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Structure and Dynamics of the Global Economy: Network Analysis of International Trade 1965-1980*

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Abstract

This article reports results from a quantitative network analysis of international commodity trade flows designed to measure the structure of the world economic system and to identify the roles that particular countries play in the global division of labor. It improves on previous network-analytic studies of the world-economy in two ways. First, by using a newly developed measure of regular equivalence, this operationalization of a nation's roles in the international system is methodologically superior to previous work. Second, we have built a dynamic aspect into the analysis by examining international trade networks at more than one point in time (1965, 1970, and 1980). This allows us to answer questions about change both in the overall structure of the world-economy and in the positions of particular countries in the system. Our findings generally conform to the theoretically expectations of the world-system perspective as well as qualitative descriptions of recent changes in the international division of labor.

What is the structure of the world-economy? How does it change? These are two basic issues in international political economy. The world-system approach suggests that the structure of the global system, and the roles that countries play within the international division of labor, is crucial in understanding a wide array of social, political, and economic changes within particular societies. The basic claim is that international connections, roles, and relationships are important independent variables in any causal analysis purporting to explain various dimensions of development within countries (on the general advantages of this structural approach, see Tilly 1984).

While the premise that the global system plays a crucial role in most types of social change is now widely accepted, there is much less consensus on its

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fundamental organizing principles and laws of motion. Neoclassical economic theories that are based on comparative advantage (Klein, Pauly & Voisin 1982; Linnemann 1966), international relations approaches that stress geopolitics (Keohane 1984; Thompson 1983), and world-system perspectives that emphasize "unequal exchange" (Amin 1974; Frank 1979; Wallerstein 1974, 1980) offer sharply contrasting models of the international system.

Social network analysis provides powerful tools for formally describing and testing theories of complex interaction systems. Ultimately, these tools may provide a means of scientifically adjudicating between competing images of international systems structure and dynamics. For example, the five empirical components addressed by the various theories of international economic systems are: (1) the constituent economies of states (or cities, hinterlands, and regions) that produce, distribute, consume, and exchange exports and imports; (2) links or directed pairwise flows between these economies/polities, and country level and international policies that regulate these flows; (3) the political-economic networks formed by these links or pairwise flows; (4) the positions occupied by constituent economies/polities in these networks; and (5) the structure of these networks as patterns of flows between positions. Network analyses of the international economic system are uniquely equipped to map each of the last four configurations. If performed at multiple time-points, network analysis also enables researchers to examine change in each of these components as well. Conceivably, it could lead to empirical tests of alternative theoretical models of the global system.

This article's more circumscribed goal is to work within the political economy of the world-system tradition and use the results of a network analysis of commodity trade flows to assess some middle-range propositions related to international trade. This assessment will demonstrate how network methodology can help adjudicate some current theoretical disputes in world-system analysis.

Network analysis is particularly appropriate in testing world-system theories that stress the importance of global economic exchange. Wallerstein (1974, 1980), Chirot (1977), Frank (1979) and others have attempted to provide sophisticated historical descriptions of the origin, operation, and organization of the modern global economy. Unlike early conceptions of dependency (e.g., see Frank 1969; for a review, see Chilcote 1974) that highlighted the particular two-way relationships between imperial metropolitan countries and imperialized satellite countries, the world-system approach stresses the importance of capturing the unity and structure of a hierarchic, differentiated world economic system. While the focus of this perspective remains on "external" international conditions affecting national development, the emphasis is on "the consequences of occupying a given structural position within the world-system as a whole" (Evans 1979a:15).

Formal properties of the global economic system are implicit in qualitative descriptions of the world-system. For instance: (1) the major theorists argue for an intermediary stratum of semiperipheral countries between core and periphery as "a necessary structural element in the world economy" (Wallerstein 1974:349); (2) there is fairly wide agreement that global inequality is maintained, at least in part, through unequal exchange, variously defined (Amin

1974; Emmanuel 1972), in international trade circuits; and (3) most theorists agree on the possibility of the mobility of countries in the global system through "dependent development" (Cardoso 1973; Evans 1979b).

While there is consensus among proponents of the world-system approach on the general validity of Wallerstein's stratified model of core/semiperiphery/periphery, there is considerable dispute over: (1) The existence of more than three strata (Nemeth & Smith 1985; Schott 1986), and whether such strata are formed by discrete clusters of countries (e.g., Wallerstein 1974) or more of a continuum (e.g., Chase-Dunn 1989). (2) The distinguishing characteristics of membership in each stratum (see Bollen 1983; Evans 1979a; Snyder & Kick 1979; Steiber 1979). A related issue is the confusion between groupings based strictly on role and those based on region or spatial clusters of trade partners (particularly apparent in studies by Snyder and Kick [1979] and Schott [1986]). (3) The assignment of particular countries to these strata. In the major monographs by Wallerstein, Frank, and Chirot, for example, the classification of particular countries into core, periphery, and semiperiphery varies considerably (see also discrepancies in Nemeth & Smith 1985; Schott 1986; Snyder & Kick 1979). (4) The nature of unequal exchange between these positions and its theoretical underpinnings (Bunker 1984; Mandel 1975; Steiber 1979; see discussion in Firebaugh & Bullock 1987). (5) The identification of mobility patterns on a country by country as well as a positional basis (Arrighi & Drangel 1986; Chase-Dunn 1983), including the extent of mobility of countries through "dependent development" (Cardoso 1973; Evans 1979b). (6) The recent emergence of a "new international division of labor" with the flight of capital from the core to the Third World, based on the receiving countries' lower production and labor costs (see Bluestone & Harrison 1982; Caporaso 1981; Fröbel, Heinrichs & Kreye 1980). (7) The shift from a more hegemonic structure with one (e.g., the U.S.) or a few highly dominant countries in the top stratum, to a more multicentric core stratum, with a number of countries converging over time in the top stratum (Arrighi 1982; Chase-Dunn 1989; Wallerstein 1979).

THE NETWORK APPROACH (GLOBAL BLOCKMODELING)

Network analysis of exchange patterns provides a rigorous way to determine the empirical status of world-system models and arbitrate some of the theoretical disputes. Measurement of a country's position in a network maps onto a matrix of positional proximities between pairs of countries. This matrix maps in turn via optimal scaling onto a smallest n-dimensional positional space. The question of dimensionality of the stratification of countries (1 above) is answered by the number of principal dimensions of the positional space. Whether the stratification is more of a continuum or a clustering of distinct types is answered by the "clusterability" of countries in this space. A blockmodel of relations between positions (blocks) can then be characterized in terms of aggregate relationships between countries in the respective blocks or positions (details of these procedures are provided later). Blockmodeling (deriving from Lorrain & White 1971), as the principal method for the network analysis of positions, consists of two steps: the blocking or clustering of actors on the basis of patterns in their network ties, and the description of aggregate relations between the positions or blocks. Analysis of the world economic trade flow between positions also allows rough assessment of patterns of unequal exchange (4 above) — such as asymmetry in trade flows — between positions.

Debates about the mobility of countries in the world economy (3, 5, 6 and 7 above) can be addressed by network measurement at different time points. These questions can be answered whether the formal structure of stratification is continuous or discrete (ranked or partially ordered positions). In the former case, we measure mobility quantitatively, or we break the continuum into strata and assess mobility between strata. In the latter case, we evaluate mobility qualitatively by assessing countries that change over time from one discrete position to another.

The nature of the distinguishing characteristics of membership in each stratum (2 above) — and the problem of distinguishing positions based on spatial proximity from those based on more global similarities in patterns of exchange — is of central theoretical importance. Characteristics of stratum membership can be assessed empirically and also form the crux of positional network analysis, which leads back to the basic issue of how positions are identified for blockmodeling.

There are two alternative bases for measuring positional proximity in a network. Snyder and Kick (1979) use a measure of the degree of structural equivalence between countries, based on similarity in their volumes of trade on each commodity for the *same identical* trading partners. This first method for determining blocks based on structural equivalence (White, Boorman & Breiger 1976) is associated with the CONCOR algorithm (Breiger, Boorman & Arabie 1975). The structural equivalence definition of network position is too narrow to capture global stratification in the world-economy. The spatial clusters in Snyder and Kick's (1979) analysis, for example, indicate greater trade with counterparts within a region than a lack of potential counterparts in other regions. These clusters do not necessarily reflect valid differences in terms of global patterns of stratification.

The more general approach taken here follows White and Reitz's (1983) derivation of regular equivalence between countries, based on similarity in their volumes of trade on each commodity for *recursively equivalent* trade partners (that is, "substitutable" trade partners which in turn have similar volumes of trade on each commodity with *their* recursively equivalent trade partners). The more general approach allows us to identify more global stratification patterns. This method, based on regular equivalence, is associated with the REGE algorithm (Reitz & White 1989; see Sailer 1978 for a related method; MacEvoy and Freeman 1987 for the implemented version of the algorithm). Schweizer (1988) has shown in empirical examples how CONCOR or structural equivalence conflates spatial proximity with global role structure, while REGE or regular equivalence precisely identifies the more generic structural positions in a network.

Previous Research and Substantive Issues

Two path-breaking articles of 1979 were the first explicit attempts to use the network approach to examine the world-system. The better known and more widely cited effort was an article by Snyder and Kick (1979). They used blockmodeling with CONCOR to proceed from raw data on presence or absence of international links, to a structural image of a hierarchic international system, and finally arrived at a multiple regression test of the effects of world-system position on indices of development. The other article by Steiber was much more modest analytically. While he did not actually run data through network algorithms, his simple analysis focusing on broad types of commodity trade showed how a careful examination of quantities and patterns of interblock flows could clarify processes like unequal exchange.

Snyder and Kick's (1979) comprehensive research design set the standard for later studies. Examining data on international exchanges circa 1965, these authors argued that their results provide quantitative evidence for Wallerstein's model of a tripartite division of countries into core, periphery, and semiperiphery (10 subblocks were also identified within these blocks). Regression analysis provided further support for the world-system model. Membership of countries in the three distinct strata is strongly related to their performance on a number of indices of development.

Although this first attempt at systematically using network analysis to measure world-system structure was an innovative step forward, Evans (1979a) reminds us that it must be considered only the "first cut" of such research. Snyder and Kick's analysis has been criticized on methodological grounds (Jackman 1980), for allegedly misclassifying a number of countries (Bollen 1983), and for inadequately operationalizing key elements of world-system theory (Nemeth & Smith 1985).

The deficiencies in the Snyder and Kick study stimulated a recent attempt to formulate a better blockmodeling of international system structure. While the former examined presence or absence of four types of international relationships (trade, military interventions, treaty memberships, and diplomatic exchanges), Nemeth and Smith (1985) focused exclusively on flows of types of international commodity trade. They argued that the world-system approach stresses the world *economy* as the basic unit of analysis, and that international trade should be subjected to analysis in its own right. Their use of data on the magnitude of different types of commodity exchange allowed them to assess directly the roles that importing and exporting countries play in the global division of labor. The results, while agreeing in broad outline with Snyder and Kick, differed in both the classification of certain countries into world-system roles and in the overall layered image of the international system that is derived. The partitioning of the data suggested the presence of *four* strata in the world-economy — core, periphery, and strong and weak semiperipheries. Additionally, the specific groupings of countries within particular blocks appeared to have more face validity in Nemeth and Smith's follow-up study than in the original Snyder and Kick classification. For example, Brazil and Mexico were classified as members of the strong semiperiphery in the 1985 article, while Snyder and Kick's research placed both countries in the periphery.

The problem with the use of CONCOR by Snyder and Kick, as well as Nemeth and Smith, is highlighted in Schott's (1986) careful decomposition of world trade patterns into three types of effects: total volume of exports and imports as expansiveness and attractiveness attributes of countries, and the particular relation that two countries have as trade partners as a deficit or excess over that expected from their export and import volumes. Analyzing the particular relation in terms of a CONCOR-like factor analysis, the resultant blocks are almost purely political (communist/commonwealth/other) and regional (e.g., Persian Gulf, Indian subcontinent, Mediterranean, West Europe). So, the structural equivalence of countries in terms of their trade patterns is highly confounded with geography.

Steiber (1979) never used formal network analysis, but relied on the network metaphor in describing empirical patterns of commodity trade. Instead of measuring structural position using an algorithmic technique, he defined core, periphery, and semiperiphery on a priori substantive criteria. His classification was gross; for instance, he lumped all the European community into the core and all Latin America and Africa into the periphery, groupings which limited the analytical strength of his findings. But, by setting up trade density matrices based on the actual trade of very general types of commodities between the three blocks, Steiber (1979) was able to draw some conclusions about the exchange relationships within and between the world-system strata. For instance, he found that his core countries trade much more heavily with each of the other blocks and have a very high level of internal commerce (most of total world trade is between core states), while his periphery's overall level of exchange was very small and heavily centered in the core. He also found some trade gradients across world-system strata for raw materials and finished products that suggested a pattern of unequal exchange, leading to the conclusion that "the core, through trade, exploits the semiperiphery and the periphery, and the semiperiphery, in turn, exploits the periphery" (35).

Steiber's research strategy, however crude, points toward a type of structural analysis that Snyder and Kick (1979) eschewed in that they used data only about presence or absence of intercountry trade and other links. We can calculate more precise trade density matrices by reaggregating country-level data on patterns of trade to reflect flows between strata in the international economy. This information is ideally suited to measure the pattern and extent of asymmetrical commodity flows and provide empirical assessments of theoretical disputes on unequal exchange.

The notion of unequal exchange has been an important and controversial issue in international political economy since the early 1970s. Early formulations by Emmanuel (1972) and Amin (1974) argued that the essence of core exploitation of the periphery lies in wage-differentials, and that this inequality is transmitted through the unequal trade of low-value and less-processed goods from the periphery in exchange for expensive finished products from the core. Mandel (1975) accepted the idea that "the average productivity of labor" between countries is crucial, but categorically rejected the claim that particular commodities are intrinsically important, since it is not the material product itself that is crucial, but the labor-process that produces it. This labor basis of unequal exchange was directly challenged by Bunker (1984) who argued that the costs of environmental degradation in peripheral economies dependent on extraction should also be considered. Bunker explains,

> I believe that the unbalanced flows of energy and matter from the extractive peripheries to the productive core provide better measures of unequal exchange in a world economic system than do flows of commodities measured in labor and prices. (1018)

This approach returned to an emphasis on particular commodities, arguing that extractive product flows are important in core exploitation of the periphery for the extrinsic reason that they lead to environmental degradation. A final wrinkle in the debate on the nature of unequal exchange came from recent arguments about the emergence of a "new international division of labor" in the past decade or so (Fröbel, Heinrichs & Kreye 1980). A growing literature shows that there has been a basic restructuring of the global economy with "capital flight" from the advanced core countries (see Bluestone & Harrison 1982) and the beginnings of large-scale but low-wage manufacturing in the Third World (Caporaso 1981).

Related to this last point is the entire issue of mobility of countries in the international system. Clearly, some countries will rise in status while others are bound to fall. However, systematic attempts to gauge this movement are few. Chase-Dunn's (1983) effort is one of the more complete attempts to survey upward and downward movement throughout the system, but classification into core, periphery, or semiperiphery is based on a vaguely measured definition of production mixes. Arrighi and Drangel (1986) offer a more explicitly operationalized criteria for distinguishing the world-system levels, but their analysis is based on the extremely dubious assumption that GNP per capita is the key measure.

Our dynamic analysis of the international system using trade data for three time points should provide a more rigorous image of the upward and downward mobility of particular countries in the global economy. The dynamic nature of our analysis also allows us to look at changes in the size and membership of world-system strata themselves. This is particularly relevant in the years between 1965 and 1980 because it is a purported period of hegemonic decline. Patterns and cycles of hegemony in the world-system are an important theoretical and empirical issue in international political economy (Arrighi 1982; Bousquet 1980; Schurmann 1974; Wallerstein 1974). Only three or four countries (e.g., Spain, the Netherlands, Great Britain, and the U.S.) have achieved a level of such political and economic dominance in five hundred years of the capitalist world-economy. During these periods, the "hegemone" enjoys unique prosperity, power, and technological innovation, and the world as a whole tends to have more politico-military stability (therefore "Pax Britannica" and "Pax Americana") (Arrighi 1982). But, historically, hegemonic domination has been transitory, leading to a predictable pattern of economic and political decline for the hegemone (Goldfrank 1983; Wallerstein 1979) and the reemergence of a competitive multicentric core (Amin et al. 1982). The present study provides a distinctive opportunity for addressing hegemony decline in a rigorous way: Was the U.S. in a unique structural position in 1965? Did it show patterns of decline thereafter? Was there a movement toward a more inclusive, multicentric core in recent years?

Research Design

This project uses the same data on commodity trade flows used by Nemeth and Smith (1985), but extends this earlier work by (1) using recent refinements in network-analytic techniques that allow a more direct measure of role equivalence, (2) examining the structure of international economic exchanges at multiple points in time, and (3) devoting more attention (following the lead of Steiber) to the pattern of commodity movement within and between international strata in an effort to understand patterns of imbalanced exchange. The longitudinal design allows us to measure changes in overall world-system structure and answer questions about the upward or downward mobility of individual countries in the global economy. The dynamic aspect of the analysis provides results that bear on a number of issues involving stability and dynamism in the contemporary world division of labor that were previously beyond the purview of quantitative research. The more direct measurement of the theoretically relevant concept of world-economic role yields country classifications that more accurately sort countries into structural positions. Finally, the careful analysis of interblock commodity flows allows rough assessments of the validity of various arguments about asymmetrical trade and global inequality.

Blockmodeling, like any other analytic technique, will only yield substantively meaningful results if the data analyzed operationalize theoretically relevant aspects of social structure. In our research, attention is focused exclusively on specific types of economic exchange. While it is plausible to claim (as do Snyder & Kick 1979) that military, diplomatic, or cultural ties are equally crucial determinants of the international system, our decision to limit analysis to trade circuits is consistent with the major thrust of world-system analysis. Despite disputes on other issues, there is broad consensus among most proponents of this approach that the basic unit of analysis is the world-economy, that materialist impulses arising out of European capitalism initially created the modern world-system, and that unequal exchange of value becomes a crucial mechanism reproducing the structural division of labor underlying global inequality (Frank 1979; Wallerstein 1974, 1979, 1980). Describing the emerging structure of international capitalism, Chase-Dunn and Rubinson (1977) highlight the importance of

> a territorial system of exchange of fundamental commodities . . . 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. (454)

This tendency to place greater emphasis on the economic basis of world-system structure — where other types of exchanges and patterns are assumed to be derivative of the material infrastructure — drew early criticism as reductionist "neo-Smithian" Marxism (Brenner 1977; Skocpol 1977). Recent formulations of the global system have stressed alternative models giving more weight to world politics and the interstate system (Chase-Dunn 1989; Evans & Stephens 1988). While these approaches may provide a more complete conception of international political economy, the present research operationalizes a more strictly economic analysis, which can be defended with recourse to interpretability and the scientific goal of parsimony. In the present work we also do not include certain theoretically important economic flows such as capital or credit, but only because such data are not available on a country-to-country basis.

DATA: COMMODITY TRADE STATISTICS

World-system analysts emphasize the importance of several kinds of commodity trade in determining stratum membership and in promoting "unequal exchange" in the multitiered world economy (Emmanuel 1972; Frank 1969; Galtung 1971). In particular, researchers have argued that commodity trade specialization, particularly in relatively unprocessed raw materials, may be characteristic of economic underdevelopment in some peripheralized regions, while core trade is more diversified and includes a large volume of highly processed exports (Firebaugh & Bullock 1987; Jaffee 1985; Steiber 1979). Recent attempts to operationalize concepts about differential international product flows use the United Nation's *Commodity Trade Statistics* (Delacroix 1977; Firebaugh & Bullock 1987; Nemeth & Smith 1985; Steiber 1979; Stokes & Jaffee 1982). Our study also draws on this source. The *Commodity Trade Statistics* are compiled annually and contain matrix-style information on thousands of specific types of products classified by country of import and export. Flows are reported by value in U.S. dollars. Although some countries invariably fail to provide all the relevant data, and there may be some differences cross-nationally in the way statistics are collected and processed, the information is surprisingly complete.[1] The data used in this article are from this source for the years 1965, 1970, and 1980 (United Nations 1976) and include complete data on over 100 countries.[2] Import data are used since they are believed to be more accurate than export figures (see Durand 1953; Linnemann 1966). As a partial control for huge differences in country size, only countries with populations greater than one million were selected for analysis. For a variety of reasons, some countries failed to report commodity trade data for each year. This reduced the number of countries to 77 for 1965, 96 for 1970, and 82 for 1980. In our final analysis we only look at the networks of exchange between countries for which data are complete at all three time points, reducing the number to 63.

In order to do the actual network analysis, a limited number of matrices on commodity flows need to be selected from the thousands available in the data. How is this to be done? Following the logic of Nemeth and Smith (1985), we begin with a notion that world trade patterns may reflect a global division of labor in which core-periphery differences are partially manifested in the relative level of processing of their exports, as discussed earlier. The raw trade data are coded following the conventions of the Standard International Trade Classifications (SITC), which are hierarchically ordered from five-digit (extremely specific) to one-digit (very general) commodity types. The broad one-digit categories appear to provide a simple way of operationalizing the differences between raw materials and finished products (Steiber 1979), but there is lack of homogeneity within these categories. Broad headings like "manufactured goods classified chiefly by material" or "crude materials, inedible, except fuels" include a wide range of products, varying from simple ones that require minimal processing to products synthesized in capital intensive high-technology settings. To examine more homogeneous categories, two-digit classifications are used in this study. While these still may contain some internal heterogeneity (see Stokes & Jaffee 1982), we decided to use this level of aggregation because measurement error and misclassification becomes increasingly problematic as researchers move to the more specific SITC categories (Durand 1953).

Expanding the research to SITC two-digit commodities enlarges the possible information to 55 matrices of trade flows. While a simultaneous analysis of all 55 commodities is technically possible, it would present major computation difficulties. How can a few theoretically relevant commodities be isolated? One possibility is to pick products that vary according to "level of processing" scales devised by previous researchers (Delacroix 1977; Firebaugh & Bullock 1987) Stokes & Jaffee 1982). But these indices have been criticized as imprecise and difficult to operationalize (Nemeth & Smith 1985; Firebaugh & Bullock 1987; Smith & Nemeth 1988). An alternative strategy is to use a factor analysis on all the bilateral exchanges between countries to find bundles of commodities that tend to move together in the international economy. Such research demonstrates that five empirically defined clusters of commodity trade sort out into a pattern that is interpretable along a rough two dimensional scale contrasting production with extraction and capital-intensive versus labor-intensive processing. This finding and the details of its derivation are discussed in detail elsewhere (Smith & Nemeth 1988). For each of these clusters we chose the three commodities that consistently loaded most highly on each of the five factors. The 15 trade variables selected represent the major types of global commodity exchange:

High Technology Heavy Manufacture
- Machinery — nonelectrical
- Artificial resins, plastics, cellulose esters and ethers
- Manufactures of metal, not elsewhere specified

Sophisticated Extractive
- Paper, paperboard, and articles of paper pulp
- Pulp and waste paper
- Gas, natural and manufactured

Simple Extractive
- Oil seeds and oleaginous fruit
- Animal oils and fats
- Cereals and cereal preparations

Low Wage/Light Manufacture
- Articles of apparel and clothing accessories
- Footwear
- Travel goods, handbags, and similar containers

Food Products and By-products
- Meat and meat preparations
- Dairy products and bird's eggs
- Crude animal and vegetable material, not elsewhere specified

This information on the 15 types of trade commodities, as exchanged between all country dyads, was collected for 63 countries for all three years. Thus, for each ordered pair of countries, there are data on the magnitude of trade for 15 commodities. This constitutes the raw data for our network analysis.

METHODOLOGY: GENERALIZING BLOCKMODELING ANALYSIS

We should emphasize that this analysis of positions in the world economy is done strictly by examining the network of commodity trade flows. No aggregate country statistics such as GNP, production statistics, or other national attributes are used. The basic network analysis technique we employ is that of blockmodeling (Arabie, Boorman & Leavitt 1978).

But, as previously noted, our analysis differs from most earlier blockmodeling analyses in that it uses a more general approach than that based upon correlating the rows and columns of the relation matrices. Consider, for example, two storekeepers each with two employees. Blockmodels faithfully operationalizing structural equivalence (Noma & Smith 1985) will identify four blocks: one for each of the two sets of employees (in each set, employees are structurally equivalent in that they have ties to the same boss), and one for each of the storekeepers. Regular equivalence, however, will identify only two blocks: one being the set of storekeepers, and the other the set of employees. Because the regular equivalence solution to the problem of identifying blocks (White & Reitz 1983) is not based on R^2 as a goodness-of-fit measure, Noma and Smith's benchmark for evaluating blockmodels cannot be employed. Instead, Reitz and White (1989) provide an algorithm for a precise mathematical model of regular equivalence that directly measures the degree of approximation to regular equivalence for each pair of points in a network.[3] Optimal scaling allows matrices of these measures to be represented as spatial configurations of distances between points (Kendall & Stuart 1961), and is also known as correspondence analysis (Greenacre 1984), dual scaling (Nishisato 1980), and canonical analysis (Gittens 1984). Hierarchical clustering is applied to these distances to determine blockings.

We will discuss methodological alternatives at each of the four basic steps in our analysis of the structure of the modern world-economy. The first step applies the relational distance algorithm (REDI, see White & Reitz 1989)[4] to the trade data. There are several reasons to prefer the raw (dollar amounts of trade on commodities) over normalized trade data (dividing entries by row or column totals, by total exports and imports, or by GNP) in this analysis. The principal reason is that we conceive of the magnitudes of trade flows as part of the phenomena of position in the world system (small countries, of course, can have large commodity flows). Total magnitudes of trade over all commodities are, of course, partly confounded with measures such as GNP. However, once a measure of position is derived, the extent to which position depends on GNP can be determined empirically, and GNP can be factored out in testing the relation between position and other variables.[5] If a single dimension results from this analysis, it cannot be due simply to a GNP or magnitude effect, since countries with similar magnitudes of trade can still have very different patterns of trade. Analysis of normalized data would tend to increase the risk of methodological artifact from magnifying measurement errors for the smaller trade flows.

As a result of the first step in the analysis, the relational-distance algorithm produces a matrix of coefficients that measure degree of dissimilarity of the positions of countries. These coefficients range from 0 for pairs of countries that have equivalent patterns of world trade relations to 1 for countries with maximally dissimilar patterns of trade. Countries with similar relational patterns play similar roles with respect to international trade.[6]

To determine the dimensionality of world-system positions in terms of trade flows, and the relative positions of countries in terms of quantitative location in a k-dimensional space that best represents these distances, an appropriate second step in the analysis is to use optimal scaling[7] on the matrix of inter-country relational distance measures (Kendall & Stuart 1961). Optimal scaling factors out the magnitude of row and column sums of the distance measures to arrive at normalized distances that reflect covariances between the distance vectors for each pair of countries. It is not unusual in optimal scaling to find that the first two coordinates provide a spatial representation of the distance space for subsequent analysis, but more complex structures would yield more dimensions.

While position (and mobility) in the space of world-system stratification can be examined quantitatively, blocks or relatively discrete positions can also be identified in this space either by the clustering of points or by establishing "cut-points" to discriminate groupings or strata. This permits us to examine blocks of countries and blockmodels of relations between them. Since some versions of world-system theory predict discrete strata (i.e., relatively distinct clusters), it is appropriate to use clustering methods to determine the most distinct clusters, and then examine the properties and relations between these clusters. (We will also use these clusters to examine the mobility of countries over time, although it would also be possible to examine mobility in terms of the optimal scaling or spatial representation of distances.) Several clustering algorithms are available. For an appropriate third step in our analysis, we use two complementary procedures, both available in the UCINET software package (MacEvoy & Freeman 1987). Johnson's (1967) complete-link method provides a first cut to find sets of countries *within* which there are close or similar patterns of trade. D'Andrade's (1978) U-Clus procedure provides a second cut to partition the distance matrix into roles based on similar patterns of distance both *inside and outside* the clusters. The hierarchical clusters of countries identified by these procedures can be superimposed on the optimal scaling results to visualize the delineation of near-equivalent roles or blocks.

To provide insight on the trade relationships between strata, once positions have been identified, our fourth step is to aggregate the raw data into a blockmodel showing average trade between blocks or, alternatively, average trade between dominant interpositional trading partners.

Results

A SINGLE MAIN DIMENSION OF WORLD-SYSTEM STRUCTURE

The positions of countries scaled by their relational distances, for 1965 to 1980, are shown in Figure 1. The dimensions of the optimal scaling account for variance in the original distance coefficients. Only two dimensions are significant in our results. However, most of the structure is accounted for by the single dimension of the horizontal axis in Figure 1. The first dimension, for each plot, accounts for more than ten times the variance of the second dimension.

The continuity in the overall configuration of the three plots is striking. In each year the result is a flattened U-curve with countries at the periphery of the world-economy on the left, those at the core to the right, and semiperipheral countries in the middle. While countries can be clustered by position, these plots can also be conceptualized as a continuum and suggest a core-periphery hierarchy. That this continuum is nearly one-dimensional (rather than two or three dimensional) is not an artifact of the method but an empirical finding consistent with world-system theory.

This result supports recent proponents of the world-system perspective who have moved away from the categorical view adopted by Wallerstein.[8] Chase-Dunn (1989) flatly asserts "the core/periphery dimension is a continuous variable" (207). Critiquing previous research that attempts to delineate precisely strata membership (including an earlier version of this article), Chase-Dunn asserts

> the vocabulary of zones is just a shorthand. I don't see any advantage in spending time trying to define and empirically locate the boundaries between zones because I understand the core/periphery hierarchy as a complex continuum. Since there is upward and downward mobility in the system there must be cases of countries or areas which are in between zones, at least temporarily. For me it doesn't matter whether there are "really" three zones, four zones, or twenty zones. (214)

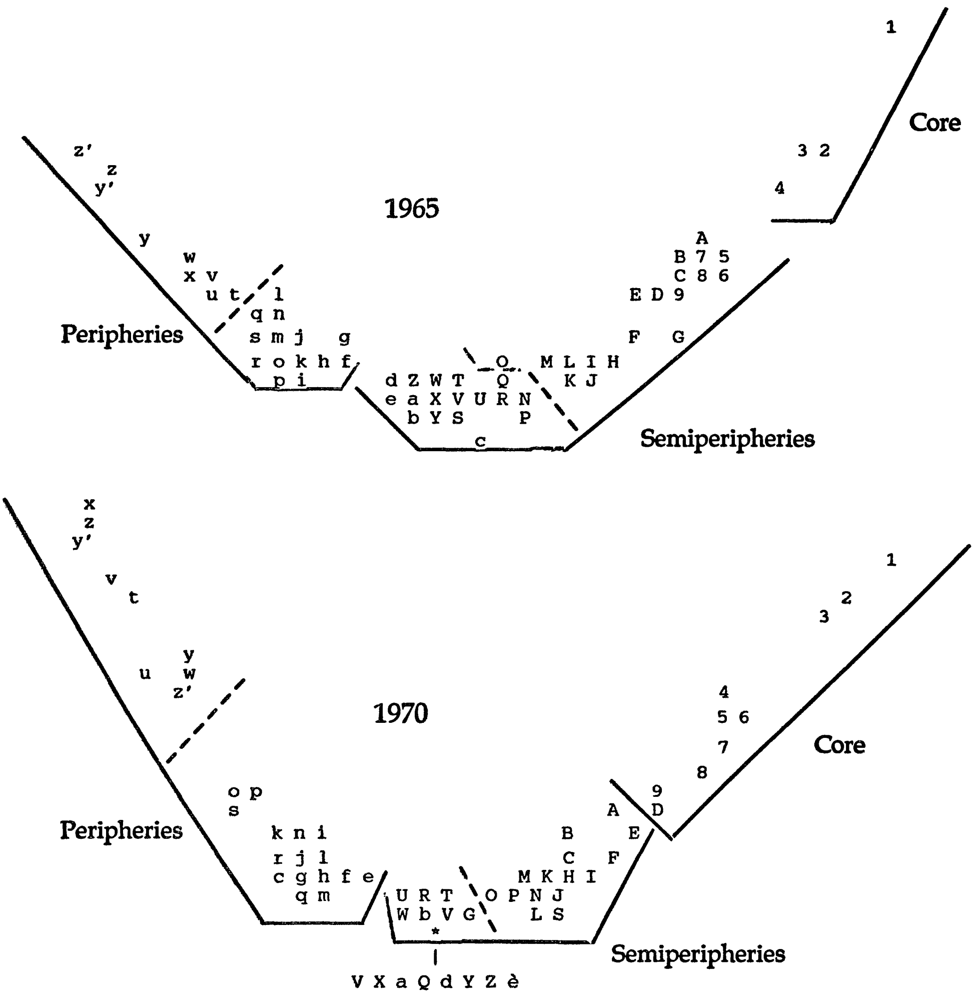
Although our results support this view of a complex continuum of world-system stratification, it not inconsistent to locate stratum boundaries within this continuum. Using boundaries is important because previous research (reflecting the original Wallersteinian view) demonstrates that stratum membership relates to a variety of developmental outcomes for particular countries. Network analytic variables purporting to measure world-system positions have demonstrated causal efficacy in predicting endogenous social change within societies, above and beyond the effects that they share with measures of development like GNP per capita (for example, see Nemeth & Smith 1985 or Snyder & Kick 1979). While cut-offs for our categories might be chosen in terms of other criteria (percentiles, for instance), hierarchial clustering algorithms offer the best method to identify empirical break points. They also offer various levels of clustering, from coarser blocking of major strata to finer divisions into subblocks. The results show three major strata that can be further partitioned into five groups of countries.

MAJOR BLOCKS ARE CORE, SEMIPERIPHERY AND PERIPHERY, WITH SUBBLOCKS

Figure 1 indicates the hierarchical clustering of countries into blocks using both Johnson's complete-link (solid lines) and D'Andrade's (1978) U-Clus (dotted brackets) methods, applied to the relational distance matrix. The countries and their block membership, scaling on the first positional dimension, and GNP per capita for the years 1965, 1970, and 1980, are identified in Table 1.

The clustering algorithms detect fairly consistent numbers of blocks for each year. The Johnson within-cluster method indicates a core-periphery, tripartite (C-S-P) hierarchy for 1965 and 1970, and a division of the periphery into two

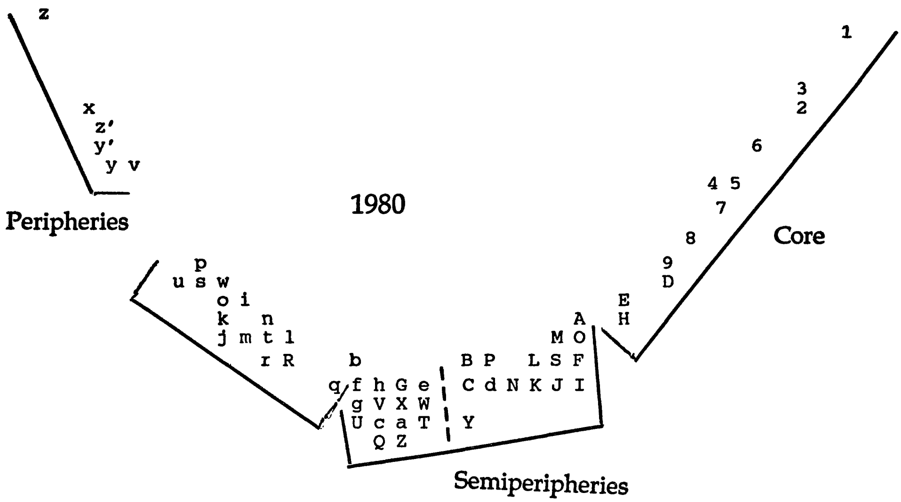
FIGURE 1: U-Clus and Complete Link Analysis Imposed on Optimal Scaling of REGE-D Coefficients for 15 Trade Relations: 1965, 1970, and 1980



disparate blocks in 1980. U-Clus arrives at a finer analysis that yields five blocks for each year, splitting the Johnson semiperiphery and periphery each in two. Both clustering techniques indicate a distinct "Fourth World" group of very poor African countries emerging in 1980.

The U-Clus splits suggest that both the periphery and semiperiphery should be divided into subgroups, which corroborates other network research on the international system in providing evidence that there are more than three structurally distinct layers (Nemeth & Smith 1985). Nevertheless, without dismissing these finer divisions, our empirical findings represent a fairly stable core, periphery, and semiperiphery pattern.

FIGURE 1: U-Clus and Complete Link Analysis Imposed on Optimal Scaling of REGE-D Coefficients for 15 Trade Relations: 1965, 1970, and 1980



The variance in intrablock maximal trade partnerships accounted for by the five-block solution is .89 compared to .80 for the three-block solution (see note 3 for an explanation of the R^2 measure).

BLOCK RELIABILITY AND REFINEMENT VIS-À-VIS PREVIOUS BLOCKMODELS

How do our results map into earlier attempts to partition the international system? First, they are very consistent with the Nemeth and Smith (1985) classification. Although both used the same commodity trade dataset, the consistency is nontrivial. Our study examines data on 15 commodities, while Nemeth and Smith (1985) examined five composite types. We use information on 63 countries, while they had data on 86. We use the REDI blockmodeling procedure, while they used CONCOR. Although our procedure should provide a better measure of world-system structure (and REDI has the added advantage of allowing a dimensional scaling of the results), a comparison of the two sets of results should reflect on their reliability. Comparing our 1970 results with those of the Nemeth and Smith,[9] we find that our core contains all nine countries included in their core as well as Switzerland (which was in their "strong" semiperiphery). Our semiperiphery includes all of the countries they classified as semiperipheral except for Libya and Egypt (which the present results classify as peripheral). All of the countries they classified as peripheral (of those included in this analysis) are in our periphery cluster, except Peru and Turkey, which we placed in the semiperiphery. The high reliability of results using either CONCOR and REDI, as well as differently constructed data sets, bolsters confidence in the findings.

The partitioning can also be compared to the Snyder and Kick (1979) classification, often used in quantitative studies as a proxy for world-system

TABLE 1: Block Memberships and GNP of 63 Nations

		Blocks				GNP		Growth[a]	
		1965	1970	1980	1965	1970	1979	1970-79	1965-83
1	United States	1	1	1	3,240	6,070	10,610	2.2	1.7
2	Canada	1	1	1	2,100	5,312	9410	2.9	2.5
3	West Germany	1	1	1	1,620	5,626	12,200	2.6	2.8
4	United Kingdom	1	1	1	1,550	3,201	7390	1.9	1.7
5	France	2	1	1	1,620	4,609	10,650	3.0	3.1
6	Japan	2	1	1	760	3,370	8,730	3.9	4.8
7	Italy	2	1	1	960	2,554	5,730	2.2	2.8
8	Netherlands	2	1	1	1,360	4,660	10,490	2.2	2.3
9	Switzerland	2	1	1	2,150	7,298	15,360	.2	1.4
A	Denmark	2	2	2	1,740	5,497	12,030	2.1	1.9
B	New Zealand	2	2	2	1,790	4,106	6,400	.5	1.2
C	Argentina	2	2	2	760	1,347	2,210	1.0	0.5
D	Belgium-Luxembourg	2	1	1	1,540	4,788	11,020	2.9	3.1
E	Sweden	2	2	1	2,130	6,499	12,250	1.1	1.9
F	Australia	2	2	2	1,750	4,610	8,870	1.4	1.7
G	India	2	3	3	90	140	210	1.6	1.5
H	Austria	2	2	2	1,080	3,668	9,130	3.5	3.7
I	Hong Kong	2	2	2	500	1,371	3,640	6.5	6.2
J	Spain	2	2	2	580	1,990	4,920	3.0	3.0
K	Finland	2	2	2	1,550	3,962	8,520	2.2	3.3
L	Venezuela	2	2	2	830	1,837	3,440	2.7	1.5
M	Ireland	2	2	2	830	2,138	4,480	2.3	2.3
N	Brazil	3	2	2	220	680	1,770	6.1	5.0
O	Norway	2	2	2	1,620	5,072	11,230	3.7	3.3
P	Yugoslavia	3	2	2	470	•	•	•	4.7
Q	Philippines	3	3	3	150	289	640	3.9	2.9
R	Pakistan	3	3	4	85	131	270	1.5	2.5
S	South Korea	3	2	2	120	344	1,510	8.1	6.7
T	Thailand	3	3	3	120	269	600	4.4	2.1
U	Peru	3	3	3	300	659	850	.2	0.1
V	Chile	3	3	3	480	811	1,890	.8	-0.1
W	Malaysia	3	3	3	260	555	1,450	5.4	4.5
X	Colombia	3	3	3	260	432	1,060	3.7	3.2
Y	Greece	3	3	2	600	1,762	4,140	4.1	4.0
Z	Portugal	3	3	3	370	1,250	2,060	1.1	3.7

[a] Growth rates GNP per capita, adjusted

status. Their inclusion of four equally weighted matrices on the presence or absence of trade, treaties, diplomatic exchanges, and military interventions between pairs of countries leads to some odd results that tend to group countries by geography, common cultures, and other factors that have little association with most theoretical conceptions of world-system structure (see Nemeth & Smith 1985). We claim our approach provides considerable improvement and eliminates some of the most glaring anomalies in the Snyder and Kick results.

Since the Snyder and Kick analysis used data circa 1965 it is most appropriate to juxtapose their classification with our results for that year. There

TABLE 1: Block Memberships and GNP of 63 Nations (Continued)

		Blocks			GNP			Growth[a]	
		1965	1970	1980	1965	1970	1979	1970-79	1965-83
a	Israel	3	3	3	1,130	2,846	4,230	1.6	2.9
b	Turkey	3	3	3	230	612	1,380	3.5	3.0
c	Egypt	3	4	3	.	266	500	5.3	4.2
d	Singapore	3	3	2	450	1,635	3,770	6.7	7.8
e	Hungary	3	3	3	870	.	.	.	6.4
f	Morocco	4	4	3	180	.	.	.	2.9
g	Tunisia	4	4	3	200	484	1,160	5.7	5.0
h	Libya	4	4	3	490	4,430	8,480	-1.6	-0.9
i	Nicaragua	4	4	4	320	581	610	-1.6	-1.8
j	Guatemala	4	4	4	300	490	1,010	3.1	2.1
k	Sudan	4	4	4	95	139	450	1.5	1.3
l	Costa Rica	4	4	4	380	713	1,630	3.2	2.1
m	Panama	4	4	4	460	929	1,550	1.3	2.9
n	Honduras	4	4	4	200	324	520	.5	0.6
o	Senegal	4	4	4	170	308	450	.1	-0.5
p	Madagascar	4	4	4	80	188	330	-2.5	-1.2
q	Ecuador	4	4	3	180	415	1,110	5.4	4.6
r	Sri Lanka	4	4	4	140	129	230	2.5	2.9
s	El Salvador	4	4	4	250	379	640	1.4	-0.2
t	Cameroon	5	5	4	110	292	590	3.1	2.7
u	Jordan	5	5	4	220	442	1,200	6.0	6.9
v	Congo	5	5	5	120	.	670	-.2	3.5
w	Gabon	5	5	4	250	.	.	.	
x	Togo	5	5	5	90	231	400	1.2	1.1
y	Niger	5	5	5	80	140	300	-1.2	-1.2
y′	Burkina Faso[b]	5	5	5	45	.	.		1.4
z	Central African Rep.	5	5	5	75	220	280	.9	0.1
z′	Malawi	5	5	5	.	.	.	.	.

[b] Burkina Faso refers to the Upper Volta.

are several serious discrepancies. The sharpest contrast is the size and membership of the core group. Snyder and Kick's core is a rather heterogeneous mix of 21 countries, while ours is an elite quartet. If we include countries that become part of our core in the subsequent years (1970 and 1980 — France, Japan, Italy, Netherlands, Switzerland, Belgium, Sweden), then there is agreement on 11 core countries. But that still leaves eight countries that Snyder and Kick's results place in the core but consistently cluster with our semiperiphery: Spain, Portugal, Greece, Yugoslavia, Austria, Norway, Denmark, and Australia. The first five of these countries are middle-income southern European countries that Wallerstein (1985) and Arrighi (1982) treat as prototypical examples of semiperipheral development. The latter three are frequently classified as core countries in world-system analysis, but a plausible argument could be made that none of them is either politically or economically central enough to deserve full core status. It would be hard to justify placing Australia and Norway with our core countries in 1965, since they rank medium to low in our semiperipheral group. This leaves Denmark as a formally and substantively ambiguous case omitted from the core. Alternatively, part of the disparity may be due to statistical cutting points of the clustering algorithms (the problem being in the clustering, not the scaling results) that may be substantively artificial in separating some of the large western economies and Japan from the core group in 1965, although not in 1970 or 1980. Those countries that Snyder and Kick do claim to be semiperipheral are also classified in that stratum in our analysis (with the exception of Jordan, which we place unambiguously in the periphery). But several countries that are included in our 1965 semiperiphery are found in Snyder and Kick's periphery (New Zealand, Thailand, Chile, Brazil, and Egypt). Of those only Egypt is ever classified as peripheral in our analysis, and then only for 1970. Of the other three, New Zealand obviously does not belong in the periphery, Chile is a debatable case, and Brazil is the very model of an upwardly mobile semiperipheral Third World society (see, e.g., Evans 1979a).

In sum, our results provide an assessment of world-system positions that is computationally more accurate, with fewer anomalies than Snyder and Kick's (1979) study, and, in comparison with Nemeth and Smith (1985), highly reliable while adding interpretable dimensionality. Our approach measures role distance unconfounded by effects of spatial propinquities. We also provide a continuous scaling of world-positioning in addition to a typology by block. Thus, these results represent considerable refinement over both earlier studies.

Finally, the correlations of GNP per capita over the time periods 1965-1970, 1965-1980, and 1970-1980, with both block membership (.75, .74, .80) and the first scaling dimension (.77, .76, .81), reinforce the view that we are measuring a distinct indicator of world-system position. Closer analysis of discrepancies between the GNP per capita figures (Table 1) shows that GNP per capita is a much poorer measure of core-periphery status. Libya, for example, fits clearly into our periphery at all three time points. Like other oil-producing countries (most of which are excluded here because of small populations) it lacks a diversified industrial economy but has a GNP per capita nearly at parity with the top core states. GNP per capita would result in an inflated measure of global position for all the Scandinavian nations, too. While Norway's economy is more productive per person than that of the U.S., it strains credulity to claim that Norway should have a higher world-system status than the U.S. Our results, which place Norway in the upper semiperiphery and the U.S. consistently at the top of the core, seem to capture more reasonably their relative positions in the global hierarchy. India, on the other hand, has a GNP per capita of countries at the extreme periphery (e.g., Togo). Its more diversified industrial production and trade patterns explain why it fits into our semiperiphery — and this finding is consistent with qualitative efforts to delineate the semiperiphery (Chase-Dunn 1983; Wallerstein 1979).

While these anomalies and the moderate correlation between GNP per capita reinforce the view that GNP per capita is not an adequate proxy for world-system status, the major blocks identified in the positional analysis *should* differ in terms of *average* level of GNP per capita. (World-system analysts predict that noncore status should be correlated with lower scores on this and other indicators of development.) Table 2 shows such averages for each block in the three time periods. Differences between blocks are statistically significant for

TABLE 2: Average Country GNP per Capita by Block and Time Period

		Core	Semi-periphery 1	Semi-periphery 2	Periphery 1	Periphery 2
1965	Mean	2,127	1,244	382	246	138
	Std. Dev.	781	583	287	128	80
1970	Mean	4,748	3,080	876	698	291
	Std. Dev.	1,433	1,938	796	1,097	151
1980	Mean	10,349	5,737	1,830	729	485
	Std Dev.	2,576	3,419	2,152	470	261

all pairs except blocks 3 versus 4 in 1965-1970. While there is considerable aggregate world economic growth during the period, the disparities between strata do not change much: for all of the time periods, those of block two are about half those of 1; those of 3 about one-third of 2; those of 5 about one-third of 3 (with block 4 GNP per capita somewhere in between 3 and 5).

If our typological results are valid, one of our most surprising results is the small size of the core in 1965.[10] The fact that there is such a large gap between the first four countries of our core and the other advanced European countries indicates a degree of structural distinctiveness in 1965 for the leaders in the world economy that erodes in 1970 and 1980. The four leading countries — the industrialized winners of World War II (U.S., Canada, U.K.), and reindustrialized West Germany — reflect the post World War II hegemony of the U.S. and its closest allies. So, we can argue for the substantive validity of a relatively small hegemonic core in 1965 that erodes later in the postwar era.

CHANGE

While fifteen years is not a long time period for macrostructural transformation in the pattern of global exchange, a high level of structural stability is worth noting in a period marked by widely acknowledged changes in the world-economy like the global crisis precipitated by the 1973 oil shock (see Amin et al. 1982), the rise of the "new international division of labor" (Fröbel, Heinrichs & Kreye 1980) and the emergence of a number of "newly industrialized countries" (Caporaso 1981).

The most noticeable change in the size and density of the blocks is the expansion of the one we label "core" from the ranks of the upper semiperiphery between 1965 and 1970. Accepting the relatively small size of our core in 1965, the subsequent growth in the size and density of this cluster is consistent with theoretical arguments about the relative decline of U.S. hegemony in the world-system and the emergence of a more competitive multicentric core (Amin et al. 1982). The U.S. remains the far right point on the graph in each plot. But the gap between this country and others is much narrower after 1965. West Germany, Canada,[11] and Japan remain closest to the U.S. in the 1980 scaling, while the United Kingdom slips farther away.

Movement between strata is another type of change that our methodological tools allow us to assay, by constructing interblock mobility tables across the years (see Tables 3, 4, and 5). In our semiperiphery there is extensive movement between the lower and upper clusters, with Brazil, South Korea, and Yugoslavia moving up to the upper semiperiphery between 1965 and 1970, and Greece and Singapore making a similar jump in 1980. Between 1970 and 1980 Table 4 also shows five countries moving up from our periphery to lower semiperiphery (one is Egypt which temporarily dropped to the periphery in 1970). Finally, three countries (Gabon, Cameroon & Jordan) move out of the bottom peripheral cluster in 1980.

Debates about the nature of the rise and decline of nations proliferate in international political economy. We make no pretense of providing a complete or comprehensive explanation of our empirical results in the brief discussion that follows. But we would suggest that mobility into and through our semiperipheral blocks may be related to the rise of a "new international division of labor" in the last quarter century.

Recent interest in a "new international division of labor" received its initial impetus from an influential book of that title in 1980 (Fröbel, Heinrichs & Kreye 1980). The authors claimed that a global shift in the locus of manufacturing was underway in the 1960s and 1970s, with a massive movement of factories and industrial jobs from high wage core countries to low wage peripheral ones. This results in deindustrialization within the core (Bluestone & Harrison 1982) concomitant with the rise of export manufacturing in the "newly industrializing countries" (NICs) of the Third World (Belassa 1981; Caporaso 1981; Deyo 1987). Walton (1985) reminds us that the global division of labor is not really "new," since the initial one emerged hundreds of years ago under European colonialism. Nevertheless, he sees the recent changes as a third basic transformation of the international division of labor in which

> capital and production are exported from the deindustrializing advanced countries (and unemployment there increased) for relocation in the hospitable confines of Third World assembly plants using cheap labor and on "export platforms" from which goods are launched to yet other countries, or back to the home markets in the core. (4)

Walton also points out that this is not a purely economic process: the state plays a key role in the mobility of capital, "for example by failing to discourage capital flight through plant closing indemnities or by welcoming foreign investment in Third World export sectors" (5).

A crucial question is to what extent changes associated with the transformation of the international division of labor actually lead to upward (or downward) mobility in the world-system. Does the growth of export manufacturing in the periphery and semiperiphery really lead to dependency reversal and ascension in the world-system hierarchy? Or do the changes associated with the "new international division of labor" simply result in different forms of dependence and reproduce global inequality? (See Chase-Dunn 1989: Chapter 11, for a discussion.) Our results provide some evidence for the claim that export manufacturing does lead to limited upward mobility. The prototypical NICs in our analysis (Brazil, Singapore, and South Korea) all move up into the "strong semiperiphery" between 1965 and 1980. Brazil's move is consistent with

TABLE 3: Block Mobility between 1965 and 1970

1970 \ 1965	Core	Semiperiphery 1	Semiperiphery 2	Periphery 1	Periphery 2
Core	1 U.S. 2 Canada 3 W. Germany 4 U.K.	5 France 6 Japan 7 Italy 8 Netherlands 9 Switzerland A Denmark			
Semi-periphery 1		B New Zealand C Argentina D Belgium-Lux. E Sweden F Australia H Austria I Hong Kong J Spain K Finland L Venezuela M Ireland O Norway	N Brazil P Yugoslavia S South Korea		
Semi-periphery 2		G India	Q Philippines R Pakistan T Thailand U Peru V Chile W Malaysia X Colombia Y Greece Z Portugal a Israel b Turkey d Singapore e Hungary		
Periphery 1			c Egypt	f Morocco g Tunisia h Libya i Nicaragua j Guatemala k Sudan l Costa Rica m Panama n Honduras o Senegal p Madagascar q Ecuador r Sri Lanka s El Salvador	
Periphery 2					t Cameroon u Jordan v Congo w Gabon x Togo y Niger y′ Burkina Faso z C. Afr. Rep. z′ Malawi

TABLE 4: Block Mobility between 1970 and 1980

1980 \ 1970	Core	Semiperiphery 1	Semiperiphery 2	Periphery 1	Periphery 2
	1 U.S.				
	2 Canada				
	3 West Ger.				
	4 U.K.				
Core	5 France				
	6 Japan				
	7 Italy				
	8 Netherlands				
	9 Switzerland				
	D Belgium-Lux	E Sweden			
		A Denmark			
		B New Zealand			
		C Argentina			
		F Australia			
		H Austria			
		I Hong Kong			
Semi-		J Spain			
periphery 1		K Finland			
		L Venezuela			
		M Ireland			
		N Brazil			
		O Norway			
		P Yugoslavia	d Singapore		
		S South Korea	Y Greece		
			G India		
			Q Philippines		
			U Peru		
			V Chile		
			T Thailand		
Semi-			W Malaysia		
periphery 2			X Colombia	c Egypt	
			Z Portugal	f Morocco	
			a Israel	h Libya	
			b Turkey	g Tunisia	
			e Hungary	q Ecuador	
			R Pakistan	i Nicaragua	
				j Guatemala	
				k Sudan	
				l Costa Rica	
Periphery 1				m Panama	
				n Honduras	
				o Senegal	
				p Madagascar	t Cameroon
				r Sri Lanka	u Jordan
				s El Salvador	w Gabon
					v Congo
					x Togo
					y Niger
Periphery 2					y′ Burkina Faso
					z C. Afr. Rep.
					z′ Malawi

TABLE 5: Block Mobility between 1965 and 1980

1980 \ 1965	Core	Semiperiphery 1	Semiperiphery 2	Periphery 1	Periphery 2
Core	1 U.S. 2 Canada 3 West Ger. 4 U.K. 8 Netherlands 9 Switzerland D Belgium-Lux. E Sweden	5 France 6 Japan 7 Italy			
Semi-periphery 1		A Denmark B New Zealand C Argentina F Australia H Austria I Hong Kong J Spain K Finland L Venezuela M Ireland O Norway	N Brazil P Yugoslavia S South Korea Y Greece d Singapore		
Semi-periphery 2		G India	Q Philippines T Thailand U Peru V Chile W Malaysia X Colombia Z Portugal a Israel b Turkey c Egypt e Hungary	f Morocco g Tunisia h Libya q Ecuador	
Periphery 1			R Pakistan	i Nicaragua j Guatemala k Sudan l Costa Rica m Panama n Honduras o Senegal p Madagascar r Sri Lanka s El Salvador	u Jordan t Cameroon w Gabon
Periphery 2					v Congo x Togo y Niger y′ Burkina Faso z C. Afr. Rep. z′ Malawi

Evans' (1979a) claim that it was undergoing "dependent development" in the 1960s and 1970s. Similarly, the mobility of Singapore and South Korea can be linked to the beginnings of export-led industrialization in two countries that make up half of East Asia's "four little tigers" (see Cumings 1984). As for the other two, Hong Kong already was in upper semiperiphery in 1965, and Taiwan lacked data for this analysis. Other cases of upward mobility are less obviously tied to global shifts of manufacturing. But it seems quite possible that a closer look at the industrial and trade profiles of the other upwardly mobile countries in Table 5 might reveal that they, too, have experienced noncore industrialization.[12]

Only three countries show any downward mobility. As mentioned above, Egypt's is temporary. India and Pakistan show declines that are not reversed, with India falling to our lower semiperiphery initially in 1970 and Pakistan dropping from our semiperiphery to periphery. It would be possible to speculate about the political and economic difficulties that might account for these declines — clearly there may be some distinctive problems affecting the Indian subcontinent (while there was insufficient data to include Bangladesh we would speculate it might have experienced some downward mobility during the period, as well), but, wary of "Indian exceptionalism," we defer to area specialists.

Despite two descending exceptions, we find much more upward than downward mobility in our analysis of the international system. This is consistent with longer-term patterns for the twentieth century that Chase-Dunn (1983) and Chirot (1977) claim using less systematic analyses. Clearly this suggests that international mobility is not a zero-sum game. This does not necessarily mean a reduction of global material inequality (Chase-Dunn 1983), particularly given that the process of semiperipheral development may actually increase poverty within countries (Gereffi & Evans 1981). The increasing structural dissimilarity between the poorest countries of Africa and even other peripheral countries does not bode well for Chirot's sanguine prediction that the periphery is destined to disappear completely as all countries move up the hierarchy. Of course, if all countries moved up to core and semiperiphery, the semiperiphery as a whole would necessarily become a renormalized periphery. *Core* and *periphery* are relative terms, not absolute.

EXCHANGE RELATIONS BETWEEN STRATA: TRADE ASYMMETRIES

Questions about trade relationships within and between blocks (*a la* Steiber 1979) can be addressed once countries are classified according to their positions in the world-system. The first step is to construct mean flow matrices between blocks using the raw trade data for each commodity. Then a variety of indices can be calculated that gauge the trade *within* blocks and the asymmetrical patterns of upward or downward commodity flows of goods *between* blocks. Both are defining characteristics of the world-economy. A principal feature distinguishing core from periphery is the massive volume of trade within the core, between its member nations. By contrast the internal market volume of trade between members of noncore blocks is minuscule.[13] Structural theories of the world-economy suggest that while intracore commerce is always predominant, peripheral countries are much more likely to trade with the core state that they have been historically dependent upon than they are to exchange goods with other countries in the periphery, even when they are geographically close (Galtung 1971; Frank 1969; Wallerstein 1979).

Asymmetrical commodity flows are related to the notion of unequal exchange proposed by world-system theorists (Amin 1974; Frank 1979; Wallerstein 1974, 1980). They claim that unequal exchange occurs when undervalued goods, produced at low wages in peripheral areas, are exchanged on the world market for expensive core-produced manufactured goods. But the debate about the precise nature of unequal exchange is a complex and contentious one. Mandel (1975) argues that the key component to the widely accepted neo-Marxist definition of unequal exchanges are differential global wage levels, which are not necessarily specific to particular patterns of commodity trade. Since our measures do not capture unequal exchanges in this sense, we will refer to "asymmetrical trade patterns" to avoid any terminological confusion. These patterns can be expressed in terms of various types of trade gradients in unbalanced imports and exports of particular commodities. Though these asymmetries may not operationalize unequal exchange in the Mandelian sense, they do provide information that is relevant to various theories about how unbalanced flows of commodities maintain global inequality (for example, see Bunker 1984, on "extractive economies") and offer empirical evidence for recent changes associated with "the new international division of labor" (Fröbel, Heinrichs & Kreye 1980).

The results of our analysis allow us to look at 45 mean flow matrices; one for each of the fifteen commodities at the three time points. Obviously, detailed analysis of this data must await another article. Here we examine only two features.[14] One is the percentage of the total trade value that is exchanged among our core countries (for most of our commodities during most years this intracore trade is a very large proportion of global commerce). The other looks exclusively at interblock exchanges by calculating the overall export/import balance between higher and lower blocks to determine whether particular commodities are generally being exported from the core and higher level strata toward the periphery and lower level blocks, or the reverse.

Table 6 presents the mean flow matrix for trade in nonelectrical machinery in 1965; average values of exports are read from column-to-row entries, those of imports from row-to-column; the topmost row shows the average export to other countries, while the column furthest left shows average imports. Intracore trade is found in the upper left cell. Not surprisingly, the average value of the exchanges of nonelectrical machinery from one core state to another dominates global trade in this commodity, comprising 68.7% of the total. A simple index of asymmetry is also calculated by adding the value of all the cells above the diagonal and dividing by the sum of the cells below the diagonal (Smith 1984). Logging this ratio provides standardization since the logged value is 0 at parity and of equal magnitude but opposite sign for inverse ratios. In Table 6 the index score of -.702 indicates that the value of machinery exported from higher to lower blocks is more than five times ($10^{.702}$) that imported. This pattern is

TABLE 6: 1965 Average Interblock Trade ($1,000) and Export/Import Ratios for Nonelectrical Machinery[a]

Mean Imports to:		Mean Exports from:				
2,588.7	Mean:	36,335.2	3,268.5	68.4	4.3	.7
Mean:	Block	1	2	3	4	5
15,762.0	1	274,280.7	20,235.5	263.9	28.1	1.4
5,447.6	2	74,972.5	6,548.9	92.4	3.0	.0
1,479.7	3	18,720.5	1970.9	91.1	1.9	.0
300.2	4	3,777.6	397.3	12.3	7.4	.0
85.3	5	734.1	187.8	.3	.8	4.8
Size		N = 4	N = 19	N = 17	N = 15	N = 8

[a] Log of export/import ratio for pairs of blocks (above/below diagonal): -.689
Percentage of total average value exchanged in intracore trade: 68.7

entirely consistent with theoretical expectations that high-technology heavy-manufacturing goods are likely to be exported from the core and higher level strata to lower level blocks.

Table 7 contains the percentage of intracore trade and the index of export/import asymmetry for each of the fifteen commodities for 1965, 1970 and 1980. The summary scores for nonelectrical machinery in 1965, derived from Table 6, appear in the upper left cells. The pattern for that commodity holds for all high-technology heavy-manufacturing commodities for across the time period: intracore trade predominates and, in fact, rises to over 70% for all three commodities in 1980, while for interblock trade these goods have ratios of exports to imports from higher to lower blocks ranging from 3/1 to 13/1. Inspecting the asymmetry index we find that food products generally move in the opposite direction, from our peripheral and other lower blocks toward consumption in the core.

This seems to fit the standard arguments (Amin 1974; Frank 1969) about trade asymmetries between core and periphery in which highly processed capital-intensive commodity production is centered in the core and export agriculture becomes a specialty of the periphery. But while the percentage of intracore trade for food products is very low in 1965 (with that year's small core block), there is clearly a great deal of food production in our core that is destined for market in other core states. And for cereals the export/import gradients are reversed, so that the higher blocks and core are net exporters to the lower blocks. While this contradicts a simplified unequal exchange that juxtaposes agriculture to industry, it is interpretable in terms of the rise of industrialized capital-intensive agriculture in the core, such as mechanized wheat production in the midwestern U.S. (Arrighi & Drangel 1986; Chase-Dunn 1989). The commodities classified as low wage/light manufacturing are of

TABLE 7: Percentage of Intracore Trade and Logs of Export/Import Ratios[a]

Intracore trade as percentage of total 1965	1970	1980	Commodity Type	Log of Export/Import from Higher/Lower Blocks 1965	1970	1980
			High Technology/Heavy Manufacture			
68.7	69.5	70.8	46 Machinery — nonelectrical	-.69	-.86	-.82
61.1	69.8	73.6	35 Artificial resins/plastic/esters/ethers	-.59	-1.21	-.83
59.7	70.2	70.1	45 Manufactures of metal, n.e.s.	-.42	-.60	-.43
			Sophisticated Extractive			
83.7	62.0	71.0	40 Paper, paperboard, articles of paper pulp	-.02	-.04	-.14
79.5	56.7	73.8	16 Pulp and waste paper	.21	.56	.14
95.1	91.4	77.5	23 Gas, natural and manufactured	-.52	-.44	.66
			Simple Extractive			
68.0	71.3	72.8	13 Oil seeds and oeaginous fruit	-.18	.02	-.20
40.4	48.0	56.7	25 Animal oils and fats	-.32	-.04	-.36
55.3	59.9	60.0	04 Cereals and cereal preparations	-.62	-.26	-.80
			Low Wage/light Manufacturing			
31.7	66.2	51.8	52 Articles of apparel and clothing accessories	.47	.50	.86
30.9	77.0	67.9	53 Footwear	.75	.22	.64
41.8	67.0	58.1	51 Travel goods, handbags, similar containers	.29	.29	.61
			Food Products			
33.8	43.0	52.8	01 Meat and meat preparations	.91	1.02	.96
11.6	63.3	71.5	02 Dairy products and birds egg	.32	.18	-.03
45.1	57.8	60.0	20 Crude animal and vegetable materials, n.e.s.	.55	.34	.43

[a] Key to conversion from logs to ratios
Fractional part of log:

		.9	.8	.7	.6	.5	.4	.3	.2	.1	.0
Integer part of log:	0.	7.9	6.3	5.0	4.0	3.2	2.5	2.0	1.6	1.3	1.0
	1.	79	63	50	40	32	25	20	16	13	10
	2.	794	631	501	398	316	251	200	159	126	100

particular interest since they are relevant to the "new international division of labor" (NIDL) thesis (Fröbel, Heinrichs & Kreye 1980) that restructuring is occurring in the global economy, with the shift of large-scale but low-wage manufacturing to the semiperiphery and even periphery. For all the "low wage/light manufacturing" our table shows a relatively low proportion of production for world trade in the small 1965 block we call the core and a clear decline between 1970 and 1980 for the expanded core group of those years.

Particularly for clothing and travel goods there is a clear trend toward increasing exports from lower blocks between 1965 and 1980 (which is precisely the period during which the NIDL changes were purported to take place). In these industries, cheap labor costs and relatively simple technology allow noncore countries to compete on international markets. We examined the mean flow matrices for these commodities more closely for 1970 and 1980. We found that the share of the average value that our two semiperipheral blocks exchanged internationally rose significantly for all three commodities — for apparel and accessories from 26.7% to 41.6%, for footwear from 14.7% to 26.4%, and for travel goods and handbags from 22.5% to 34.2% — and almost entirely at the expense of core production for global trade. These results provide clear evidence for the NIDL thesis. The patterns for the remaining two groups of commodities, simple and sophisticated extractive products, are more varied and prone to fluctuation. These unstable patterns may be of intrinsic interest, since they may be indicative of either dramatic market swings for extractive products or changing patterns of shortage and resource depletion (see Bunker 1984, for a discussion linking excess reliance on extractive exports and international economic vulnerability).

This brief discussion of trade asymmetries is meant to be suggestive and not conclusive. A much more detailed analysis of the intricacies of the 45 trade flow matrices is possible. For example, it is possible to construct statistical measures of the pattern of exchange between each of the hierarchic strata and to examine the precise sequence of high to low commodity movement (e.g., showing block 2 is the highest exporter, then 1, 3, 4, 5), for each mean flow matrix. This type of analysis yields a rich source of information bearing on various theoretical notions of international commodity trade, but there is insufficient space here for further examination.

While the discussion of these trade gradients remains preliminary, the exchange patterns are generally consistent with international political economic theories about commodity trade between different world-system zones. These patterns provide further validity for our relational equivalence operationalization of global hierarchy.

RELATIONS AND MOBILITY

With both mobility patterns of countries and detailed information on interblock exchange relations for particular commodities in hand, it is tempting to link specific patterns of export specialization or diversification to rise and decline in the international system. Currently, the authors are carrying out a rigorous analysis of this data which will explore the relationship between centrality in particular trade networks and patterns of upward or downward mobility for specific countries (White & Smith 1988). For now we merely offer some tentative observations.

Upward mobility within the core for countries like Japan and West Germany seems to be heavily reliant on the export of high-technology heavy-manufacturing products. All core countries, however, have highly diversified economies. Relatively advanced economies that are more specialized in areas like food production (Ireland, New Zealand) are most likely to remain in the semiperiphery.

Mobility within our semiperiphery is most likely related to rising levels of manufacturing, with countries in our upper semiperiphery exhibiting some heavy industry and countries in the lower semiperiphery concentrating on low-wage light industry. By 1980 even countries in our periphery are shifting their exports toward some of these simple manufactures.

While specialization in extractive products is often seen as a viable development strategy for noncore countries, our findings suggest that this may be problematic. Even relatively sophisticated extractive exports (like natural gas) appear to offer limited avenues to mobility given the fluctuating trade patterns for these commodities. Similarly, although cereal export seems to be associated with higher strata in the international system, the wide swings in its export ratios suggest that grain specialization is a risky strategy for moving up in the hierarchy.

Conclusion

This article has presented a rich body of data detailing the results of a network analysis of international commodity trade patterns. The methodology used to unravel these global configurations represents the most recent refinement of efforts to measure and analyze role equivalence and exchange relations in social networks. Nevertheless, while our major contributions may be methodological and empirical, the analysis was designed to test existing theory on the structure and processes of the world-economy.

Our main purpose was to use network analysis to reassess the empirical status of the world-system perspective's model of international hierarchy and exchange between blocks. This effort involves more than mere replication of prior research. By focusing on commodity trade we have improved on the insufficient operationalization of the theoretically crucial global relationships in Snyder and Kick (1979). The use of an improved quantitative measure of role equivalence (or its converse, relational distance) and the inclusion of multiple time points in our study mark important advances over Nemeth and Smith (1985). While our findings corroborate some of the general results of these earlier network analyses of the global system, they also significantly extend them.

In terms of the structural morphology of the international system, there is broad agreement with previous research and the general world-system model. The existence of three major positions in the world-economy — core, semi-periphery, and periphery — is amply verified (although subblocks are also present). The precision of our measures of position, the general stability of our results, and their analytic interpretability, offer a more fine-grained measurement of world system position than has hitherto been possible. The general pattern lends support to Wallerstein's hierarchical model of the international system, although our findings suggest that the number of analytically identifiable levels may be more than three. We find at least two stable subdivisions or blocks within the periphery and the semiperiphery, but our methodology allows the hierarchy to be conceived as a complex continuum with alternative break points into strata of varying degrees of discreteness. In this vein, a striking (and depressing) result of our positional analysis for 1980, compared to earlier periods, is that the extreme or lower periphery of "Fourth World" countries appears to be becoming increasingly distinct and marginalized on this continuum between 1965 and 1980.

Questions of the number or hierarchical trees of blocks/subblocks in the world-economy are significant if we can identify substantive differences in their roles. Our operationalization of the world-system resulted in a continuum-like structure with a single main dimension and a strongly hierarchical nature.

Network analysis allows us to examine carefully exchange relationships within and between strata in the world-economy. Steiber's often overlooked 1979 article points to the theoretical importance of understanding these patterns. Massive intracore trade is one of the defining features of this strata's global dominance. Analysis of asymmetrical trade patterns provides insight into unequal exchange as a potential mechanism in the reproduction of global inequality and hierarchy. The results support two complementary arguments.

First, our results support world-system and dependency arguments about the asymmetrical flows of raw materials versus processed goods. Exports of high-technology heavy-manufacturing goods flow primarily within our core and from it to the lower blocks. While the lion's share of these commodities circulate within the core, the interblock exchanges follow a cascade pattern: all through the international system it is more likely to move from higher to lower strata. The standard image of core advantage in high levels of processing and capital intensiveness implies precisely this pattern (Chase-Dunn 1989; Firebaugh & Bullock 1987). The reciprocal pattern of exporting agricultural goods (crude animal and vegetable material, meat products) also fits this model: while intracore exchange is still very large, we find that interstrata exchange is more likely to move from the periphery to higher blocks, including the core. Highly industrialized capital-intensive agriculture is the exception in that it is mostly exported from higher to lower blocks.

Second, the recent declines in our core block's share of low-wage and simple manufacturing — and trade gradients that show these exports increasingly flowing from our semiperiphery — are consistent with the "new international division of labor" argument (Fröbel, Heinrichs & Kreye 1980). Emerging specialization in low-wage manufacturing (especially cloth and clothing-related industries) may help explain the existence of an advanced or upper semiperiphery and the differentiation of two semiperipheral roles in the world-system. For example, the upward mobility of countries with high clothing manufactures from the lower to upper semiperipheries supports Schneider's (1977) argument that cloth, clothing, and apparel are one of the major low-wage manufacturing industries that provide mobility in the semiperiphery in the world-system.

These various configurations of asymmetrical trade between strata may ultimately provide insights into the mechanisms of the observed patterns of the mobility of countries in the world-system. While the overall configuration of the international economy is remarkably stable between 1965 and 1980, there are clear-cut patterns of mobility for particular countries. Particularly notable is the erosion of a small U.S.-aligned and dominated core in 1965 that gives way to a larger and less U.S.-dominated core in 1970 and 1980. Note as well that the

United Kingdom appears to be slipping to a less central position within our core block, while Japan and West Germany move closer to the U.S. All this dovetails with qualitative descriptions of recent decline of U.S. hegemony and realignments in the core (see Amin et al. 1982).

The overall pattern of mobility (Tables 3, 4, and 5) is a trend toward ascension in the system, particularly in the semiperiphery and periphery. Overall upward mobility implies a growing core and shrinking peripheries and is consistent with other assessments of mobility and "dependency reversal" (Chase-Dunn 1983). Various types of upward dependent development in the semiperiphery appear to be linked to particular types of international specialization. Indeed, the continuity of Canada as a country designated "core" in this analysis — in spite of its dependency on the U.S. — suggests that certain types of dependency may be compatible with "coreness" and mobility in the world-system. More interesting still are the specific countries on the rise outside the core. Our analysis indicates that a number of countries, cited as examples of "dependent development" in the semiperiphery (i.e. Brazil, South Korea, Singapore), do in fact move from the lower to the upper intermediate strata, again consistent with more case-focused accounts (Cumings 1984; Evans 1979). Further research is underway examining export profiles of particular countries (Schwartzman 1988) and their location in specific trade nets (White & Smith 1988) that should provide more definitive answers to questions of mobility. Ultimately, network analysis of mobility patterns may yield results that have policy implications for export and industrial/agricultural strategies in Third World countries.

Obviously, we are convinced that quantitative analysis of global exchange is a powerful tool for understanding world-system structure and dynamics like national mobility. It provides an overview of global patterns and how they either change or stay the same. But we are fully cognizant that our analysis raises as many questions as it answers about more specific mechanisms underlying processes like mobility. For example, we agree with Walton (1985) and Evans and Stephens (1988) about the crucial role of politics and the state in determining development strategies and mediating international economic dependency. Explicit or implicit state policies, fashioned by elites under a variety of political and economic pressures, ultimately determine industrial and export strategies (Gereffi & Wyman 1990). These development strategies and the degree to which they are successfully implemented may lead to changes in export mixes and alter a country's structural position in the international economy. Understanding how national mobility in the world-system takes place (and, ultimately, recommending policy alternatives) requires linking the global external analysis of the type done here to research focusing on internal regional, national, and historical political economies. A multilevel perspective capable of unraveling such a complex reality requires both detailed case studies and the type of research reported in this article, as well as a willingness to integrate and articulate the multifarious results.

Finally, we hope that this article, with its focus on measurement and preliminary interpretations of the structure of the world-economy and how it changes, will contribute to a more complete political economy of the world-system by providing an image of global structure and dynamics useful to other comparative social scientists. Our results derive from data consisting only of the network of trade relationships; the representations of world-system structure arise solely from analysis of this network, and not from consideration of the economies and attributes of individual countries that are standard in the analysis of the international economy. Because this network analysis is a pure structural approach, we think our results provide a better set of strata and mobility variables for further research on the causes and consequences of global economy change.

Notes

1. An important exception is the lack of data on most Eastern Bloc countries. Without this information, we are unable to address the longstanding debate (relevant prior to 1989) over the existence of one unified world-economy or two — the one capitalist and the other socialist (Chirot 1977; Frank 1969; Galtung 1971; Szymanski 1982).

2. The actual commodity trade data used were obtained from the United Nations Statistical Office. 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).

3. A benchmark test of a blockmodel solution from regular equivalence methods could be designed using a modification of Noma and Smith's (1985) R^2 criteria on a reduced matrix of points by blocks. In this reduced matrix, values for pairs of points and blocks on each commodity would represent quantities of commodity trade with maximal trading partners in the block. The total unexplained sum of squares is the sum of squared deviations of the observed relations from the block means, for all blocks and all relations. The total sum of squares is the sum of all squared deviation from the grand mean. One minus the total unexplained sum of squares divided by the total sum of squares is R^2, the percent of variance explained by the assignment of actors to blocs. Computing regular equivalence R^2s for all possible partitions is prohibited for large matrices by the astronomical number of such partitions. The validity of regular equivalence partitions for smaller matrices can be evaluated by this means, however, as well as the effect of perturbing the results by reassigning individual points to different blocks. Since regular equivalence is based on an exact algorithm that must by definition approximate the case of the maximal regular equivalence R^2, only the R^2 from the final blocking solution will be computed here.

4. REDI shares many of the formal properties of the REGE algorithm developed by White (Reitz & White 1989; White & Reitz 1983) and available in MacEvoy and Freeman (1987). The version of the program used in this study was rewritten by White to run on a CRAY supercomputer.

5. In 1965, for example, GNP per capita accounts for 56.8% of the variance of the positional measure. Total volume of exports and total imports account for only 5.4% and 5.1% additional variance, respectively. About a third of the variance in the positional measure is not attributable either to magnitude of trade or GNP per capita. Magnitude effects thus do not appear to be major compared to the standard GNP per capita "development" index.

6. Once again, the concept of generalized position or role differs from the stricter notion of structural equivalence (Lorrain & White 1971; White, Boorman & Breiger 1976). In the latter notion, countries are structurally equivalent with respect to trade if they exchange the same commodities in like quantities with the same partners. Two perfectly structurally equivalent countries hold isomorphic or mutually substitutable positions in the world-economy. The more general conception of positional or role equivalence (White & Reitz 1983) is less restrictive. It does not require that equivalent countries trade with the *same* countries, but only that they trade with *equivalent* countries. For example, consider A and B who trade the same commodities in the same quantities with all the same partners except one. Whereas A buys machinery from C, B buys the same quantity of machinery from D. If we have already determined that C and D are equivalent, then the fact that A buys its machinery from C and

B from D does not diminish their role equivalence. In this definition, equivalence is deliberately recursive (Reitz & White 1989; White & Reitz 1983). By the logic of relational or "regular" equivalence, A and B might be perfectly equivalent yet not trade with any of the same partners, provided they trade with equivalent partners. Yet in practice, even in this expanded definition, no country is perfectly equivalent to another. The relational distance algorithm (REDI) computes the degree of approximation to role equivalence (0 relational distance) for each pair of countries.

7. For optimal scaling the distances are converted to similarity scores by subtracting all scores from 1. The more standard REGE measure computes similarities directly, but does not converge as rapidly, which is a disadvantage in large matrix computations. The optimal scaling program used here was rewritten by White for the CRAY supercomputer and verified against other versions.

8. Wallerstein's early formulations of the categorical nature of the core, periphery, and semiperiphery reflect his wariness of the idea of a world-system continuum. For instance, he explicitly argues (Wallerstein 1974:349) that, while "there are semiperipheral areas that are in between the core and the periphery on a series of dimensions," this stratum "is not the artifice of statistical cutting points" along indices of national development (see also Evans 1979b). Perhaps Wallerstein's preference for a discrete, discontinuous image of global hierarchy grew from an appreciation of the affinity between "modernization theory" and the uncritical use of gross national product per capita and other quantitative indices of "level of development."

9. There is not a one-to-one correspondence between the analysis presented in this article and that in Nemeth and Smith (1985) since the latter study included 22 more countries (in this article we only included cases with full data for all three years). Many of the countries in Nemeth and Smith's blocking (and particularly many in their periphery) are not in the present results. Since inclusion of different reporting countries can change the network position of their partners, the consistency of the pattern across these two studies is even more remarkable.

We only include countries with full temporal data to eliminate any possible methodological artefact of including different nations at different time periods. Our data, however, is much more complete for individual years. It includes 96 countries for 1970, for example (including some Eastern European countries). We are currently analyzing these more complete trade networks. Preliminary results indicate that the "missing" countries generally cluster in the expected blocks according to world-system expectations.

10. The separation of some of the large advanced European economies from the core in that same year seems to occur primarily because of the large gap between the four most central core countries and the other European countries. The clustering algorithm has selected a cutting point on distance criteria whose mapping to these country's global roles is arguable. It probably makes good sense substantively to redraw the boundary of the core to include the clump of points just left of the formal edge of the core block. Some peculiarities of the bunching near the middle of this plot is more difficult to explain: India and Argentina, for instance, are farther to the right and nearer to the core than might be expected.

11. Canada's consistent classification as part of the core block is interesting and perhaps perplexing: after all there is no question that it is a very "dependent" country. A reviewer suggested that perhaps Canada's core position is an artifact of its "almost unique trading and investment relationship with the United States." We can unequivocally state that this is not the case. Our network analytic approach places Canada and the United States close to each other because they have very similar commodity trade profiles when exchanges with *all* export and import partners are considered. This result indicates that both are trading heavily with other core nations, have commerce that is diversified over a range of commodities, are very likely to be exporting heavy manufactures and high technology, and exhibit a similar "core" commodity trade pattern.

This, however, does not deny the empirical reality of Canadian economic dependency. Hammer and Gartrell (1986) argue that Canada experienced massive investment by United States based multinational firms, particularly during a period of "American Corporate Imperialism" after 1960. They show that this foreign penetration, which they characterize as "mature dependency," has retarded long-term economic growth in Canada. But this situation is quantitatively and qualitatively different from dependency in the periphery, or even "dependent development" in the rising semiperiphery, and illustrates that "a country can be both a member of the core and dependent" (Hammer & Gartrell 1986:212). Classifying Canada in the core is also consistent with the alternative operationalization of zones in the world-economy based on relative mixes of productive activity (Arrighi & Drangel 1986; Chase-Dunn 1989).

12. Of course, our results provide only a broad morphological image of recent changes in the global economy. To demonstrate definitively that certain patterns of export manufacturing are linked to global mobility would require more in-depth case oriented research on the trade profiles of particular countries which are beyond the purview of this article (but, see Schwartzman 1988). Furthermore, export profiles emerge because of particular national industrial and trade policies, which, in turn, are the result of political and class patterns and dynamics within countries (Gereffi & Wyman 1990). A comprehensive understanding of international mobility involves retracing these links in order to integrate the broad "configurational analysis" (see Hamilton 1984) we have done, with historical-structural analysis of the political-economic dynamics of these societies.

13. Using non-world-system categories, Riddell (1981) reports that in 1979 67% of international trade value was exchanged between the more-developed countries with 30% of the world's population, while the trade between the remaining less-developed countries accounted for only 4% of the total. These figures are consistent with the data presented below on Table 7.

14. In earlier drafts we focused primarily on interpreting the index of asymmetry and trade between world-system blocks. A reviewer perceptively noted that this diverted attention from "diagonal analysis" of trade within blocks, particularly intracore exchanges. In order to formally incorporate this into Tables 6 and 7 we initially calculated a core versus noncore internal trade ratio by dividing the average value of intracore exchange by the sum of intrablock trade for the other strata. Logged this yielded a diagonal asymmetry measure parallel to the asymmetry measure for exports/imports. However, since intracore trade, with a few exceptions, is massive compared to other intrablock exchanges, these ratios tended to be uniformly large and difficult to interpret. Since intracore trade (and how it varies by commodity and year) is what really matters theoretically and dominates empirically, we opted to present the much simpler and readily interpretable intracore trade as a percentage of total averaged trade value in both tables.

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