Communication and Globalization: A Longitudinal Analysis of the International Telecommunication Network[1]

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ABSTRACT

This paper extends the theoretical arguments of the world-systems perspective to the emerging post-industrial society. Using survey data gathered by AT&T and published in the World's Telephones (1978-1990) and data gathered by the International Institute of Communication and published in TeleGeography (1991-1992), this paper describes the process of globalization by examining the changes in the international telecommunications network from 1978 to 1992. Based on network analysis, the results indicate that the system was relatively stable over this time period. In the late 1970s, the system was composed of a number of sub-groups. By 1980, it had coalesced into a single group with the United States and the other western economic powers at the center and the Eastern block and less developed countries in the periphery. Over time, the network slowly became denser, more centralized and more highly integrated. During the 1980s, the newly industrialized countries (NICs) of East Asia and the wealthier Latin American countries moved from the periphery of the network toward the center. Beginning in 1989, the former members of the Soviet block also moved from the periphery toward the center of the system, supplanting the wealthier countries from Latin America. The Asian NICs, however, retained their semiperipheral position.

THEORY

With the recent advent of computer-based communication technologies, communication networks have become an important factor in global interaction. The world in the information age may be described as being connected by a lattice of networks (Mulgan, 1991). Telephones, for example, provide the basic connection for social interaction between individuals, and the linkages both within and among nations, producing what Deutsch (1953) has called "a web of nations." This is first time in history that humans beings are able to realize the prospect of communication networks which link everyone in

the world (Dizard, 1989). In fact, information technologies now provide the basic infrastructure for an interdependent world, leading theorists to characterize the world as a "global village" (McLuhan, 1966).

The ongoing information revolution involving data storage, processing, transmitting and retrieval obviously affects all aspects of social, political and economic life. There are two major characteristics of the information age or post-industrial society: the information economy and transborder communication. While industrial society was based on the production of goods, the information society is built on the creation and distribution of information. The emergence of the information economy has led the expansion of the service sector as compared to the manufacturing sector. Statistics about the information economy are striking. According to Bell (1973), a total of 39.5% of the workers were in the service sectors (e.g., transport, trade, insurance, banking, public administration, personal service) in the 1960s. The proportion had increased to 47.6% by 1973. Porat (1977) also described the emergence of the information economy noting that by the 1970s,

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near half of the U.S. work force can be classified as information workers.[2] This trend has continued.

Frederick (1993) observed that worldwide telecommunication services during 1980s grew about 800%.[3] UNESCO reported, "that the total world information and communication economy in 1986 was $1,185 billion, about 8 to 9% of total world output, of which $515 billion was in the United States" (p. 58). Information has saturated every aspect of human life including international political, economic and social relations. In other words, information is the resource of power for countries' interaction with each other on the global stage.

Globalization, the other major characteristic of the information age, is the process of strengthening the worldwide social relations which link distant localities in such a way that local events are shaped by circumstances at other places in the world (Giddens, 1990). Thus, what happens in a local neighborhood is likely to be influenced by factors operating at an indefinite distance away from that neighborhood itself. The increase in transborder communication has led to the rapid global diffusion of values, ideas, opinions, and technologies. Transborder communication has changed our concepts of time and space (Giddens, 1990). Technologies have eliminated national boundaries and geographic separation and created a global community (Cherry, 1977; Pool, 1990; Frederick, 1993).

Wallerstein (1974) has argued that this process has been occurring in the economic sphere since about 1500. Other world- systems theorists (see below) contend that the

process of extending economic linkages to more distant geographical settings can be traced back at least to antiquity and even to the paleolithic era.

Giddens (1990) argues that globalization is an inherent part of modernization. One consequence of modernization is the increase in time-space compression which makes physical distance increasingly less important in social relations. Globalization stretches the boundaries of social interaction such that the connections between different social contexts or nations become networked

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across the earth as a whole. Indeed, as Barnett and Choi (1995) found in their analysis of the international telecommunication network, physical location accounts for only a relatively small percentage of the structure of this network, while cultural factors, such as language, account for a much larger percentage.

Along with the advancement of information technologies, the world can be divided into the information-rich and the information-poor countries. The global economy may be characterized by an unequal exchange between powerful information-rich and information-poor countries (Barnett, Choi, Jacobson & Sun, 1993). This gap between the "haves" and the "have-nots" in the global interaction is widening. In fact, a country's interaction patterns are associated with its levels of economic and political development (Sun & Barnett, 1994). These relations may be understood in the context of world-systems theory (Wallerstein, 1976; Chirot & Hall, 1982; Chase-Dunn, 1989; Knoke & Burmeister-May, 1990; Chase-Dunn & Grimes, 1995).

World-systems theory seeks to analyze long-term social changes by combining the study of societal level processes with the study of intersocietal relations. It challenges the assumption that nations are independent and that their development can be understood without taking into account the systematic ways in which societies are linked to one another in the context of a larger network of material and capital exchanges (Chase-Dunn, 1989).

World-systems theory focuses on the unequal distribution of power and goods in the capitalist world-system. It argues that an identifiable social system exists beyond the boundaries of nations and states. This social system is the global economic system. All countries are interrelated and linked in the world capitalist system and any change in an individual country is a result of events in the world-system. Economic relationships within the world-system are politically enforced and, as such, are relatively stable. This integration is a result of the interdependence and dynamic interaction among nation-states of uneven power (Chase-Dunn, 1992).

World-systems theory describes the global structure in terms of three types of structurally equivalent components: the core, the periphery, and the semiperiphery. In modern history, economic relationships exist among these components. Peripheral societies specialize in the production and export of labor-intensive, low-wage, low-technology goods desired by the core and the semiperiphery. In return, the core produces capital-intensive, high-wage, high-technology goods in order to export to the periphery and semiperiphery. The semiperiphery engages in both core-like activity (the exploiter), and peripheral-like activities (the exploited) in the world-system (Shannon, 1989). While there is some dispute regarding the classification of specific nations as core, semiperipheral and peripheral (Smith & White, 1992), a country's membership in one of these categories tends to be stable. Core countries stay at the center of the world's economic system and the peripheral states remain peripheral. What little change there is involves the semiperipheral societies, as they move toward the center or periphery depending on global social, political and economic factors.

The implications of world-systems theory are:

1. The structural position of a country determines its potential for development and its interaction patterns;
2. The structural position of a country is a result of its interactions with other countries;
3. There are two kinds of semiperiphery nations: a) core- like nations which are developing core-like dominance in the world-systems; and b) periphery-like nations which are losing major dominance in the world-systems;
4. The relationships among the nations in the network are relatively stable, changing only as the distribution of the modes of production change.

Traditionally, world-systems theory has ignored the exchange of information among the world's nations. Only recently has it been discussed in these terms (Barnett, et al., 1993; Chase-Dunn & Hall, 1994). This paper extends the theoretical arguments of the world-systems perspective to the emerging post-industrial society.

Clearly, the transition into an information based economy could serve as a catalyst to reorganize the world-system provided that this transition involves changes in the modes of production and their patterns of ownership. These changes could increase competition and conflict, create new scarcities of necessary resources, result in dependencies on new

types of production and the need for collective savings and investment in long term, large scale projects which would alter the structure of the global economy (Chase-Dunn & Hall, 1994). However, these changes have not occurred. The relations among the world's nations which have been described by world-systemss analysis for the industrial age (Snyder & Kick, 1979; Smith & White, 1992; Bollen, 1983) are quite similar for the emerging information age (Barnett, et al., 1993). Ownership of the information technologies is by the core, primarily the United States, Western Europe and Japan. Thus, world-systems theory would argue for stability in the international telecommunication network.

Galtung (1971) also describes international relations in structural terms. He proposes four rules for defining the structure of international interaction (communication): 1) international communication is vertical between center and peripheral nations; 2) interaction between peripheral nations is missing; 3) multilateral interaction involving all three is missing; 4) interaction with the outside world is monopolized by the center. In other words, "there is interaction along the spokes, from the periphery to the center hub; but not along the rim, from one periphery nation to another (Galtung, 1971, p. 97)."

Past research has characterized the international telecommunications system as a single interconnected group (Barnett, et al., 1993). At the center of this group are the English-speaking countries, United States

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and the United Kingdom, as well as the wealthier western European countries, Germany, France, Italy, Switzerland, Spain and the Netherlands. At the periphery are third world countries in the Pacific, Africa, Asia and Latin America, as well as, former Eastern-block countries. Consistent with world-systems theory (Wallerstein, 1976; Chirot & Hall, 1982; Knoke & Burmeister-May, 1990), the more connected and central a country is in the network the greater its Gross National Product per capita. Barnett, et al. (1993) report correlations as high as .56 between a country's connectedness and centrality in the network and its GNP per capita.

Further, Sun and Barnett (1994) report that a country's position in the international telecommunication network is also an excellent predictor of its level of democratization. Correlations ranged from .27 to .55 between connectedness, centrality and integration and political participation. Choi (1993) found a high degree of correspondence between the telecommunications network and the structure of international trade, mail flows and air traffic.

Barnett and Choi (1995) indicate that the language spoken by the inhabitants of the individual countries and its physical location accurately predict a nation's position in the international telecommunications network. Together, these two antecedent conditions

account for over 36% of the variance in the network's structure. Consistent with Galtung's (1971) structural theory of imperialism, they describe the network as being like a star or having a radial structure with the United States near the origin or center of the network. Near the center is the hub. It is composed of most Western European nations. Emanating from the hub are three spokes composed of regional neighbors; one for Latin America, a second for Eastern Europe and, a third for the Pacific, Asia and the Middle East. A nation's distance from the hub (center) is indicative of how peripheral they are such that the semiperipheral nations are closer to the hub.

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   Journal of World-Systems Research

The research reported in this paper addresses three questions:

- What is the structure of the world-system based upon international information flows?
- How has this structure changed over time, simultaneously with the emergence of the information age?
- How have the positions of the semiperipheral countries changed during this same period?

Specifically, this paper describes the changes in the international telephone network between 1978 and 1992. Given current trends in the information society such as globalization, it would be expected that over this period of time the system would become denser, more tightly connected and more highly integrated. However, world-systems theory would predict that the relations among the nations in the international communication network would remain relatively stable over this short period of time in spite of changes in the transition into an information based economy. Indeed, what little change that might have occurred would be among the relations of those countries characterized as semiperipheral (Chase-Dunn & Hall, 1994). During the 1980s, the semiperipherals were the newly industrial countries (NICs) of Asia including, Korea, Taiwan, Singapore and Hong Kong, and the more highly developed nations of Latin America including, Mexico, Brazil, Venezuela and Argentina. Additionally, the former socialist countries of Eastern Europe (i.e., East Germany, Poland, Hungary, Czechoslovakia and Russia) may be classified as semiperipheral because they are at the periphery of the capitalist world-system, in spite of their relatively high level of economic development (Knoke, & Burmeister-May, 1990; Bergesen, 1992). The changes in the relative network positions of these three sets of semiperipherals will be described.

METHODS

The changes in the structure of the international telecommunications may be examined through network analysis. Network analysis is a set of research procedures for identifying structures in social systems based

on the relations among the system's components (Rogers & Kincaid, 1981; Richards & Barnett, 1993). The method may be generalized to describe the patterns of communication among different social systems or nation-states. In this paper, we are concerned with the changing relations among societies from the late 1970s until the early 1990s. The specific relation of concern is the frequency of communication among nations mediated through telecommunications; for purposes of this research, the telephone, although these procedures may be extended to other forms of telecommunication (Barnett & Rice, 1985; Danowski & Edison-Swift, 1985). Network analysis has in the past been used to investigate the implications of world-systems theory (Snyder & Kick, 1979; Bollen, 1983; Smith & White, 1992; Barnett, et al., 1993).

The basic network data set is an `n x n` matrix **S**, where n equals the number of nodes in the analysis. A node is the unit of analysis. It may be an individual or higher level component, such as an organization or a nation. Each cell, sij, indicates the strength of the relationship among nodes i and j. In communication research, this relationship is generally the frequency of communication among the nodes. The frequency may be restricted to a particular topic, communication channel (the telephone) or language. For example, sij could be the frequency of communication over the telephone between i and j in German or French. **S** is symmetrical (sij = sji) when one is not concerned with direction. In those instances when the source and receiver of the information are differentiated, **S** is asymmetrical (sij `ne` sji). In this case, non-directional communication among nations using the telephone is examined.

The Data

International Telephone. This paper analyzes the changes in the international telecommunications network using 14 points in time, 1978 to 1992. The network is described annually with the exception of 1984. The data were gathered from two sources. The data from 1978 to 1990 were collected as part of a self-report survey by AT&T and published in

The World's Telephones (AT&T, 1990). The 1991 and 1992 data were collected by the International Institute of Communications and were published in TeleGeography (Staple, 1992).

AT&T asked representatives of countries to report the most frequently called countries and the number of messages sent. Since not all respondents reported the number of messages, the analysis of the network is based only upon the most frequently called countries. The data were reported in rank order of the number of messages and were treated in this way in the analysis. The ten most frequently called countries were reported. The links were coded 10 for the most frequently called country, 9 for the second most, 8 for the third, and so on.

In the 1978 data only the three most frequent countries were reported. The number increased to five for 1979. For 1980 to 1983 only the seven most frequent countries were reported. Between 1985 and 1990 the ten most frequently called countries were reported. A somewhat different set of countries responded to the survey each year. The sample sizes ranged from 85 in 1985 to 137 in 1979. Eliminated from the analysis were Puerto Rico, The Virgin Islands, The Channel Islands and the various South African homelands. The United Kingdom did not report its frequencies of international telephone calls in the AT&T data sets. However, since the reported data were directional, it was added as a node based on its rank as a receiver of telephone messages. The final sample sizes for each data set are reported in Table 2.

The 1991 and 1992 data were compiled by the International Institute of Communications (IIC) from an independent survey of telecommunications service providers (Staple, 1992). In some cases, traffic data were estimated based upon annual reports, government publications and industry interviews. They also consulted the following publications: Yearbook of Statistics (ITU, Geneva, 1991); International Fernsprechstatistik (Siemens, Munich, 1992); The World's Telephones January 1990, (AT&T, Indianapolis, IN, 1992); and The World's Telephones January 1989 (AT&T, Indianapolis, IN, 1990).

These data are reported in MiTT--Minutes of Telecommunication Traffic. MiTT refers to paid minutes of public voice circuit traffic including operator assisted calls. Depending upon national conditions, MiTT may include voice and non-voice (facsimile, slow speed data) traffic (Staple & Mullins, 1989).

Only 41 countries are included in TeleGeography 1992 (1991 data), including all European Common Market members. Missing are most lesser developed nations and former members of the Eastern Block. For example, South Africa is the only sample member from that continent and Hungary is the only representative from Eastern Europe. The number of links reported ranged from 8 to 20 with an average of 14.

In 1992, the sample was expanded to 51. Other former Eastern Block countries (Russia, Poland and Czechoslovakia) were added as were lesser developed countries from South

America (Peru and Columbia) and South Asia (Sri Lanka, Bangladesh and Thailand). The number of links ranged from 10 to 25 with an average of 15.

In spite of the problems of variable number of links and sample size, research indicates that the data are reliable (Barnett, et al., 1993). Network indicators (connectedness, centrality and integration) among 1982, 1986 and 1989 for 53 countries who reported their international calls for all three points in time correlated between .77 and .99.

Analysis Procedures

NEGOPY (Richards, 1989; Rice & Richards, 1985; Richards & Rice, 1981) was used to analyze the telephone network at each point in time. NEGOPY is a computer program for communication network analysis (Rogers & Kincaid, 1981) which examines the cohesion among the nodes. It provides communication role indicators (e.g., group member, isolate, attached isolate, liaison or tree node [4]) for each node and continuous measures of the

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relations among the nodes including connectedness, centrality and integration, as well as, overall network characteristics, such as system density. The program was run with default parameters without specifying directionality. For 1991 and 1992, two MiTTs were required as the minimum link strength.

Centrality is the mean number of links required to reach all other nodes in a group, such that the lower the mean the more central the node. The use of NEGOPY's continuous measure of centrality is consistent with recent advocates of world-systems theory (Smith & White, 1992). Chase-Dunn (1989, p. 207) asserts that, "the core/periphery dimension is a continuous variable". This is somewhat at odds with Wallerstein's (1974) original formulation of discrete boundaries between the core, semiperiphery and periphery countries. This implies there are discontinuities in the world hierarchy, thus suggesting a discontinuous measure of centrality.

NEGOPY's measure of centrality does not consider the strength of links (frequency of communication) among nodes. It accounts only for the number of links required to reach each of the other nodes in the network. An alternative is Bonacich's (1972) measure of centrality. It considers the strength of the relationships among the nodes by taking the eigenvector of the largest eigenvalue of matrix **S**, standardized so that its length is equal to the eigenvalue. The loadings on this vector indicate a node's centrality. The algorithm from UCINET IV (Borgatti, Everett & Freeman, 1992) was employed to determine the countries' centrality for 1992.

Connectedness is simply defined as a node's number of links. Integration is the proportion of a focal node's links that are connected to one another. Density is the actual

number of links divided by the number of possible links [n(n-1)/2] (for non-directional data). Each of these measures indicates the state of the system (level of globalization) at a single point in time.

To describe how the network is changing over time, the node level indicators can be averaged and then longitudinal patterns observed. These trends may be verified through regression analysis (indicator over time). Similar procedures were used by Danowski and Edison-Swift (1985) to examine changes in an organization's telecommunication network in response to a crisis. Due to the process of globalization, it is expected that the system should become denser and more highly integrated over time. That is, the social relations (links) within the worldwide telecommunications network should become strengthened over time.

RESULTS

Description of Network

Table 1 presents the connectedness, centrality and integration for the individual countries for one point in time -- 1992. The results are similar to those reported by Barnett, et al. (1993) and Sun and Barnett (1994) except that there are only 51 nodes. Missing from the data are large numbers of lesser developed countries. However, because there are fewer nodes the overall structure is easier to discern.

TABLE 1
INTERNATIONAL TELECOMMUNICATIONS NETWORK -- 1992

	links	row mean	centrality standard distance	Bonacich eigen	integration
United States	48	1.00	-3.116	95.53	.324
United Kingdom	44	1.08	-2.716	34.67	.367
Germany	40	1.17	-2.315	30.61	.400
France	37	1.23	-2.014	17.98	.417
Italy	36	1.25	-1.914	18.54	.430
Canada	31	1.35	-1.413	73.93	.439
Switzerland	25	1.48	-.812	11.31	.657
Netherlands	24	1.50	-.712	9.19	.656
Spain	23	1.52	-.611	7.73	.553
Australia	22	1.54	-.511	6.08	.563
Sweden	22	1.54	-.511	3.89	.723

Belgium	22	1.54	-.511	5.64	.710
Japan	21	1.56	-.411	14.28	.614
Denmark	18	1.63	-.110	2.48	.791
Norway	17	1.65	-.010	3.89	.809
Taiwan (ROC)	16	1.67	.090	6.03	.792
Singapore	16	1.67	.090	1.95	.767
Hong Kong	16	1.67	.090	6.78	.758
Austria	16	1.67	.090	5.10	.892
Portugal	16	1.67	.090	2.38	.758
Turkey	15	1.69	.190	4.23	.819
Russia	15	1.69	.190	1.14	.771
Poland	15	1.69	.190	2.38	.905
China	14	1.71	.290	3.03	.857
Hungary	14	1.71	.290	1.27	.857
Czechoslovakia	14	1.71	.290	1.66	.934
Thailand	13	1.73	.391	1.24	.872
South Korea	13	1.73	.391	7.70	.872
India	13	1.73	.391	4.34	.769
Greece	13	1. 73	.391	2.67	.872
Brazil	13	1.73	.391	5.18	.603
Malaysia	12	1.75	.491	0.90	.879
Indonesia	12	1.75	.491	0.75	.803
Israel	12	1.75	.491	4.97	.818
Finland	12	1.75	.491	1.03	.939
Mexico	12	1.75	.491	41.30	.788
Argentina	12	1.75	.491	1.18	.636
Philippines	11	1.77	.591	7.46	.782
Luxembourg	11	1.77	.591	1.04	1.000
Ireland	11	1.77	.591	3.76	.873
Venezuela	10	1.79	.691	2.63	.733
New Zealand	9	1.81	.791	1.02	. 944
South Africa	9	1.81	.791	1.35	.917
Peru	7	1.85	.992	2.73	.667
Columbia	7	1.85	.992	5.67	.905
Saudi Arabia	6	1.88	1.092	1.35	.733
Iceland	5	1.90	1.192	0.26	1.000
Chile	5	1.90	1.192	0.58	.900
Uruguay	3	1.94	1.393	0.08	1.000
mean	16.9	1.65		9.14	.752
s.d.		.208		17.57	

n = 49 (Sri Lanka and Bangladesh are isolates)

total links = 828

The results from NEGOPY indicate that the network is compose of a single group with the United States and the western economic powers--United Kingdom, Germany, France, Italy and Canada at the center, and the LDC's (Uruguay, Peru, Columbia, Saudi Arabia, and Chile) at the periphery (See Table 1). Japan is the least central of the core countries, perhaps due to its location in East Asia. Sri Lanka and Bangladesh are not group

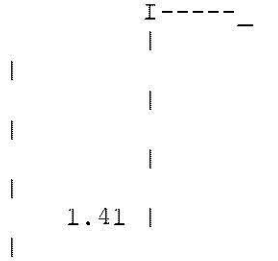
members. They may be classified as attached isolates with links only to the United Kingdom. The system is relatively dense (.352), with about one in three possible connections present.

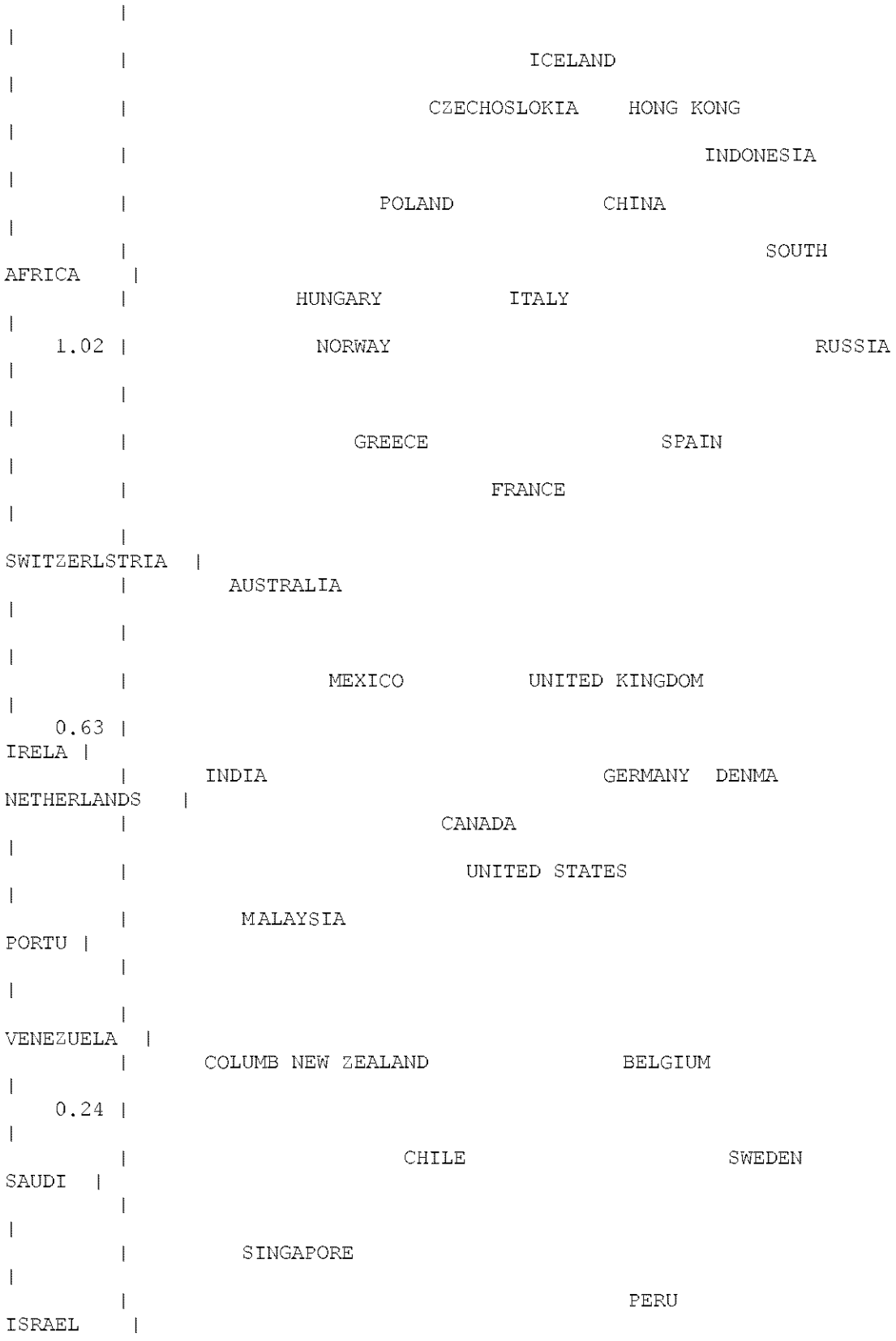
Bonacich's measure of centrality is also presented in Table 1. Worth noting are the differences between the two centrality measures. NEGOPY's results are Eurocentric in the sense that it places the UK, Germany, France, Italy, Canada, Switzerland, the Netherlands and Spain at the center directly after the United States. Bonacich's measure is centered more about the United States. Due to Canada's and Mexico's great frequency of interaction with the United States, they are ranked as the second and third most central countries in the system followed by the core European countries. Japan is more central by the Bonacich measure, moving from the thirteenth to eighth most central, supplanting Switzerland, the Netherlands and Spain. The other European nations are more peripheral, while the Latin American countries are somewhat more central.

Overall, the two measures correlate .71 ($F = 48.12$, $p < .001$). Both measures correlate significantly with GDP per capita. The coefficients are: .624 ($F = 29.31$, $p < .001$) for NEGOPY and .438 ($F = 10.90$, $p < .001$) for the Bonacich measure.

Figure 1 presents the two-dimensional results of a multidimensional scaling of matrix **S** (the frequency of communication--1992) obtained from the non-euclidian metric MDS algorithm from UCINET IV (Borgatti, et al., 1992). These two dimensions account for 70.1% of the variance in the network. At the center of the figure are the United States, United Kingdom, Canada, Germany and France. Around the periphery are Uruguay, Ireland, South Africa, Hungary, Turkey, Luxembourg, Malaysia, Philippines, Indonesia, Saudi Arabia, Columbia, Iceland, Sri Lanka and Bangladesh. These countries are relatively less economically developed than the countries at the center of the network and thus are consistent with world-systems theory. Worth noting is Japan's location among the peripheral Asian countries.

FIGURE 1
INTERNATIONAL TELECOMMUNICATIONS NETWORK 1992
METRIC MULTIDIMENSIONAL SCALING

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GREECE
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CANADA
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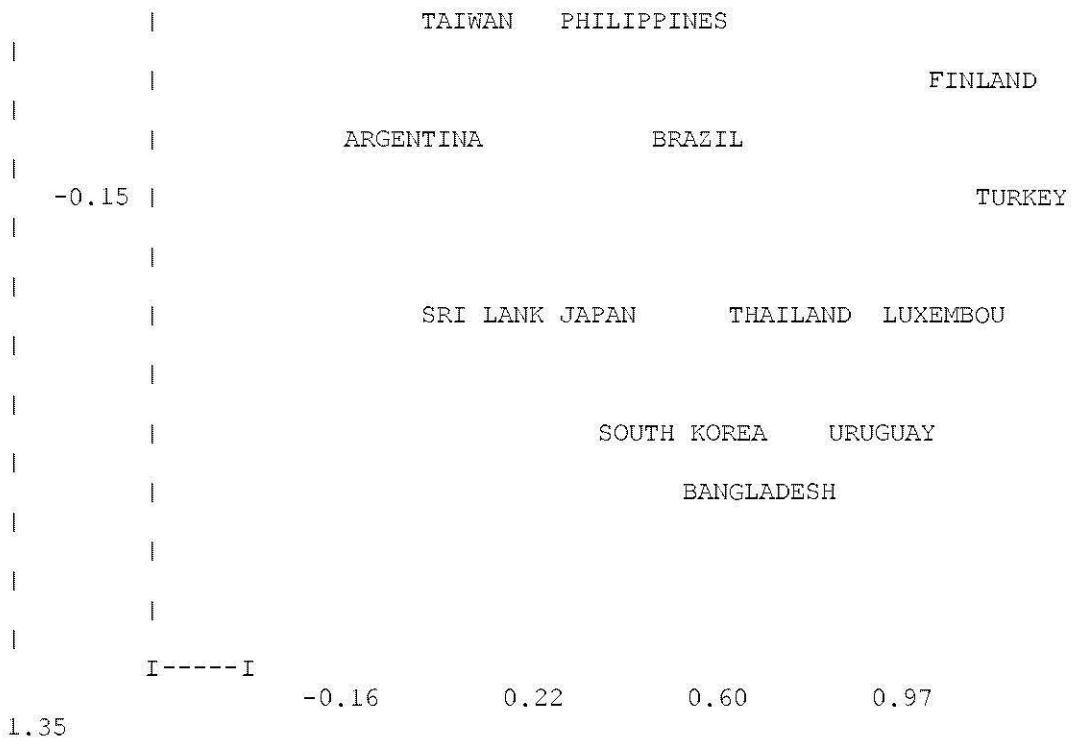


Longitudinal Results

Overall, the network remained relatively stable over the period of investigation. In 1978, the network was composed of six groups with extensive connections among them. The six groups were: 1) Southwestern Pacific Islands and Australia; 2) Caribbean; 3) Western Hemisphere and the Netherlands, United Kingdom, English-speaking Africa, the Middle and India; 4) Scandinavia; 5) Europe, French-speaking Africa and Pacific Islands; and 6) East Asia. Also, the network included 18 countries which NEGOPY identified as liaisons. There were 156 links (45% of a total of 344) among the six groups.

A year later in 1979, the network coalesced into two interconnected groups, one with 120 countries and including most of the world (groups 1 through 5 from 1978) and another made up of 14 East and South Asian countries (group 6). Again, there were extensive ties (33 links) among the two groups, mainly through core countries (United States, United Kingdom, Germany, Italy and Canada). Since 1980, however, the network has consisted of a single group.

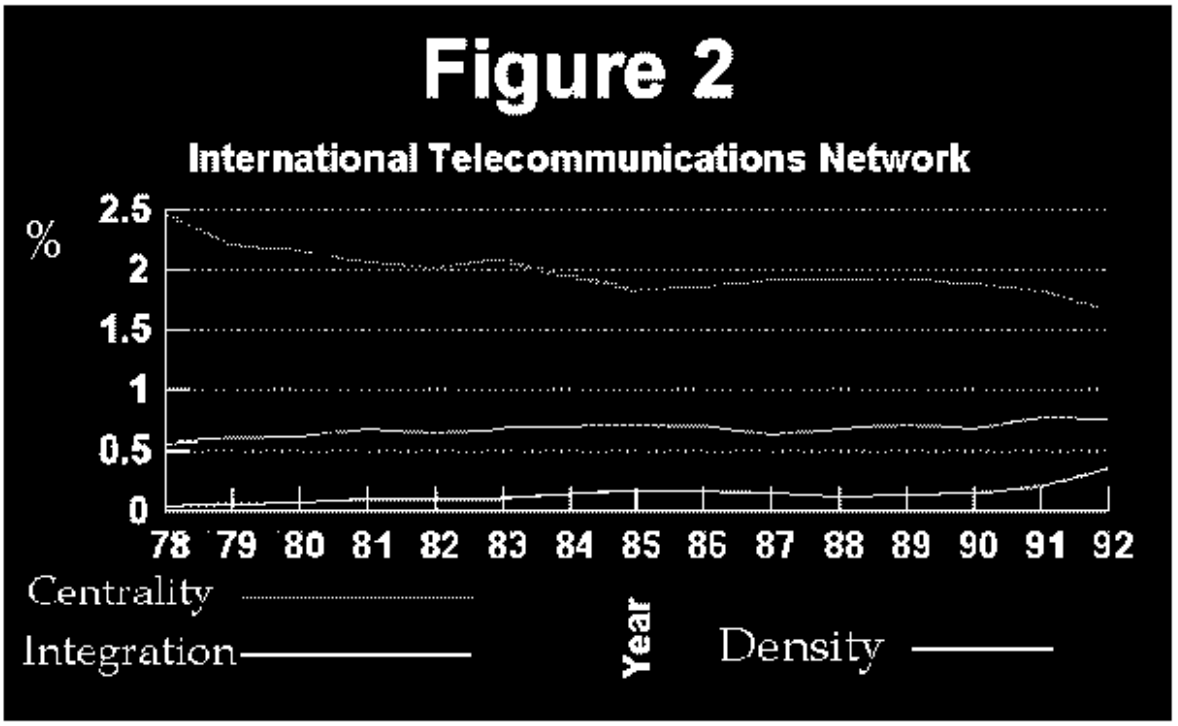
Table 2 and Figure 2 present the density, and the average centrality and integration for each of the 14 points in time -- 1978 to 1992. While these indicators show that the network is changing, the rate of change is relatively slow.

TABLE 2

International Telecommunication Network 1978 -1992

Date	Centrality	Integration	Density	N
1978[1]	2.46	.555	.042	126
1979[2]	2.21	.594	.060	137
1980	2.15	.613	.073	107
1981	2.06	.672	.100	101
1982	2.02	.630	.092	111
1983	2.08	.670	.094	107
1985	1.84	.710	.173	83
1986	1.85	.700	.166	86
1987	1.91	.617	.140	102
1988	1.91	.674	.127	97
1989	1.92	.705	.133	93
1990	1.88	.674	.144	78
1991	1.83	.765	.211	41
1992	1.65	.752	.352	51
r2	0.775	.664	.662	
F	41.25	23.75	23.48	
a	2.30	.579	0.023	
b	-0.042	0.011	0.015	

Data Source: 1978-1990 AT&T, The World's Telephones 1991, 1992 IIC, TeleGeography 1992, 19931. 1978 was composed of 6 groups.
2. 1979 was composed of 2 groups.



Density. The results indicate that the network has been getting denser over time ranging from .042 (1978) to .352 (1992), a change of 31.0%. Annually, this amounts to an average change of only 1.5%. A linear regression of density over time was significant ($r^2 = .66$; $F = 23.48$, $p < .001$).

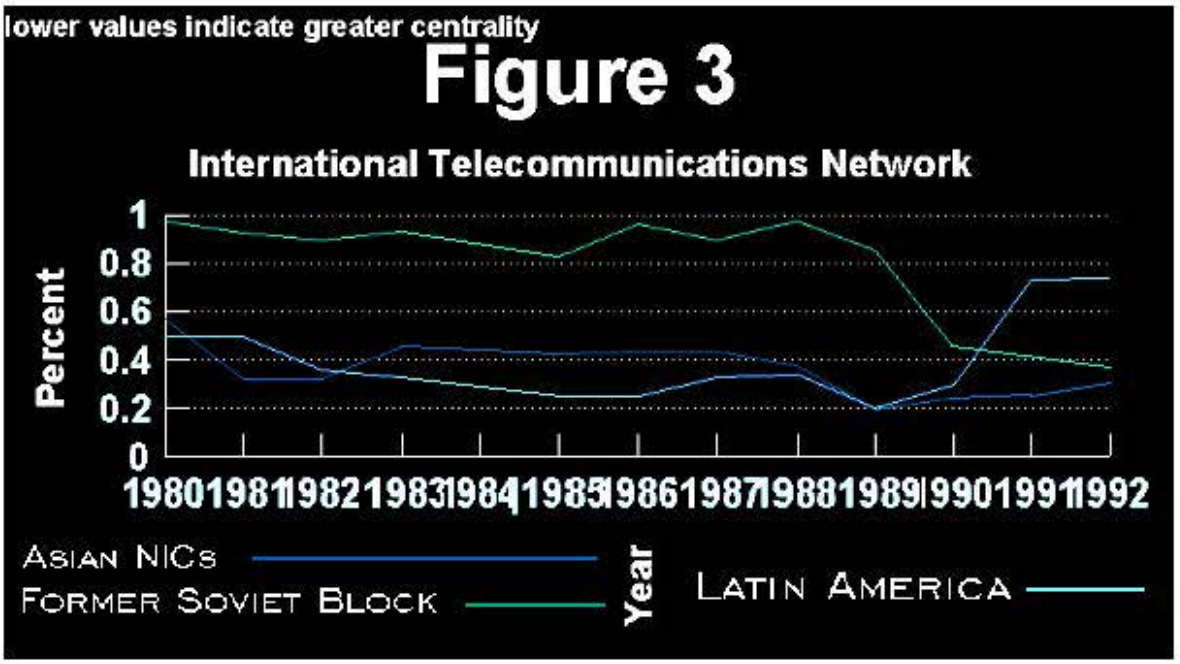
Centrality. The network has become more centralized. In 1978, the average mean number of links according to NEGOPY required to reach each other node was 2.46. It declined to 1.65 by 1992. A linear regression of average centrality over time was significant ($r^2 = .78$; $F = 41.25$, $p < .001$).

Integration. The network has become more highly integrated over time. The average proportion of a node's links that are interconnected has increased from .555 in 1978 to .765 between 1980 and 1991, a change of 19.7%. In 1992, it declined to .752. Annually, the average change is only 1.1%. A linear regression of average integration over time was significant (r-squared = .66; $F = 23.73$, $p < .001$)

Throughout the 1980s, the core, semiperiphery and periphery were composed of the same members. At the center were the English-speaking countries, United States, the United Kingdom and Canada, the wealthier Western European countries, Germany, France, Italy, Switzerland, Spain and the Netherlands. At the periphery were the third world countries in the Pacific, Africa, Asia and Latin America, as well as, former Eastern-block countries. Between the these two categories were the semiperipheral countries.

Over time, there was some movement among the semiperipheral countries. To examine the changes in centrality of these countries, the percentiles of their ranks on centrality (according to NEGOPY) were determined annually between 1980 and 1992. They were not determined for 1978 and 1979 because the network was composed of more than one group. Next, three group mean percentiles were calculated, one for the newly industrial countries (NICs) of Asia (South Korea, Taiwan, Hong Kong and Singapore), another for wealthier countries of Latin America (Mexico, Venezuela, Brazil and Argentina), and a third for the former members of the Soviet block (East Germany, Poland, Hungary, Czechoslovakia and Russia [USSR]).

It was necessary to examine the centrality of a group of nations rather than those of individual countries for two reasons. First, the classification of specific countries as semiperipheral is open to debate. Second, data were not available for all individual countries at each point in time. For example, there are no data for East Germany after 1989 when it ceased to exist. As a result, the individual centrality rankings are somewhat unstable and the tracking of single countries difficult. By aggregating among countries the overall patterns of change become easier to observe. The changes in the centrality for these three groups are presented in Figure 3.



Over time, the newly industrial countries of Asia became more central. In 1980, their average percentile was .568. During the middle of the decade it had dropped to between .455 and .375. By the end of the decade, it was about .20. The overall trend indicates movement from the periphery of the network toward the center (r-squared = .47, a = .532, b = -.026, $F = 6.21$, $p < .05$).

The Eastern European countries also became more central during this period. However, their change occurred at a later point in time. During most of the decade, they were at the periphery of the network. Between 1980 and 1989 their average percentile ranged between .973 and .828. 1989 marked the breakup of the Soviet Union. After this date, there was rapid movement toward the center of the network as these countries became integrated into the world capitalist economy. In 1990, the percentile centrality dropped to .452, and by 1992, it had reached .382. The overall trend indicates movement from the periphery of the network toward the center (r-squared = .50, a = 1.08, b = -.038, F = 8.99, $p < .05$).

The pattern for the Latin American semiperipherals is more interesting. In the early 1980s, these countries were relatively peripheral. Their percentile centrality was .50 in 1980 and 1981. It dropped to a range between .36 and .25 between 1982 and 1988, reaching its most central level, .2, in 1989. After this date, the Latin American countries moved toward the periphery. In 1991 and 1992, their percentile centralities were .73 and .74, respectively. An examination of Figure 3 suggests that these countries' positions in the world's communication system was supplanted by the new democracies of Eastern Europe. The breakup of the Soviet Union seems to have provided the impetus to reposition the former Eastern Block toward the center of the network as they formed direct links to the core countries in Western Europe. At the same time the Latin American countries were forced to the periphery as the Eastern European countries took over their location in the network.

DISCUSSION

This paper raised three research questions. The discussion of the results of the data analysis will be organized to answer these questions. The first question asked, "What is the structure of the world-system based upon international information flows?" As demonstrated by the 1992 data, the structure of the international telecommunications network is consistent with world-systems theory. The results indicate that the network is composed of a single group with the United States and the other Western economic powers at the center and the lesser developed countries at the periphery. A nation's centrality in the network is significantly correlated with its GDP per capita.

These findings are similar to Smith and White (1992) who examined commodity trade flows and also found a single core/periphery dimension. At the center were United States,

Western Europe and Japan. At the periphery were the lesser developed countries in Latin America and Africa and between these two groups were nations generally classified as semiperipheral. The correlation of a country's position on the core/periphery dimension with its GNP per capita ranged from .76 to .81 depending on the year.

The second question was, "How has this structure changed over time, simultaneously with the emergence of the information age?" As predicted by world-systems theory, the international telecommunication network was relatively stable over the period 1978-1992. The core, semiperiphery and periphery were composed of the same countries, although there was some movement among the semiperipherals.

Smith and White (1992) also report a high level of structural stability among the core, semiperiphery and periphery for commodities between 1965 and 1980, in spite of the 1973 oil shock, the rise of the new international division of labor and the emergence of a number of newly industrial countries. The changes that did occur included the expansion of the core and extensive movement among the semiperiphery.

As suggested by Chase-Dunn and Hall (1994), technological changes in communication have facilitated the incorporation of small-scale systems into a single global network. This occurred prior to 1980. Further, as the world moved into the information age, the network slowly became denser, more centralized and more highly integrated. In other words, globalization was taking place.

The international telecommunication network became more centralized throughout this period. This indicates that an increasing amount of information

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is flowing through the core countries rather than being exchanged directly among more peripheral nations. This is consistent with Galtung's (1971) structural theory of imperialism. It suggests that the core nations are maintaining and perhaps enhancing their positions of economic power as the modes of production change from industrial to informational.

While these findings are intriguing, data quality problems prevent us from making precise predictions about the future of the network (Rietveld & Janssen, 1990). As a result, only general trends in the data were identified. The poor quality of the data prevented a more sophisticated analysis of the changes in the network over time. This analysis was conducted primarily with the rank orders of contacts for a limited number of nodes. Furthermore, a somewhat different set of countries made up the data set at each point in time. Thus, little can be said about the changes in network position of specific countries. They can only be described by the grossest of patterns.

Furthermore, these conclusions should be viewed with some caution. The number of reported contacts varied over time. It grew from three countries in 1978, to five in 1979, seven in 1980 and ten in 1985. In 1991, it was almost fourteen and in 1992 each country had an average of fifteen links. The increase in the number of links may influence the functions which describe the changes in the network.

Also, the number of countries in the analysis fell from highs of 126 and 137 (1978 & 1979), to lows of 41 and 51 (1991 & 1992). As the number of nodes in a socio-matrix decreases, as with these data, the measure of connectedness tends to go up, the measure of integration tends to increase and the measure of centrality changes likewise. These trends are observed in the data, but they may be no more than an artifact of the variable sample size and might not be regarded as evidence of the social process of globalization.

The 1991 data set consisted of only 41 countries and 1992 was composed of only 51 nations. These countries were generally the developed or newly industrialized nations who are somewhat more tightly interconnected. Thus, these data may bias

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the findings by suggesting that the overall network is denser than it might really be and that the over time trend toward a denser, interconnected, centralized network is stronger than may be the case. In other words, the evidence for globalization is weaker than the results might suggest.

While it would be ideal to construct a data set composed of the same countries over the entire fifteen year period, problems with sampling prevent the application of this procedure. So few countries are members of the sample at all points in time that the data would be insufficient to describe the international telecommunications system from a world-systemss perspective. For example, the United States is the only core country present in the sample for all data points. No African country is present at each time point.

The third question asked was, "How have the positions of the semiperipheral countries changed during this same period?" Through out the 1980s, the newly industrialized countries of Asia became more central in the network. Throughout most of the decade, socialist Eastern Europe was at the periphery of the international telecommunication system. However, at the end of the decade, they became more central. The Latin American semiperipherals became more central by the middle of the 1980s, but with the break up of the Soviet Block, their position in the world communication system was supplanted by the Eastern Europeans.

These findings raise an additional question, "What is the relationship between the structure of international communication and other patterns of relations among the countries of the world? Snyder and Kick (1979) found that the nations of the world could

be structurally differentiated into core, semiperiphery and periphery based on trade, military interventions, diplomatic relations and treaty memberships. While they used block modeling to differentiate the countries, the ones they labeled as core were also the most central in our analysis. Those they labeled as semiperiphery were moderately central and likewise, those identified as periphery were peripheral in the communication network. Again, Smith and White (1992) report similar findings when examining commodity trade flows.

Barnett and Wu (1995) examined international student exchanges for 1970 and 1989 using data from UNESCO. Consistent with the results reported in this paper, they found a single group differentiated by a center to periphery dimension for both years. The United States, Canada, United Kingdom, Germany and France were at the center and the LDC's at the periphery. The correlation between centrality in the international education network and GNP per capita for 1989 was .661. Change in the network was a result of changes in historical, economic and cultural factors.

Kim and Barnett (1996) examined the structure of international news flow and found it also could be described by a center to periphery dimension. At the center were the Western industrial nations with the LDC's at the periphery. Along with economic factors, the structure was predicted by physical location, language and political freedom.

In the most comprehensive analysis of the relationship between the telecommunications network and the patterns of other international relations, Choi (1993) examined trade, air traffic and mail flows among nations. He found similar structures among all four networks. The correlations between the measures of centrality were: .70 for communication and trade; .57 for communication and transportation; and, .52 for communication and mail.

The similarity between the international communication network and other global structures may facilitate speculation about the reasons behind the changes among the relative positions of semiperipheral nations. Clearly, telecommunications does not occur in a vacuum. As Eastern Europe opened for trade with the core economic powers in North America, Western Europe and Japan, communication links were established and intensified. Capital investment was increased, perhaps at the expense of Latin America. Indeed, one of the factors behind the collapse of the Mexican economy in 1994 was capital flight. Perhaps, these moneys were relocated to Eastern Europe because the core felt that this region represented a greater potential return on investment. To examine this hypothesis, the structure of international

monetary flows should be examined. It may be suggested that the changes in the relative positions of Latin America and Eastern Europe in the telephone network parallel changes in international monetary flows.

Prior research also suggests other reasons for the increase in centrality of the Eastern European countries. Cultural factors, such as language, account for a much larger percentage of the variance in the structure of international communications. Culturally, Eastern Europe is much more similar to the core countries than Latin America. Thus, with the political and structural barriers to communication removed, we would expect the links among the European countries to grow stronger.

There has been much speculation in the world-systems literature that the United States's position as the core hegemon is declining (Wallerstein, 1993; Chase-Dunn & Grimes, 1995). An examination of international communication network fails to support this position. The United States has remained the most central nation in the world communications network. Further, one might consider the transition of the American economy from industrial to post-industrial as a manifestation of continued centrality. By redefining the mode of production, such that the value of informational products are worth more than industrial products and placing these products in the global marketplace, the United States is sustaining its hegemonic role in the world economic system.

Recent writings examine the cyclical nature of certain world-systems processes (Weber, 1983; Chase-Dunn & Grimes, 1995). Economic cycles result from the introduction of new sets of products, such as computers and telecommunications technologies. They are introduced and sell well, which expands the market and related employment and consumer spending. Eventually, the market becomes saturated, sales drop, income contracts and workers are laid off. Cycles of three lengths have been identified. 1) The Juglar or normal business cycle which lasts seven to ten years. 2) The Kuznets cycle is 20 to 25 years long and may be considered a generational cycle of investment. 3) The third is the Kondratieff cycle, a 40 to 60 year cycle which results from the periodic rebuilding of societal infrastructure

incorporating new technologies.

The argument could be made that the information revolution and its related technologies should be the impetus to stimulate an upswing in any (or all) of the three cycles. These economic changes would manifest themselves as changes in the structure of the world communication system. The frequency of communication among the system's nodes would increase. The network would become denser and more highly integrated. Given

that the technologies originate in the core countries, the system would also become more highly centralized.

This argument, however, cannot be tested at this time. There is insufficient data to determine the existence of the proposed cycles. Data on the structure of the communications network exists for only fifteen years. This is less than the minimal time required to determine the presence of any of the cycles in the data (Arundale, 1980). Future research will continue to track the international telecommunication network as more current data becomes available.

The telecommunications network will be compared to other communications networks which have complex relationships to telecommunications. For example, the use of telex is declining as facsimiles sent over telephone lines replace the older communication channel. Indeed, recent research by Ahn and Barnett (1995) indicates that the international telex network has become more sparse. The density among approximately 200 countries dropped from .238 to .213 between 1981 and 1991. In addition, the telex network has become less centralized and connected by weaker (less frequent) links.

Future research will continue to investigate other international networks such as trade (Choi, 1993), transportation (air traffic), migration, mail (Choi, 1993), student exchanges (Barnett & Wu, 1995) and tourism to examine how changes in these networks compare to and impact the changes in the telecommunication network. As data become accessible, this research will be extended to the international exchange of video and perhaps most importantly, to computer networks such as the Internet. Finally, the authors have recently begun to examine international monetary flows. These data can then be compared with trade and communication data to help resolve a number of the questions posed in this paper.

NOTES

1. Previous drafts of this paper have been presented to the Sunbelt Social Networks Conference/International Network of Social Network Analysts, Charleston, SC, February, 1996 and the International Communication Association, Chicago, May, 1996. The authors would like to thank the reviewers of earlier drafts of this paper for their insightful comments.

2. Information workers are those whose main job activity is the production, processing or distribution of symbols (Porat, 1977).

3. Telecommunication services come from that sector of the economy that processes and disseminates information (Frederick, 1993). It includes computing services, data

processing, software, on-line data bases, computer communications services, postal services and telecommunications common carriers (telephone, telegraph and telefax).

4. A group member is a node whose majority (50.1%) of links are with other members of a group. An attached isolate is a node with only a single link to another member in the network. A liaison is a node that has most of its interactions with members of groups, but not with members of any one group. They provide direct connections between the groups which they connect. A tree node is a member of a system who serves as the primary branch connecting the rest of the network to attached isolates. If a tree node were removed from the system, the nodesit connects to the network would become isolates.

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