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Position Statement: Sizing Up Information Societies—Towards a Better Metric for the Cultures of ICT Adoption

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ABSTRACT
When researchers study technology diffusion in a global and comparative manner, they often find that economic productivity explains differences in the diffusion of information and communication technologies (ICTs). But when researchers study technology diffusion in a regional, national or sub-national context, they often find that politics and culture explains different diffusion rates. How do we make use of different kinds of conclusions drawn from different levels of analysis? Just knowing the ways in which wealth explains technology diffusion can obscure the ways in which politics and culture also explain patterns in technology diffusion. In this research note, we offer a new perspective on weighting technology diffusion data by economic wealth to set into sharp relief the ways in which other factors—such as politics and culture—influence how well a country metabolizes new technologies. A simple but useful computation is offered, examples are assessed, and implications for public policy, industry and research are discussed.

KEYWORDS
Digital divide, technology diffusion, comparative methods, metrics

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INTRODUCTION

Why does technology adoption vary so widely around the world? It is surprisingly difficult to compare the different ways in which new computing and communications technologies are globally adopted. When researchers tackle this problem by studying particular countries and single national markets, they often find that features of telecommunications policy, the leadership of a few tech-savvy politicians, or some aspect of political or popular culture explain why people choose to rapidly adopt and adapt new technologies. When researchers do large scale quantitative studies, modeling technology adoption over many countries or several periods of time, they often find that differences in economic wealth accounts for which countries seem to have the highest rates of technology adoption. When different research methods on the same research question reveal different things, we need new approaches, or perhaps new questions.

Indeed, especially when one compares countries located at opposite ends of the economic development spectrum, the notion of a "digital divide" in access to digital communication technologies may sometimes be better described as a "digital chasm." While six out of every 10 people in the United States reported ever using the internet by 2005, only six out of every 100 people reported doing so in Indonesia, and only six out of every 10,000 people in Tajikistan reported doing so. Even though the common digital divide metrics are consistently critiqued, researchers use them anyway because they are convenient (Barzilai-Nahon, 2006; Kitsing & Howard, 2008). Here, we offer a perspective on how to make a simple mathematical transformation to such metrics to improve their analytical purchase.

A growing number of information society researchers are examining what causes this digital divide, assessing whether or not it is narrowing or widening, and determining what individual countries can do to improve their lot. While divergent findings occasionally emerge, it can be observed that a common approach has been adopted in order to quantify and thus evaluate the digital divide. Specifically, indices of the global diffusion of information and communication technologies (ICTs) have been utilized in ways that include assessing perceptions of a country's "network readiness," patterns of internet access and usage, or the costs of digital technologies for governments and consumers. Most have examined wealthier countries or a regional subset of countries while constructing either static models or ones that comprise only a few years of data at best.

Despite the known problems with digital divide data and the diffusional perspective, researchers continue to work with these indicators. Though significant insights have been generated from many of these studies, in this article we offer a way of moving beyond the diffusional perspective of technology adoption by weighting adoption trends by economic wealth. The primary finding of most digital divide research to date has been that economic wealth explains most of the variation in technology adoption around the world, yet researchers consistently work data about mobile phones, internet use, and computers that does not weight for country's economic wealth.

In this article, we indentify two challenges facing digital divide researchers. First, researchers doing local, qualitative research on technology diffusion often reach different conclusions from those doing international, quantitative research. Second, even though we know that economic wealth explains much of the variation in rates of technology adoption, researchers have yet to work with data that distinguishes such effects from the impact of political culture on technology adoption. Next, we suggest a simple computation that turns country data on technology adoption into a comparative index weighted for economic wealth. This isolates the impact of political culture on technology adoption—factors such as telecommunications policy, regulatory transparency, or the health of existing infrastructure. This index provides benchmarks for how high or low technology consumption is given economic productivity, and we call these benchmarks a Technology Distribution Index (TDI). Then, we assess the utility of this index through a short comparative analysis of four countries and conclude with an interpretation of the full range of values of computers, mobile phones, bandwidth and internet users for all countries (Howard, Busch, & Cohen, 2008).

THE CHALLENGE OF INTERNATIONAL COMPARISON

Technology adoption means different things in different parts of the world and simple counts of mobile phones per capita or internet users per capita do little to reveal the economic, political and cultural processes leading to adoption in each country (Barzilai-Nahon, 2006; Vehovar, Sicherl, Hausing, & Dolnicar, 2006). It is delineating how such processes have different outcomes in different parts of the world that intrigues many of us who study information societies. Some of the things that suppress the adoption of one technology may stimulate adoption of other technologies in a single country. Moreover, local and qualitative research tends to emphasize political and cultural explanations for technology adoption, while international and quantitative research privileges the economics of affordability. Local and ethnographic investigations of technology adoption reveal that forms of technological adoption occur for a variety of cultural and political reasons. In Iran, the uptake in blogging may be because a “disparate class of nonintellectuals deliberately undermines this authority by neglecting or flouting grammatical and orthographic standards and calling into question the linguistic and cultural authority of the intellectuals (Doostdar, 2004).” In India, mobile phone adoption may be occurring rapidly, but the reason for acquisition—the ability to “beep” without calling friends and family—may be culturally specific (Donner, 2007).

In some countries, political leaders see technology adoption as key to modernization and economic development. They develop national ICT strategies and devote public resources to building out the infrastructure needed to support consumer information technologies. Technology adoption is only meaningful in a comparative perspective: one country's telecommunications policy may only work there, and may not be usefully exported. Is adopting a smart phone the same things as adopting a mobile phone or a personal computer? A count of computers per capita does not reveal whether such technologies are individually owned, or collectively shared resources.

ICTs themselves are often cultural prestige items, and the symbolism of mobile phone ownership is very important in many parts of the world. But this alone may not explain high adoption rates. For example, ethnographic work in South Korea revealed that the latest mobile phone was adopted in a wide spread manner not because it was a prestige item, which maintained social distance, but that it was the new norm, which everyone had quite soon after its release. In this way, cultural expectations inform not only what is adopted, but the rate at which adoption takes place. In places like Singapore and Hong Kong, it dense urbanism explain how much new information technology is acquired every year. How ICTs enable rural-urban connections could have a significant impact on diffusion. For example, in some countries there are extensive rural-urban networks that create a need for full 'coverage', as it were, of people who have access to ICTs.

In some countries a flagship IT company leads innovation and introduces innovative new products to consumer electronics markets. Some countries are part of the network of IT manufacturing and remanufacturing, and so have a relatively cheap supply of IT goods. Other countries have little or no capacity to repair laptops and cellphones, much less manufacture semiconductors or technology components. A local technology champion—a successful IT startup, someone who rolls out technology for education, or a policy maker who champions broadband—can mean the difference between having a pool of ICTs with a population of sophisticated ICT users and having neither of these. Such a champion frames ICT-enabled growth as a public good. In other countries, the pressure for privatization and neoliberal policy reform has left the state incapable of leadership in this area, with ICT diffusion lead by private firms that have less interest in building the long-term information architecture of a country. Indeed, in comparing small sets of countries, slight variations in public policy and political environment can seem to have significant causal implications for technology adoption (Guillén & Suarez, 2001; Oyelaran-Oyeyinka & Lal, 2005).

THE RESEARCH DIVIDE ON THE DIGITAL DIVIDE

Whereas early research found that economic factors far outweigh others in determining a country's placement on the digital divide spectrum, more recent studies suggest that political and social variables also have significant though secondary explanatory traction (Howard & Mazaheri, 2009; Milner, 2006; Norris, 2001). Among the widely-cited large-N studies of late, the overall theme is that income, education, telecommunication infrastructure, and the state's regulatory system are all important determinants of where a country sits on the digital divide (Caselli & Coleman, 2001; Chinn & Fairlie, 2004). Dedrick et al. finds similar results in their study of 31 countries between 1985 and 1995, concluding that a country's economic structure, income level, telecommunication infrastructure and human capital best explain cross-national patterns of investment in ICTs (Dedrick, Gurbaxani, & Kraemer, 2003).[1] At the same time, literacy rates, core-periphery status in the world economy, and levels of "cultural cosmopolitanism" have sometimes found to be statistically significant predictors as well (Guillén & Suarez, 2005).

Contributing to these findings, Pohjola analyzed 49 countries between 1993 and 2000 and concluded that lacking an agricultural economy was important in predicting the amount of ICT investment in a country (Pohjola, 2003).[2] Kiiski and Pohjola also examined a panel of 60 countries over 1995 to 2000 and found relevance for the role of income, telephone access costs, and level of schooling on the number of internet hosts in a particular country (Kiiski & Pohjola, 2002). Mann and Rosen further point out in their study of 21 APEC countries that, over time, high access charges and a lack of political freedom is negatively associated with rates of internet diffusion (Mann & Rosen, 2001). In addition, Goolsbee and Klenow as well as Kiiski and Pohjola both conclude that a dense urban population and extensive telecommunication network are key factors behind the adoption of new technologies as well as being placed on the narrowing side of the digital divide spectrum (Goolsbee & Klenow, 2002).[3] Finally, several studies find that a country's degree of property rights protections and level of regulation of the telecommunication sector also matter (Chinn & Fairlie, 2004; Wallsten, 2005; Weber & Bussell, 2005).

Democracies may be more likely than autocracies to promote the spread of internet users and internet-related ICTs, as Milner's study of approximately 190 countries over the time period 1991 to 2001 shows (Milner, 2006). Important case studies in the literature have also offered many hypothesized causal paths regarding the relationship between democratic institutions and internet usage (Abbott, 2001; Everett, 1998; George, 2006; Hogan, 1999). At the same time, it is important to observe the fact that both democracies as well as dictatorships top the list of rates of growth for internet users, internet hosts, mobile phones, personal computers, and secure servers. Indeed, both democracies and dictatorships are also at the bottom of this list. Moreover, Johnson and McGlinchey's close examination of several Central Asian countries reveals that unstable democracies may actually be *more* likely to restrict internet service providers than confident authoritarian regimes (Johnson & McGlinchey, 2005). Similarly, Kalathil and Boas find that authoritarian regimes may significantly develop their digital communication infrastructure specifically as a means of extending the reach of the state (Kalathil & Boas, 2003).[4]

Understanding the impact of state telecommunications policy on national development is a relatively new area of inquiry. However, a debate has already emerged in regards to the role that privatization of the telecommunication sector can play in a country's adoption of new kinds of communication tools (Milner, 2006). Guillén and Suarez, with evidence from 61 countries between 1997 and 2001, argue that a country's level of internet use is associated with its level of privatization and competition in the telecommunication sector (Guillén & Suarez, 2005). In addition, Wallsten finds that certain characteristics of regulatory regimes—such as agency independence, transparency, and discretion—can explain the growth of internet users and internet hosts in 45 countries in 2001 (Wallsten, 2005). Yet with time-series analysis, Howard and Mazaheri demonstrates that the common ways of reforming the telecommunications sector have had a very mixed record of improving technology diffusion (Howard, 2007; Howard & Mazaheri, 2009).

While digital divide research has consistently found that economic wealth explains the distribution of technologies around the world, we remain most interested in factors other than economic wealth. Yet, we also remain wedded to measures that obfuscate the role of politics and culture in explaining technology adoption. In other words, even though scholars are interested in understanding how politics and culture may have an impact on technology adoption, we have yet to meaningfully isolate these effects in a comparative manner. In this way there is a significant gap between our research interests and our ability to compare the impact of politics, policy, or culture—things other than economic wealth— on technology diffusion.

CONCEPTUALIZING AND MEASURING TECHNOLOGY DISTRIBUTION

To better weight for the impact of economic wealth and isolate the impact political culture on technology diffusion, we formulated a Technology Distribution Index (TDI). This index relates the number of Internet users to the GDP of each country in a way that allows us to identify, for example, countries where the number of internet users is more or less than what would be expected in relation to the GDP of that country. For instance, countries with a lower GDP may have surprising numbers of computer, mobile phone, and internet users, while countries with high levels of GDP may have fewer such users.

This index is created through a ratio of two ratios. First, we calculate a ratio of a country's economic output to the output of all countries in a given year. Then we calculate a ratio of a country's technology use to the technology use of all countries in a given year. The ratio of these two ratios reveals whether a country has about the proportion of ICTs it should have given its economic productivity. Expression A gets at whether a country's supply of information technology, in this case personal computers, is in balance with its share of global economic product.

Expression A: Ratio of Two Ratios

$$Ratio\ of\ Ratios = \frac{PC_{country} \div PC_{world}}{GDP_{country} \div GDP_{world}}$$

Half the distribution of possible values from this ratio of ratios ranges from 0 to 1 (a disproportionately small share of computers in a country given its GDP) and the other half ranges from 1 to +infinity (a disproportionately large share of computers in a country given its GDP). However, by taking the natural log of the ratio of ratios the index will become more balanced: from -infinity to 0 becomes less than proportionate share, and from 0 to +infinity becomes more than proportionate share.

Expression B: Technology Distribution Index Value

PC country PC TMI ln world T GDP GDP country GDP world y

Expression B creates a value for how far above or below a country is from the global norm of technology diffusion and economic productivity in a given year. Computing such values for all the countries in the world yields an index of how far each country is from this grand mean. Appendix A offers TDI values for as many countries as possible, for the distribution of computers, mobile phones, internet bandwidth, and internet users in 2006, and the full dataset for all years is available online at www.wiareport.org.

The number of personal computers in a country is reported by national telecommunications agencies to the International Telecommunications Union.[5] Cellular mobile telephone subscribers refers to the number of users of portable telephones subscribing to an automatic public mobile telephone service. Internet bandwidth capacity is a measure of the amount of data that users can transfer over an internet connection, and is valued at mega bits per second. If the incoming speed is different from the outgoing speed, the outgoing speed is used. The national count of internet users is usually estimated by national service providers, and is the best estimate of the size of the population able to access and use the internet in a country. Internet users refers to the number of people that have used the internet at any point in time during a specific year.[6] To weight these five indicators for economic productivity, we use the annual GDP PPP at constant price so as to account for inflation rates in international comparison.

Discussion—Using the TDI in Country Case Comparisons: Brazil, China, India and the United States

This form of indexing can bring to light interesting points of comparison and contrast between countries and technologies. Figure 1 reveals the changing TDI values for internet users in Brazil, China, India and the United States from 1995-2006. This figure reveals that over time, even as more and more internet users come online, it is possible to distinguish the relative distribution of internet users. In an important way the TDI also provides a metric of how the digital divide between these countries has closed over time. The proportion of the global supply of internet users has become more equitably distributed, when each country's proportion is weighted by the size of their economy. In the late 1990s the United States had significantly more internet user than would be expected—even considering the size of that country's economy—because the ICT consumer markets were so well developed. Over time the gap between the United States and India, Brazil and China has closed. But by 2006, Brazil was the country with a surprisingly high number of internet users, even considering the rapid per capita adoption of technologies in India and China. Indeed, as country TDI values move towards 0, the distribution of internet users becomes more equitable when considering economic productivity.

FIGURE 1 ABOUT HERE

Discussion—Using the TDI in Larger Quantitative Comparison

Appendix A identifies the Technology Distribution Indicators for all countries for 2006. The ranges are, for the most part, between the values of negative nine and positive five: the more negative the TDI value means that the country has fewer internet users than would be expected given its GDP. On the other hand, a more positive value means that the country has more internet users than would be expected given its GDP. This process was repeated for three more variables tracked by the World Bank: the number of personal computers in each country, the number of mobile phones in each country, and the international internet bandwidth measured as the data transfer rate for each country.

The TDI allows digital divide researchers to compare the technology adoption rates, relative to global or regional averages, and identify the countries that are adopting at higher or lower rates than expected. And doing so reveals the relative importance of the political and cultural aspects of technology diffusion. Countries at the bottom of the index are ones which, given their economic wealth, one would expect a greater proportion of the global supply of information technology than what is currently present. The countries with the most negative values, far from 0.00 and the index mean, are countries that should have much higher levels of ICT adoption given their even meager economic wealth. Countries in the middle of this index, with values around 0.00 and the index mean, are countries in which the proportion of information technology is reasonably matched with their annual economic productivity. Countries at the top of this index, with positive values well above 0.00 and the index mean, have significantly larger shares of global ICT supply than expected given their economic wealth.

For example, our greatest TDI value for Internet users was for Zimbabwe, a value of 2.90. This value means that this country has an amount of Internet users that is significantly greater than what is to be expected given its GDP. Equatorial Guinea, on the other hand, has a TDI value of negative 3.46, far less than our previously expected negative four to positive four scale. This means that Equatorial Guinea has considerably less Internet users than what we would normally extrapolate from a GDP of its size. Zero serves to be the establishing point at which the number of Internet users is exactly what would be assumed by the country's GDP. Therefore, countries such as Cuba or Myanmar, with TDIs near zero, have the proportion of internet users that would be expected.

TABLE 2 ABOUT HERE

Over time, the amount of data on computers, mobile phones, internet bandwidth and internet users has improved, such that by 2006 there is complete data on around 200 countries. The average values for the pool of countries (different each year) also reveal interesting things about the development of a global information society. The rapid rise in global TDI averages for internet users and mobile phones suggests that the digital divide is closing rather rapidly, considering how relatively well distributed users and phones are, relative to economic size. Between 1995 and the present the global average TDI value for computers increased somewhat, and given that the data on computer distribution goes back to 1990 this too is perhaps not so surprising. Yet the relative distribution of internet bandwidth has declined over time—and was at its lowest values at the turn of the millennium. Thus, these TDI values serve as a meaningful benchmark of the inequity of bandwidth distribution among the world's economies. Such a conclusion is borne out by the consistently negative high and low values for internet bandwidth.

With the addition of multiple variables, the average of TDI values was taken for each country in order to calculate a new TDI value that incorporates all the variables we considered.

CONCLUSION

Researchers are slowly rising to the multiple challenge of finding better ways to size up information societies (Menou & Taylor, 2006). The TDI method offered here allows researchers to define the universe of cases in a way that is relevant for their set of comparisons, is flexible enough to be used for several different kinds of ICTs and ICT-related phenomena, and can be used for multiple data sources even with incomplete data on all countries. The advantage of indexing countries this way is that doing so reveals which countries adopt technologies at higher rates than GDP alone would predict. Ultimately, this simple computation allows for a more appropriate "sizing" of information societies: the aspects of political culture that either drive up or slow down technology adoption.

Understanding the causes and consequences of the digital divide through this kind of weighted index is important for several reasons. First, it allows a closer mapping of the particular impacts of telecommunications policy reform on technology adoption in a country, allowing policy making bodies to shape policies more appropriately. Second, ICT industries that rely solely on economic data will make marketing decisions without a full understanding of the opportunities and roadblocks that may arise through the political culture of the country in which they hope to operate.

This way of indexing information societies has several advantages over raw counts of ICTs per capita. While there are measures of government transparency and ICT policy maturity, this index allows for a weighting of these as a technology adoption outcome. In some countries, active state regulation seems to have created burdens on business and citizens that discourage technology adoption; while in other countries, active state regulations seems to have resulted in higher technology adoption. In this way, the bureaucratic state can either enable or constrain technology adoption. Similarly, in some countries corruption sets up roadblocks (with tolls!) while in others, it enables charismatic leaders to quickly roll out projects. This index allows for a benchmark of the impact of variations of political culture.

Second, this way of indexing sets into sharp relief countries that are rapid technology adopters, even when they are poor. Often the United States is considered an important market for the large number of people who have sufficient income and technology fetishes to spend money on acquiring new innovations in consumer ICT products and services. China and India are considered large important markets for similar reasons—most importantly for their size. But holding economic wealth constant actually reveals that the United States is not the rapid adopter that some other countries are. Most important, economic size can obscure the set of smaller countries that adopt technologies at unusually high rates.

Fourth, it is possible to adjust the outer boundaries of the comparison set. The TDIs presented in Appendix A were computed using the sum of global ICT supply and the sum of Global GDP. If a researcher was interested in OECD countries alone, or in comparing countries within Sub Saharan Africa, the index could be computed with the total supply of ICTs or GDP for the group. This would yield different values for a researcher who thought these particular comparison sets meaningful for their argument.

Understanding technology diffusion in particular countries often means explaining the things that make a country a unique case of either rapid or halting technology use relative to that country's neighbors. We have argued that the best way to assemble—indeed reconcile—local and qualitative research with international and quantitative research on the digital divide is through this mid-level comparative perspective.

TABLES AND FIGURES

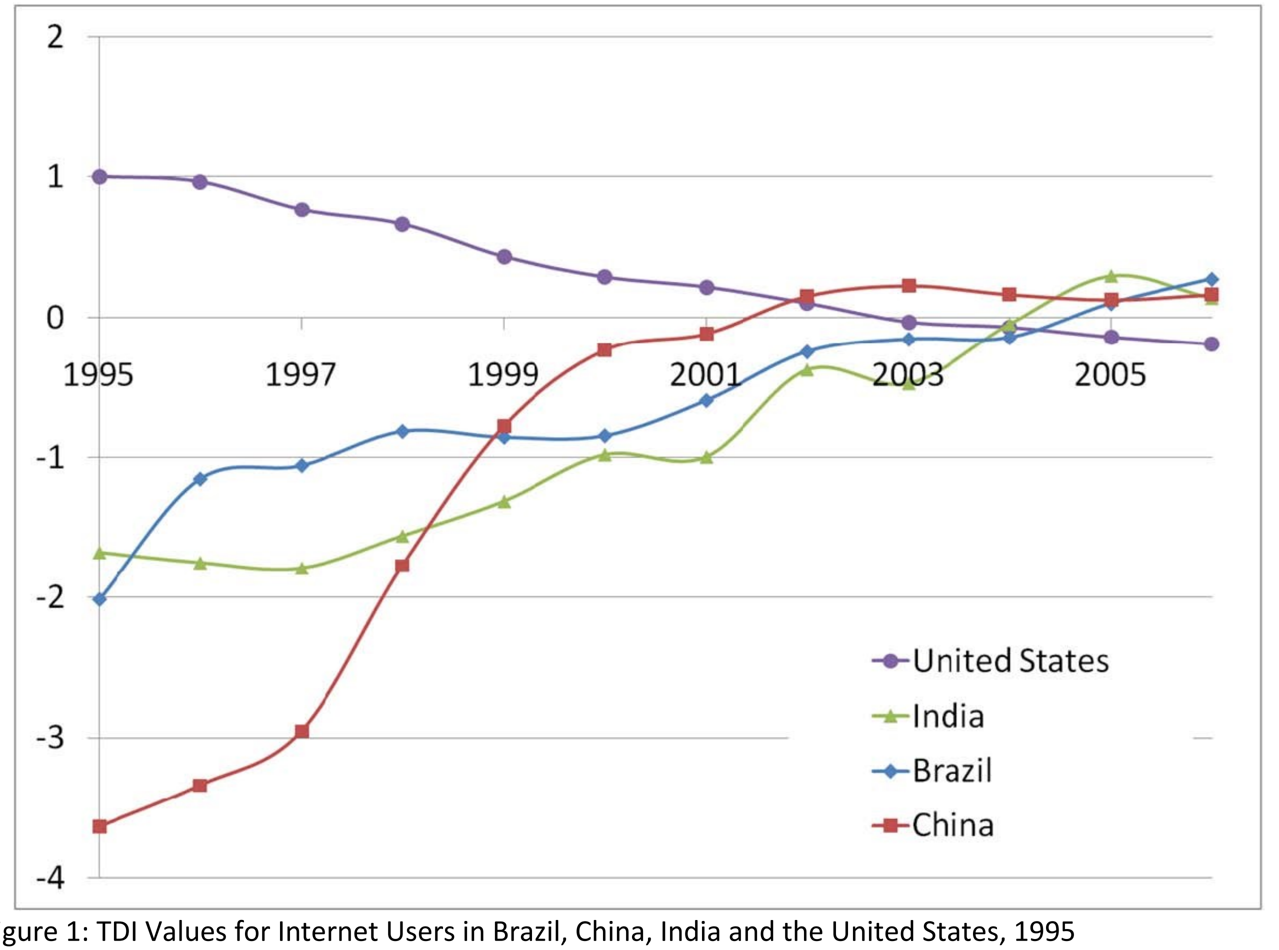

Figure 1: TDI Values for Internet Users in Brazil, China, India and the United States, 1995

Source: Authors' calculations based on data from the World Bank's World Development Indicators (2008).

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Change
N of Countries Computers Mobile Phones Bandwidth Internet Users	 162 167 68 185	 182 186 92 198	 187 190 149 205	 189 196 168 207	 199 198 202 206	 197 200 202 207	 198 200 202 207	 200 203 202 207	 202 206 204 206	 201 207 203 205	 201 207 198 204	 201 206 196 203	 39 39 128 18
Average Values Computers Mobile Phones Bandwidth Internet Users	-0.69 -1.04 -0.14 -1.77	-0.5 9 -1. 130.2 3 -1. 65	-0.5 3 -0. 96 -1 .66 - 1.37	-0.5 5 -0.97 -1.81 -1.27	-0.55 -0.89 -1.49 -1.00	-0.57 -0.73 -2.23 -0.88	-0.57 -0.48 -2.56 -0.76	-0.51 -0.33 -2.24 -0.60	-0.45 -0.20 -2.15 -0.42	-0.5 0 -0. 07 -2.11 -0.3 7	-0.4 4 0.01 -1.78 -0.30	-0.43 0.04 -1.47 -0.25	0.26 1.08 -1.34 1.52
Maximum Values Computers Mobile Phones Bandwidth Internet Users	0.69 1.38 5.29 1.83	1.18 1.28 4.98 1.40	1.08 1.20 2.12 1.27	1.00 1.08 2.11 1.09	1.04 0.97 2.42 0.87	1.04 0.96 2.30 1.14	1.00 1.08 2.23 1.39	1.01 1.24 2.63 1.40	1.89 1.27 2.32 2.01	2.32 1.42 2.48 2.35	2.75 1.57 3.18 2.77	2.82 1.65 3.12 2.90	2.13 0.26 -2.17 1.07
Minimum Values Computers Mobile Phones Bandwidth Internet Users	-5.11 -7.03 -5.96 -7.90	-4.8 1 -5. 21 -5 .41 - 7.48	-3.3 5 -5. 78 -7 .75 - 6.72	-3.5 9 -4.71 -9.25 -7.18	-3.67 -5.11 -6.25 -7.66	-3.21 -4.48 -7.31 -8.06	-3.47 -4.44 -8.33 -7.71	-3.38 -3.23 -8.21 -7.63	-3.21 -2.96 -7.22 -3.85	-3.3 0 -2. 99 -6 .88 - 3.99	-3.1 4 -3.22 -6.90 -3.52	-3.17 -3.39 -6.94 -3.46	1.93 3.64 -0.97 4.44

Countries	*Computers*	*Mobile Phones*	*Internet Bandwidth*	*Internet Users*	*Average*
AfghanistanAlbania	-1.26 -1.62	0.84 0.59	-6.31 -4.96	0.16 0.28	-1.64 -1.43
AlgeriaAmerican Samoa	-2.18	0.78 0.00	-4.82	-0.50	-1.68 0.00
Andorra Angola	 -2.28	-0.86 -0.39	0.31 -3.56	-1.08 -2.80	-0.54 -2.26
Antigua and BarbudaArgentina	-0.53 -0.68	0.48 0.39	2.39 -0.46	0.18 -0.09	0.63 -0.21
Armenia Aruba	0.32 0.00	-0.74 0.00	-2.98 0.00	-0.48 0.00	-0.97 0.00
Australia Austria	0.36 0.13	-0.53 -0.38	1.27 0.69	0.08 -0.31	0.30 0.03
AzerbaijanBahamas, The	-1.39 0.00	0.32 0.00	-2.79 0.00	-0.21 0.00	-1.02 0.00
BahrainBangladesh	-1.05 0.28	-0.24 0.85	-1.72 -2.58	-1.11 -2.03	-1.03 -0.87
BarbadosBelarus	-3.17 -2.87	-2.66 0.33	-2.30 -1.54	-2.05 1.11	-2.55 -0.74
BelgiumBelize	-0.27 0.18	-0.51 0.11	1.29 -0.17	-0.34 -0.27	0.04 -0.04

Table 2: Descriptive Statistics for the Global TDI Values for Computers, Mobile Phones, Internet Bandwidth and Internet Users

Source: Authors’ calculations based on data from the World Bank’s World Development Indicators (2008).

References

Abbott, J. (2001). Democracy@Internet.Asia? The Challenges to the Emancipatory Potential of the Net: Lessons from China and Malaysia. *Third World Quarterly, 22*(1), 99-114.

Barzilai-Nahon, K. (2006). Gaps and Bits: Conceptualizing Measurements for the Digital Divide/S. *The Information Society, 22*(5), 269-278.

Caselli, F., & Coleman, W. J. (2001). *Cross-Country Technology Diffusion: The Case of Computers*. Cambridge, MA: National Bureau of Economic Research.

Chase, M., & Mulvenon, J. (2002). *You've Got Dissent! Chinese Dissident Use of the Internet and Beijing's Counter Strategies*. Washington, DC: Rand.

Chinn, M. D., & Fairlie, R. W. (2004). *The Determinants of the Global Digital Divide: A Cross-Country Analysis of Computer and Internet Penetration*. Madison, WI: Social Systems Research, Institute University of Wisconsin.

Dedrick, J., Gurbaxani, V., & Kraemer, K. (2003). Information Technology and Economic Performance: A Critical Review of Empirical Evidence. *ACM Computing Surveys, 35*(1), 1-28.

Donner, J. (2007). The Rules of Beeping: Exchanging Messages Via Intentional "Missed Calls" On Mobile Phones. *Journal of Computer Mediated Communication, 13*(1).

Doostdar, A. (2004). The Vulgar Spirit of Blogging: On Language, Culture, and Power in Persian Weblogestan. *American Anthropologist, 106*(4), 651-662.

Everett, M. (1998). Latin America on-Line: The Internet, Development, and Democratization. *Human Organization, 57*(4), 385-393.

George, C. (2006). *Contentious Journalism and the Internet: Towards Democratic Discourse in Malaysia and Singapore*. Seattle: University of Washington Press.

Goolsbee, A., & Klenow, P. (2002). Evidence on Learning and Network Externalities in the Diffusion of Home Computers. *Journal of Law and Economics, 45*(2), 317-343.

Guillén, M., & Suarez, S. (2001). Developing the Internet: Entrepreneurship and Public Policy in Ireland, Singapore, Argentina, and Spain. *Telecommunications Policy, 25*, 349-371.

Guillén, M., & Suarez, S. (2005). Explaining the Global Digital Divide: Economic, Political and Sociological Drivers of Cross-National Internet Use. *Social Forces, 84*(2), 681-708.

Hogan, S. (1999). To Net or Not to Net: Singapore's Regulation of the Internet. *Federal Communications Law Journal, 51*(2), 429-446.

Howard, P., Busch, L., & Cohen, S. (2008). ICT Diffusion and Distribution Dataset, 1990-2007. *ICPSR Public Dataset #9908*.

Howard, P. N. (2007). Testing the Leap-Frog Hypothesis: Assessing the Impact of Extant Infrastructure and Telecommunication Policy on the Global Digital Divide. *Information, Communication & Society, 10*(2), 133-157.

Howard, P. N., & Mazaheri, N. (2009). Telecommunications Policy and the Adoption of Information and Communication Technologies. *World Development, 37*(3).

Johnson, E., & McGlinchey, E. (2005). Digital Divide in Central Asia: Comparing Isp Policy. *Midwest Political Science Association*.

Kalathil, S., & Boas, T. C. (2003). *Open Networks, Closed Regimes: The Impact of the Internet on Authoritarian Rule*. Washington, DC: Carnegie Endowment for International Peace.

Kiiski, S., & Pohjola, M. (2002). Cross-Country Diffusion of the Internet. *Information Economics and Policy, 14*(2), 297-310.

Kitsing, M., & Howard, P. N. (2008). *From Dirt Roads to Information Highways: The Challenges of Measuring Information Societies*. Seattle: University of Washington.

Mann, C. L., & Rosen, D. H. (2001). *The New Economy and Apec*. Singapore: APEC Secretariat.

Menou, M. J., & Taylor, R. D. (2006). A “Grand Challenge”: Measuring Information Societies. *The Information Society, 22*(5), 261 -267.

Milner, H. (2006). The Digital Divide: The Role of Political Institutions in Technology Diffusion. *Comparative Political Studies, 39*(2), 176-199.

Norris, P. (2001). *Digital Divide: Civic Engagement, Information Poverty, and the Internet Worldwide*. New York: Cambridge University Press.

Opennet Initiative. (2005). *Internet Filtering in China in 2004-2005: A Country Study*. Toronto: University of Toronto.

Oyelaran-Oyeyinka, B., & Lal, K. (2005). Internet Diffusion in Sub-Saharan Africa: A Cross-Country Analysis. *Telecommunications Policy, 29*(7), 507-527.

Pohjola, M. (2003). The Adoption and Diffusion of ICT across Countries: Patterns and Determinants. In D. C. Jones (Ed.), *The New Economy Handbook* (pp. 77-100). New York: Elsevier.

Vehovar, V., Sicherl, P., Hausing, T., & Dolnicar, V. (2006). Methodological Challenges of Digital Divide Measurements. *The Information Society, 22*(5), 279-290.

Wallsten, S. (2005). Regulation and Internet Use in Developing Countries. *Economic Development and Cultural Change, 53*(2), 501-523.

Weber, S., & Bussell, J. (2005). Will Information Technology Reshape the North-South Asymmetry of Power in the Global Political Economy? *Studies in Comparative International Development, 40*(2), 62-84.

World Bank. (2008, June). World Bank Development Indicators.

Appendix

TDI Values for Computers, Mobile Phones Internet Bandwidth, and Internet Users, All Countries, 2006

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
N of Countries										
Computers	162	182	187	189	199	197	198	200	202	201
Mobile Phones	167	186	190	196	198	200	200	203	206	207
Bandwidth	68	92	149	168	202	202	202	202	204	203
Internet Users	185	198	205	207	206	207	207	207	206	205
Average Values										
Computers	-0.69	-0.5 9	-0.5 3	-0.5 5	-0.55	-0.57	-0.57	-0.51	-0.45	-0.5 0
Mobile Phones	-1.04	-1 130.2	-0. 96 -1	-0.97	-0.89	-0.73	-0.48	-0.33	-0.20	-0. 07
Bandwidth	-0.14	3 -1	.66 -	-1.81	-1.49	-2.23	-2.56	-2.24	-2.15	-2.11
Internet Users	-1.77	.65	1.37	-1.27	-1.00	-0.88	-0.76	-0.60	-0.42	-0.3 7
Maximum Values										
Computers	0.69	1.18	1.08	1.00	1.04	1.04	1.00	1.01	1.89	2.32
Mobile Phones	1.38	1.28	1.20	1.08	0.97	0.96	1.08	1.24	1.27	1.42
Bandwidth	5.29	4.98	2.12	2.11	2.42	2.30	2.23	2.63	2.32	2.48
Internet Users	1.83	1.40	1.27	1.09	0.87	1.14	1.39	1.40	2.01	2.35
Minimum Values										
Computers	-5.11	-4.8	-3.3	-3.5	-3.67	-3.21	-3.47	-3.38	-3.21	-3.3
Mobile Phones	-7.03	1 -5	5 -5	9	-5.11	-4.48	-4.44	-3.23	-2.96	0 -2.
Bandwidth	-5.96	21 -5	78 -7	-4.71	-6.25	-7.31	-8.33	-8.24	-7.22	99 -6
Internet Users	-7.90	.41 - 7.48	.75 - 6.72	-9.25 -7.18	-7.66	-8.06	-7.71	-7.63	-3.85	.88 - 3.99

Countries	*Computers*	*Mobile Phones*	*Internet Bandwidth*	*Internet Users*	*Average*
AfghanistanAlbania	-1.26 -1.62	0.84 0.59	-6.31 -4.96	0.16 0.28	-1.64 -1.43
AlgeriaAmerican Samoa	-2.18	0.78 0.00	-4.82	-0.50	-1.68 0.00
Andorra Angola	-2.28	-0.86 -0.39	0.31 -3.56	-1.08 -2.80	-0.54 -2.26
Antigua and BarbudaArgentina	-0.53 -0.68	0.48 0.39	2.39 -0.46	0.18 -0.09	0.63 -0.21
Armenia Aruba	0.32 0.00	-0.74 0.00	-2.98 0.00	-0.48 0.00	-0.97 0.00
Australia Austria	0.36 0.13	-0.53 -0.38	1.27 0.69	0.08 -0.31	0.30 0.03
AzerbaijanBahamas, The	-1.39 0.00	0.32 0.00	-2.79 0.00	-0.21 0.00	-1.02 0.00
BahrainBangladesh	-1.05 0.28	-0.24 0.85	-1.72 -2.58	-1.11 -2.03	-1.03 -0.87
BarbadosBelarus	-3.17 -2.87	-2.66 0.33	-2.30 -1.54	-2.05 1.11	-2.55 -0.74
BelgiumBelize	-0.27 0.18	-0.51 0.11	1.29 -0.17	-0.34 -0.27	0.04 -0.04
BeninBermuda	-1.62 0.00	0.74 0.00	-3.07 0.00	1.20 0.00	-0.69 0.00
BhutanBolivia	-1.08 -0.90	-0.36 0.48	-2.38 -2.14	-0.51 -0.19	-1.08 -0.69
Bosnia and HerzegovinaBotswana	-0.57 -1.38	0.49 -0.08		0.67 -2.00	0.20 -1.15
Brazil Brunei Darussalam	0.19 -2.36	0.26 -1.45	-1.71 -1.37	0.27 -1.01	-0.25 -1.55
BulgariaBurkina Faso	-0.86 -2.03	0.83 0.32	0.62 -1.93	0.21 -1.36	0.20 -1.25
Burundi Cambodia	0.32 -2.04	0.21 0.09	-4.13 -4.76	0.14 -2.30	-0.86 -2.25
CameroonCanada	-0.97 0.47	0.32 -1.16	-3.05 0.68	-0.62 -0.04	-1.08 -0.01
Cape Verde Cayman Islands	0.00	0.00 0.00	0.00	0.00 0.00	0.00 0.00
Central African RepublicChad	-1.28 -2.65	-0.29 -0.41	-5.17 -5.55	-1.47 -1.80	-2.05 -2.55
Chile	-0.31	0.25	-0.43	0.02	-0.12

Source: Authors' calculations based on data from the World Bank's World Development Indicators (2008). Note: These are TDI values for all countries with available data and are offered for illustration and comparison. Source data on technology diffusion are regularly updated, we recommend that researchers use fresh data and run the computation described above, rather than just using the data in this table for their models. The data presented here is offered as illustration, and are current as of summer 2008.

ENDNOTES

[1] Further exacerbating the digital divide is the fact that there is a great difference in skill sets between populations throughout the world. This can prevent many people from taking advantage of the internet given that some competence in English and computer skills is necessary. This aspect of the digital divide is sometimes labeled a "second order" digital divide. [2] Despite the salience of their findings, it might be noted that one limitation when applying Dedrick et al's (2003) and Pohjola's (2003) results to the current day is that they cover a time period before most of the digital infrastructure arrived in developing countries as well as before the dot-com crash. [3] Indeed, this makes intuitive sense as countries with good social and economic infrastructure will be more likely to invest in other improvements, such as those of a technological nature. [4] Also see the studies on China by Chase and Mulvenon (2002) and the Opennet Initiative (2005).

[5] In many countries, the cost of a personal computer is higher than the average annual income for most citizens. The number of personal computers may underestimate the total use of computers, especially in poor countries where computers are a shared resource, and such a value does not reveal the great differences in the quality of computers. The number of personal computers underestimates the use of computers in countries where mainframe computers are prevalent and where computers are a collective, not personal resource. A count of the number of personal computers may exclude networked gaming systems and other information technologies. [6] Estimates of internet users are from the subscription rates reported by in-country internet service providers, rates that might not reflect the actual number of people using each shared internet access point (Miller & Slater, 2000). Thus, the number of reported internet users may be underestimated in poor countries where multiple users will share computing resources belonging to friends and family, a library, or cybercafé.