

THE GLOBAL IMPACT OF THE INTERNET: WIDENING THE ECONOMIC GAP BETWEEN WEALTHY AND POOR NATIONS?

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Abstract

Does the Internet have the potential to accelerate development in poor nations? Or is it an innovation that will widen the gap between wealthy and poor countries? This paper places the Internet in a framework of major innovations in modern economic history that have contributed to increased global economic inequality. To study whether the Internet has the potential to do the same, we investigate the determinants of Internet diffusion and explore differences between developed and developing nations. Our findings indicate that developing countries are being left behind as the transformation to the "new economy" takes place in wealthier countries. If this trend continues, it may have dire consequences for world economic inequality and political stability, as did great innovations of earlier eras. We consider policies that might accelerate the development of information technology in poorer countries so these nations can benefit from the technological revolution occurring in wealthier countries. We also discuss why it might be in the interest of the developed countries to pursue such policies.

INTRODUCTION

The Internet and information technology (IT) represent a revolution that may well have an economic impact corresponding to the wave of innovations that made up the core of the industrial revolution two centuries ago. The industrial revolution dramatically increased global economic inequalities, which in the 19th and 20th centuries produced discrepancies in political power among nations that led to imperialism and warfare.

After a discussion of earlier technological breakthroughs, this paper presents data that show a significant gap between wealthy and poor countries in the rate of diffusion of the Internet. The evidence suggests that poor countries are being left further behind as a result of the ongoing technological revolution elsewhere in the world. We consider proposals for helping developing countries participate in the "new economy" by improving their communications infrastructures and transferring technology from technological leaders to poorer countries, as well as whether it might be in the interest of leading nations to sponsor such efforts.

The Internet and Economic Growth

The last half of the 20th century has witnessed a revolution in information technology, capped off at century's end by the Internet. Numerous popular and academic articles describe the "new economy" and new business models stimulated by IT. Computers, databases and communications networks are pervasive in post-industrial countries. The Internet provides standards for worldwide connectivity, and its impact on business and commerce has been dramatic. The impact of IT on economy-wide measures of productivity is also increasingly evident, particularly but not exclusively in the United States, the leader in applying information technology.

The Internet allows global market access for a vendor; over 150 million people can access the web site of someone with a product or service to sell on the Net. Many organizations are developing electronic customer/supplier relationships, resulting in a dramatic increase in efficiency. There is a movement toward purchasing "hubs" in which a web site joins together buyers and sellers, for example, shippers with trucking companies. Led by Detroit automakers, a number of industries are establishing

purchasing sites to reduce the cost of dealing with suppliers. Companies are integrating their supply chains and providing suppliers with access to their production plans.

The Internet has given rise to new business models. Companies such as Dell Computer and Cisco Systems integrate technology into all of their operations. Cisco processes almost all of its orders on the Web, and handles approximately 85% of its customer service on the Internet. Companies adopting the Internet are substituting technology for physical assets. In addition to developing commerce, the Internet offers the potential for new forms of distance-education and learning, and for improving the quality of medical care.

The Internet needs a robust telecommunications infrastructure to function well. In the United States, there are a number of Internet Service Providers (ISPs) that connect individuals to the Internet backbone. Companies like Uunet provide high-speed fiber backbone communications to carry Internet traffic. In 1999 Uunet was reportedly expanding its capacity 10 times a year to keep up with demand.

Individual organizations connect to the Internet through leased lines to a service provider, generally at a much higher speed than the 56Kb of a typical modem. Many home users only have the option of a modem, but increasingly high-speed home service is available through cable TV companies, DSL lines from the phone company, or satellite TV providers. A communications infrastructure is a prerequisite for obtaining maximum benefits from the Net.

Web Inequality

The Internet in 1999 connected 58,000 separate networks with an estimated 150 million users world-wide (Petrazzini and Kibati,1999). A UN Human Development

Report (1999) noted that the lead of the US in Internet development has resulted in 80 percent of web sites being in English and 26 percent of Americans using the web, whereas only 3 percent of Russians, 0.04 percent of South Asians, and 0.02 percent of people in Arab states do so. The US has more computers (potential web access) than the rest of the world combined. Moreover, while an American can buy a computer with a month's salary, a Bangladeshi would need 8 year's income to buy one. Nearly half of U.S. homes have Internet access in 2000. By implication, the reduction in worldwide economic inequality that occurred in the last half of the twentieth century is being reversed, contrary to the rosier scenarios of some economists who argue that the recent reductions in inequality are likely to continue in the twenty-first century.

An optimistic scenario has developing countries adopting the Internet to stimulate economic growth. There are many stories of artisans in poor countries marketing their products world-wide through a web site. The Internet is promoted as a technology that will enhance education and expand commerce, allowing developing countries to make rapid advances.

The Internet is a kind of technological infrastructure, however, and developing countries are notoriously short of infrastructure. The Internet also requires a level of education and training to use, and educational opportunities in poorer countries are generally inferior to those in wealthy countries. Unfortunately, our data analysis shows that poor countries are almost "off the screen" as far as Internet capabilities. The data suggest that what appear to be key determinants of the Internet's penetration in more developed country settings have almost no explanatory power for developing countries. If this situation persists most of the continued diffusion of Internet technologies will

occur in wealthy countries, and the likelihood increases—based on the historical impacts of earlier network technologies—that economic inequality and political and social instability will increase in the world.

New Technologies and Economic Inequality among Nations: Historical Perspectives

The consensus of economic historians is that roughly two centuries ago there was far less economic inequality among the world's major regions and societies than there is today. From then to the present, the gap in average incomes between rich and poor societies became much wider. Two hundred years ago it is estimated that the was on the order of 2 to 1; today it is more like 30 to 1 (Lucas, 2000).

Consider the three most populous nations in the world today, China, India, and the United States of America. Together the three have about 40 percent of the world's people. In the United States, a rich country, the average income is approximately 30 times the income of the average person in these other two countries. Just 200 years ago, however, the people of the United States, according to the noted nineteenth-century American historian Henry Adams, had living standards little different from those of the ancient Romans or medieval Europeans (Adams, 1931 [1889]). In 1800, living standards in China and India may not have been on a par with those of Europe and the United States, but economic historians deem it unlikely that they were very different, in contrast with the great differences now (Pomeranz, 2000).

What raised the gap between rich and poor nations from a ratio of 2:1 to 30:1 in two centuries? The succinct phrase economic historians have used in response to this question is “the industrial revolution.” The initial industrial revolution, England's, began with late 18th-century technological breakthroughs in the production of textiles, coal, and

iron, and the innovation of steam engines. Economic historians use these specific or “core” examples of innovative change to develop general principles underlying industrialization. Spinning and weaving breakthroughs in textiles represent the general principle of substituting power-driven machines for human labor. Technological developments in iron (and coal) processing illustrate the substitution of abundant mineral substances for scarcer animal and vegetable materials. Steam engines generalize to the substitution of inanimate converters of energy for traditional animate (human, plant and animal) converters (Landes, 1998).

Each specific technological breakthrough represented a quantum leap forward in production and the productivity of human labor. As the general principles involved were extended to other industries, economic growth—production per person--increased and became self-sustaining. From textiles, machine production spread to other industries. Iron led directly to steel, and as the chemical technologies involved were increasingly understood, a host of new materials were developed and used across a range of modern industries. Steam engines were forerunners of internal combustion engines and nuclear reactors.

With these epochal developments, living standards rose. But not everywhere, or at the same rate in different societies. England, which by the mid-nineteenth century became “the workshop of the world,” and the United States were the leaders among the larger countries. Continental Europe took up the technological revolution in the nineteenth century, during which time industrialization spread from western to central and, to a lesser extent, eastern Europe. At the end of the century Japan began a major industrial upsurge, and remained for decades the only non-Western country to be an

industrial society. Among this group of industrializers, the followers or late-comers tended to grow faster than the pioneers, so that eventually the differences in income levels among all of them became much less than between them and the non-industrial rest of the world. Well into the twentieth century, that “rest of the world” lagged well behind Europe, North America, and Japan. But in the second half of the twentieth century, it too began to industrialize.

This traditional economic-historical account of the industrial revolution helps to explain the dramatic increases in economic inequality among nations that developed during the past two centuries. It also indicates how that inequality eventually tends to be reduced. The latecomers grow faster than the pioneers, reducing the income gaps that the industrial revolution initially engendered among them.

In a recent article, Robert Lucas, a prominent economic theorist and Nobel laureate, utilized these stylized facts of economic history to develop a model predicting that economic inequality in the world would be far lower a hundred years from now than it is today (Lucas, 2000). Latecomers to industrialization grow faster than earlier industrializers by a factor proportional to the average income gap between the two groups; eventually eliminating the gap, and all industrialized countries grow at the same rate. As more and more of the world’s countries industrialize, world economic growth slows down, and income gaps among countries are greatly reduced. According to Lucas, this phenomenon has been happening since the middle of the twentieth century, and it is likely to continue over the coming century as more or less the whole world becomes industrialized.

If Lucas is right, we need not worry, as the UN's 1999 Human Development Report does, about the tendency of the Internet and other new information technologies to increase inequality. They too will be incorporated into the world's stock of technology, and with some lag will be adopted by latecomers even more rapidly than by today's leaders. Eventually—maybe in a hundred years—all or most countries will be at similar levels of income.

There are reasons, however, to doubt such a rosy scenario. Lucas's model, which does seem to capture some important stylized facts of economic history, is deficient in others. It appears to assume that the world's stock of state-of-the-art technology is relatively unchanging or changing very slowly, so that latecomers can avoid the costs incurred by pioneers, dip into it, and then by growing faster than the pioneers, eliminate the income gaps between them.

Suppose, however, that the Internet and related IT, as some argue, are really epochal innovations such those of the British industrial revolution two centuries ago, or the railroad technologies that came along in the middle decades of the nineteenth century, or the electrical and automotive technologies that were developed in the late nineteenth and early twentieth centuries. If so, these new technologies, like the older ones just mentioned, might well increase inequality in the world for decades, with political and social consequences that do not differ from those that came with inequalities brought by industrialization after 1800.

Networks and Network Externalities

A newer interpretation of the past two to three centuries from the one above puts this possibility in historical perspective. This new interpretation of economic history,

while not denying the importance of the great inventions and innovations of the industrial era, gives more emphasis to the importance of network innovations and network externalities in shaping the modern economic world.

In the new view, the Internet and IT technologies in general are the latest of several major breakthroughs in network technologies that were fundamental in promoting and sustaining industrialization where it took place. The earlier network technologies, in order of their appearance, were modern financial systems in the seventeenth and eighteenth centuries (before the industrial revolution), early transportation networks (road, canal, ocean and waterway shipping, and, most prominently, railway networks) from the late eighteenth to the late nineteenth centuries, and, finally modern transportation (highway, airway), communication (telegraph, telephone) and electrical networks which began in the late nineteenth and early twentieth centuries.

Each of these historical network breakthroughs can be associated with the industrialization of the modern world and the income gaps among nations and world regions to which “selective” industrialization led. In the first (and least recognized) of the great network technologies of the modern world, finance, the pioneers were the Dutch Republic in the late 16th and early 17th centuries, the British who adopted and added to Dutch financial techniques in the late 17th and early 18th centuries, and the United States which adopted and added to British financial techniques in late 18th and early 19th centuries. All of these countries early in their modern histories had what some have termed “financial revolutions.” In all three, financial networks—banking systems and securities markets, for example—were in place to mobilize and allocate capital before the Industrial Revolution, so that the revolution could advance rapidly without capital-supply

constraints. Although economic historians have not commonly drawn attention to this suggested relationship of financial development and economic modernization, nearly all of them, if asked to name the most advanced economies of the past four centuries, would say, in order, the Dutch Republic in the seventeenth and eighteenth centuries, Britain in the late eighteenth and nineteenth centuries, and the United States from the late nineteenth century to the present (Sylla, 1998, 1999).

The early transportation technologies of the 19th century, particularly the railways, which developed rapidly from their start in the late 1820s to the 1880s, were classic network technologies. Those countries (and individual entrepreneurs) that built and used the new network technologies earliest and to the greatest extent tended to prosper the most, while others were left to catch up later, or left in the dust. Inequality widened.

Just as the range of applications of industrial technologies widened over time, so too did the range of network technologies. A third wave of network development occurred from the late 19th through the early 20th century. First came the communication networks represented by the telegraph and the telephone. Then the automobile followed by the airplane created the need for new transportation networks, highways on land and air traffic systems for flight. Simultaneously, electrical networks spread and spawned a host of industrial and consumer applications. These innovations led to more inequalities of income and wealth between the rich and the poor of the world.

From the early decades of the 20th century to the IT revolutions at its end, there were no great breakthroughs in network technologies. Television was important at mid-century, but was more an application of the earlier developments than something new. One has to wonder if the absence of major network developments during much of the 20th

century might have created the sort of economic world envisioned in Robert Lucas's model. In such a world, the have-nots could adopt the technologies already developed by the haves and catch up with them, as the model predicts. In other words, the poorer countries could install the infrastructure necessary to join the networks established earlier by the richer countries, and disproportionately benefit from doing so since they became members of large networks previously developed by others. At the same time, by enlarging the network their membership created network externalities for existing members, who could now "reach" more members.

On the other hand, if we are indeed on the edge of a new era of network technological innovation represented by the Internet and other IT advances, then we may also be on the edge of an era when economic inequalities in the world again increase, as they did in the wake of earlier network introductions. Past network developments bypassed many people and large areas of the world for long periods of time. For these reasons we think it is important to examine the characteristics of the adoption rate of Internet technologies to determine whether the haves are advancing rapidly while the have-nots are being left behind. If the gap between rich and poor nations is rising, what are the implications?

The Internet and Prescriptions for Economic Growth

Landes (1998) has proposed the following factors for stimulating economic growth in developing nations:

1. Manage and build instruments of production; master the technological frontier
2. Impart knowledge to the young
3. Hire and promote based on competence and relative merit
4. Encourage initiative, competition and emulation
5. Allow people to benefit from their labor and enterprise

6. Practice gender equality
7. Have a political system that:
 - a. Secures the rights of private property
 - b. Secures the rights of personal liberty
 - c. Enforces the rights of contracts
 - d. Stable government of laws rather than men (not necessarily democratic)
 - e. Provides responsive and honest government
 - f. Moderate, efficient and non-corrupt government keeping taxes down
8. An ideal society would be honest

To successfully integrate the Internet into an economy, a country's leaders will have to follow many of Landes's suggestions. The instrument of production for the Internet is a telecommunications infrastructure, something that is expensive and competes with other infrastructure projects such as roads. While a developing country may be able to use wireless technology for phone connections, high-speed Internet access demands either fiber optic lines or satellite communications.¹ The rich countries have the capital and know-how to develop such new infrastructures and are doing so. The poor countries likely do not.

Knowledge is an important prerequisite for Internet use. Individuals have to learn how to use the Internet, and set up servers and Web sites. There is a need to transfer this knowledge to developing countries if they are to secure the benefits of the Net. Much of the development of Internet business has been entrepreneurial, which means that people have to be allowed to benefit from their labor and investments; there must be a right to private property and there is a need to honor contracts.

Later in the paper, we explore policy initiatives to accompany these factors for developing an Internet capability in a developing country. The next section presents the

¹ DSL technology offers high speed Internet access over copper wire, but has a number of limitations.

results of an analysis of data on the status of Internet development in different groups of countries. The results are not encouraging for the poorer countries.

THE GROWTH AND DISTRIBUTION OF THE INTERNET

Which countries are using the Internet today? What is the extent of Internet use among developing countries? What factors predict the intensity of Internet use in a particular country? The answers to these questions are important in formulating policies to assist developing countries take advantage of technology.

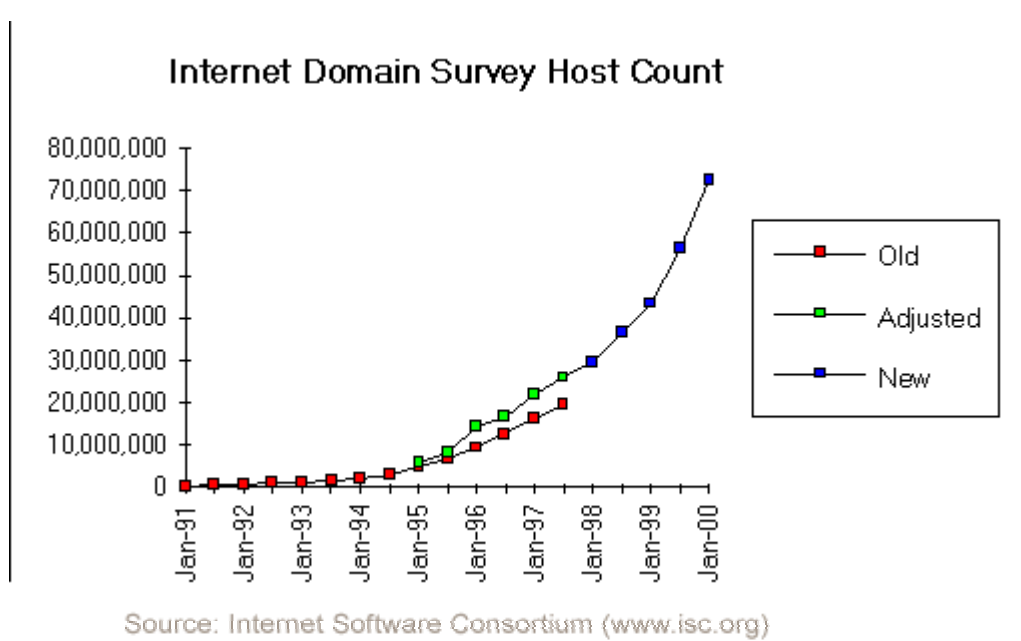
Research Design

To address the questions above, we collected data from the World Bank on 1998 economic development indicators. We added to these data information about the number of Internet hosts in each country from the Network Wizards Web site:

<http://www.isc.org/ds/>. Hosts are the computers on the Internet that contain content; they respond to requests from client computers. A PC in one's office running a browser like Netscape Navigator or Internet Explorer is a client computer. It requests information from a variety of servers using a URL or Universal Resource Locator. As an example, the URL for the Stern School of Business at New York University server is <http://www.stern.nyu.edu>. A country with a large number of hosts or servers is indicative of more Internet penetration and activity than a country with fewer hosts.

Figure 1 shows a recent survey of Internet hosts. Note the rapid, exponential growth of the Internet over the last 7 years. Compared to other innovations like radio and television, the Net has grown considerably faster, especially since it became available for

Internet Hosts
Figure 1



profit-making use in 1995. This rapid diffusion adds urgency to the needs of developing countries; each day they delay developing an Internet presence, they fall further behind.

The Data

We obtained development-indicator and Internet-host data from the World Bank and from a survey of Internet Domain names by the Internet Software Consortium (<http://www.isc.org>). There are some problems with the data. First, the World Bank data for different countries may not be for the same year due to different practices on collecting and reporting information in various countries. The Internet host data are based on high-level domain names. For example, a domain name that ends in "com" generally is from the United States, while one that ends in "sg" is from Singapore, "ca"

from Canada and so on. However, there is no law that says domain names have to reflect the physical location of the server. The Taliban government in Afghanistan has a Web server, but the host data showed no hosts in Afghanistan in 1998 or 1999. We suspect the server is in neighboring Pakistan.

Press (1997) reports on a number of errors in estimating the number of hosts in a country based purely on the domain name, and suggests that data from *Matrix Maps Quarterly* is a better source as it has been adjusted for misclassification of domain names. We purchased the MMQ data for the host count of July 1998; MMQ begins with the Network Wizards data and then adjusts it. Comparing the two counts, the MMQ data generally adjusts the number of hosts in a country upward while correcting for overcounts in countries with a large number of hosts. However, none of the countries with fewer than a 100 hosts in the Network Wizards survey has 100 or more hosts in the MMQ data. The largest discrepancy is for Canada where MMQ estimates almost 600,000 more hosts than the Network Wizards data show. MMQ also estimates a quarter of a million more hosts in Taiwan than Network Wizards. In the analysis below, we estimate our basic model with combined data from both surveys. We use the MMQ data when it exists for a country, and the Network Wizards estimate where it does not. (There was no material difference in the results below comparing the same analysis with the Networks Wizards survey and the combined, adjusted host count reported below.)

Variables in the Study

There is no accepted number of hosts for a country to be considered as having a major Internet presence. We chose to divide our sample of countries at the median host count for 1998, 632 hosts. The appendix lists countries split at the median. Countries

without much presence on the Internet may be found in Africa, the Middle East and parts of Asia. Table 1 contains descriptive statistics on the two host subsamples in terms of the development-indicator variables in the study. The variables include population and gross domestic product per capita adjusted for purchasing power and recorded in U.S. dollars. IncomeF is an estimate of the percentage of the average income in a country that females earn; it is a measure of gender equality in the workplace. Life expectancy is a measure of health while literacy rate is indicative of educational levels in a country. The percent of paved roads is a measure of physical infrastructure. In its 1999 *Knowledge for Development Report*, the World Bank uses the number of phones per 1000 people as a measure of information access. PCs per thousand people is an indicator of technology diffusion, but unfortunately, there are too many missing observations to use this variable in the regression analyses which follow.

Comparing countries with fewer than the median number of hosts with those equal to or greater than the median, the adjusted GDP in the first group is 54% that of countries having 632 or more hosts. The percentage of average income earned by women is nearly the same in each group. However, life expectancy and literacy rates are lower in the less-than-632-host group. This group with fewer hosts also has fewer paved roads, PCs and phones per thousand people than countries with 632 or more hosts.

The growth rate of hosts between 1995 and 1998 in the two groups of countries favors countries with less than the median number of hosts. However, the low host group grew from a small base, averaging, 6, to 100. This figure compares with over 380,000 hosts in the greater than median group. The countries with fewer than 632 Internet hosts in 1998 average three orders of magnitude fewer hosts than the countries having more

than 632 hosts. Recently published data confirms that developed countries, especially the U.S., are experiencing greater growth in Internet hosts than poorer nations. Preliminary OECD data shows that between September 1999 and March 2000, the U.S. added 25.1 Internet hosts per 1,000 inhabitants, the U.K. 5.5, Japan 4.1, Germany 3.0 and France 2.7 (*Wall Street Journal*, 6/21/2000). *There is a significant gap between the countries with little presence on the Internet and countries that have a more substantial presence. Countries with fewer than the median number of hosts on the Internet are a long way behind those with a substantial Internet presence.*

		Number of hosts <632		Number of hosts ≥632	
Name	Definition	N	Mean	N	Mean
Pop	Population	107	9,451,217	92	50,391,809
Adjgdp	Adjusted GDP PPP \$	91	\$2758	83	\$5093
IncomeF	% average income tofemales	80	33%	83	33%
Lifeexpt	Life expectancy	91	60 years	83	72 years
Lirate	Literacy rate	91	68%	83	90%
Roadpav	Paved roads	87	35%	80	61%
Phone1000	Phones/1000 people	111	92	91	275
PCs1000	PCs/ 1000 people	25	16	70	78
Hosts95	Internet hosts 1995	46	6	87	55,755
Hosts98	Internet hosts 1998	147	96	94	389,921
Host98Adj	Adjusted hosts 1998	147	105	94	380,738

Descriptive Statistics

Table 1

Note that World Bank's *Knowledge For Development* Report 1999 uses phone density as a measure of population's ability to access information

PREDICTING INTERNET HOSTS

To answer the question of what characteristics of a country are associated with a presence on the Internet, we used the data described in Table 2 to predict the number of Internet hosts in 1998 divided by population. (The actual calculation is for the adjusted hosts (Host98Adj) divided by population times one billion; the equations below predict the natural log of this number.) The independent variables in the analysis for 1998 include the natural log of population, the natural log of adjusted gross domestic product per capita, the literacy rate, the percentage of income earned by females, and phone density.

Equation 1 presents the results for the entire sample. (The numbers in parentheses under the variables are t statistics²; please note that the number of countries in the analysis below is less than the number in Table 1 due to missing data for the independent variables.) Three of the four variables in the equation are significantly related to hosts divided by population, explaining 61% of the variance in the dependent variable. The adjusted gross domestic product is an indicator of wealth, literacy rate of education, and phones per 1000 people of technology and communications infrastructure. As authors like Landes predict, wealth, education and infrastructure are associated with a greater presence on the Internet. It is interesting to note that our measure of gender equality, the percentage of average income going to females, does not predict the number of hosts. It may be that gender equality is fairly low in all countries except a few industrial

² The countries included in these results represent a census of countries having an Internet host, though not a census of all countries in the world. Given data that are more the census than a sample, it is probably not necessary to be concerned over statistical significance. However, most readers are familiar with t statistics and significance levels as one measure of the strength of a relationship, so they are included here.

democracies; Table 2 shows no difference in IncomeF between firms below and those at or above the median number of hosts.

Equation 2 presents the results of predicting hosts divided by population for countries with fewer than the median number of Internet hosts. Here, the model explains very little variance, only 21%. Adjusted gross domestic product and phones per 1000 people are significant, but only at the .10 level.

Equation 3 applies our model to the data for countries at or above the median number of Internet hosts in 1998. The independent variables explain 84% of the variance in the number of hosts divided by population. Adjusted gross domestic product and phones per 1000 people are highly significant in the equation.

All hosts

$$1) \text{LNHOST/POP} = -16.92 + 2.54 \text{LNADJGDP} + 5.21 \text{E-02 LITRATE} + \\ (3.94)^{***} \qquad \qquad \qquad (2.86)^{***} \\ + 5.57 \text{E-02 INCOME} + 9.24 \text{E-03 PHONE1000} \\ (1.38) \qquad \qquad \qquad (4.52)^{***}$$

Significance levels for t and F statistics * \leq .01 ** \leq .05 *** \leq .10

Adjusted $R^2 = .61$ F= 62.38 n=160

Hosts <median (632)

$$2) \text{LNHOSTS/POP} = -12.92 + 1.72 \text{LNADJGDP} + 3.01 \text{E-02 LITRATE} \\ (1.68)^* \qquad \qquad \qquad (1.04) \\ + 0.12 \text{INCOME} + 2.51 \text{E-02 PHONE1000} \\ (1.63) \qquad \qquad \qquad (1.85)^*$$

Adjusted $R^2 = .21$ F= 6.13 n=79

Hosts >=median (632)

$$\begin{aligned} 3) \text{LNHOSTS/POP} = & -5.66 + 1.88 \text{LNADJGDP} + 1.90 \text{E-02 LITRATE} \\ & (4.70)^{***} \qquad \qquad \qquad (1.52) \\ & +1.48 \text{E-02 INCOMEF} + 7.32 \text{E-03 PHONE1000} \\ & (0.79) \qquad \qquad \qquad (9.84)^{***} \end{aligned}$$

Adjusted R² = .84 F = 107.40*** n = 81

Discussion

The analysis demonstrates clear differences between countries that have embraced the Internet and those that have not. Landes's (1998) economic development factors help explain some of these differences. What leads to the development of the technological infrastructure represented by the Internet? Landes argues that wealth is necessary to produce capital and that education and gender equality are important for economic growth. These data support several of his conditions for development and extend them to technology infrastructure. Higher levels of Gross Domestic Product, higher levels of literacy and communications infrastructure are associated with greater Internet presence for all countries combined, though the effect of literacy does not appear in the two subsamples. In those countries having fewer than the median number hosts, the independent variables have little predictive power. However, there is some evidence that wealth and communications infrastructure are important here. The results on wealth and communications infrastructure are much stronger for countries at or above the median number of Internet hosts.

RECOMMENDATIONS

The UN Development Report data and the results above suggest a wide gap between countries that have adopted the Internet extensively and those that have not. The major factors associated with Net adoption are GDP and telecommunications infrastructure as measured by the number of phones per 1000 people. For the countries with the lowest adoption in the analysis, these variables are only modestly associated with the number of Internet hosts, and the model explains little variance. The conclusion is inescapable that less developed countries are significantly behind on Internet technology compared to those with more resources.

If we assume that the Internet and associated technologies are important for economic growth, then what are the policy implications of these findings? What factors inhibit the adoption of the Internet, and what can be done to mitigate them?

Barriers to Net Adoption

There are many barriers to the adoption of new technology; for example, Kedia and Bhagat, 1988, stress general problems related to culture and social influence. Some countries tend to see the Internet as an American-dominated technology and therefore as something to be distrusted. In addition to cultural issues, the Internet requires a group of knowledgeable users to diffuse the technology to others. Many developing countries lack such a corps of dedicated IT professionals.

Many developing countries have undemocratic governments, which are concerned with the free flow of information. An Indonesian government minister said at a conference in Kuala Lumpur on November 25, 1997 that no one from the government had validated the information on the Internet. The opponents of the regime had a Web site

that they did not submit to government censors. The minister complained that the Indonesian army set up a Web site to put forth its views, and no one accessed it! In addition to concerns over the control of information, governments may be worried about the ease with which dissident groups can communicate with each other through Web sites and email. Finally, the ability to access the Internet opens up a world of Web sites, over one billion pages of information at last count, some of which is critical of non-democratic forms of government.

Developing countries lack the funds for investing in a telecommunications infrastructure, purchasing computers, and providing education on how to use the technology. The lack of infrastructure, phones and PCs is a major impediment to Internet adoption. Where the infrastructure exists, Internet access is considerably more expensive in poor countries than in wealthy ones relative to income. In Ghana an account with Africa Online costs \$50 a month, nearly twice the monthly income of most Ghanaians. Ghana at least has competition in communications; a half circuit or local portion of the network is \$2500, while in Kenya an ISP pays \$8000 for a half circuit (Petrazzini and Kibati, 1999). In Russia the price for an Internet connection is \$121 a month; adjusting for GDP per capita, Russian Internet users pay 485 times as much as users in Finland.

Current Intervention Efforts

There is growing awareness that Internet access is important for growth in developing countries:

- The US Peace Corps announced that it would provide extensive Internet training for its recruits (though one has to wonder if the recruits are not likely to know more about the Internet than the staff!).
- The UN Asia-Pacific Development Information Program is planning a data network for the war-ravaged island of East Timor; the first priority is e-mail

using a satellite connection to Singapore. (The UN began this program in 1997 to help Asian governments and community group develop information structures to join the electronic marketplace. *New York Times*, 12/27/99.)

- Private foundation efforts like one in India that has placed two computers with Internet access in an impoverished village are a small start. Other Indian villages have bought computers with their own funds to provide price information on crops and to access government services (*New York Times*, 5/28/2000).
- Volunteers in Technical Assistance provides information and aid for countries to enhance development. The organization has low earth orbit (LEO) satellites and is focusing on e-mail communication in poorer countries. The organization estimates that half of the world's population has never made a phone call (www.vita.org).

All of these efforts are positive, but they are quite modest given the exponential growth of the Internet in developed countries, and the anemic presence of the Net in developing ones.

Proposals for Assistance

What sorts of policy measures might dramatically increase the adoption of the Internet and help poorer nations narrow their substantial technology gap with wealthier countries? And can they be justified? If the gap that we and others have identified between wealthy and poor countries continues to accelerate, and the Internet and IT revolution suggest that it will, poor countries will see stagnating living standards and incomes, while the wealthy countries become wealthier. This phenomenon has occurred before in modern history. An increased gap between the rich and poor tends to lead to an environment that encourages political instability, wars within and between nations, and a continuing cycle of misery for the people in affected countries.

Policy measures that might reduce such possibilities by diffusing more rapidly the benefits of Internet technologies throughout the world include:

1. A sustained effort by the United Nations and individual, wealthy countries to build the most appropriate communications infrastructure in developing countries.
2. The dedication of sufficient satellite transponders for two-way Internet access for poor countries using technology to be rolled out at the end of 2000 by Gillat, an Israeli company, in conjunction with Echostar, a satellite provider, and Microsoft Network.
3. An Internet Corps within the UN or individual countries modeled after the Peace Corps. This group of aid workers would have as its primary responsibility establishing connectivity and training people in less developed countries on how to access the Internet and how to build Web sites. Part of the aid would be devoted to developing native language Web sites and content.
4. A concerted effort by aid agencies to encourage government policies in developing countries that favor innovation, venture capital, investments in research, and education about technology.
5. A \$1 per month surcharge on the Internet accounts of every user in wealthy nations to fund the activities above, similar to the surcharge on US phone bills to connect schools to the Internet and provide phone service for low income subscribers.
6. A 1% tax on all electronic commerce dedicated to expanding Internet use in developing countries.
7. An International Developing Countries Venture Capital Fund to allocate the capital raised in steps 5 and 6 above; some of the capital should be applied to infrastructure, and some to new ventures that involve the Internet.

While taxes and surcharges such as those in 4 and 5 above would not be popular, they can be justified on economic grounds. Substantial network externalities from the Internet and World Wide Web mean that both buyers and sellers benefit from increasing the number of users of the Net around the world. The more users connected to the Net, the more valuable the Internet is to content providers, who in turn, attract more users. Subsidies from rich to poor countries to increase the Internet network can be justified on grounds that the benefits of expansion of the network, initially at least, may be greater for existing members than for new ones.

The Internet phenomenon near the end of the 20th Century is as dramatic a revolution were the industrial revolution and financial, transportation, communication, and electrical network breakthroughs that occurred during the past three centuries. Will wealthy nations stand by and see information technology widen the gap between rich and poor countries that resulted from the industrial revolution? Or will they, in their own interest, make an effort to reduce the gap between rich and poor through the substantial benefits the Internet can provide to developing countries? The choices wealthy countries make with regard to the Internet and the communications infrastructure of developing countries may well determine the economic future of half the world's population and the stability of large regions of the globe. Due to network externalities, the kind of assistance suggested here has the possibility of contributing as much to the countries offering aid as those receiving it. It is not too soon for concerted action, before the Internet gap between wealthy and poor countries becomes an insurmountable chasm, resulting in many of the negative consequences that arise from the uneven diffusion of industrial and network technologies in the world economy.

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APPENDIX: Countries in the Study

Countries with hosts greater than Or equal to the median 632

Antarctica
Barbados
Guam
Bangladesh
Channel Islands
Korea, Dem. People's Rep. of
West Bank and Gaza
Belarus
Brunei Darussalam
El Salvador
Georgia
Kenya
Liechtenstein
Monaco
Namibia
Nicaragua
Oman
Panama
Paraguay
Zimbabwe
Bermuda
Bulgaria
Costa Rica
Croatia
Cyprus
Dominican Republic
Ecuador
Egypt
Guatemala
Kazakhstan
Kuwait
Latvia
Lebanon
Luxembourg
Macau
Malta
Niue
Pakistan
Peru
Philippines
Puerto Rico
Tonga
Trinidad and Tobago
Venezuela
Virgin Islands (U.S.)
Yugoslavia
Argentina
Australia
Austria

Countries with hosts less than the Median of 632

Albania
Algeria
American Samoa
Angola
Aruba
Ascension Island
Benin
Bhutan
Bouvet Island
British Indian Ocean Territory
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
Christmas Island
Comoros
Congo
Cook Islands
Cuba
Dem. Rep. of the Congo
Djibouti
Dominica
East Timor
Equatorial Guinea
Eritrea
Ethiopia
Falkland Islands (Malvinas)
French Southern Territories
Gabon
Gambia
Grenada
Guernsey
Guinea-Bissau
Guinea
Guyana
Haiti
Heard And Mc Donald Islands
Iraq
Isle of Man
Jersey
Kiribati
Lao People's Dem. Rep.
Lesotho
Liberia
Libyan Arab Jamahiriya
Madagascar

Belgium
Brazil
Canada
Chile
China
Colombia
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hong Kong, China
Hungary
Iceland
India
Indonesia
Ireland
Israel
Italy
Japan
Korea, Rep. of
Lithuania
Malaysia
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Romania
Russian Federation
Singapore
Slovakia
Slovenia
South Africa
Soviet Union
Spain
Sweden
Switzerland
Taiwan, Province Of China
Thailand
Turkey
Ukraine
United Arab Emirates
United Kingdom
Uruguay
USA

Malawi
Maldives
Mali
Marshall Islands
Martinique
Mauritania
Mayotte
Micronesia, Federated States Of
Mongolia
Montserrat
Mozambique
Myanmar
Nauru
Netherlands Antilles
Niger
Nigeria
Norfolk Island
Northern Mariana Islands
Palau
Papua New Guinea
Pitcairn
Qatar
Reunion
Rwanda
Saint Kitts and Nevis
Saint Lucia
Saint Vincent
Samoa (Western)
Sao Tome and Principe
Saudi Arabia
Seychelles
Sierra Leone
Solomon Islands
Somalia
South Georgia And The South Sandwich Isla
St. Helena
St. Pierre And Miquelon
Sudan
Suriname
Svalbard And Jan Mayen Islands
Syrian Arab Republic
Tajikistan
Togo
Tokelau
Tunisia
Tuvalu
Uganda
United States Minor Outlying Islands
Vanuatu
Vatican City State (Holy See)
Viet Nam
Virgin Islands (British)
Wallis And Futuna Islands
Yemen
Zaire
Andorra

Anguilla
Antigua and Barbuda
Armenia
Azerbaijan
Bahamas
Bahrain
Belize
Bolivia
Bosnia And Herzegovina
Botswana
Cayman Islands
Cocos (Keeling) Islands
Cote d'Ivoire
Faroe Islands
Fiji
French Guiana
French Polynesia
Ghana
Gibraltar
Greenland
Guadeloupe
Honduras
Iran, Islamic Rep. of
Jamaica
Jordan
Kyrgyzstan
Macedonia, FYR
Mauritius
Moldova, Rep. of
Morocco
Nepal
New Caledonia
San Marino
Senegal
Sri Lanka
Swaziland
Tanzania, U. Rep. of
Turkmenistan
Turks And Caicos Islands
Uzbekistan
Zambia