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Globalization and Technology Divides: Bifurcation of Policy between the "Digital Divide" and the "Innovation Divide"*

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The global diffusion of digital technology, which occurred more rapidly than the global diffusion of any technology previously, has been mired by its uneven distribution across, and unequal effects on, societies worldwide. In addition, policy initiatives to close this global digital divide, which peaked with the two World Summit on Information Society conferences, still did not change the course of this differentiated globalization process. In this article, I attribute the cause of such stalling of policy on the issue of the global digital divide to the bifurcation of current international policy: attention is split between concern for the impeded access of the poor to this revolutionary technology, on the one hand, and the race to lead the world in creating the next "hot" technology, on the other. These two concerns, which have been given the pithy titles of the "global digital divide" and the "global innovation divide," are leading to two separate policy tracks, targeting the world's laggards and leaders as separate entities and operating under separate logics. This separation is problematic because the issues of access to technology and ownership of rights to technology are intertwined. This article describes the two global technology divides and analyzes the policies that are currently charted to address them.

Technology is considered a marker of human achievement: from the "stone age" to the "space age," we take note of particular eras in the history of civilization by their technological accomplishment. The current era celebrates digital technology, commonly referred to as information and communication technology (ICT), as its marker. Our times are surely shaped by ICT, partly because such technologies carry the essence of what is commonly referred to as the age of globalization: global reaches, fast pace, and knowledge as the main commodity. Indeed, the global diffusion of ICT has occurred at a pace exceeding that of any other technology: it took the telephone 75 years and television 13 years to acquire 50 million users worldwide, whereas it took the Internet only 5 years to reach the same following (Main 2001). But the current era, which is appropriately marked with the addition of the prefix "e-" to the new and global economic sector (e-economy) and to related technology-based social initiatives (e-government and e-mpowerment),

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also gave similarly clever labels to their critiques (e-mperialism and e-litism). Scholars and policy-makers are concerned, therefore, not only with the opportunities for global integration and economic prosperity that come with ICT but also with the social divides that are magnified by the vastly differentiated access and use of digital technology.

This article discusses global inequality in ICT access and capacity by considering the two most acute global technology divides: (1) the "digital divide" which describes the gap in access and use of ICT and (2) the "innovation divide" which describes the gap in technology creation and thus in ownership of the related intellectual property (IP). Both of these divides are regarded as global, differentiating among countries and creating a world of unequal distribution and, most importantly, diverging trajectories of social progress. This shared vision of technology as a basis for global divides, I argue, masks the bifurcation of research and policy on the uneven globalization of ICT: the attention split between the "digital divide" and the "innovation divide" results in two separate policy tracks, targeting the world's laggards and leaders as separate entities and operating under separate logics. This separation is problematic because, as explained in the following article, the issues of access to technology and ownership of rights to technology are intertwined.

To articulate this argument, I start by describing the phenomenal rates of ICT globalization in the past several decades, adding that such rapid rates of technology creation and global distribution have resulted in dramatic global divides. Specifically, I describe in detail two ICT-related global divides, namely the global digital divide and the global innovation divide. I compare between the two global ICT-related divides, highlighting how their unique definition of technology diffusion as a social problem create a bifurcated image for policy-makers. To accentuate the point that this bifurcation of policy is problematic, I compare between ICT-related policies and international initiatives regarding medical technology. I conclude with comments about the image of digital technology as a panacea for global social ills.

Speed and Hope Intertwined: The Global Diffusion of Digital Technology

Departing from its tradition of naming a "Man of the Year," in 1982 *Time Magazine* chose instead to name the computer the "Machine of the Year." In the short two and a half decades since then, computers, and other ICTs such as mobile telephones and the Internet, came to fulfill the dedication statement made by *Time Magazin*e's editor at the time: ICT came "to symbolize our times so richly" and to "be judged by history as the most significant" of human technologies (Time Magazine 1983).

The significance of ICT comes not only from its visible impact on our daily life but also from the exceptional rate of ICT adoption worldwide. The single ENIAC machine of 1946 proliferated into more than 900 million personal computers (PCs) in use, more than 1.4 billion Internet users, and more than 3.3 billion mobile phone users worldwide in 2007.[1] Such rapid adoption into households and businesses meant a shortening of the duration of building up a market for the products and of building a users' community for each product. The expansion of the Internet confirms both "Moore's Law," which predicts the doubling of computing power every 18 months, and "Gilder's Law," which forecasts the doubling of telecommunications power every 6 months (see Drori 2005). With this rapid expansion of capacity also came a dramatic reduction in cost: the cost of a single megabit of computer memory dropped from U.S.$ 5,257 in 1970 to only U.S.$.17 in 1999 (UNDP 2001). These changes in availability and affordability of ICT made these technologies accessible to more people in more places.

Such availability and accessibility allowed developing nations to "leap frog" into the digital age. Most obviously, developing nations were able to progress by relying on mobile telephony, which eliminated the need for costly infrastructure investment. In Africa, for example, the number of subscribers to fixed-line telephones (per 100 inhabitants) grew between 1996 and 2006 from 1.9 to 3.2, whereas the subscription rate to mobile phones grew 100-fold, from 0.2 to 21.6,[2] with mobile phone users accounting for 89.6 percent of total telephone subscribers in this region in 2007.[3] Similarly, broadband Internet connection has been replacing narrowband connectivity, allowing for faster and more reliable access to the worldwide Web (ITU/UNCTAD 2007).

Resulting from such proliferation of ICT and from the subsequent "gadget race" to bring more ICT to market, a new economic sector emerged. The consolidation of Silicon Valley as a new type of industrial sector and district in the 1970s (Lécuyer 2006), with contemporaneous techno-entrepreneurial initiatives in Scandinavia (Richards 2004), were rapidly followed by the spread of technology manufacturing and later R&D to several Tiger economies.[4] Within a decade, the new economic sector turned global (Kogut 2003). This emergence of a new global economic sector marks the creation of a post-industrial and global information economy, which also changed the nature of global business (Gereffi 2001). Its emergence was carried by a wave of liberalization initiatives in countries worldwide, most dramatically after 1989 (Simmons, Dobbin, and Garrett 2008), which lowered the barriers to such industrial and commercial penetration. As a consequence, this emergence of a new sector demanded major economic adjustments: in infrastructure (wiring, energy supply, and industrial parks), in labor skills (computer and engineering skills, language), and in funding sources (venture capital, rapid IPOs). These resulted in a new global industrial geography, creating clusters of high-tech industry spread worldwide (Drori and Yue 2009; Hillner 2000; Jussawalla and

Taylor 2003). The transnational nature of this emerging economic sector induced rapid change to the foundations of trade and business. First, "around the clock" work shifts morphed into "around the world" work shifts, as IT corporations spread their operations worldwide and stretched production accordingly with the goal of expediting time-to-market. Second, labor, capital, and commodities became truly mobile on a global scale and thus required an adjustment in the international and national governance mechanisms to administer and guide such fields (see Rose 2005; Sassen 1996; West 2005).

Several countries took advantage of the emerging global e-economy and transformed their national economic structure. Costa Rica, for one, dedicated financing from Inter-American Development Bank as early as 1974 to expand the Costa Rican Technological Institute into what has become one of Latin America's most advanced computer science and software engineering schools; this human capital investment helped lure Intel into building one of its biggest microchip plants in Costa Rica in 1997; and, in 1999, computer microchips accounted for 37 percent of Costa Rica's exports and transformed this once "banana republic" (Hoffmann 2004; Kendall 2002). Other countries, most notably India, Israel, and Taiwan, complemented this strategy of public investment in human capital with a strategy of reliance on their diasporic communities (Breznitz 2005, 2006; Saxenian 2002). These countries strengthened the relations with their diaspora in Silicon Valley to help build a national ICT sector, to create impressive national venture capital (VC) activity, and—with acquisitions of local technology by American high-technology companies and the building of local R&D centers for American high-technology companies—to sprout many start-ups that brought substantial foreign direct investment (FDI). In Israel, for example, exports of high-technology products accounted for 55 percent of all exports in 2000, up from 23 percent in 1991,[5] and in 2006 the total telecommunication revenue accounted for 4.2 percent of gross domestic product (GDP).[6]

But even for nations who came to be known as "IT superstars," the economic growth and prosperity from ICT did not trickle down to be evenly shared among the whole population. Rather, access and use of ICT came, first and foremost, to the socially privileged. Globally, this uneven distribution is clear as well, with the world's richest economies also being those leading in ICT penetration. For example, in 2006 the world's top 20 countries in terms of broadband penetration included 12 European countries, 5 Asian countries, and Israel, the United States, and Canada.[7] In this way, fast globalization meant highly unequal diffusion and high global inequality: the "information society" and great promises of its related "information superhighway" and "digital opportunities" also meant the creation of a "digital divide."

Gaping Divides: The Uneven Global Diffusion of Digital Technology

In 2000, Jeffrey Sachs proclaimed that "today's world is divided not by ideology but by technology," reflecting the enchanted reality prior to 9/11 and the bursting of the dot.com bubble. At that time, the fast pace of expansion of the e-economy seemed unstoppable. But, on its flip side, the fast pace of ICT diffusion also meant that laggards were rapidly left fast behind, or "falling through the net" (as was the title of a series of NTIA[8] reports on the digital have-nots in the United States). Hence, when ICT of various sorts have been proliferating rapidly worldwide, access and use of such technologies have been unevenly distributed, both intranationally and internationally.

The Global Digital Divide

In 2006, just over 10 percent of the population in developing countries was using the Internet, compared with close to 60 percent in the developed world.[9] In Africa the situation was much worse: in 2007, only some 5 out of every 100 Africans used the Internet, compared with an average of 1 out of every 2 inhabitants in the G8 countries. African countries accounted for 20 out of the world's 30 countries where Internet penetration is lower than 1 percent. The total number of Internet users in the whole of Africa amounted to less than 20 percent of Internet users in the United States alone. Even the much celebrated leap-frogging enabled by mobile telephony did not eliminate the differences in the penetration of this technology across world regions: whereas the average annual growth rate in mobile phone subscribers in the short period 2002–2007 in Africa is a staggering 49 percent, bringing Africa mobile phone penetration in 2007 to 28.44 per 100 inhabitants; this region lags far behind the world average mobile phone penetration (50) and Europe's commanding lead (111).[10]

Figure 1 dramatizes the dimensions of the global digital divide. It compares the distribution of digital use, defined as the number of Internet and cell phone users per 100 inhabitants, among four groups of countries: the United States, the remaining members of the wealthy G7 countries (labeled G6 and including Canada, France, Germany, Japan, Italy, and the United Kingdom), the remaining members of Organization for Economic Cooperation and Development (OECD; numbered at 23), and all other countries combined into the last category.[11] The figure shows the average number of Internet and cell phone users per 100 inhabitants for the group (marked with a dot) and the spread between the highest and lowest such number within the category of countries. Substantively, the figure highlights the leadership of the United States and the overwhelming dominance of the G7 with regards to the Internet: although very few developing countries surpass the United States in

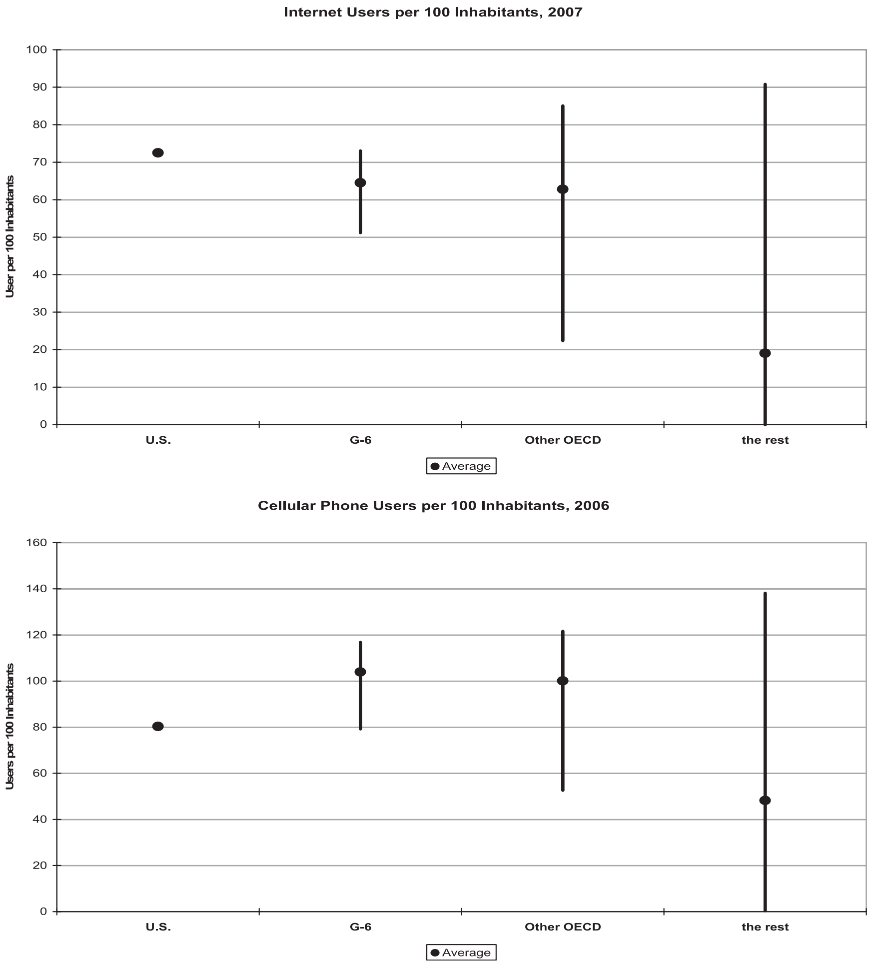

Figure 1
The Global Digital Divide.

Internet penetration, specifically Scandinavian countries among OECD members and Greenland in the group labeled "the rest," the gap in the average Internet use across the groups of nations is dramatic. Specifically, whereas the gap across various members of OECD in the number of Internet users is slight (ranging between 72.5 per 100 inhabitants in United States, 64.5 for G6 to 62.81 for the remaining members of OECD), the Internet penetration rate in the remaining countries is dramatically lower (at a mere 19). Yet, with regards to cell phone use, the United States is lagging behind many other nations; also, average scores of cell phone penetration are lower in groups of nations further from the global core, whereas cell phone use is rather expansive in the world's margins. This confirms that the cell phone is a leap frog digital technology. The difference between Internet and cell phone penetration rates reveals that the global digital divide is narrowing with regards to some related technologies, while expanding with regards to others (see ITU/UNCTAD 2007). Overall, these staggering figures translate into a simple abstract conclusion: access to ICT and use of ICT are unevenly distributed.

The uneven distribution of ICT across society is labeled the "digital divide," distinguishing between "digerati" and "have-nots" and thus defining "cyber-classes." Unequal access to ICT is determined by social and physical barriers, from never having seen a PC to absence of electricity infrastructure to power a PC. Comparative research reveals that the causes of the global digital divide depend on income or wealth differentials (Chinn and Fairlie 2007; Kim 2007), the complex array of economic, political, and socio-cultural matters (Guillén and Suárez 2005), and the level of embeddeness in world society activity (Drori and Jang 2003). The impact of these factors varies over the course of the process of technology globalization and across the various ICTs (Dewan, Ganley, and Kraemer 2005). Although the understanding of such causes assists in devising strategies for alleviating the problem, the importance of this issue as a social problem comes from its impact: differential access to ICT leads to unequal acquisition of related skills (e-literacy) and defines inequality in the types of use of ICT, namely those without the relevant skills are unable to type commands or to navigate a cursor on a compute screen, let alone be able to surf the net at the level of sophistication that the digerati are now accustomed to (see Pietrass 2007). Not surprisingly, such uneven distribution traces social markers: within nations the digital divide follows the lines of gender, wealth and education, race, and minority designation, whereas between countries this global digital divide follows the lines of national wealth, literacy, and democracy (Drori 2005). The confluence of digital gap with other social markers of inequality raises the question how new is this new divide. While some regard the digital divide to be a combination of new technologies and old social inequalities, others see it as a more egalitarian form of social demarcation because it adds meritocratic aspects to the traditional array of status markers. Kenneth Keniston (2004:17) says of the new Indian cyber-elite that "unlike older Indian elites, the privileges of the new digerati are based not on caste, inherited wealth, family connections or access to traditional rules, but on a combination of education, brainpower, special entrepreneurial skills, and the ability to stay on the 'cutting edge' of knowledge". Regardless of one's stand on the issue of newness, the debate still rages about the trajectory of the gap, revealing "a trend of growing eqaility over time in the Gini coefficients for several key ICTs" (ITU/UNCTAD 2007:25) or evidence of a "Matthew effect" (Drori 2005:144; Guillén and Suárez 2005:697) or a widening of the global digital divide.

The digital divide is a case of an "access divide"—here with regards to high technology. Once conceived as an access divide, the digital divide quickly came to be defined as a global social problem (Drori 2004; Ritzer 2004), becoming a rallying call for agencies whose mission is and has been to alleviate global problems. The most prominent international policy initiatives to alleviate the problem of the global digital divide are the UN's Information Society initiative and the related World Summit on Information Society (WSIS), which was organized by the UN's International Telecommunications Union (ITU). In these fora, tech-optimists gathered under the banner of this euphemistic title to establish as a mechanism and a collaborative platform for policy and action on the emerging social problem of the global digital gap. The WSIS brought two innovations to the UN Summits and to its development initiatives. First, in the hopes of building accountability into development agendas, the WSIS was organized in two stages: in 2003 in Switzerland and a follow-up Summit in 2005 in Tunisia. Second, in realization that the public sector needs the support of the much wealthier private sector and of the more localized civil society sector to achieve its ambitious development goals, the WSIS built a multi-sectoral dialog reflected in the proceedings of the Summits. The WSIS initiative to close the global digital divide is also captured in the Millennium Development Goals (MDGs): Target 18, which specifies Goal 8 of establishing a global partnership on development agenda, outlines that "in cooperation with the private sector, [the goal is to] make available the benefits of new technologies, especially information and communications."[12] This sense of urgency regarding the global digital divide reflects the way ICT came to define our era of globalization (Drori 2007). Still, with all the media attention around the WSIS and for all the promises made by ICT corporate giants to work on closing the global digital divide, the attention of corporate heads and the leaders of the strong economies has been drifting toward the race to innovate.

The Global Innovation Divide

Starker than any global divide in access to ICT is the global innovation divide, which identifies the gap between technology innovators and non-innovators. Innovators create novel technologies and then benefit from both their use and the royalties of their commercialization; non-inventors are dependent on purchasing the rights of use of any such technology (Sachs 2003).

This global innovation divide differentiates among countries and also among firms, mostly global in operations. It distinguishes among such global players, on various scales of innovation and of technology creation. Technology creation worldwide is on a dramatic rise in the past few years: more than half of the 6.1 million patents in force in 2006 were filed during the period between 1997 and 2003 (WIPO 2008). Because commercial potential of such innovation became a powerful economic engine, economies (as well as firms) are now judged by their innovative capacity and technology ownership stock. The United Nations Development Programme (UNDP) scales countries along the technology achievement index, and with the sub-index of technology creation calculated based on patent registration and royalties on patents. It notes the remarkable innovative capacity of Scandinavian countries, the Asian Tigers, Belgium, and Israel, along with the "regulars" of United States, Canada, United Kingdom, Australia, New Zealand, and Germany. It also distinguishes among four categories of countries: innovation leaders,[13] potential leaders,[14] dynamic adopters,[15] and marginalized countries (UNDP 2001; see also Desai et al. 2002), thus marking countries by their relative position in a world market of technology innovation and commercialization.

The recent wave of ICT innovation and emergence of a global e-economy pushed technology innovation to new records: the total 727,000 patents granted across the world in 2006 account for 18.2 percent increase from the previous year (WIPO 2008). The intensity of economic globalization contributed to the increase in international patent registration, where non-residents are rushing to protect their intellectual property rights (IPRs) in potential markets or in "wild" IPR zones where enforcement of the Patent Cooperation Treaty (PCT)[16] or of TRIPS[17] is still weak.[18] This explains the growth rate of total patent filings by non-residents (+7.6 percent in 2005, over 2004) and the increase in non-resident patent filings in countries such as China, India, Mexico, South Korea, and Russia. These trends are particularly noticeable in the field of electronics, which represented 35 percent of worldwide patent filings between 2000 and 2005 (WIPO, 2008). Overall, these trends mark a global surge in innovation.

Still, this surge of innovation, like the wave of digital tools and capacity that it produces, is accompanied by a widening global innovation gap. Most patents granted are concentrated in the patent offices of only five leading economies: granted patents registered in the five largest patent offices (patent offices of the United States, Japan, South Korea, China, and the European Patent Office) accounted for approximately 76.5 percent of the total patent grants of a total of 727,000 patents granted across the world in 2006 (WIPO 2008). China is experiencing the most dramatic gains, increasing its share of total worldwide patent filings from 1.8 to 7.3 percent between 2000 and 2006, mostly because of increases in domestic patent filings (WIPO 2008), whereas Japan has experienced a decrease in total patent filings by 6.7 percent between

2000 and 2006 (WIPO 2008). Similar such increases, even if not as dramatic, are experienced among other emerging market economies, but in most of the world there is very little, if any, of innovation technology.

Figure 2 demonstrates the extent of the global innovation divide. It shows the dramatic difference in the number of patents in force per four groups of countries. Figure 2, set up in a similar format as Figure 1, shows that whereas Japan leads the world with 1,613,776 patents in force in 2005, with the United States following with 1,214,556 patents in force, the rest of the world trails far behind. The national average precipitously drops, with non-OECD countries averaging a mere 1,242.37, mostly accounted by Russia (with 99,819 and Ukraine with 32,566). Said slightly differently, 22 percent of all patents registered in 2005 were granted to U.S. inventors and additional 46 percent were granted to inventors from G6 countries, having these seven big economies accounting for more than 68 percent of all patents registered in 2005.

The importance of these records comes from the economic benefits that come to owners of the intellectual property registered as patents. Such economic benefits of technological capacity are indicated by revenue (or royalties) from patents, which directly relate innovation with its commercial value. The group of countries that benefits from patent royalties is indeed exclusive: only five countries, namely Sweden, Finland, Netherlands, United Kingdom, and United States, receive royalties and license fees in excess of U.S.$100 per capita in 1999. Even South Korea, which ranks fifth in the world on the UNDP's technology achievement index, receives royalties and license fees of only U.S.$9.8 per capita. This means that very few countries reap financial rewards from their technology creation; this also means further dependence of most countries on the technology ownership of a few innovation leaders.

This transition from invention (a discovery) to innovation (the commercialized and transformative invention) required several foundational factors, which together compose the "national innovation system" (NIS; Lundvall 1992; Nelson 1993; Freeman 1995; Etzkowitz and Leydesdorff 2000; Sharif 2006; Marklund, Vonortas, and Wessner 2009). Among such foundational factors of NIS are policy initiatives on innovation and entrepreneurship, human capital capacity, availability of funding for R&D and alike, thus combining education, technological, financial, governance, and trade-related matters as they pertain to innovativeness. With this array of factors now added onto innovation, it is obvious that the cross-national variation in NIS capacity is further magnified. For example, Atkinson and Andes (2009), scaling 16 such factors into a single index of innovation-based global competitiveness across 36 countries and 4 world regions,[19] show dramatic differences across the world. Specifically, the top nine rankings are given to three Scandinavian countries (Denmark, Sweden and Finland), two Asian countries (South Korea and

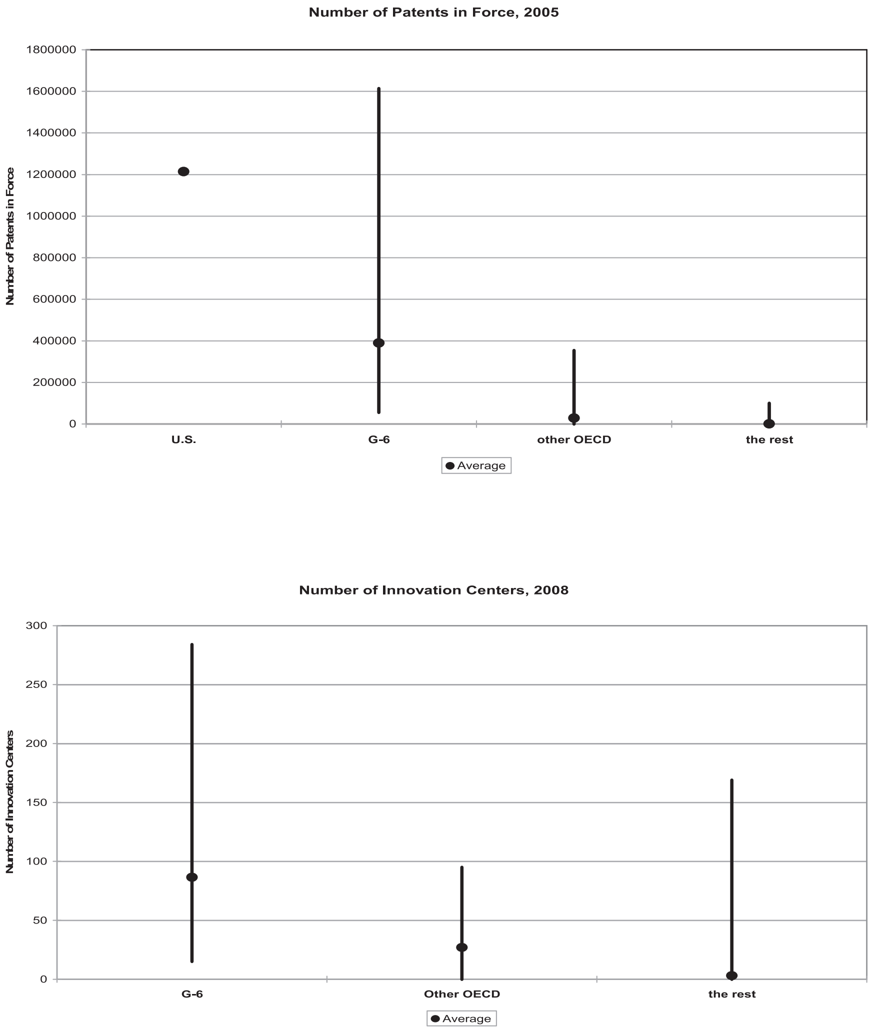

Figure 2
The Global Innovation Divide.

Japan), the United States, and United Kingdom. The findings also reveal dramatic rates of change over time: China and Singapore far outpace other countries and regions in change to their rank on innovation-based global competitiveness. This attention to NIS, rather than solely to technology creation, affirms the broader social causes of innovation and, with that, the social causes of the global innovation divide.

Three main factors are commonly cited as causes for the global innovation divide. First is the social geography of innovation: innovation is sparked in specific clusters that bring together communities of scientists with commercial venues of industry (Bresnahan and Gambardella 2004). Most such global clusters are also unique in terms of demographics, drawing highly skilled labor from across the world (Saxenian 1994, 2006). Silicon Valley is noted as the so-called Mecca of the world's innovation centers. Although it emerged innately, nourished by the "Triple Helix" of government contracts, Stanford University, and surrounding companies, many countries are trying to foster similar conditions in hope of establishing local technology clusters (Rosenberg 2001; Bresnahan and Gambardella 2004; Kogut 2003). Notable technology hubs have sprouted worldwide: Silicon Fen (Cambridge, U.K.) and Silicon Wadi (Jerusalem, Israel) are among the notable examples which are also named in reference to the "original," but Brazil, China, and Germany have the largest national concentration of such centers (Drori and Yue 2009). Among the 46 top global hubs ranked by the *Wired Magazine* in 2000, nine are in Asia, two in South America, and two in Africa (Hillner 2000). Still, as shown in Figure 2, the United States dominates the global sector of innovation centers: some 45 percent of the world's estimated 4,000 innovation centers in 2008 are located in the United States (Drori and Yue 2009), and such component of the NIS is hardly available in any non-OECD country.

The second factor relates to the infrastructure of innovation, which includes diverse features such as venture funding, legal protections for IPRs, and human capital investments. Here, the role of government is central, in establishing the enforcement mechanisms that would incentivize inventors to operate locally, rather than migrate. Government is responsible for establishing the educational foundations for highly skilled local labor. Additionally, government funding to seed start-ups, although contrary to the current emphasis on the importance of private VC, has indeed been the key to the successful technology innovation and commercialization in Israel and Singapore. Policy reform of the intellectual policy regime further facilitated the growth in technology innovation and related commercial activity (Borrás and Kahin 2009; Elsmore 2009). Countries indeed vary greatly on these various dimensions of governmental support of both technological literacy and of the R&D process. In this regard, Israel and Singapore are marked as model cases for the role government played in spurring a national high-tech sector (see Trajtenberg 2002; Wong and Singh 2008). Specifically, Singapore's transformation into a "BioPolis" relied heavily on concentrated government initiative and prior push on education (Parayil 2005); similarly, Israel's rise as a global hub of innovativeness relied on heavy governmental investments, though military R&D and employment strategies, and a subsequent formation of a highly active venture capital market (Breznitz 2005, 2006; De Fontenay and Carmel 2004). Public sector support played a similarly important role in additional "latecomer" countries (Hu and Mathews 2005). From this perspective, the difference in innovation is rooted in variation—across countries and across historical eras—in the nature and scope of innovation policy (see Lundvall and Borrás 2005).

The third factor addresses the cultural foundation of innovation, pointing to entrepreneurial spirit as an intrinsic cultural trait. Most research on this topic relies on Geert Hofstede's cross-cultural studies and assesses the impact that such socio-cultural disposition has for innovativeness and entrepreneurial spirit. In a meta-analysis of previous research on this issue, Sun (2009) shows that innovativeness is more prevalent in societies that stress equality and opportunity to everyone (low power distance, in Hofstede's terminology), that are more individualistic (rather than collectivist), and where normative emphasis is put on achievement, control, and power ("masculinity" in Hofstede's terminology; see Hofstede 1980). This issue of culture of innovation is also raised in other circles: for example, Subroto Bagchi, who prior to founding the Indian VC firm MindTree Consulting served as VP for both Lucent Technologies and Wipro, explains the innovation divide in such cultural terms when explaining India's lag in the global innovation race by claiming that "our middle class is adaptive, not innovative" (*The Economist* 2007:74). Lacking the "gene" for entrepreneurship and creativity, non-innovative societies are imagined as destined to lose in the global race for technology innovation and thus doomed to lose their footing in the global economy.

Intersecting Patterns of Inequality

As much as both these global divides rank countries on their technological capacity, their particular foci—on access and on innovation—create unique scales for such rankings among countries. In other words, global leadership on innovation of technology and global leadership on access to technology do not always coincide. Rather, the intersection of these two inequality scales, although both are global- and technology-related, reveals a complex set of relations, made even further complicated by the dearth of accurate data and by the rapid rate of change in technology globalization. In spite of such inherent limitations, I propose that the complex relations between digital and innovation divides can be sorted out into several archetypical categories, summarized in Table 1. The following section explores the patterns of relationship between both such scales of technology-related global inequality.

Table 1
Cross-Cutting Innovation and Access: Exemplar Cases

	Leader in innovation	Laggard in innovation
Leader in access	Scandinavian countries	Canada, U.K.
Laggard in access	China, India	Sub-Saharan African countries

Scandinavian countries are the archetypical countries where both access to technology and innovation of technology are high. Scandinavian countries are unique in several ways that impact their dual high ranking here: most obviously, they have strong government involvement in industry and education and they are socially cohesive (Fagerberg, Mowery, and Verspagen 2009; Richards 2004). Also in this group are Singapore and Israel, aided partly by their size,[20] as well as United States and Japan, whose sheer magnitude of innovation is overwhelming and where wealth allows for widespread access to ICT.

Canada and the United Kingdom are the archetypical countries where access is high but innovation is relatively low in comparison. Specifically, Canada's innovativeness is remarkably low: the number of patents registered in Canada is about 3 percent of the annual patent registration in Japan and about one-third of that in France; also, Canada, while bordering the huge U.S. field of some 2,000 incubators and technology parks, has a mere 35 incubators. At the same time, Canada shares the Digital Access Index (DAI) score of 0.78 on DAI with United States. Similarly, the United Kingdom holds a DAI score of 0.77, but has only 4 percent of Japan's registered patents in 2007 and only 65 incubators. These countries are challenged by both innovativeness and also entrepreneurship, and in both there are aggressive policy initiatives towards enterprise (e.g., Della-Giusta and King 2006).

The third group of countries includes those that are high on innovation but low on access. Typical cases in this group are China and India both challenged by their enormous population which cripples chances for wide access to ICT yet at the same time both have elite science fields that allow for cutting-edge and world-ranked innovation (see Altenburg, Schmitz, and Stamm 2008). Specifically, China's DAI score is 0.43; at the same time, China's innovation, although still relatively low, is rapidly changing: China's annual patent registration in 2007 only 20 percent of France's, yet it ranks first in change in innovation-based competitiveness between 1999 and 2009, growing by 160 percent on this index scale. India holds a similar DAI score (0.32) and

Table 2

Bifurcated Image of the Problem of Information and Communication Technology (ICT) Globalization: Comparing the Global Digital Divide and the Global Innovation Divide

Dimension of comparison		Global digital divide	Global innovation divide
Conceptual frame	Definition	Worldwide differences in access and use of ICT	Worldwide differences in creation, and thus ownership, of rights to technology
	Essence of inequality problem	Access: right, capacity, and infrastructure	Innovation: creativity, production, and ownership
	Domain of policy	Development, framed in terms of aid, technology transfer, and poverty alleviation	Development, framed in terms of trade, IP rights, and commercialization of knowledge
Scope of attention	Volume of discussions on topics[a] in:		
	ISI Web of Knowledge[b]	24 (767)	0 (0)
	Lexus/Nexus[c]	107 (999, as max)	1 (5)
	Google Scholar	1,350 (41,900)	17 (79)
	Leading international policy initiatives	—Two UN Summits on Information Society —Millennium Development Goal #8, Target 18	—

Notes: [a]Operationalized as the number of mentions of the phrases "global digital divide," "digital divide" in parentheses, "global innovation divide," and "innovation divide," again in parentheses, on January 25, 2009.
[b]With phrase as topic.
[c]In the past 10 years, in major U.S. and world publications.
IP, intellectual property.

innovation, although still very low, is rapidly changing. Also in this group, although not as remarkable, are BRIC countries. Russia, for example, ranks above average in terms of access (DAI score of 0.50), yet ranks below average for innovativeness (with annual patents registration being one-third of those in South Korea and some 6 percent of that in Japan).

The last group is that of countries where both innovation and access are very low. Typical cases are sub-Saharan African nations, which are plagued by the "double whammy" effect of poverty, government corruption and the related weakness of social services, insufficient basis in industry and commerce, and dearth of human capital skills. In these countries there are neither pull nor push forces for technology.

Overall, although technology access and technology innovation are intertwined dimensions of global inequality, this categorization of the relationship between these two global divides reveals the complexity of global inequality. As stated earlier, leadership in one technology scale does not guarantee high achievement on the other; various countries have different capacities of access as they do of innovation. In addition, although both distributions are heavily skewed, access scales are more normally distributed than innovation scales. Still, this categorization allows for further examination of the social causes of global technology-based divides, as it points to certain national-level capacities (such as government intervention, industrial basis, and, most importantly, human capital capacity) as being core to achievements on either scale. These discussions of possible causes of the global innovation divide have not swelled into a research tradition and little has come in the form of policy. This is the most obvious distinction between the global innovation divide and the global digital divide. The following section describes some of the initiatives taken to alleviate the two global technology-related divides.

Identifying Causes, Setting Policies

Policy initiatives to address the global technology-related divides trace the current understanding of causes for such divides, with programs tailored to addresses the specific sources of each divide. With the global digital divide attributed to barriers of supply (affordability of ICT for poor nations and people) and demand (low e-literacy), policies to bridge the global digital divide are designed around technology aid. Specifically, ITU describes the goal of achieving equitable communication for everyone as hinging on three main features of the technology: (1) accessibility (user-friendliness), (2) availability (handiness and propinquity), and (3) affordability (reasonably priced).[21] To date, initiatives to close the global digital divide have hit on at least one such goal, if not on all. Many programs are designed to transfer technology to the ICT have-nots, mostly at low or no cost, thus targeting availability and affordability. Such technology aid initiatives, which are designed to close the gap in access to ICT, range from providing mobile phones and computers to rural and poor clients to sponsoring e-library connectivity to universities in developing countries. Other initiatives target the socio-cultural barrier to technology diffusion, therefore offering an answer to challenges of accessibility.

One such initiative is that of the Simputer, a hand-held yet most powerful computer operating with images and by touch. Even if long in the making, the Simputer's by-passing of basic literacy issues is designed to make digital technology user-friendly in rural Indian.[22] Seeing the complexity of the demands, the UN's WSIS and MDG initiatives are designed to build into their tools all features of success.

The closing of the global innovation divide is understood to be obviously dependent on these basic conditions of ICT access and e-literacy, but it is also addressed with several targeted policies. The first set of policies is designed to foster communities of innovation by establishing clusters of technology creation and commercialization. Governments, local and regional, heavily invest in creating innovation centers: for example, all of Israel's current 23 innovation centers were initially funded by Israel's Office of the Chief Scientist at the Ministry of Industry, Trade and Labor, even if several have been privatized successfully since then. The second set of policies is designed to create the required infrastructural conditions. Included in these initiatives are governance reform initiatives, which focus on creating proper legal codes and enforcement mechanisms to protect IPRs and thus to maintain the incentive structure for technology innovation. Currently, loose IP protection across national lines explain the dominance of three countries in patent registration: United States, Japan, and Germany account for 57 percent of worldwide patent filings by non-residents, who are seeking protection for their IP in these markets where IP enforcement is guaranteed. With more countries joining the small group of technology innovators,[23] the circle of countries that have a stake in the tightening of a global IP regime and a corresponding expansion of a rationalized legal system in general is growing too. Still, the IP regime is predicated on the tenuous balance between monopoly and disclosure and also between protection as incentive and right to access (see Granstrand 2005). No patenting policy to date, in spite of heated debates and recent reforms (see Borrás and Kahin 2009; Smith, Correa, and Oh 2009), fully resolves these tensions. Third and most complex is the policy challenge of addressing the cultural roots of technology innovation. The relations between creativity and innovation are complex and understudied (Westwood and Low 2003); in addition, the effects of societal norms on innovation or related entrepreneurial drive, although overall significant, are complex.[24] As a policy matter, the challenge centers on how to train or educate for entrepreneurship and creativity. Here, Singapore is proposing a new path, with an aggressive art education initiative. Assuming that creativity can be fostered through art appreciation studies and training in the expressive arts and assuming that such art-induced creativity can be later translated into creativity in technology and business, Singapore's government has been directing funds to art education curricula since 2000. With this "social experiment" in art studies, Singapore is hoping to close the global innovation divide, to match its global lead in economic competitiveness and science education with a future global top rank on technology innovative.

Comparing Global Technology Divides

This education strategy highlights one common feature between the global digital divide and the global innovation divide, namely the importance of knowledge and skills, which are gained through education. Both these global technology-related divides are conceived as rooted in literacy gaps—recently titled "the global knowledge divide"—and therefore a complimentary set of policy initiatives targets education, with UNESCO serving as the key agency for many such initiatives. E-literacy is only one among many education programs: whereas e-literacy targets people who had no access to ICT, other education programs target students in secondary and tertiary education (to foster science and math literacy in general) and ICT professionals (to foster skills specific to the ICT sector). With that, students are trained in the relevant fields, thus creating a national cadre of skilled labor to service the growing demand for ICT. With science, math, and technology education being seen as the foundations for a prosperous economy, countries compare themselves with other nations on science and technology literacy, on scales similar to the aforementioned indexes of technology capacity and achievement. Therefore, results from TIMSS[25] testing in science and math, which repeatedly rank 13-year-old students in Singapore, Taiwan, South Korea, Hong Kong, and Japan far ahead of students in other countries, confirm fears of the perpetuation of global technology divides.

On all issues additional to their foundation in education gaps, current discussions of the global digital divide and the global innovation divide are completely separate from each other: attention is split between concern for the impeded access of the poor to ICT, on the one hand, and the race to lead the world in creating the next "hot" technology, on the other. Although both concerns carry similarly phrased titles—namely, the "global digital divide" and the "global innovation divide"—they diverge on other matters, as summarized in Table 2.

First and foremost, the two global technology-related divides differ in their definition of what about technology's global diffusion is of essence. As noted in preceding discussions, the global digital divide is defined as a worldwide gap in access and use of ICT, whereas the global innovation divide is defined as a worldwide gap in creation of, and thus ownership of rights to, technology. In this way, the two divides differ in what they regard as the essence, or root, of global inequality: access and use versus creation and ownership. As a result, the two global technology-related divides are constructed as focusing on opposing populations: even if both discussions set prosperity and justice as their ultimate goals, the global digital divide is framed as a matter of lagging in technology adoption and thus as a worry about poor and marginalized countries, whereas the global innovation divide is framed as a matter of global competitiveness and thus as a concern about world leadership. Last, this bifurcated image of the two divides is further perpetuated by the discursive nature of the policy discussions related to this issue: matters of the "global digital divide" are discussed within the framework of aid and poverty alleviation where technology transfer is often the sensible policy solution, whereas issues pertaining to the "global innovation divide" are framed within the policy domain of trade, regulation of IP, and economic incentive strategies. Overall, then, the two divides diverge in their image of technology, of social inequality, and are thus immersed in separate discourses.

The most dramatic difference between these two global technology-related divides is the amount of attention they have received. In a simple exercise to measure the volume of discussions on these two global divides, I note in Table 1 the staggering difference in the number of mentions of the key phrases in scholarly and news publications. These numbers reveal an overwhelming imbalance in public discussions of the two global divides: the global digital divide is widely discussed, whereas there are very few references to the global innovation divide.

I take this gap in the volume of discussion as evidence of the diverging construction of these two issues as global social problems (see Ritzer 2004): the issue of the global digital divide is accepted as a legitimate global social problem (Drori 2004), whereas the global innovation divide has not been successfully constructed as such. Even if the issue of global social problem of the digital divide is widely used interchangeably with the recalled translate, the optimistic title of "information society," a sense of crisis (hence, a problem) permeates all these discussions.

The difference in the extent of constructing the two global technology-related divides as social problems impacted the consolidation of policy and the rallying of social action on these issues, as the articulation of global inequalities as social conditions remedied by policy (what sociologists refer to as the definition of these divides as a social problem) set a challenge before policy-makers to form bridges across such global divides. Yet, although the challenge of global digital divide was met with determined international action, most notably by the UN in its two WSIS gatherings and the continuous pressing on Target 18 of the 8th MDG, to date the global innovation divide has not been the target of such action. Overall, therefore, the two global technology-related divides are structured as relying on two separate policy tracks, targeting the world's laggards and leaders as separate entities and operating under separate logics. In the following section I describe the policy initiatives that target the alleviation of these global technology-related divides and argue that the bifurcation of the field of technology diffusion into two distinct social problems harms the closing of both global gaps.

Bifurcation as a Challenge for Policy

Although both global technology-related divides address a specific set of technologies, namely ICT, the bifurcated image of the field creates a serious challenge for policy-making. Operationally, this separates, rather than unites, the power of international organizations and creates false competitive tensions among them. It also splits their policies, initiatives, and funding campaigns and thus weakens their impact. Conceptually, this bifurcation of technology globalization demarks technology access from technology achievement, or use from innovation, constructing a gulf between high and low technologies and between the needs of developed and developing countries. It evokes the antiquated development agenda, which distinguished civilized from savage and prescribed distinct policies for each. With that, the globalization of ICT is guided by two sets of policy logics, rather than by a unified image of how ICT may serve human development.

One set of advanced technologies has avoided this bifurcation: the globalization of medications, in particular of life-saving medications, is seen as a junction point between an access divide and an innovation/ownership divide (see Smith, Correa, and Oh 2009). On the access side, it is clear that life-saving medications are needed where people are suffering from life-threatening diseases. Some such diseases require medications that are readily available: for example, yellow fever, which accounted for 200,000 ill and 30,000 dead per year in the world's tropical areas of Africa and South America, is easily treated with rehydration salts and paracetamol and is prevented with vaccination. On the innovation/ownership side, pharmaceutical companies, mostly located in developed nations, are guarding their licensing of such medications with the intent of recovering their investment in the lengthy and risky R&D process that resulted in bringing such medications to market. The capacity to produce the medications is available in developing nations, but the lion share of the production cost is because of licensing fees for the related intellectual property. Thailand, for example, has some 200 private medication factories and locally produced medications have 50–60 percent of the market share, leaving the remaining share to imports. India, China, and Brazil have substantially bigger pharmaceutical manufacturing facilities for medication; and, they have taken advantage of this capacity in challenging the current global regime of IPRs. To address the dilemma of access versus ownership, these three "emerging markets" challenged the WTO's TRIPS Agreement by using its "national emergency" clause to manufacture medications locally without paying licensing or royalty fees: as Article 8 of the TRIPS Agreement allows WTO members to "adopt measures necessary to protect public health and nutrition" in their countries, these countries declared several diseases as creating a national crisis so as to produce a generic form of these medications cheaply by by-passing TRIPS' compulsory licensing requirements. The ensuing debate in WTO regarding the national emergency clause of TRIPS and the Indian, Brazilian, and South African manufacturing of generic medications, accentuated the dilemma between access and ownership and brought the topic into public debate. The "loophole" in TRIPS was somewhat tightened in several rounds of international discussions since, but the obvious tension, or weak balance, between the interests of the ill but poor, on the one hand, and of the inventors and patent owners, on the other, are still unresolved.[26] Still, in such (heated) discussions, the facts are clearly recognizable: with regards to medications, the global access divide is intertwined with the global innovation divide. This realization has not been achieved with regard to the globalization of ICT.

Why are policy discussions of ICT diffusion bifurcated between access and innovation whereas with regard to medications access and innovation are intertwined? This comparison across technological fields suggests that the presumably inherent tension between access and innovation differs across sectors: ICT (where policies are bifurcated) versus medications (where policy discussions confront the tension). One possible explanation draws from the differing moral and ethical implications of uneven distribution of each such technology: although barriers to the diffusion of ICT retard development, the implication of limited access is literally death. The difference between the policy discussions, therefore, reflects the difference in the sense of urgency to resolve the tension between ownership and access. Second explanation, building on this one, is more political in nature: social mobilization on the issue of access/ownership of medications builds upon this sense of urgency and on the moral and ethical implications and is thus more vocal, explicit, and unambiguous, and to date more effective than on the issue of ICT access/ownership. A third possible explanation builds on current studies of governance of IP across sectors. Preliminary studies of the IP regime across sectors confirm the specificity of IP governance per sector, revealing differences in effectiveness and enforceability of these proprietary rights (Elsmore 2009). Moreover, because the American IP system, where IP law is predicated upon sector specificity, serves as the model for recent reforms of IR systems worldwide (Borrás and Kahin 2009), this duality between medications and ICT is currently diffusing and is reinforced. These proposed explanations, drawing attention to the technologies themselves, to the political use of discourse about the technologies and to the political economy of the related sectors are only suggestive. Still, these can serve as venues for future research on the bifurcated nature of technology-related policy.

In summary, the interconnection between these issues of access and ownership has become the underpinning of current debates surrounding medications. It is appropriate that policy-makers—and scholars—weave notions of access and ownership also as a guide for policy-making with regard to the globalization of other technologies, in particular the globalization of ICT. Currently, discussions of ICT globalization pose ownership and access as competing logics, with technology creation and equitable diffusion of technology as competing interests and competing policy priorities.

This dilemma, about the priorities related to technology creation and diffusion, is at the center of policy discussions in many international organizations, with several specific gadgets becoming "lightening rods" for such debates. For example, the OLPC laptop, standing for "One Laptop Per Child" and commonly referred to as the "100 dollar laptop," is hailed as the affordable computer whose software is designed to be easily localized. It was unveiled at the 2005 WSIS by UN Secretary-General Kofi Annan and Nicholas Negroponte, the founder of MIT's Media Lab and OLPC's Chairperson, and in 2006 it won the support of the World Economic Forum and the UNDP. But while OLPC is intended to be sold to governments, which will later distribute them to schools and community centers, and while several developing nations and American states proclaimed their wish to enroll in this initiative, to date only Peru and Uruguay have committed to purchasing it.[27] As much as OLPC is designed with care for its usability and impact, it still falls short of its intended goals.

Specifically, OLPC is criticized for its cost (currently at U.S.$199), dependence on expensive batteries or access to electricity, and the cost being exclusive of the expenses of e-literacy workshops for teachers and users. Additional criticism comes from considering the alternatives to OLPC, thus directly engaging the dilemma of regarding technology aid priorities. In a debate on this exact issue, John Wood, the founder of Room to Read and a former Microsoft executive, argued that building community access, rather than encouraging individual access, is both more cost-effective and more respective of local customs. In place of individual laptops, technology aid initiatives should focus on building computer labs, for schools and communities. He also argued that most communities in developing countries would benefit more directly from "low-tech" libraries or from schools than from high-technology gadgets which anyhow are too low-tech to truly close to the digital divide. Emphasizing affordability and scalability, Wood explained that the U.S.$2,000 spent on a library that serves 400 children, costing just U.S.$5 per child, surely outweigh that of OLPC.[28] With OLPC compromising digital capability for the sake of cost, this technology aid initiative is seen by many as a form of "technology dumping," providing only outmoded and thus irrelevant technology. This tale of a remarkably well-intentioned technology aid initiative being so fiercely criticized is confusing policy-makers.

Concluding Comments: On the Construction of ICT as a Solution to Social Problems

"Development in the network age without the Internet is like industrialization without electricity," says Manuel Castells in his commentary on the information age (Desai et al. 2002:95). With rapid technological advances driving a historic shift from the industrial to the network age, ICT is seen as a social imperative. Consequently, any gaps in ICT-related capacity—from access and use to innovation and ownership—become a cause for public concern. Yet, as described in this article, concerns with the global diffusion of ICT are split between concerns of access and of innovation: concerns of access to ICT are encapsulated in conversations of the "global digital divide," which are very vigorous in the global arena, whereas concerns with innovation and thus ownership of ICT are encapsulated in the much less public or vocal conversation on the "global innovation divide." Whereas both technology-related divides essentially address the uneven global distribution of ICT, between and within countries, the two conversations are kept independent of each other, also resulting in two distinct policy paths.

Current policy on the globalization of ICT is therefore bifurcated: policy is challenged by the tension between issues of access, on the one hand, and issues of innovation and thus ownership, on the other hand. The bifurcation of ICT-related policy assumes the incommensurability of the social goals. As I point out, this notion of competition among the goals of access and innovation is not only socially constructed as irresolvable, but it may very well also be sector-specific: tenuous relations between access and ownership of technology are at the center of current policy discussions on medications, whereas essentially similar tenuous relations with regard to ICT have resulted in bifurcated policy field. This cross-sector comparison and analysis of policy bifurcation have a direct implication for policy-making. In charting policies to guide the globalization of ICT, policy-makers and social activists need to look at the debates over medications to create an integrated, rather than a bifurcated, path toward development of a parallel policy regarding the global diffusion of ICT.

Another guideline for future policy that is derived from these findings is with regard to setting priorities for ICT-related policy: seeing the four distinct clusters of countries and the archetypical countries in each such cluster, which of these paths is a model to be emulated? What priorities should policy-makers assign to the social goals of access and of innovation and are these goals mutually exclusive desiderata? Some policy paths are risky: the mobility of labor and capital makes it a risky venture for governments to be aggressive in reforming their IP regime in favor of the goal of greater access. Yet other policy tracks seem to carry no, or little, risk: investment in upgrading of human capital, through general education or specifically education in IT fields, has been at the heart of India's and Israel's remarkable advances and would give any country flexibility in adjusting to global changes. These decisions are particularly crucial for poor countries and current policy discussions do little to help the governments of these countries navigate through the challenges of duality of ICT-related social goals.

The implications for scholarship are different in tone. First, at the level of empirical analysis, further research is due on investigating the social causes and social implications of ICT-related divides, both within and between countries. To date, the focus on the "global digital divide" yielded several studies that analyze its various social causes (see Drori and Jang 2003; Guillén and Suárez 2005). Yet, the silence on the issue of the "global innovation divide" resulted in limited sociological studies of the social causes of global gaps in innovation. The review here suggests several social causes, from culture, the nature of the regulatory regime, the degree of state intervention, and obviously variations in capacity of various human skills and material resources. Analysis of such causes, as well as research into the trajectories and implications of these ITC-related global divides, will provide further understanding of the dynamics of globalization and inequality: studying whether the trajectories of the divides are widening or shrinking, what paths have ICT-related policies taken, and how has ICT diffusion impacted other dimensions of global inequality (in trade, literacy, security, or democratization).

A second track for future research may confront the mythology that is at the root of discussions of ICT globalization and of the digital and innovation divides. In asking "why is technology constructed as the panacea for economic development and for social progress?" and "which particular technology comes to be conceived as the key to human progress?" such research will problematize the discursive connection between technology and progress, thus adding a constructivist perspective to current sociological studies of globalization and inequality (e.g., Suter 2009 and related articles). From this perspective, the allure of ICT and of their promise to development is the core inducement behind international ICT initiatives and also fuels the fixation on both the digital and innovation divides as pressing global social problems. This image of technology in general as a solution to poverty and other social ailments is made clear in the focus on policy initiatives on opportunity: ICT is so firmly anchored in a discourse of breakthrough and progress that ITU and WSIS, the leading international organizations to champion the information society initiatives, rely in their analysis on the composite index ICT-OI, namely ICT-Opportunity Index (ITU/UNCTAD 2007). But while such ICT initiatives encouraged technology transfer and aid campaigns, which provide ICT to developing countries with low or no cost, not all technologies receive the same attention. Clearly, here, high technology captures the imagination of policy-makers more than any of the “old” technologies. For example, there are more phone connections on the island of Manhattan than in all sub-Saharan countries combined; and, there are more cars in Manhattan than in sub-Saharan Africa. Still, as Linda Main argues, “no-one is suggesting sending more automobiles to Africa” (UNDP 2001:94). The criteria for deciding which technology is to be made available globally are clear to all: technology should make a positive impact on humans and nature, by encouraging progress without harm or injustice. But which are the technologies that fulfill these criteria remains uncertain.

ENDNOTES

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[1]<http://www.itu.int/ITU-D/icteye/Indicators/Indicators.aspx>, accessed January 24, 2009.

[2]<http://www.itu.int/ITU-D/ict/statistics/ict/index.html>, accessed December 27, 2007.

[3]<http://www.itu.int/ITU-D/icteye/Indicators/Indicators.aspx>, accessed January 24, 2009.

[4]Initially, several Asian Tigers, but also Ireland, Israel, and Estonia (see Breznitz 2006).

[5]<http://www.globes.co.il/serveen/globes/docview.asp?did = 258771&fid = 954>, accessed December 27, 2007.

[6]World Bank country report: <http://devdata.worldbank.org/ict/isr_ict.pdf>, accessed January 24, 2009.

[7]<http://www.itu.int/ITU-D/ict/statistics/ict/index.html>, accessed December 27, 2007.

[8]National Telecommunications Infrastructure Administration, at the U.S. Department of Commerce.

[9]<http://www.itu.int/ITU-D/ict/statistics/ict/index.html>, accessed December 27, 2007.

[10]<http://www.itu.int/ITU-D/ict/statistics/ict/index.html>, accessed January 24, 2009.

[11]The category labeled “the rest” includes 175 countries.

[12]The indicators for progress on this MDG Target 18 are: telephone lines and cellular subscribers per 100 people (indicators 8.14 and 8.15, respectively) and PCs in use per 100 people (indicator 8.16). See the Millennium Development Report 2008, <http://mdgs.un.org/unsd/mdg/Resources/Static/Data/Stat%20Annex.pdf>, accessed January 25, 2009.

[13]A group of 18 countries, which includes countries such as the United States, Canada, South Korea, Japan, Singapore, Australia, New Zealand, all of West Europe, Scandinavia, and Israel.

[14]A group of 19 countries, which includes countries such as Spain, Italy, Poland, Chile, Costa Rica, Argentina, and Mexico.

[15]A group of 26 countries, which includes countries such as Panama, Thailand, South Africa, Tunisia, and Egypt, but also the big emerging economies of Brazil, China, and India.

[16]Which is administered by the World Intellectual Property Organization (WIPO).

[17]Trade-Related Aspects of Intellectual Property Rights agreement, which is administered by the World Trade Organization (WTO). See additional discussion in following section.

[18]WIPO, which is the specialized UN agency responsible for this issue and which compiles these data, defines country of origin of registered patents as the country of residence of the first-named applicant or assignee of a patent application.

[19]European Union (EU)-15 region, EU-10 region, EU-25 region, and the North Atlantic Free Trade Agreement (NAFTA) region.

[20]These are the only two cases where the whole country is noted by Hillner (2000) as a single hub of technology.

[21]<http://www.itu.int/themes/accessibility/>, accessed January 24, 2009.

[22]See <http://www.simputer.org/>, accessed January 26, 2009.

[23]South Korea, China, and India had the highest increase in non-resident filings over 2004: +27.3 percent for South Korea, +27.9 percent for China, and +23.6 percent for India. The increase over 2004 was also notable in New Zealand (+13.3 percent), Israel (+11.1 percent), and South Africa (+10.6).

[24]For a recent review of the empirical evidence in this field of research, see Sun (2009).

[25]Third International Mathematics and Science Study, developed by the International Association for the Evaluation of Education Achievement (IEA), first administered in 1995, and conducted now in some 60 countries.

[26]For updates on TRIPS-related discussions, see WTO-TRIPS Fact Sheet, at <http://www.wto.org/english/tratop_E/TRIPS_e/factsheet_pharm00_e.htm> (accessed October 19, 2009).

[27]As reported in the Boston Globe, December 1, 2007; <http://www.boston.com/business/technology/articles/2007/12/01/one_laptop_per_child_orders_surge/>.

[28]For a PodCast of this discussion, see <http://itc.conversationsnetwork.org/shows/detail1033.html>.

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