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Hargittai, Eszter. 1999. Weaving the Western Web: Explaining Differences in Internet Connectivity Among OECD Countries. *Telecommunications Policy*. 23(10/11)

Weaving the Western Web
Explaining Differences in Internet Connectivity Among OECD Countries*

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Forthcoming. *Telecommunications Policy*.
Posted on the Web: August 21, 1999•

ABSTRACT

Despite the Internet's increasing importance, there is little social scientific work that addresses its diffusion. Our knowledge is especially limited with respect to the conditions that encourage its spread across nations. This paper takes a first step in explaining the differences in Internet connectivity among OECD countries. After examining the impact of economic indicators, human capital, institutional legal environment, and existing technological infrastructure, the empirical analyses show that economic wealth and telecommunications policy are the most salient predictors of a nation's Internet connectivity.

Keywords: Internet global diffusion, connectivity, international network

* I would like to thank Marta Tienda, Miguel Centeno, Martin Dodge, Bruce Western, the members of Princeton University's 1998/99 Sociology Empirical Research Seminar and an anonymous reviewer for their helpful comments on earlier drafts of this paper. I am grateful to Tim Kelly, Ben Petrazzini and Sam Paltridge for their help in providing data.
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The Internet is a major technological innovation of the 20th century with key political, social, and economic consequences (Castells 1996). Politically, the Internet is expected to revive participatory democracy (Anderson et al. 1995, Naisbitt 1982, Deaken 1981, Rheingold 1993, Geser 1996) and has even been used as an indicator of a country's level of democracy (Anderson et al. 1995). Socially, the new medium is expected to act as a moderator of inequality by making low-cost information available to everyone without discrimination (Anderson et al. 1995, Hauben and Hauben 1997). Yet, others have argued that the technology contributes to increasing inequality given that it is unequally distributed among the population (NTIA 1995, 1998, 1999, Novak and Hoffman 1998). Research has also shown that people use the Internet as a complement to traditional media rather than a substitute for them, thereby increasing information gaps across the population (Robinson, Barth and Kohut 1997, Robinson, Levin and Hak 1998).

Although several of the above mentioned claims regarding the effects of the Internet have also been contested (Calhoun 1998, Etzioni 1992, Stoll 1995), the far-reaching impact of the Internet is uncontroversial. Despite its overarching importance, little attention has been devoted to the study of its spread, especially on an international level. Given the potential wide-ranging effects of the technology, the level of diffusion in a country can influence the degree to which a country can hold its place in the global economy. This paper explores what circumstances explain international variation in Internet connectivity among the member countries of the Organization for Economic Cooperation and Development (OECD).[1]

[1] As the section on Data and Methods will elaborate, only 18 countries of today's 29 member nations were included in this analysis.

In the next section, I provide a brief background of the Internet with particular emphasis on its recent exponential growth. Then, I summarize relevant literature on communication technology diffusion that leads to testable propositions. The data and methods section presents details of the data set and modes of operationalization. That section is followed by a discussion of findings and a conclusion that also highlights avenues for future research.

BACKGROUND

The Internet is a world-wide network of computers, but sociologically it is also important to consider it as a network of people using computers that make vast amounts of information available to users. Given the two services of the system - computer-mediated communication and information retrieval - the multitude of services allowed for by the network is unprecedented. Although the system was first implemented in the 1960s, it was initially restricted to a small community of scientists and scholars in just a few nations. Moreover, the World Wide Web, — the key aspect of the Net concerning its wide popularity — was invented only in 1990 and the graphical interface that made its use accessible to the layperson, the Web browser, was created only in 1993. It was this addition to the technology that significantly accelerated its spread both nationwide in the United States and internationally. Thus, significant Internet diffusion can be observed worldwide only in the past few years with the global number of network connected computers surpassing 35 million in 1998 compared to less than 1.5 million in 1993.

Similar to infrastructure innovations of the past such as railroads and the telegraph, the Internet contributes significantly to the convergence of space and time by making various types of communication – regardless of geographical proximity -

quicker than ever before. The ramifications of this spatio-temporal convergence are profound and not well understood because no previous technology has embraced and allowed for as many communication services as the Internet. Since knowledge-intensive activities are an increasingly important component of OECD economies (Reich 1992) and since today's telecommunication infrastructure underlies virtually all domains of economic activity (Drake 1995: 22), exploring the spread of the network is imperative for understanding which nations will be able to advance their economies the most. The presence of the Internet in a society may create new economic activities and jobs, and may also allow for potential improvements in social benefits by offering new educational opportunities, improving health care delivery, and access to cultural and leisure activities (OECD 1997a). More generally, the network functions – and will do so increasingly with technological innovations – as a link between all sectors of the economy affecting also social, political and cultural relationships. Given such potential wide-ranging consequences, the Internet's level of diffusion in a country can influence many of its economic and socio-cultural spheres. Conversely, its absence can have negative impacts with equally important implications.

During the last five years, the rate of growth in the network's global diffusion has exceeded fifty percent annually (Network Wizards 1998.) Between the years 1994 and 1998, the use of the system more than quadrupled in the United States to include between 30 and 35 percent of Americans over the age of sixteen (Pew 1998, CommerceNet 1998.) The system has seen similar popularity in several other nations such as Finland, Sweden, New Zealand, and Australia. However, other nations such as France, Spain, Italy and Greece have been much slower in embracing this new technology. Existing literature about diffusion data is often descriptive (ITU 1997, 1999, OECD 1997a, 1998a, 1999a, Paltridge & Ypsilanti 1997) and does not use methods that allow us to isolate the impacts of indicators controlling for other factors and thus understand their relative importance in explaining connectivity. Alternatively, existing studies only focus on the impact of information technologies on the economy, ignoring the conditions that shape information technology landscapes across countries. Although some literature does exist regarding the Internet's unequal spread to lesser developed nations (Goodman et al. 1994, Hargittai 1996, 1998, ITU 1997, 1999, Press et al. 1998, Rao 1995), there has been surprisingly little discussion of the Internet's unequal spread among developed countries, i.e. those with resources to accelerate adoption.

By concentrating on a group of nations with approximately similar levels of social and economic development, i.e. the OECD, it is possible to examine the more intricate details influencing the spread of the medium. The OECD is an ideal case for investigating the details leading to differences in international Internet diffusion among countries of approximately similar socio-economic development. The members of the organization represent advanced capitalist countries and thus membership controls for a general level of development. In this case, the top-tier nations – as classified by the United Nations Development Programme’s Human Development Report (UNDP 1998) – of the high development level category are examined. This paper fills a gap in the literature by exploring what factors explain the level of Internet connectivity among OECD countries by teasing out the particularities affecting the technology’s diffusion among countries witnessing the greatest spread.

THEORETICAL CONSIDERATIONS

In this section, I summarize existing literature about important predictors of Internet connectivity. Specifically, I discuss how the economic situation of a country, the education level of its inhabitants, the institutional legal environment governing communication technologies, and the existing communication technology infrastructure may be related to Internet connectivity.

Findings From Previous Research

Some studies have attempted to explain differences in international Internet connectivity generalizing to the entire global landscape. Using the Human Development Index (HDI) measure from the UNDP's Human Development Report, Hargittai (1996, 1998) found that a country's human development level is correlated with its level of Internet connectivity. HDI uses information on adult literacy rate, education, Gross Domestic Product, and life expectancy to create an index of countries' level of development. The International Telecommunications Union (ITU 1997) used the same measures and found a similar relationship between the two variables. The limitations of these studies lie in the fact that they only include one overarching measure of development, which leaves little room for understanding the specifics of what factors lead to differentiated Internet connectivity. Moreover, these analyses cannot isolate explanatory factors among countries of similar development levels. The conclusion that general level of development influences Internet connectivity is not helpful in understanding how and why countries with similar levels of development have unequal levels of connectivity.

Kelly and Petrazzini (1997) included more variables, such as information on connectivity prices and language in addition to wealth and education, in their discussion of differentiated connectivity levels. However, their methods were restricted to simple correlations between two variables at a time. Thus, their findings do not provide a comprehensive understanding of what factors determine a country's level of network connectivity. Nonetheless, Kelly and Petrazzini's analysis does suggest that wealth, education, language and pricing are important correlates of Internet connectivity.

Economic Factors

Studies on technology diffusion have found that economic wealth strongly predicts a population's adaptation of new technologies (Rogers 1983). A country's overall economic strength will affect Internet diffusion in that the necessary resources are more likely to be present, and capital required for the expansion of the technology is more available, in richer countries. Another economic factor that influences Internet connectivity is the level of inequality in a country. The more egalitarian, the more people will be able to afford the new technology, thus increasing the probability of a high level of diffusion.

Human Capital

There are two ways in which the level of human capital may be relevant to Internet connectivity: the population's level of education and its English language proficiency. Most studies that have examined the education level of adopters of new technologies find that more educated people are quicker to adopt new innovations than people with comparatively less education (Rogers 1983). In the case of the Internet's global spread, this suggests that countries with better educated populations will be more likely to show higher rates of Internet diffusion than nations with less educated citizens. Kelly and Petrazzini (1997) also suggest that academic institutions often play an important role in spreading the Internet since they are often among the first institutions in a nation to be wired. This provides another reason for considering the education level of a nation in understanding the necessary and sufficient conditions for Internet connectivity. Higher scores on the education measure are likely to reflect a higher number of academic institutions because the scores reflect gross enrollment ratios.

Individual knowledge may affect the spread of a communication technology in yet another way. Laponce (1987) suggests that some languages have greater status than others and they dominate certain areas of life such as English language having a prominence in the computer industry and even international media sphere. Weinstein (1983) argues that English is especially dominant in the realm of international communications. Barnett and Choi (1995) claim that English is so important in some areas that not speaking the language leads to a serious barrier in access to telecommunications technology. Given the prominence of the English language on the content of the World Wide Web, level of English proficiency may affect the number of people interested in using the medium. The prominence of English on the Web is not due to a higher rate of diffusion in the United States, but the relative size of the U.S. population compared to other countries. There is evidence that the U.S. dominates content on the Web with a large percentage of the most visited Web sites being created and located in the United States (OECD 1997e). Because English is the major international language linking people of different origins (Fishman, Cooper and Conrad 1977), even non-Americans on the Web may contribute to English content as long as their Web content is directed at viewers from other nations. English is by far the most pervasive language on sites hosted outside of the United States excluding the native language of the host country (OECD 1999c). Overall, the two aspects of human capital relevant to Internet connectivity are education level and familiarity with English.

Institutional Legal Environment

The institutional legal environment in a country is also relevant to the Internet's spread because national policies can enhance or hold back diffusion of a technology, depending on their approach to regulating mechanisms, privatization, and free competition. The Information, Computer and Communications Policy Division of the OECD's Directorate for Science, Technology and Industry has published several reports advocating the importance of free competition in the telecommunications sector (OECD 1996, 1997a, 1997b, 1997c, 1998b, 1999b). The International Telecommunications Union has contributed to the literature in similar ways (ITU 1997, 1999). These reports suggest that free competition in the telecommunications sector will improve the options for telecommunications services and reduce the price of access charges. These arguments suggest that countries with free competition in the telecom sector will have higher Internet connectivity than countries with monopolies in this sector of their economies.

Existing Technologies

In his work on the diffusion of the telephone in Germany, Thomas (1988) found that the spread of technology is contingent upon certain technological and infrastructural factors being present in the target nation. Kelly and Petrazzini (1997) also emphasize this point when explaining the large differences between connectivity among countries of different income categories. With respect to the Internet, existing telecommunication facilities may be crucial for understanding variation in the spread of the Internet.

Testable Propositions

In sum, the review of related studies identifies several important factors in the discussion of international Internet connectivity and suggests the following testable propositions. Greater economic wealth and a higher level of economic equality will lead to higher connectivity, whereas less wealth and larger inequality is likely to have an opposite effect. A country whose population has high levels of education is likely to be more densely connected than a country with lower levels of general education. English language exposure will influence connectivity by favoring native speakers most, followed by countries with populations exhibiting high levels of English training, and discriminating most against populations with low English exposure and proficiency. Free competition in the telecommunication sector will have a positive effect on Internet density while telecom monopolies will impede the network's spread. Lower Internet access charges will act as a catalyst for network diffusion. Finally, claims based on the importance of existing telecommunications infrastructure predict that telephone density affects Internet connectivity positively. The following section presents the data and methods, and is followed by a discussion of these propositions based on empirical results.

DATA AND METHODS

The study includes 18 member countries of the OECD.[2] The unit of analysis is the nation-state.[3] As *Figure I* shows, there is considerable amount of variance in Internet connectivity among OECD countries to warrant exploration and explanation. Data were collected from various sources on the aggregate country-level. (See *Appendix I* for details about the sources of the data set.) Data are lagged: the outcome variable is reported in January 1998 figures, whereas explanatory variables are reported for 1994-1996 (depending on availability) with the exception of the Gini coefficient, which is only available for earlier years (see *Appendix I* for information on specific years).[4] The lag in the data is necessary because the question involves explanatory variables for diffusion and attempts to understand what country attributes lead to adaptation of the Internet.[5]

[2] Although every attempt was made to include all member countries of the OECD, due to lack of data on several important variables (most notably access charges and English competence), only 18 countries could be included. Data were missing for the most recent members of the OECD (Czech Republic, Hungary, Korea, Poland, and Mexico) and some other nations (Iceland, Japan, Norway, Portugal, and Switzerland). I used t-test significance testing for means differences to determine whether the excluded cases are significantly systematically different from the ones that were included in the analysis. Only one variable showed systematic difference; all excluded countries had monopolistic telecommunications markets in the year studied. This should be kept in mind when interpreting the results with respect to the overall OECD population. For demographic information on OECD nations, see http://www.oecd.org/publications/figures.

[3] In the future, when comparable data become available for sub-national geographical units, analysis on cross-border regions/cities would also be important and revealing. Such work would be especially helpful in understanding national inequalities.

[4] The use of earlier figures as inequality measures is not a serious problem because level of inequality does not change quickly in these long standing democratic countries.

[5] Studies of diffusion often look at data over time in order to include the rate of diffusion in the model with special importance attributed to the starting point of the diffusion. Although there is a difference in timing regarding countries' initial connection to the Internet, most connections (with the exception of Luxembourg) took place relatively close to each other all between 1988-1990 (OECD 1996). Given that this study looks at 1998 connectivity levels, these initial differences are likely not to be an overarching explanatory factor concerning the differences in the outcome variable. Regarding the specific theories addressed in this paper, lack of sufficient data on predictor variables made over-time analysis impossible.

Outcome Variable

Internet connectivity is measured as number of hosts per 10,000 inhabitants in January 1998 where hosts are individual computers with network access.[6] Because multiple users may use a single host computer, this is not a measure of number of users, and can be regarded as the most conservative measure of Internet presence in a country.[7] One can only estimate the number of users from information about hosts, but, unfortunately, such estimates are much less reliable than host count measures and no such systematic measures exist. Therefore, host count is the most precise available data on the presence of the Internet in a country (OECD 1998a). Since the outcome variable reveals a somewhat skewed distribution, it was logged for the regression analyses in order to make it meet the assumptions of the OLS regression analysis.[8]

Explanatory Factors

Characteristics of the countries are explored with respect to their economic situation, human capital, related institutional legal environment, and existing technological infrastructure. Gross Domestic Product is used as a measure of economic wealth. The Gini coefficient represents a country's level of inequality.[9] General level

[6] Hosts are measured by top-level domain names, the United States includes figures for generic top level domain names (.com, .edu, .gov, .mil, .org, .net) and .us. Although weighted host data are available that account for the number of top level domain names registered by countries other than the United States (OECD 1998b, OECD 1999a), these data were less suited for meeting the assumptions of regression analysis and thus results of the other data are reported. Nonetheless, the tests were run on the weighted data as well and the findings are robust.

[7] There is no systematic information available on the number of users per host across nations. The Discussion section elaborates on what this lack of data implies for the findings of this study and its implications for future research.

[8] I experimented with different scales for the dependent variable for performing the log transformation and the results are robust. The regression results are only discussed with respect to standardized coefficients so the log transformation does not affect the discussion of the outcome. The results are also robust without logging the dependent variable.

[9] Gini coefficients are difficult to collect, represent measures for varying years, and the data source acknowledges the questionable quality of some of the figures (Deininger and Squire 1996). Nonetheless,

of education was derived from the UNDP's Human Development Report and stands for combined first-, second-, and third-level gross enrollment ratio. English language proficiency was coded as dummy variables. Its values are derived from information about the percentage of students in general secondary education learning English as a foreign language. Countries where English is the dominant language were coded as Native speakers and represent the baseline, whereas all others were split into high and low English exposure (see *Table 1* for details).

To address the hypotheses regarding a nation's legal institutional environment, information on the telecommunications sector and on Internet access charges is included in the analysis. Telecommunications policy was coded as a dichotomous variable distinguishing between countries that have monopolies in the telecommunications sector and those that have some level of competition in the year studied. The average cost of a twenty hour monthly Internet access basket is used to indicate pricing.[10] Existing telecommunications infrastructure is measured by information on phone density. This composite variable was constructed by including information on both mainlines per 100 inhabitants and cellular phone subscribers per 100 inhabitants.[11]

Table 1 presents descriptive statistics for all the variables. Despite general similarities among the members of the OECD, most variables exhibit considerable amount of variance. Finland has the highest level of Internet connectivity with the

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they are the only available source of income inequality. The quality of the data must be kept in mind when interpreting the effects of this variable. Lower coefficients denote lower inequality.

[10] It is important to note that this information on pricing does not distinguish between flat-rate versus measured charges. A flat-rate connection fee may seem more with respect to a twenty-hour connection charge, but it may become more preferable when compared with the forty-hour fee of measured charges. Twenty-hour rates were used in this analysis because that is the way data are available for this measure (OECD 1997d).

United States following close behind. Spain, Italy, and Greece exhibit the lowest levels of network connectivity among the 18 countries included in the analysis. On the wealth measure, Luxembourg and the United States lead the group whereas Spain and Greece show figures half the per capita value of the wealthiest nations. Finland and Spain have the lowest levels of inequality according to the Gini coefficients whereas New Zealand and Australia represent relatively greater levels of inequality although the overall variance is not large for this measure. Luxembourg scores far below the other 17 nations in education although this is probably due to the fact that the majority of the people in this country pursue post-secondary education abroad. Italy also occupies a low rank on this measure. In contrast, Canada, Finland, and the United States have larger populations with higher levels of education.

There are six native English speaking countries included in the study. Eight countries exhibit high exposure to English whereas four (Greece, Belgium, Italy, Luxembourg) have populations with low exposure to English. Seven countries had competition in their telecom markets for the year studied: Australia, Canada, Finland, New Zealand, Sweden, the United Kingdom, and the United States, whereas the remaining eleven countries all had monopolies at this time. Not surprisingly, countries without monopolies have the lowest off-peak Internet access tariffs; Canada, Australia, Finland, and the U.S. Austria's prices are far higher than any other nation's with rates in Greece and Germany also quite high in comparison to most others. Ireland and Spain have the lowest levels of phone density whereas Sweden is far ahead of the group followed by other Scandinavian countries and the United States, Canada and Australia.

[11] Personal computers could also be used to measure related existing technologies. However, given the close conceptual relationship between computer ownership and Internet connectivity, the use of that variable would be problematic for this purpose.

Appendix II presents a correlation matrix for the outcome and all explanatory variables. Although several variables are highly correlated, the correlation coefficient is rarely prohibitively high. Among the predictor variables, of particular concern is the high correlation between telecommunications policy and phone density, which yields a correlation coefficient of -0.633. The strength of this relationship is not surprising given that telecommunications policy can have a direct impact on phone density. Free competition in the telecom market can be expected to encourage phone diffusion in contrast to the hindering effects of a telecom monopoly. Given the high value of the relationship between these two variables, their inclusion together in one model should be interpreted with caution.

FINDINGS

Table 2 presents the results of OLS regression models. The first set of models (Models 1-4) show the individual explanatory power of the hypothesized variables. The second set of models (Models 5-8) address the impact of the variables in relation to other explanatory factors. The nested models are presented with respect to propositions suggested in the review of prior studies. Model 5 considers the hypotheses regarding the effect of human capital indicators – general level of education and English language exposure – in addition to economic variables on Internet connectivity. Model 6 looks at the additional importance of telecommunications policy in explaining the level of Internet spread in a country. Model 7 explores the significance of existing telephone infrastructure. Finally, Model 8 is presented to demonstrate that having both policy and phone density measures in the model does not add to the model's explanatory value.

Although economic wealth of a country is a significant predictor of Internet connectivity, it is clear from Model 1 that among rich nations, economic factors alone do not explain the level of Internet connectivity. Adding information on human capital (Model 5) – both level of education and English language proficiency – significantly improves the fit of the model. However, adding information on policy (Model 6) adds even more to the fit of the model and the effects of both education and language competency disappear. The positive value of high English proficiency is contrary to the expected direction of this correlate since it was hypothesized that a native English speaking population (i.e. the base value in this model) would encourage Internet spread compared to countries' with other native languages. However, it seems that having a population of native speakers versus good English speakers does not make a difference. The reason for this could be that browsing the large amounts of information available on the Web only in English requires no more than an exposure to and familiarity with the language because most browsing activity involves reading. However, having even lower levels of English exposure also does not have a large impact on connectivity. This may be due to the fact that people use the Internet as much for one-to-one communication as for browsing. It is fair to assume that most people will engage in personal communication with others that share a common language in which case exposure to English may not be an important concern in deciding whether to become connected.[12]

In contrast to the low influence of English language competency, the results show evidence in support of telecommunication policy's role in the puzzle. The existence of a monopoly in the telecom sector of a nation seems to have a considerable negative impact on that country's Internet connectivity. Interestingly, price of access is

[12] Why these ideas are merely hypothetical is elaborated in the final section, which discusses what we know about people's actual use of the Internet.

not a significant predictor of Internet connectivity and has a very small ? value. This small effect is probably due to high correlation with the policy variable.[13]

Model 7, which does not include information on telecom policy, adds information on phone density. This proves to be an important addition to only having wealth and human capital measures. However, the explanatory value of this model is lower than the one obtained with the inclusion of telecommunications policy, suggesting that policy exhibits a more salient influence on Internet connectivity than does phone density. This is not surprising given that phone density may be just as dependent on telecom policy as Internet density.[14] This suggests that telecom policy is not only related to directly making Internet services available to users through encouraging affordable pricing, but it also contributes to the development of the necessary telecommunications infrastructure of a country, which in turn facilitates connectivity. Overall, the findings lend support to the hypotheses that economic wealth and especially telecommunications policy are important predictors of a country's level of Internet connectivity among OECD nations.[15] The results also show that presenting simple correlations for predictor and outcome variables (Kelly and Petrazzini 1997, Hargittai 1996, 1998, ITU 1997) is not sufficient for understanding the interplay of the various factors that may influence Internet connectivity.

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[13] Note that dial-up pricing and not leased-line pricing was included in this analysis. The model was also run with the inclusion of data on leased-line pricing, but similarly to the model reported here, the policy variable was the most salient predictor of connectivity level.

[14] As stated earlier, because of the high correlation between telecom policy and phone density, including both in the same model leads to unstable results. Model 8 demonstrates that this is, in fact, the case given that the model is not significantly improved by the inclusion of both factors, and the explanatory value (adjusted for the increased number of variables) is lower than that of the model with information only on telecom policy.

[15] Recall that the 11 excluded OECD countries have monopolies in the telecom sector. Given that this is coupled with a slight means difference in Internet connectivity with excluded countries exhibiting lower levels of connectivity, if anything, the findings of this analysis are likely to be conservative with respect to policy's influence on Internet connectivity with respect to all OECD nations.

DISCUSSION

The aggregate quantitative analyses provide a good sense of the overarching explanatory factors regarding countries' Internet connectivity in OECD nations. However, the quantitative aspects discussed so far need to be supplemented by qualitative information about country-specific attributes that may also affect connectivity. Of particular interest is the parallel topic of telephone diffusion that was explored by Rammert in his paper comparing the telephone's diffusion in the U.S., France, the U.K. and Germany (Rammert 1990). His departing premise is that the rate of telephone diffusion across these societies was very different during the first years of the diffusion process, despite the fact that all four of these countries were similar in their industrial advances and available capital. Therefore, Rammert argues that cultural considerations need to be examined to understand how the telephone was first perceived, how it fit the lifestyles of a society, and thus, how it was adopted.

In the United Kingdom, for example, face-to-face encounters in business dealings were essential in determining the other party's social status. Because such information was paramount for business transactions, adapting to business interactions over the phone was difficult. In contrast, Rammert argues that the entrepreneurial spirit characteristic of the United States at the time was much more conducive to incorporating the telephone in everyday life. Although the article only contains descriptive statistics, the author's observation about affinity towards the use of a technology may be relevant to understanding differences in Internet diffusion among countries of similar levels of development.

Currently, few systematic studies exist on people's use of the Internet with such basic questions left unanswered as to what proportion of Internet use involves computer-mediated communication services (e.g. e-mail) as opposed to information retrieval use (e.g. Web browsing). We know even less about how people incorporate these specific services into their lives and what previous activities they substitute or complement with network applications. Once such information becomes available, it will be possible to incorporate cultural aspects of Internet use into the study of the network's diffusion across nations. However, even when such data become available, they may not be the type that can easily be included in a statistical equation. This justifies the inclusion of qualitative descriptions of country specific approaches to Internet technology (Press et al. 1998). Therefore, I present two cases that draw on the above empirical findings to explain the Internet connectivity of a nation complemented by country-specific information that is not possible to quantify for systematic inclusion in regression analyses.

Figure I shows Finland's striking position in the diffusion hierarchy as being by far the most wired nation. Information on telephone density also underlines Finland's strength with respect to communication technologies. Finland is one of the few European nations with open competition in its telecommunications sector over several years. This is probably the reason for Finland's Internet access charges being among the lowest across the countries included in this study. With respect to flat rate versus measured access charges, Helsinki Telecom had flat rate off-peak charges during this period which may have also contributed to higher use. Moreover, the Finnish government initiated a national information society strategy as early as 1994, leading to the full-time connectivity of all higher education institutions and the majority of government organizations (Mosaic 1998). The country's per capita information technology production is also among the highest in the world (Lyytinen and Goodman

1999) thanks to being home to such major players in the telecommunications equipment industry as Nokia, supplying local know-how and equipment to encourage the spread of communication networks.

The position of France on the connectivity hierarchy is surprising in the opposite direction. Although the country has internationally recognized research institutions in the field of information technologies (e.g. INRIA), the nation has been slow at gaining widespread connectivity to the Internet. In contrast to the Finnish government's early efforts in playing an active role regarding the creation of a national information infrastructure, France's leaders have done much less to encourage the spread of the Internet. Not until 1997 did a top official express support of the technology (Giussani 1997). All of this is not to say that French citizens are not networked. Since 1982, the French have had their own national network – the videotext system Minitel. It provides users with many of the services currently available on the Internet. However, it does so on a text-based system (no graphics). Moreover, it is an isolated network that does not have any international connections, so its proliferation cannot be easily translated into high level national Internet connectivity. Rather, it can almost be seen as an impediment to that process. France's telecommunications policies also do not encourage the diffusion of the Internet. Monopoly in the telecom sector had restricted competition and had kept Internet access charges high. Moreover, France has had a strict approach to policies regarding national security with respect to encryption software, which may have also added to the slow spread of the Internet (Fletcher 1998, Giussani 1997).

As the examples of Finland and France show, nation-specific postures and policies need to be considered when assessing the full range of issues that affect the

Internet connectivity of a nation. Nonetheless, the findings of the quantitative analysis in this paper provide a basis for what factors are necessary to consider in understanding Internet connectivity, in addition to possible other factors. Both Finnish and French cases underscore the role of telecommunications (and possibly other) policies in Internet diffusion, and illustrate the importance of case-specific studies to understand the pace of Internet connectivity worldwide.

CONCLUSION

There are several implications of the above findings. First of all, it is important to recognize that the current spread of the Internet indicates that even among the richest countries of the world, general economic strength does matter in predicting Internet connectivity. This is important to keep in mind when making overarching optimistic claims about the Internet's potential role in eliminating international differences. The finding about the importance of telecommunication policy suggests that if governments are interested in keeping afloat an increasingly knowledge-intensive economy with a large reliance on information, they may need to consider the implications of their telecommunication policies with respect to Internet connectivity in particular.[16] The findings of this paper lend empirical support to the message conveyed in several publications of the OECD regarding the role of competition in assisting the spread of the Internet (OECD 1996, Paltridge 1996, Paltridge and Ypsilanti 1997).

Regarding future research on this topic, an important next question needs to address what it is about the societies with competition in their telecom markets that has

[16] As this paper does not address the question of national patterns of diffusion, the findings have no specific implications for what types of policies need to be considered in order to allow for equal distribution within a nation preventing the possible rise of national inequalities.

led them to adopt their particular policies. More qualitative information about each nation will help uncover the answers to this question. Moreover, as more relevant data become available, time-series analysis will tell us how the current changes in policy regulations are influencing Internet connectivity.[17]

The macro-level analyses presented above should eventually – when such data become available – be supplemented by more detailed information on national diffusion patterns. Future research needs to examine specific implementation and use in more detail. Whether there is an equal distribution of technology in a country may significantly affect its final impacts for that society. Although host distribution is a good raw measure of Internet connectivity, once data are available, it should be supplemented by information on the number of users, their time spent online, the quality of connectivity, the amount and type of data transferred, and the technology's distribution among the population.[18] With respect to individual characteristics, information on age, socio-economic status and political affiliation may tell us more about who within a nation is adopting the technology. Now that we have a sense of what overarching factors explain the network's spread to certain nations, we can start focusing in on the particularities in order to have an even better understanding of the process.

Documenting the level of connectivity across long-standing democratic societies is a first step in understanding the potential global impact of the Internet. The findings can be used to guide research on network diffusion to other areas of the world, although data availability problems make this a difficult task at the present. By

[17] The OECD Communications Outlook reports publish relevant data (OECD 1997a, 1999a) so it is clear that over the years the necessary lagged data will be available for use in time-series analyses.

identifying the key predictors of Internet connectivity among OECD countries, this paper has set the agenda for more detailed analyses regarding this important social phenomenon on a world scale.

[18] Although some work has been done at this level in the United States (e.g. see Kraut et al. 1998), data are yet to be collected on a random sample of the population (even just online population) that would allow for generalizability.

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Figure I.
Internet Host Distribution, January 1998
(Hosts Per 10,000 Inhabitants)

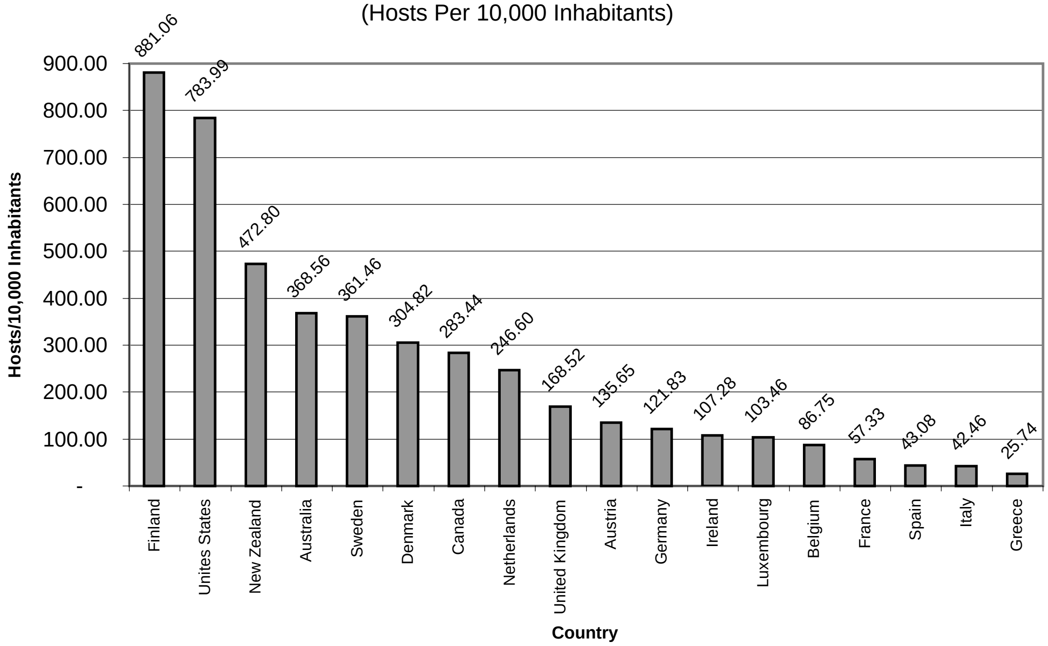

Table 1. Descriptive Statistics of Variables (N=18)

	Minimum	Maximum	Mean	Std. Deviation
Internet Hosts*^	25.74	881.06	255.26	247.46
GDP*	13945	33202	21941.61	4299.08
Gini Coefficient	25.91	41.72	32.32	4.66
Education	58	100	86	9.71
Pricing	20.59	89.81	43.74	15.6
Phone Density*	40.39	90.85	60.18	13.45
English Proficiency	dummy variables:			frequency
	Native** [base in models]			6
	High level	(>90% of high school students)		8
	Low level	(64-76% of high school students)		4
Telecom Policy	dichotomous variables:			frequency
	Competition (partial or free)			7
	Monopoly [base in models]			11

* per capita figures (see Appendix for per capita specifics, description of variables, and data sources)

^ U.S. includes figures for .com, .edu, .gov, .mil, .org, .net, .us

** Canada is coded as an English speaking country given that English is a national language, it is the first language of the majority of its population, and the rest of the population studies it extensively in school

Appendix I.
Description of Variables, Data Sources

Variable	Description	Measurement	Year	Source
Internet Hosts	Individual computers connected to the Internet	per 10,000	1998	Network Wizards, 1998
GDP	Gross Domestic Product	per capita	1996	OECD Communications Outlook 1997
Gini Coefficient	Gini Coefficient for income inequality	score	various*	Deininger and Squire Data Set 1996
Education	Combined first-, second, and third-level gross enrollment ratio	percentage	1995	UNDP Human Development Report 1998
English	Percentage of students in general secondary education learning English as a foreign language; Native speakers	percentage	1995	Eurostat Yearbook 1997
Telecom Policy	Competition vs. monopoly	Y/N dichotomy	1990s	ITU 1997, OECD 1997d
Pricing	The cost of a 20 hour monthly Internet access basket	PPP$	1996	OECD Communications Outlook 1997
Phone Density	Composite variable consisting of: mainlines cellular phone subscribers	 per 100 per 100	 1995 1995	OECD Communications Outlook 1997

*France, Germany 1984, Luxembourg 1985, Austria, Ireland 1987, Greece 1988, Spain 1989, Australia, New Zealand 1990, Canada, Finland, Italy, Netherlands, United Kingdom, United States 1991, Belgium, Denmark, Sweden 1992

Appendix III. Correlation Coefficients for All Variables*

Pearson's Correlation Coefficient (Significance; 2-tailed test on second line)

	Hosts	GDP	Gini Coef	Education	Native Eng	High Eng	Low Eng	TelecomPolicy	Prices
GDP	0.350								
	0.155								
Gini Coef	0.210	-0.129							
	0.403	0.611							
Education	**0.447**	-0.323	0.038						
	0.063	0.191	0.881						
Native Eng	**0.437**	0.070	**0.536***	0.337					
	0.074	0.784	0.022	0.171					
High Eng	0.075	-0.150	-0.315	0.213	**-0.632****				
	0.767	0.553	0.203	0.396	0.005				
Low Eng	**-0.578***	0.100	-0.231	**-0.637****	-0.378	**-0.478**			
	0.012	0.692	0.356	0.004	0.122	0.045			
Telecom Policy	**-0.751**	-0.031	-0.308	-0.386	**-0.645****	0.255	0.426		
	0.000	0.902	0.214	0.113	0.004	0.307	0.078		
Prices	**-0.435**	-0.152	-0.091	-0.221	**-0.470***	0.391	0.065	**-0.604****	
	0.071	0.548	0.720	0.377	0.049	0.109	0.797	0.008	
Phone Density	**0.699****	0.347	0.136	0.110	0.067	0.178	-0.289	**-0.633****	**-0.404**
	0.001	0.158	0.590	0.663	0.791	0.480	0.245	0.005	0.097

Hosts/10,000 logged, GDP/cap; bold: p<.1, * p<.05, ** p<.01

Table 2. OLS Regression Results for Internet Hosts^

Standardized Betas with Significance reported in parentheses

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
GDP	0.383				0.521	0.491*	0.278	0.494
	[.123]				[.028]	[.007]	[.155]	[.036]
Gini Coef	0.259				0.155	0.173	0.015	0.175
	[.286]				[.523]	[.310]	[.939]	[.397]
Education		0.094			0.378	0.298	0.286	0.299
		[.734]			[.190]	[.148]	[.209]	[.172]
English High		-0.250			-0.062	0.338	-0.208	0.344
		[.315]			[.816]	[.136]	[.341]	[.358]
English Low		-0.638			-0.384	0.049	-0.376	0.053
		[.054]			[.261]	[.848]	[.166]	[.872]
Monopoly			-0.768*			-0.667**		-0.673
			[.003]			[.007]		[.082]
Prices			0.029			-0.011		-0.012
			[.894]			[.950]		[.950]
Phone Density				0.699**			0.497*	0.007
				[.001]			[.013]	[.983]
Adjusted R2	0.080	0.262	0.506	0.457	0.435	0.736	0.657	0.707
F-Test Significance					**0.031~**	**0.009**	**0.013~~**	0.983

^N=18, Hosts per 10,000 inhabitants logged
* p<.05, ** p<.01 (2-tailed)
~Significance change from Model 1 to Model 5
~~Significance change from Model 5 to Model 7