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The Digital Divide

The Role of Political Institutions in Technology Diffusion

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What factors have promoted and retarded the spread of the Internet globally? The Internet is one example of the diffusion of technology. Much as other technologies, the Internet has diffused unevenly across countries, raising concerns over a "digital divide." My main proposition is that its spread has been driven by neither technological nor economic factors alone. Rather, political factors exert a powerful influence. Groups that believe they will lose from the Internet use political institutions to enact policies that block the spread of the Internet. Some political institutions make this easier than others. Data from roughly 190 countries from 1991 to 2001 show that a country's regime type matters greatly, even when controlling for other economic, technological, political, and sociological factors. Democratic governments facilitate the spread of the Internet relative to autocratic ones. Thus, the spread of democracy may help reduce the digital divide.

Keywords: *technology diffusion; democracy; Internet; digital divide*

This gap between rich and poor is also mirrored in the new information economy. A digital divide—the name given to the disparity in information resources—is emerging between North and South. Industrialized economies are moving towards greater dependence on and access to increasingly sophisticated information technologies. Yet more than one-half of humanity has never used a telephone, and there are more telephones [in] Montréal than in all of Bangladesh.

—Canadian International Development Agency[1]

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1. Canadian International Development Agency (2002, p. 10).

Introduction

What factors have promoted and retarded the spread of the Internet globally? The Internet is one example of a new technology. As a means for spreading information at very low cost, however, the Internet, like other communications technologies, may have a wider political impact. It is also an important element in the current globalization process that is linking countries ever more tightly to a global economy. Many scholars, as the quote above exemplifies, worry that its uneven spread is exacerbating the "digital divide" between the rich and the poor. As Franda (2002, p. 11) notes, "The introduction of the internet has not made any part of the world poorer. . . . But the internet is contributing to a widening of the gap between the better-off and worse-off parts of the world because it has enabled some nations to create new sources of wealth and of international diplomatic and political power relative to others."

The diffusion of technological innovations is a topic of great importance. Scholars now believe that economic growth is propelled largely by technological change (e.g., Parente & Prescott, 2000). Countries hoping to develop must innovate or adopt new technologies that increase productivity. Factors that influence the adoption rate of new technologies are, therefore, of critical importance for economic development (Acemoglu & Robinson, 2000, 2002; Hall & Jones, 1999; Mokyr, 1990; Parente & Prescott, 2000). Basically, some countries exploit the latest and most efficient technologies and production processes and experience very rapid growth, whereas others fail to do so and lag far behind. Some scholars attribute the rise of the West to its superior ability to innovate and adopt new technologies (e.g., Diamond, 1997). Today, the widening gap between rich and poor countries is often attributed to faster rates of growth in the richest countries, driven in part by their rapid adoption of innovations (e.g., Landes, 1998). Thus, understanding what factors affect the rate of adoption of new technologies, like the Internet, is of great importance.

Because the world stock of knowledge is capable of use by all countries, and because differences in human and physical capital do not seem to account for differences in the adoption of technology, scholars have turned their attention to other factors. Primary among these have been political ones, such as the role of institutions, ruling elites, and public policy. Some scholars now claim that the rate of adoption of technology depends on the political environment and the preferences of those in power (e.g., Acemoglu & Robinson, 2000, 2002; North, 1990; North & Thomas, 1973). Some institutional environments allow governments and ruling elites who so desire to foster technological change; others enable them to slow it down or derail it

completely. Political obstacles, not economic ones, are now seen as the central cause of differential rates of technological change and, hence, of economic growth.[2]

This article seeks to explain the distribution of the Internet across space and time. Much as other technologies, the Internet has diffused unevenly across countries. My main proposition is that the pattern of Internet adoption among countries has been driven neither by technological forces nor by economic ones alone. Rather, political factors, especially domestic institutions, exert a powerful influence. Political institutions in particular matter for the adoption of new technologies because they affect the manner and degree to which winners and losers from the technology can translate their preferences into influence. Groups that believe they will lose from the Internet try to use political institutions to enact policies that block the spread of the Internet. These "losers" hope to slow down or stop its diffusion, and some institutions make this easier to do than others.

In particular, countries that are democratic are more likely to adopt at faster rates than are nondemocracies. The ruling group in autocracies often sees the Internet's disadvantages as outweighing its advantages. The Internet can provide civil society with uncensored information, costless sharing of that information, and tools to overcome collective-action problems for organizing opposition. All of these can threaten the interests of ruling groups in autocracies. Because they have institutions that do not rely on broad public support, it will also be easier for them to slow down its spread. Thus, autocratic governments have both greater desire and more ability to impede the adoption of threatening technologies. Regime type should be a major factor explaining the digital divide.

Past research provides ambivalent conclusions about this topic. Some have claimed that autocratic governments are more opposed to and restrictive of the Internet. Goodman et al. (1998, p. 243) conclude from their study of 13 countries 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.

2. Acemoglu and Robinson (2000, p. 126) propose the "political loser" hypothesis. They claim that the effect of technological changes on the political power of groups explains whether such innovations will be adopted. Those groups whose political power (not their economic rents) is hurt by technological change will block innovations. Their main point is that one should focus on the nature of political institutions to understand the sources of technological backwardness.

Or, as Wilson (2004, p. 327) claims, "When countries have environments that promote stability and respect for law and democratic rights, . . . rapid ICT [information and communication technologies] diffusion is more likely."

In contrast, other scholars suggest that the Internet will be much less threatening to leaders capable of greater control over it. Lessig (1999) argues that the Internet is a means for exercising perfect control over society and, thus, that societies must force governments to adopt regulations that allow the Internet to remain a device for freedom. Chase and Mulvenon (2002, pp. 87-89) point out that China has been successful in preventing the Internet from influencing politics and that the government has used it to blanket the country with its official propaganda and to bolster its political control. Kalathil and Boas (2003, p. 137) likewise argue that "states still call the shots." They conclude their study of eight authoritarian governments by noting that "the state plays a crucial role in charting the development of the internet in authoritarian regimes and in conditioning the ways it is used by societal, economic and political actors. Through proactive policies . . . authoritarian regimes can guide the development of the internet so that it serves state-defined goals and priorities. This may extend the reach of the state in significant ways" (Kalathil & Boas, 2003, p. 136). From this viewpoint, authoritarian governments have little to fear from the Internet and may well be able to use it for their own purposes. Hence, it is not clear cut that regime type should matter.

Many have argued about whether the Internet will have a democratizing effect (e.g., Kalathil & Boas, 2003; Norris, 2001), but few have systematically examined whether a country's regime type affects its rate of Internet adoption. Among the extant studies, a number of them do not find clear-cut evidence for the impact of regime type. Kedzie (1997), examining data on e-mail usage from 1993, shows that a strong correlation exists between countries' rankings on their levels of interconnectivity and Freedom House measures of political and civil liberties. He disavows any causal claim about whether democracy promotes the Internet or vice versa, however. Norris (2001, p. 62) shows that in a simple regression on a cross section of countries in 2000, democracy has a significant effect on the percentage of the population online. She, however, attributes most of its impact to economic-development levels, demonstrating that the impact of democracy fades into insignificance when other socioeconomic factors are introduced (Norris, 2001, p. 63). Oxley and Yeung (2001) in a cross section on Internet hosts per capita demonstrate that the rule of law as measured by LaPorta, Lopez-Silanes, Shleifer, and Vishny (1997) has a positive effect; it seems to have none for Internet users, however. Finally, Guillen and Suarez (2001) show that Polity's democracy score predicts higher levels of Internet users and

hosts in a cross section of countries. Almost all analysts agree that political institutions and policy matter greatly for the diffusion of the Internet, but they do not agree on the exact nature of that relationship.

This study attempts to move this research agenda on political institutions and technology diffusion forward. I first explore the theoretical linkages between regime type and Internet development. Second, I provide different statistical models than those used in earlier studies by adding a time-series dimension, using better measures of democracy, and employing more appropriate statistical methods. This study then attempts to provide a stronger test of the linkages between domestic regime type and technological change.

This article has five sections. After the introductory section, I present data showing that the adoption of the Internet has varied greatly among countries but that a democratic advantage exists in Internet adoption. The next section discusses why regime type influences how new technologies are received by countries. The fourth section presents a quantitative analysis of 184 countries from 1991 to 2001 of the spread of the Internet. The main finding is that regime type, in particular democracy, promotes the adoption of new technologies or, at least, that autocracies tend to slow it down. The fifth section concludes.

Are Democracies Different?

The rate of Internet adoption has varied considerably among countries. For instance, in 2000, almost a decade after the Internet became a publicly known technology, Iceland led the world in the percentage of its population using the Internet; close to 60% were users.[3] In the next group of heavy users were Norway, Sweden, the United States, and Canada with more than 40% using it. Some rich and technologically adept countries like Germany and Japan had less than 30% of their populations online, or half of Finland's rate. Other rich countries like France and Spain had only 14% of their populations as Internet users. Other well-off countries had even fewer users: Saudi Arabia had less than 1% of its population online; Russia, less than 2%; and Greece, less than 10%. In fact, by 2000, 73 countries out of 184 for which data exist (about 40% of the world) had less than 1% of their populations online. What accounts for this variation in the adoption of an important new technology?

A country's regime type seems to have a salient impact. Among countries coded as democratic, the average percentage of the population that was an

3. For a complete discussion of data sources, see the Empirical Analysis section.

Internet user in 2000 was 12%.[4] The same figure for autocracies was only 2%. For the number of Internet hosts per 10,000 inhabitants, democracies on average in 2000 had 211, whereas autocracies had 10. Figures 1a and 1b show this relationship for the entire decade (all figures are per 10,000 inhabitants); it is always the case that democracies have a greater percentage of users and hosts than autocracies. This advantage escalates over time as well.

Because democracy and level of development are closely related ($r = .43$), this relationship might be a function of the fact that democracies are richer. But if one controls for level of income, the same results arise (Milner, 2003). In countries that the World Bank classifies as low income, democracies on average have more users per capita than do autocracies; in 2000, for instance, poor democracies averaged 0.5% of their population as users, whereas for poor autocracies, only 0.3% were users.[5] In 2000, middle-income democracies had 6% of their populations online, and autocracies had only 2%. In terms of hosts, democracies had 45 per 10,000 inhabitants, and autocrats had a mere 3 in 2000. The richest democracies outscore the richest autocracies in Internet users and hosts. In 2000, for example, nearly 30% of rich democracies' populations were online, whereas in rich autocracies, this figure was only 17%. Rich democracies also had more hosts per capita than did rich autocracies (602 per 10,000 vs. 143). At all levels of development, democracies have more users per capita than do autocracies, and at all levels but the poorest, they have an advantage in hosts as well. In nearly every case, this democratic advantage was also growing over time.

Why Are Democracies More Likely to Adopt the Internet?

As with any technology, its successful adoption is likely to depend on the underlying political order. The laws, regulations, subsidies, and taxes that governments choose to employ may substantially affect whether actors invest in the new technology, as North (1990), among others, has argued. Political and economic groups that lose from the spread of the Internet may also try to retard its diffusion through such political means (e.g., Acemoglu & Robinson, 2000). They will use the country's political institutions to enact policies that do this. Some institutions may be more susceptible to such purposes than others.

4. In the two figures, countries were coded as democratic if they scored at or above a 6 on the POLITY scale; otherwise, they were autocratic.

5. With respect to the number of hosts per capita, the differences are much smaller. For the poorest countries, buying the equipment to support Internet hosts poses the biggest constraint, and thus, one expects the least difference here.

Figure 1a
Average Internet Users by Regime Type

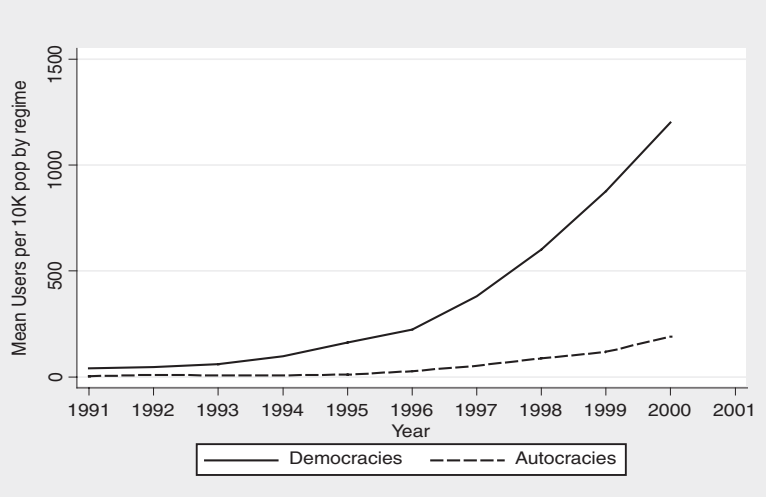
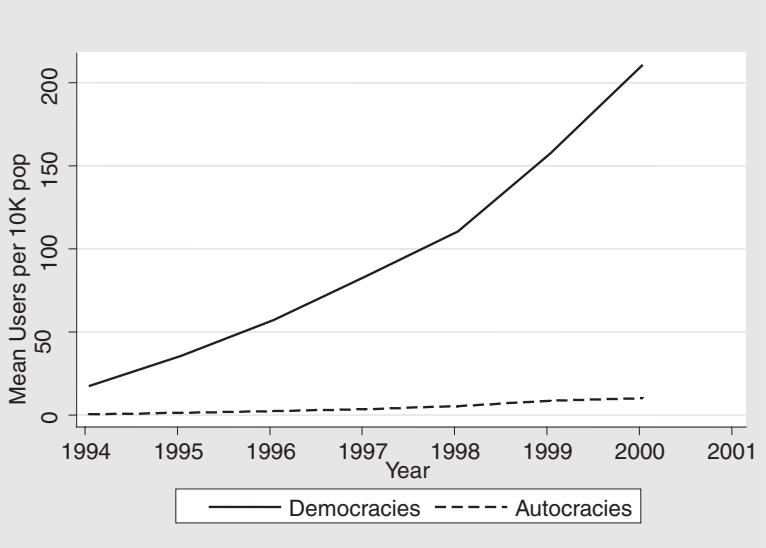


Figure 1b
Average Internet Hosts by Regime Type



In what ways might regime type matter for choices about adopting the Internet? All technological change creates groups that gain and lose: its winners and losers. The political institutions in place may allow the losers to block or slow down its adoption, or they may enable winners from its adoption to promote it. Different political institutions have different distributional consequences (Knight, 1992). Governments and interest groups that lose from rapid Internet adoption may use political institutions to slow down its diffusion. Political actors need to possess both the desire and the capacity to block technological change. Autocratic governments, I claim, are more likely to possess both than are democratic ones. This argument is different from those that emphasize how democracy enhances human capital and public-goods provision (e.g., Baum & Lake, 2003; Bueno de Mesquita, Smith, Siverson, & Morrow, 2003; Lake & Baum, 2001).

Leaders in all countries pay attention to the economy for their survival; they certainly pay heed to the economic fortunes of groups that are their major supporters. But democratic governments tend to be more sensitive to economic failure and its consequent political problems (e.g., Bueno de Mesquita & Siverson, 1995). This heightens their concern for economic growth and, in turn, enhances their desire to promote, or at least not block, technological change that portends faster economic growth. Autocrats, who tend to survive longer and to be less sensitive to economic problems, can fail to promote or can even block technological change that threatens them or their supporters. Autocratic governments are more likely to be able to use their institutions to pass policies that inhibit Internet diffusion. As one report on Internet freedom notes, "45 countries now restrict Internet access on the pretext of protecting the public from subversive ideas or violation of national security—code words used by censors since the sixteenth century" (Sussman, 2000, p. 1); they are all autocracies.

These policies matter because they can result in slower adoption of the technology. The Internet is a network technology par excellence. Its value depends in part on how many others access the network; more businesses, more private groups, and more citizens on the net mean more value for each of them from the net. Policies that forbid certain types of uses or users reduce demand for access to the net, thus making investment in it less likely. Policies that control the content of the Internet can also indirectly reduce demand for access to and the supply of the Internet. For instance, scholars have noted a relationship between high levels of television ownership in a country and low levels of government control of the content and number of channels (Meyen & Hillman, 2003). A potential consequence of the policies discussed below is lower Internet use and slower Internet adoption; these policies have overwhelmingly been the brainchild of autocratic governments.

On average, autocratic governments should be more likely to prefer and better able to retard the spread of the Internet than democratic ones. The Internet threatens autocrats because it promotes uncensored access to information, the wide sharing of that information, and the capacity to overcome collective goods problems, thus enhancing the public's ability to organize against a regime. Autocratic regimes may create environments that hinder the growth of the Internet because these three functions of the net threaten autocrats' control. As Goodman et al. (1998, pp. 23-24) claim,

> To the extent that it provides an additional communications medium, the Internet can be seen as a threat to coercive control, whether internal or external. In its most basic form, it is merely another means of sharing information. However, the robust nature of the international network . . . presents unique problems to [national] security services.

Others note that

> the Internet poses a new challenge to such censorship, both because of the sheer breadth of content typically available, and because sources of content are so often remote from Chinese jurisdiction, and thus much more difficult to penalize for breaching restrictions on permissible materials. There is some evidence that the government has attempted to prevent the spread of unwanted material by preventing the spread of the Internet itself, but a concomitant desire to capture the economic benefits of networked computing has led to a variety of strategies to split the difference. (Zittrain & Edelman, 2002, p. 1).

This suggests that autocratic governments will desire to regulate the Internet closely and perhaps restrict its diffusion, if not just its content.

Autocratic leaders are caught in a dilemma, however. They face contradictory pressures regarding technological innovation and the Internet in particular. Their country's economic growth rate, and thus their legitimacy, may depend on such innovations, but they may also undermine a regime's control capabilities. For example,

> China faces a very modern paradox. The regime seems to believe that the Internet is a key engine of the new Economy . . . and that future economic growth in China will depend in large measure on the extent to which the country is integrates with the global information infrastructure. Economic growth is directly linked to social stability of the Beijing leadership, maintenance of prosperity has become the linchpin of regime legitimacy and survival. . . . Chinese leaders view the development of information technology, particularly the internet, in China as an indispensable element of their quest for recognition as a

> great power. In the words of a recent *People's Daily* article, "the degree of development of information networking technology has become an important yardstick for measuring a country's modernization level and its comprehensive national strength." . . . At the same time, however, China is still an authoritarian, single party state with a regime whole continued rule relies on the suppression of antiregime activities. The installation of an advanced telecommunications infrastructure to facilitate economic reform greatly challenges the state's pursuit of internal security. . . . Faced with these contradictory forces of openness and control, China has sought to strike a balance between the information-related needs of economic modernization and the security requirements of internal stability. (Chase & Mulvenon, 2002, pp. 45-46)

In general, there are a variety of ways in which governments can delay or prevent the spread of the Internet. Autocratic governments should be better able than democratic leaders to determine the supply of the Internet and other communications infrastructure and to affect the overall content and use of the network. Most of these policies require an authoritarian government that is able to limit political and civil rights. The eight main ways that a regime can "squelch the net" provide an interesting inventory of such governmental practices ("Squelching," 2003, p. 31). These policies can directly affect the number of users by chilling their interest in it because of fear of government action against them or lack of interesting content. They can also directly affect the number of hosts by reducing the willingness of private groups to invest in making the technology available.

Firewalls. Governments employ proxy servers—that is, computers that act as intermediaries between the global Internet and domestic users on private networks—to scan e-mail for "offensive" or prohibited content and to review all Web traffic by checking URLs against a constantly updated blacklist. For instance, in the late 1990s, a number of Middle Eastern countries, such as Saudi Arabia, UAE, and Yemen, used a firewall that monitored their few access points to the global Internet (Franda, 2002; Kalahtil & Boas, 2003). Such restricted content and spying on users are not conducive to the widespread adoption or supply of Internet technology.

Routers. Firewalls will not work well once a country has a high volume of Web traffic or where multiple Internet service providers (ISPs) have established many servers that can access the global net. China, for example, would need thousands of proxy servers to monitor all incoming and outgoing Web traffic. The approach of countries in this position is to force the ISPs to monitor the Web for them. Routers capable of blocking offending Internet Protocol (IP) addresses and even filtering content must be installed by ISPs. The

main channel for users to access the Web can thus be reduced as ISPs are deterred from entering the market and offering their services.

Software filters. Censorship can be imposed by using software to filter all e-mail and Web traffic. Governments can use their proxy servers or can force their ISPs to install software filters that comb the e-mail and Web traffic of their users. Some filters block entire banned sites; others use keywords or messages with offensive terms to stop e-mail or prevent access to a URL. Singapore, among other tactics, had made extensive use of such filters, as do many Muslim countries (Guillen & Suarez, 2001, pp. 357-360). Users never know which sites are blocked, and they often do not know that they are being watched. A recent project documenting filtering shows that the Chinese government was blocking roughly 10% of all sites (an inspection of about 200,000 sites showed nearly 19,000 blocked; Zittrain & Edelman, 2002). Banning content reduces demand for the Internet and, in turn, reduces investors' willingness to supply the technology.

Internet police. They conduct surveillance on users and act as informants. *Wired* notes that China has 30,000 e-mail police who enforce a bevy of net-related laws and monitor messages. The chilling effect of such policing is obvious; it raises the costs of using the technology for all users.

Coercion. Governments often employ "self-regulatory measures," in particular those aimed at ISPs. In 2002, China required all ISPs and media to sign "Public Pledge on Self-Discipline for the Chinese Internet Industry," which forced them to agree to abide by all laws and regulations regarding the Internet or be punished; failure to sign resulted in being blacklisted or losing one's access ("Squelching," 2003, p. 31). In many other countries as well, including Singapore and most of the Middle East, these types of policies have forced ISPs to self-censor, thus relieving the government of this direct role (Kalathil & Boas, 2003). Such restriction of content and monitoring of use have inhibitory effects on users and suppliers.

Restricted access. Many countries force all users to register with their ISP or governmental authority. Users know the government can track them and are often inhibited in their behavior. Moreover, some countries restrict access to institutions and prevent individuals from gaining entrée. By permitting access only in group situations, users, they hope, will be deterred from prohibited behavior because others can more easily monitor them. Cuba, for example, limits Web access very severely; a few public institutions are granted permission (Kalathil & Boas, 2003, chap. 3; Seror & Arteaga, 2000).

This policy means that Cuba has less than 1% of its population with e-mail accounts and only half of that with connections to the global Web as of 2000 (Kalathil & Boas, 2003, pp. 44, 53).

High access prices. Three sets of costs matter for users: the prices of local telephone calls for making an ISP connection, the prices users pay ISPs for access to the net, and the prices for ISPs to lease local lines. High prices make access unaffordable to the vast majority. Although more manipulable in nondemocratic countries, democracies can and do affect these costs. An autocratic country, like Jordan, uses high taxes and instructs its telecommunications monopoly to keep the cost of the net very high, so that fewer than 30,000 Jordanians were online around 2000.

National intranet. Another method is to develop a national intranet that is controlled solely by the government and that limits all contact with the global Web. China has been trying to wall itself off from international cyberspace and to develop an intranet for Chinese speakers governed by the authorities using the Chinese language only; this system is called the "169 network" (Franda, 2002, p. 198). In contrast, in more democratic Turkey, a small number of conservative members of the Turkish parliament advocated developing such a closed national intranet, but the proposal lacked public support, and the government refused to act on it, preferring instead an open Internet (Wolcott, 1999, p. 59).

Governments thus have an assortment of policies that they can employ to hinder the spread of the Internet. Some types of governments will be more able to use these policies than will others. Most democratic governments, for instance, could not employ many of these strategies without violating basic civil and political rights and, hence, facing enormous public resistance. Comparisons of the filtering done by the U.S. government relative to that by autocratic ones, like Saudi Arabia and China, show the latter to be much more involved in such activities (Zittrain & Elman, 2002). Elected democratic leaders trying to adopt these policies would face near certain eviction from office and probably legislative and judicial pressure to desist. Democratic governments can thus credibly commit to not adopting many of these policies, leaving private actors more willing to invest in and spread new technologies.

Autocratic governments, on the other hand, seem perfectly capable of most of these policies. They thus have tools for impeding the growth of the Internet that democratic countries do not. Moreover, autocracies have fewer ways to credibly commit to not adopting such policies now or in the future (Wintrobe, 1998, pp. 25-27). Hence, in addition to the stultifying effect these

policies have on technological change, they also face the problem of getting private actors to invest in and spread new technologies. Thus, on average, autocratic countries are likely to have less penetration by the Internet as a result of their greater desire to squelch it, their superior ability to do so, and their lack of ability to commit not to do so. By motivation and capacity, democratic governments will be less able to impede it.

Empirical Analysis

What factors have caused the spread of the Internet? In particular, does a country's regime type affect its adoption of Internet technology? The primary sources of evidence are two measures of Internet diffusion: the number of Internet hosts and users per capita among roughly 200 countries from 1991 to 2001. The main data here are collected by the World Bank in its 2001 *World Development Report* on the number of Internet users (INTUSERS), which is taken from the International Telecommunications Union (ITU; http://www.itu.org). INTUSERS measures the number of people with access to the worldwide network; these are not just subscribers to ISPs, nor are they actual users. I supplement the World Bank data on users with data from the ITU for 2000 and 2001. This is normalized by a country's population, per 10,000 inhabitants. Second, I use the number of Internet hosts (HOSTS), or computers with active IP addresses connected to the Internet, as collected by the Internet Software Consortium (http://www.isc.org).[6] I normalize HOSTS by a country's population, per 10,000 inhabitants.[7] Summary statistics for all variables are in Table 1.

To test the relationship between regime type and Internet diffusion, I use negative binomial regressions, in particular conditional, fixed-effects, overdispersion models.[8] The inclusion of country fixed effects has a similar effect

6. The Internet Software Consortium (ISC) ran an electronic survey pinging all Internet hosts 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. (See the ISC Web site for an extensive discussion of the survey methodology and its problems.)

7. A problem with using the 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 a host is. Assigning each host to a country can be tricky. I follow others who use the simple rule that the two-letter International Organization for Standardization country code *Top Level Domain* identifies where the host is actually located, but this is not always the case. The data for the number of users are probably more reliable as a measure of Internet adoption than are the data for the number of hosts.

8. In an earlier version, I explore the cross-sectional evidence for a relationship between regime type and Internet diffusion (Milner, 2003). Democracy was always positively and significantly related to greater Internet penetration in the cross-sectional models. This was useful

Table 1
Summary Statistics for Regressions

Variable	Obs.	Mean	Standard Deviation	Minimum	Maximum
USERS	1443	380.49	854.74	0.00	6866.20
HOSTS	1528	60.19	198.75	0.00	2171.90
POLITY	1562	2.60	7.00	–10.00	10.00
DEM	1812	0.54	0.50	0.00	1.00
POLRITES	2027	3.52	2.22	1.00	7.00
LNGDP PC	2036	7.58	1.55	4.44	10.98
LN POP	2276	15.35	2.06	9.85	20.96
URBAN	2398	53.68	23.97	5.20	100.00
PHONES	2139	172.83	193.86	0.30	869.80
AV HOSTS	1910	59.32	46.67	7.43	150.25
US HOSTS%	1910	0.07	0.01	0.07	0.08
AV USERS	2866	264.23	297.94	7.81	927.13
US USERS%	2627	0.06	0.03	0.03	0.11
PRIVTZN	2866	0.21	0.41	0.00	1.00
YEAR	2866	1995	3.45	1990	2001

to first differencing the data, except that the differences are calculated from the country means. This means that the cross-sectional elements of the data are eliminated; the analysis concerns longitudinal changes within countries. Any variable that does not vary within a country over time is eliminated from the analysis. Hence, the time-series cross-sectional (TSCS) analysis differs significantly from a cross-sectional one. All right-hand-side variables are lagged one period. The TSCS models address the question of what drives a country's pattern adopting new technology over time. I use a negative binomial regression to estimate these models because the dependent variables are counts of hosts and of users per capita. These counts 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, which can handle nonlinear functional forms better. I choose the latter because goodness-of-fit tests rejected the Poisson model.[9]

because it allowed one to examine the impact of slowly changing variables (structural ones) that differentiate among countries. However, a more thorough investigation requires a time-series cross-sectional analysis; by adding a time-series element, one is better able to make claims about causality.

9. The Poisson distribution has a special, restrictive assumption that the variance is equal to the mean. Often, this condition is violated, and then, other models, such as the negative binomial,

These regressions include controls for a country's size (log of population [LNPOP]), its level of development (log of GDP per capita [LNGDP_PC]), its urban density (percentage living in urban areas [URBAN]), and its political institutions as the baseline model.[10] Adoption of an innovation tends to be correlated with the potential adopter's wealth, education, and propensity for risk taking (Morrill, Gaile, & Thrall, 1988, p. 52). Wealthier countries should have a greater demand for and supply of the new technology. Urbanization also matters because urban centers are wealthier generally. Earlier studies, for example, have shown that the diffusion of the television in Poland predominated in the richest and most urban parts of the country (Loboda, 1974). Both Hargattai (1999) and Norris (2001) show that a country's level of economic development is critical for explaining its level of Internet connectivity. These variables are thus important controls.

I employ three measures of regime type for the sake of robustness. *POLITY* refers to the Polity IV dataset measuring regime type on a scale from –10 for complete autocracies to 10 for full democracies (Marshall & Jaggers, 2001). This index combines data on five factors that capture the institutional differences between democracies and autocracies: (a) the competitiveness of the process for selecting a country's chief executive, (b) the openness of this process, (c) the extent to which institutional constraints limit a chief executive's decision-making authority, (d) the competitiveness of political participation within a country, and (e) the degree to which binding rules govern political participation within it. Following Gurr, Jaggers, and Moore (1989) and Jaggers and Gurr (1995), these data are used to create an 11-point index of each state's democratic characteristics (DEMOC) and an 11-point index of its autocratic characteristics (AUTOC). The difference between these indices (POLITY = DEMOC – AUTOC) yields a summary measure of regime type that takes on values ranging from –10 for a highly autocratic state to 10 for a highly democratic one.

I also use two other democracy indicators to show how robust the findings about democracy are. DEM is taken from Przeworski, Alvarez, Cheibub, and Limongi (2000) and measures regime type as a dichotomous variable, with democracy being 1 and 0 otherwise. This measure codes a regime as democratic if and only if high political offices are chosen through fair and free con-

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which assume only that the variance is somehow proportional to the mean, are preferable. The negative binomial is preferred to the Poisson when two key assumptions of the latter are likely to be violated: that events accumulating during the observation period are independent and that they have a constant rate of occurrence (King, 1989, p. 51). As shown later, strategic interaction is occurring, and accelerating adoption at times is prevalent. Both of these facts call into question the validity of Poisson models, suggesting a preference for the negative binomial one.

10. The first three are from the World Bank's World Development Indicators.

tested elections where alternation of leaders occurs. POLRITES is a measure of political liberties taken from Freedom House (2000); it ranges from 1 to 7, with 7 being the least democratic. To code the political-rights variable, Freedom House considers to what extent the system offers voters the opportunity to choose freely from among candidates in competitive elections and to what extent the candidates are chosen independently of the state. In countries where the military, the monarchy, or an unelected dictator retains a significant political role over elected leaders, these are also coded as undemocratic. Note that this variable runs opposite the other two: Higher number of POLRITES indicates less democracy, and thus, we expect a negative sign here. These three measures then comprise a wide variety of meanings and codings for democracy.

I also examine the impact of other variables. Government policy toward the telecommunications sector can affect the Internet's spread. Policies regarding government control over and intervention in telecommunications sector, as well as licensing, taxation, subsidization, foreign investment, access control, infrastructure investment, and standards setting in this sector, are of particular importance. Different governments will make different choices about these policies and, in doing so, will affect the rate of Internet adoption (e.g., Franda, 2002; Kogut, 2003; Petrazzini & Guerrero, 2000). In particular, the privatization of the telecommunications industry may matter. I include a variable (PRIVTZN) for the period in the 1990s over which a country's telecommunications systems was privatized. More privatization should lead to greater Internet use as competition rises and prices fall. In addition, I include the state of the preexisting telecommunication infrastructure (proxied by the number of telephone lines per capita [PHONES]), the role of American hegemony in Internet technology (the percentage of global users or hosts that are American [US USERS and US HOSTS]), and the extent of global diffusion of the technology (the average number of users or hosts in the rest of the world [AV USERS and AV HOSTS]). Past innovations and how successfully they were adopted may shape the environment for future innovations (e.g., Moss & Townsend, 1998, 2000); hence, controlling for the telecommunications infrastructure is important. Furthermore, the adoption of new technology is likely to depend on the diffusion of that technology from the leading innovator, which is the United States. The level of violent conflict that a country is experiencing may also matter for explaining the adoption of new technologies. Countries involved in wars, whether international or civil, should be less likely to adopt, because their capital spending and investment and their attention are diverted to winning the war not to adopting new civilian technology. These variables provide controls for the most important alternative explanations for the spread of the Internet.

Tables 2 and 3 present results from the TSCS analysis. The dependent variable in Table 2 is the number of Internet users per 10,000 inhabitants. The results in Table 2 for the number of users strongly support the regime-type argument. More democratic governments promote the faster spread of the Internet. As countries become more democratic, the number of users rises. This regime effect is true for all three measures of democracy. The result is substantively important as well. A one-unit rise in democracy, holding all other variables at their mean in Equation 3 in Table 2, leads to a 1.03 increase in the incidence rate of Internet users in a country. The democratic advantage endures even when controlling for many of the alternative factors that drive technological change.[11]

Countries with higher per capita incomes and those with more urbanization have more users. The population variable is always positive and significant for the TSCS; bigger countries foster more Internet users. The existing telecommunications infrastructure (telephone lines per capita) has a positive effect. Oddly, privatization is not beneficial for adoption. American dominance of the Internet lowers the number of users elsewhere, but this may reflect the fact that U.S. dominance has been declining over the 1990s and the number of users elsewhere has been rising. Indeed, the time-trend variable had to be dropped from this equation because it was extremely highly correlated with U.S. hegemony ($r = .90$). Finally, the global-diffusion variable is positive and significant. More users elsewhere promote more users at home. War was never significant.

Table 3 reveals that regime type plays an important role in influencing the number of hosts per capita as well. More democratic countries have more hosts per inhabitant. This result is true using any of the three democracy measures. Regime type has an important effect. A one-unit increase in democracy leads to a 1.03 increase in the incidence rate of Internet hosts per capita, holding all the variables at their means in Equation 3 in Table 3. This result holds up despite the inclusion of a wide variety of controls.[12] As with the number of users, larger countries also have more hosts. Urbanization has a weaker but still positive effect. A country's development level is now negatively, but more weakly, related. Previous research indicated that a central element necessary for the Internet is a high urban population and an extensive telecommunications network (e.g., Goolsbee & Klenow, 1999; Kiiski & Pohjola, 2002) and that research is supported here. Privatization had no durable impact, nor did conflict. American dominance of the Internet now has a

11. All regressions in Table 2 were also run with a lagged dependent variable; the results for the regime variables did not change.

12. The regressions in Table 3 were also conducted using a lagged dependent variable; the results for the regime variables did not change.

Table 2
Time-Series Cross-Sectional Regressions on Internet Users

	Internet Users per 10,000 Inhabitants					
Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
POLITY	0.038*** (0.007)	0.040*** (0.008)	0.032*** (0.007)	0.033*** (0.008)		
DEM					0.431*** (0.107)	
POLRITES						–0.113*** (0.022)
LNGDP PC	0.172*** (0.050)	0.074 (0.068)	0.147*** (0.052)	0.144*** (0.052)	0.215*** (0.052)	0.150*** (0.047)
LNPOP	0.107*** (0.032)	0.108*** (0.031)	0.095***(0.032)	0.096*** (0.031)	0.061** (0.027)	0.081*** (0.024)
URBAN	0.011*** (0.003)	0.011*** (0.003)	0.011*** (0.003)	0.011*** (0.003)	0.010*** (0.003)	0.009*** (0.003)
YEAR	0.465*** (0.007)	0.453*** (0.009)				
PHONES		0.001** (0.000)				
AV USERS			0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
US USERS%			–34.65*** (1.732)	–35.08*** (1.752)	–33.80*** (1.630)	–35.37*** (1.568)
PRIVTZN				–0.101* (0.060)		
Constant	–930.90*** (14.719)	–906.1*** (18.065)	–1.70*** (0.585)	–1.68*** (0.582)	–1.77*** (0.498)	–0.856* (0.464)
n	1,085	1,071	1,085	1,085	1,142	1,309
Countries	139	139	139	139	168	170
Log likelihood	–4,115.39	–4,057.36	–4,130.01	–4,128.62	–4,059.43	–5,001.50
Wald chi-square	5856	6008	5410	5424	5013	6306
Prob. > chi-square	0.00	0.00	0.00	0.00	0.00	0.00

Note: Negative binomial regression (XTNBREG in STATA 8.1) with country fixed effects. All independent variables lagged one period except for YEAR, AV USERS, and US USERS as percentage of world. Standard errors in parentheses.
*p = .1. **p = .05. ***p = .01.

Table 3
Time-Series Cross-Sectional Regressions on Internet Hosts

	Internet Hosts per 10,000 Inhabitants					
Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
POLITY	0.039*** (0.013)	0.032** (0.016)	0.032** (0.013)			0.031** (0.013)
DEM				0.640*** (0.202)		
POL RITES					–0.116*** (0.034)	
LNGDP_PC	0.058 (0.088)	–0.232** (0.113)	–0.006 (0.083)	0.031 (0.091)	0.022 (0.076)	–0.013 (0.083)
LNPOP	0.109* (0.065)	0.121** (0.059)	0.129** (0.055)	0.268*** (0.044)	0.334*** (0.038)	0.132** (0.056)
URBAN	0.005 (0.005)	0.002 (0.005)	0.003 (0.005)	0.014** (0.006)	0.005 (0.004)	0.003 (0.005)
YEAR	0.405*** (0.008)	0.380*** (0.010)				
PHONES		0.002*** (0.001)				
AV HOSTS			0.017*** (0.000)	0.021*** (0.001)	0.017*** (0.000)	0.017*** (0.000)
US HOSTS%			38.66*** (4.082)	12.97*** (4.426)	37.72*** (3.800)	37.74*** (4.099)
PRIVTZN						0.106 (0.071)
Constant	–810.07*** (16.727)	–757.02*** (19.561)	–4.60*** (1.093)	–6.23*** (0.816)	–7.85*** (0.728)	–4.60*** (1.094)
n	1,061	1,048	1,061	1,154	1,325	1,061
Countries	137	137	137	167	169	137
Log likelihood	–1,774.32	–1,748.58	–1,877.88	–1,778.53	–2,292.45	–1,877.85
Wald chi-square	3,436	3,592	2,334	2,569	2,844	2,335
Prob. > chi-square	0.00	0.00	0.00	0.00	0.00	0.00

Note: Negative binomial regression (XTNBREG in STATA 8.1) with country fixed effects. All independent variables lagged one period, except YEAR, US HOSTS, and AV HOSTS. Standard errors in parentheses.
*p = .1. **p = .05. ***p = .01.

positive effect rather than the negative one on users. Finally, global diffusion pressures promote Internet development, as they did the number of users. After controlling for all of these influences, however, a country's regime type still matters.

Conclusions

This article investigates the factors that explain the geographic and temporal spread of the Internet. As an example of a new technology, the Internet seems to be following well-known patterns. Its *s*-shaped diffusion process and economic determinants are not surprising. But it is also clear that political factors matter. The Internet is being adopted at very different rates by different countries. Given that the technology is widely known and has large benefits, why have some countries not adopted as fast as others?

Following the New Institutional Economics literature, which stresses the importance of political institutions for economic growth, my argument is that political institutions play a large role in determining the spread of the Internet. Regime type is particularly important. Democracies adopt the Internet at a much faster pace than do autocracies. This result exists using various definitions of democracy and controlling for a large number of well-known alternative explanations.

All technological change creates groups that gain and those that lose from the change: its winners and losers. The political institutions in place either affect the ability of losers to block or slow down its adoption or enable winners to promote it. Governments have the capacity to affect the rate of technological change by making policies that shape the costs and benefits of its use, thus affecting both demand and supply for the technology. These policies can range over a wide gamut. Some institutions allow governments to block technological adoption by instituting such policies more easily than others. But governments must possess both the desire and the capacity to block technological change.

Autocrats, who tend to survive longer and to be less sensitive to economic problems than democratic governments, can fail to promote or can even block technological change that threatens them or their supporters. And the Internet can be very threatening as it complicates attempts to censor information, makes widespread sharing of that information more likely, and can even foster collective social action against the government that might previously have been impossible. I detail the many ways in which autocratic governments have tried to restrict the Internet. The chilling effect of these policies affects both users and suppliers of the technology. Restricting content, moni-

toring use, and policing users all make using the Internet less appealing as they raise its cost and lower its quality. Such policies reduce demand for the Internet and, in turn, make suppliers less likely to invest in the technology in the first place. The consequences of these policies are lower Internet use and slower Internet adoption.

This finding has two important implications. This behavior by autocracies lessens the integration of these countries into the world economy, and it slows down their economic development. It thus facilitates the prolongation, and perhaps deepening, of the digital divide. Political institutions and changes in them can affect the extent of the digital divide. In turn, the rate of technology adoption affects economic development. Hence, this research underscores that regime type can indirectly affect economic growth, with autocratic institutions tending to impede technological change and thus growth.

The adoption of technology, in this case of the Internet, has a clear political component. Both international and domestic political factors can affect its spread. One cannot explain the growth of the Internet, and perhaps of any other new technology, without considering such political variables. Political institutions matter for overcoming the digital divide. Democracy may indirectly spur economic growth through its salutary effect on technological change. Groups within democracies may desire to prevent or slow the adoption of disruptive new technologies, but they will find the institutional environment much less conducive to such plans than in autocratic systems. The spread of democracy around the globe may thus help reduce the digital divide and indirectly accelerate economic development.

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