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International Trade and World-System Structure:

A Multiple Network Analysis*

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Introduction

Sociology in general, and American sociology in particular, has tended to focus much of its research efforts on advanced industrial societies, and to neglect social statics and dynamics in the rest of the world. In the past two decades, however, interest in patterns of comparative international development has grown rapidly. The sociology of development has become an important area in the discipline and a critical locus for conflict between competing theoretical perspectives on social change. In recent years, the dependency/world-systems perspective has replaced "modernization theory" as the domi-

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nant paradigm in this subfield. Work from this perspective generally has followed two broad paths, centering either on theoretical or conceptual refinement or on measurement and specification issues.

The latter of these concerns will be the subject of this article. Our research attempts to determine the structure of the world economic system by analyzing networks of economic exchanges. Specifically, countries are mapped into structural positions in the world economic system according to their patterns of commodity trade. Before discussing this research, we will provide a brief overview of the development of and major theoretical contributions to dependency/world-systems theory, present a review and critique of past attempts to measure dependency and the structural positions of countries, and discuss the appropriateness of using multiple network analysis (and more specifically blockmodeling) to the substantive questions at hand.

Theoretical Background

In the late 1960's and early 1970's many social scientists began to question the central tenet behind most existing work in the sociology of development—the linear notion that the historical growth of Western societies represents *the* pathway of development for the contemporary Third World. This premise reflected the culturalist and developmentalist assumptions of the dominant paradigm of the time, modernization theory (Valenzuela & Valenzuela, 1978). Although this label included a broad range of notions concerning the nature of social change, most proponents of this perspective held that the diffusion of "rational" values and the institutions of the West were prerequisites for the subsequent economic and social advancement of the less developed areas (for a classic statement concerning the need for cultural diffusion, see Parsons, 1971: 134-37). This approach assumed that once these cultural prerequisites were attained, poor countries would follow a path of development similar to that experienced in the West during the nineteenth and twentieth centuries.

Although modernization theory has come under attack from several quarters, much of the early criticism can be traced to the development of "dependencia theory." Dependencia theorists argued that countries in Latin America were "underdeveloped" as a result of their international economic relations—not because of internal structures or cultural characteristics. Like human ecologists, some early proponents of this approach focused attention on the development of an exchange system with asymmetric relationships between the parts. Whereas human ecologists traditionally have focused on "communities" (Hawley, 1950) or "urban systems" (Duncan, et al., 1960), for the dependencia writers the boundaries of the system are set by the imperialism and neo-imperialism of economically advanced countries. Thus, the ground work is set for turning attention to the "world-system." Because profits (surplus value) produced in less developed, "peripheral" countries are expropriated by the advanced "core" nations, formerly *undeveloped* areas of the world become *underdeveloped.* This process forms the basis of Frank's description of "the development of underdevelopment" (1969). Thus, as a result of the penetration of foreign political and economic influence, many formerly undeveloped areas have been incorporated as peripheral or "dependent" underdeveloping appendages to the colonial core states. The early dependencia theorists emphasized the effects of international exchanges on development. This perspective posits that "unequal exchange" between peripheral and core nations will benefit the latter and lead to restricted or distorted growth in the former.

The intention of these early dependencia theorists was to develop a framework for dealing with the problems associated with underdevelopment in contemporary peripheral nations, particularly those in Latin America. Their attention, however, to the two-way relationship between imperial core nations and colonized peripheral countries has been criticized as too narrow. Furthermore, the terminology used by these researchers seemed to imply an either/or situation: "dependent" or "autonomous," "metropolis" or "satellite," core or periphery. These deficiencies are at least partially overcome when a more comprehensive conception of a world economic *system,* like that proposed by Wallerstein, is accepted (Evans, 1979a: 16). Though the focus of this world-systems perspective remains on external conditions affecting development, the emphasis is on "the consequences of occupying a given structural position within the world-system as a whole" (1979a: 15). This conceptualization further allows for the following: (1) an intermediary stratum of "semiperipheral" countries as "a necessary structural element in the world economy" (Wallerstein, 1974a: 349) and (2) the possibility of mobility in the international system through "dependent development" (see Cardoso, 1973; Evans, 1979b). Empirically, major monographs on the modern world-system have attempted to provide qualitative historical descriptions of the origins, organization, and operation of the global economy (Wallerstein, 1974a, 1980; Chirot, 1977; Frank, 1978, 1979). Generally, the literature points to a tripartite division into core, periphery, and semiperiphery. Despite agreement about the three-tiered model, there seems to be considerable dispute about the distinguishing characteristics of membership in these distinct positions (see Evans, 1979a: 17; Steiber, 1979: 24; Snyder & Kick, 1979: 1101). In an effort to more firmly establish the "empirical status" of the world-systems model, Snyder and Kick (1979) have examined data on international exchanges using the technique of "blockmodeling." In this article we extend and refine these efforts.

Conceptualization and Measurement of Dependency and Structural Position

Recently there has been great interest in quantitative cross-national studies of dependency (Galtung, 1971; Chase-Dunn, 1975; Rubinson, 1976; Bornschier, et al., 1978; Bornschier & Ballmer-Cao, 1979). These researchers have been concerned primarily with testing the effects of linear measures of dependency on various indicators of national development. Invariably, these studies operationalize dependency as a broad continuum using indicators of trade concentration or direct foreign investment and/or aid. A major criticism of this quantitative literature is that the indicators used to measure dependency do not accurately capture the conceptual subtleties of dependencia theory (Duvall, 1978; Gereffi, 1979). In this regard, Duvall argues as follows:

> [T]he almost universal representation of dependencia theory by North American scholars as a theory about the relationship between dependence and development (or underdevelopment) is an unfortunate and misleading representation. It is reasonable only to the extent that it implies that in a *context* of dependence certain processes affect the rate, the direction, even the possibility of economic expansion, or development. That is, development is affected by processes X, Y, and Z, *given* a context of dependence. But such is not generally the implication given by most representatives of the theory. The common implication is that development is affected by dependence, in which case the latter is transformed into a (central) concept in theory, and hence, is nothing more than a variable property of countries. Such a representation reflects a fundamental misunderstanding of the meaning of dependence for dependencia theory and distorts tremendously the nature of that theory (1978: 58-59).

Thus, a construct that was intended as a general referential context in which to delimit the bounds of the theory has become in many quantitative studies the central concept to be measured (a variable property of countries).[1]

When the concept of dependence is used as a "general referential context," it closely resembles Wallerstein's notion of countries holding structural positions in the world-economy. Although Wallerstein does present a coherent rationale for the tripartite division between core, periphery, and semiperiphery (1974a, 1980) and other social scientists have used the notion of an identifiable semiperiphery in illuminating ways (Evans, 1979b; Chase-Dunn, 1980; Gereffi & Evans, 1981), one need not necessarily accept the three-tiered model of the

1. For reviews and critiques of recent quantitative cross-national research on dependency see Gereffi (1979), Chase-Dunn (1981), and Rubinson and Holtzman (1981).

world-economy. The crucial insight here is not the number of layers, but the idea of countries occupying structurally isomorphic levels in a coherent world-system. When dependency is viewed as a referential context or in terms of structural position in the world-economy, the focus of the analysis is no longer on characteristics of individual countries, but on the relationships between countries.

Recent attempts to locate nations in structural positions within the world-system have recognized this need to study relationships between countries (Evans, 1979; Steiber, 1979; Friedmann, 1981). The work of these and other authors suggests that social-network analysis could be usefully employed in studies of international relationships between countries and to classify nations into structural positions. Although these methods of analysis have developed out of sociometric studies of interpersonal ties, their applicability to quantitative research on international exchanges has been illustrated in recent attempts to empirically locate structural positions in the world-economy.[2] By using blockmodeling and other clustering techniques, the structure of a social system can be defined by the network of interactions between its units (Breiger, et al., 1975; White, et al., 1976). A key notion underlying multiple network analysis is the importance of grouping "actors" into blocks on the basis of their "structural similarity" to one another (White, et al., 1976: 739). Basically, two actors in a network are structurally equivalent if they relate to all other actors in the system in exactly the same manner (Burt, 1978: 191-92). Breiger explains this concept in reference to the network of countries:

> [A] blockmodeling approach to international trade assigns status to positions according to [the] structural similarity of the nation's imports and exports to all other states, across various types of economic exchange (1981: 357).

2. For examples and discussions of the use of social-network analysis in sociometric literature see Breiger, Boorman, and Arabie (1975) and White, et al. (1976).

In addition to sorting the various units in the network into blocks, blockmodeling permits one to examine the aggregate patterns of interrelationships that obtain between the derived blocks. Thus, a second goal of this analytical procedure is to examine the distinctive patterns of interrelations that the blocks induce on the original exchange data. These patterns can then be matched to ideal typical patterns that are suggested by the theory guiding the analysis (see Chase-Dunn, 1978: 163; Breiger, 1981: 358-59 for examples relevant to exchanges in the world-system).

Snyder and Kick's attempt to group countries on a variety of international linkages was the first effort at using blockmodeling to analyze structural position. Their analysis discerned ten groups ("blocks") of nations, which were characterized as representing roughly the three structural positions suggested by the world-systems perspective (1979: 1109-16). This ten-block classification was then used to measure the effect of block membership on economic development. This was accomplished by regressing countries' growth in GNP per capita over a fifteen-year period on a set of dummy-coded block variables. Their findings indicate that the countries interpreted as occupying peripheral or semi-peripheral positions have slower rates of economic growth than core countries, and thus appear to lend support to a world-systems explanation of national development.

The work of Snyder and Kick illustrates the usefulness of network analysis in studying questions from a world-systems perspective (Evans, 1979a; Breiger, 1981). As Evans (1979a) has indicated, however, the work done thus far should be considered only as a "first cut" in deriving world-system structure. Improvements in conceptualization and data make it possible to construct blockmodel representations that are better grounded in world-systems theory.

The most significant change proposed in this research involves the type of networks that will be used to construct the blockmodel. Synder and Kick give equal weight to four matrices of international relationships: trade, military interventions, treaty memberships, and diplomatic exchanges. In our study attention is focused exclusively on networks of economic exchanges. This decision is consistent with the major thrust of the dependency/world-systems perspective. Despite disagreements on other issues, there is a general consenus among most proponents of this approach that the basic unit of analysis is the world-economy (see Frank, 1969; Wallerstein, 1974a, 1980; Chase-Dunn, 1975; Chirot, 1977). Unequal exchange initially creates and continuously maintains the structural division of labor in the global economy. In their discussion of the emerging international structure of world capitalism, Chase-Dunn and Rubinson emphasize the importance of

> a territorial system of exchange of fundamental commodities. The division of labor in this exchange network was not only functional but also geographic, involving the exchange of relatively processed and differentiated goods for raw materials. The main structural feature of this world system came to be this division of labor between the emerging core areas producing manufactured goods and the emerging peripheral areas producing raw materials. The boundaries of the system were determined by the extent and intensity of economic production and exchange (1977: 454).

Despite criticisms that charge world-systems approaches with reductionism (Brenner, 1977; Skocpol, 1977), the tendency within this perspective is to place greater emphasis on the economic base of the world-system's structure. To some extent, other types of exchanges and interaction patterns can be seen as "derivatives" of the material basis of the world-economy.

Ideally, a blockmodel representation of the world-economy would be based on an analysis of flows of profit between countries. Data of this type, unfortunately, are not available in systematic forms amenable to network analysis and, even if they were, they would undoubtedly be of questionable reliability (Vaitsos, 1974). A primary mechanism of unequal exchange and profit flows is the type of commodity that nations trade on the world market. World-systems theory suggests that position in the world-economy is related to the type of commodities nations trade. The economic strength of the core countries is reflected in the type, diversity, and quantity of their exports. Moreover, these countries trade with nations located in all the strata of the world-economy. Conversely, peripheral countries are tied to the world-economy mainly through bilateral trade with core (and some semiperipheral) nations. They are likely to specialize in the export of a few raw materials and import finished products. Semiperipheral countries are perhaps best described as occupying an intermediate role, in both an economic and political sense. They are a middle category in terms of commodity mixes and flows and function as a political buffer between the two extremes of the world-system. The dual role of the semiperiphery is succinctly summarized by Wallerstein:

> The semiperiphery is . . . assigned as it were a specific role, but the reason is less economic than political. That is to say, one might make a good case that the world-economy would function every bit as well without a semiperiphery. But it would be far less politically stable, for it would mean a polarization of the world-system. The existence of the third economy means precisely that the upper stratum is not faced with the unified opposition of all others because the middle strata is both exploited and exploiter (1974b: 405).

In the research to be presented, commodity trade data are used in a blockmodel analysis to empirically determine the structural positions that countries occupy in the modern world economy.

Constructing a Blockmodel of the World-System: Data and Methodology

World-systems analysts have suggested that certain kinds of commodity trade will be critical in determining stratum membership within a multitiered world-economy. Specifically, the exchange for finished products has been seen as an important mechanism of unequal exchange (Frank, 1969; Galtung, 1971; Emmanuel, 1972). Recent attempts to examine empirically the world-systems hypotheses have tried to operationalize this distinction using United Nations Commodity

Trade Statistics (Delacroix, 1977; Steiber, 1979; Stokes & Jaffee, 1982).

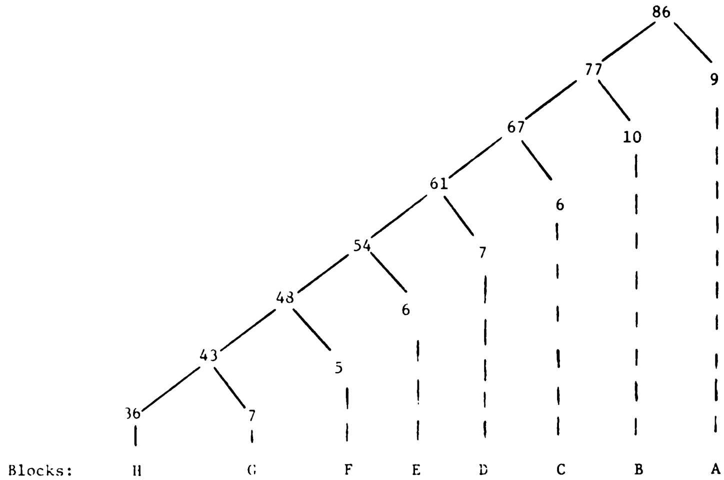
The data used here are from this source for the year 1970 (United Nations, 1976).[3] Information on thousands of commodities classified by country of import and export for 211 countries is available. Although full data on export volume are available, only import data are used because, as a result of a number of factors, reports on imports and exports do not always match perfectly and there is reason to believe that import figures are more accurate (see Durand, 1953: 117-29; Linnemann, 1966: 61-62). As a partial control for the huge differences in country size, only nations with populations greater than one million were selected for analysis. This restriction, coupled with missing data for a number of countries, limited analysis to 86 nations (see Figure 1 for a full listing.[4]

To operationalize the differences between raw materials and finished products, Steiber (1979) examined data for four broad types of one-digit commodity classes.[5] A problem with this procedure is the lack of homogeneity within categories. If one examines the Standard International Trade Classification (SITC) used to compile the United Nations data, it is clear that categories such as "chemicals" or "machinery and transportation equipment" include a wide range of products, varying from simple ones needing little processing to products synthesized in capital-intensive high-technology settings.

3. The actual commodity trade data used were obtained from the United Nations Statistical Office in August, 1982. These data represent continually updated files on a number of countries for which information has only recently become available and upgraded data for other nations. For a fuller discussion of this data source, see Allen and Ely (1953) and Linnemann (1966).

4. Unfortunately, commodity trade data on most countries affiliated with the Eastern Bloc are unavailable. Without data on these countries, our study is unable to address the longstanding debate over the existence of one unified world-economy or two—one capitalist and the other socialist (Frank, 1969, 1977; Galtung, 1971; Wallerstein, 1974b; Chirot, 1977; Steiber, 1979). Data on a number of Middle Eastern nations also are unavailable, including information on Saudi Arabia.

5. The data are hierarchically ordered from five-digit (most specific) to one-digit (most general) commodity categories.



A: Belgium, Canada, France, Italy, Japan, Neitherlands, United Kingdom, United States, West Germany
B: Australia, Austria, Brazil, Denmark, Mexico, Nigeria, Spain, Switzerland, Sweden, Venezuela
C: Argentina, Hong Kong, India, Philippines, Singapore, South Korea
D: Finland, Greece, Iran, Ireland, Israel, Libya, Norway
E: Cameroun, Ivory Coast, Madagascar, Morocco, Senegal, Tunisia
F: Chile, Columbia, Ghana, Pakistan, Thailand
G: Egypt, Kenya, Malaysia, New Zealand, Portugal, Zaire, Zambia
H: Afganistan, Benin, Bolivia, Burma, Cambodia, Central African Republic, Chad, Congo, Costa Rica, El Salvador, Equador, Ethiopia, Guatemala, Honduras, Indonesia, Jordan, Laos, Lebanon, Liberia, Malawi, Mali, Mauritania, Nicaragua, Niger, Panama, Paraguay, Peru, Sri Lanka, Somalia, Sudan, Tanzania, Togo, Turkey, Uganda, Upper Volta, Uruguay

NOTE: Factor scored from SITC Commodity Trade.

Figure 1: Listing of Countries in Each Block and Five-Network Model for 86 Nations, 1970

In an effort to examine more homogeneous categories, two-digit classifications are used in this study. These still may contain some internal heterogeneity (see Stokes & Jaffee, 1982: 403). However, we decided to use this level of aggregation because measurement error becomes increasingly problematic as researchers move to more specific SITC categories (Durand, 1953).

In the past studies have tried to operationalize the refined versus processed dimension by establishing scalar rankings of various commodities or commodity groups (Delacroix, 1977; Stokes & Jaffee, 1982). Using these scales or devising a ranking system of our own and then selecting representative commodities for analysis was one possible research strategy.

But this approach has problems. A primary concern is with the validity of such "degree of processing" scales. Such measures tend to be based on the qualitative judgments of their originators and, thus, are somewhat arbitrary. For instance, Stokes and Jaffee (1982) devised a weighting system in which "hats" (scoring 3) were seen as more processed than "vegetable oil" (scoring 2), but equally processed compared to "petroleum products" (also scoring 3). The point is not that Stokes and Jaffee's scales are wrong; the difficulty is that they fail to provide any rigorous guidelines for determining when particular commodities will fall into one of their six categories.

An additional problem with selecting certain key commodities for analysis is somewhat more mundane. Given that there are data on 53 two-digit commodities (and our goal is to derive an image of the structure of the world-system based on networks of international trade), looking at only a small number of commodities entails discarding a tremendous amount of information.

Lacking good instruments to measure the processed versus unprocessed distinction and reluctant to discard data, we opted for a form of data reduction that included all the commodities, but empirically clustered them into broad types. A factor analysis was performed to discern the degree of commonality between the trade patterns of the two-digit commodities. As we were reluctant to assume any underlying structure to the data, a principal-component analysis was used to extract the initial factors. The derived components are the "best" linear combination of variables (i.e., they account for more explained variance in the data, as a group, than any other linear combination of variables) (Harman, 1967). Each component is assumed to be orthogonal; hence, each successive component must be the linear combination of variables that accounts for the most residual variance after the effects of previous components are removed from the data. To determine the number of initial factors to be extracted, we used the Kaiser or eigenvalue criterion (eigenvalues greater than or equal to one were retained) (Harman, 1967). The first five factors were found to add significantly to the explained variance; thus, only they were used to derive a final solution. In determining a final solution, factors were not assumed to be orthogonal, therefore an oblique (Promax) rotational technique was used. The original scores for the 55 commodities were converted to z scores. The z scores then were converted to factor scores in standard-score form (Harman, 1967: 349). The five distinct groupings that emerged from the factor analysis are presented in Table 1.

An interesting result that lends some additional credence to a world-systems approach is that commodities do tend to cluster together in readily interpretable patterns. Despite a few commodities that do not seem to "fit" in with others that load on the same factor, the analysis is amenable to interpretation based on a processed/nonprocessed or manufactured/raw materials schema. Factor 1 appears to contain heavy and high-technology manufactures; Factor 2 includes intermediate manufactures; Factor 3 clusters various types of raw materials; Factor 4 contains light manufactures; and Factor 5 includes a number of food products and by-products. Several of the apparent anomalies that seem to cluster with an appropriate group are commodities that do not load heavily on any one factor (i.e., crude rubber, petroleum products, leather manufactures). These results show in a concrete way that bilateral world commodity trade patterns *do* tend to have a coherent structure amenable to description using the raw material/finished product distinction. This finding is consistent with descriptions of the mechanisms of unequal exchange suggested by theories stressing imperialism and dependency relations (Frank, 1969; Galtung, 1971; Emmanuel, 1972).

TABLE 1

Factor Groupings of Commodity Trade Statistics, 1970

Factor 1

53 dyeing, tanning, and coloring materials
58 artificial resins and plastic materials, and cellulose esters and ethers
71 machinery–nonelectrical
86 scientific instruments, photographic apparatus, optical goods, watches, and clocks
59 chemical materials and products, n.e.s.
81 sanitary, plumbing, heating and lighting fixtures, and fittings, n.e.c.
54 medicinal and pharmaceutical products
55 essential oils and perfume materials, toilet, polishing, and cleansing preparations
69 manufactures of metal, n.e.s.
51 organic chemicals
62 rubber manufactures, n.e.s.
43 animal and vegetable oils and fats, processed; waxes of animal or vegetable origin
72 electrical machinery
9 miscellaneous edible products and preparations
65 textile yarn, fabrics, made-up articles, n.e.s., and related products
67 iron and steel
52 inorganic chemicals
61 leather, leather manufactures, n.e.s., and dressed furskins
35 electric current
23 crude rubber (including synthetic and reclaimed)

Factor 2

64 paper, paperboard, and articles of paper pulp, of paper, or of paperboard
34 gas, natural and manufactured
25 pulps and waste paper
56 fertilizers, manufactured
57 explosives and pyrotechnic products
3 fish, crustaceans, and mulloscs and preparations thereof
73 transportation machinery
68 nonferrous metals
24 cork and wood
82 furniture and parts thereof
27 crude fertilizers and crude minerals (excluding coal, petroleum, and precious stones)
11 beverages
33 petroleum, petroleum products, and related materials

TABLE 1 (Continued)

Factor 3

22 oil seeds and oleaginous fruit
4 cereals and cereal preparations
41 animal oils and fats
32 coal, coke, and briquettes
21 hides, skins, and furskins, raw
28 metalliferous ores and metal scrap
8 feeding stuff for animals (not including unmilled cereals)
12 tobacco and tobacco manufactures
26 textile fibers (other than wool tops) and their wastes (not manufactured later)

Factor 4

83 travel goods, handbags, and similar containers
84 articles of apparel and clothing accessories
85 footwear
89 miscellaneous manufactured articles, n.e.s.
63 cork and wood manufacturers, n.e.s.
66 nonmetallic mineral manufactures

Factor 5

2 dairy products and birds eggs
1 live animals chiefly for food
29 crude animal and vegetable materials, n.e.s.
5 vegetables and fruits
6 sugar, sugar preparations, and honey
7 coffee, tea, cocoa, spices, and manufactures thereof
42 fixed vegetable oils and fats

Using the results of the factor analysis, scoring coefficients for commodity trade between each pair of countries were calculated using a regression method. This procedure yielded a summary score for each bilateral exchange on each of the five factors. These scores are interpretable as the linear combination of the standardized scoring coefficients for each factor multiplied by the dollar value of the total trade between countries. Because of the manner in which these scores were calculated, many of their values are larger than magnitudes usually found in standardized scoring coefficients.[6] The data matrices used in the blockmodeling analysis were constructed using these scores.

The blockmodeling methodology provides a way of determining the "structural equivalence" of countries in terms of their pattern of trade of the five broad commodity groups. Blockmodeling operationalizes structural equivalence using a discrete measure (i.e., by mapping actors into distinct positions [or "blocks"] according to the similarities of actors in various networks of exchange or relatedness). The algorithm most widely used to seperate actors into structurally similar blocks is the Convergence of Iterated Correlations (CONCOR). CONCOR is a divisive hierarchical clustering procedure that continuously splits actors into successively smaller groups. In this study, each of the five commodity groupings represents a distinct network of exchanges. The summary scores for each commodity factor have been arrayed in a matrix cross-classified by sending and receiving countries. These matrices have been stacked to create a $5 \times 86 \times 86$ matrix that is input into the CONCOR program. The CONCOR program first calculates Pearson product-moment correlation coefficients between each pair of countries. An 86×86 matrix of correlations containing linear measures of similarity between each pair of actors, based on the degree of similarity with all other countries, results. The greater the positive correlation between a pair of countries, the more structurally similar they are. CONCOR then enters this correlation matrix as an input into the correlation program, only this time it correlates all pairs of nations (each column of the matrix consisting of 86 correlation coefficients). The resulting matrix of second-order correlations is then, in turn, input into the correlation program, with

6. The "mean flow matrices" on Table 2 were calculated using these scores. Some readers have noted the high values for some of these cells. These cells do represent monetary value flows between the countries of the various blocks, although not in terms of dollars. The high scores are a result of (1) the calculation of these scores as linear combinations of standardized values and dollar value of exchange and (2) the summation of a number of these composite scores for a number of bilateral exchanges to calculate each cell value in the mean flow matrices.

this process repeated until all entries in the matrix equal either positive or negative one. This results in a two-block partition of the original set of nations with all countries positively correlated sorted into one block and all countries negatively correlated placed in the other block. This procedure of repeatedly submitting the correlation between pairs of nations as input to the correlation procedure is conducted separately for each commodity (nework) until either each country occupies its own block or it reaches a predetermined number of blocks.[7] Thus, CONCOR produces a classification of countries into discrete, mutually exclusive, and exhaustive categories based on their trade of all five commodity groups.

Structure and Position in the World-System

Model Results and Discussion

The results of the blockmodeling procedure are summarized in Figure 1. The diagram shows the overall structure of the partitioning of the data and the number of countries in each successive split. Each of the blocks obtained in the eight-block partition is labeled by an arbitrary letter "name." A list of the countries in each block appears on this table, as well.

At this point, it is possible to discuss this overall pattern and the inclusion of specific nations in particular blocks. Do the results appear to make sense in the theoretical context of the world-systems approach? How do these results compare to the overall structure and particular blockings obtained by Snyder and Kick (1979)?

First we shall examine the basic structure of the international system that has been derived. The initial split in the data separates Block A from the rest of the data. A cursory examination of Figure 1 reveals that this block contains na-

7. In this study we report the findings arrived at when an eight-block partition is specified.

tions generally associated with the "core" of the contemporary world-economy: the United States, Canada, Japan, and six of the leading countries of western Europe. This basic distinctness of a core block in opposition to all other countries is consistent with the qualitative discussions of world-system structure described above. At the other end of the spectrum, the grouping of a large number of countries from diverse geographical areas of the Third World that are, by and large, indisputably "peripheral" also squares well with theoretical notions of a large, structurally similar category at the bottom of the hierarchy. The configuration that Snyder and Kick (1979) obtained is not as theoretically consistent. Their initial split separates a group of African peripheral countries from the rest of the world's nations, suggesting a basic difference between these countries and all others. In their analysis the core countries are grouped with a number of nations they label as "peripheral" and "semi-peripheral." It takes further partitions of the data for the core to emerge as a distinct block.

The actual groupings that Snyder and Kick obtained also tend to lack theoretical face validity. Several of their groups are clearly geographical in nature (Blocks A and B—Africa; Block E—Central America). Perhaps the reason for this lies in the equal weight that their analysis places on ties such as "treaties" or "diplomatic exchanges" that tend to be regionally based, but that have little to do with the mechanisms that would be expected to determine a nation's role in the world-economy. Ironically, while giving equal weight to all four of matrices of "international transactions," Snyder and Kick admit that their interpretation of a three-tiered world-system "is most clearly reflected in the image matrix for trade" (1979: 1114). Of all our blocks, only one contains members exclusively from one world region (Block E—Africa).[8]

A more serious problem in Snyder and Kick's blockmodeling results is the theoretically inconsistent placement of some countries in the various strata. Cyprus is "semi-peripheral,"

8. This pattern is likely a result of the close economic ties that the six African states in this block have with France, their former colonial master.

Brazil and Mexico are "peripheral." In a particularly curious grouping (Block F) Czechoslovakia, Malta, China, and New Zealand cluster together and are consigned to the periphery. Our results, based on international commodity trade networks, seem to conform more closely to the expectations of the world-systems perspective. Our "core" is a smaller, more homogeneous cluster of countries that more unambiguously fit that categorization. Blocks B, C, and D—the first splits off the noncore group—can be labeled as semiperipheral. These three blocks are geographically diverse, including several less economically central European countries as well as Third World nations such as Brazil, Argentina, India, Iran, South Korea, and Nigeria. Blocks E through G seem to occupy a somewhat more ambiguous position. A unique colonial heritage may explain the partitioning off of block E; these countries do not seem to fit into an economic stratum distinct from the peripheral nations of Block H.[9] The other two blocks (F and G), on the other hand, seem to represent a "second" or "weak" semiperiphery, intermediate between the periphery and the "first" semiperiphery. The large periphery of Block H fits qualitative descriptions of this category quite well.[10]

Table 2 presents the "mean flow matrices" of the value of trade between the eight blocks of countries for each of the five commodity types. The eight columns represent the exporting blocks, with the rows indicating the importing blocks. The cell entries for each matrix were calculated by first summing all the standardized score values of nations in each block that trade with countries in corresponding blocks. These overall value scores then were divided by the number of possible trade ties between each pair of blocks. Thus, the cells represent the average value per possible trade tie between any two blocks. For example, the average trade tie in heavy

9. Subsequent analysis bears out this notion of structural similarity between Blocks E and H (see below).

10. Some analysts have argued that Turkey and Indonesia are semiperipheral (Chirot, 1977: 213). If we had further partitioned the data, it is likely that these and/or other nations would have split from group H, perhaps forming blocks that would be structurally similar to Blocks F and G.

TABLE 2
Density and Image Matrices of 9-Block Model of International Trade, 1970

Heavy Manufactures/High Technology

	A	B	C	D	E	F	G	H
A	50,106	4675	1390	1162	46	342	371	54
B	12,546	1712	201	502	3	64	126	20
C	6110	475	329	58	1	158	34	9
D	5644	1203	108	180	4	18	45	15
E	1111	52	14	8	24	4	7	2
F	3285	264	139	47	1	12	13	5
G	2397	373	217	44	1	23	18	5
H	684	73	61	16	3	24	8	10

	A	B	C	D	E	F	G	H
A	1	1	1	1	1	1	1	1
B	1	1	1	1	0	1	1	0
C	1	1	1	1	0	1	0	0
D	1	1	1	1	0	0	0	0
E	1	0	0	0	0	0	0	0
F	1	1	1	0	0	0	0	0
G	1	1	1	0	0	0	0	0
H	1	1	1	0	0	0	0	0

Intermediate Manufactures

	A	B	C	D	E	F	G	H
A	41,645	4690	936	5639	738	393	597	252
B	6365	1110	46	944	113	79	184	30
C	2205	258	253	391	14	136	141	30
D	3399	999	27	525	64	32	15	17
E	624	46	0	21	34	1	10	1
F	1780	151	67	164	14	46	17	15
G	1570	252	100	143	12	21	25	10
H	389	76	21	35	6	15	4	5

	A	B	C	D	E	F	G	H
A	1	1	1	1	1	1	1	1
B	1	1	0	1	1	1	1	0
C	1	1	1	1	0	1	1	0
D	1	1	0	1	0	0	0	0
E	1	0	0	0	0	0	0	0
F	1	1	0	1	0	0	0	0
G	1	1	1	1	0	0	0	0
H	1	0	0	0	0	0	0	0

Raw Materials

	A	B	C	D	E	F	G	H
A	24,578	5997	4208	1066	414	1468	976	753
B	2959	523	600	218	21	153	99	77
C	2936	328	109	7	24	515	173	80
D	1512	273	106	100	46	54	104	42
E	428	14	3	5	20	61	15	7
F	959	206	183	3	1	30	5	21
G	565	238	126	24	4	214	45	48
H	227	46	43	12	4	26	18	10

	A	B	C	D	E	F	G	H
A	1	1	1	1	1	1	1	1
B	1	1	1	1	0	1	1	0
C	1	1	1	0	0	1	1	0
D	1	1	1	1	0	0	1	0
E	1	0	0	0	0	0	0	0
F	1	1	1	0	0	0	0	0
G	1	1	1	0	0	1	0	0
H	1	0	0	0	0	0	0	0

Light Manufactures

	A	B	C	D	E	F	G	H
A	27,963	2680	7689	1447	79	119	391	54
B	4578	1016	723	552	4	24	186	13
C	1128	98	267	3	0	10	6	6
D	1427	630	179	127	5	5	69	13
E	295	5	15	1	16	1	1	1
F	398	105	88	3	2	8	5	1
G	576	69	222	12	1	6	20	3
H	146	20	32	6	3	5	5	10

	A	B	C	D	E	F	G	H
A	1	1	1	1	1	1	1	1
B	1	1	1	1	0	1	1	0
C	1	1	1	0	0	0	0	0
D	1	1	1	1	0	0	1	0
E	1	0	0	0	0	0	0	0
F	1	1	1	0	0	0	0	0
G	1	1	1	0	0	0	0	0
H	1	1	1	0	0	0	0	0

TABLE 2 (Continued)

Food Products

	A	B	C	D	E	F	G	H
A	18,957	9189	4884	2619	2469	2160	3707	1023
B	2122	1001	592	293	68	310	171	118
C	839	418	271	36	42	141	168	57
D	823	430	400	264	84	259	93	70
E	407	46	24	18	114	1	14	6
F	492	145	147	16	3	16	60	43
G	274	171	144	18	6	50	106	25
H	127	43	63	14	12	20	27	15

	A	B	C	D	E	F	G	H
A	1	1	1	1	1	1	1	1
B	1	1	1	1	0	1	1	0
C	1	1	1	0	0	1	1	0
D	1	1	1	1	0	1	0	0
E	1	0	0	0	0	0	0	0
F	1	1	1	0	0	0	0	0
G	1	1	1	0	0	0	0	0
H	1	0	0	0	0	0	0	0

NOTE: Columns represent exporting blocks and rows indicate importing blocks. Cell entries were calculated by summing all the standardized score values in corresponding blocks. These overall value scores were then divided by the number of possible trade ties between each pair of blocks. Image matrices are based on comparison of the amount of trade between corresponding blocks compared to the median trade for the entire network. A 1 represents a tie between blocks, indicating that the trade between the two blocks was greater than the median value for all cells in the matrix.

manufacturing/high technology products between core countries (cell 1,1) is 5010 times larger than the average trade between peripheral countries (cell 8,8).[11]

Presented in Table 2 are blockmodel "image matrices" for each of the five commodity types. Each binary image matrix is a reduced form of the actual density matrix derived by the method outlined above. A 1 in Table 2 (representing a "tie" between blocks) indicates that the trade between the two blocks was greater than the median value for all cells in the matrix.[12] It should be noted that the primary purpose of the image matrices is to simplify the data to facilitate interpretation. It is important to keep in mind that the actual blockmodeling was performed using continuous indicators of the value of bilateral trade between countries.

11. The reader should remember that the entries in each cell are not dollar values, but average converted standard score values for the trade between countries in any two blocks. See the explanation in Note 6.

12. The use of the median as a cut-off is fairly arbitrary. This demarcation point was chosen (instead of the mean) because of the highly skewed nature of the density scores.

With only a few notable exceptions, the analysis of the density and image matrices supports and elaborates on our earlier interpretation of the structure of the data partitioning. In fact, the overall patterns of trade are similar (albeit much more complex with an 8×8 matrix) to the ideal-typical pattern of exchange for a core-periphery structure outlined by Breiger (1981). In general, the patterns that emerge from these matrices are interpretable as a four-position structure: a core, a periphery, and two semiperipheral positions.

An examination of the matrices for all five commodity types reveals that Block A clearly is the core. By an overwhelming margin, Block A is involved in the greatest volume of trade (both import and export) with nearly every block and for all commodity types. This finding parallels the trade patterns of the core country block found by Snyder and Kick (1979). In our analysis, however, we are able to go far beyond this general pattern to examine the amount and direction of types of commodity trade. The matrices for all five commodity types indicate that the pattern of import and export trade for Block A varies in ways predicted by the dependency/world-systems perspective.

The density matrix for the heavy manufacturing/high-technology commodity type indicates that position A is the chief exporter to all other blocks as well as the leading importer from each other block. As would be predicted from a dependency/world-systems perspective, the density matrix shows that these core countries send much greater values of these products to other blocks than they receive from them. Also consistent with the world-systems approach is the finding that trade within the core group results in the highest density score in the matrix (or in *any* of the matrices for the other commodities, for that matter). These matrices reveal that the core nations' importation of heavy manufacturing/high-technology products from the periphery (Blocks E and H) is very small, as would be anticipated.

A similar pattern of trade is discernable for intermediate manufacturing, with only one exception. The core receives more of this type of trade from Block D (a member of one of the semiperipheral strata) than it exports to Block D. Block A generally receives more raw materials from the other seven blocks than it exports (the two exceptions to this general pattern have a nearly equal balance of trade with Block A on this commodity). An interesting finding that can be gleaned from the density matrix for raw material trade is that the core receives more of this type of product from the semiperiphery than from the periphery. The image matrix for the light manufacturing commodity type reveals that Block A has importing and exporting ties with all other blocks. The density matrix indicates that the amount of this type of trade flowing out of Block A is greater than the amount being received, except for large inflows from semiperipheral Blocks B and C. Finally, although Block A is both an importer and exporter of food products, the density matrix for this commodity reveals that it consistently imports much more than it exports from each of the other blocks.

Examination of the image and density matrices also supports our contention that there seem to be a number of blocks that occupy intermediate semiperipheral positions. In opposition to world-systems orthodoxy, however, we find a four-tiered division rather than the tripartite split usually referred to in the world-systems literature. Blocks B and C seem to unambiguously belong to a strong or first semiperiphery. Blocks F and G are clearly members of a second or weak semiperiphery. A close look at the image and density matrices reveals that Block D, whose membership seems to resemble that of Blocks B and C, exhibits international trade patterns on some of the commodity types that more closely match those of the blocks of our second semiperiphery. In the trade of both heavy and intermediate manufactures, however, Block D exhibits patterns that indicate that it is closer to the first semiperiphery composed of Blocks B and C.

First, we will discuss this strong semiperiphery. The image matrix for the heavy manufacturing/high-technology grouping gives strong support to our contention that Blocks B and C belong in this semiperipheral category. Each has importing and exporting ties with the core and with other semiperipheral blocks (D, F, and G.)[13] Using the image matrix as our guide, Block D's pattern appears to be quite different. Although it is totally integrated on both imports and exports to the core, Blocks B and C, and itself, Block D does not show export ties to members of the second semiperiphery. Block D does not export substantially less to these blocks, but it should be noted that the values it sends to both fall just marginally short of being classified as "ties." Furthermore, Block D resembles B and C in that all three blocks trade most heavily first with the core, then with themselves, next with other semiperipheral blocks, and, finally (and only marginally), with the periphery. Blocks B, C, and D, in general, trade greater amounts of heavy manufactures and high-technology products than either the second semiperiphery or the periphery.

The pattern of trade of intermediate manufactures also points to the cohesion of these three blocks in a strong semiperipheral position. Blocks B and D show identical patterns of exports—shipping large amounts of this commodity to the core and all semiperipheral blocks. Block D seems to be a particularly important producer and exporter of these products; the value of its exports to Block A exceed the value of its imports from that block (the core is a net exporter to all other blocks). Blocks B and C import more of these goods (including significant ties with the weak semiperiphery) and, in the case of Block B, even peripheral Block E. Once again, trade patterns for all three blocks center mainly on the core, next on the semiperipheral blocks, and only marginally on the peripheral blocks.

An examination of the image matrix for raw materials shows a similar pattern of ties to the core and all other semiperipheral blocks, but an absence of ties with the periphery. Block D's exports are an exception to this pattern; they are very low in value to Blocks C, F, and G. This block's imports from Block F are low as well. All three blocks receive more raw materials from the core than from elsewhere. But in terms

13. The one exception to this pattern—Block C's receiving of heavy manufacturing/high-technology commodities from Block G—is barely under the minimum density value necessary to show up as a tie.

of value, both Blocks B and C export far more of the commodity to the core than they receive from it. The importance of these blocks for the provision of various raw material products to the core may help to explain their semiperipheral role in the world-economy.[14]

The matrices for both light manufactures and food products further reinforce the contention that particularly Blocks B and C are structurally similar and occupy a strong semiperipheral position. For light manufacturing, trade Blocks B, C, and D all have importing and exporting ties with the core and other semiperipheral blocks and exhibit fairly high levels of intrablock trade. All of the blocks' exports to the core are much greater than their imports from the core. Block D's export of these light industrial goods is very low compared to the other two; in fact, its lack of export ties to Blocks C, F, and G suggests a pattern that is more consistent with the second semiperiphery. But Block D's import pattern is more diversified than Block C's. The export of light manufactures by Blocks B and C to the periphery and the lack of imports from the periphery is a pattern that would be expected for semiperipheral areas. Also consistent with what would be expected of a strong semiperipheral strata, the vast majority of the total trade of this (and, in fact, most other) commodities is carried out either with the countries of the core or other nations in Blocks B, C, and D.

Finally, the pattern of trade in food products is similar in all three blocks of the first semiperiphery. All have import and export ties with the core and other semiperipheral blocks; none has any large trade ties with the periphery. For this com-

14. One of the commodities that we often think of as a crucial raw material in the international economy, of course, is oil. Not surprisingly, a number of the major oil exporters are found in the strong semiperiphery. Mexico, Nigeria, and Venezuela all are members of Block B; Iran and Libya are members of Block D. Doubtlessly, even by 1970, major oil reserves must have aided these countries in developing more diversified and industrial economies, as reflected in our blockmodeling of international trade patterns. However, we did not accord petroleum trade any extra weight in the network analysis. In fact, the data reductions procedure utilized found that oil did not load heavily on any of the five commodity factors. Thus, oil exporting played little direct role in determining block membership, although its indirect role may have been crucial.

modity group, Block D's exports are both more sparse and less diversified.

Examination of the trade patterns of the five commodity groups indicates that Blocks F and G occupy similar positions in the world-economy and may be classified as the second or weak semiperiphery. Generally, these two blocks have import and export trade with Blocks A through D, but engage in little trade with either the periphery or other countries in their own blocks. These two characteristics of their trade patterns coupled with the overall sparseness of trade to any non-core blocks differentiate these two blocks (F and G) from those that we classified as members of the strong semiperiphery. Because their trade volume is much greater and not quite so heavily bilateral with the core, we argue that it is appropriate to distinguish these two blocks from the periphery. Although Block D exhibits patterns similar to those of Blocks F and G for some types of trade, we will claim that, on balance, it is more appropriately categorized as a member of the first semiperiphery.

Finally, the trade configurations of Blocks E and H indicate that they occupy a distinct peripheral position in the world-economy. Their connection to the international trade system is almost exclusively through the core nations.[15] Neither block imports many heavy manufacturing/high-technology goods, but both are dependent on the core to supply imports of these products. Both blocks exchange imports and exports of all other products with the core, showing net imports on each of the three types of manufactured goods and large net exports of raw materials and food products.[16] The picture that emerges for the members of blocks E and H is one of classic dependence on the nations of Block A: These two blocks con-

15. Exports of heavy and light manufactures from semiperipheral Blocks B and C are the only exceptions, and even these ties are based on modest amounts of trade as compared to the value of core-periphery exchanges.

16. A single exception to this pattern is Block E's slight net export of intermediate manufactures to Block A. This apparent anomaly is consistent with recent writings suggesting a trend toward some manufacturing by multinational corporations in the periphery (Frank, 1981).

form well to world-systems analysts' conceptualization of the periphery.

In summary, an examination of the image/density matrices of trade flows has confirmed some of our earlier speculations about the structure of the international system. These matrices are readily interpretable from a dependency/world-systems perspective. We have argued that the results of the blockmodeling procedure suggest a hierarchically ordered international economic system consisting of core, periphery, and two distinct intermediate semiperipheries. The amount and direction of trade flows for each commodity type reinforce earlier evidence that Block A is composed of nations at the core of the world-economy. Similarly, Blocks E and H exhibit the pattern and low level of trade that supports our contention that these groups of countries occupy a peripheral position in the international system. Their relatively high value of trade, the intensity of their trade with the core, themselves, and other intermediate blocks lends credence to the view that Blocks B, C, and D hold strong semiperipheral positions. Finally, Blocks F and G have a similar pattern of close integration with the core and strong semiperiphery, but lack exchanges with the periphery or other nations in their own category, suggesting that they comprise a fourth strata that we have labeled the weak semiperiphery.

Looking only at the pattern of exchanges on the image matrices in Table 2, one world-systems hypothesis appears not to be borne out. Given the emphasis on unequal exchange based on differences in raw material/finished product flows, it is rather surprising that the image matrices for all five commodity types are so similar.

To some extent, the presence of a consistent configuration reflects a very real (and expected) correlation between trade volume and structural role in the world-economy. The core, because of its sheer amount of activity in world trade, shows both import and export ties on all commodities and with all other blocks. Core economies are diversified and very large. Their strength in the world-economy is a result of the autonomy and self-sufficiency that this diversified production brings. It is not surprising that they send products such as food and raw materials as well as various types of manufactures to peripheral and semiperipheral areas.

In spite of this qualifying statement, however, our data do show a fairly consistent pattern of differences on commodity trade between blocks by volume. These differences, though, are *not* apparent when one compares the image matrices on Table 2. Recall that these image matrices were created by converting all the values on the mean flow matrices to 1's, indicating a trade tie. The choice of the median as a cutting point is entirely arbitrary. Other threshold values for the presence or absence of a tie can be set. One might argue that significant linkages are present only if two blocks exchange well above the median value for trade in a particular commodity group. In Table 3 another set of image matrices has been constructed. Presence of a tie in this table is indicative of a value in the top quintile for each matrix.

The series of matrices shows some clearer differences between commodity trade patterns that were not apparent when the median was the cut-off. Volume still is important and the total number of ties still is distributed hierarchically, with the core showing the most and the periphery the fewest. Nevertheless, a pattern more suggestive of unequal exchange is present. The core exports heavy manufacturing to all other blocks, but only receives this type of commodity from other core and first semiperiphery nations. On the other hand, food exports from all other blocks flow to the core, whereas it sends these products only to core and semiperiphery destinations.

A final point involves the changing nature of dependency relationships in the world-economy. Several commentators have argued that with the rise of supranational economic units (e.g., multinational corporations) dependency relations are becoming increasingly tied to control of flows of technology and finance capital (Cardoso & Falletto, 1979; Evans, 1979b; Frank, 1981). Consequently, the type of unequal exchange captured by examining the movement of raw materials versus finished products gradually may become less significant. Unfortunately, capital flows and/or technology transfers are much more difficult to measure than commodity flows.

TABLE 3
Mean Flow Matrices (top quintiles) of 8-Block Model of International Trade, 1970

Heavy Manufacturing/ High Technology

	A	B	C	D	E	F	G	H
A	1	1	1	1	0	0	1	0
B	1	1	0	1	0	0	0	0
C	1	1	0	0	0	0	0	0
D	1	1	0	0	0	0	0	0
E	1	0	0	0	0	0	0	0
F	1	0	0	0	0	0	0	0
G	1	1	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0

Light Manufactures

	A	B	C	D	E	F	G	H
A	1	1	1	1	0	0	1	0
B	1	1	1	1	0	0	0	0
C	1	0	1	0	0	0	0	0
D	1	1	0	0	0	0	0	0
E	1	0	0	0	0	0	0	0
F	1	0	0	0	0	0	0	0
G	1	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0

Intermediate Manufactures

	A	B	C	D	E	F	G	H
A	1	1	1	1	1	0	1	0
B	1	1	0	1	0	0	0	0
C	1	0	0	0	0	0	0	0
D	1	1	0	1	0	0	0	0
E	1	0	0	0	0	0	0	0
F	1	0	0	0	0	0	0	0
G	1	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0

Food Products

	A	B	C	D	E	F	G	H
A	1	1	1	1	1	1	1	1
B	1	1	1	0	0	0	0	0
C	1	1	0	0	0	0	0	0
D	1	1	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0
F	1	0	0	0	0	0	0	0
G	0	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0

Raw Materials

	A	B	C	D	E	F	G	H
A	1	1	1	1	0	1	1	1
B	1	1	1	0	0	0	0	0
C	1	0	0	0	0	1	0	0
D	1	0	0	0	0	0	0	0
E	1	0	0	0	0	0	0	0
F	1	0	0	0	0	0	0	0
G	1	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0

NOTE: Interpret this table exactly as Table 2, but now 1 indicates a trade volume in the top quintile of the values in the mean flow matrix.

Nevertheless, the pattern that emerges from the blockmodeling is readily interpretable from a dependency/world-systems perspective. The analysis presented above suggested that the eight strata derived from the blockmodeling can be conceptualized as occupying four distinct roles in the world-economy. The country groupings and the patterns they adduce on the trade data conform well to world-systems descriptions of core, periphery, and semiperiphery structure.

Block Structure and National Development Toward Empirical Verification

Though the high degree of theoretical face validity for our blockmodel is interesting in and of itself, an alternative measure of its usefulness is the relationship between stratum membership and national development. Above we contend that the blocks that the network analysis obtained are interpretable as a core, periphery, and two semiperipheries, as these terms are usually used in world-systems literature. In this section we will assay the value of grouping nations into these four roles by determining how well strata membership differentiates between countries on indices of development.

The notion of "development" is, at once, a universal goal and an extremely nebulous concept (Barnett & Mueller, 1974: 148). Many social scientists, particularly those working with the "developmentalist" assumptions of "modernization theory," have assumed that economic growth is the ultimate measure of national advancement. Writers from the world-systems perspective, however, have emphasized that adequate conceptions of national development also include the notion of "social transformation"—involving "a more egalitarian distribution of income and widespread access of the population to 'social goals'" (Portes, 1979: 56). Therefore, in this analysis we will examine the relationship between our four structural positions and a measure of income distribution and social welfare, as well as economic growth.

As indicators of economic strength and growth, we have chosen GNP/capita in 1970 and the average annual growth rate in GNP/capita for the period 1970-1979.[17] GNP/capita

17. Data for GNP/capita and the average annual growth rate in GNP/capita are from the World Bank (1982).

was selected because it is the most conventional indicator of the size of a country's economy. Because of its highly skewed distribution, however, the natural log of GNP/capita was used in the analyses. Average annual growth in GNP/capita was selected over other methods of measuring economic growth because of its reliability in reflecting general trends rather than cyclical factors or irregular variations in any particular year. This indicator was computed by fitting trend lines to the logarithmic values of the population and GNP/capita at constant market prices for each year of the ten-year period 1970-1979. This method of gauging economic growth has the advantage of using all available observations within the relevant time period and thus is likely to be more accurate than measures of economic change that simply take the difference between two points in time. Furthermore, percentage growth rates are much less likely to be severely skewed, a characteristic of measures of absolute change in GNP/capita, and therefore are less likely to be affected by estimated disturbances that are heteroscedastic (Hanushek & Jackson, 1977; Jackman, 1980).[18]

Two quantitative measures of social transformation also were selected. To tap economic inequality we use the Gini coefficient of income distribution for each country.[19] This measures ranges from 0 to 1, with 0 indicating a perfectly equal income distribution. Child mortality rate was chosen as the indicator of social well-being.[20] This measure has been used widely as

18. One of the basic assumptions of multiple regression analysis is that the variance of the error term is constant over all the values of the independent variable. The problem that arises when this assumption is violated is referred to as heteroscedasticity (Kerlinger & Pedhazur, 1973: 47-48).

19. Estimates of Gini coefficients are from Bornschier and Heintz (1979). An unfortunate aspect of these estimates is that they are not measured for the same year for all countries (date of measurement ranges from 1960 to 1973). Moreover, these estimates are not always measured for the same unit of analysis. Some are measured at the household level, others are at the individual level. These estimates are used here because they represent the most comprehensive data available. See Bornschier and Heintz (1979) for a fuller description of the methods used to calculate these estimates.

20. Data on child mortality are from the World Bank (1980).

TABLE 4
OLS Regression Analysis of Structural Role on Economic Development and Growth, Income Inequality, Social Welfare, and Measures of Urbanization

ln GNP/capita 1970	b	B	p	energy consumption	b	B	p
R^2 = .6150				R^2 = .6266			
1. SP-I	-0.968	(-.325)	.005	4. SP-I	-3426.919	(-.685)	.0001
SP-II	-2.287	(-.604)	.0001	SP-II	5135.806	(.819)	.0001
PERI	-2.876	(-1.07)	.0001	PERI	-5555.661	(-1.25)	.0001
R^2 = .7032				R^2 = .6454			
2. school enrollment	0.041	(0.839)	.0001	5. ln GNP/capita 1970	1330.831	(0.803)	.0001
R^2 = .7515				R^2 = .7485			
3. school enrollment	0.029	(0.588)	.0001	6. ln GNP/capita 1970	930.432	(0.562)	.0001
SP-I	-0.180	(-.180)	.55	SP-I	-2534.135	(-.506)	.0001
SP-II	-0.852	(-.225)	.03	SP-II	-3008.072	(-.480)	.0001
PERI	-1.079	(-.402)	.005	PERI	-2880.159	(-.646)	.0001
F-ratio (Eq. 3-2) = 4.35 3/73 d.f.***				F-ratio (Eq. 6-5) = 10.42 3/76 d.f.***			
change GNP/capita 1970-1979				% change GNP/capita 1970-1979			
R^2 = .6258				R^2 = .0824			
7. SP-I	-2162.293	(-.458)	.0001	10. SP-I	.419	(0.080)	.65
SP-II	-4558.814	(-.774)	.0001	SP-II	-1.144	(-.175)	.27
PERI	-4770.294	(-1.12)	.0001	PERI	1.033	(-.219)	.23
R^2 = .6258				R^2 = .0186			
8. GNP/capita 1970	1.047	(0.947)	.0001	11. ln GNP/capita 1970	.239	(0.136)	.23
R^2 = .9120				R^2 = .0920			

9.	GNP/capita 1970	0.908	(0.822)	.0001
	SP-I	-527.989	(-.111)	.06
	SP-II	-1191.518	(-.202)	.001
	PERI	-997.471	(-.235)	.005

F-ratio (Eq. 9-8) = 4.73 3/74 d.f.***

Gini coefficient

	R^2 = .1273			
13.	SP-I	4.764	(0.269)	.16
	SP-II	7.308	(0.342)	.05
	PERI	8.557	(0.518)	.01
	R^2 = .0938			
14.	ln GNP/capita 1970	-1.864	(-.306)	.02
	R^2 = .1310			
15.	ln GNP/capita 1970	-0.569	(-.094)	.64
	SP-I	4.130	(0.233)	.26
	SP-II	6.020	(0.282)	.19
	PERI	6.961	(0.422)	.14

F-ratio (Eq. 15-14) = .76 3/53 d.f. (n.s.)

12.	ln GNP/capita 1970	-.275	(-.157)	.38
	SP-I	0.161	(0.031)	.87
	SP-II	-1.774	(-.271)	.15
	PERI	-1.818	(-.385)	.15

F-ratio (Eq. 12-11) = 1.99 3/74 d.f.*

ln child mortality

	R^2 = .5873			
16.	SP-I	1.251	(0.392)	.001
	SP-II	2.473	(0.620)	.0001
	PERI	3.120	(1.091)	.0001
	R^2 = .7219			
17.	ln GNP/capita 1970	-.897	(-.850)	.0001
	R^2 = .7492			
18.	ln GNP/capita 1970	-.687	(-.651)	.0001
	SP-I	0.587	(0.184)	.06
	SP-II	0.903	(0.226)	.03
	PERI	1.129	(0.395)	.006

F-ratio (Eq. 18-17) = 2.72 3/75 d.f.**

NOTE: SP-II = Blocks F and G; SP-I = Blocks B, C, and D; Per. = Blocks E and H; Gini = Gini coefficients for income inequality; ln child mortality rate, 1970; % change = average annual change in GNP/capita 1970-1970; GDP 60-70 = change in GDP/capita 1960-1970; energy consumption = annual use of energy in million metric tons of coal equivalent.

*** Significant at .25 probability level.**

**** Significant at .05 probability level.**

***** Significant at .01 probability level.**

an indicator of access to basic health care and has the advantage of being more completely reported than infant mortality.

Table 4 reports the results of regression models relating structural roles to these development indicators. The equations focus on stratum membership as a predictor of development controlling for the possible confounding influence of 1970 secondary school enrollment and 1970 gross national product per capita. These two control variables are used because of the importance placed on them by "modernization theory" explanations of development (Delacroix, 1977; Snyder & Kick, 1979). For each dependent variable a series of three equations is presented: The first includes three of the four dummy coded variables as the only predictors of development.[21] The second utilizes the control as the sole independent variable, and the last includes both structural roles and the control variable. An F-ratio is calculated comparing the second and third equations in each set. F-ratios measure the statistical significance of the differences in explained variance (R^2) between the restricted model (including only the control variable) and the unrestricted model (including control plus structural role). It should be noted that this is a conservative test for the effects of structural role on the various measures of development, as the control variable is assumed to explain all the predictive power it shares with the structural variables.

Results

Models 1, 2, and 3 measure the effects of 1970 secondary school enrollment and structural position on 1970 GNP/capita. Taken by themselves, the structural role variables explain better than 60% of the variance of logged GNP/capita. As the dependency/world-systems perspective would predict, membership in any noncore stratum serves to substantially depress the level of economic development. Belonging to the first

21. Exclusion of one of the four dummy-coded position variables is necessary to derive unique estimates of each (Miller & Erickson, 1981). For substantive interest, the core was chosen as the omitted category. Thus, the estimates for each of the remaining position variables are interpreted as deviations resulting from occupying a structural position other than the core.

semiperiphery has a negative effect on GNP/capita; membership in the second semiperiphery increases that dampening effect; location in the periphery strongly inhibits a country's level of GNP/capita. The strong negative coefficients for economic development (and economic growth in subsequent equations) are consistent with the image of a "widening gap" (Barnett & Muller, 1974) in a world-economy characterized by the "persistent poverty" of the periphery (Beckford, 1972).

Model 2 indicates that secondary school enrollment alone explains 70% of the variation in GNP/capita and exhibits a strong positive effect. When the three structural position variables are entered (Model 2), they contribute nearly 5% additional explained variation. The F-ratio of the two model R^2s indicate that this is a statistically significant addition. Once again, an examination of the parameter estimates indicate that, compared to the core, being in each of the other structural positions has an expected negative effect on level of GNP/capita. Moreover, the relative magnitudes of the standardized coefficients vary in a manner readily interpretable by dependency/world-systems perspective. The strong semiperiphery has only a marginal dampening effect, whereas location in the periphery strongly inhibits a country's level of GNP/capita.

Models 4, 5, and 6 indicate that a similar pattern of effects is evident when an alternative measure of economic development is used. Level of energy consumption has been used by some researchers as a nonmonetary measure of the development of economies (Chase-Dunn, 1975; Rubinson, 1976). The F-ratio of the models' R^2s and the pattern and strength of the parameter estimates indicate strong support for the dependency/world-systems perspective. Indeed, the negative influence of occupying a peripheral position on energy consumption is stronger than the positive effect of GNP/capita.

Models 7, 8, and 9 test the effects of structural position on the growth of GNP/capita during the 1970's net of the effect of initial level of economic development in 1970.[22] These

22. Secondary school enrollments from 1970 were initially used in combination with 1970 GNP/capita as control variables for the reasons mentioned above.

models closely replicate the analyses of Snyder and Kick (1979).[23] Panel 7 reveals a pattern similar to the ones found in Equations 1 and 4. This equation explains better than 60% of the variance in the economic growth variable. Consistent with the expectations of the dependency/world-systems approach, all noncore strata negatively affect the absolute change in GNP/capita in a strong and substantial manner. Once again, the relationship is a monotonic one with the first semiperiphery possessing the smallest negative effect, the second semiperiphery a larger one, and the periphery an enormous dampening effect on economic growth.

Panels 8 and 9 indicate that even after controlling for the initial level of GNP/capita, the inclusion of the structural position variables adds significantly to the explained variance. Although the parameter estimates are small, all three noncore structural positions continue to affect negatively the absolute change in GNP/capita.

The use of absolute differences in GNP/capita between two time points as a dependent variable in such a test has been criticized (1) for being susceptible to "noise"—the short-term fluctuations of particular national economies for given years—and (2) as violating basic assumptions concerning the use of

Because of the high correlation between these two variables (.84), however, the inclusion of both as controls in the same model leads to problems with multicolinearity. Multicolinearity arises when the independent variables in regression equation are highly correlated with each other. In the extreme instance, where these predictor variables are perfectly correlated with each other, the matrix algebra necessary to derive correlation coeffecients cannot be performed. Whenever this correlation between independent variables is high, as for school enrollment and economic level in this case, regression analysis will not provide a clear picture of the relationship between them and the dependent variable (Kerlinger & Pedhazur, 1973: 396). Thus, one of the two control variables had to be excluded. As level of GNP/capita has been most commonly used as a control of countries' initial economic levels, and because of substantive linkage to the question being addressed, it was retained as the sole control variable.

23. Unlike Snyder and Kick (1979), who tested the effects of a ten-block model on growth of GNP/capita for a fifteen-year period, we look at the predictive power of the four structural positions derived in the earlier analysis. Because we use fewer categories of positions than Snyder and Kick, we would expect to explain less of the variance of the selected dependent variables and to arrive at more modest model R^2s.

ordinary least squares regression (Jackman, 1980).[24] For these reasons, the effects of structural positions on economic growth were tested using average annual percentage of growth in GNP/capita as the dependent variable.[25]

Equation 10 shows that when the variables for structural role are regressed on the percentage change in GNP/capita, only 8% of the variance was explained. Although this may seem like a low R^2, it is considerably higher than the variance accounted for using logged GNP/capita as the control variable. An interesting pattern of parameter estimates appears for Equation 10. Weak semiperipheral and peripheral countries continue to show substantially slower growth rates than the core. The strong semiperiphery, however (after controlling for initial level of GNP/capita), has a growth rate nearly identical to the core's. This finding is consistent with world-systems arguments about dependent development in the semiperiphery (Cardoso, 1973; Evans, 1979) and squares well with other recent empirical findings (Jackman, 1982; see Figure 1).[26]

Panel 11 reveals that logged GNP/capita explains virtually none of the variation in economic growth and that the inclusion of the structural position variables increases the explained

24. See Jackman (1980) for a discussion of the possible effects of heteroscedastic error terms on parameter estimates.

25. In a research note on the measurement of growth rates in cross-national research, Jackman (1980) criticizes Snyder and Kick's (1979) use of absolute change in GNP/capita as a dependent variable. He argues that GNP/capita is usually highly skewed and, thus, the estimated disturbances in a predicted model using this variable are likely to be heteroscedastic. As a result, the parameter estimates are likely to be inefficient, and conventional tests of their statistical significance are likely to be biased. Using a simple test recommended by Johnson (1972), Jackman found the rank-order correlations between the absolute value of the residuals and GNP/capita 1960 to be strong and significant (.43). Thus, he concluded "that the disturbances in their model are not homoscedastic or constant across values of the explanatory variable" (1980: 609). Employing the same rank-order correlation test, we found the association between GNP/capita 1970 and the absolute value of the residuals to be weak and insignificant (.156). This same test was used to test for heteroscedasticity in all models presented in Table 3. None of the variables tested was found to be even moderately correlated with the residuals.

26. We already have noted the large number of oil-exporting countries in this role. Obviously petroleum sales during the 1970's would explain, at least in part, this economic growth.

variance by 6 percent. As in equation 10, the first semiperiphery's effect on economic growth is similar to the core's.

Because development includes more than economic growth, we also tested the effects of structural positions on indicators of inequality and social welfare.

Panels 13, 14, and 15 examine the effects of strata membership on income inequality. Similar to the regression results using average annual growth as a dependent variable, none of these models explains a large proportion of the variance of the Gini coefficients. Once again, the structural role variables account for more of this variance than does logged GNP/capita. In this case (although adding the structural position variable does increase the explained variance by 4%) the F-ratio of the difference between the two model R^2s is insignificant. Nevertheless, although they are not quite as large as in previous equations, the parameter estimates for structural roles display a pattern consistent with our theoretical expectations. All noncore positions are positively related to income inequality, with the strongest relationship between inequality and strata position found in the periphery.

Finally, this brings us to models in which social welfare is the dependent variable. Panels 16, 17, and 18 exhibit the results of the regression analysis on logged child mortality. Structural roles alone account for about 59% of this variance. Parameter estimates for each equation follow a familiar pattern. All are positive, indicating lower child mortality levels in the core than in all other categories. The magnitude of the estimates increases as one moves from first semiperiphery to second semiperiphery to periphery. Panel 17 indicates that the logged measure of economic level by itself explains 72% of the variance and, as expected, is negatively related to child mortality. Adding structural position to the model increases the explained variance by 3% (significant at the .10 probability level). The parameter estimates are reduced, but not substantially in the unrestricted model. Both semiperipheries have somewhat stronger relationships to child mortality than the core (net of economic development). The periphery, however, has a strong positive relationship even when controlling for

1970 GNP/capita. Clearly, peripheral strata membership increases suffering and slows "development" using this measure of social welfare. This provides more evidence for viewing the periphery as the extreme case of "the development of underdevelopment."

Discussion and Conclusion

Recent empirical treatises examining the influence of international dependence in the world-economy have specified and attempted to measure dependency as a variable property of individual countries. We argue that these measures of dependency do not accurately capture the theoretical essence of this concept as it is used in the political economy of the world-systems literature. The relational aspect of dependence is critical. World-systems analysts are most concerned about the structural positions that various countries and regions hold in a hierarchically ordered international economy. Following the pioneering work of Snyder and Kick (1979), we used multiple network analysis of international interactions in an attempt to empirically derive the structure of the world-economy. Unlike Snyder and Kick, however, attention was limited here to trade flows of various commodity types, thus focusing attention on the economic base of the international system.

A blockmodel analysis of the trade patterns of 86 noncentrally planned countries was conducted. The general decomposition patterns, as well as the direction and magnitude of the trade of each commodity type between blocks, were used as evidence that the eight-block division that resulted could be interpreted as four distinct structural positions in the world-economy. Further support for this interpretation was obtained from analyses of the effects of occupying a structural position on a nation's economic strength and growth, income inequality, and level of social welfare. In all of the analyses the effect of strata membership on the various development indicators was consistent with patterns expected by variants of dependency/world-systems theory.

Although this article does address a number of important questions related to conceptualization and measurement in dependency/world-systems research, it is necessary to point to some limitations. Because of lack of data, it was impossible to look at the trade patterns of Eastern European and other Soviet-aligned centrally planned economies. This precluded our research from bearing on the debate about their position in the world economic system—or, as some have argued, their status in a separate socialist world-economy (see Chirot, 1977; Frank, 1977; Steiber, 1979). The cross-sectional nature of our structural role variable is a further limitation. World-systems analysis usually is directed to studies of social change in which the system itself is open to dynamic structural alterations. An interesting question for future research might be the stability or fluidity of the structure we have derived. Examining the pattern of trade of similar commodity types at another point (perhaps 1960 or 1980) using the same methodology would be useful in addressing this issue. Moreover, a longitudinal analysis could address questions about the differences between ascending and descending nations in the world-economy and the possible influence of period effects on countries occupying different structural positions in the system. These are but a few of the issues that a replication of this research using data from another point in time may be able to address.

A final point needs to be made. We feel strongly that cross-national quantitative research can legitimately extend our knowledge of world-systems structure and dynamics. Our findings indicate that it is possible to derive empirically a structure of exchange in the international system that conforms to the expectations of a political economy of the world-systems approach. Furthermore, we find that the structural position that a country occupies can restrict or promote patterns generally associated with national development. This does not argue, however, for the primacy of "external" world-system factors over "internal" regional or historical effects as the ultimate explanation for social change. Indeed, we feel that posing the question of the importance of factors affecting development in such stark dichotomies actually obfuscates the complex interrelatedness of processes operative at the various levels of the modern world-system. In other research we have emphasized the importance of the timing of incorporation of a country into the world economy and argued that the initial level of indigenous factors such as natural resources, transportation systems, and political organizations are crucial for subsequent national development (Nemeth & Smith, 1983). There is a complex interplay between the particular colonizing country and the "internal" social structures that evolve only partially in response to these exogenetic influences. Clearly the relationship between each set of factors is complex and not easily separated by cross-sectional, multinational analyses. For this reason, a full understanding of the complexity of the modern world-economy is only possible by complementing the type of analysis presented here with in-depth comparative case studies.

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