-16.13	-0.80
	172 CHI	10.29	26.42	-16.13	-0.61
	173 CUB	16.72	26.96	-10.24	-0.38
	174 EGP	7.30	20.42	-13.12	-0.64
	175 IND	58.85	36.69	22.17	0.60
	176 INS	11.29	12.30	-1.01	-0.08
	177 ISR	22.72	34.43	-11.71	-0.34
	178 JOR	8.28	19.54	-11.26	-0.58
	179 NTH	24.84	13.64	11.20	0.82
	180 POL	6.47	11.34	-4.87	-0.43
	181 USR	58.86	33.51	25.36	0.76
	182 UNK	91.86	62.15	29.71	0.48

APPENDIX FIVE

GRAPHS OF NATION-NATION RELATIVE INVOLVEMENT INDICES: 1963

The graphs which follow were based upon the observed m^2_{ij} and expected m^2_{ij} (written $\hat{m}^2_{ij}$), related to each other according to the following formula:

$$RI_{ij} = \frac{m^2_{ij} - \hat{m}^2_{ij}}{\hat{m}^2_{ij}}, \quad \hat{m}^2_{ij} \geq 0 \quad ;$$

when $\hat{m}^2_{ij}$ is less than zero (meaning in this case below the mean value of the raw data scores as the m^2_{ij} were taken across standardized data), the sign of the RI_{ij} is, in effect, reversed from that given in the above calculation, which is to say we calculate according to the following formula:

$$RI_{ij} = \frac{\hat{m}^2_{ij} - m^2_{ij}}{\hat{m}^2_{ij}}, \quad \hat{m}^2_{ij} < 0.$$

By so doing, we are always taking the absolute number of standardized units above or below which the observation is, relative to the expecta-

tion. As mentioned in the text, under the condition that the expectation is negative, there is no implication for the mix or relative proportions of various activities which any given magnitude might represent, assuming conditions were favorable for making such inferences otherwise, for the square root of a negative number has no theoretical meaning so far developed, much less an empirical measurement equivalent. The raw data from which the RIs were hand calculated are shown in the table following the figures.

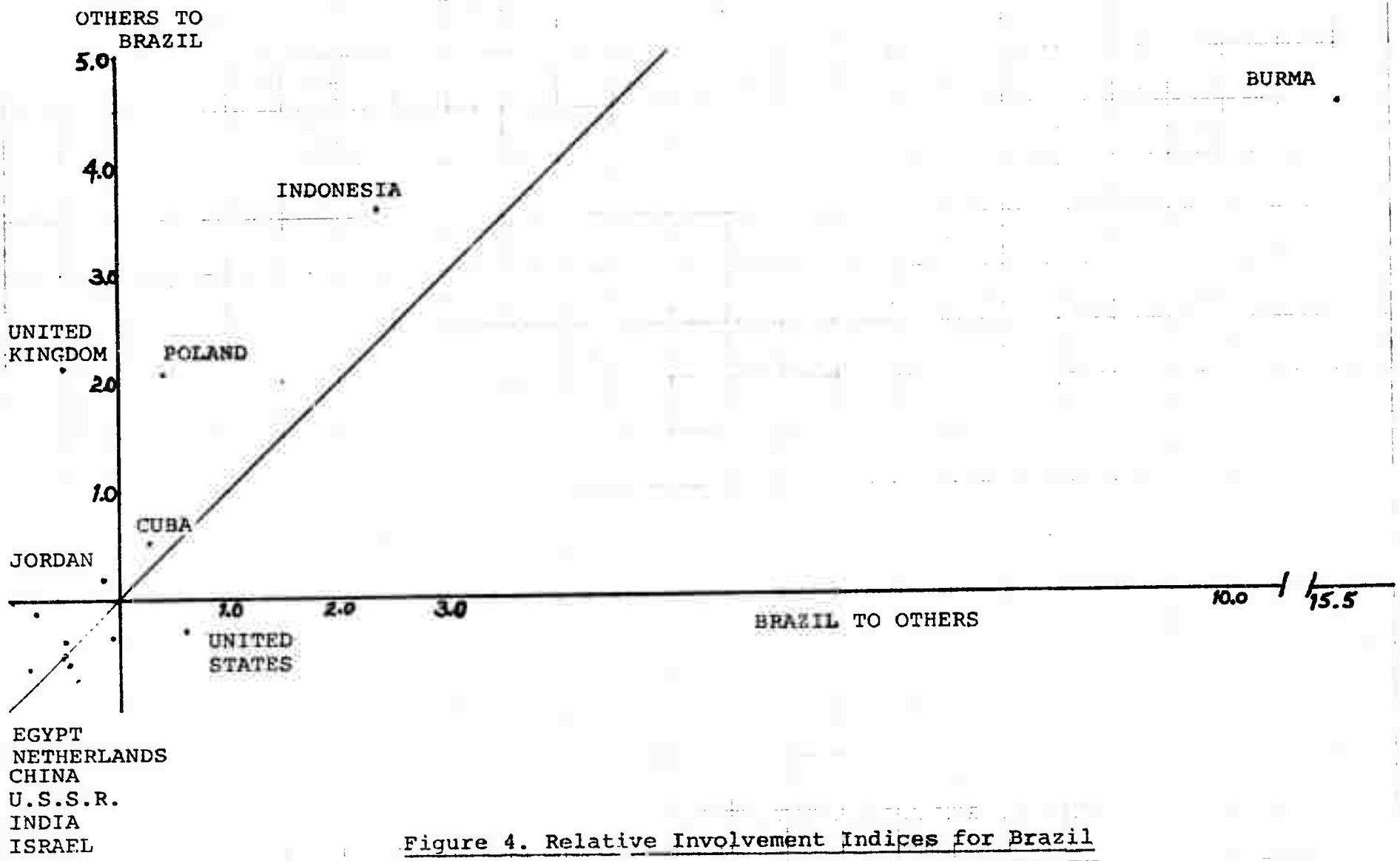


Figure 4. Relative Involvement Indices for Brazil

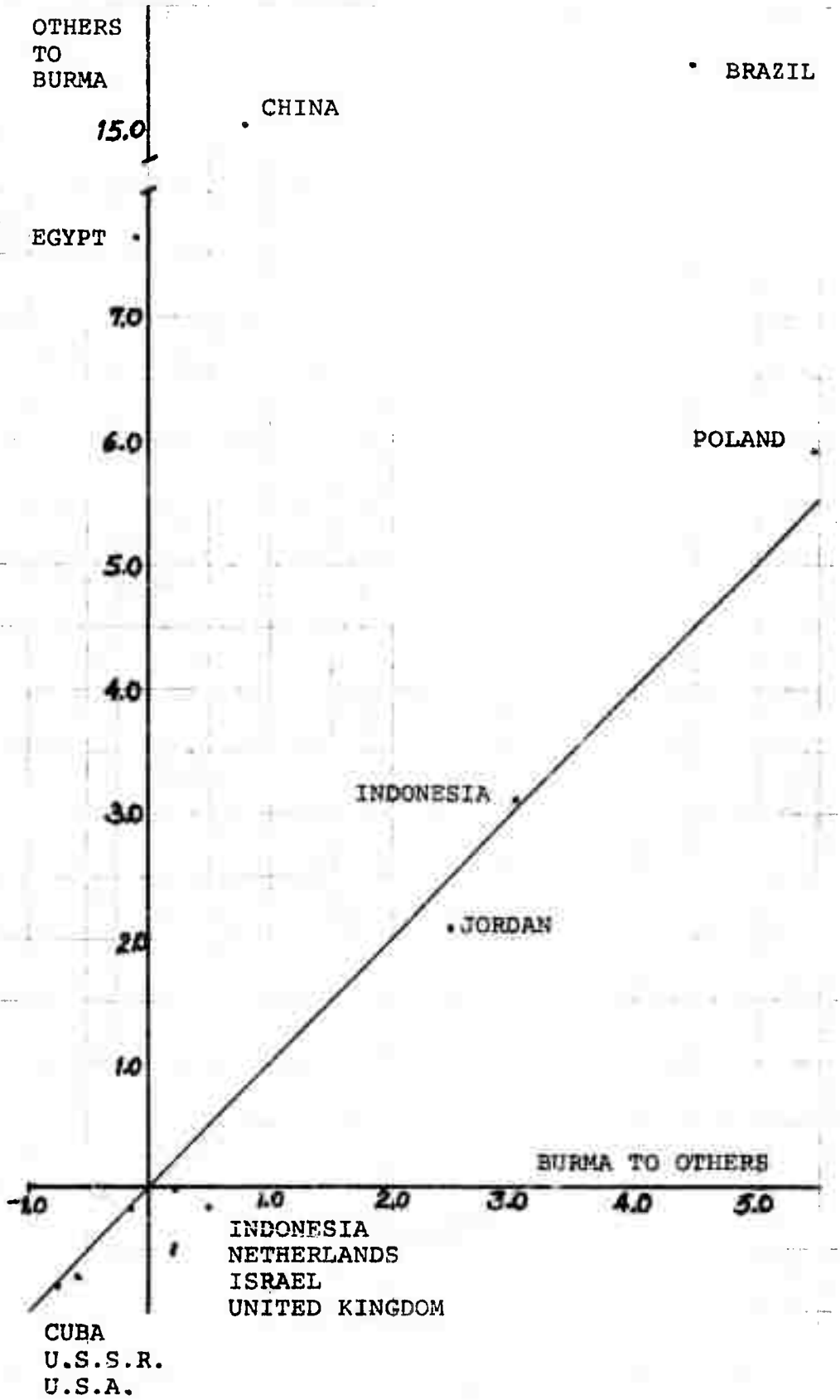


Figure 5. Relative Involvement Indices for Burma

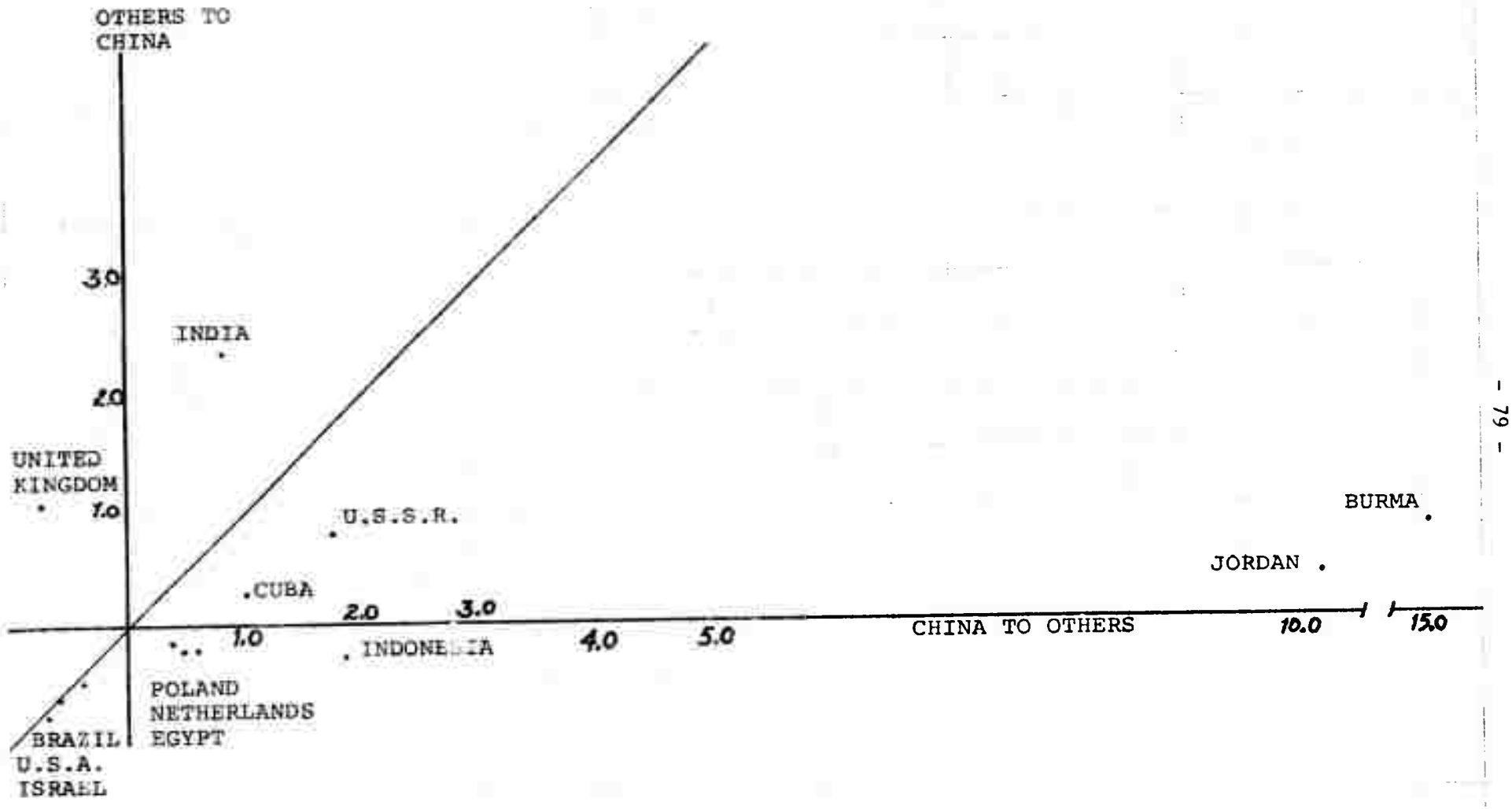


Figure 6. Relative Involvement Indices for China (Mainland)

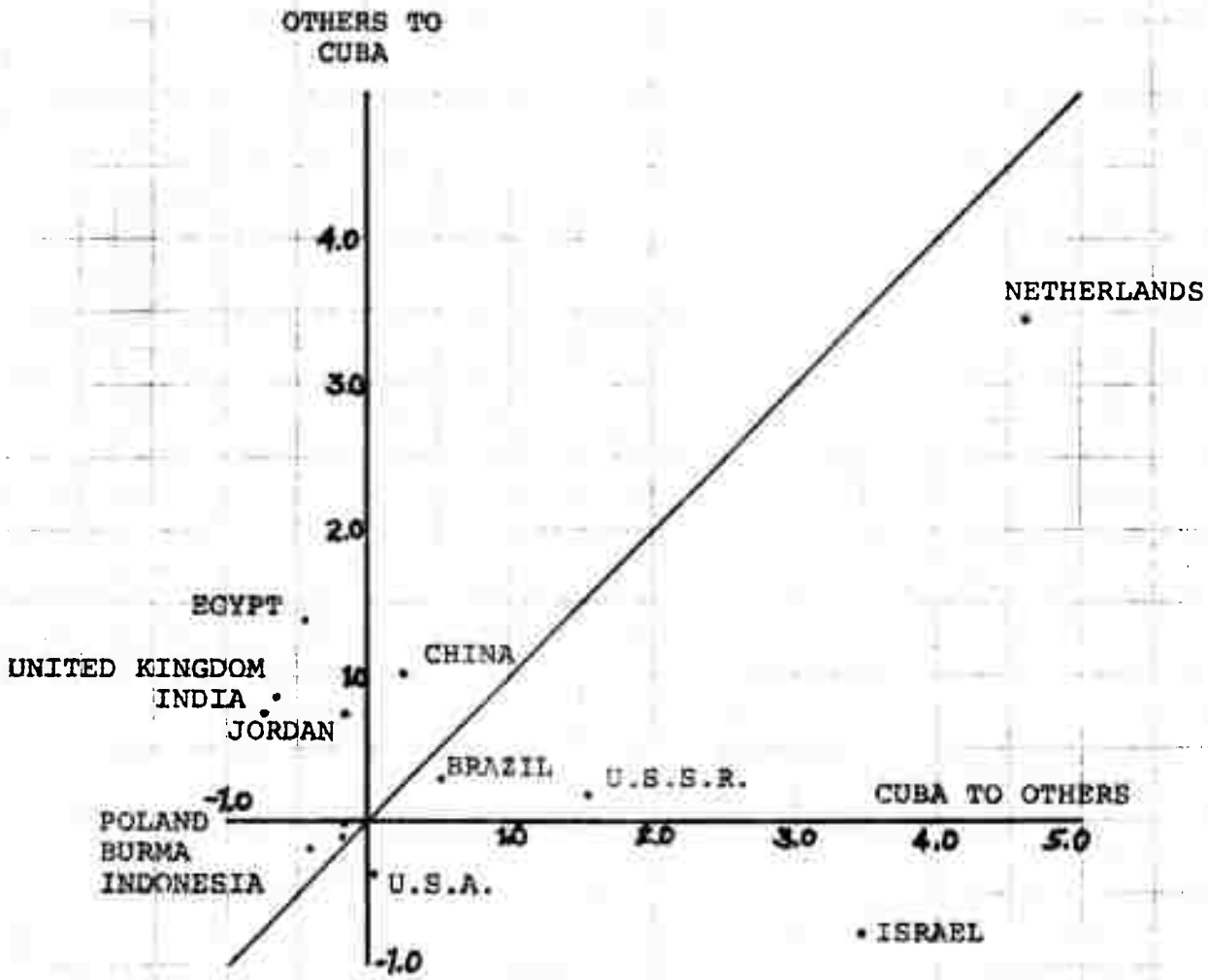


Figure 7. Relative Involvement Indices for Cuba

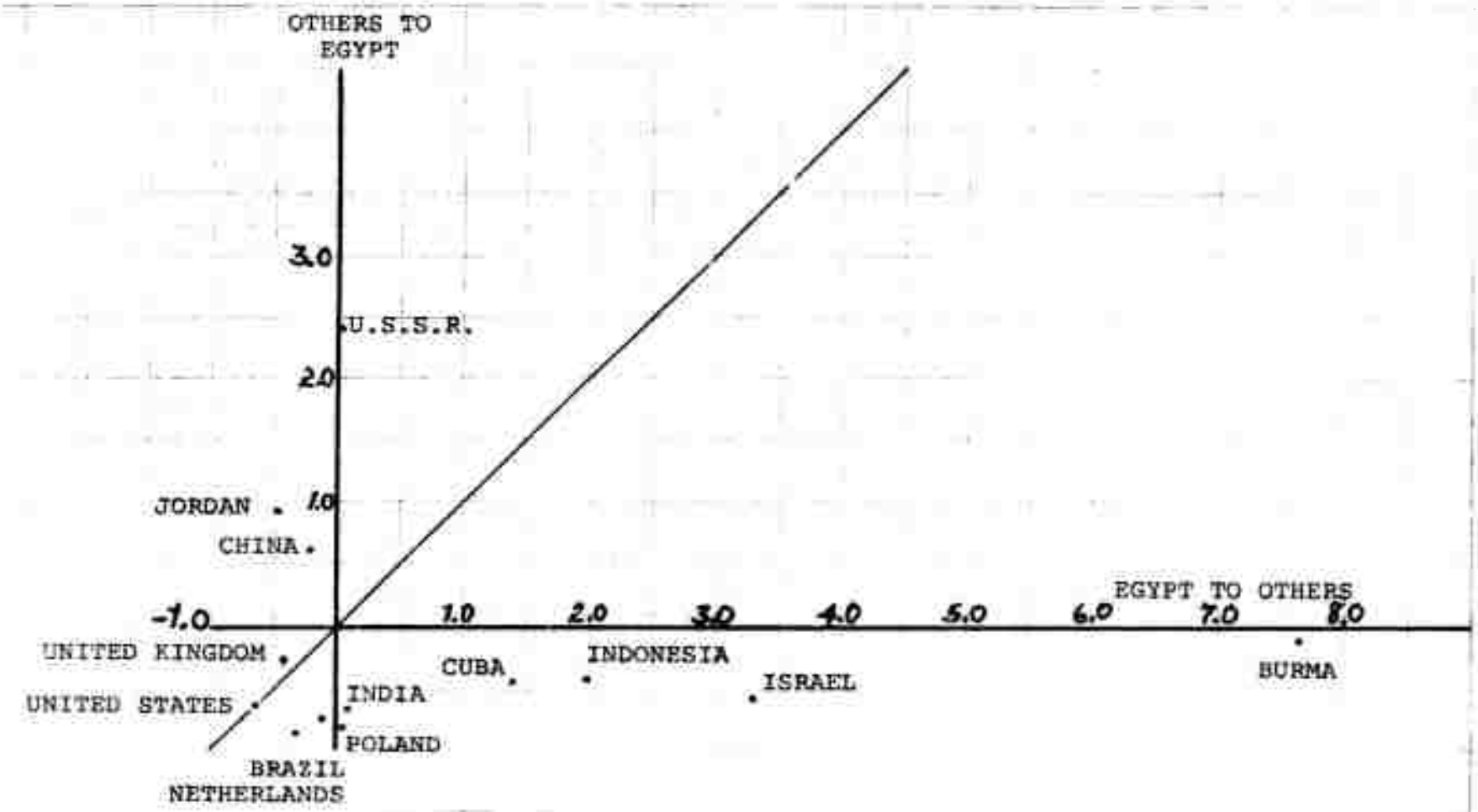


Figure 8. Relative Involvement Indices for Egypt

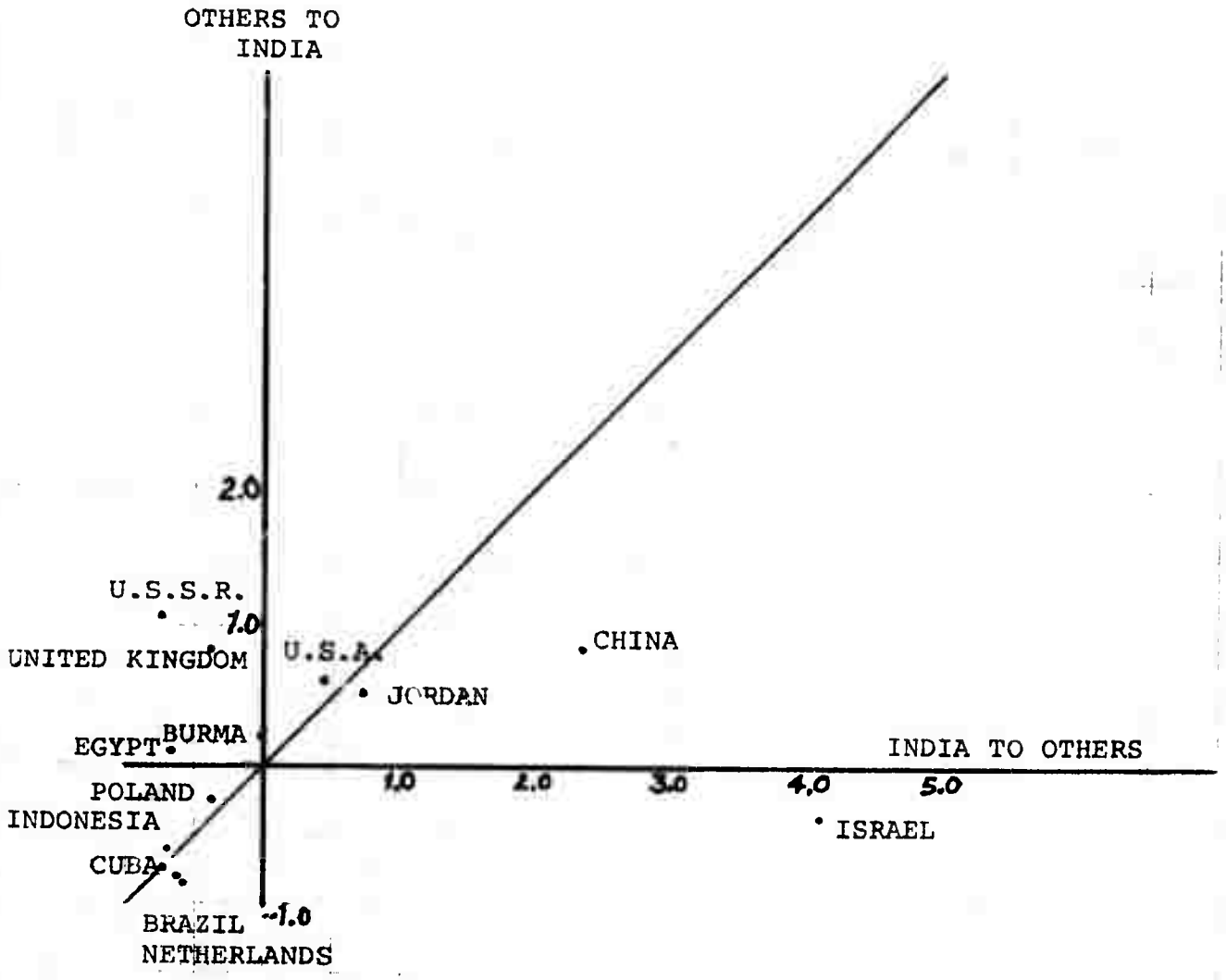


Figure 9. Relative Involvement Indices for India

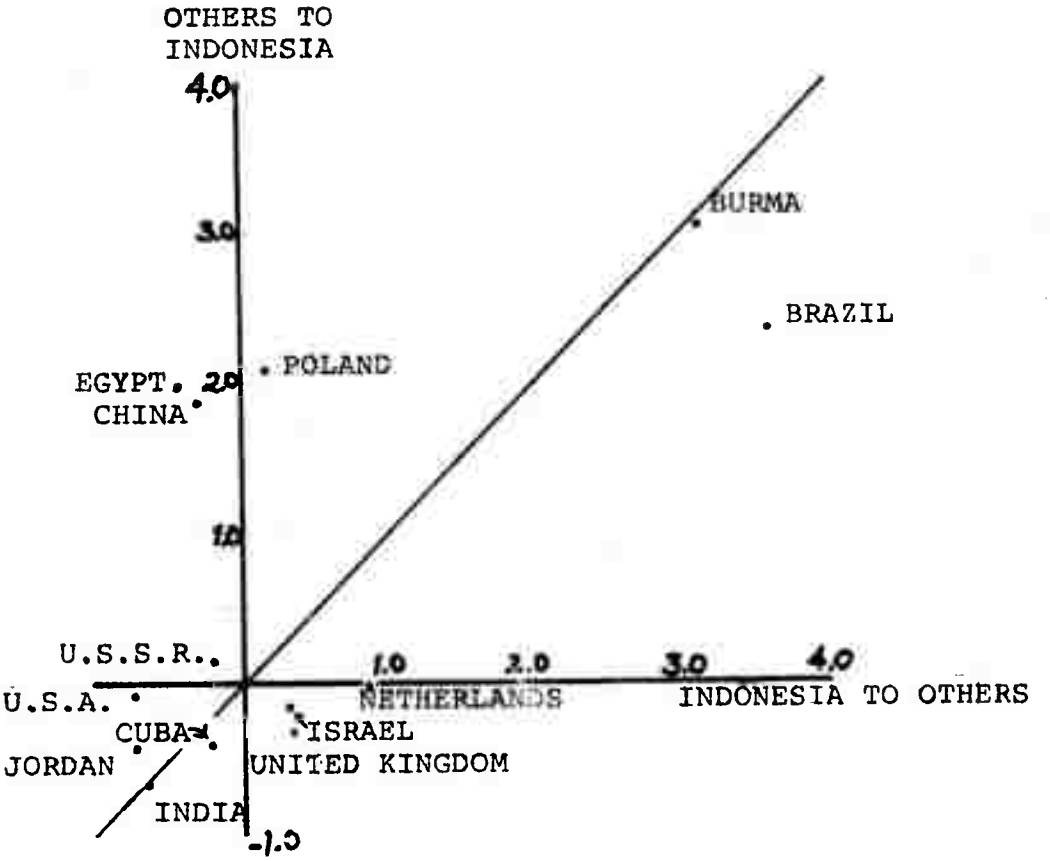


Figure 10. Relative Involvement Indices for Indonesia

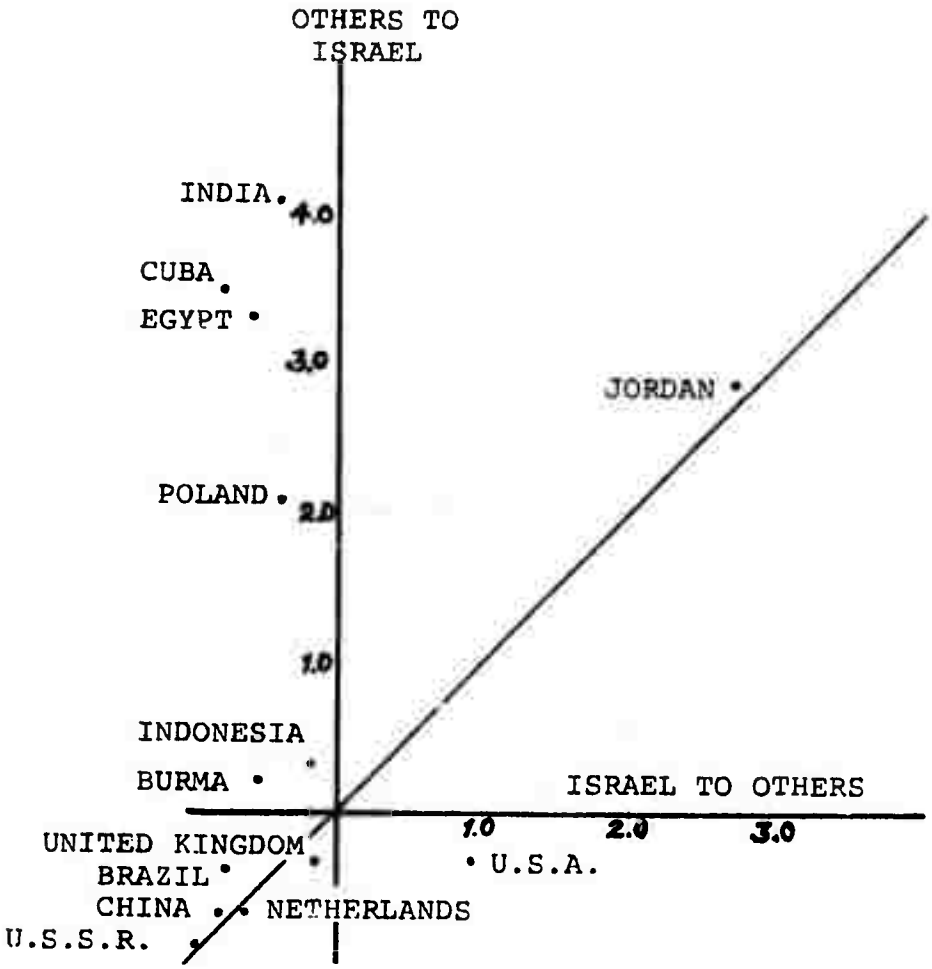


Figure 11. Relative Involvement Indices for Israel

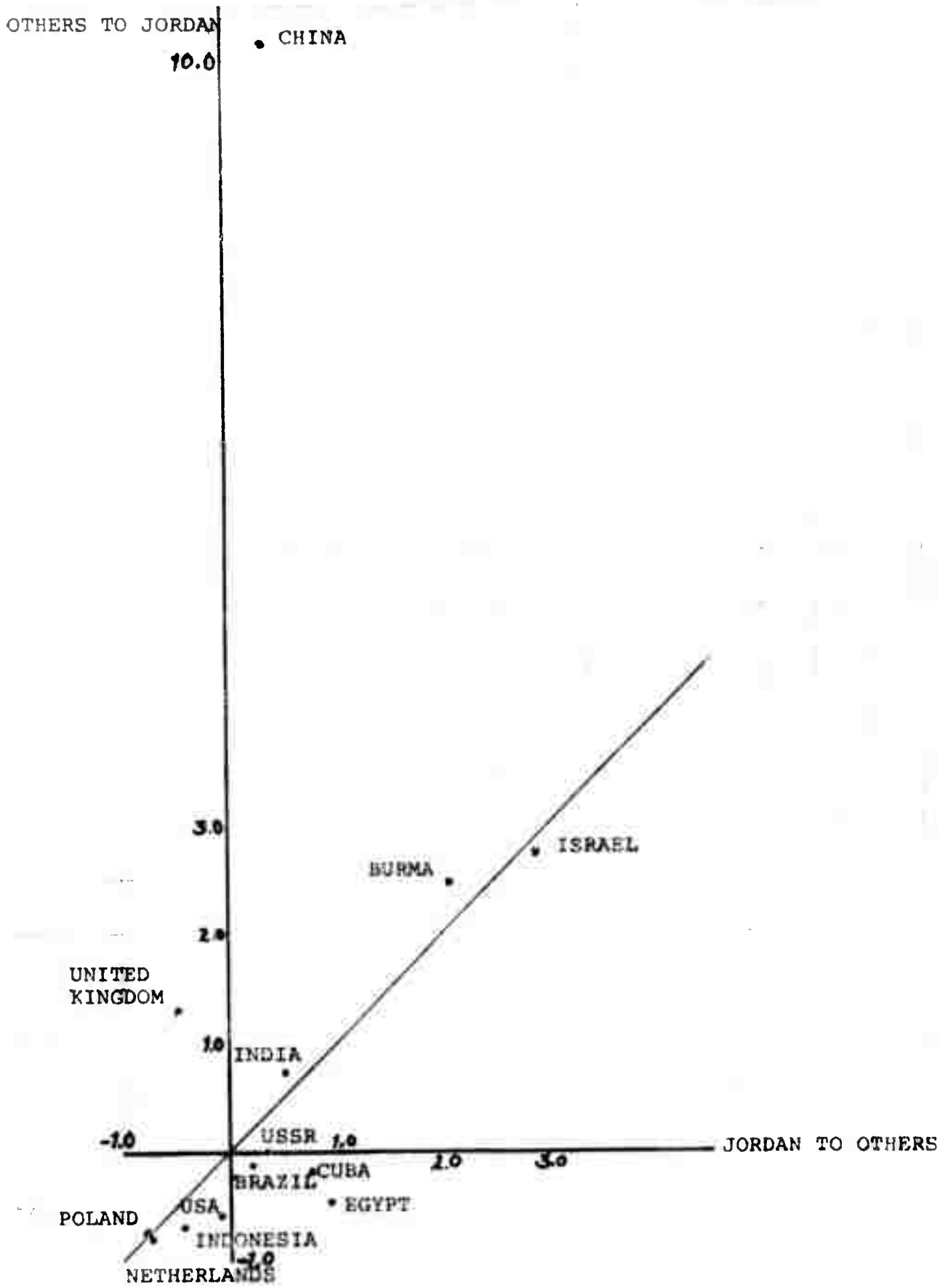


Figure 12. Relative Involvement Indices for Jordan

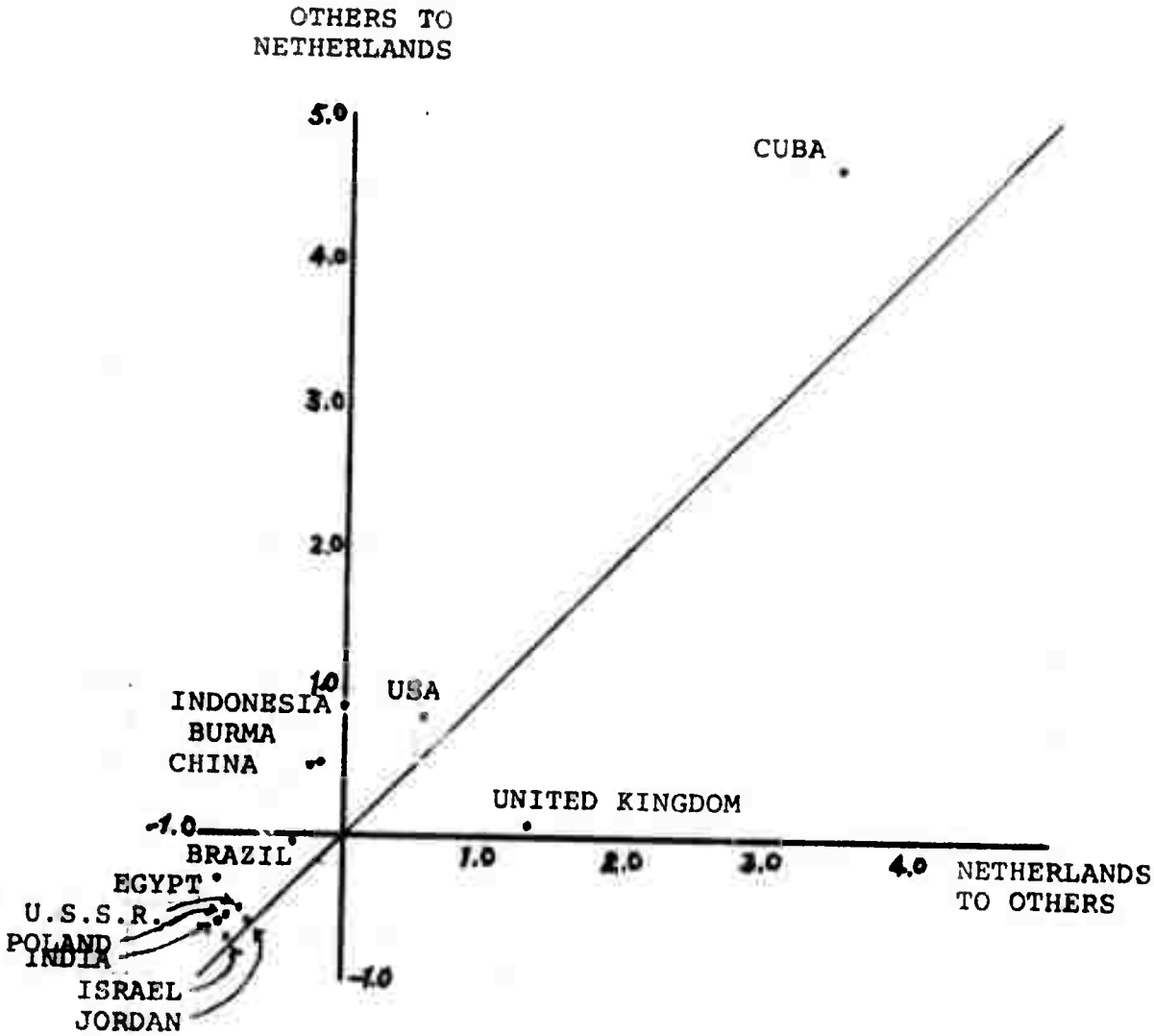


Figure 13. Relative Involvement Indices for Netherlands

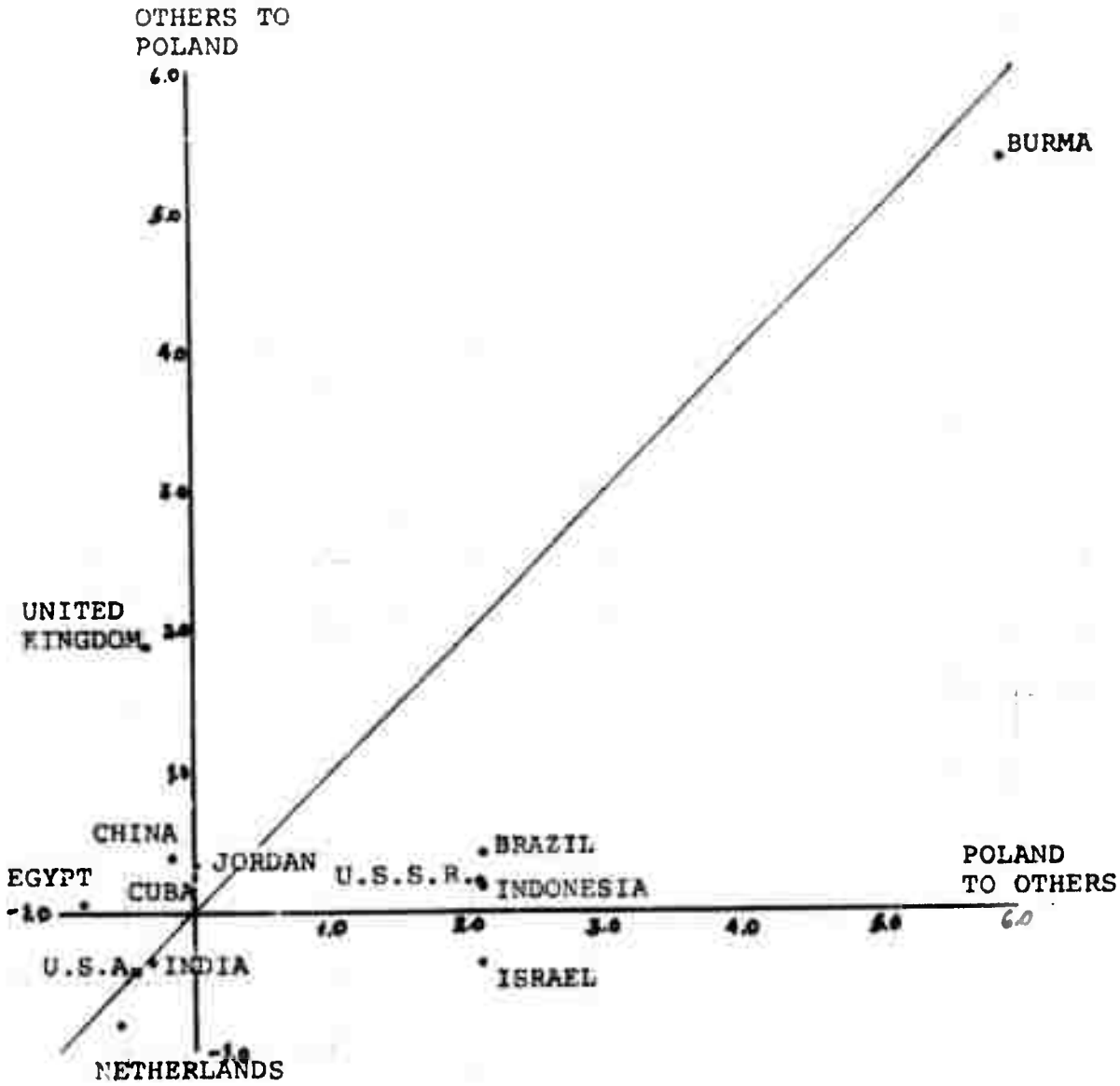


Figure 14. Relative Involvement Indices for Poland

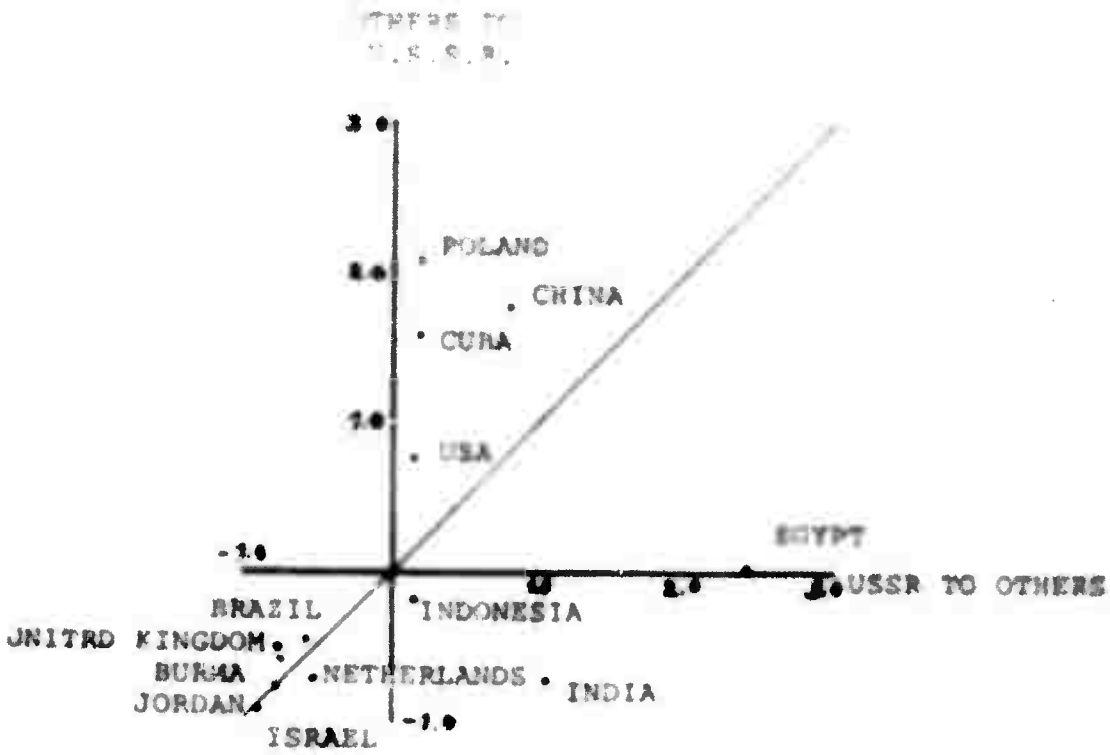


Figure 15. Relative Involvement Indices for the U.S.S.R.

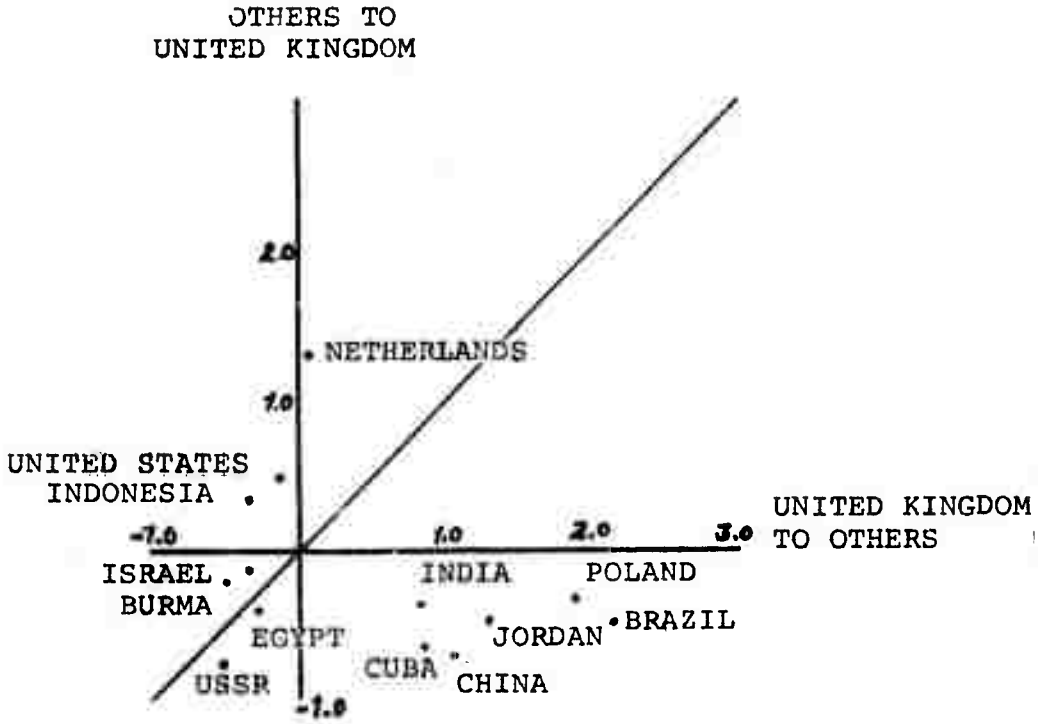


Figure 16. Relative Involvement Indices for the United Kingdom

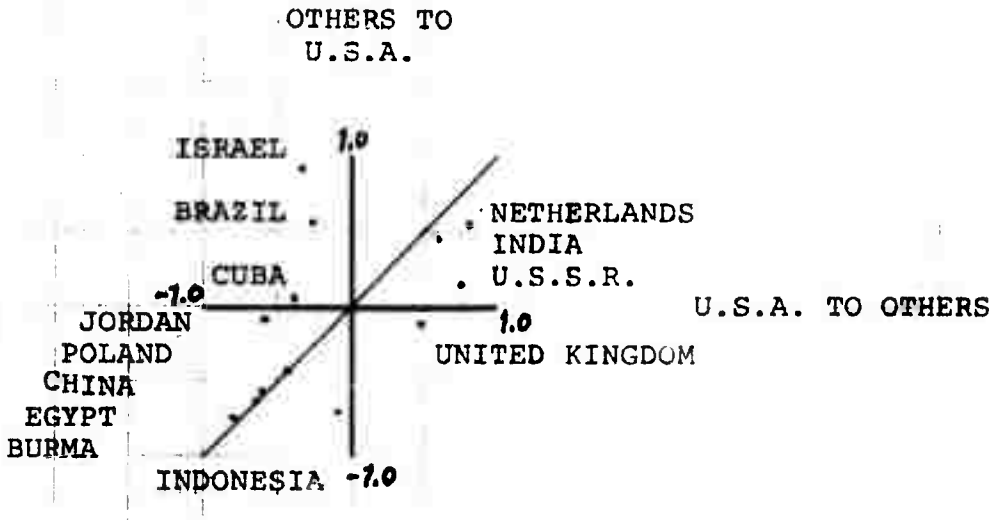


Figure 17. Relative Involvement Indices for the United States