Cyber-Space and Post-Industrial Transformations:

A Cross-National Analysis of Internet Development.

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ABSTRACT

At century's end, a combination of telecommunications and computer technologies has resulted in the creation of the Internet, a global network of computers that has been growing at an exponential rate. Although the Internet/World Wide Web combination is widely hailed as a new, powerful engine of global social and economic change, there has been very little sociological theorizing and even less sociological research on the globalization of the Internet. Using classical macrosocial theories of development as a springboard, we hypothesize that the level of development, political openness/democracy, mass education, the presence of a sizeable tertiary/services sector, and interactions between some of these variables will drive the Internet's growth and spread around the globe. In our cross-national analysis of approximately 75 developed and developing countries, we find that Internet capacity is not in fact a simple linear function of economic and political development, but rather has been driven by complex interactions that could aptly be termed “post-industrialism.” Uncovering some of these structural preconditions and determinants of Internet diffusion provides a first step toward providing a theoretical and empirical sociology of this "third technological revolution."

INTRODUCTION

One of the more profound technological revolutions occurring at the end of the twentieth century is the elegant blending of telecommunications and computer technology known as the "Internet." Evolving from humble beginnings as a U.S. Department of Defense project in the 1960s (i.e., the ARPANET) to a mass-production/consumption technology propelled by the World Wide Web, the Internet is rapidly outgrowing its former role as a specialized tool of governmental and educational elites. Today there is the growing perception that the Internet/WWW has become a new, powerful engine of global social and economic change, and as such its spread around the globe as well as its social implications are ripe topics for sociological analysis.

The Internet's sociological relevance follows on both pragmatic and theoretical grounds. The economic importance of new information technologies to "post-industrial" nations can hardly be overestimated, given that on average over half of economic production in OECD countries is generated by knowledge-based industries. The social impact of Internet usage is no less important, with increasing attention being paid to social inequalities in usage, the urban morphological changes attendant on telecommuting, global homogenization of national cultures, the social isolation/loss of community encouraged by web "surfing," and shifts in social organization brought about by the "electronic cottage" (United Nations 1999:57-76; Marien 1996; Mitchell 1995; Schiller 1992; Slouka 1995; Toffler 1980).

The global spread of the Internet also holds important theoretical ramifications. In essence, the theories that shape our current understanding of society were forged in the industrial crucible of the nineteenth century. Whether we are discussing Durkheim's (1893) organic and mechancial solidarities, Tonnies' (1963) gemeinschaft and gesellschaft, Marx' industrial

capitalism ([1867] 1967) or more contemporary notions such as modernization theory's "logic of industrialism" (Kerr et al. 1960), the abilities of current macrosocial theories to shape future social thought are challenged by what Daniel Bell (1989) has called "the third technological revolution." In discussing this post-industrial revolution, Bell (1973) argues that post-industrial societies are dominated by large information-driven economies run by a new class of technically and scientifically skilled workers who manipulate and process theoretical knowledge for the formation and maintenance of social and economic production and policy. Fundamental to Bell's analysis is the dissemination of information as the fulcrum for social processes in the post-industrial society. Certainly the post-industrial society retains elements of gesellschaft, such as complex networks of instrumental relations based on rationality, meritocratic achievement, specialization, objectivity, standardization and individualism, but these become extended and reshaped via an entirely new media -- telecommunications technology. Information sharing becomes the major form of economic and social sustenance for large segments of post-industrial populations.

Put in the formal language of human ecology, this means that the creation and processing of information becomes a new key function in the post-industrial society. Hawley defines a "key function" as a set of institutions that comprise a society's social organization devoted to deriving sustenance from the broader resource environment (Hawley 1950). Due to the powerful constraints of tight interdependencies, all key functions have far-reaching power to regulate, dominate and/or transform social organization. Changes in the primary system of subsistence inevitably "ripple" through the entire web of social relationships and institutional arrangements, isomorphic pressures that force the institutional/organizational matrix to re-create itself to promote efficiency and functional integration.

This is important because ecological theory asserts that different types of key functions promote different types of social organization. Applying this logic to the question at hand, the key functions of a technologically advanced and organizationally complex society are increasingly social, in that the manipulation of social goods and services is the currency that makes or breaks post-industrial endeavors. During the industrial revolution, highly specialized roles and relations emerged around complex production and trade processes; in essence, industry and trade comprised the key function while administrative centers, employers and employees served as coordinating units. According to the post-industrial thesis, however, the increasing reliance on adequate and timely information by social actors is the new sine quo non of competitiveness and social change, meaning that information creation/dissemination comes to replace industrial production as the major sustenance activity for post-industrial populations, thereby constituting the new key to socioeconomic progress in the contemporary world. Thus, given the rapid formation of global interdependencies and web of communication networks devoted to innovation, information-sharing, coordination and control, it is possible that the world is verging on another true revolution potentially as profound at the industrial transformation of the last century.

Despite these important implications, analysts in the commercial and media realms have been far more attentive to this budding revolution than have sociologists. Their discussions are often organized around the new global economy, however defined, and how information oils the gears of this new production system. Whether called the "information superhighway" or some other name, utopian and dystopian thinkers alike frequently focus on the nature of telecommunications as the key aspect of this economy, the keener observers noting that telecommunications technology is both a cause and effect of the post-industrial revolution.

Unfortunately, these analyses generally lack a deeper understanding of sociological processes. The purpose of this article is therefore to determine if current theories used in macrosociology are capable of gaining purchase on the current cross-national distribution of Internet development. In our cross-national analysis of approximately 75 countries, we find that adoption of the Internet has not been a simple linear function of economic and political development, but instead has been driven by complex interactions involving different structural dimensions that could be termed "post-industrialism." By uncovering some of these structural preconditions and determinants of Internet diffusion and adoption we take a first step toward providing a theoretical and empirical sociology of this revolutionary new phenomenon.

THE INTERNET: GROWTH AND IMPORTANCE

While the Internet has received little sociological treatment from a cross-national perspective, what has been accomplished provides an important opportunity to examine this phenomenon. First, a number of organizations keep statistics about the Internet, its users, where it has spread and where it is going cross-nationally. *Network Wizards* (see references) is a company that maintains a biannual Internet survey of the number of Internet hosts (i.e., any computer that has full two-way access to other computers on the Internet) worldwide, categorized by nation -- data which can now also be obtained from the World Bank. Counting the number of Internet hosts is one way to quantify the Internet, although one must remember that the number of hosts does not indicate the number of users or the quality of usage. The most current Internet Domain Survey (January 1999) suggests that the number of Internet hosts stands at approximately 43 million around the world. The current count is substantially higher than the figures in the early 1980s when the study began (see figure 2). The NUA compiles approximate

statistics from a number of sources on the number of worldwide users of the Internet. As of May 1999, they estimated approximately 171.25 million people use the Internet worldwide (NUA 1999). The Internet and WWW is continually growing, according to these results.

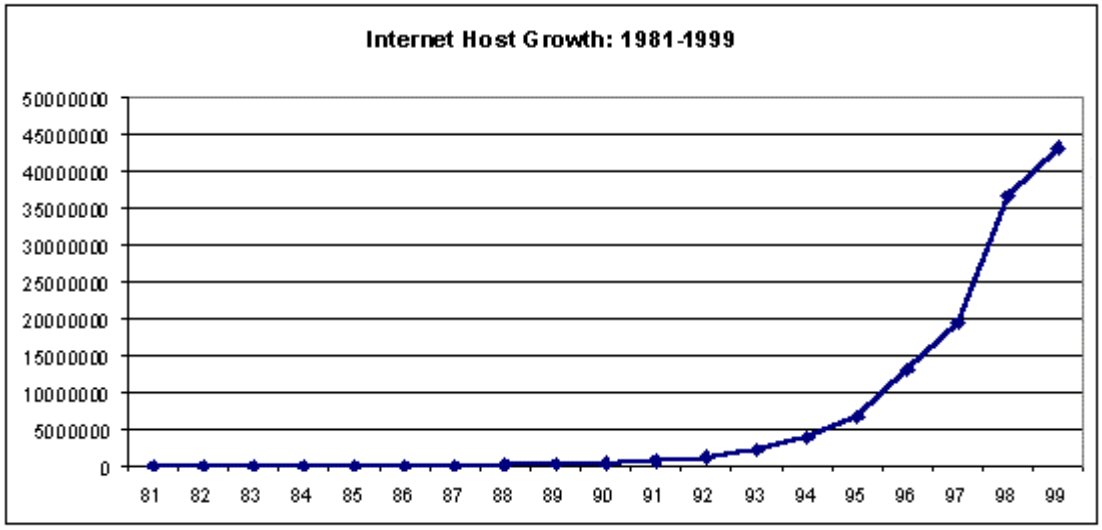

Figure 2: Internet Host Growth (Source: *Network Wizards*)

In addition to this exponential growth, sociologists are interested in the social and economic impact of Internet development. Socially and culturally, the advertisement of cultural products and therefore the diffusion of cultural traits promise to increase in political significance for developing nations (Danowitz et al. 1995; Drake 1995; Targowski 1996). Since the Internet is predominantly Western and Anglophone, the potential for one-sided cultural diffusion is high (Hedley 1998), and of course the consumption of goods and services over the Internet may come to represent status as much as commerce, particularly in developing countries. Moreover, the emergence of telecommunications can change social organization in developing societies by determining who communicates with whom, "over what distances, with what time delays, and with what possibilities for feedback or return communication" (Hardy 1980). For instance,

infrastructural and fiscal constraints often allow elites in many LDCs greater contact with foreign elites than with colleagues in their own back yards (Hegener 1996; Richardson 1996).

The political dimension of the Internet also demonstrates that it is not just a one-way flow media like television and radio, but rather a multi-dimensional form of communication, comparable in some ways to the telephone. For instance, the Internet is a proven political tool ideally suited to social mobilization, as the Seattle protests during the meeting of the World Trade Organization in late November 1999 clearly demonstrated (Financial Times 1999). Given such evidence, some analysts argue that the Internet is a liberalizing form of media that provides users access to outside political information and the potential to disseminate political ideas (Drake 1995; Rudolph 1996). We should also note that fledgling nation-states as well as established governments can and will take advantage of the Internet to build their own legitimacy. A prime example of this is the " national" website. If "nationality" consists of a "wide complementarity of social communication" as Karl Deutsch (1966) suggests, then government-sponsored Internet sites can be used to extend practical information, communicate cultural traits to promote national cohesion, and propagandize in favor of government stances and actions. Of course, benign uses by government (e.g., cheap dissemination of information and techniques such as medical and healthcare information to underdeveloped rural hinterlands) must be weighed against the possibility of malign or self-serving uses by government elites. The differences between "nation-building" and "internal colonialism" can be subtle.

Although its social, cultural and political implications are important, the Internet's economic ramifications capture the lion's share of scholarly attention. In a nutshell, telecommunications reduce economic transaction costs and minimize uncertainty concerning the distribution of goods/ services (and the purchase of these) in a high mass consumption society

(Rostow 1990; Hudson 1997; Kayani and Andrew Dymond 1997; Hufbauer 1996). Much like transportation, telecommunications' primary economic impact is via fluidity and efficiency in economic matters (Glover and Simon 1975). The latest communications innovation, the Internet, is similar to prior forms of telecommunications although more extensive and revolutionary in a number of ways (e.g., richness of data transmission). Thus, like other telecommunications technologies before it, the Internet promises the expansion of markets and the acceleration of innovation and technological diffusion (Hudson 1997; McKnight and Bailey 1997). As an example of this acceleration, Internet sales are expected to top $300 billion by 2002 (United Nations 1999:60).

This rapid transformation of developed countries into "cyber-societies" presents special difficulties for those less developed countries that have not yet experienced the industrial revolution, much less a post-industrial one. Telecommunications researchers note that economic underdevelopment is correlated with telecommunications underdevelopment; lesser developed nations have proportionately fewer telephone lines than do more developed nations (Saunders, et al 1994; Danowitz, et al 1995). For instance, Africa accounts for about 2% of the global stock of telephone mainlines although it has a global population share of about 12% (Kiplagat and Werner 1994). Generally, the less developed nations have lower gross percentages of all telecommunications technologies. Not surprisingly, the impoverished state of telecommunications development in LDCs may present severe economic impediments in an increasingly post-industrial world where foreign investments, technological transfers and export structures are predicated on a country's infrastructural capacities.

Indeed, previous research demonstrates a correlation if not a causal relationship between telecommunications development and economic development. (Saunders et al. 1994; Dholakia

and Bari Harlam 1994; Dholakia and Bari Harlam 1994; Guiscard 1987; Cronin et al. 1991). Dholakia and Harlam (1994) find in their study of U.S. states that telecommunications predict average annual pay and per capita income better than education, physical infrastructure and energy consumption. Even older studies on the role of telephony and other communications technologies note this correlation. Jussawalla (1980) observes that technology transfer is foundational for economic development, particularly communication technology (1980). He maintains that multinational corporations (MNCs) bring technology to the developing world and thus have the potential for stimulating market demand and economic growth. Hardy (1980) maintains that telecommunications allow managers to communicate over greater distances with greater ease, encouraging spatial articulation and superior economic coordination.

A few studies of developing countries find that areas with high levels of resources and skilled labor but with lower levels of telephony have fewer "productive enterprises" (Kyani and Dymond, 1997). Telecommunications infrastructures may also enable better development of agricultural and natural resources and manufacturing, thereby increasing "self-sufficiency and export growth" (Hufbauer 1996; Kiplagat and Werner 1994). Additionally, telecommunications technology reduces the need for geographic concentration, perhaps even allowing for social and economic diffusion and consequently regional integration in certain third world hinterlands (Alonso 1980; Wellenius 1977). As market shares increase in international scope and corporations become global, the need for information increases. A reliable and competitive telecommunications structure may, in turn, encourage investment by multinational corporations (Hudson 1997; Sauvant 1983), which in turn encourages global trade and network formation (Drake 1995; World Bank 1998; Kiplagat and Werner 1994).

Although a fairly comprehensive literature on telephony exists, much less research examines the modern Internet and related computer networks. What little exists focuses on Internet concentration and connectivity within the United States. Moss and Townsend (1998) conduct a spatial-economic analysis of inter-metropolitan Internet concentration and traffic flows using two measures: "the number of Internet domains registered by organizations in a specific geographic area, and the capacity and extent of Internet backbone links to other metropolitan areas." They find that areas that are substantially less urbanized, economically and socially depressed cities, and a few other regions with less information-intensive industries and infrastructure fall behind the rest of the nation in Internet concentration. Additionally, Wheeler and O'Kelly (1999) perform an analysis of Internet connectivity within the United States. Using transportation analysis, these researchers analyze matrices of connectivity with important nodes (cities) for the major US Internet service provider backbones. They also examine Internet accessibility for 141 cities. Their results indicate a hierarchy of cities based on the number of connections to other cities directly serviced by the sampled commercial backbones. Those cities that have been historically important in national transportation networks and information flows are at the top of the accessibility list, suggesting that both infrastructure and occupational differentiation are important precursors of accessibility (e.g., New York, Chicago, Dallas and D.C.).

Generally speaking, then, telecommunications play key roles in economic and social life in the modern world and increasingly in the developing world. Using a spatial metaphor, the Internet is a new cross-roads, a cybernetic point at which social change accelerates. Given its importance in a rapidly globalizing economy, the development and concentration of the Internet is worth investigating. Pursuant to this, our goal in this research is to identify those social

structural factors that predict the level of Internet development/concentration across nations, with the ultimate aim of understanding how the Internet is likely to spread across the globe in the near future. Secondarily, we hope to demonstrate the usefulness of extant macrosocial theories in predicting the likely pattern of Internet diffusion and usage.

SOCIOLOGICAL THEORY AND THE DIFFUSION OF THE INTERNET

Given that few studies of the Internet explicitly tap into sociological theory, the main purpose of our analysis is to use macrosocial theories to shed light on the international diffusion of the Internet and, perhaps along the way, begin to address the need for structural theories of post-industrial societies. Fortunately, we are guided by some preliminary research detailing the diffusion of the Internet by the Mosaic Group, a research affiliation with the Information Sciences program at the University of Arizona (Goodman et al. 1994; The Mosaic Group 1998). In their current speculations into the processes and determinants of the global Internet diffusion, they specify a number of variables that influence spread of computer telecommunications: prior development of telecommunications infrastructure (e.g., teledensity), personal computing and software, financial resources, human capital, sectoral demand and awareness, and a competitive environment. Translated into the concerns of development theory and macrosociology, most of these variables can be subsumed under a modernization and/or diffusion umbrella. Supplemented by political economy, a fairly parsimonious account of Internet diffusion emerges.

Economic and Infrastructural Development

Modernization theory suggests that the economic and social development of a nation is due to internal and evolutionary characteristics of the nation itself. Certain internal

characteristics are necessary before a nation can engage in the “take off” stage toward industrialization (Rostow 1990). One of these prerequisites is the availability of a market for investment and output. Additionally, some threshold of infrastructural development is necessary to proceed to later stages of economic development (Alonso 1980; Rostow 1990). Indeed, as Spencer (1876:509-12) first noted, the more complex the society the greater the ratio of information to material resources (Turner 1993: 29). Therefore, industrialized societies have a need for adequate transportation and telecommunications over less developed societies mainly because access to information and the ability to disseminate information is increasingly crucial for complex interdependent social systems -- an environment ripe for Internet adoption.

Furthermore, Bazar et al. (1998) note that among the Internet’s prerequisites are national and organizational demands and opportunities for technological acquisition, available technology like computers, appropriate user skills, monetary and capital resources, appropriate political management of Internet adoption and diffusion processes, and the presence of suitable funding institutions. Other factors that make this diffusion possible are advanced research and development, commercial competition, and market size (i.e., a high enough level of affluence to afford the technology). Therefore, the more complex the economy, the higher the level of competition and the greater the incentive to improve communications between segments of society.

In a related point, complex economies driven to efficiency under competitive pressure form agglomeration economies, or large urbanized markets. Agglomeration economies provide more efficient "externalities' through spatial proximity. Among these efficiencies are: (1) accelerated and improved communication between individuals, firms and other social organizations; (2) larger and more diverse markets for labor, capital, agrarian and non-agrarian

goods (which lower costs of factor searches); (3) greater opportunities for occupational and product specialization; and (4) lower costs for intermediate inputs such as transportation, warehousing and basic infrastructure (Henderson 1988:32). We would expect, all else constant, that societies enjoying such agglomerative advantages could diffuse the Internet much more rapidly than more disarticulated economies.

As cases in point, Danowitz et al. (1995) researched the barriers to Internet growth in five North African countries (Egypt, Tunisia, Algeria, Libya and Morocco). A few of these barriers were slower growth of incomes and failure to develop the necessary degree of consumption, lack of regional social and economic integration, low teledensity infrastructure, language barriers, incompatibility between more tradition values and the modernizing influences of information technology, and a labor surplus which prevents mechanization and importation of technologies (Danowitz et al. 1995).

Probably the major mediator between development level and Internet diffusion is the prior existence of telephone mainlines, given that connectivity is overwhelming dependent on telephone infrastructure. Presently, much of the non-sociological work on the diffusion of the Internet concurs with the need for a high degree of teledensity (i.e., telephone mainlines per capita) (Bazar et al. 98; Goodman et al. 1994; Hadi Salim 1995; Press 1995; The Mosaic Group 1998; Wheeler and O'Kelly 1999). Sadly, over 25 percent of the world's nations have not yet reached a teledensity of 1, meaning that countries like Kenya and Cambodia do not even have one telephone for every 100 people in their populations (United Nations 1999). So, in addition to the level of development and all it entails, simple infrastructure will constitute an insurmountable "proximate determinant" in Internet diffusion, at least so long as current technological constraints remain unchanged.

Political Openness

A political institution that is open to different internal political and social input from its citizenry is probably more likely to embrace a diversified, individually-empowering technology like the Internet that allows the spread of information and opportunity across national borders. As Buchner (1988) noted, formerly Marxist states demonstrated a very strong preference for television diffusion over telephone diffusion, at least in comparison to non-Marxist nations. The fundamental reason behind this preference was the perception that the telephone threatens established political monopolies by (1) promoting individual dissemination of ideas possibly counter to the party line, and (2) spreading information across national borders that might prove embarrassing or threatening to the regime in power. Just as importantly, telephone communication is notoriously difficult to control and expensive to monitor (Buchner 1988). Consistent with these ideas, Buchner found that while the diffusion of televisions remained fairly uniform across societies, the telephone diffused more rapidly and thoroughly in non-Marxist states. Because the telephone allows individuals and private groups/enterprises greater freedom to communicate and thus to coordinate activities independently of the state, Marxist states tended to prevent the diffusion of two-way flow technologies such as the telephone.

Extending this logic, more politically open nations will accept telecommunications technology like the Internet since it can serve as an important link to political mobilization and global economic opportunity. Modernization theory suggests that politically open societies are generally more accepting of technology because such societies enjoy competitiveness in both economics and politics, and the diffusion of telecommunications technologies enrich these competitive processes. Alternatively, more open or democratic societies usually embrace the notions of private property, investment and individual consumerism, meaning that they are less

likely to closely regulate or restrict their civic societies . For instance, Danowitz et al. (1995) found that the political context of a nation greatly influences technological diffusion. Governments that are overly concerned with security issues or harbor unsympathetic or inept policies that "pre-empt bandwidth" for their own purposes and prevent commercial usage can destroy the Internet's potential for a nation. Thus, political freedom is a likely requirement for the successful diffusion of the Internet.

Modernizing Institutions: Education

If education is the "handmaiden of industrialism" (Kerr et al. 1960), then it becomes post-industrialism's "woman of the house." Two arguments can be made about the influence of education on post-industrial development, one microsocial and the other macrosocial.

At the microsocial level, educated people use resources more cleverly, are more productive on the job because they have greater facility with productive technologies (like the Internet), and make more intelligent consumers, forcing product quality ever upward. Because they are literate and easily trained, an educated work force reduces training costs while at the same time allowing an accelerated pace of technological change in the workplace. Thus, an educated population is more productive, perhaps more materialistic (i.e., consumer-oriented), and more flexible in responding to economic changes. These microsocial accounts can be lumped under human capital theory (Schultz 19961; Becker 1964).

Unfortunately, because human capital theory leans strongly toward methodological individualism, the perspective overlooks the macrosocial effects of mass education. Most of the theoretical mechanisms posited by structural modernization theorists are conditioned by the level of formal schooling in a population. For instance, some theorists hypothesize that economic

change will be most rapid from low to intermediate levels of development because improvements in labor productivity peak as workers are reallocated from subsistence agriculture to urban/industrial employment. Mass education accelerates this structural transition by (1) 'lubricating' the movement of workers between sectors by providing workers with the necessary cognitive skills and attitudes; and (2) encouraging rapid rural-to-urban migration as literate agricultural workers seek better lives in the city (Bairoch 1988). As a simple extension of this logic, the demand for computers and on-line skills will be driven in part by the degree of education in the population.

More importantly, mass education lays the groundwork for rapid diffusion of material and non-material artifacts (Rogers 271-311). By providing populations with a unifying language and cultural heritage, national education systems promote greater understanding between groups and regions. Moreover, literacy and basic technical education allow populations to spread innovations much more quickly than would otherwise be the case, and of course secular attitudes gained in schools would reduce hidebound opposition to social change. On a more abstract level, the presence of secondary educational institutions suggests cultural and institutional isomorphism and thus convergence with the West on issues of development, in this case the uses of telecommunications (Meyer et al 1979; Namboodiri 1988). Diffusion researchers note that an innovation or idea is more expediently spread when diffusing agents are homophilous with potential adopters (Rogers 1995), suggesting that national populations that share a "cognitive template" (Strang and Meyer 1993) with developed nations by being introduced into a similar worldview via formal education are much more likely to embrace the Internet.

Education's role in modern economic progress should therefore be pervasive because its effects at the macrosocial level are no less important than those found at the microsocial level.

Of course, this should be particularly true for types of post-industrial change that hinge on the creation and dissemination of information (e.g.,the Internet), which is generally the conclusion of Internet diffusion researchers (Press et al. 1998; Bazar et al. 1998; Danowitz et al. 1995; Press 1995; Press 1996; Schware and Schware 1998; The Mosaic Group 1998; Yahya 1993).

Sectoral Development

While many of the dimensions discussed above constitute the supply side of the equation (i.e., facilitators of Internet development), the existence of a strong services sector, which includes information science and other information technology as well as other knowledge-intensive fields such as education, medicine, and government, should exert a strong, direct demand for Internet development. A complex tertiary sector suggests an increasingly differentiated and occupationally-specialized society that encourages the need for advanced communications and transportation or, as noted by Bell (1973: 30): "The post-industrial society...is a 'game between persons,' but a game between persons requires increasing amounts of coordination...." The tertiary sector thus breeds networks knit together in complex interdependencies, an environment that places a strong premium on innovation in communications technology.

Furthermore, as the post-industrial thesis posits, services quickly outgrow their role as the "junior partner" in economic development, a role that may have been unfairly assigned in the first place. In fact, because the service sector's shares of employment and gross domestic product tend to increase faster than the industrial sector's shares regardless of the level of development (Sundrum 1990:28-32), it is entirely possible that the tertiary and quaternary sectors are not epiphenomena of industrialization at all. This possibility is reinforced by noting

also that the tertiary predates the industrial secondary in virtually all historical cases (Riddle 1986:35)..

On the other hand, while we predict that strong service sectors will encourage Internet diffusion, we must acknowledge a more complicated reality in the developing world. For instance, the view of service economies as accretions of dead-end and/or informal activities that add little to a nation's productive capacity (e.g., Evans and Timberlake 1980) complicates investigations of nascent "post-industrialism" in LDCs. Obviously "hypertrophic" or "bloated" (i.e., impoverished and informal) tertiary sectors may not encourage Internet diffusion/adoption, but unfortunately there is no way to "tease out" the budding post-industrial from the hypertrophic using existing cross-national statistics. Considering this, we expect that service dominance will exert an effect on Internet development, but perhaps only in combination with the other dimensions discussed above.

Theoretical Expectations of Interactions

In perusing the literature on the diffusion of telecommunications, one important observation remains: most researchers argue that a confluence of factors are necessary and no single factor will suffice to nourish Internet development/diffusion. In other words, in addition to their simple additive effects, the dimensions of modernization described above are also likely to interact with one another in shaping the development and diffusion of the Internet. Specifically, given that post-industrialism is a "game between persons" (to repeat Bell's memorable phrase), we might expect interactions between a society's educational foundation and its other dimensions of modernization. Thus, interacting education with political context, service sector percentage and industrial and infrastructural development should provide a series of measures for the concept of post-industrialization.

For instance, one might expect to see an interaction between education and the proportion of the labor force employed in the service sector. The effect of services on Internet diffusion, in other words, is conditioned by the degree of literacy and computer skills of the population. Thus, the proportion of the labor force involved in the service sector alone may not be enough to encourage adoption of the Internet, but when highly developed tertiary sectors are matched by highly skilled labor forces then we would expect to see very rapid diffusion of the Internet. In addition, the educational capacity of a nation may interact with the degree of industrialization to produce higher levels of Internet capacity. In other words, while industrialization provides the affluence or income level that makes the development of the Internet possible, this development is supercharged if the population has the cognitive wherewithal to embrace advanced, diverse and personalized telecommunications. Finally, a more open political regime allows its populace to maximize their educational capital in pursuing communications for business and pleasure. Moreover, open political systems that also enjoy a well-educated labor force would be particularly enticing to new high-tech investment ventures, whether through domestic or foreign capital.

METHODS AND DESIGN

The present study examines Internet development in both developed and developing countries using approximately 74 observations in the base models.[1] With the exceptions of the dependent variable as well as labor force in services, the political variable, sectoral inequality, ethnic homogeneity and British colonialism (sources noted below), the remainder of the variables considered below come from the World Bank World Development Indicators CD (1997). The data for the dependent variable is available from the World Bank CD (1997 and 1998) and on-line through an organization named Network Wizards (Network Wizards 1999).

This organization has been conducting an Internet Domain Survey once or twice a year since 1981, although an adequate number of cases becomes available only after 1995.

We chose OLS regression because of its wide use in cross-national studies. Although we considered using a factor analysis to create a latent construction called “post-industrialism,” we ultimately decided that OLS analysis of discrete variables was preferable given our interest in opening the “black box” of “post-industrialism “ (i.e., determining how different aspects of post-industrial differentially impact Internet development, how and if each is mediated by teledensity, and how each variable interacts with education). Preliminary results indicated that most of the variables were moderately to highly skewed due to the nature of the population under study. Consequently, performing a regression analysis with these variables might present some difficulties in using OLS to analyze the data. For the sake of consistency, all variables used in the analysis have thus been logged.

Our study proceeds in three steps. First, the dependent variable is regressed on our theoretical model which incorporates the level of development, political openness, secondary school enrollment ratios, the percentage in the labor force working in services, and multiplicative terms between schooling and these variables (see Set 1). Second, we take this base model (although, to reduce multicollinearity, we retain only the interaction between schooling and tertiary labor force) and subject it to a variety of control variables that include the stock of foreign investments, ethnic homogeneity, sectoral inequality, population density, economic openness, and British colonial heritage (see Set 2). Finally, in our last analysis, we consider the influence of teledensity as a "proximate determinant" that may mediate some of the structural effects found in steps 1 and 2 (see Set 3) (commas denote simultaneous entry of variables, whereas '/' means discrete entry).

Set 1:Y = f{ EC, PO, ED, TERT, ED*TERT/ ED*PO/ ED*EC}

Set. 2:Y = f{EQUATION 1, FI/ EH/ GIN/ PDEN/ EO/ BRIT}

Set 3:Y = f{TD, EC, PO, ED, TERT, ED*TERT, FI/ GIN}

where:

Y= Log of Averaged Internet Hosts per 10,000 people, 1995-99

EC = Log of Energy Consumption, 1990

DE = Log of Political Openness, 1994

TD = Log of Telephone Mainlines per 1,000 people, 1995

ED = Log of Secondary Educational Enrollment Ratio, 1985

TERT= Log of Percent in Tertiary Sector, (ca. 1990)

FI = Log of Stock of Foreign Direct Investment, 1995

EH = Log of Ethnic Homogeneity

PDEN=Log of Population Density, 1995

GIN = Log of GINI Coefficient of Sectoral Inequality, 1970

EO = Log of Exports + Imports as Percentage of GDP, 1995

BRIT= British Colonial Heritage, dummy variable

Dependent Variables

The dependent variable, Internet Capacity, is operationalized as the number of Internet hosts per 10,000 people associated with a nation-state. Specifically, these Internet hosts are categorized according to their top level domain name suffixes such as .uk or .ar for the United Kingdom or Argentina. These suffixes are comparable to the commonly found .org, or .edu in the United States. However, the top-level-domain name measure does not include all hosts within a nation. For instance, a UK Internet address might use the suffix ".com" rather than ".uk"; consequently, those with non-corresponding top level domain names are not included in the data. Nonetheless, significant proportion of Internet addresses in the UK use the appropriate suffix; furthermore, an Internet host with an .uk suffix is likely to be located in the United Kingdom and likewise for all the other international suffixes. Thus, this is an approximate measure for Internet capacity within a nation and is the best indicator currently available.

Hypothetically, at least, sufficient data exist for a longitudinal analysis (1995-1999), but we doubt such a short span of time warrants longitudinal analysis, and in fact the autocorrelation between the dependent and lagged dependent variables would make such an analysis questionable. For this reason, we compile an average Internet host count including all the data from these five years, yielding an average number of Internet hosts per 10,000 for this five year period. This results in better coverage and a more stable indicator.

Independent Variables

We adopt our general measure of development, the log of energy consumption per capita, from the World Bank (1995), following a long precedent in cross-national studies (e.g., Firebaugh 1983). This is defined as energy consumption per capita measured in kilograms of oil equivalent for the year 1990, a recent year that maximizes samples sizes. Moreover, we use a measure for telecommunications infrastructural development in our final analysis, again adopted from the World Bank (1997). This teledensity variable is measured as the number of telephone mainlines per 1,000 people for 1995.

We measure political openness using a subjectively- ranked political variable representing the "general openness of political institutions" (Jaggers and Gurr 1996), as reported in the Polity III data set (which covers the years between 1880 and 1994). The variable is scored from 1 to 10 with 10 indicating the most "open," and can be considered a measure of democratization measuring elective government and constitutional constraints on governmental power.

We operationalize the education variable as secondary school enrollments in 1985 as a percentage of the population in that age category. Given the likelihood that a considerable lag time exists between the acquisition of the knowledge and skills and its impact on economic

matters (such as adoption of the Internet), we have lagged this variable back into the mid-1980s.

Percentage of the labor force in the tertiary sector was obtained from the International Labour Office's Yearbook of Labour Statistic, reported for various years but generally around the year 1990. The ILO does provide subsector breakdowns for some countries that partition the tertiary into consumer services and producer services. Nonetheless, while the use of such breakdowns might help to better pinpoint the "post-industrial" syndrome in developing countries, both types of service in fact contain a mixture of traditional services and what are now called "quaternary sector" activities. For this reason, as well as to preserve samples sizes, we use the aggregated tertiary figures.

Control Variables

Foreign direct investment is a series of external inputs that may determine an economy's output of goods and services, including telecommunications technologies like the Internet. Furthermore, the level of foreign monetary inputs may reflect integration into the global economy, for better or worse, and hence the potential to join the telecommunications revolution. Foreign investment probably has a larger effect for those nations that are still developing. On another level, higher amounts of investment suggest greater political and social openness to external change, again a prerequisite for cultural and technological diffusion and development. We measure this important political-economic variable by controlling for the net inward stock of foreign direct investments as a percentage of GDP in 1995 (World Investment Report 1998).

A society's ethnic, cultural and/or linguistic composition may also hold consequences for its communications development. Ethnic heterogeneity can lead to internal conflicts, retard "cultural diffusion" (communication) and economic development, and vitiate interregional and

intergroup cooperation on all levels (Easterly and Levine 1997). In ethnically homogeneous societies, the processes of communication should be more fluid and less prone to breakdown and stalling, as Roger's (1983) homophily principle of diffusion suggests. In addition, multiple groups vying for political dominance may make collective decision-making very difficult, including goals such as the provision of telecommunications infrastructure. We adopt ethnic homogeneity, or the percentage of the population belonging to the majority ethnic/linguistic group, from Vanhannen (1991).

According to ecological theory, population size and density reflect social adaptation to a given environment (Hawley, 1968; Boserup 1981). In other words, a population responds to environmental constraints either by developing and adapting technology to maximize its resources or by reducing it size and/or concentration. Since population and available resources are constantly seeking balance, a dense population suggests a historical process of economic competition and technological innovation. These societies experience an increasing social division of labor which is a manifestation of the competition for survival. The emergence of a society into the post-industrial revolution would indicate population size because a denser population forces occupational and hence technical specialization—the very type of specialization and modernization that allow for such telecommunications developments (Wheeler and O'Kelly 1999). We include population density for 1995 as a very basic proxy for this ecological thinking (World Bank 1997).

Generally, the level of inequality in a nation should influence the degree of telecommunications development. Telecommunications are generally concentrated at the top economic levels, while those at the bottom or even in the middle may be somewhat removed from the local and international economies that utilize new communications technologies. Thus,

telecommunications development is likely to be unevenly distributed socially and spatially. Those nations with higher levels of internal inequality should experience lower levels of Internet capacity compared to nations with less inequality. As a proxy for generalized economic inequality/disarticulation, we include the GINI coefficient of sectoral inequality for 1970, an indicator that gauges the disparity between labor productivity in agriculture and non-agriculture (Taylor and Hudson 1972). This measure suggests the degree to which a nation's population is "ghettoized" in subsistence agriculture.

We have also included a measure of the sum of export and import values as a percent of Gross Domestic Product for 1995 (World Bank 1997). We incorporate this measure in the general belief that societies open to global capitalism are much more likely to embrace its trappings, in this case the Internet. So, in short, the greater a country's 'external' economy, the greater its connection to the world economy and its electronic coordination/control networks. Just as importantly, greater and more intensive contact with the "globalization" process may lead to higher levels of societal acceptance of "modern" institutions and technologies.

Finally, as noted above, the Internet is Anglophone in that the majority of its users speak English and share some type of English heritage (this is true because of U.S. dominance of the Internet -- see Hedley 1998). Given this, we extend the logic of diffusion theory by expecting linguistic/cultural homophily to lend considerable energy to Internet diffusion. Consequently, those nations which are linguistically and/or culturally homophilous with Anglophone nations will probably have a greater likelihood of Internet presence and capacity than non-Anglophone nations, all things being equal. British colonial heritage, which codes all former British colonies (and of course Great Britain) as 1, are adopted from Bank (1978).

Outlier diagnostics for the base models in the first table suggest that three cases are influential: Algeria, Saudi Arabia and Syria (Mongolia and Nepal are influential in the base models that include the interaction of education and energy consumption and the interaction of education and political openness, respectively). However, because omitting these cases from our analyses would not change our substantive conclusions, we use all available cases to estimate our models.

To correct for heteroskedastic disturbance terms, we apply White's (1980) correction procedure for standard errors in our reported models. Also, variance inflation factors and other collinearity diagnostics point to some multicollinearity generated by incorporating multiplicative effects, which is to be expected, but our reported coefficients and significance tests are nonetheless quite stable. We conclude that our analyses conform to OLS assumptions.

Analysis

Table 1 presents the zero-order correlations and corresponding sample sizes for the variables in the analyses. All of our theoretically-relevant variables are positively and significantly related to the number of Internet hosts, with teledensity sharing the strongest correlation. Among the controls, the logs of foreign investment, ethnic homogeneity, population density and sectoral inequality share the expected relationships with the log of Internet Capacity, although only the correlation between sectoral inequality and the dependent variable has a magnitude similar to the theoretically-relevant variables such as energy consumption or political openness. Of course, the moderate to high correlations between some of the theoretical variables suggests the need for multivariate analysis, however.

Table 2 reports the unstandardized coefficients for our base models. Model 1 demonstrates the strong influence of development (i.e., the log of energy consumption per

capita) on Internet Capacity. This variable alone explains 62% of the variance in Internet development around the globe. On the other hand, development subsumes variance that in fact should be attributed to other dimensions. In Model 2 we see that the log of political openness exerts a unique influence on Internet Capacity net of development level, added another 11% to explained variance (adjusted R^2 = .73 versus .62 for Model 1). Models 3 and 4 suggest that our other theoretical variables, the logs of secondary educational enrollment ratios and the percentage of the labor force in the tertiary, are not significantly related to Internet development. On the other hand, these main effects are conditioned by each other, as demonstrated by Model 5. To interpret, while the effects of the logs of energy consumption and political openness diminish to some degree, the main effect of the log of secondary schooling is a -3.60 when both main effects are held at zero (given that this multiplicative term uses ratio-level variables) and the main effect of the log of tertiary employment is a -5.21, again when both variables are held at zero (which explains the sharp negative magnitudes of both coefficients). On the other hand, the multiplicative term is a positive 1.42. This suggests that, as the log of tertiary labor force rises by one unit, the coefficient between schooling and Internet capacity becomes more positive by 1.42 units. Conversely, as the log of secondary schooling rises by one unit, the coefficient between the logs of Internet Capacity and tertiary labor force becomes more positive by the same 1.42 units. Put in more intuitive terms, this indicates that the coefficient between schooling and Internet Capacity is positive after tertiary labor force rising above approximately 12% of the labor force. Or, from the alternative vantage point, the coefficient between tertiary labor force and Internet Capacity is positive after secondary schooling rises above 38% of the eligible population pool.

Models 6 and 7 can be interpreted in the same way. The significant, positive multiplicative term in Model 6 equals .88. This indicates that the negative coefficient between political openness and Internet Capacity becomes positive after secondary schooling rises above approximately 20% of the eligible population. Conversely, the negative effect of secondary schooling on Internet Capacity becomes positive after political openness surpasses a value of 2, a relatively low level of openness. Model 7 indicates the negative effect of energy consumption per capita on Internet development becomes positive once secondary schooling tops the 10% mark, again a very low level of schooling. Alternatively, the negative influence of secondary schooling on Internet Capacity turns positive once energy consumption has surpassed about 41 kg. of oil-equivalent energy usage per person, about the development level of Niger.

These interactions suggest that, starting from relatively low levels of each variable, schooling intertwines with other theoretically-relevant effects to produce a greater development of the Internet than might be expected otherwise. In practical terms, the influence of development, democracy, and tertiary employment on Internet development are "supercharged" by formal, secondary education. As anticipated, human capital becomes increasingly important in a post-industrial world.

In Table 3 we repeat these analyses controlling for some selected alternative explanations. In these models we retain only the interaction term between secondary education and tertiary labor force to make the analyses manageable, although using either of the other two interactions would produce similar substantive conclusions (analyses not shown). Model 8 demonstrates that the higher the penetration of foreign capital, the greater the Internet development. In this case, a 10% increase in foreign stock over GDP results in a 2.3% increase in Internet hosts per 10,000. This confirms what Hudson (1997) and others have speculated –

foreign investment apparently boosts a nation's telecommunications infrastructure independently of development, political regime, education, and other social structural forces.

On the other hand, Model 9 does not confirm our expectations about ethnic/linguistic homogeneity. Although the parameter estimate is positive, it is far from statistically significant, inferring that whatever the supposedly benefits from cultural and ethnic unity, they must be mediated by the other variables in the model. Model 10, however, points to a strong effect of sectoral inequality. All else equal, a 10% rise in sectoral inequality results in a 8.9% decrease in Internet development. We conclude that disarticulated economies, or those that have a strong dualism or schism between their modern sector and "traditional" subsistence sector, are much less able to embrace Internet development that are other nations.

Population density, like ethnic homogeneity, apparently exerts no strong influence on Internet development net of our base model (although the coefficient is positive but quite weak). The same is true of economic openness (or trade dependency, as some would have it) and British colonial heritage. Neither gains purchase on Internet Capacity net of our base model.

In Table 4 we report our investigation of teledensity as a mediating factor in Internet development. Model 14 demonstrates that both the logs of energy consumption per capita and political openness are apparently mediated by telecommunications infrastructure. These findings, which is at least partially consistent with theoretical expectations, suggest that the main avenue whereby development and political regime create the potential for Internet capacity is through their creation of public infrastructure, in this case telephone mainlines. While we had expected development and democratization to have unique influences beyond teledensity (i.e., they should be weakened by entering teledensity, but not washed out as they are here), the fact that they don't still comports well enough with modernization and political economy.

Development generates the demand and fiscal capacity that brings about the provision of telephone mainlines, while political openness removes many political and legal barriers to such provision. Current speculations on Internet development are therefore correct in emphasizes teledensity as a proximate determinant of the Internet's potential.

The only other finding of note is the negative influence of ethnic/linguistic homogeneity once teledensity has been controlled in the equation. Although some account could be concocted that might place this finding into a context that makes sense, we should note that this coefficient is only marginally significant. Moreover, our diagnostics suggest that outliers may play a larger role in this finding than elsewhere in our models. For this reason we believe that more research needs to be done before we conclude that homogeneous populations actually retard Internet development. We think it is far more likely that a positive effect of ethnic/linguistic homogeneity (seen in the bivariate case in Table 1) is probably mediated by other variables in the model, and that a few outliers unique to this equation produce the counterintuitive sign of this coefficient. We do note that the log of ethnic homogeneity is significantly correlated with most of the other variable in our analyses, which lends some weight to our speculation in this regard.

DISCUSSION

The present investigation reveals that Internet capacity is fundamentally predictable using current macrosocial theories of development. Aside from the influences of development level and political freedom on Internet development, which are very intuitive, our most important observation is that educational attainment (measured here as secondary school enrollment ratios in 1985) conditions the influences of the other variables in our theoretical model. Foremost, mass education increases the influence of tertiary labor force on Internet capacity (and vice

versa), which is to say that the effects of mass education and tertiary development are conjunctural on Internet growth. Additionally, the other two interactions tested here, between education and development level and education and and political openness, are also significant, indicating that education is an important catalyst in the formation of post-industrial technologies and social structures. This makes enormous sense from an ecological point of view. If the manipulation, consumption and production of the cyber is quickly replacing the manufacture of "real" goods as the principal key function of post-industrializing societies, then education operates for post-industrialization very much as cheap labor did for industrialization. Mass education may well be the sine quo non of social change in the 21st Century. Of course, two important questions follow from this: Will less developed countries have the wherewithal to join in this information revolution, and if so, will they prosper from their participation.

While the recency of Internet development and the limitations of cross-national information do not allow us to address the second question, our results do provide a preliminary answer concerning the abilities of LDCs to participate in the Internet. True, it does not require statistical analysis of cross-national data to identify those nations that will experience extreme difficulty in joining the information revolution. Countries like Ethiopia, Niger, Tanzania, or Laos will not be well-represented on the World Wide Web anytime soon. These countries, low on all the social structural characteristics we have identified as leading to Internet capacity, are simply too far behind to catch up in the next several decades. On the other hand, identifying the "up-and-comers" is a more difficult task. According to our analyses, there are several countries whose structural attributes should support more Internet development and usage (e.g., Jamaica, Botswana, much of Central America and South America, Indonesia, Korea, and several other "newly industrialized countries). Only time will tell if these nations do in fact embrace the

Internet, but they do possess the minimum requirements to have a greater presence in the rapidly expanding global network of computers.

Of course, changes in technology could change these profiles. For instance, connectivity using satellite uplink may free the Internet from its prison of telephone mainlines, thereby allowing the spread of connectivity to even the remotest, least developed places on Earth (Kohn 1997). Although we agree that such a shift in technology would increase the flexible and absolute size of the Internet, we seriously doubt it would change relative usage rates around the world. Literacy, the demands of the post-industrial economy, the size of markets for sophisticated goods, income distribution and affluence thresholds will still prove constraining to Internet development and usage even in a world of expanded, aspatial connectivity. That is, problems on the ground will persist, and some countries will lag far behind even late into the coming century.

Another interesting finding is that the log of foreign direct investment as a percentage of GDP has a positive effect on Internet capacity net of other structural effects. Although we concede that the causal direction here is open to interpretation (i.e., perhaps MNCs are locating in areas that already have an Internet capacity), drawing the causal arrow from investment to Internet development is perfectly consistent with the modern multinational corporation's need for global coordination and control. We should also note that, while foreign investment apparently improves the Internet capacity of a nation, the effects of this diffusion are not addressed by our finding. Whether this will well-serve those countries affected by multinational presence cannot be answered by our analyses, but it does bolster the assertion that foreign investment brings new technologies to host countries.

The importance of the negative effect of economic disarticulation (sectoral inequality) is that, net of the other effects, serious gaps in the labor productivities of different sectors of an economy prohibit the emergence of suitable markets for information technology, even years in advance of such markets. Furthermore, this variable suggests that inequality is deleterious to post-industrial progress, an interesting finding considering the increase of inequality in post-industrializing economies. Although this finding does not examine the reverse relationship, one could argue that if inequality proscribes further specialization in the information economy then a country's ability to join in a rapidly changing global economy is partially circumscribed. It is just such circumstances that might vitiate the abilities of new technologies like satellite connectivity to allow developing countries to catch up.

One surprise is that economic openness (or trade dependency, if you will) apparently has no appreciable influence on Internet development. It is possible that other effects such as development level, service sector employment, and political openness might be squeezing out the effect of the world trade measure. Given the increasing importance of global trade in a post-industrial world and the assumption that trade should promote greater diffusion of technology and cultural traits supporting technology, this finding is surprising. Examining Table 1, however, we find that this variable is negatively correlated with all the developmental variables thought important to the spread of the Internet, but is positively related to sectoral inequality. This suggests that the world trade variable is an indicator of dependency rather than economic vitality and openness. Regardless, its effect is neither appreciable nor robust, which is also true of the effects of ethnic homogeneity and British colonial heritage.

Our results also suggest that the influence of development level and political openness on Internet diffusion are entirely mediated by teledensity. While this is not necessarily a great

surprise, given that teledensity figures so prominently in theories of Internet diffusion, we think it unlikely that all the mechanisms driving the spread of the Internet that are related to development and political regime are wholly reducible to the provision of telephone mainlines. Certainly the affluence of a population, popular tastes for information and electronic entertainments, consumer markets, structures of taxation and the ownership of intellectual property all condition Internet spread and usage, and these things are separable effects from telephony and its infrastructure. Unfortunately, the present inquiry is limited to a cross-sectional design by the type of data addressed. At the time of this writing, Network Wizards has accumulated adequate data on Internet Hosts by nation for only six years. Due to a small sample size at the beginning of the survey, data beginning in 1995 are more useful for cross-national analyses. If the Internet Domain Survey is continued indefinitely, another ten years of data will provide sufficient data to conduct longitudinal analysis. We suspect that when the data finally become available to support a meaningful and extensive longitudinal analysis these issues will be resolved in favor of unique influences of development and political regime on Internet development.

We have determined that a sociological explanation for post-industrial dynamics is possible, and that this explanation can rely on older theories of macrosocial development. Nonetheless, this study focuses exclusively on the *determinants* of international Internet diffusion. While our findings suggest a blending of modernization, diffusion, and political economy best predicts the spread of the Internet, we have not addressed the global consequences of Internet diffusion. Therefore, in addition to longitudinal analyses of Internet development, future research should concentrate on the consequences of Internet diffusion on such topics as

democratization, quaternary sectoral expansion, inequality and other post-industrial phenomena (the second major set of sociological questions about the telecommunications revolution).

One interesting area of inquiry would be the effects on urban/technological enclaves and disarticulated economies (Jussawalla and Meheroo 1980). The central question would be whether advanced telecommunications tends to "localize" economic activities outside of major urban/economic enclaves (Rudolph 1996). In short, does the Internet encourage spatial and economic centripetalization or, as many have speculated, centrifugalization? The answer to this question is critical to many problems that currently plague the world's megacities.

Another concern about the consequences of Internet diffusion is "cultural imperialism" (Hedley 1998). Like telephony, the Internet and other technologies are bound to have certain consequences involving cultural/linguistic hegemony and therefore social control, cultural dominance, and the ability to wield symbolic power. Hedley emphasizes the value-laden nature of this form of information diffusion, observing that U.S./Western hegemony in information technology poses the threat of an imposed cultural convergence on those who wish to "hook-up" to the global economy. Certainly the Internet is no respecter of borders and, as a consequence, is spreading a homogenizing culture around the globe, particularly among elites (Rudolph 1996). While cultural and institutional diffusion is nothing new (Meyer Boli-Bennett et al. 1979), telecommunications technology is unique in its speed and the high-quality of its transmission of ideas and information.

To sum up, an adequate understanding of the consequences of advanced information technology and telecommunications on global development is just beginning to coalesce. In the meantime, it is important to note that just as the Industrial revolution was irreversible, so may be the post-industrial revolution. Developed regions like North America and Western Europe are

soaring ahead of the rest of the world in development of the cyber. The corresponding social gaps and resulting consequences around the globe are destined to become important social issues, and just the social sciences emerged as respectable disciplines due to the tumult of the Industrial revolution, so the new information revolution provides many opportunities for new theories of post-industrialism.

APPENDIX A

[1] Network wizards collects data through a networking program that "pings" Internet hosts around the globe for numeric responses. The signal returns with approximated number of hosts per host category (top-level domain name).

[2] "On the Internet, the term 'host' means any computer that has full two-way access to other computers on the Internet. A host has a specific 'local or host number' that, together with the network number, forms its unique Internet Protocol address. If you use PPP to get access to your access provider, you have a unique IP address for the duration of any connection you make to the Internet and your computer is a host for that period. In this context, a 'host' is a node in a network." (*whatis.com* definition)

APPENDIX B: Observation Lists

[3] The following lists the countries in all the models for Table 2 and Table 3 Capitalized countries are found in every model. The superscript denotes those models that contain the specific cases.

DFA

Angola(Models 5-9), Albania(Models 5-9), ARGENTINA, AUSTRALIA, AUSTRIA, Belgium(Models 5-12,13), Burkina-Faso(Models 5-8,12-13), Bulgaria(Models 5-8,11-13), BRAZIL, CANADA, Switzerland(Models 5-9,11-13), CHILE, China(Models 5-9,11-13), CAMEROON, COLOMBIA, COSTA, RICA, Cuba(Models 5-7,9,12-13), DENMARK, DOMINICAN, REPUBLIC, ALGERIA, ECUADOR, SPAIN, ETHIOPIA, FINLAND, FRANCE, GHANA, GUINEA, GREECE, Hungary(Models 5-9,11-13), INDONESIA, INDIA, IRELAND, ISRAEL, ITALY, JAMAICA, , JAPAN, , KENYA, KUWAIT, MOROCCO, MEXICO, MALI, Mongolia(Models 5-9,12-13), Mozambique(Models 5-9,12-13), MAURITIUS, MALAYSIA, Niger(Models 5-10,12), Nigeria(Models 5-10,12), Nicaragua(Models 5-10,12), NORWAY, NEPAL, New, Zealand(Models 5-911-13), Oman(Models 5-912-13), PAKISTAN, PANAMA, PERU, , PHILIPPINES, Poland(Models 5-9,11-13), Portugal(Models 5-8,11-13), Paraguay(Models 5-10,12-13), Romania(Models 5-9,11-13), Saudi, Arabia(Models 5-10,12-13), Singapore(Models 5-10,12-13), SWEDEN, SYRIA, THAILAND, TRINIDAD,

TOBAGO, TUNISIA, TURKEY, TANZANIA, UNITED KINGDOM, URUGUAY, UNITED STATES, VENEZUELA, ZAMBIA

The following lists the countries in all the models for Table 4 in Appendix A. The findings substituting Energy consumption per capita for telephone mainlines per/k) Capitalized countries are found in every model. The superscript denotes those models that contain the specific cases.

Angola(Models A1-4,6-8), Albania(Models A1-4,6-8), ARGENTINA, AUSTRALIA, AUSTRIA, Belgium(Models A1-5,7-8), Burkina Faso(Models A1-3,6,8), BRAZIL, Switzerland(Models A1-4,6-8), China(Models A1-4,6-8), CHILE, CAMEROON, COLOMBIA, COSTA RICA, DENMARK, ALGERIA, ECUADOR, SPAIN, ETHIOPIA, FINLAND, FRANCE, GHANA, GUINEA, GREECE, Hungary(Models A1-4,6-8), INDONESIA, INDIA, IRELAND, ISRAEL, ITALY, JAMAICA, JAPAN, KENYA, KUWAIT, MOROCCO, MEXICO, MALI, Mongolia(Models A1-4,6-8), Mozambique(Models A1-4,6,8), MAURITIUS, MALAYSIA, Niger(Models 1-6,8), Nigeria(ModelsA1-6,8), Nicaragua(Models A1-6,8), NORWAY, New Zealand(Models A1-4,6-8), Oman(Models A1-4,6,8), PAKISTAN, PANAMA, PERU, PHILIPPINES, Poland(Models A1-4,6-8), Portugal(Models A1-3,6-8), Romania(Models A1-4,6-8), Saudi Arabia(Models A1-6,/8), Singapore(Models 1-6,8), SWEDEN Syrian(Models A1-6,8), THAILAND, TRINIDAD, TOBAGO, TUNISIA, TURKEY, TANZANIA, UNITED, KINGDOM, URUGUAY, UNITED, STATES, VENEZUELA, ZAMBIA

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	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1. Log of Internet Hosts		93	96	106	96	97	87	85	86	108	97	118	80	90	119
2. Log of Political Openness	.65*		85	85	85	86	80	85	79	86	87	92	71	72	93
3. Log of Energy Consumption	.79*	.47*		86	86	85	78	79	86	90	86	95	71	76	96
4. Log of Telephone lines/k	.87*	.66*	.93*		88	88	80	78	79	96	89	105	74	82	106
5. Log of Secondary Education	.69*	.49*	.85*	.85*		87	87	85	86	92	87	95	73	77	96
6. Service Sector	.71*	.58*	.84*	.84*	.82*		87	80	78	92	92	96	76	76	97
7. School*Service Sector	.77*	.62*	.90*	.90*	.95*	.95*		80	78	85	83	86	69	71	87
8. School*Democracy	.68*	.99*	.47*	.67*	.47*	.59*	.60*		79	82	80	84	67	69	85
9. School*Energy	.79*	.49*	.98*	.98*	.93*	.85*	.95*	.49*		84	78	85	65	71	86
10. Log of Foreign Investment	.32*	.34*	.17	.20	.13	.28*	.26*	.36*	.16		91	107	77	90	108
11. Log of Ethnic Homogeneity	.44*	.26*	.61*	.60*	.63*	.59*	.64*	.28*	.63*	.17*		96	80	77	97
12. Log of Population Density	.19*	.15	.11	.25*	.24*	.18	.20	.15	.13	.00	.14		79	89	118
13. Log of Inequality	-.70*	-.50*	-.60*	-.62*	-.60*	-.53*	-.61*	-.56*	-.66*	-.24*	-.39*	-.27*		67	80
14. Log of Exports + Imports/GDP	-.47*	-.39*	-.50*	-.48*	-.49*	-.46*	-.48*	-.41*	-.52*	.04	-.36*	-.07	.54*		90
15. British Colonial Status	-.08	.01	-.11	-.17	-.11	.01	-.07	.02	-.15	.23*	-.19	.24*	.10	.28*	
Mean	***.34***	***.77***	***6.60***	***4.17***	***3.79***	***3.64***	***14.18***	***3.58***	***26.40***	***-2.26***	***4.15***	***3.99***	***3.03***	***-19.99***	***0.17***
Standard Deviation	***3.53***	***1.42***	***1.71***	***1.82***	***.80***	***.66***	***4.73***	***5.77***	***1.52***	***1.52***	***.45***	***1.38***	***0.87***	***2.13***	***0.38***

*P < .05 (Sample sizes for each correlation appear above the diagonal in the matrix)

Table 1: Zero-order Correlations Between Modeled Variables

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	-.10.31 (.74)	-8.97 (.69)	-9.30 (1.03)	-8.85 (1.82)	5.80 (3.44)	-10.06 (1.78)	1.58 (2.43)
Log of Energy Consumption 1990	1.64*** (.11)	1.34*** (.12)	1.17*** (. 25)	1.18*** (.35)	.98*** (.32)	1.01*** (.33)	-1.43* (.78)
Log of Political Openness 1994		.89*** (.17)	.93*** (.19)	.97*** (.26)	.86*** (.26)	-2.63** (1.05)	.88*** (.25)
Log of Secondary School Enrollment 1985			.37 (.57)	0.44 (.53)	-3.60*** (.87)	.82* (.46)	-2.45** (.56)
Log of Service Sector Ca 1990				-.22 (.79)	-5.21*** (1.25)	-.06 (.78)	.23 (.75)
School*Service Sector					1.42*** (.35)		
School*Democracy						.88*** (.25)	
School*Energy Consumption							.62*** (.14)
N	96	85	79	74	74	74	74
R^2	.62	.74	.73	.72	.76	.75	.77
R^2 adjusted	.62	.73	.72	.71	.74	.74	.75

***P<.01 One-tailed test, **P<.05 One-tailed test, *P<.10 One-tailed test

Table 2: The log of Internet hosts per 10,000 Regressed on Selected Independent Variables, Standard Errors Corrected using White's (1980) Procedure (Standard Errors in Parentheses)

	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
Intercept	5.83	3.85	4.81	5.85	1.72	5.79
	(3.54)	(4.02)	(4.01)	(3.36)	(4.12)	(3.45)
Log of Energy Consumption 1990	.80***	.94***	.75**	1.00***	1.05***	.97***
	(0.34)	(.34)	(.37)	(.31)	(.20)	(.32)
Log of Political Openness 1994	.71****	.85***	.72**	.84***	.62***	.86***
	(0.25)	(.27)	(.29)	(.26)	(.19)	(.26)
Log Secondary Education 1985	-3.74***	-3.35***	-2.19*	-3.82***	-2.61***	-3.58***
	(.92)	(.91)	(1.25)	(.95)	(.88)	(.87)
Log of Service Sector ca 1990	-5.57***	-4.95***	-3.43***	-5.35***	-4.48***	-5.21***
	(1.27)	(1.23)	(1.22)	(1.26)	(1.17)	(1.27)
School*Service Sector	1.50***	1.35***	0.95**	1.46***	1.21***	1.42***
	(0.36)	(.37)	(.43)	(.35)	(.27)	(.36)
Log of Foreign Investment 1995	0.23*					
	(0.10)					
Log of Ethnic Homogeneity		.31				
		(.60)				
Log of Inequality 1970			-0.89***			
			(.32)			
Log of Population Density 1995				0.14		
				(.17)		
Log of Exports+Imports/GDP 1995					-.03	
					(.10)	
British						-0.02
						(.51)

N	73	71	59	62	73	74
R^2	.78	.76	.79	.87	.76	.76
R^2 Adjusted	.76	.73	.76	.86	.74	.74

***P<0.01 One-tailed, **P<0.05 One-tailed, *P<0.10 One-tailed

Table 3: The log of Internet Hosts per 10,000 Regressed on Selected Independent Variables and Control Variables; Standard Errors Corrected using White's (1980) Procedure (Standard Errors in Parentheses)

	Model A1	Model A2	Model A3	Model A4	Model A5	Model A6	Model A7	Model A8
Intercept	-6.52	7.23	8.77	8.82	6.99	7.19	3.2	7.36
	(1.06)	(2.96)	3.25	(3.86)	(3.51)	(4.46)	(3.5)	(4.37)
Log of Teledensity 1995	1.35***	1.74***	1.70***	1.93***	1.70***	1.7***	1.38***	1.81***
	(.46)	(.37)	(.36)	(.43)	(.33)	(.44)	(.34)	(.43)
Log of Energy Consumption 1990	.19	-.10	-.07	-.07	-.08	-.06	.24	-.12
	(.41)	(.37)	(.40)	(.37)	(.35)	(.40)	(.25)	(.39)
Log of Political Openness 1994	.39	.34	.29	.28	.25	.35	.20	.30
	(.27)	(.29)	(.28)	(.27)	(.30)	(.23)	(.19)	(.23)
Secondary Education 1985		-2.9***	-3.14***	-2.42***	-1.62	-3.02**	-2.44***	-3.00***
		(.72)	(.76)	(.86)	(1.00)	(1.33)	(.65)	(1.28)
Log of Service Sector ca 1990		-5.04***	-5.34***	-4.6***	-3.48***	-5.09***	-4.26***	-5.13***
		(1.15)	(1.23)	(1.15)	(1.16)	(1.62)	(1.11)	(1.58)
School*Service Sector		1.11***	1.19***	.97***	.59*	1.4**	1.01***	1.13***
		(.27)	(.29)	(.29)	(.34)	(.43)	(.23)	(.42)
Log of Foreign Investment 1995			.29**					
			(.14)					
Log of Ethnic Homogeneity				-.97*				
				(.57)				
Log of Inequality 1970					-.94***			
					(.28)			
Log of Population Density 1995						.06		
						(.17)		

Log of Exports+Imports/GDP 1995							-.02	
							(.08)	
British								.45
								(.54)
N	68	68	68	66	55	67	58	68
R^2	.78	.82	.83	.82	.83	.81	.90	.82
R^2 Adjusted	.78	.80	.81	.80	.80	.79	.89	.80

***P<0.01 One-tailed, **P<0.05 One-tailed, *P<0.10 One-tailed

Table 4: The log of Internet Hosts per 10,000 Regressed on Selected Independent Variables and Control Variables, Including Both Log of Energy Consumption and Log of Teledensity; Standard Errors Corrected using White's (1980) Procedure (Standard Errors in Parentheses)