# The Global Spread of the Internet: The Role of International Diffusion Pressures in Technology Adoption.

Helen V. Milner
Columbia University
Hvm1@columbia.edu
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Abstract:
What factors have promoted and retarded the spread of the internet globally? Much as other technologies, the internet has diffused unevenly across countries. The main proposition is that its spread is neither purely economic nor entirely domestic. International diffusion pressures exert a powerful influence. The adoption of new technology depends on domestic policy, and this in turn depends on the choices that political leaders make about rules governing new technologies. I examine the impact of international diffusion pressures on political leaders, testing the role of five types of such pressures. The distribution of capabilities globally may shape the spread of the internet, as dominant power(s) may directly or indirectly coerce others into adopting. Patterns of adoption may also be shaped by competitive pressures from the world market. Technological change especially may depend on network externalities, involving the number of adopters already in existence. Learning from other countries or from participating in international organizations may stimulate adoption. Finally, countries may simply copy the policies and hence the adoption patterns of other countries with whom they share sociological similarities. Data from about 190 countries since 1990 shows that diffusion pressures matter, even when controlling for domestic factors. Economic competition and sociological emulation play consistently important roles in affecting the spread of the internet.

**INTRODUCTION**.

What are the factors that have promoted and retarded the spread of the internet globally over the past decade? As a form of technology involving communications, the internet is an example of the diffusion and adoption of technology. As a means for spreading information at very low cost, however, the internet may have a wider impact than some prior forms of communications technology. This paper seeks to explain the distribution of the internet across space and time. Much as other technologies, the internet has diffused unevenly across countries. The main proposition is that its spread is neither purely economic nor entirely domestic in origin. Rather international diffusion pressures exert a powerful influence. Although not focused on policy choice directly, this paper asks why countries have adopted the internet at different paces. The adoption of new technology depends on the rules and norms governing sectors experiencing change. Political leaders create these rules and laws. Hence their choice of policy affects the rate of adoption of new technologies. What factors determine the choice of technologically-friendly policies versus repressive ones, and thus ultimately shape the rate of technology adoption?

This paper seeks to examine the impact of five different diffusion processes on the global spread of the internet. It asks whether the adoption patterns of other countries have affected the choice of each country. Are countries' choices of technology and policies affecting it interdependent? Do the policies of dominant global powers, international institutions, neighbors, competitors or socio-culturally similar countries shape the policy choices and technology adoption patterns of a country? Diffusion pressures can take at least five distinct forms. First, the most powerful countries in the world—the so called superpowers or main poles—can affect the policy choices and practices of less powerful states. Traditional international relations theory relies on such pressures. For instance, balance of power theory suggests that weaker states will shape their foreign policies according to the behavior of the main powers. They will balance against those powers near them that threaten them, rejecting their lead. In contrast, hegemonic stability theory argues that weaker powers will follow the lead of the hegemon, being more likely to adopt similar policies and practices. These two Realist versions of diffusion rely on opposing causal mechanisms.

Second, diffusion can arise as a result of competitive pressures from a global market, especially one based on capitalism. Such an international market may force countries to adopt policies that foster new technologies or to otherwise try to speed technological change in the quest to maintain competitiveness. The demands of the market may determine the policies toward technological change that a country selects. In particular, these pressures may involve the behavior of a country's closest competitors or challengers for market access abroad. Market pressures may force a country to choose the most efficient technology to produce goods and services. Concerns over the "race to the bottom" evoke this type of argument. However, many economists nowadays are skeptical of this claim. Much evidence has revealed wide divergence in the type and rate of technological adoption (i.e., TFPs differ too much across countries) among countries for purely economic pressures to be at work. On the other hand, globalization may have progreesed far enough now that such market pressures are overwhelming.

Third, countries may engage in a process of rational learning. That is, they might watch and see what types of policies and technologies are successful in other countries and then select those they feel have demonstrated a proven advantage. This type of learning process should lead to a slow movement over time and across space toward convergent practices. In the long run, most or all countries would end up with similar "best practices," having emulated other successful countries. Countries are more likely to learn from countries that share some kind of interaction with them. That is, they may learn from their neighbors or other states in their region, or they may learn from being in the same international organizations.

A fourth mechanism for diffusion is through the creation of network externalities. Such pressures arise when technologies produce increasing returns to scale and scope. If more users elsewhere make the technology more valuable at home, then these externalities may influence countries and their policy choices. This more technological determinant of diffusion is based on distinct causal mechanisms from the other four. It suggests that as more users adopt in other countries, pressures for more favorable policies and more adoption at home should follow.

Fifth, countries may emulate others that are seen as being similar to them. Copying those with whom one shares some affinity might be an appealing policy in the face of great uncertainty as when a new technology arises. Countries with similar historical, linguistic or cultural ties may provide important clues for policy makers in another country about what might work for them. One would expect that the greater the uncertainties surrounding the technology, the greater the temptation to simply copy what other, "similar" countries do. This social emulation process would be distinct from the rational learning process in that one would not expect convergence on "best practices" and one should see inefficient or otherwise undesirable policies adopted. Socio-cultural similarities among countries should be markers for emulation processes.

This paper attempts to sort out the implications of these different diffusion pressures and to see if they have played a central role in the spread of the internet. It also asks whether these global pressures have played a more important role than more domestic ones in shaping policy toward the internet. Using data on about 190 countries from 1990 to 2001, it shows that international diffusion pressures are important, even when controlling for domestic factors. Economic competition and imitation of "similar" countries induce a country to initiate and adopt internet technology faster.

**LITERATURE REVIEW**.

There exists a large literature on diffusion. It covers the diffusion of virtually everything one could think of: technology, ideas, rumors, institutions, disease, cities, plants, language, etc. Diffusion is defined as a process by which some type of innovation "is communicated through certain channels over time among the members of a social system" (Mahajan and Peterson 1985: 7). An innovation is any kind of "idea, object or practice that is perceived as new by members of the social system and can range from a rumor to a rocket ship" (Mahajan and Peterson 1985: 7). The diffusion of innovations from place to place leads to maps that differ from one another (Brown 2001: 3676). Starting from research by Hagerstrand (1952, 1967), it has been shown that all diffusion processes tend to follow a similar pattern over time. The s-shape (logistic curve) growth of adoption of a new idea or process seems well-established (e.g., Morrill et al. 1988: 10; Rogers 1995; Valente 1995: 3; Brown 2001). From its place of origin, a few innovators begin the process; but then over time a rapid period of adoption occurs as the innovation spreads very quickly.  Finally, the process slows as the diffusion becomes complete. Note that this implies that the adoption process is non-linear.

Figures 1 and 2 show that this process is being repeated in the case of the internet. The graph in figure 1 shows the growth in the total number of internet users per 10,000 population in all countries since 1990. But since the net is new, the leveling off phase (i.e., the top of the s) has not been reached yet. The graph in figure 2 examines the growth in the total number of internet hosts per 10,000 inhabitants since 1994; it too shows the s-shaped diffusion process in its early phases. Diffusion appears to be occurring rapidly. The goal is to explain how this process is occurring in space and time.

Recently, several groups of scholars have revived interest in diffusion pressures in world politics.  Mansfield (1998), for instance, clams that as more states enter into preferential trading agreements (PTAs) this increases pressure on other states to form and join PTAs.  Kopstein and Reilly (2000) show that spatial diffusion has been an important element explaining the pattern of democratic change in the transition countries in the 1990s.  Pressures for democratization grow as one's neighbors democratize, especially if one is close to the Western European democracies.  Cederman (2001) shows that learning seems to be occurring among democracies in their foreign policy choices.  Democracies learn when interacting among themselves that peaceful relations are the norm and in time they internalize this behavior. Simmons (2000, 2001) argues that compliance with international norms and regulations toward capital markets has been driven in part by the number of other countries that choose to comply.  As more countries adopt a policy, pressures for others to adopt a similar one grow.

Guler et. al. (2002) examine three forms of diffusion pressures to explain the differential adoption of technology standards across countries; they examine coercive, normative, and mimetic pressures and find that the first and last matter a great deal. In particular, coercive pressures across states and close trade relations among countries affected adoption rates significantly. Diffusion of the internet in particular has also been noted for domestic usage; the behavior of neighbors appears important to its spread within a country (e.g., Goolsbee and Klenow 1999). Interest in diffusion processes seem to be renewed.

Diffusion involves interdependence among the units; the behavior of each is related to the behavior of others. Such interdependence is a central element of strategic interaction in general. Is diffusion simply a subset of such strategic interaction? One question about these processes is whether they are best modeled as ones of strategic interaction where each actor knows (or is making estimates about) the likely behavior of the others or whether these processes rely on systemic dynamics unknown to the actors. If the former is the case, then we have the tools in game theory to be able to model such interactions, even if they are very complex. If the latter is the case, then the type of modeling is quite different. The scholars cited above seem to take different approaches to this question. Mansfield adopts a strategic interaction model that relies on rational behavior. In contrast, Cederman adopts an evolutionary model where a stochastic process generates change over time. Guler et. al. use network analysis which again moves one away from actors to their systems of relations. This is the familiar choice between focusing on actors and their strategies versus on system dynamics. Unless one can generate empirical tests that differentiate between the predictions of these two types of models, there seem few ways to settle the debate over the best way to conceptualize diffusion.

**SOME HYPOTHESES**.

What can we learn about the pattern of internet adoption from a study of diffusion pressures? The adoption of the internet in countries is a process of great interest; many have speculated that it will not only change the economy but also political institutions and social relations. The rate at which actors introduce a new technology (its supply) and people in a country being to use the technology (its demand) are greatly affected by the policies that a government chooses for a large range of areas. "In most emerging industries, governments intervene through various types of regulation, thereby affecting the diffusion of new technologies" (Gruber and Verboven 2001:1190). In the case of the internet, the number of servers linked to the world wide web and the number of users of those servers represent the outcome of such policies, as well as other factors. These outcomes are the best proxies we have for a country's policy toward internet adoption.

As in other areas, like international trade, where the policies that affect the issue-area are multidimensional, hard to measure and with uncertain effects on outcomes, the best that one can usually do is to use actual outcomes as proxies for the country's policy choices. Again much as in the area of foreign trade, once one controls for the "natural" components that shape these outcomes, what is left over can be attributed to policy effects. For international trade, one basically uses the gravity model and then assumes that whatever is left unexplained in terms of outcomes (i.e., trade flows) is due to policy. Since we cannot find a measure of all policies that affect the rate of adoption of the internet, the best we can do is use outcomes indicating the rate of server introduction and users as proxies for these policies, once we control for obvious "natural" factors that affect these outcomes.

Diffusion may occur as a result of hierarchical forces (Morrill et. al. 1988:13). Many have noted that spatial diffusion tends to begin in large cities and then spread to less populated, outer-lying areas, or to move from large cities to smaller cities in a hierarchical flow (Morrill et. al. 1988: 47-9). Urbanization levels may thus be an important factor in tracing the spread of innovations. Such hierarchies are important because the likelihood of interaction among change agents and potential adopters is directly related to the size of the place. More dense populations support more interaction, and hence greater chances for adoption. As economic geographers have claimed, "cities are communications systems" (Abler 1970), and we expect the distribution of the internet to reflect that fact. Moss and Townsend (1998, 2000) show that the existing hierarchy of urban centers in the US (ranked by population, economic wealth, or communications infrastructure) is a primary determinant of the distribution of the internet. The internet does not seem to be challenging this hierarchy, nor leading to the demise of cities and centralization. This finding suggests that pre-existing patterns of both urbanization and global hierarchies should be replicated in the distribution of the internet globally.[1]

Economic factors might affect the distribution of the internet globally, as they probably do nationally. "Previous research on the most advanced economies has established that differences in internet development across countries are accounted for by

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[1] . In terms of the impact of the internet, there is great debate over whether it will lead to radical change of hierarchies or simply reinforce existing ones. Most sensibly, Tyler (2002: 201-2) notes that "the social consequences of technology depend upon the social context in within which the technology is utilized….Whether the Internet is, in fact, a social-leveling technology depends not upon the technology itself, but upon the political and social framework within which it is implemented."

per capita income, and by the existing infrastructure and competition in the telecommunications sector." (Guillen and Suarez 2001: 350) Evidence exists, for example, that the distribution of the internet follows that of the existing communications infrastructure (e.g., Oxley and Yeung 2001; Kiiski and Pohjola 2002). This pattern could be the result of two distinct factors: the dependence of the internet upon existing infrastructure (i.e., phone lines for modem access) or the dependence of both upon underlying economic conditions. It may well be that a region's level of development (i.e, its per capita GDP) provides a critical impetus for the density of communications technologies, for both supply and demand reasons. As has been pointed out, when innovations require specialized infrastructures, their adoption will be channeled to those places that have invested in the infrastructure. Whether these investments have been made often depends on the government in place, and especially on the local political institutions (Morrill et. al. 1988: 54-5). Moreover, if models of increasing returns to scale and network effects are correct, then initial advantages should lead to disproportionate growth in the future. If economic factors explain a substantial portion of the distribution of the internet and if initial economic advantages cumulate into growing density over time (i.e., "path dependence"), then this would give support to largely economic explanations of internet diffusion.

Adoption of an innovation tends to be correlated with the potential adopter's wealth, education, and propensity for risk-taking (Morrill et. al. 1988: 52; Norris 2002). Given that using the internet requires that its users have a fairly substantial level of education, we expect that a country's educational level or human capital will affect the decision to adopt it. Countries with higher levels of schooling among their populations should adopt faster and more extensively. Several recent studies of the internet's spread, however, show that education may not be that important (Norris 2002; Hargittai 1999; Kiiski and Pohjola 2002).

Other than the level of development, various factors such as a country's size (i.e., its population), its geography (i.e., its distance from major trading partners, whether it's an island), its culture (i.e., its religion, past (colonial) history, ethnic mix) and linguistic practices (i.e., percent speaking English) may be of importance. Size and geography are obvious influences. The gravity model of trade flows uses them to predict how much countries will trade with each other. They also seem important influences on the decision to adopt a new technology. Bigger countries may be slower to adopt, ceteris paribus. However, if distance raises transport and communications costs, then a technology like the internet may be especially useful (cost-effective) in a larger country. Traditionally, it is expected that countries that are more distant or isolated from others should be less likely to adopt. This may not be the case for the internet if the costs of distance again trump the value of increased interaction. If social emulation across countries depends on similarities in culture and language, then these factors should also play a large role in explaining its spread across countries. All of these factors tend to be relatively constant over time; hence they cannot well explain a country's adoption patterns over time (i.e., the longitudinal element of change within a country). But they may do a good job of explaining broad cross-national patterns of adoption.

Economic competition among countries (or perhaps even political competition) might explain adoption patterns as well. The global market may create very substantial diffusion pressures, encouraging political actors to tailor policy in ways to encourage its adoption. The internet may provide important economic advantages. Scholars (e.g., Freund and Weinhold 2000) have shown that it increases trade flows, largely by reducing information and transaction costs. It may generate significant political advantages relative to other countries as well. Countries may be forced by competitive pressures to imitate their neighbors or rivals and adopt this technology. If so, diffusion should be driven by other countries' adoption patterns. Do other countries' rates of adoption affect a country's own rate? In particular, we might anticipate that regional neighbors would exert a powerful effect on the adoption patterns of states within their regions (i.e., "neighborhood effects"). As other countries adopt the internet, does that make a country more likely to do so? More specifically, as other countries in a country's own region adopt, does that make the country more likely to? It may also be the case that a country's adoption patterns follow those of its economic rivals closely; do, for instance, the rates of adoption of a country's leading trading partners affect its own rate? Catching up with or staying even with one's neighbors and rivals may be a political and economic imperative for countries.

Do political factors matter for the diffusion of the internet globally? Is there reason to believe that, even after controlling for the above factors, domestic political influences might explain the distribution of internet activity? As with the adoption of any technology, its success is likely to depend on the underlying political order. The laws, regulations, subsidies, and taxes that governments choose to employ or not may substantially affect whether actors invest in the new technology, as North (1990) among others has argued. Political and economic groups that lose politically from the spread of the internet may also try to retard its diffusion (e.g., Mokry 1990; Acemoglu and

Robinson 2000). They may seek to use the country's political institutions to enact policies that do this. Some institutions may be more susceptible to such purposes than others.

Do domestic political institutions make a difference for these policy choices? First, countries that are more democratic will be more supportive of the growth of the internet. The extent of civil liberties may also matter; more freedom of the press, association, religion, etc. may all encourage the development of internet activity. Certainly, we would expect that autocratic regimes and ones where civil liberties are restricted would not create environments that facilitated the growth of the internet.[2] Autocratic governments should want and be better able than democratic ones to prevent the spread of the internet. Some have already claimed that evidence shows that autocratic governments are more opposed to and restrictive of the internet. Goodman et al. (1998:243) conclude from their study of 13 countries that "It appears clear at this point in the studies that government policy plays a key role in the diffusion of the Internet. A general rule that has emerged is that stronger centralized control results in slower Internet development and less proliferation. This is likely due to the fact that the strength of government control is somewhat inversely proportional to popular participation in and support of the government. That is, the more coercive the government, the more it has to lose from easing controls; it is caught in a self-reinforcing cycle whereby strong controls are necessitated by lack of popular support and a lack of popular support is due in large

[2] . According to Freedom House reports (Susman 2000:7), the countries which exert very significant control over Internet access are Azerbaijan, Belarus, Burma, China, Cuba, Iran, Iraq, Kazakhstan, Kyrgyzstan, Libya, North Korea, Saudi Arabia, Sierra Leone, Sudan, Syria, Tajikistan, Tunisia, Turkmenistan, Uzbekistan, and Vietnam. Note that these are all autocratic.

part to oppressive government controls." Are democratic countries more likely to foster the adoption of the internet than more autocratic ones, ceteris paribus?

In sum, the empirical analysis examines in particular five types of diffusion pressures. Power and leadership from the world's leading countries affect the choices that leaders in other countries make about policies regarding the adoption of new technologies, especially ones trumpeted by the leaders. The pressures of global markets on countries may also be of importance. Those countries facing greater adoption rates by their main trading competitors should be more likely to enact (prevent ) policies that foster (delay) the adoption of new technologies. This is especially true for the internet which has been shown to positively influence trade flows (Freund and Weinhold 2000).

Political leaders may also rationally learn from other countries. They may adopt policies similar to those of nearby countries that have been successful. Learning may also depend on interaction within international organizations where countries learn what others are doing and how successful they have been. Network externalities are clearly present in the case of communication technologies like the internet; hence we would expect to see that as adopters rise globally, countries individually become more likely to adopt. Finally, countries may simply copy others who are socio-culturally similar in hope that the policies of these countries may work for them as well. These diffusion pressures should be especially important in the case of the internet since it is a primary means of diffusing information about itself.

## EMPIRICAL ANALYSIS.

The impact of global diffusion processes and of domestic politics on the distribution of the internet are the central issues here. How important are these global pressures relative to domestic ones? The primary source of evidence here will be the use of a database on the number of internet hosts and users among roughly 190 countries and territories from 1990-2001.[3]

Measuring the internet's spread and use has become a growth industry. There are now a number of such measures available. All of them have problems. Our main data on the number of hosts (HOSTS), or computers with active Internet Protocol (IP) addresses connected to the internet, is collected by the Internet Software consortium (ISC, www.isc.org) twice a year.[4] The ISC runs an electronic survey pinging all internet hosts on the web globally to determine their domain names and numbers. The domain survey attempts to discover every host on the Internet by doing a complete search of the Domain Name System. It is sponsored by the Internet Software Consortium with technical operations performed by Network Wizards. (See the ISC website for an extensive discussion of the survey methodology and its problems.[5]) We normalize HOSTS by a country's population, dividing it by each 10,000 people.

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3 . As ISC says, a" host used to be a single machine on the net. However, the definition of a host has changed in recent years due to virtual hosting, where a single machine acts like multiple systems (and has multiple domain names and IP addresses). Ideally, a virtual host will act and look exactly like a regular host, so we count them equally."

4 . ISC defines a host as a "domain name that has an IP address (A) record associated with it. This would be any computer system connected to the Internet (via full or part-time, direct or dialup connections)."

5 . We used their data in the following way. We allocated hosts to countries only by using those country code domain names that were clearly associated with a country. Data for the United States is different; it is the sum of five domain names: com, gov, edu, mil, and us. To some extent, this may overstate the US numbers, but note that we excluded org, which has many hosts in the US. Data for Russia is the sum of two domain names: ru and su. Then, we used the data for mid-1995 as our starting point for (end of year) 1994, and we then used the data for end of 1995 data for 1995. We did not use mid-year data from then on. All data are for end of the year. In the variation used here, we created HOSTS_0, where in early years when

I also use the data collected by the World Bank in its 2001 World Development Report on the number of internet users (INTUSERS) which is taken from the data collected by the International Telecommunications Union (ITU, www.itu.org). INTUSERS are the number of people with access to the worldwide network; note that these are not just subscribers to internet service providers (ISPs) nor are they actual users. We supplement the World Bank data on users with data from the ITU for 2000 and 2001. And we normalize the number by a country's population, dividing it by each 10,000 people in a country. Summary statistics for all variables are in table 1.

The main problem with using number of hosts is that it does not measure the number of users or the intensity of their use. Moreover, there are ambiguities connected with defining what is a host; see http://www.isoc.org/inet2000/cdproceddings/8e/8e_1.htm for discussion of this. Furthermore, assigning each host to a country can be tricky. We and others use the simple rule that the two-letter ISO country code Top Level Domain does a good enough job of identifying where the host is actually located, but this is not always the case. In order to supplement this, we also use data on the number of internet users. Again, this measure tells us how many have access but not how much they use it.

I seek to test the five diffusion arguments here. To do so requires interacting other countries' internet adoption patterns with various social, economic and political indicators. The coercion hypothesis is tested by looking at three variables. Two measure American economic power relative to the world; US Hegemony in trade measures its exports and imports as a percent of world trade, while US hegemony in production

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data for countries were supposedly missing (prior to 1994) we gave the country a zero instead. Since all countries had been pinged, we did not know what missing meant.

measures US GNP relative to world GNP. These measures were never significant and hence were dropped in the results presented here. A measure of US dominance in the internet was constructed as well; US users per capita or hosts per capita relative to total world users or hosts (USUSER or USHOST) was developed. It is unclear this measure is very useful; it simply declines over time as other countries adopt the new technology. It is generally negative and often significant throughout the regressions.

The economic competition hypothesis is tested using three indicators. First, a trade-weighted average of the internet users or hosts per capita of a country's top ten trading partners (TRADE PARTNERS) is calculated. This measures on average how many users or hosts per capita a country's largest ten trading partners had in any year. It is assumed that a country's trading partners are its main economic competitors, but this may not be a good assumption. In addition, the average number of users or hosts per capita for all countries in a country's geographic region (as defined by the World Bank) was calculated (REGION). And similarly, the average users or hosts per capita for a country's neighbors (NEIGHBORS) was measured. A country's regional peers and its neighbors were assumed to be its main economic competitors. REGION and NEIGHBORS are very highly correlated and cannot be used in the same regression. The same is true for TRADE PARTNERS and NEIGHBORS. These three are generally substitute measures, not complements.

Learning is especially hard to measure. In part, I assume that countries in proximity to one another are more likely to learn from each other; hence, NEIGHBORS and REGION may be in part measures of learning. Evidence exists, however, that countries can learn from others that are far away. It seems likely to that countries in major international institutions might also learn from one another.  I include a variable measuring WTO membership by country year (WTO).

Network externalities imply that the value of a technology is rising as other countries use it more.  Dekimpe, Parker, and Sarvary (2000b) find strong evidence in the cellular telephone adoption process that such externalities matter. The simple measure of this is the total number of users or hosts in the world in year t excluding country i itself (ROW). This variable is highly correlated with both the US percent of users or hosts (USUSER or USHOST) and the trade-weighted index of internet users to hosts (TRADE PARTNERS).  It can only be used in regressions without these other measures.

Finally, emulation occurs through the imitation of the policies and practices of other, socio-culturally similar countries.  To test this, I construct three separate but related variables.  First, to measure linguistic similarity, the average number of users or hosts per capita in other countries that speak country i's primary language (LANGUAGE) is used. Next, I create a variable of the average number of users or hosts per capita for other countries that share the same primary religion as country i in year t (RELIGION).  And last, cultural similarity is measure through a variable that shows the average number of users or hosts per capita for other countries that were colonized by the same colonizing country as country i in year t (COLONY). These three variables are very highly correlated and cannot be used in the same regressions; they are substitute measures for the same phenomena, emulation of culturally similar countries.  COLONY is also highly correlated with the number of users or hosts in the rest of the world (ROW) and with the measure of trading partners (TRADE PARTNERS); it cannot be used alongside them.

These relations among the diffusion variables mean that the analysis uses at most four diffusion variables at a time. The WTO variable is always employed; either LANGUAGE, RELIGION or COLONY is used; either REGION or NEIGHBOR is used; and either US internet dominance, the rest of the world's numbers (ROW) or trade partners is used. Various combinations of these four categories are employed largely to test for robustness of the different hypotheses to different measures.

To test for the impact of international diffusion processes, I must hold constant relevant domestic factors. The regressions include controls for a country's size (population. LNPOP), its level of development (GDP per capita), its urban density (percent living in urban areas, URBAN), its date of privatization of its telecommunications industry (TELECOM PRIV), and its political institutions (POLITY). The first three of these are from World Bank WDI; the fourth is from Wallsten (2002). POLITY here refers to the Polity IV dataset measuring regime type on a scale from -10 for complete autocracies to 10 for full democracies (Marshall and Jaggers 2001). These variables have already been shown to be important factors in other research (e.g., Milner 2003; Guillen and Suarez 2001 ; Kedzie 1997).

As we saw above, the internet has grown extremely rapidly. This growth has been unprecedented, but also very uneven (Goodman et. al 1998: 241). Why have some countries adopted it much faster than others? Figures 3 and 4 show the number of countries initiating internet use per year. For users in figure 3, we define initiation as the first year in which at least 0.1% of the population had access to the internet. For hosts in figure 4, we define initiation as the first year in which there were hosts for at least 0.1%

of the population.[6] As the figures make clear, some countries have been rapid adopters, "innovators," and some have been "laggards" (Rogers 1995: 262-69). We first ask what accounts for this pattern of initial adoption.

The analysis presented in tables 2a and 2b shows the factors that affect a country's initiation choice as seen from its users' perspective. We perform a logit analysis to see what factors drive faster and slower initiation.[7] I include the main domestic variables of interest and these are generally significant as expected. Richer countries, more urban ones and more democratic ones all are more likely to initiate; they tend to be innovators. Sometimes having a privatized telecommunications sector helps, and sometimes smaller countries seem more likely to initiate. Holding these domestic factors constant, it is clear that diffusion pressures play a role. Some of the diffusion variables are every closely related and cannot be included in the same regressions due to collinearity problems, as noted above. Nevertheless, the two tables (2a, 2b) show that these diffusion pressures are consistently important.

The coercion hypothesis is supported in the negative. US dominance of the internet is always a negative influence on other countries. As above, this may simply be because US dominance is declining over time and adoption by others is rising over time. The economic competition hypothesis is also supported. When a country's main trading partners, other countries in its region, and its neighbors have more internet users in the previous period, it is more likely to initiate. Learning is hard to measure and the variable I employ, membership in the WTO (WTO), is rarely significant; but it does suggest that

[6] . This data is left censored. I do not have data before 1994 for hosts, so many countries all enter the dataset at 1994 as having initiated.
[7] . The use of logit or probit is standard for understanding the factors that affect the decision to adopt a technology, which is equivalent to the initiation decision here. See Geroski 2000 for a good discussion.

being a member of the WTO earlier makes initiation more likely in the future. The total number of users in the rest of the world is an important positive influence, indicating that network externalities are at play. Finally, emulation receives strong support. Countries are more likely to adopt if other countries sharing the same language, religion, or colonial experience have more users. This data seems to suggest that economic competition and sociological emulation play the strongest roles of the different diffusion process in affecting initiation. Laggards then are countries who are more isolated from international market pressures and who share few sociological or cultural similarities with other countries.

The same logit analysis was performed for a country's decision to initiate adopting internet hosts. Tables 3a and 3b show the results. Generally, they are weaker than those for users but support the same claims. Domestic factors like wealth and democracy play an important positive role, while sometimes urbanization and telecom privatization does so as well. Holding domestic factors constant, however, shows the role of international diffusion processes. By and large, the economic competition model is most strongly supported. The more hosts that countries in the same region have, that a country's main trading partners have, and that neighbors have increases the probability that a country will initiate. A country's colonial heritage also seems to matter, but the rest of the factors play a lesser role. Again, this supports the main finding above that economic competition and sociological emulation play key roles in diffusion. Laggards tend to be more isolated and less "similar" to other countries.

A second type of analysis is often advocated by scholars of diffusion. Many suggest trying to understand the factors that shape the diffusion curve of each country explicitly (e.g., Gruber and Verboven 2001; Dekimpe, Parker and Sarvary 1998 and 2000a, b). Diffusion processes tend to follow an S-shaped curve, and figures 1 and 2 above show this to be true for the internet. Scholars advocate matching countries in terms of their potential for adoption and their timing of adoption. Here I am interested in what creates the S-shaped curve in each case. This process requires one to match the countries by their ratio of actual to potential adopters at each point in time and by their time of adoption. I use a nonlinear technique-- negative binomial regression--to estimate the adoption curve since it is also nonlinear. The dependent variables are counts of hosts and of users per capita; they are always positive and in early periods are often zero. As is well known, such count variables rarely assume a normal distribution, and hence they tend to be better fitted by various maximum likelihood estimators, such as the Poisson or negative binomial. I choose here the latter since goodness of fit tests rejected the Poisson model.[8]

I first analyze the factors that affect the adoption rate of countries in terms of their actual number of users per capita versus their potential number minus their actual. This gives a measure of how many more adopters a country could have given its potential. I measure potential as others do by using the rate of urbanization domestically. The variable is actual users per capita/(potential users-actual users).[9] The countries are then matched time-wise from their first year of adoption. So year 1 refers for each country to the year that it initiated internet use as defined above; these are not the same years for

[8] . The Poisson distribution has a special and restrictive assumption that the variance is equal to the mean. Often this condition is violated and then other models, such as the negative binomial, which assume only that the variance is somehow proportional to the mean, are preferable.

[9] . This variable is highly correlated with the absolute number of users per capita, r=0.9.

each country. This matching is important for it means the analysis is asking what factors determine the underlying S-shaped adoption curve in each country.

In tables 4a and 4b, I present the results for the number of internet users. The dependent variable is the ratio of actual users per capita to potential users minus actual users, matched by initiation date. Among the domestic variables, both richer countries and more democratic ones have greater numbers of users. Holding these and other domestic influences constant, however, the impact of international diffusion pressures is apparent. Again, socio-cultural emulation and economic competition appear very important. In terms of emulation, linguistic and religious similarity matter, although colonial heritage does not. Economic competition is driven by regional proximity, neighborhood status, and trade relations. Unlike the earlier regressions on initiation, adoption over time seems to depend on learning through interaction in international institutions. The WTO variable is always positive and significant.[10] Network externalities are apparent too; the total number of users in other countries exerts a positive impact on a country's own adoption pattern. The impact of hegemonic coercion is less apparent; US dominance in users is negatively related, but this may simply be due to the declining time trend involved.

In tables 5a and 5b, I present results for hosts. The dependent variable is hosts per capita, matched by date of initiation.[11] The domestic variables have significant impacts. As before, richer countries and more democratic ones have more adopters. More urban countries and smaller ones have more adopters of new technologies. Here though

[10] . Being in other PTAs or in lots of international organizations in general has no impact however. The WTO seems especially important, perhaps because of its link to trade and economic competition.
[11] . It would be better to control for potential hosts as well, as done for users. But a marker for "potential" hosts is difficult to figure out.

telecommunications privatization also matters. Earlier privatization enhances the number of hosts. Given that internet hosts are usually installed by telecommunications providers, this finding makes sense. AS one might expect, the number of users is less affected by privatization of the industry than is the installation of hosts. These findings support other research which indicates that a central element necessary for the internet is a high urban population and an extensive telecommunications network ( e.g., Kiiski and Pohjola 2002; Goolsbee and Klenow 1999).

International diffusion pressures are present even when controlling for these domestic factors. As before, a central influence is economic competition. Countries with extensive trade relations, ones in the same region, and neighbors all tend to foster more rapid introduction of hosts over time. Network externalities are also evident, as the total number of hosts in the rest of the world has a positive effect. American hegemony plays a positive role as well, inducing other countries to adopt more quickly. Emulation and learning are not as evident for the adoption of hosts as for users. Neither language nor religious similarity matter; colonial relations have some impact though. The WTO has none in this case, nor did the number of international organizations to which a country belonged nor its participation in PTAs.

As with users and with initiation generally, the most consistent diffusion pressures come from economic competition. Countries are concerned with what their main trading partners, their neighbors, and their regional peers are doing. Keeping up with the neighbors and competitors is a driving factor for internet adoption; I expect such competition to work directly through private enterprise channels as well as indirectly by changing government's policies toward the new technology. As globalization theorists argue, increasing economic competition globally should lead to changes in government's policies, making them more friendly toward the adoption of new technologies like the internet.

**SOME CONCLUSIONS**.

What factors explain the geographic and temporal spread of the internet across the globe? The internet seems to be following some well-known patterns of technology adoption. Its s-shaped diffusion process and economic determinants are not surprising. But it is also clear that political factors may matter. Domestic politics plays a role. But even when controlling for all of these factors, diffusion pressures from the international system seem to be playing a role.

Of the five types of global diffusion pressures identified at the beginning, it seems as if two of them are most apparent. In all cases, economic competition plays a consistently positive role. A country's own internet adoption rate and initiation were affected positively by those of its strongest trading partners, its regional peers and its neighbors, all of whom are likely to be its most fierce economic competitors. Countries appear to pay particular attention to their competitors and especially close by ones. Fear of being left behind in an uncompetitive economic position seems to drive countries to adopt new technologies faster. In future research it might be interesting to see if this competitive effect is moderated by a country's political institutions.

The second salient diffusion pressure seems to come from emulation of a country's socio-cultural "neighbors." Countries that share primary languages, religions, and colonial heritage appear to also be attentive to what each other is doing. This research indicates that they tend to copy one another's policies and/or practices. Such sociological emulation plays an important role in technological change; "similar" actors are more likely to emulate each other, as others have also shown (Dekimpe, Parker, and Sarvary 2000b).

The other three types of diffusion pressures had less consistent effects. I argued that participation in international organizations might be a place where learning occurred; ideas would spread more easily as policy makers from different countries spent more time together, exchanging ideas. There is some evidence that learning is occurring. Learning through contacts in the WTO appeared important from time to time, especially for users. Other international institutional contacts, such as PTAs, did not seem to matter. Network externalities are clearly present in the case of the internet. More total users or hosts in the rest of the world played a role in each country's own choices. This result is not very surprising given the internet's purpose and design. Finally, American hegemonic pressures had mixed effects. The only time they seemed to play a central role was in inducing faster adoption of hosts in other countries. Coercion in technological adoption is not likely to be a central pressure faced by countries.

In sum, the adoption of technology, in this case of the internet, is clearly affected by international diffusion pressures. Even when controlling for a variety of domestic factors, diffusion pressures from other countries can affect its spread. Economic competition, especially in our globalized economy today, exerts consistent pressures for quicker technology adoption. Imitation is also present among socio-culturally similar groups. We cannot explain the growth of the internet, and perhaps of any other new technology, without considering such international variables. At the international level the diffusion pressures created by the global capitalist market and through imitation of "similar" countries can have an important impact on a country' own choices about the new technology.

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Figure 1: Internet Adoption by USERS, Globally (per 10,000 inhabitants)

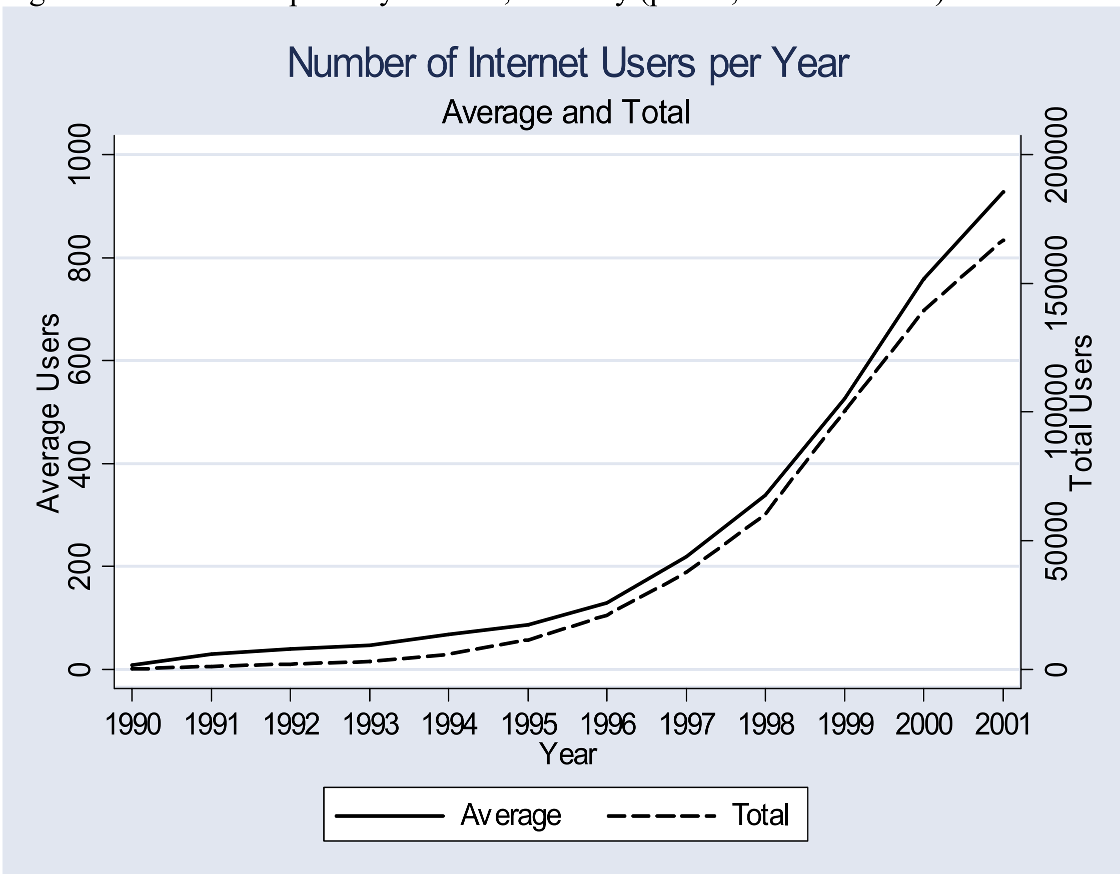

Figure 2: Internet Adoption by HOSTS, Globally (per 10,000 inhabitants)

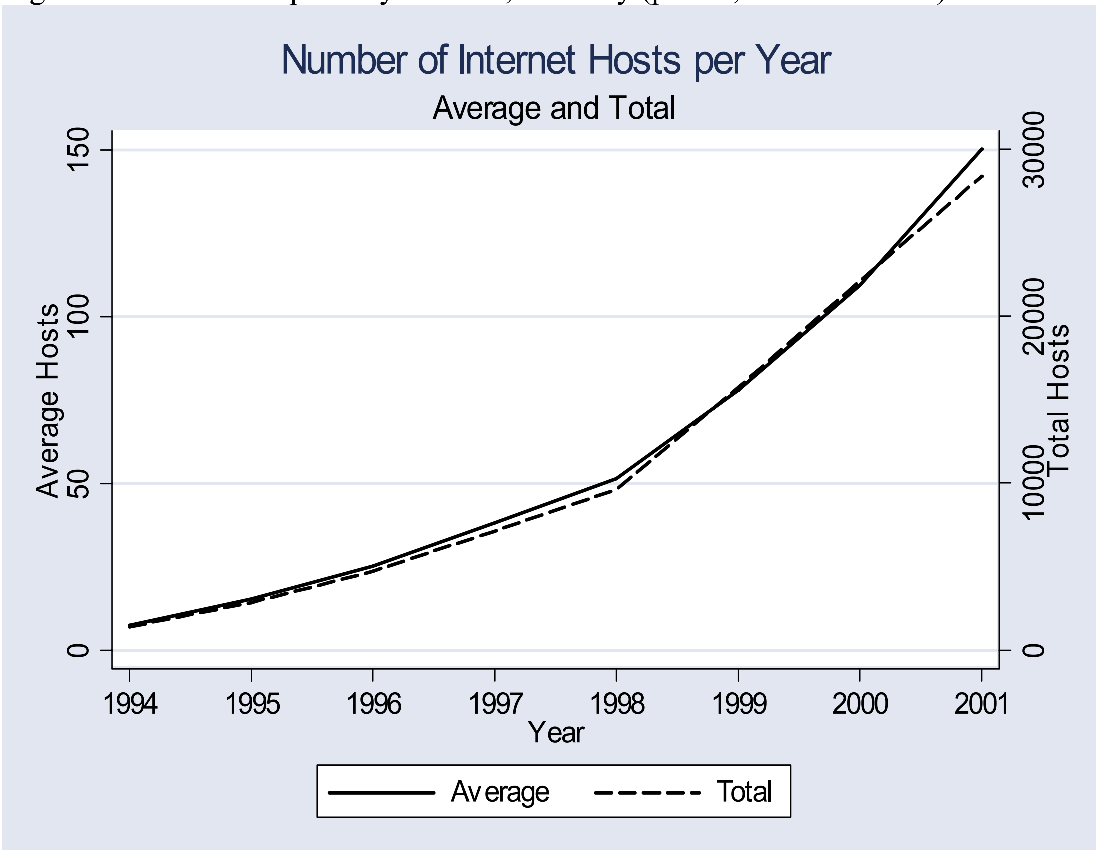

Figure 3: Number of Countries Initiating Internet Users Per year

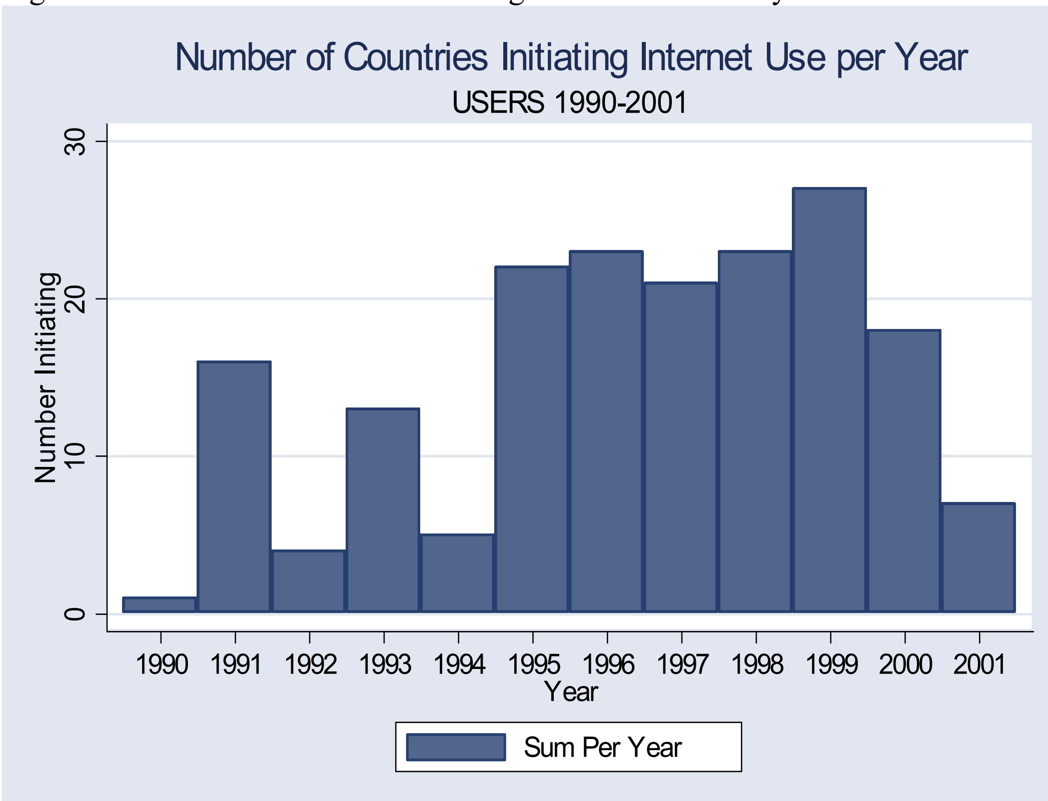

Figure 4: Number of Countries Initiating Internet Hosts Use per Year

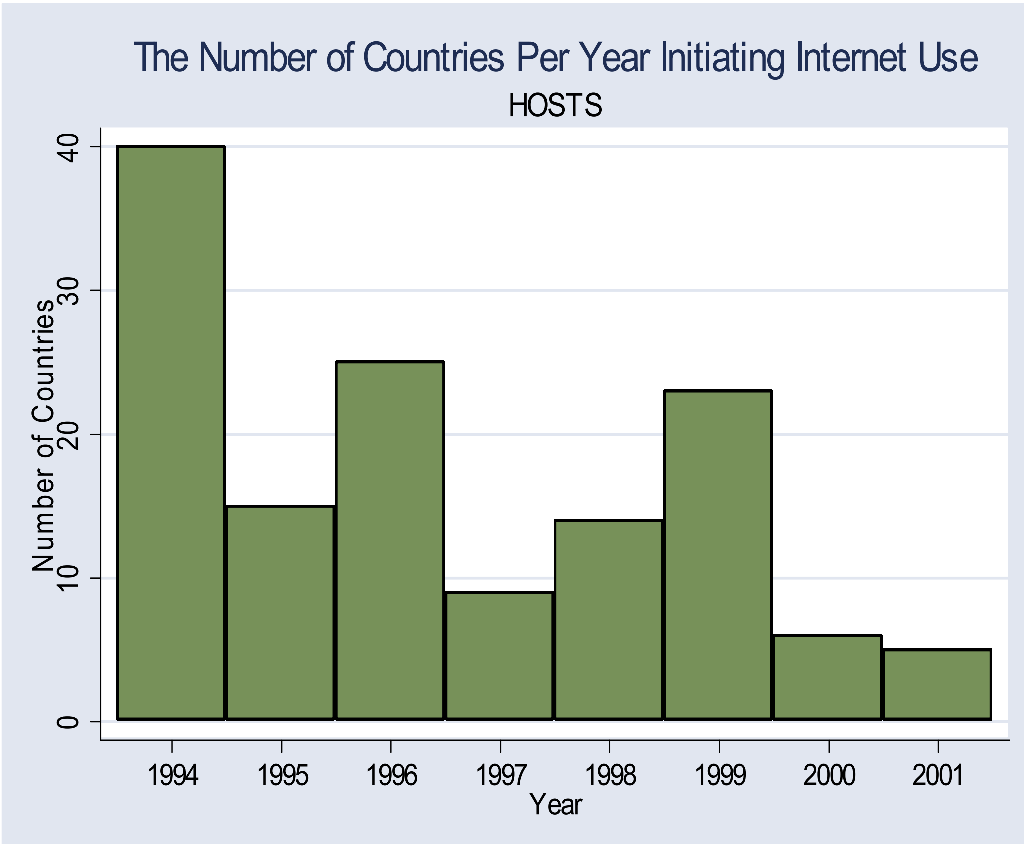

TABLE 4: SUMMARY STATISTICS

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| HOSTS INIT | 1730 | 0.42 | 0.49 | 0 | 1 |
| USERS INIT | 1632 | 0.60 | 0.49 | 0 | 1 |
| USERS PC | 1443 | 380.49 | 854.74 | 0 | 6866.20 |
| HOSTS PC | 1528 | 60.19 | 198.75 | 0 | 2171.90 |
| LANGUAGE H | 1821 | 60.98 | 157.77 | 0 | 2171.90 |
| LANGAUGE U | 2403 | 0.03 | 0.06 | 0 | 0.69 |
| RELIGION U | 2545 | 0.03 | 0.06 | 0 | 0.54 |
| RELIGION H | 1878 | 61.81 | 144.94 | 0 | 1677.02 |
| REGION U | 2866 | 0.02 | 0.04 | 0 | 0.42 |
| REGION H | 2866 | 32.09 | 82.44 | 0 | 1009.12 |
| US % WLD USERS | 2627 | 0.06 | 0.03 | 0.03 | 0.11 |
| US % WLD HOSTS | 1910 | 0.07 | 0.01 | 0.07 | 0.08 |
| TELECOM PRIV | 2866 | 0.21 | 0.41 | 0 | 1 |
| TRADE PARTNER H | 1800 | 186.83 | 276.27 | 0 | 1873.93 |
| TRADE PARTNER U | 1800 | 844.74 | 1105.33 | 0 | 4866.55 |
| NEIGHBOR H | 2002 | 23.31 | 83.78 | 0 | 1719.06 |
| NEIGHBOR U | 2002 | 149.31 | 373.84 | 0 | 4404.19 |
| GDP PC | 2036 | 6109.36 | 9738.84 | 84.72 | 58486.54 |
| LN POP | 2276 | 15.35 | 2.06 | 9.85 | 20.96 |
| URBAN | 2398 | 53.68 | 23.97 | 5.2 | 100 |
| POLITY | 1562 | 2.60 | 7.00 | -10 | 10 |
| RATIO USERS | 1439 | 0.08 | 0.25 | 0 | 3.92 |
| NEIGHBOR U (ln) | 1492 | 3.29 | 2.60 | -4.86 | 8.39 |
| TRADE PARTNER U (ln) | 1530 | 5.45 | 1.74 | -1.96 | 8.35 |
| YEAR | 2866 | 1995 | 3.45 | 1990 | 2001 |
| TOTAL USERS LN | 1489 | 18.35 | 1.49 | 8.52 | 20.03 |
| TOTAL HOSTS LN | 1904 | 17.05 | 1.02 | 14.33 | 18.40 |
| NEIGHBOR HOST LN | 1181 | 0.85 | 3.25 | -9.35 | 7.45 |
| TRADE PARTNER H LN | 1200 | 5.05 | 1.19 | -0.75 | 7.54 |

Table 2a: Initiation of Internet, by Users

| Dependent Variable: users_init | Internet Initiation, Users | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| LANGUAGE | **72.081*** ** | | **61.301*** ** | | **86.179*** ** |
| | (17.407) | | (18.178) | | (20.062) |
| REGION | **25.475** ** | **20.646* ** | **49.804* ** | **52.892* ** | **28.624* ** |
| | (10.820) | (10.597) | (26.310) | (30.331) | (14.899) |
| US % WLD | **-84.792*** ** | **-92.845*** ** | | | |
| | (12.476) | (12.792) | | | |
| WTO | 0.108 | 0.378 | 0.285 | 0.379 | 0.283 |
| | (0.383) | (0.363) | (0.479) | (0.460) | (0.373) |
| RELIGION | | **45.849*** ** | | **31.514*** ** | |
| | | (12.434) | | (11.911) | |
| TOTAL USERS | | | | | **0.000*** ** |
| | | | | | (0.000) |
| TRADE PARTNER | | | **1.137*** ** | **1.260*** ** | |
| | | | (0.204) | (0.206) | |
| TELECOM PRIV | 0.316 | 0.252 | 0.201 | 0.161 | 0.337 |
| | (0.338) | (0.342) | (0.352) | (0.360) | (0.353) |
| URBAN | **0.045*** ** | **0.047*** ** | **0.045*** ** | **0.046*** ** | **0.048*** ** |
| | (0.010) | (0.010) | (0.011) | (0.011) | (0.011) |
| LN POP | -0.059 | -0.046 | -0.113 | -0.089 | **-0.206** ** |
| | (0.081) | (0.105) | (0.090) | (0.099) | (0.080) |
| GDP PC | **0.000*** ** | **0.000*** ** | **0.000*** ** | **0.000*** ** | **0.000** ** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| POLITY | **0.124*** ** | **0.106*** ** | **0.097*** ** | **0.076*** ** | **0.105*** ** |
| | (0.024) | (0.027) | (0.026) | (0.027) | (0.024) |
| Constant | 1.150 | 1.232 | **-9.057*** ** | **-10.046*** ** | -1.610 |
| | (1.621) | (1.842) | (1.866) | (2.069) | (1.391) |
| | | | | | |
| Observations | 1088 | 1115 | 933 | 947 | 966 |
| log likelihood | -284.82 | -304.10 | -242.95 | -254.00 | -262.76 |
| Wald chi2 | 145 | 171 | 125 | 142 | 102 |
| Prob > Chi2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| R2_adj | 0.60 | 0.59 | 0.60 | 0.59 | 0.54 |

Logit with robust standard errors in parentheses (clustered on country). All Ivs lagged one period. Natural log of trade partner used. Two-tailed tests: * significant at 10%; ** significant at 5%; *** significant at 1%.

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Table 2 b: Initiation of Internet, by Users

| Dependent Variable: users_init | Internet Initiation, Users | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| LANGUAGE | **50.258*** ** | | | | |
| | (15.111) | | | | |
| NEIGHBOR | **0.548*** ** | **0.620*** ** | | | **0.534*** ** |
| | (0.101) | (0.099) | | | (0.107) |
| US % WLD | **-90.894*** ** | **-87.340*** ** | **-131.22*** ** | **-110.15*** ** | **-116.96*** ** |
| | (11.988) | (12.457) | (15.529) | (17.403) | (16.800) |
| WTO | 0.201 | 0.555 | 0.230 | 0.854* | 0.882* |
| | (0.353) | (0.353) | (0.398) | (0.501) | (0.456) |
| COLONY | | | **28.071*** ** | **36.556*** ** | **20.110* ** |
| | | | (10.062) | (13.386) | (12.101) |
| REGION | | | | **24.120** ** | |
| | | | | (10.684) | |
| TELECOM PRIV | 0.530 | 0.501 | 0.345 | 0.415 | 0.555 |
| | (0.336) | (0.344) | (0.426) | (0.432) | (0.416) |
| URBAN | **0.041*** ** | **0.044*** ** | **0.048*** ** | **0.046*** ** | **0.045*** ** |
| | (0.011) | (0.011) | (0.010) | (0.011) | (0.012) |
| LN POP | **-0.171* ** | -0.147 | -0.058 | -0.087 | -0.171 |
| | (0.095) | (0.110) | (0.127) | (0.125) | (0.134) |
| GDP PC | **0.000*** ** | **0.000*** ** | **0.001*** ** | **0.000*** ** | **0.001*** ** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| POLITY | **0.098*** ** | **0.072** ** | **0.104*** ** | **0.105*** ** | **0.060** ** |
| | (0.028) | (0.029) | (0.025) | (0.027) | (0.028) |
| Constant | 2.154 | 0.969 | 3.163 | 1.913 | 2.533 |
| | (1.593) | (1.769) | (2.082) | (2.228) | (2.137) |
| | | | | | |
| Observations | 992 | 1019 | 832 | 832 | 745 |
| log likelihood | -236.49 | -241.52 | -238.33 | -231.01 | -192.54 |
| Wald chi2 | 143 | 164 | 141 | 144 | 163 |
| R2_adj | 0.63 | 0.63 | 0.59 | 0.60 | 0.62 |

Logit regression with robust standard errors in parentheses (clustered by country). All IVs lagged one period. Natural log of neighbors used. Two-tailed tests: * significant at 10%; ** significant at 5%; *** significant at 1%. logituser1
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Table 3a: Initiation of Internet, by Hosts

| Dependent Variable: hosts_init | Internet Initiation, Hosts | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| LANGUAGE | 0.011 | | 0.002 | |
| | (0.007) | | (0.007) | |
| REGION | **0.020*** ** | **0.020*** ** | **0.013** ** | **0.013** ** |
| | (0.005) | (0.005) | (0.006) | (0.006) |
| US % WLD | 3.648 | -2.910 | | |
| | (19.156) | (17.808) | | |
| TWO | 0.291 | 0.195 | 0.187 | 0.160 |
| | (0.488) | (0.524) | (0.636) | (0.628) |
| RELIGION | | **0.012** ** | | **0.011** ** |
| | | (0.005) | | (0.005) |
| TRADE PARTNER | | | **0.487** ** | 0.291 |
| | | | (0.216) | (0.211) |
| TELECOM PRIV | 0.501 | 0.482 | 0.486 | 0.486 |
| | (0.370) | (0.349) | (0.444) | (0.443) |
| URBAN | 0.023 | 0.019 | **0.035* ** | 0.034 |
| | (0.016) | (0.016) | (0.021) | (0.021) |
| LN POP | -0.010 | 0.011 | 0.186 | 0.220 |
| | (0.155) | (0.153) | (0.161) | (0.164) |
| GDP PC | **0.001*** ** | **0.001*** ** | **0.001*** ** | **0.001*** ** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| POLITY | **0.176*** ** | **0.170*** ** | **0.236*** ** | **0.228*** ** |
| | (0.062) | (0.065) | (0.069) | (0.067) |
| Constant | -4.96 | -4.65 | **-11.12*** ** | **-10.83*** ** |
| | (3.282) | (3.029) | (4.013) | (4.032) |
| | | | | |
| Observations | 950 | 950 | 788 | 788 |
| log likelihood | -242.57 | -239.40 | -162.62 | -159.16 |
| Wald chi2 | 72 | 68 | 49 | 54 |
| R2_adj | 0.63 | 0.64 | 0.70 | 0.71 |

Logit with robust standard errors in parentheses (clustered by country). All IVs lagged one period. Natural log of trade partner used. Two-Tailed tests: * significant at 10%; ** significant at 5%; *** significant at 1%. logithost
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Table 3b: Initiation of Internet, by Hosts

| Dependent Variable: hosts_init | Initiation , Hosts | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| LANGUAGE | | | | | 0.006 |
| | | | | | (0.008) |
| NEIGHBOR | **0.415*** ** | | | **0.390*** ** | |
| | (0.110) | | | (0.100) | |
| US % WLD | 22.80 | **53.23** ** | 11.93 | 35.94 | |
| | (20.71) | (22.37) | (21.05) | (26.96) | |
| RELIGION | 0.007 | | | | |
| | (0.005) | | | | |
| COLONY | | **0.007** ** | **0.011*** ** | 0.006 | |
| | | (0.003) | (0.003) | (0.004) | |
| REGION | | | **0.020*** ** | | **0.017*** ** |
| | | | (0.005) | | (0.005) |
| TOTAL HOSTS | | | | | **0.000*** |
| | | | | | (0.000) |
| WTO | -0.376 | **-0.884*** | 0.315 | -0.649 | 0.106 |
| | (0.549) | (0.517) | (0.636) | (0.617) | (0.521) |
| TELECOM PRIV | 0.639 | **0.613*** | 0.582 | **0.745*** | 0.436 |
| | (0.400) | (0.366) | (0.391) | (0.416) | (0.373) |
| URBAN | 0.012 | **0.030*** | 0.029 | 0.022 | 0.022 |
| | (0.018) | (0.016) | (0.020) | (0.020) | (0.016) |
| LN POP | -0.056 | -0.030 | -0.059 | -0.133 | -0.009 |
| | (0.165) | (0.159) | (0.178) | (0.194) | (0.157) |
| GDP PC | **0.001*** ** | **0.001*** ** | **0.001*** ** | **0.001*** ** | **0.001*** ** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| POLITY | **0.152*** ** | **0.164*** ** | **0.177** ** | **0.144** ** | **0.188*** ** |
| | (0.058) | (0.062) | (0.071) | (0.058) | (0.067) |
| Constant | -4.096 | **-7.202** ** | -5.361 | -4.254 | -4.920 |
| | (3.470) | (3.497) | (3.834) | (4.182) | (3.028) |
| | | | | | |
| Obs | 897 | 713 | 713 | 668 | 950 |
| log likelihood | -233.80 | -222.48 | -195.38 | -186.44 | -239.92 |
| Wald chi2 | 74 | 67 | 78 | 64 | 72 |
| R2_adj | 0.62 | 0.54 | 0.60 | 0.59 | 0.64 |

Logit with robust standard errors in parentheses (clustered by country). All IVs lagged one period. Natural log of neighbor and total hosts used. Two-tailed tests: * significant at 10%; ** significant at 5%; *** significant at 1%. logithost1
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TABLE 4a: Adoption Rate for Ratio of Actual to Potential Internet Users

| Dependent Variable: ratio_users | Ratio of Internet Users, Actual to Potential, | Matched by Date | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| LANGAUGE | **4.384*** ** | | **2.556*** ** | | |
| | (0.622) | | (0.717) | | |
| RELIGION | | **3.812*** ** | | **1.924** ** | **3.602*** ** |
| | | (0.751) | | (0.793) | (0.814) |
| REGION | **5.905*** ** | **5.542*** ** | **3.838*** ** | **3.268*** ** | **4.956*** ** |
| | (0.655) | (0.811) | (0.760) | (0.707) | (0.873) |
| US % WLD | **-27.035*** ** | **-33.359*** ** | | | |
| | (4.359) | (4.478) | | | |
| TRADE PARTNER | | | **0.621*** ** | **0.723*** ** | |
| | | | (0.076) | (0.093) | |
| TOTAL USERS | | | | | **0.460*** ** |
| | | | | | (0.088) |
| WTO | **0.764*** ** | **0.796*** ** | **0.887*** ** | **0.866*** ** | **0.801*** ** |
| | (0.223) | (0.225) | (0.279) | (0.293) | (0.233) |
| TELECOM PRIV | **0.298** ** | 0.209 | -0.045 | -0.148 | 0.131 |
| | (0.147) | (0.179) | (0.145) | (0.169) | (0.198) |
| URBAN | 0.000 | -0.000 | 0.004 | 0.004 | 0.001 |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| LN POP | -0.019 | -0.067 | -0.071 | **-0.104*** ** | -0.050 |
| | (0.048) | (0.057) | (0.047) | (0.035) | (0.060) |
| GDP PC | **0.000*** ** | **0.000*** ** | **0.000*** ** | **0.000*** ** | **0.000*** ** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| POLITY | **0.081*** ** | **0.074*** ** | **0.078*** ** | **0.073*** ** | **0.077*** ** |
| | (0.026) | (0.028) | (0.026) | (0.026) | (0.029) |
| Constant | **-3.27*** ** | **-2.19** ** | **-8.01*** ** | **-8.12*** ** | **-12.4*** ** |
| | (0.894) | (0.997) | (0.997) | (0.999) | (2.018) |
| | | | | | |
| Observations | 828 | 840 | 737 | 741 | 784 |
| log likelihood | -178.02 | -182.01 | -152.61 | -153.73 | -181.35 |
| Wald chi2 | 1192 | 1103 | 2043 | 2131 | 1263 |
| Prob > chi2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| # of countries | 144 | 145 | 121 | 121 | 141 |

Negative binomial regression (NBREG in STATA 8.1) with robust standard errors in parentheses (clustered on country). Matched by date of initiation of internet users. Natural log of neighbors, trade partners and total users used. All IVs lagged one period. Two-tailed tests: * significant at 10%; ** significant at 5%; *** significant at 1%.
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TABLE 4b: Adoption Rate for Ratio of Actual to Potential Internet Users

| Dependent Variable; ratio_users | Ratio of Internet Users, | Actual to Potential, | Matched by Date | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| LANGUAGE | **3.598*** ** | | | | |
| | (0.728) | | | | |
| RELIGION | | **2.969*** ** | | | |
| | | (0.712) | | | |
| COLONY | | | 3.961 | 4.211 | 2.649 |
| | | | (3.492) | (3.510) | (2.354) |
| NEIGHBOR (ln) | **0.373*** ** | **0.394*** ** | | | **0.492*** ** |
| | (0.112) | (0.124) | | | (0.156) |
| REGION | | | | **4.513*** ** | |
| | | | | (1.341) | |
| US % WLD | **-24.103*** ** | **-26.810*** ** | **-47.145*** ** | **-34.214*** ** | **-20.380** ** |
| | (8.419) | (8.379) | (6.801) | (4.240) | (9.429) |
| WTO | **0.841*** ** | **0.840*** ** | 0.469 | **0.728*** ** | **0.785*** ** |
| | (0.238) | (0.243) | (0.292) | (0.257) | (0.243) |
| TELECOM PRIV | 0.053 | 0.032 | **0.733** ** | **0.903*** ** | **0.572** ** |
| | (0.184) | (0.180) | (0.308) | (0.278) | (0.255) |
| URBAN | -0.005 | -0.009 | -0.001 | -0.002 | -0.003 |
| | (0.006) | (0.006) | (0.011) | (0.010) | (0.010) |
| LN POP | 0.068 | 0.063 | **0.168** ** | 0.040 | 0.128 |
| | (0.080) | (0.080) | (0.077) | (0.082) | (0.078) |
| GDP PC | **0.000*** ** | **0.000*** ** | **0.000*** ** | **0.000*** ** | **0.000*** ** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| POLITY | **0.061** ** | 0.052 | **0.104*** ** | **0.092*** ** | **0.058** ** |
| | (0.030) | (0.032) | (0.028) | (0.025) | (0.028) |
| Constant | **-5.980*** ** | **-5.646*** ** | **-5.507*** ** | **-4.241*** ** | **-8.046*** ** |
| | (1.427) | (1.324) | (1.462) | (1.424) | (1.510) |
| | | | | | |
| Observations | 750 | 761 | 599 | 599 | 516 |
| log likelihood | -164.69 | -165.70 | -110.44 | -107.63 | -95.90 |
| Wald chi2 | 1490 | 1036 | 932 | 941 | 686 |
| Prob > chi2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| # of countries | 137 | 138 | 109 | 109 | 103 |

Negative binomial regression (nbreg in STATA 8.1) with robust standard errors in parentheses (clustered by country). All Ivs lagged one period. Matched by date of initiation of internet users. Two-tailed tests: * significant at 10%; ** significant at 5%; *** significant at 1%.

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TABLE 5a: Rate of Adoption of Internet Hosts, Matched by Initiation Date

| Dependent Variable: hosts_0_ppop | Adoption of Internet Hosts, | Matched by Date | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| TRADE PARTNER | | | **0.173**** | **0.189**** | |
| | | | (0.085) | (0.083) | |
| LANGUAGE | **0.001*** | | 0.001 | | 0.001 |
| | (0.001) | | (0.001) | | (0.001) |
| REGION | **0.006***** | **0.006***** | **0.005***** | **0.005***** | **0.004***** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| US % WLD | **19.210*** | 16.503 | | | |
| | (10.720) | (10.187) | | | |
| WTO | 0.244 | 0.240 | -0.382 | -0.168 | 0.096 |
| | (0.380) | (0.370) | (0.955) | (0.854) | (0.380) |
| RELIGION | | **0.002**** | | | |
| | | (0.001) | | | |
| TOTAL HOSTS | | | | | **0.355***** |
| | | | | | (0.125) |
| TELECOM PRIV | **0.604***** | **0.607***** | **0.524***** | **0.551***** | **0.476***** |
| | (0.175) | (0.176) | (0.170) | (0.185) | (0.181) |
| URBAN | **0.029***** | **0.028***** | **0.030***** | **0.031***** | **0.029***** |
| | (0.008) | (0.008) | (0.010) | (0.011) | (0.008) |
| LN POP | **-0.228***** | **-0.234***** | **-0.155*** | **-0.168*** | **-0.216***** |
| | (0.070) | (0.069) | (0.089) | (0.089) | (0.071) |
| GDP PC | **0.000***** | **0.000***** | **0.000***** | **0.000***** | **0.000***** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| POLITY | **0.108***** | **0.105***** | **0.126***** | **0.132***** | **0.115***** |
| | (0.024) | (0.024) | (0.019) | (0.020) | (0.023) |
| Constant | 1.073 | 1.431 | 0.884 | 0.557 | **-3.568*** |
| | (1.354) | (1.358) | (2.817) | (2.906) | (2.072) |
| | | | | | |
| Observations | 735 | 735 | 521 | 589 | 735 |
| log likelihood | -2694.18 | -2692.16 | -2123.76 | -2177.73 | -2680.70 |
| Wald chi2 | 415 | 398 | 392 | 409 | 439 |
| Prob > chi2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| # of countries | 147 | 147 | 122 | 122 | 147 |

Negative binomial regressions (NBREG in STATA 8.1) with robust standard errors in parentheses (clustered by country). Natural log of trade partners and total hosts used. All IVs lagged one period. Two-tailed tests: * significant at 10%; ** significant at 5%; *** significant at 1%.

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TABLE 5b: Adoption Rate for Internet Hosts, Matched by Initiation Date

| Dependent Variable: hosts_0_ppop | Adoption of Internet Hosts, | Matched by Date | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | hosts_0_ppop | hosts_0_ppop | hosts_0_ppop |
| LANGUAGE | 0.001 | | | |
| | (0.001) | | | |
| NEIGHBOR (ln) | **0.222*** ** | **0.226*** ** | | **0.238*** ** |
| | (0.061) | (0.059) | | (0.049) |
| US % WLD | **33.913*** ** | **29.507*** ** | **29.422* ** | **27.359* ** |
| | (9.564) | (9.015) | (15.749) | (14.467) |
| RELIGION | | 0.002 | | |
| | | (0.001) | | |
| COLONY | | | **0.006** ** | **0.005** ** |
| | | | (0.003) | (0.002) |
| REGION | | | **0.004*** ** | |
| | | | (0.001) | |
| WTO | 0.263 | 0.279 | -0.020 | -0.044 |
| | (0.299) | (0.291) | (0.433) | (0.332) |
| TELECOM PRIV | **0.296* ** | **0.288* ** | **0.713*** ** | 0.325 |
| | (0.158) | (0.162) | (0.237) | (0.204) |
| URBAN | **0.019** ** | **0.019** ** | **0.030*** ** | **0.020*** ** |
| | (0.008) | (0.008) | (0.007) | (0.007) |
| LN POP | **-0.142* ** | **-0.149** ** | **-0.251*** ** | **-0.150* ** |
| | (0.076) | (0.073) | (0.092) | (0.083) |
| GDP PC | **0.000*** ** | **0.000*** ** | **0.000*** ** | **0.000*** ** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| POLITY | **0.087*** ** | **0.082*** ** | **0.135*** ** | **0.102*** ** |
| | (0.019) | (0.019) | (0.026) | (0.020) |
| Constant | -0.595 | -0.146 | 0.369 | -0.213 |
| | (1.318) | (1.293) | (1.865) | (1.518) |
| | | | | |
| Observations | 592 | 592 | 520 | 395 |
| log likelihood | -2417.09 | -2411.97 | -1595.35 | -1392.46 |
| Wald chi2 | 342 | 271 | 283 | 281 |
| Prob > chi2 | 0.00 | 0.00 | 0.00 | 0.00 |
| # countries | 138 | 138 | 111 | 103 |

Negative binomial regression (NBREG in STATA 8.1) with robust standard errors in parentheses (clustered on country). All IVs lagged one period; matched by date of initiation. Two-tailed tests: * significant at 10%; ** significant at 5%; *** significant at 1%.

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