W(h)ither the digital divide?

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Abstract *The "widening digital divide" has the status of fact in most discussions of the global distribution of information and communications technologies (ICTs), and that this divide is a problem is widely accepted. This paper challenges both assumptions. First, looking at various measures of the digital divide, there is a divide in per-capita access to ICTs but developing countries show faster rates of growth in network development than developed countries. Moreover, when employing a per-income measure of access, developing countries already "digitally leapfrog" the developed world. Second, the paper examines the prediction that disparities in absolute access to ICTs between countries will lead to reduced development prospects in poor countries. Past experience has shown that it is very difficult to make predictions of this type. The paper concludes that we may be posing the wrong policy questions when focusing on a "digital divide" as it is commonly understood.*

Introduction

Despite the groundward gyrations of new economy stocks, worrying about the "digital divide" has remained a popular preoccupation of academics, NGOs, development policymakers and G-8 summiteers. The core of the digital divide creed is that the spread to ubiquity of information and communication technologies (ICTs) in developed countries is leaving the developing world behind, with potentially cataclysmic consequences in terms of development prospects. This paradigm, perhaps better suited to the general digital delirium of the late 1990s, might need a gentle shift to better complement the digital hangover of the last three years. It is a propitious, perhaps overdue, moment to re-visit the basic premises of the digital divide. We do so in two ways.

First, we look at various measures of the digital divide and develop a refined view of global patterns of access to information and communications technologies (ICTs). We confirm a rather obvious divide in per-capita access to telecommunications and the Internet that, historically, has widened in absolute terms. However, in relative terms developing countries show faster rates of growth in network development than developed countries. This suggests that at present ICT growth rates, the developing world would eventually catch up to the developed world, in absolute levels. Moreover, when employing a per-income measure of access to a variety of ICTs, we find that developing countries already "digitally leapfrog" the developed world[1].

Second, we ask the question: do we need to worry about the digital divide? And if we need to worry, what precisely do we need to worry about? We ponder on possible mechanisms that might lead to greater ICT development in rich countries to reduce the development prospects of poor countries. We conclude that there may indeed be reasons to be worried, but also grounds to be cheerful! However, it is still uncertain what the net effect of new ICTs and their unequal availability across nations might be. Past experience has shown that it is notoriously difficult to make predictions of the long term impact of new technologies. This does not mean that there is not a potential problem to be overcome regarding ICTs and development, merely that we may be

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posing at the wrong policy question when focusing on the digital divide as it is commonly understood.

The paper is organized as follows. Section 1 uses available data on the availability and use of telecommunications and the Internet, to draw a thorough picture through time of the digital divide as it is usually measured. In Section 2, we discuss concerns about the digital divide that link it to growing global inequality. We conclude the paper in Section 3 by offering some thoughts on why misconceptions about the digital divide might lead to misconceived policies.

1. What is the digital divide?

The term digital divide came to prominence more for its alliterative potential than for its inherent terminological exactitude. In another world we might have had the "silicon split," the "gigabyte gap" or the "pentium partition." As such, it would be wrong to ponder for too long on what, exactly, should be meant by the term[2]. But at least four possible interpretations do appear in the literature:

(1) A gap in access to use of ICTs – crudely measured by the number and spread of telephones or web-enabled computers, for instance.
(2) A gap in the ability to use ICTs – measured by the skills base and the presence of numerous complimentary assets.
(3) A gap in actual use – the minutes of telecommunications for various purposes, the number and time online of users, the number of Internet hosts and the level of electronic commerce.
(4) A gap in the impact of use – measured by financial and economic returns.

What we should be ultimately most interested in is, of course, the final measure, and we will return to a discussion of potential impacts in the next section. But what the literature tends to concentrate on is part of 1 and part of 3 – the number of phones and computers and the number of Internet users. This is probably as much to do with data availability than any of the priors of the participants, but nonetheless, when you ask the question "Is there a digital divide?" the answer comes back "Yes – look at the number of users (computers, hosts, or mobile phones) per capita."[3]

As illustration, a number of leaders in the development community, such as Mark Malloch-Brown (head of the UNDP) have suggested that there is a growing digital divide between rich and poor and they base these statements on numerous reports and studies that point to Internet usage and access statistics[4]. The ILO's World Employment Report for 2001, which included a section on ICTs, noted under the section heading "a widening digital divide" that "barely 6 per cent of the world's people have ever logged onto the Internet and 85 to 90 per cent of them are in the industrialized countries." A study by Ernest Wilson and Francisco Rodríguez (1999) which looked at rollout figures for a number of ICTs asks "whether the data on ICT is characterized by convergence or divergence between developed and developing countries" and concludes that there is "a widening gap." Again, Bridges, a respected South African ICT think tank, concludes that "[r]eal disparities exist in access to and use of information and communications technology (ICT) between countries (the 'international digital divide') and between groups within countries (the 'domestic digital divide') … There is an overall trend of growing ICT disparities between and within countries."[5,6] And, in the interests of full disclosure, one of the authors of this paper was on the writing team of an earlier report saying much the same thing[7].

Again, what is important to note about the digital divide as presented in these reports and pronouncements is, first, that it is almost universally described in terms of the gap between telephones per capita, Internet users or Internet hosts in the developed and developing world and, second, that it is growing.

And that case can be made. In high income countries, when one adds together mobile and fixed connections, the telephone is so ubiquitous that there is more than one phone per person – compare that to a fixed and mobile teledensity of three telephones per 100 in developing countries. The increase over the 1975-2000 period has been by a little over 900 phones per 1,000 people in high income countries, compared to just 24 phones per 1,000 people in poor countries. Looking at Internet use, an average of one third of the population in high income countries were using the technology in 2000, compared to just 0.4 percent in low income countries. Given that effectively no-one anywhere in 1990 had Internet access, it is clear that the absolute growth rate in terms of Internet access has also been far higher in rich countries than in poor over that period. The "growing digital divide" case can be graphically illustrated in Figures 1 and 2 (data here and elsewhere in the paper come from the World Bank, 2002).

The large and widening differences in per-capita stocks and use of ICTs in absolute terms are real and affect the lives of hundreds of millions of people. Nevertheless, we argue that, this "simple" digital divide story is neither particularly surprising nor does it tell the whole tale. In fact, it conceals important facts and trends that, if taken into account, lead to a much refined view of the digital divide. We make two distinct points. The first asks whether developing countries are really falling behind and shows that, in fact, the per-capita ICT stock and use gap is closing. The second point poses the question of whether per-capita stock or use rates are really the right measure and points to a quite different picture when using per-income access measures[8].

Are poor countries really "falling behind"?

A widening absolute gap in per-capita ICT access does not necessarily imply that poor countries are falling behind. The key point is that for assessing whether developing countries

Figure 1 — Fixed and mobile telephones/1,000 population

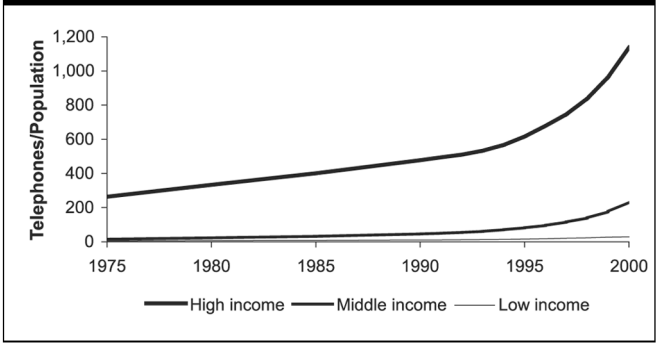
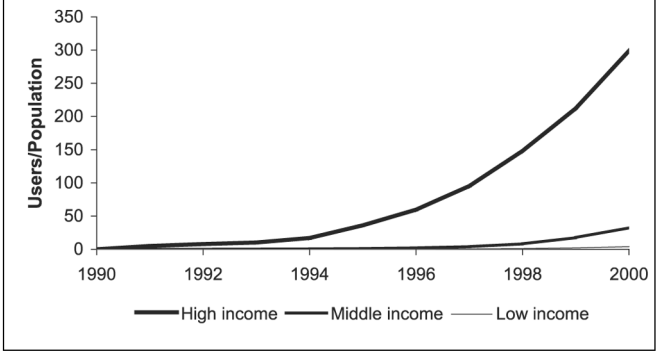


Figure 2 — Internet users/1,000 population



are falling behind, we really should look at relative rates of growth. If poor countries experience faster growth in ICT usage and access levels, it is mathematically inevitable that, at some point, they surpass the rich world – notwithstanding the possibility that in the short term, the absolute gap may continue to widen. And indeed, what the numbers tell us is that developing countries are not falling behind[9]. The ICT gap between rich and poor countries is closing in relative terms. Over the last 25 years, telephone penetration has been expanding faster in low income countries, and considerably faster in middle income countries, than it has in high income countries (Figure 3)[10].

Turning to the Internet, growth rates of users per capita have been higher in poor countries than in rich ones since the early 1990s – pretty much from the birth of the Internet, in other words (Figure 4). Remarkably, during the "Internet boom years" of the late 1990s, per-capita usage was growing twice as fast in the developing world than in the developed world. The large absolute gap illustrated in Figure 2 stems from the fact that usage rates in 1992 were far higher in high income countries. But that gap has been shrinking ever since then in relative terms[11]. The most stunning feature of the digital divide is not how large it is, but how rapidly it is closing.

It is obvious that the growth rates observed in the second half of the 1990s cannot persist for long. If they did, there

Figure 3 — Average annual growth of telephones/capita

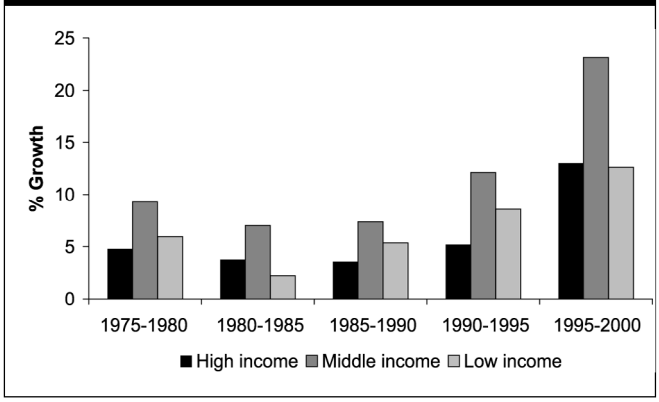
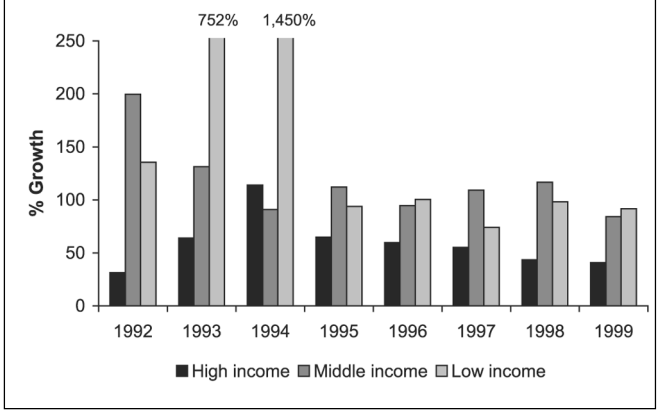
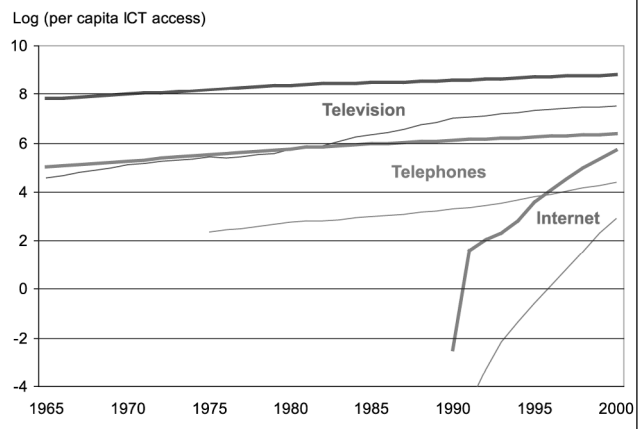


Figure 4 — Average annual growth of Internet users/capita



would already be more than 1,000 Internet users per 1,000 inhabitants in high income countries by 2004! So, growth rates will eventually come down. But if history is any guide, growth rates are likely to remain higher in the developing world. Figure 5 plots the evolution of per-capita access to the Internet, telephones and television sets (a technologically more mature ICT). For ease of presentation, we focus on the divide between developed and developing countries only (the latter defined as low and middle income countries). Access rates are transformed into their natural logarithms, such that the divide between the rich and the poor is depicted in relative terms. The comparative patterns of ICT diffusion suggests a remarkably persistent rule of thumb: within a few years of introduction of a technology, relative gaps in terms of access start to fall, pointing the way to convergence in access over the long term. It is nearly always the case that very new technologies emerge first in wealthy countries (Dolly the sheep was cloned in Scotland, not Swaziland) – what is impressive with the history of ICTs is how fast, and how increasingly fast, developing countries begin to catch up.

Figure 5 — The lessons of history



Notes: The lines measure per-capita access to television sets, telephones and the Internet in developed countries (bold lines) and developing countries (fine lines). For presentational convenience, per-capita ownership of television sets is measured per 100 population, per-capita access to telephones and the Internet is measured per 1,000 population. Data before 1975 are only available for 1960 and 1965

Evidence of a closing ICT usage and access gap may not be surprising to many. It might be argued that once a particular technology covers a sizeable share of the population, demand is increasingly saturated and growth rates start to fall not much above the rate of population growth. However, for our purposes, it is mute to ponder on the extent to which demand may be saturated in rich countries. Whatever the reasons, the statistics tell us the ICT gap is closing, not widening as is frequently argued.

Are per-capita stocks and use the right measures?

Even if ICT stock and Internet usage rates are converging, a large absolute per-capita access gap clearly remains. But this should come as no surprise[12]. Telecommunications and Internet services are (indirectly) part of GDP – both from the expenditure side and from the income side. Rich country consumers have, on average, more money to spend on telecommunications and information technology than poor country consumers. And the ICT sector contributes more dollars to national output in richer countries[13]. This is why over 80 percent of the cross-country variation in stocks of telecommunications or Internet users at any one time can be explained by GDP per capita (Forestier *et al.*, 2002).

In fact, finding no or a negative correlation between the ICT stocks and GDP per capita would be anomalous to say the least. Poor countries have less ability to acquire most things that cost money – that is what being poor signifies. If per-capita revenues from telecommunications were as high in the Philippines as in the USA, these revenues would equal the country's gross national income[14]. This would not leave much money to buy bread or water. For countries poorer than the Philippines (China, India and most of Africa, for example), they would have to spend more than their gross national income each year to equal US telecoms expenditures. This suggests that the idea of equal per-capita stocks or use worldwide will have to wait upon far more equal distribution of income worldwide.

From an economic perspective, one might argue that a more revealing measure is per-income stock or use of ICTs. After all, the provision of connectivity requires real resources that are generated by the productive capacities of a nation's economy. While there is no reason to expect nations to necessarily devote the same share of GDP to ICTs, it is still interesting to ask if poor countries see less ICT stocks or use per unit of income than rich countries.

Using this definition of access, we in fact find a "digital leapfrog" in the case of telecommunications (Figure 6). Middle income countries have the greatest numbers of telephone lines for each dollar of GDP, followed by low income countries and high income countries. And the leapfrog – at least between middle and high income countries – has widened substantially in the late 1990s, in absolute terms.

In the case of Internet usage, we also find a digital leapfrog of middle income countries *vis-à-vis* high income countries (Figure 7). Countries in the middle income range surpassed the developed world somewhere between 1998 and 1999. Low income countries still lagged behind high income countries in 2000, but were clearly on a take-over course and may, by 2002, have already overtaken the developed world[15].

Figure 6 — Fixed mobile telephones/GDP

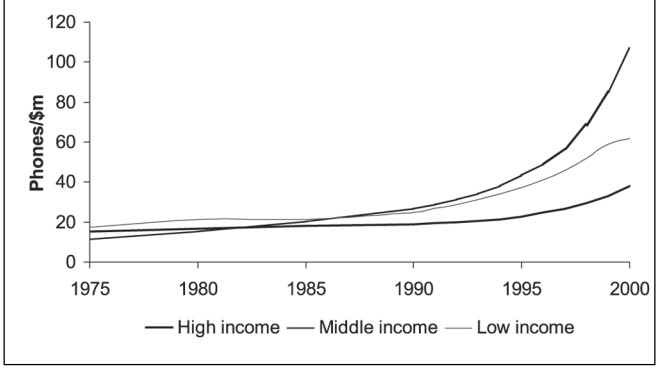
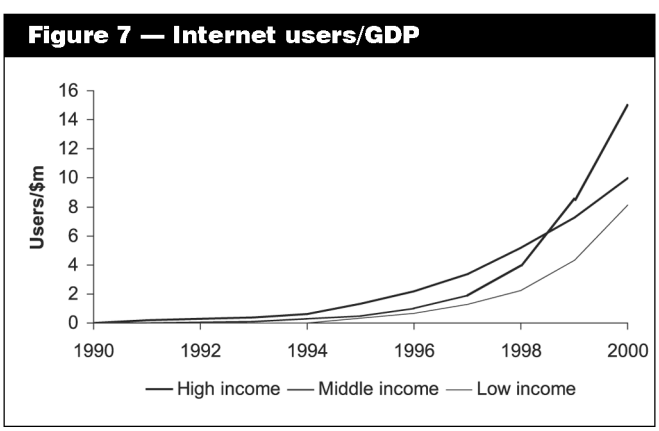


Figure 7 — Internet users/GDP



Again, it is interesting to look at statistics regarding the technologically more mature ICT of television. We find a pronounced digital – or better analogue – leapfrog of the developing world *vis-à-vis* the developed world, and low income countries showing the greatest per-income stocks of televisions (Figure 8). Poor countries had already surpassed rich countries in the late 1960s. If this historical pattern were any model for the future evolution of telephone and Internet access, the absolute per-income leapfrog already observed for these technologies would widen substantially over the decades to come[16].

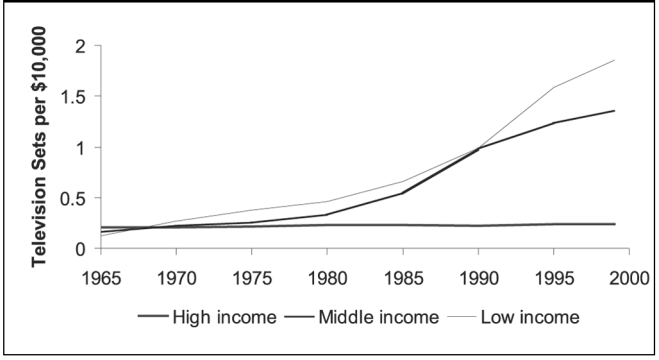
We are not arguing that a per-income measure is always and objectively the best indicator of ICT access[17]. The choice of measure depends, of course, on the purpose of measurement (more on that in the next section). But the point we want to make here is that depending on the denominator employed, one can paint quite a different picture of comparative ICT access across countries.

2. Why worry about the per-capita digital divide?

We have seen that the per-capita digital divide is shrinking, not growing, using the standard measurements, and that it has largely disappeared using a measurement that is perhaps more appropriate than per-capita levels. Is there still a reason to worry about the different per-capita rates of use between rich and poor countries?

It is quite possible to argue that the emergence of powerful new ICTs has added another layer of inequality to already existing inequalities in income, life expectancy, access to health and education, and other aspects of human development. But such an argument misses two important points. First, it seems overwhelmingly likely that the changes in ICT stocks worldwide have had a positive impact on the populations of poor countries. Over the past 15 years, the number of telephone mainlines (both fixed and mobile) in developing and least developed countries more than tripled and mobile and Internet services were virtually unavailable 15 years ago. It is hard to think of any sector in the developing world that has shown a similarly stellar performance during this time span.

Figure 8 — Television sets/GDP



Second, the shrinking per-capita digital divide documented in the previous section has occurred even though incomes have not converged. In 1975, GDP per capita (measured in purchasing power parities) in developed countries was about 6.7 times GDP per capita in developing countries. This ratio increased to around 7 in 2000, suggesting a modest divergence of incomes[18]. These figures make clear that even though developing countries have fallen behind economically over the past decades, they managed to catch up digitally.

Why then worry about the digital divide? Some people have expressed their concerns in terms of the differential impact of ICTs. Either because of lower penetration levels or a less favorable general economic environment, the benefits of ICTs – for example, in the form of accelerated productivity growth – may be smaller in poor nations compared to wealthy countries (see Heeks and Kenny, 2001; Kenny, 2003). A related argument is that some countries with the lowest level of provision may not have reached a threshold level that allows them to fully benefit from ICT stocks or use[19]. But even if one accepted those arguments, they only give grounds for worrying about ICT investments and their impact in poor countries – regardless of what is happening in the rich world. To worry about the digital divide, we must believe that the unequal availability of ICTs across nations fosters economic processes that systematically favor growth in rich countries and limit the development prospects of poor countries.

And again, that case can, in principle, be made. One economic process that may be relevant is agglomeration. Might it be that the "historical advantage" of greater ICT development in rich countries leads to the agglomeration of economic activities in the developed world, permanently disadvantaging poor countries? Venables (2001) offers some educated guesses on the possible impact of new ICTs on international inequality[20]. He argues that these new technologies are likely to foster movement of some activities to poor countries. For example, activities which are more readily transportable and less dependent on face-to-face communications may relocate to lower wage countries (one might call this the "death of distance effect"). At the same time, some of these activities may cluster together once relocated, such that only a small number of developing countries may benefit. Hence, de-agglomeration forces may not lead to a uniform process of income convergence.

Other activities may become more deeply entrenched in high income countries. For example, new ICTs may allow the spatial separation of activities that benefit from proximity to markets and suppliers ("front room activities"), from activities that can readily be outsourced ("back room activities"). This effect may strengthen agglomeration forces. Another argument is that new technologies may allow firms to better monitor local market trends and the desire to quickly adjust production to changing market conditions may make remote

production more costly – again favoring agglomeration. The decision of some US textiles producers to re-locate production to the USA provides anecdotal evidence to this effect[21].

What is the additional impact of the digital divide on the process of agglomeration or de-agglomeration? One could make the simple argument that if new technologies foster dispersion of economic activities, the digital divide may slow down the de-agglomeration process. But the emergence of new technologies *per se* would still be a benign development for poor nations and may foster income convergence. By contrast, if new technologies foster agglomeration, then the digital divide may exacerbate inequalities. Unfortunately, the net impact is not at all obvious. It is notoriously difficult to speculate about the implications of new technologies on such complicated processes as agglomeration. *Ex ante* predictions on the impact of past technology revolutions (e.g. transport or electricity) have *ex post* often looked naive.

Of course, one can think of other economic processes besides agglomeration that may generate income inequality. For example, might it be that the potential for ICT ubiquity in developed countries fosters business practices that exclude firms in ICT-scarce developing countries from international trading opportunities? It is not implausible to imagine a scenario in which a developed country consumer of LDC-produced inputs moves its purchasing system online, the LDC producer cannot or does not follow suit, and the consumer switches to an e-commerce enabled alternative source in the developed world. There is indeed empirical evidence that communications costs and infrastructure affect a country's participation in international trade in goods and services, (for example, Fink *et al.*, 2002a; Freund and Weinhold, 2000, 2002), and also evidence that moving purchasing systems online has a dramatic impact on supplier choice (see Heeks and Kenny, 2001). Due to the historical disadvantage of less ICT availability, poor countries may be "stuck" in a dynamic comparative advantage in industries that have slower productivity growth, fostering divergence in incomes. But again, it is equally possible that the introduction of new ICTs *per se* has enlarged trading opportunities of poor nations to such an extent that potential adverse effects of unequal ICT availability are overshadowed.

In any case, per-capita differences in stocks or use of ICTs that are central to the digital divide creed are unlikely to enlighten us about economic processes that may be specific to industry, technology and geography. ICT use per unit of GDP may be a better measure of the potential scale of the problem than ICT use per capita. Using that measure, the "divide problem" seems to have disappeared or be fast disappearing, as we have seen. Supporting this, at the micro level, survey work suggests that the "business digital divide" between countries is far smaller than the per-capita digital divide. Further, where LDC firms are in a business where consumers are more likely to be online, the number of such firms online is dramatically higher[22].

Given all of the above, it is likely that increased access to ICTs has and will improve the economic plight of developing countries. Reasonable people can disagree about whether new ICTs are a force for divergence or convergence of incomes between countries – but, it is not always clear what these arguments have to do with worrying about the comparative figures produced when discussing the digital divide.

3. Canyon or mirage? Some final thoughts

The divide is cavernous. Already, there is more than a 70-fold difference in access rates between US and Indian households. That gap is far larger than the income divide between the two countries. Worse, the divide is linked to productivity, suggesting this differential access will promote ever-widening divergence in income. The divide we are talking about is, of course, the air conditioner divide.

As it happens, the air conditioner divide really is almost exactly the same size as the differential between Internet users per capita in India and the USA. Further, the air conditioner has been linked by economists with improvements in productivity[23]. But arguments for a G-8 Task Force on overcoming the air conditioner divide would – rightly – be dismissed as insane. Why are things different for the digital divide?

An optimistic view is that the digital divide paradigm may be used to promote good policy. There is convincing evidence that countries which introduce effectively regulated private competition in information infrastructure provision see improved efficiency, lower prices and wider access. Further, countries that get the broader legal and regulatory environment for e-commerce, or that support the development of the needed human capital to use the new technologies, will further increase returns to ICT investment (see Fink *et al.*, 2002b; Kenny, 2001, 2002b for reviews). By painting a menacing scenario of countries being on the wrong side of the digital divide and thus not being able to integrate into the emerging "globally networked economy," advocates of sensible policies may accelerate the political momentum for reform.

A more pessimistic view is that the paradigm of the "growing digital divide," by being a misconceived premise, may lead to misconceived policy conclusions. At the level of national policies, for example, Governments may set over-ambitious roll out targets in service licenses – as has happened in a number of developing countries (South Africa, Brazil and the Philippines, for example). Similarly, while there are good reasons to justify subsidies to promote universal access to telecommunications services, subsidies should be rationalized on the grounds that careful analysis at the country-level suggests significant economic and social

returns, not with an appeal to comparative statistics at the global level.

From the perspective of development policy, the nostrum of "bridging the digital divide" – while an attractive metaphor – appears as fuzzy as the digital divide concept itself. We do not want to question that new ICTs can be a powerful tool in support of development. However, seriously arguing for closing the per-capita divide in ICTs – for example, attempting to reach per-capita (as opposed to per unit of GDP) Internet usage levels as ubiquitous in Africa as they are in the USA – seems unrealistic and limited in value[24]. Whatever the proposals of bridging the digital divide are, they are likely to cost money. And it can be questioned whether this is the best use of international aid – which, unfortunately (but realistically) will remain scarce. For one, private capital stands ready to support developing countries that create the right enabling environment[25].

Second, it is clear that there are challenges that are more serious to the well-being of people living in developing countries than the unequal per-capita access to ICTs across nations. For example, the spreading HIV/AIDS pandemic in large parts of the developing world poses an unprecedented humanitarian crisis and has already severely affected the economic prospects of a number of nations. Yet international aid to fight the disease remains inadequate[26]. If there is little evidence to suggest that some indirect mechanism will make the purported "digital divide" a larger threat to developing country welfare, it is to direct threats like AIDS that significant donor resources should be targeted (even if that aid sometimes uses the Internet as a tool to tackle the AIDS threat).

We suggested at the outset the need for a gentle paradigm shift from the notion of a growing digital divide with cataclysmic consequences[27]. The new paradigm would retain the idea that new ICTs offer significant opportunities to people in developed and developing countries alike. It would retain the idea that policymakers need to grapple with the challenges and grasp the potential of the Internet[28]. At the same time, there would be a shift away from the language of a growing gap in access that itself presents a development challenge. The gap is not cataclysmic and it is closing, not growing. In the semantic battle between "digital divide" and "digital opportunity", then, we place ourselves firmly in the second camp. ■

Notes

1 With apologies to Jane Austen and Emily Bronte, the issue is not so much one of Pentiums and Prejudice, but a divide of Withering Bytes.

2 The term "digital divide" is most frequently used to describe unequal ICT access patterns across nations and our discussion, too, focuses on between country differences in ICT access. Occasionally, analysts use the term "digital divide" to describe unequal ICT access patterns within countries – most importantly, the divide between rural and urban regions, or poor and rich citizens. While a discussion of unequal ICT availability within nations would merit additional considerations beyond those raised here, we would argue that parts of the analysis presented in this paper for the "between country divide" are likely to be relevant – if not directly applicable – to the "within country divide."

3 We do not claim it as an original comment to note that, if there is a "digital divide," its more important manifestation is in the differing ability to exploit the new technology. For example, Mark Warschauer (2002) has argued that "... a digital divide is marked not only by physical access to computers and connectivity, but also by access to the additional resources that allow people to use technology well." However, he goes on to note that "the original sense of the digital divide term – which attached overriding importance to the physical availability of computers and connectivity, rather than to issues of content, language, education, literacy, or community and social resources – is difficult to overcome."

4 See www.undp.org/dpa/frontpagearchive/july00/22-23july00

5 See www.bridges.org/spanning/report.html

6 The A.T. Kearney/Foreign Policy Magazine "Measuring Globalization" study (in the *Foreign Policy* issue of January 2001), actually puts most of Europe on the wrong side of the digital divide, as well. "Rather than a division between developed and developing countries, however, the divide at this moment reflects the vast technological advances in North America and the Scandinavian countries compared with the rest of the world. Together, those two regions stand on one side of a gaping digital chasm that appears to have left much of the remaining world behind."

7 To whit: "The gap in [ICT] provision is large – much larger than income disparities for some regions. In particular, the gap is growing in provision of advanced services" (World Bank, 2000). In (only) partial defense, the paper did note that "some of the trends in ICT provision around the world have been toward convergence."

8 It should also be noted that there are a number of issues related to data quality and interpretation. Internet user statistics are hardly reliable. For example, data on hosts and Internet users suggest that there are about two users per host in the US, but nearly 1,300 in Nigeria – an unbelievably high number (Kirkman *et al.*, 2002). But the figures do suggest that more users access each computer in the developing world than in the developed world. And does a telephone line in London stand for the same kind of access to telecommunications as a telephone line in a remote village in India? The likely answer is no. If this is the case, then the absolute differences depicted in Figures 1 and 2 actually overstate the true access gap between poor and rich countries. A related issue arises with regard to the treatment of fixed and mobile telephony. A priori, it is unclear whether one should use the sum of mobile and fixed connections in measuring access to telecommunications, or consider fixed and mobile telephony separately. The former approach is justified if fixed and mobile services are substitutes for one another, whereas the latter approach is more appropriate if the two are complementary

services. Across income groups, we expect mobile to be more of a complimentary service in rich countries and more of a substitute service in poorer countries, where fixed-line network rollout is typically scanty. Again, if this is the case, then absolute differences in a per-capita measure based on the sum of fixed and mobile connections actually overstate the true access gap.

9 Primo Braga (1998) already noted that ICT spending grew more quickly in most developing country regions than in high income economies in the 1992-1997 period.

10 Other measures of convergence suggest the same thing: in a sample of 101 countries for the 1960-2000 period, mainlines per capita have seen the coefficient of variation drop from 1.76 to 0.98 over that time, the population weighted coefficient of variation fall from 1.80 to 1.34, the number of telephone lines in the bottom 20 percent of countries in terms of rollout expressed as a proportion of telephone lines in the top 20 percent of countries rise from 0.003 to 0.008 (Kenny, 2002).

11 Specifically, the elasticity of the average annual growth rate of per-capita Internet usage between 1996 and 2000 with respect to the level of per-capita Internet usage in 1996 takes a value of –0.174 (estimated across 114 countries by a log-linear regression of the growth rate on an intercept and the 1996 level). In other words, across countries a 10 percent higher Internet penetration in 1996 is, on average, associated with a –1.74 percent lower annual growth rate in the subsequent four years.

12 The strong positive correlation between teledensity and GDP per capita is also not a particularly new discovery. It was already brought to light some 30 years ago by Jipp (1963).

13 Interestingly, we find an approximately proportional relationship between (fixed plus mobile) teledensity and per-capita income. For 2000, the elasticity of per-capita telephone access with respect to income takes a value of 0.985 (estimated across 162 countries by a simple log-linear regression of teledensity on an intercept and income). By contrast, we find an over-proportional relationship between per-capita Internet usage and per-capita income, with an estimated elasticity of 1.113 (estimated across 166 countries). From a purely statistical viewpoint, this is plausible. As countries grow richer, consumers may spend a larger share of their income on using the Internet. And in richer, more diversified economies the provision of Internet and related services may account for a larger share of output.

14 Calculated from ITU, 2001 and World Bank, 2002.

15 Interestingly, in 1996 the elasticity of per-income Internet usage with respect to per-capita GDP took a value of 0.567 (estimated across 118 countries by a log linear regression of Internet users over GDP on an intercept and per-capita GDP) – suggesting that higher incomes still had a sizeable association with greater per-income use of the Internet. By 2000, this elasticity had fallen to 0.151 (seven countries had to be excluded from the regression, because the 2000 data were missing), pointing to a substantial weakening of this relationship.

16 Another way to look at the rate of convergence in access to ICTs is to ask how fast developing countries attained the proportion of world ICT stock and use that their share in world income would suggest. It took about 45 years from its invention (from 1923-1968) for the share of the world's TVs that were in developing countries to reach the proportion that would be expected given their income share (where the lines cross on Figure 7). For fixed telephone lines, the time taken was even longer. Both PCs and cellular services are already as widespread in LDCs as their share of world income would suggest, though both were only invented about 25 years ago. And for the World Wide Web, the gap looks like it will be even shorter – a technology invented in 1991 will see proportionate usage given income as early as next year – after only 12 years.

17 One interpretational problem of the per-income measure is that one compares a stock figure (number of telephone and Internet connections) to a flow figure (GDP). Using capital stock instead of GDP would be a more consistent normalization variable, but the data are not available for as many countries as they are for GDP. At the same time, where data are available, one finds a strong positive correlation between capital stocks and GDPs.

18 Unfortunately, purchasing power parity adjusted GDP figures are not available in our database before 1975. A similar conclusion is reached when comparing per-capita GDPs using nominal exchange rates. In 1960, per-capita income of the rich was 18.54 times per-capita income of the poor. This ratio rose to around 20 in 1975 and took a value of 23.4 in 2000. Going much further back into history, Lant Pritchett's (1997) characterization of the evolution of cross-country income inequality as "divergence, big time" has already become a cliché.

19 The theory of network economies suggests that there is an exponential value to the arithmetic addition of connections to a network. There is far greater value to the individual "connector" in connecting to a large network than connecting to a small one. This theory suggests a potential problem for LDCs. If networks in developing countries are very small, they will have little utility to users. If they have little utility, few new users will join, and so the network will remain small. Roller and Wavermann (1994) argue that the lack of network economies in small networks explains their finding that there is no link between telephones per capita and economic growth below a certain "threshold" level of telephones per capita. Under these circumstances, a digital divide between rich and poor nations should be of concern if it sees poor nations on one side of the threshold and rich nations on the other. There are, however, problems with such an interpretation. First, whilst such a finding would be disappointing, it is not clear what should be done about it. If launching LDCs over the "network threshold" involves moving their levels of per-capita ICT provision significantly closer to developed country levels, we have seen that such a move would be prohibitively expensive. Second, with network economies, the issue at hand is absolute network size, not per-capita measures. The countries in trouble, then, are more likely those with small populations rather than low per-capita incomes. For example, Switzerland, with a mere 1.4 million Internet users in 1999, should have been begging India, with twice that many, for assistance to overcome the crippling disadvantages of a limited

Internet network. Third, for a technology with the "World Wide Web" at its heart, one wonders why national network size is at issue at all. Network connections do not stop at national borders, indeed, especially in nationally small networks, a great percentage of Internet traffic is cross-border (see Africa Internet Forum, 1999). Users in small, poor countries benefit from the opportunity to connect with users in rich, big ones. Empirical evidence that threshold effects are not dramatically reducing the utility of networks in LDCs is that, as we have seen, Internet usage rates and subscriber lines have been expanding dramatically. If LDCs as a whole were caught in a low-use, low utility trap, we would not see such growth.

20 Leamer and Storper (2001) also provide a perspective on the possible effects of the Internet on (de-)agglomeration forces.

21 Looking at the USA, it appears that ICT-intensive industries do "cluster" in that the rate of convergence across regions in terms of employment in such industries occurs at one half of the rate for all industries. Having said that, the evidence suggests that this is not because of technology intensiveness *per se*, but because ICT-intensive industries tend to rely on (unequally distributed) high-skilled labor. ICT-intensive industries that do not rely on high-skilled labor see faster convergence – suggesting smaller clustering effects. In the absence of a high-skilled labor force, then, there is little grounds for thinking there is a "first mover" advantage – and so a role for government support for cluster development – in ICT-intensive sectors (Kolko, 2002).

22 Overall, the Eastern Europe-G-7 use gap for individuals is a factor of about ten, compared to a use gap of less than two-fold for companies. The Tanzania-G-7 access gap for individuals is a factor of over 200, compared to an access gap of less than four-fold for companies (see Kenny, 2002b). Choudhury and Wolf's (2002) study of IT use amongst SMEs in East Africa, based on surveys in Kenya, Tanzania and Uganda, suggests a number of interesting findings. First, the percentage of tourism firms that have a computer in Uganda is five times, and in Tanzania ten times, the percentage of food firms equipped with one (10 percent of Ugandan tourism SMEs and 36 percent of Tanzanian tourism SMEs have a computer). This despite the fact the average capital stock of a food enterprise is approximately twice that of a tourism enterprise. And similar variations occur around the world – in India, for example, 27 percent of plants in the motion picture industry have the Internet as compared to zero percent in sanitation (Joseph, 2002). What this variation suggests is that computer ownership is determined at least as much by considerations of utility particular to the sector or firm as it is by capital availability or macro factors affecting that utility. If government policies or other macroeconomic factors were the driving force behind the net utility of the computer, one would expect little variation across sectors within the same economy. If lack of capital was the major barrier to expanded use amongst SMEs, one would expect lower use in firms with less capital. Instead, the wide variation in computer ownership suggests the unsurprising result that where computers are useful (in attracting global clients to tourism ventures), SMEs buy computers. Where they are not so useful (in the local food industry), SMEs do not buy computers.

23 The data in this paragraph are culled from a number of sources: US air conditioner ownership from Myers (2002), Indian air conditioner ownership from Gallup, Org. (1996) and Internet and income statistics from World Bank, 2001 (WDI). The link between air conditioning and productivity has been convincingly made by Lee Kuan Yew with regard to Singapore (see http://www.neec.gov.sg/aboutus/sub_speech06.shtm), and by Raymond Arsenault with regard to the southern United States in "The Cooling of the South" (*Wilson Quarterly*, Summer 1984).

24 Take access in schools as an example. It may be, as Nicholas Negroponte, founder of the MIT media lab, argued, that an education strategy that focuses digital technology on primary education, particularly in the poorest and most rural areas would have significant returns (Negroponte, 1998) But given the cost of providing one computer per 20 students in LDCs has averaged above $78 per student per year, and annual discretionary budgets per student in the primary schools of least developed countries are as low as $5, it does not appear likely that it is a feasible strategy (Grace and Kenny, 2001). More generally, given that Internet usage rates are very low even amongst those in developing countries with access, it is clear that barriers to use like literacy, language skills, lack of credit facilities and lack of relevant content are likely to lower returns to that access (See Kenny, 2002b).

25 While even the poorest countries of the world were able to attract private capital in telecommunications, we acknowledge that a number of least developed countries – for example, those emerging from armed conflicts – may still be perceived too risky to warrant foreign direct investment. In addition, a short term challenge is that many large operators are currently crippled by debts from over-investments in the late 1990s and lack the resources to enter new markets. At the same time, anecdotal evidence suggests that a number of multinational companies in the ICT sector may in future show greater interest in emerging markets, as over-capacities have reduced investment opportunities in developed country markets.

26 The latest projections by UNAIDS put the cost of the global struggle against AIDS at $10.5bn a year by 2005 and $15bn a year by 2007, up from estimated aid flows of just $3bn in 2002.

27 It is worth noting that a similar paradigm shift has already been called for in the debate about the internal US digital divide. Thierer (2000), for example, questioned the merit of $2 billion programs to extend Internet access whilst usage rates were climbing at a rate historically unprecedented for electronic goods.

28 It is probable that support for education, or policy reform, or improvements in the institutions of governance would be the most efficient way to increase returns to new ICTs. In other words, it is quite likely that the best way to improve the impact of new ICTs on development is to foster development to increase returns to ICTs. Eggs do come before chickens, and at least large chunks of the old economy probably do have to come before the new.

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