

5. A NEW, INCLUSIVE ICT INDEX

As the world moves towards a global information society, countries are becoming increasingly aware of the central importance of extending access to information and communication technologies (ICTs) to their populations. With the growing recognition of ICTs as an effective tool for social development and economic growth, there are ever-greater incentives for countries to foster higher access levels. Alongside countries' desire to increase ICT access at the national level, there is a growing international demand for reliable and comprehensive statistical information to help countries set their own targets, measure progress and make useful international comparisons. For this, a selection of indicators — usually compiled into an index — gives a far better overview than any single indicator.¹

While a number of existing indices go some way to meeting this need, almost all of them concentrate primarily on developed economies, and many do not systematically use internationally comparable indicators. In earlier chapters, this report has attempted to identify a basic set of indicators — aimed at striking an optimum balance between detailed information, and broad applicability across all countries — for measuring access to the information society. In this chapter, existing indices developed by various organizations are reviewed. In light of the strengths and weaknesses of these indices, and building on the previous work by ITU on developing indicators and indices, the framework for a new, inclusive *Digital Access Index* (DAI) is set out.

5.1 Why indices are important

An index combines multiple indicators into a single overall value. The values obtained for ICTs, for

instance, can be used to generally represent the state of ICT development in a country. One of the main benefits of an index is that ICT development can be compared between individual countries, categories or regions. Comparisons are particularly valuable between countries of similar income level, or with similar geographic, social or regional characteristics, because they can provide an excellent basis for realistic targets or policy decisions to be established. Indices are equally useful in measuring ICT developments over time. A time series index allows for comparisons from one year to the next in an economy, permitting policy-makers to judge the effectiveness of ICT programmes and initiatives. Furthermore, nations often struggle in certain areas of ICT but may excel in others. An index can capture multiple effects and produce results that tell a wider, more complete story about the economy than a single indicator. Other factors such as social and demographic conditions or affordability also have an impact, which can be reflected to some extent by using an index.

While the advantages of an index are undeniable, it is also important to bear in mind the limitations of narrowing a large amount of information into a single figure. An index is useful for simplifying comparisons but should not be used to draw overly simplistic conclusions. This is true of all scores and rankings of this nature, which are always imperfect due to methodological assumptions that may not be applicable to every country, and to missing or incorrect data.

A trade-off has to be made by index designers between breadth of coverage and level of detail. Data collection

is rarely symmetric. In other words, different economies provide different levels of detail in different data areas. Indices aimed at providing greater detail will use a higher number of variables, resulting in a smaller set of “well-covered” economies. Covering a wide range of economies on the other hand, requires limiting the number of variables used. Data omissions or errors will have a stronger relative influence on the overall index score.

5.2 Existing ICT indices

A number of organizations—intergovernmental, private and academic—compile ICT indices.² This section briefly examines some of the most popular ones.

The World Economic Forum (WEF) publishes a Network Readiness Index (NRI) that measures “*the degree of preparation of a nation or community to participate in and benefit from ICT developments*”.³ Categories include environment, readiness and usage. The 2002-03 index covers 82 countries over a range of 120 indicators, and offers a mixture of qualitative and quantitative data, with a large number of variables coming from surveys. Benefits of the index include coverage over a wide range of variables, a detailed methodology, and the use of statistical tools to build categories and impute missing data. One drawback is use of survey results for data that are susceptible to respondent bias. Although the index covers more countries than most other indices, it still is limited to less than half of the nations in the world.

The latest version of the market research firm International Data Corporation’s (IDC) Information Society Index, which claims to be the oldest of all ICT indices, examines and ranks countries according to their ability to “*absorb and utilize Information and Information Technology*”.⁴ The index covers 53 countries and contains 15 variables organized into four categories: computers, Internet, telecommunication and social. While the latest set of variables are quite relevant and the categories logical, indicators for social aspects tend to be qualitative, making comparisons more difficult. Unfortunately, the IDC does not make its detailed methodology publicly available so it is difficult to analyse. The methodology also changed in 2003, implying that results cannot necessarily be compared with previous years, and rankings cover only a limited number of countries.

The Economist Intelligence Unit publishes an annual index — now in its fourth year — of e-readiness rankings.⁵ Covering the sixty largest economies, the

index allows “*countries to compare and assess their e-business environments*” and determines “*the extent to which a market is conducive to Internet-based opportunities*”. The index uses around 100 variables organized into the following six categories: connectivity and technology infrastructure; business environment; consumer and business adoption; social and cultural environment; legal and policy environment, and supporting e-services. The index focuses primarily on business adoption of ICT and there are a large number of qualitative variables, making objective analysis more difficult.

As another example, the Mosaic Group provides a framework for measuring the state of Internet diffusion in an economy.⁶ Six factors are rated: pervasiveness, sector absorption, connectivity, organizational structure, geographic dispersion, and sophistication of use. Each factor is ranked on a scale of zero (non-existent) to four (highly developed). The Mosaic group does not combine the six factors to compute an overall index score for a country although others, notably ITU, have done so (Box 5.1). The methodology is well documented, so that values can and have been computed by different groups. However, the lack of an overall score makes it more difficult to make broad comparisons of the overall state of Internet diffusion in different countries. Also, the mix of quantitative and qualitative data in the analysis means that scores are more vulnerable to subjective interpretation.

Another interesting index comes from Orbicom.⁷ Their “Infostate” Index ranks 139 economies based on 17 indicators across two categories. What makes the Orbicom index different is that it compiles each country’s index in relation to the average of all of the other countries’ indicators. The index has been constructed so that one can observe changes over time and index values going back several years are provided. All data used is quantitative so that subjective bias is avoided. One drawback is that some of the indicators selected such as Internet hosts or secure servers may not be optimum for representing the actual situation in a country.

There have also been several one-off indices. The United Nations Development Programme (UNDP), for instance, included a Technology Achievement Index (TAI), in its 2001 *Human Development Report*.⁸ Using eight variables spread over four categories the TAI measured the technological capacity in a country. While the TAI did not solely measure ICTs, many of its variables were ICT related. The TAI, in keeping with the methodology of UNDP’s other indices, used

a limited number of variables. One interesting element was the attempt to measure the developmental chain of technology in a country. The first category looked at the creation of technology, the second and third at diffusion, and the last at how prepared users were for the technologies. The index put more emphasis on fewer variables, with the disadvantage that the choice of indicators and data omissions or discrepancies had a large impact on the score. For example, the selection of “Internet hosts per capita” instead of measuring actual Internet users falls prey to the unreliability of Internet hosts. This is because Internet hosts may be registered within a country, but they may equally be registered outside it, leading to a distortion of the national figures. Despite the low number of variables,

the index could be compiled for only 72 countries, providing a limited picture of global ICT levels.

The United Nation Conference for Trade and Development (UNCTAD) has produced several indices measuring the development of ICTs in economies.⁹ As with Mosaic, UNCTAD does not combine the category scores to produce an overall ICT score. Rather, the work presents four separate indices that can be used to measure certain elements of development, namely connectivity, access, policy environment, and usage. In addition to building the four indices, UNCTAD averages the scores from the connectivity and access indices to create an ICT Diffusion Index. UNCTAD’s methodology uses a

Box 5.1: ITU indices

As the United Nations’ agency responsible for telecommunications, and as part of its mandate to help extend the benefits of ICTs to the world’s populations, ITU has long been involved in developing statistics and in analysing ICT developments. While many other indices have drawn upon ITU resources, ITU itself has recently developed its own indices.

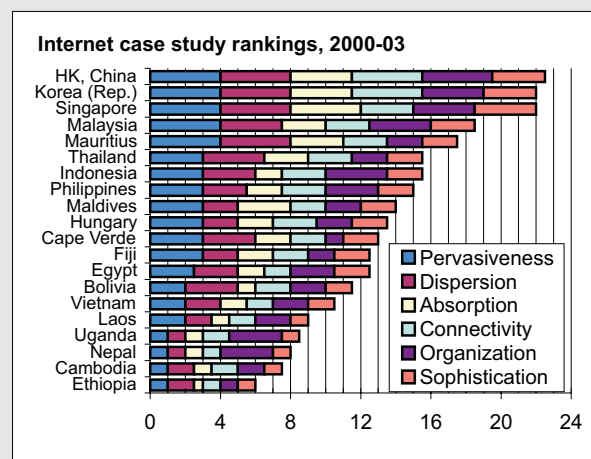
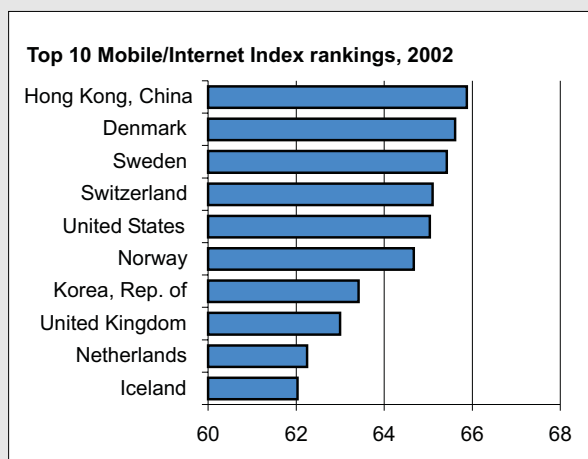
In its fourth Internet Report, *Internet for a Mobile Generation*, ITU published a Mobile/Internet index in 2002 measuring the relative levels of mobile and Internet development (Box Figure 5.1, left).¹⁰ This index also attempted to predict how well each economy might take advantage of ICTs in the future. The index covered 177 economies with 26 quantitative variables broken into three clusters: infrastructure, usage and

market structure. Benefits of the Mobile/Internet Index methodology include the use of strictly quantitative data, a significant number of variables and wide coverage. Among improvements identified for this index are the use of a weighting structure for categories and inclusion of a method for testing the robustness of rankings.

As part of the Internet Case Studies project, ITU used the Mosaic Group framework for measuring the state of Internet diffusion in different economies.¹¹ Overall scores for the six categories: - pervasiveness, sector absorption, connectivity infrastructure, organizational infrastructure, geographic dispersion, and sophistication of use - have been compiled for 20 economies (Box Figure 5.1, right).

Box Figure 5.1: ITU indices

Top ten economies in Mobile/Index, 2002 (left) and Mosaic values of ITU Internet Case Study economies, 2000-03 (right)



Source: ITU Internet for a Mobile Generation and ITU Internet Country Case Studies.

Box 5.2: “Lies, Damned Lies and Statistics”¹²

The Republic of Korea is well advanced in information and communication technology (ICT) development. It leads the world in broadband Internet access, is ranked fourth in overall access to the Internet and was one of the first countries to launch third-generation mobile Internet services. It has achieved universal access, not only with practically every household having telephone service, but also with two-thirds having broadband Internet access. Korea also has one of the leading ICT manufacturing sectors in the world. Related to the high level of ICT development is the fact that Koreans rank high in literacy and overall educational achievement. Yet, on most international ICT rankings, Korea is not in the top ten. Why the discrepancy between the statistics and the rankings?

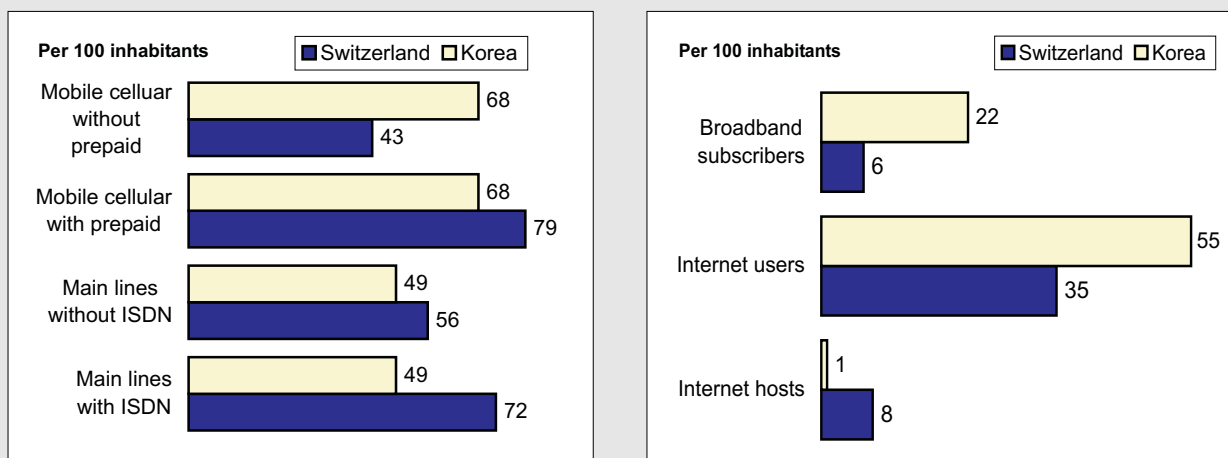
For one thing, there is often a bias of quantity over quality. The rankings are typically designed to favour a common denominator of widely available indicators, rate high per capita values without adjusting for methodological discrepancies, and do not include adjustments for qualitative differences. The potential inaccuracies of such an approach can easily be illustrated by comparing Korea and some usually higher-ranking countries, for example Switzerland.¹³ Like many European nations, Switzerland includes Integrated Services Digital Network (ISDN) channels in the number of main lines—a common indicator in all of the indices, which effectively inflates the total figure reached. Korea on the other hand, does not include ISDN channels. If the number of physical telephone lines were compared, Korea would in fact rank relatively higher (Box Figure 5.2, left). A similar situation exists for mobile cellular subscriber figures that include prepaid cards. This figure is distorted because not all prepaid cards are active. As Switzerland has a high proportion of prepaid cards, it

appears to rank higher than Korea on this indicator. Korea on the other hand, has few mobile prepaid subscribers and consequently has a more realistic, but relatively lower, figure for total mobile penetration.

Another methodological weakness is that many surveys use the number of Internet hosts per capita to measure Internet usage. This is misleading since host computers can be located anywhere and are not necessarily in the country of their domain name. On a per capita basis, the number of Internet host computers in Korea—based only on the .KR domain name—is relatively low, affecting its ranking. On the other hand, Korea’s high level of Internet and broadband penetration is rarely reflected in the standings (Box Figure 5.2, right).

Global rankings also appear to be biased in favour of theoretical perceptions of competitiveness rather than actual achievement. In general, few Asian nations rank among the top ten. Hypothetical assumptions appear to have more weight with the rankings more focused on the means rather than the ends. For example, a nation that supposedly allows a greater degree of competition than another would be ranked higher even though the latter might have a far greater level of infrastructure. Another shortcoming is that the rankings tend to weight per capita income highly. In the case of Korea, it is doing exceedingly well in ICTs despite a relatively low per capita income. If anything, Korea’s ranking should be raised because of this fact. In terms of purchasing power parity, Korea’s per capita income is twice that of the conventional measurement. The case of Korea suggests that these scorecards are not very useful in accurately measuring ICT achievements in some countries.

Box Figure 5.2: Re-comparing Korea and Switzerland



Source: ITU World Telecommunication Indicators database.

limited but robust group of variables to capture ICT effects, with the risk of some distortions owing to the small number of variables used.

The indices described above are not the only ones available, of course, but they do provide an idea of the major ones developed to date, and of the pitfalls encountered in the design of such indices. While there is no shortage of ICT indices then, none is completely satisfactory for measuring access to ICTs, especially with regard to the low number of countries covered. Furthermore, most are not specifically targeted at measuring ICT access, and some have methodological snags or are susceptible to distortions due to the use of qualitative variables (see Box 5.2). While there are also a number of commercial organizations that compile indices, these often make only general summaries available to the public and charge substantially more for complete data. Wherever these indices use too many variables, transparency and comparability are compromised.

5.3 The Digital Access Index

ITU has developed a Digital Access Index (DAI) to measure the overall ability of individuals in a country to access and use ICTs. Among other things, it can be used to track Target 18 of Millennium Development Goal 8, which calls upon governments to: “make available the benefits of *new* technologies, specifically information and communications” (see Chapter four).

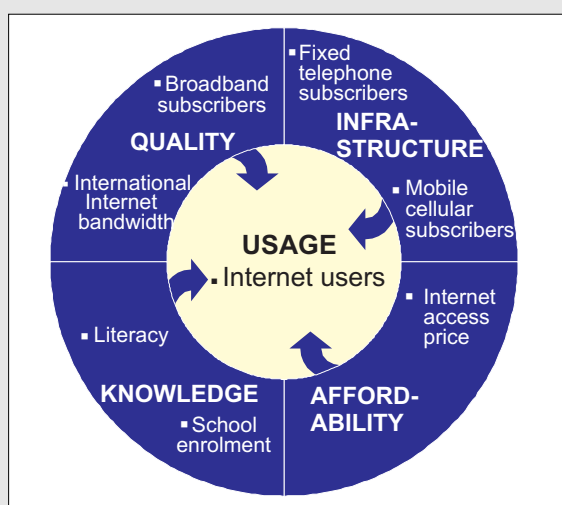
The DAI overcomes limitations of earlier indices, in terms of its specific focus on access, country coverage and choice of variables. The DAI has three main aims. One is to measure a country’s capacity for using ICTs. The second is to be digitally *inclusive*, that is, to embrace as many countries as possible in the index. A third is to make the index as transparent as possible. These considerations suggest that the index would be composed of a few, but well chosen variables, in order to include the widest number of countries and enhance clarity.

Four fundamental factors impact a country’s ability to access and use ICTs (Figure 5.1 and Box 5.3). These are availability of infrastructure, affordability, educational level and quality. If the infrastructure is not available, there can be no access. If the population cannot afford to pay for ICT products and services, there can be no access. If citizens do not have a certain level of education, they will not be able to use newer ICTs such as computers or the Internet. If the ICT experience is poor, people will either cease using them or be incapable of using them effectively or creatively. Finally, in addition to the aforementioned four factors, a fifth — actual usage of ICTs — is critical for matching reality with theory. As described later, the inclusion of usage also captures other aspects not explicitly accounted for in the other four factors.

Beyond this range of factors, it can of course be argued that others also affect ICT access. However, it is important to concentrate on only those factors that affect immediate availability. For example, a liberalized ICT market could result in more competition that might lead to additional infrastructure or a drop in prices. But that impact does not affect what a country has today in terms of infrastructure, people’s ability to pay for it or the skills that are in place to do so. Moreover, although levels of liberalization may have an impact, it is unclear how that affects ICT development. In reality, there are countries that measure up as having a restrained regulatory environment, but that are doing well in ICTs, and vice versa. The degree of market liberalization is also difficult to quantify objectively. Conversely, other policy areas that are not directly related to the ICT sector, also have an impact on ICT access. One such example is a country’s educational system. External factors will therefore be more useful for the interpretation of the results, rather than as actual indicators, for example by using them as explanatory variables for why some countries are doing better than others.

Figure 5.1: Factors affecting ICT access

Indicators making up the Digital Access Index



Source: ITU.

Box 5.3: Factors impacting ICT access

Although the impact of infrastructure, pricing and education on Information and Communication Technology (ICT) access seems obvious from an intuitive angle, it is useful to match these assumptions with the reasons people give for not using ICTs. In order to do this, Internet user surveys were analysed. Some surveys have questions asking non-users why they do not currently use computers or the Internet. The most common reasons given are affordability, lack of infrastructure and lack of skills.

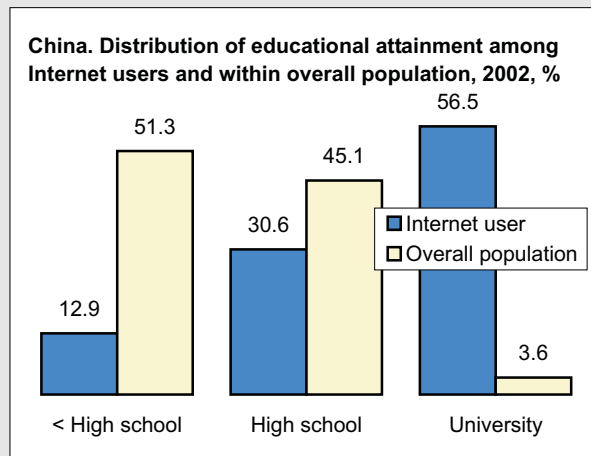
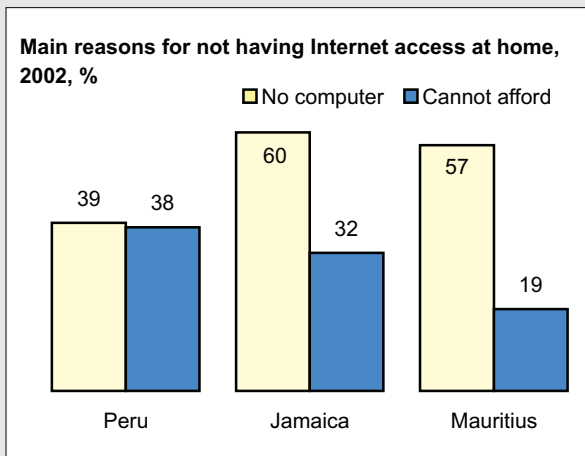
Unavailability of *infrastructure* is often cited as a main barrier. This is borne out in data from Jamaica where the main reason (60 per cent of cases) for not having home Internet access was the lack of a personal computer (PC). The lack of a PC is also the main reason given in Peru (39 per cent). Likewise in Mauritius, the main reason cited for not having Internet access was “No equipment” (57 per cent of respondents).

Affordability is also a major barrier. In Peru, 38 per cent of respondents say they cannot afford Internet access while in Jamaica the corresponding figure is 32 per cent. In Mauritius, affordability was the third largest reason for not having Internet access, cited by 19 per cent of respondents.

The impact of *knowledge* on PC and Internet use is striking, as shown by the educational profiles of users. In China, those with some university education account for over half the Internet users even though they only account for four per cent of the overall population. Students also have a disproportionate share with 28 per cent being Internet users though they represent only 18 per cent of the population. The contrast is similarly striking in developed nations. In the Netherlands, where 90 per cent of those with a university education use a PC, twice as many highly educated people use the Internet as less educated persons. The influence of knowledge is also reflected in barriers to ICT use questions where a common answer is that the respondent does not know how to use computers. In Venezuela the main reason given for not using the Internet is that the respondent does not know how to (27 per cent).

Quality is also an important issue, particularly for those already online. In many surveys, quality is typically a major complaint and often revolves around speed. In China, thirty per cent of users are unsatisfied or disappointed with the speed of the Internet. In Thailand, speed is the main subject of complaint, cited by 63 per cent of respondents.

Box Figure 5.3: Factors impacting ICT access



Source: ITU World Telecommunication Indicators database.

5.3.1 Selection of variables

In an ideal index, the variables for measuring infrastructure would include availability of ICTs in homes, schools, businesses and the government, as well as in public locations such as post offices, libraries and Internet cafés. Affordability variables would consist of various ICT service prices in relation to income, ideally from household expenditure surveys. Educational variables would

comprise measurements of the digital literacy of the population. Quality variables would incorporate objective measurements of the service reliability and speed of networks. Unfortunately most of the variables suggested above are available only for a limited number of countries. At the present time, an “ideal” index built on this basis would exclude so many countries that its usefulness would be very limited.

The need for the DAI to be inclusive and intuitively understandable has an impact on the variables selected. The use of too many variables poses problems in terms of data collection and verification, and can lead to overlap. Careful consideration of a few well-thought out variables can suffice to represent ICT access, a case of “quality rather than quantity”. This also reinforces the goal that users of the index should understand it easily. The actual values of the variables used can be presented together with the index, thereby enhancing transparency.

With a view to achieving an optimum balance, the DAI consists of a selection of eight variables categorized into five areas: infrastructure, affordability, knowledge, quality and usage. The variables to be included in the DAI have been selected as proxies for the categories they represent (Table 5.1). The categories and variables have been chosen based on extensive case study research and previous literature on ICT indices.

Although the DAI aims to capture the ability of individuals to access and use ICTs, there is a bias towards Internet access. One reason is that access to the Internet is often put forward as a major policy goal. Much of the discussion behind the information society revolves around the ability of citizens to access information and online business and government services that are delivered over the Internet. The MDGs also refer to making available “new technologies.” While other ICTs such as radio or television may be perceived as more relevant for some developing countries, they do not offer the same range and interactivity as telephones or the Internet. The inclusion of broadcasting variables in the index would have had little relevance for a number of economies and work against inclusiveness by limiting the usefulness of the DAI to a particular group of countries. In any case, inclusion of broadcasting statistics would have practically no effect on a country’s relative ranking since there is a direct relation between availability of newer technologies and older ones. On the other hand, access to the Internet is an issue in every country. The focus on the Internet also has the advantage that it encompasses other ICTs. For example, computers are not included in the index but since the vast majority of Internet access is via a computer, their availability is captured. Similarly, telephone service is reflected in both its selection as an infrastructure indicator, and as a component of pricing when applicable. Mobile cellular service is also included in the DAI while cable television is covered when used for Internet access.

The *infrastructure* category contains variables that proxy overall network development. The variables included are the number of *fixed telephone subscribers* and *mobile cellular subscribers*. Fixed and mobile telephones provide the means for voice, fax and data communications. Dial-up Internet access is the prevalent means of Internet access in most countries. In others, where broadband access is growing, digital subscriber line (DSL) technology also uses the conventional telephone line. While cable television, leased lines and fixed wireless access paths are important, they are not included because they currently are not a predominant form of ICT access in most countries. In any case, the effect of these alternative access networks is largely captured in the *quality* category described below.

The *knowledge* level of a country has a significant impact on the ability to use new technologies. The educational attainment of the adult population (as reflected by literacy statistics) and the number of students both impact ICT take-up. *Adult literacy* and *overall school enrolment*—widely available for many countries from international sources—are used as proxies for the capacity of the population to use new ICTs. There are weaknesses with these indicators. For example, the definition of literacy varies widely among nations. Furthermore skills beyond basic literacy are needed to use newer ICTs such as the Internet. Research has shown that even among countries with high levels of basic literacy, true levels of literacy are lower.¹⁴ ITU has carried out research on development of knowledge indicators for the information society.¹⁵ Unfortunately the required indicators are not widely available for most countries.

Affordability plays a key role in determining users’ digital opportunities. Although infrastructure may be widely available, it must also be affordable if it is to be used. Affordability is measured by the *price of Internet access as a percentage of per capita income*. Internet access prices generally reflect the relative prevailing tariffs for other methods of access such as Internet cafés or leased lines. The dial-up price would also include telephone usage charges if applicable, serving as a proxy to some extent for telephone service charges. Internet access prices used in the DAI assume a usage factor of one hour per workday per month. In most countries, the price of dial-up access (averaged over ten hours of peak time and ten hours of off-peak time) is used since it is often the only method of consumer access or is cheaper than broadband access. If broadband prices are cheaper than dial-up then they are used instead. Pricing cannot be viewed in isolation

and the speed of the connection to the Internet affects the price. However, the major objective is to establish affordability so the cheapest Internet access prices were selected regardless of the speed offered. The speed factor is also covered by the next category: quality.

The *quality* category deals with the impact that the experience of using ICTs has on access. If the experience is poor because of slow speed, then either people will not use ICTs, or they will not be able to use them effectively and creatively. This category also allows for greater distinction to be introduced in the index. For example, many developed nations have high values for infrastructure, affordability and education. The inclusion of a quality category allows for finer granularity. The variables selected for quality are the amount of *international Internet bandwidth* and the number of *broadband subscribers*.¹⁶ In many developing countries, most Internet access is to sites abroad and therefore the amount of international bandwidth has a major impact on performance. In many developed countries, people visit domestic sites so that international bandwidth is not as important as

“last mile” bandwidth. The number of broadband subscribers measures this, with broadband defined as access technologies faster than 128 kbit/s in at least one direction. This includes DSL, cable modem and wireless technologies.

The *usage* category measures the actual utilization of ICTs. Given the infrastructure, affordability, education and quality aspects of a country’s ICTs, a variable is needed to gauge the extent of their utilization. The number of Internet users is selected as the usage variable. In addition to capturing usage, the variable also incorporates aspects of access not easily captured by the other categories or where additional variables would have been necessary. For example, Internet users can proxy for the number of computers, as well as the prevalence of Internet cafés. If a country has many users accessing the Internet from Internet cafés and other public locations, this would be reflected in the number of users. While usage does to some extent reinforce the impact of other categories its explanatory power for socio-cultural aspects and other variables not included in the DAI more than merit its inclusion.

Table 5.1: DAI Indicators

Indicators used to construct the DAI

<i>Category</i>	<i>Variable</i>	<i>Indicator ~</i>
1. Infrastructure	Fixed telephone subscribers § Mobile cellular subscribers	1. Fixed telephone subscribers per 100 inhabitants 2. Mobile cellular subscribers per 100 inhabitants
2. Affordability	20 hours per month of Internet access*	3. Internet access as percentage of Gross National Income (GNI) per capita **
3. Knowledge	Literacy ^ School enrolment ^	4. Adult literacy 5. Combined primary, secondary and tertiary school enrolment level
4. Quality	International Internet bandwidth (Mbit/s) Broadband subscribers #	6. International Internet bandwidth per capita 7. Broadband subscribers per 100 inhabitants
5. Usage	Internet users	8. Internet users per 100 inhabitants

Note: § = Public Switched Telephone Network (PSTN) + Integrated Services Digital Network (ISDN) subscribers.
 * = Cheapest dial-up or broadband plan averaged over 20 hours of peak and 20 hours of off-peak usage.
 ** = Annual average exchange rates from the International Monetary Fund are used to convert the Internet tariffs to United States dollars. GNI per capita data is from the World Bank.
 ^ = Obtained from the United Nations Development Programme’s Human Development Index.
 # = Including Digital Subscriber Line (DSL), cable modem and other technologies faster than 128 kbit/s in at least one direction.
 ~ = BankPopulation data for converting the variables to indicators is obtained from the national statistical agency.

Source: ITU.

5.3.2 Methodological issues

The variables selected for the DAI must be made comparable before they are combined. This is done by converting the variables into indicators, generally by dividing them by the population does this. The indicators are then “normalized”, a process, which transforms the indicators into a value between zero and 1, so they can be added or averaged. “Goalposts” (i.e. minimum and maximum values that may be achieved) are used to normalize each country’s data. Care must be taken in choosing the goalposts to avoid the index becoming outdated.¹⁷ If the goalpost is surpassed, the index must either assign a value of 1 to the variables or increase the goalpost, requiring all previous years to be recalculated.

Normalizing telecommunication variables is more difficult than for other kinds of data since the values change so frequently with technological development. As stated above, variables such as *mobile subscribers per 100 inhabitants* can now reach levels greater than the total population, making it difficult to establish long-term goalposts. Also, as technology changes, new ICTs emerge. For example an index designed five years ago most probably would not have included broadband. The definition of high-speed today could be too slow for applications ten years from now. At the same time, some technologies can reach a peak or go into decline.

The goalposts for the DAI are designed partly through logic and partly through examining existing values. This was influenced by the objective that countries should be able to achieve a perfect ranking. It was also assumed that countries could and do start from zero in any variable (e.g. a country that does not yet have a mobile cellular network) so this was established as a minimum goalpost. The goalposts chosen are shown in Table 5.2 and Figure 5.2 and are further described below.

A single index value is computed for each of the five DAI categories. Weights must be assigned to each indicator for categories that have multiple indicators. The logic behind the weights chosen for multiple indicator categories is described below. An example showing how the DAI is compiled is given in Box 5.6.

One aspect of building an index is ensuring that values for all the variables are included. In other words, it can prove impossible to gather identical, fully compatible variables for every single country. In general, this is not an issue with the DAI as it uses widely available data. Nonetheless, some data is not officially collected by some countries, the latest data is not always available, and data for some economies is not available from the standard source. These difficulties have generally been

overcome by using reliable secondary source data, by estimating the latest data based on past years values and using national data when internationally comparable data is not available.

The *infrastructure* category consists of the two indicators *main telephone lines per 100 inhabitants* (teledensity) and *mobile cellular subscribers per 100 inhabitants* (mobidensity), both of which come from the ITU World Telecommunication Indicators database. In order to enhance comparability, main telephone lines are defined as fixed telephone subscribers plus payphones. This means that Integrated Services Digital Network (ISDN) subscribers rather than channels are included.¹⁸ The goalpost for teledensity has been set at 60. The highest observed value was 69.3 back in 1998; since then teledensity has been declining due to mobile substitution as well as less need for second lines due to broadband. The goalpost for mobidensity has been set at 100. Though this figure has already been exceeded as noted above, this is mainly due to inactive prepaid accounts and second mobile phones. A mobidensity of over 100 implies that all adults (and many youth) would have at least one mobile phone. Teledensity and mobidensity are given equal weight (50 per cent) in computing the infrastructure category value. The reason is that even though in most countries there are now more mobile subscribers than fixed telephone lines, most Internet access is still via fixed lines. At the same time, mobile phones can be used to provide Internet access and this is likely to grow in the future.

The *affordability* category is compiled from the price of twenty hours of monthly Internet access divided by monthly per capita gross national income (GNI). The cheaper of dial-up or broadband is used. The Internet price data were collected by the ITU during the third quarter of 2003 using information from the largest Internet service provider (ISP) in each country, and incumbent telephone operators. The tariffs are converted to the United States dollar equivalent using the 2002 annual average exchange rate. The GNI per capita income data come from the World Bank.¹⁹ National data is used for economies for which World Bank data is not available. Subtracting the proportion of monthly income that Internet tariffs consume from 1 creates an *affordability indicator*. The logic behind this conversion is to create an indicator where a high value is desirable so that it is consistent with the other indicators. The goalpost for this indicator is 1, a situation where the Internet would be free. On the other hand, where the affordability indicator is negative (e.g. prices are more than per capita income), no points are awarded since a person cannot spend more on Internet access than they earn.

Table 5.2: DAI goalposts
Maximum values for DAI indicators

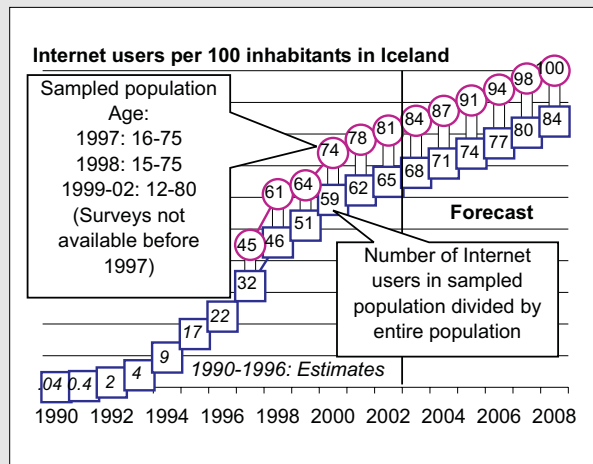
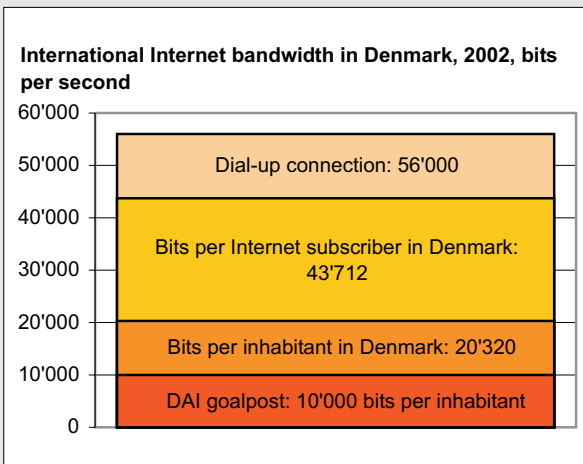
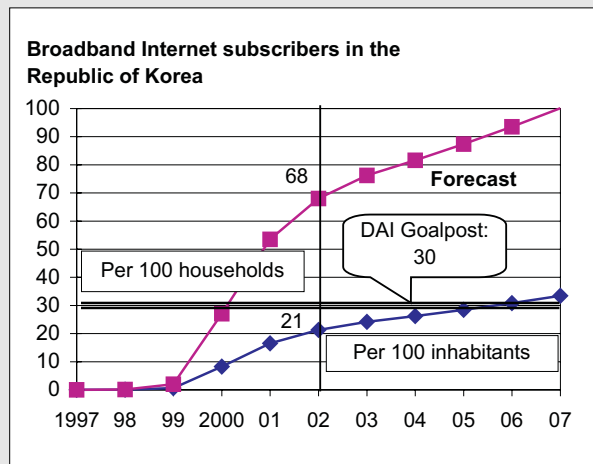
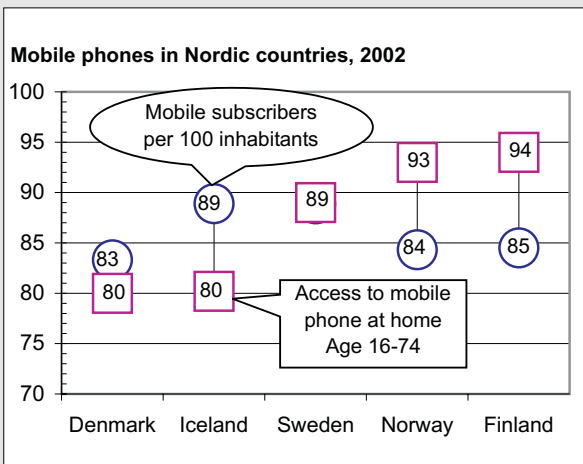
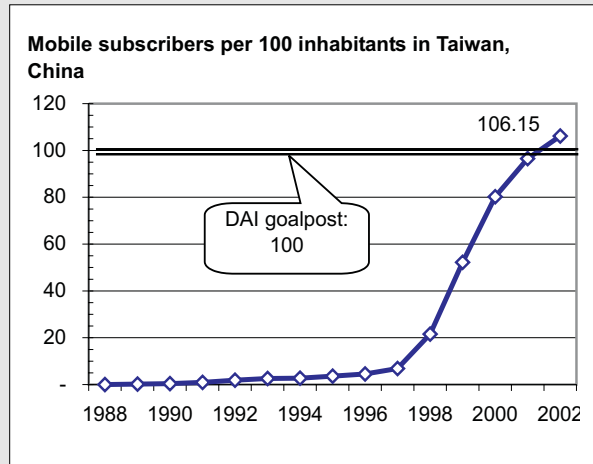
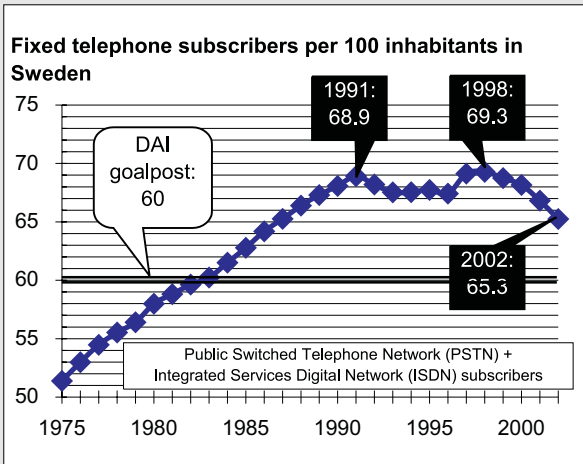
<i>Indicator</i>	<i>Value</i>	<i>Note</i>
Main telephone lines per 100 inhabitants	60	The number of fixed telephone line subscribers has been in decline since 2000. ²² The highest record value for this indicator was 69.3; by Sweden in 1998. This has since declined to 65.3. It seems unlikely therefore that the highest value will ever again be attained. It appears that much of the decline in fixed telephone lines is due to substitution by mobile phones, a fairly recent phenomenon as well as replacement of second lines used for Internet access by higher speed alternatives, which share the same line. It will take some years before the high value for main lines per 100 inhabitants reaches a stable level. A goalpost of 60 implies a very well developed fixed line network.
Mobile subscribers per 100 inhabitants	100	Mobile phones are a more personal possession than fixed telephone lines that tend to be shared in households or offices. Thus it is logical to set a higher threshold. The value of 100 has already been reached by two economies: Luxembourg and Taiwan, China. This level implies that all inhabitants have a mobile phone. Of course in practice this is not realistic since infants and very young children would not use mobile phones. Thus there is some duplication (e.g. from people having more than one phone, from non-residents that may take out a mobile subscription in the country they work). Duplication could also arise from delays in administrative records between when a subscriber stops using a subscription on one network and switches to another. Though a lower value might be set at which it might be estimated that all inhabitants that are able to use a mobile phone would have one, this would vary among countries. A limit of 100 implies that all adults have at least one mobile phone.
Literacy	100	The United Nations Development Programme establishes these values. ²³
School enrolment	100	
Affordability	1	The goalpost for this indicator is 1, a situation where the Internet would be free. On the other hand, where the affordability indicator is negative (e.g. prices are more than per capita income), no points are awarded since a person cannot spend more on Internet access than they earn. Some people make much more than the average and could afford access. However when affordability exceeds the average income in the country, the Internet is clearly out of the financial reach of most inhabitants.
Broadband subscribers per 100 inhabitants	30	Broadband access is still evolving so the penetration limit is unknown. The Republic of Korea leads the world with 21 broadband subscriptions per 100 inhabitants at the end of 2002. This translates into a household broadband connection rate of 68 per cent. At a level of 30 per 100 inhabitants, more than ninety per cent of households would have a broadband connection in Korea.
International Internet bandwidth per capita	10'000	This level has already been exceeded in three countries and most notably Denmark, where the value is more than twice the goalpost. This indicator is computed on a per capita basis but in reality the actual amount of international bandwidth available to an Internet user would be much higher.
Internet users per 100 inhabitants	85	The highest value for Internet penetration over the entire population occurs in Iceland with a rate of 65. This corresponds to 81 per cent of Icelanders aged 12-80. A goal post of 85 for this indicator implies that all in that age range are using the Internet.

Note: Minimum goalposts are always 0.

Source: ITU.

Figure 5.2: Economies shaping the DAI goalposts

Fixed telephone subscribers in Sweden 1975-2002 (top left); Mobile telephone subscribers per 100 inhabitants in Taiwan, China, 1988-2002 (top right); Mobile phones per 100 inhabitants and access to mobile phone at home (age 16-74), Nordic countries, 2002 (middle left); Broadband internet subscribers per 100 inhabitants and 100 households, Republic of Korea, 1997-2007 (middle right); International Internet bandwidth in Denmark, bits, 2002 (bottom left); and Internet users per 100 inhabitants, Iceland 1990-2008 (bottom right)



Source: ITU World Telecommunication Indicators database, Nordic Information Society Statistics, Statistics Iceland, TeleGeography.

The *knowledge* index is computed from the adult literacy rate and the gross school enrolment. Adult literacy is defined by the UNDP as “*The percentage of people aged 15 and above who can, with understanding, both read and write a short, simple statement related to their everyday life.*”²⁰ Overall school enrolment refers to the gross rate and is defined as the number of students in primary, secondary and tertiary schools divided by the population of that school age. The figure can exceed 100 due to repeaters or those older or younger than the official school age being enrolled. These data are from the UNDP and are used in its Human Development Index (HDI). The goalposts (both 100) and weighting (two thirds for literacy and one third for school enrolment) correspond to the HDI methodology.

The *quality* index consists of two indicators, bits per capita and broadband subscribers per 100 inhabitants, both from the World Telecommunication Indicators database.²¹ Bits per capita are computed by dividing the international Internet bandwidth by the population

of the country. There are some definitional issues with international Internet bandwidth. This includes what value to assign when the bandwidth is not symmetrical (e.g. the incoming bandwidth is greater than the outgoing). Some countries add the incoming and outgoing bandwidth while others use one or the other. Another point is that international bandwidth may not be as relevant in countries that have a large amount of domestic content. This category of countries would tend to have less need for international bandwidth and this will be reflected in a lower score. The goalpost for bits per capita is set at 10’000, a considerable amount considering not all of the population will be accessing the Internet at the same time. Because the international Internet bandwidth per capita varies tremendously and is arguably more important at initial stages of Internet development—when not much local content is available—the value is transformed using a logarithmic function. If the data were not transformed, the value would be close to zero for many developing nations because of the high goalpost. The goalpost for broadband subscribers per 100 inhabitants

Box 5.4: Testing the robustness of the DAI

The weighting methodology of an index can have a large impact and should be tested to ensure robustness. Spearman rank and Pearson correlation tests are statistical tools that can be used to measure how sensitive an index is to changes in category weights. Essentially, they test whether different weighting scenarios produce overall index values that are statistically different from one another.

The robustness of the DAI is tested using several variations on the weighting structure. The scores are first calculated by simply averaging the categories. Second, the weights are determined by a principal components analysis. Lastly, five variations assign 40 per cent of the weight to one cluster and 15 per cent to each of the remaining categories. Once the scores for each weighting scheme are calculated, a Spearman rank test and Pearson correlation are run over all possible weighting schemes.

	<i>Infrastructure</i>	<i>Affordability</i>	<i>Knowledge</i>	<i>Use</i>	<i>Quality</i>
Averages	20%	20%	20%	20%	20%
Principal components	21%	19%	18%	20%	21%
Variation 1	40%	15%	15%	15%	15%
Variation 2	15%	40%	15%	15%	15%
Variation 3	15%	15%	40%	15%	15%
Variation 4	15%	15%	15%	40%	15%
Variation 5	15%	15%	15%	15%	40%

The resulting Pearson and Spearman coefficients indicate that all the weighting methods are statistically identical in terms of the overall DAI value. The lowest Pearson coefficient is 0.96 between variations 2 and 4 and the lowest Spearman coefficient is 0.98 between variations 2 and 3. These high scores do not imply that the values for individual economies

will not change. Rather, the changes will be so slight that they will have no statistically significant effect on the overall rankings of the index. Therefore, the most appropriate weighting scheme for the DAI is the method of averaging categories, as it is more transparent than more complex schemes.

is set at 30, a value implying that all households would have a connection. Each indicator is given equal weight in the category.

The *usage* index consists of Internet users per 100 inhabitants with the data from the World Telecommunication Indicators database. The goalpost is set at 85. The reason is that it is unrealistic to assume that all inhabitants will use the Internet. The question of at what age the Internet becomes relevant is difficult to answer. Although some surveys compile the number of Internet users from the age of two it seems questionable how many very small children could use the Internet effectively. Also, the limit of the number of Internet users per 100 inhabitants will vary depending on the age structure of the country. The value of 85 is an estimate of the average percentage of the worldwide population aged ten and over.

The majority of indices simply average category scores to obtain an overall index value, the same practice followed by the DAI (i.e. each category is assigned equal weight of 0.2). This technique has several advantages. First, it is the most transparent weighting method. Each category receives the same amount of weight in the final calculation, regardless of the number of variables it contains. Indices computed this way are easy to decompose and understand for users. It is worth noting that an equally weighted index causes a high score in one category to compensate for a deficiency in another.

The DAI was continually revised and refined throughout the construction process. There was an iterative process between the logic of test results and the selection of variables and weighting. The DAI was also subjected to various statistical tests measuring the weightings and correlation of the variables (Box 5.4).

5.4 Results

The results of the DAI lend themselves to a particular categorization of economies (Table 5.4 and Figure 5.3):

- **High (0.7 and above).** Economies in this category have achieved a high level of access to digital technologies for a majority of their inhabitants. There is sufficient infrastructure, prices are affordable, knowledge levels are high and efforts are being placed on enhancing quality through the provision of faster access. The main criterion that distinguishes economies in this category is usage.

This often seems to be more related to the social-cultural characteristics of the population than any of the DAI factors. For example, why is Iceland's Internet penetration highest in the world when it is not top-ranked in any of the other DAI categories? The individual rankings for economies in this group are close so that a minor change in calculation can shift a country's ranking a few notches. The statistical calculations are based on general assumptions that sometimes do not reflect the underlying realities of individual countries, adversely affecting their score. For example, countries such as Canada, the Republic of Korea, Japan and the United States score relatively low on international Internet bandwidth per capita. One reason is that they have extensive domestic content so there is less need for users to access overseas sites. The usage category is most susceptible to comparability since Internet user surveys differ in measurement of age ranges and the frequency of use.

Of note is the select group of five countries that have a DAI value of above 0.800. These include four Nordic countries: Sweden, Denmark, Iceland and Norway. Their presence at the top reflects that region's traditional emphasis on equitable access, affinity for technology and top-notch infrastructure. Perhaps one surprise is the Republic of Korea, ranked fourth in the DAI. This should not be unexpected since Korea was the first nation to launch a third generation mobile network and is the world leader in broadband penetration. Korea is an inspiring message to other countries of how quickly progress can be made in lifting digital access (see Section 5.5.3).²⁴

The group of high DAI economies is homogenous, almost all emanating from the developed regions of Western Europe, North America, East Asia and the Pacific. The International Monetary Fund classifies them as advanced economies. The one exception is Slovenia. That Central European nation has been an early adopter of technology. It connected to the Internet back in 1992 and government sponsored Internet access encouraged many Slovenes to go online in the mid 1990s. Mobile phone growth has also been rapid and literacy and school enrolment levels are close to those of European Union members. The establishment of a Ministry of Information Society²⁵ and ongoing liberalization of the telecommunication industry suggest that Slovenia could raise its level of digital access even higher in the years to come.²⁶

- **Upper (0.5-0.69).** Countries in this group have achieved an acceptable level of access for a majority of their inhabitants. What often sets this group apart from the high category is imbalance in a specific category. For example some countries in this group may have a high level of infrastructure availability but score low in affordability. Analyzing the separate category values can be useful for policy-makers seeking to find out where their countries are weak in access to the information society.

This group of economies have a degree of homogeneity. For the most part the upper DAI group consists of countries from Central and Eastern Europe, the Caribbean, Gulf States and emerging Latin American nations. Many of these nations have a strong interest in ICTs as a development enabler. In Central and Eastern Europe, this is reinforced by European Union trends and ICT objectives for candidate countries.²⁷ The potential of ICT industries to generate economic growth is a focus among Caribbean nations. They are particularly keen about offshore software development and ICT services support which are viewed as complementary to the island states location, English-speaking population, knowledge levels and good quality infrastructure. Other upper DAI governments are committed to major ICT projects such as the *Dubai Internet City* in the United Arab Emirates (the highest ranked non-advanced, non-European nation in the DAI), the *Multimedia Super Corridor* in Malaysia (the highest ranked developing Asian nation in the DAI) and the *Cyber City* in Mauritius (along with Seychelles, the highest ranked African nation in the DAI).²⁸

This is a competitive collection of countries, with many aiming to graduate to a higher level of digital readiness. Some are eager to accomplish this through ambitious government projects while others are hoping market liberalization will provide the impetus. Most are combining the two. It is clear that this is one group where complacency risks falling behind. The DAI will provide a useful yardstick for measuring their progress over the coming years.

- **Medium (0.3-0.49).** The biggest barrier to higher levels of digital access in this group is a shortage of infrastructure. Nations in this group are primarily Latin American and South East Asian, along with some from Africa and the Middle East and North Africa. They would benefit from greater

liberalization of their ICT markets to make them attractive for investors.

The presence of three least developed countries (LDCs) in this group is notable (Cape Verde, Maldives and Samoa). Cape Verde and the Maldives have partly privatized their telecommunication operators resulting in increased effectiveness and access to networks. In Cape Verde over 90 per cent of the country is covered by mobile cellular whereas in the Maldives, all inhabitants are within walking distance of a telephone. What these countries need to do is to leverage their infrastructure accomplishments into higher levels of digital access. This includes increasing training and awareness and launching innovative services to tempt a larger portion of the population online.

Peru ranks high despite a relatively low level of infrastructure. It is positioned between two countries that have twice the level of telephone penetration. The explanation is Peru's high level of Internet access compared to other countries in this group. This is due to the widespread availability of Internet cafés. This raises Peru's level of usage, helping to compensate for low values in other categories.

Other countries in this group are attempting to replicate Peru's success with mass Internet access. For example "free" Internet access was introduced in Egypt in January 2002. Instead of Internet access provider charges, users now only pay a nominal rate for dial-up telephone usage. As a result Egypt now has among the lowest Internet access prices in the world, reflected in the affordability category of its DAI. In Tunisia, all tertiary and secondary schools are connected to the Internet and there are plans to connect all primary ones. There are also 280 public access facilities. The Government is hoping that expansion of public access facilities will lift the number of Internet users by a factor of six, from half a million at end 2002 to three million by the end of 2006. This would boost Tunisia's DAI to just below the upper level. Perhaps with an extra effort, Tunisia could reach that level when it hosts the second World Summit on the Information Society in 2005.

- **Low (less than 0.3).** Countries in this category are the poorest in the world and most are LDCs. They have a minimal level of access to the information society. Their lack of digital access is one more deprivation along with poverty and hunger and shortages of basic human needs such as good

shelter, clean water and adequate health care. Apart from low levels of communication infrastructure, a factor that almost all countries in this group have in common is relatively high access prices. In most nations in this group, an hour a day of Internet access exceeds the average daily income. There is little hope of this group joining the information society unless prices are dramatically reduced. This should be a primary focus of development assistance, particularly since greater use of ICTs in these countries could help achievement of the Millennium Development Goals (see Chapter four).²⁹

Although this group has the common factor of high communication charges, there are significant variations among other DAI categories, notably knowledge. Indeed the major factor having an impact on a country's rank among this group is its level of literacy and school enrolment. This suggests that there is significant potential for countries with high knowledge levels if other barriers could be overcome. For example, contrast Syria and Zimbabwe, two of the highest ranked economies of this group. Zimbabwe's Internet penetration is more than three times higher than Syria's. One reason is because Zimbabwe has a high knowledge level—its literacy rate is the highest in Africa—preconditions for a higher level of digital access.³⁰ If Zimbabwe had Syria's level of infrastructure, it would be in the medium DAI

category. Conversely, if Syria had Zimbabwe's literacy level and Internet penetration, it too would be in the medium category. Hence the DAI helps to identify different solutions for these two different countries to raising their level of digital access.

5.5 Future work

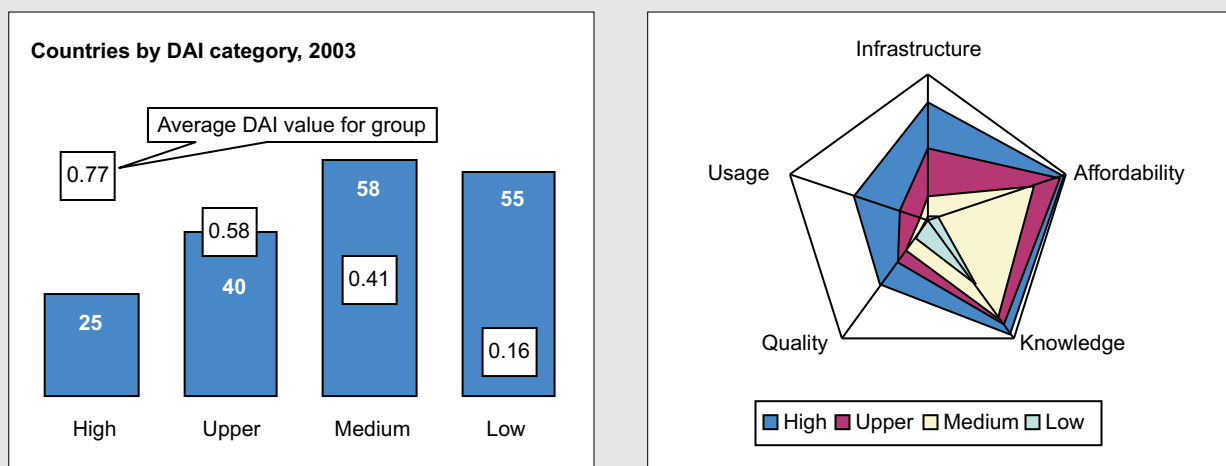
The DAI has been presented as an initial attempt to create a transparent way of measuring access to newer ICTs. As it is still in its infancy, this index will be further developed on the basis of comments and inputs from countries and researchers. We envision that this feedback will help ITU to optimize the usefulness of the index. Hopefully, the DAI will also generate an improvement in the data. While most of the data for the variables are widely available, there are some for which the quality is uncertain. This includes the number of Internet users that is not based on surveys for around half the countries. There are three areas where additional work on the DAI would be useful: national indices, gender disaggregated indices and the construction of time series.

5.5.1 National DAIs

While comparisons between countries will be one of the main purposes of the DAI, the index can equally be used to measure the level of access within a nation. One problem many countries have is selecting an appropriate indicator to measure internal access to ICTs. The DAI can identify internal digital divides so

Figure 5.3: The digital divide through the DAI

Average country Digital Access Index (DAI) value by DAI classification and category, 2002



Source: ITU.

that priority can be focussed on underserved areas to promote equitable nationwide access. Few countries today have all of the data needed to carry out such analysis. Some, such as Chile publish most of the needed indicators on a disaggregated national level that can be used to calculate a DAI sub-index for its 13 regions.³¹ Calculating regional DAIs uncovers a number of challenges. In terms of infrastructure, many countries have a breakdown of main telephone lines by region. However the availability of disaggregated mobile cellular subscribers is more problematic. This is due to the widespread popularity of prepaid cards. While the number of prepaid subscribers can be ascertained at a country level this is practically impossible at the provincial level. This is because prepaid cards do not require a subscription so the residence of the purchaser is unknown. Thus while administrative records exist for subscription-based subscribers in Chile, there is no such data for prepaid subscribers. A proxy could be obtained from surveys by querying respondents about whether they have a mobile subscription. This has been done in Chile at both the individual and household level but the survey is not carried out on an annual basis.

Another challenge is the computation of regional affordability. Internet access prices are not always uniform nationwide. In some countries, the absence of points of presence (POPs) and lack of nationwide calling numbers can mean that those in rural areas pay long distance calling charges for Internet access. Internet tariffs can also vary because the same ISPs may not operate nationally. Another challenge is to obtain per capita GNI on a regional basis. Instead, regional incomes are usually computed on a household income basis as is the case in Chile.

Knowledge indicators can also be difficult to obtain. The UNDP has carried out national human development reports for a number of countries where these data are available. However this is often not carried out on a regular basis. In the case of Chile, disaggregated indicators for adult literacy and school enrolment at the regional level are available from the UNDP for 1998.³²

Quality indicators also pose a challenge. Like main lines, broadband subscriptions can be derived from administrative records at a regional level as is the case of Chile. More difficult is a regional measure of international Internet bandwidth. This is because in many countries, international Internet gateways only exist in a few locations. Traffic is then distributed via local networks to their destination. Thus the concept

of international bandwidth is not so logical in a regional sense. A proxy might be the amount of national bandwidth available at the regional level. Although Chile has several domestic fibre optic and satellite networks, data could not be obtained on the regional distribution of bandwidth. In many cases, national backbone speeds are uniform so the bandwidth would be the same. In Chile, nine provincial capitals and the national capital are linked by a 155 Mbps fibre optic asynchronous transfer mode (ATM) backbone. The other provinces use slower speed satellite connection.

As mentioned throughout the report, many developing nations do not carry out Internet surveys and therefore do not have disaggregated provincial-level data. Though Internet subscriptions by province are sometimes available, these are not an ideal proxy because of the variations that can exist between the number of subscriptions and actual users. Other countries may carry out surveys but not on an annual basis. This is the case of Chile where a nationwide survey with data disaggregated at a regional level was carried out in November 2000 but has not been updated since.

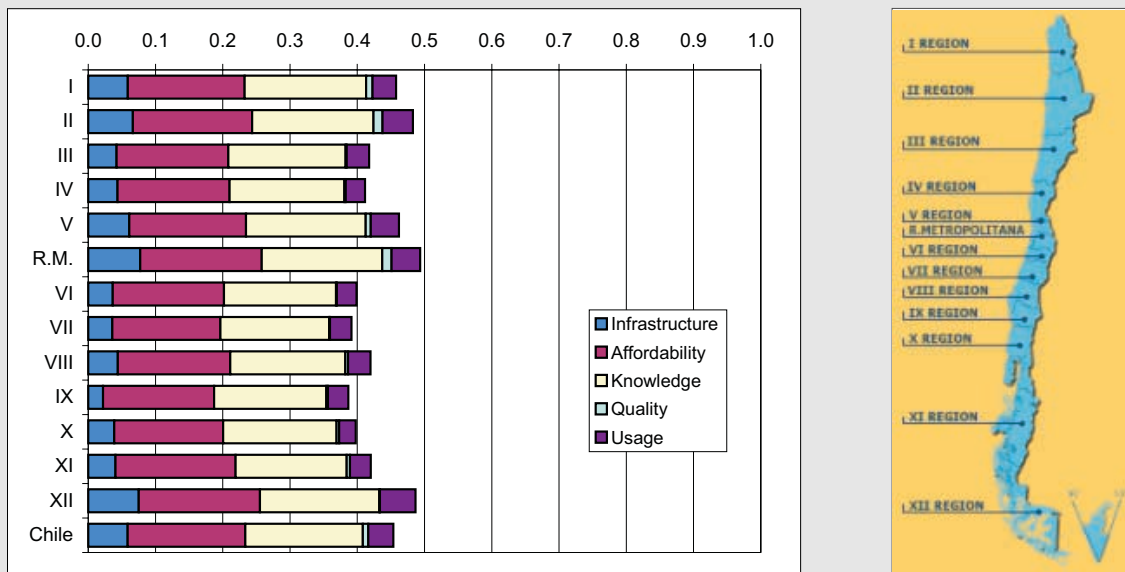
To summarize the Chilean situation, DAI indicators or reasonable proxies are available at a provincial level except international Internet bandwidth. The main limitation is that the data set is not consistent across time. The indicators on main telephone lines and broadband subscriptions are from December 2002, mobile subscribers and Internet users from November 2000 and the other indicators from 1998. It is nonetheless possible to derive regional indices since the data are from the same date for all provinces with the caveat that this would not be comparable to Chile's actual country level DAI and hence to other countries. The results indicate that though there are variations in the DAI across Chile's regions, they are not glaring. The difference between the highest DAI value—in the capital Santiago—and the lowest—in Araucanía in Region 9—is 28 per cent (Figure 5.4). The main reason for the discrepancy is infrastructure (including broadband Internet access) rather than affordability or knowledge. This would suggest that efforts should be devoted to enhancing infrastructure in Chile's remote provinces.

5.5.2 A gender disaggregated DAI

Just as the DAI can be disaggregated at a regional level within a country, it could theoretically be split along other characteristics such as age, income and gender. With regards to gender, it is important to have

Figure 5.4: National DAI

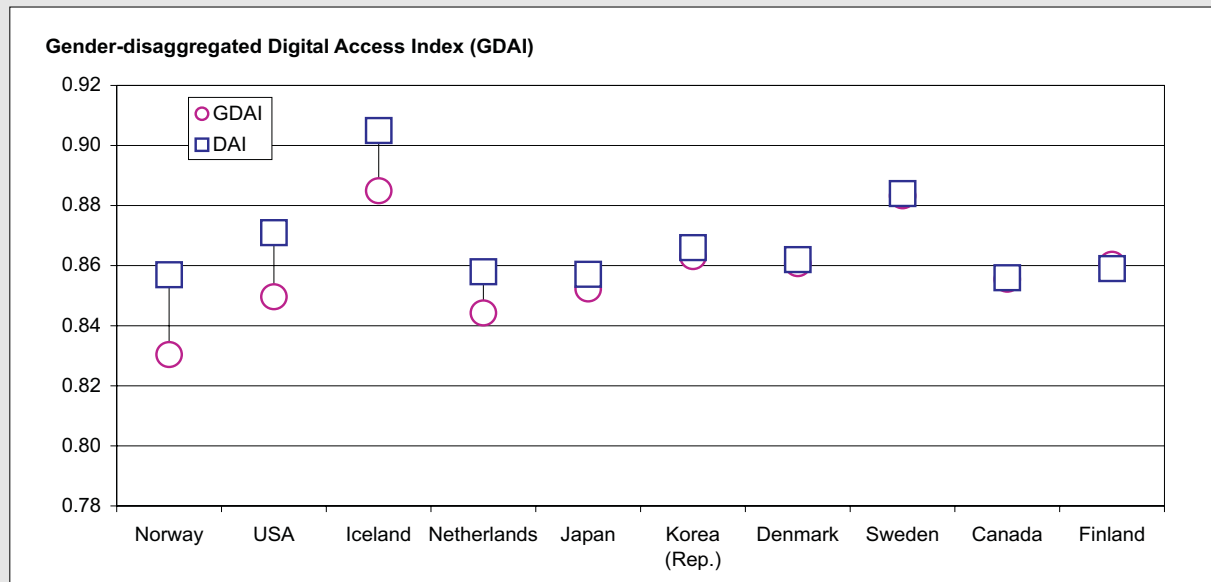
DAI in Chile's regions, 2002



Note: See text for modifications to DAI necessary for a regional index for Chile.

Source: ITU.

Figure 5.5: A gender modified DAI



Note: The DAI was reconstructed along the same categories as those used for the gender-disaggregated version (i.e. affordability, knowledge and usage). A gender-disaggregated index was then calculated for the resulting top ten ranked economies.

Source: ITU.

an understanding of the level of access between males and females (Box 5.5). One limitation is data availability. Infrastructure data such as fixed, mobile telephone and broadband subscriptions are obtained from administrative records and are not available on a gender disaggregated basis. In any case their inclusion in the DAI was meant to show the availability of infrastructure rather than how it is used. Trying to create gender-disaggregated data for this category of indicators would therefore be contrary to their purpose. It is much like measuring a country's transport network. The main criterion is the availability of roads rather than who is using them. Another issue is conceptual. Some indicators do not lend themselves to clear gender delineation. For example, fixed telephones are typically shared in offices or homes and not "owned" by a specific person.

Parts of the DAI do lend themselves to disaggregation by gender. This includes social indicators such literacy and school enrolment as well as the Internet users in the usage category. In addition, per capita income is available by gender. These indicators can be used to create a gender sub-index: affordability, knowledge and usage. Thus three of five DAI categories (excluding infrastructure and quality) can be calculated along gender lines. The major problem is data availability, particularly for Internet users disaggregated by gender. A gender sub-index has been calculated for selected economies to illustrate the possibilities (Figure 5.5).³³ The results show that there is not always a relationship between a country's DAI result and equity in access.

Another possibility is to design a modified DAI using proxies for the indicators. These proxies do not always support the strict purpose of the DAI but nonetheless would give a more complete picture of female access to ICTs (Table 5.3).

5.5.3 DAI over time

One of the most important uses for the DAI will be to measure progress over time. While monitoring future change is important, it is also insightful to extend the index into the past to analyse the historical performance of countries. One drawback is that time series for Internet access prices and international Internet bandwidth are lacking for many countries. When the former are available, they often have not been calculated using the same methodology as the DAI, making comparisons difficult.

Comparable data for 1998 have been obtained for 40 economies covering most developed and major developing nations. Despite the short time span of four years (1998 compared to 2002) there were noteworthy differences in relative DAI rankings, illustrating how rapid technological diffusion has been (Figure 5.6). The most striking development is the improvement of Asian economies particularly the Republic of Korea and Taiwan, China. The Republic of Korea improved its rank the most, moving up 20 places among the 40 economies examined. Taiwan, China was next, moving up 13 places. Korea's rapid progress reflects strong government commitment to ICTs with the payoff noticeable in high levels of broadband connectivity and Internet usage. Taiwan, China's jump shows the effect of telecommunication liberalization, particularly in the mobile sector, moving the economy to the number one position in the world in terms of penetration. Several predominantly Anglophone nations dropped in the rankings. This may mark a turning point in the internationalisation of ICTs with English becoming less of an advantage than it was in the past. Indeed one observation from the Asian economies that have improved their rankings is the growth of digital content. The development of local content in non-Latin scripts, such as Chinese, Korean and Japanese, has progressed at a fast pace. These three languages make up eleven per cent of Internet content a higher figure than either French or Spanish.³⁷

Box 5.5: Thai Women Online

A glance at Internet penetration shows that the gap between developing and developed nations is substantial. Thailand, for example, had 4.8 million Internet users in 2002 – a mere 7.8 per cent of the population. However, if the data is gender disaggregated, a different picture emerges. Thai women account for 45 per cent of the total Internet users in the country. When compared to developed European nations this is impressive (Box Figure 5.5, left).

Women’s ability to take advantage of ICTs is dependent upon a number of cultural and structural factors, such as education, affordable access, impediments to usage, etc. What makes the measurement of such factors imperative is that average education or income levels assume gender neutrality. For example, the United Nations Development Programme (UNDP) has calculated a gender-related development index (GDI) out of its popular human development index (HDI). A comparison of the difference between GDI and HDI ranks shows that Thailand performs better in gender (+2) compared to countries such as Luxembourg (-3), the Netherlands (-2) and Spain (-1).

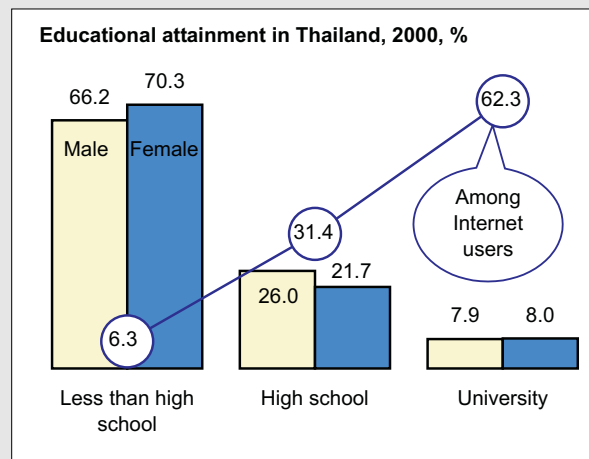
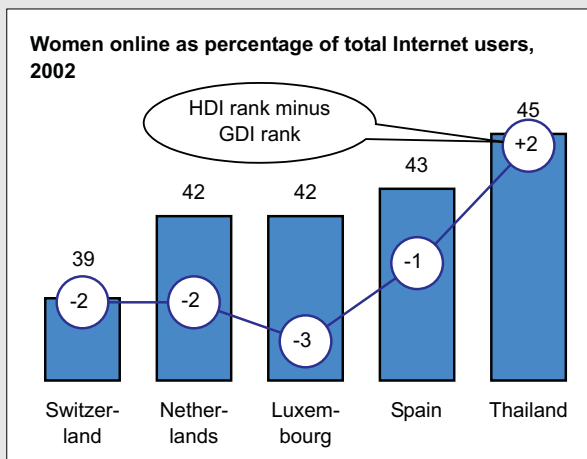
Delving deeper into the causes behind the relatively high figure for female Thai Internet users highlights a number of factors. Education, for instance, is essential for gender equality. It allows women to participate in the decision-making process within the family, the community, at work and in the political arena. There is also a close link between education—the

number of students a country has or the educational level of its population—and Internet use. In Thailand, opportunities for females improve as they move up the educational ladder. Gender disaggregated school enrolment figures show that more women than men enrol in secondary and tertiary institutions. Males have a slight advantage in the overall educational level of the population with around a three per cent higher rate in literacy. However this lead is dissipating and already there are slightly more college-educated women than men (Box Figure 5.5, right).

The Internet in Thailand is mainly accessed from either the household or work and men and women log on in almost exactly the same proportions from these locations. Unlike other countries, there are also no social barriers preventing Thai women going online from places such as Internet cafés. Within the household, Thai women wield a significant amount of economic power and have historically controlled family finance.³⁴ Because they are encouraged to contribute to the economic well being of the family unit, women contribute significantly to the country’s economy. Female labour force participation in Thailand stands at an astounding 73 per cent as compared to the figure for the United States — 59 per cent. Thai women are encouraged to participate in the economic well being of the family unit, and have thus worked alongside men. High Internet use from the place of work, and the high proportion of women working point to an important factor leading to the high numbers of Thai women on the Internet.

Box Figure 5.5: Thai Women Online

Women online as a percentage of total Internet users, selected economies, 2002 (left) and educational attainment by sex, Thailand, 2000 (right)



Note: In the left chart, HDI = UNDP Human Development Index and GDI = UNDP Gender-related Development Index. In the right chart, educational attainment refers to population age 6 and over.

Source: ITU adapted from national Internet surveys, National Statistical Office — Thailand, National Electronics and Computer Technology Center — Thailand (NECTEC), United Nations Development Programme (UNDP).

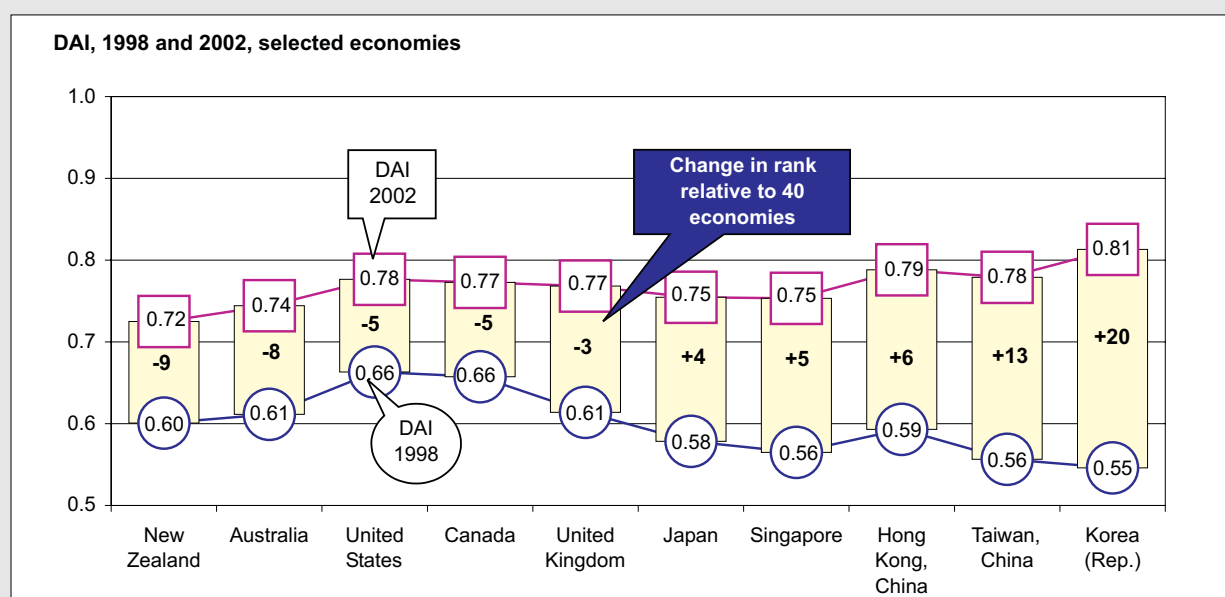
Table 5.3: Substitutes of DAI indicators for gender analysis

<i>DAI indicator</i>	<i>Substitute gender indicator</i>	<i>Note</i>
Main telephone per 100 inhabitants	Not available	Available data suggest that women tend to use fixed telephones more than men. ³⁵ However there is scarce research on female access to fixed telephone lines.
Mobile cellular subscribers per 100 inhabitants	Percentage of females with access to mobile phone at home	A number of countries have compiled this statistic through surveys.
Internet access tariffs as % of GDP per capita	Internet access tariffs as % of female estimated earned income	UNDP provides income data disaggregated by gender.
Adult literacy School enrolment	Female adult literacy rate Female overall school enrolment ratio	UNDP provides literacy and school enrolment data disaggregated by gender.
Broadband subscribers per 100 inhabitants	Percentage of female broadband Internet users	Singapore has compiled this statistic through a survey. ³⁶
International Internet bandwidth per capita	Not available	There is scarce research on access or usage of international Internet bandwidth by gender.
Internet users per 100 inhabitants	Percentage of females using the Internet	A number of countries compile this statistic in national Internet user surveys.

Source: ITU.

Figure 5.6: Reversal of fortune

DAI values in 1998 and 2002, selected economies



Source: ITU.

Box 5.6: Compiling the Digital Access Index

The following example shows how the Digital Access Index (DAI) is compiled for Hong Kong, China. The Office of the Telecommunications Authority (OFTA) provided all ICT infrastructure data. Population and Internet usage statistics are from the national statistical agency, the Census and Statistics Department (C&SD). The Internet access prices are from i-Cable. Hong Kong is a role model for data availability with all of these indicators freely available on the OFTA, C&SD and i-Cable websites.³⁸ As for other economies, GNI per capita, exchange rates, literacy and school enrolment are from international sources.

DAI data for Hong Kong, China

2002

Indicator	Value
Population	6'786'100
Gross National Income (GNI) per capita in United States dollars (US\$)	US\$ 24'750 (2'063 month)
Annual average exchange rate (Hong Kong Dollar (HK\$) to one (US\$))	7.80
Fixed telephone subscribers	3'841'787
Fixed telephone subscribers per 100 inhab.	56.6
Mobile cellular subscribers	6'218'984
Mobile subscribers per 100 inhabitants	91.6
20 hours Internet access per month	HK\$ 30 (US\$ 3.85)
Adult literacy (age 15 and over)	93.5
Combined school enrolment (gross primary, secondary and tertiary)	63
International Internet bandwidth	12'668 Mbps
Bits per capita	1'866.8
Broadband subscribers	989'115
Broadband subscribers per 100 inhabitants	14.6
Internet users	2'918'800
Internet users per 100 inhabitants	43.0

Source: OFTA, C&SD, i-Cable, World Bank, IMF, UNDP.

Infrastructure

The goalpost for fixed telephone subscribers per 100 inhabitants is 60: $56.6 / 60 = 0.94$.

The goalpost for mobile cellular subscribers per 100 inhabitants is 100: $91.6 / 100 = 0.92$.

Each indicator is weighed equally:

$$0.94 \times (1/2) + 0.92 \times (1/2) = 0.47 + 0.46 = 0.93.$$

Affordability

Affordability indicator:

$$1 - (20 \text{ hours of Internet access} / \text{Monthly GNI} * 100) = 1 - (\text{US\$ } 3.85 / \text{US\$ } 2'063) = 0.2998.$$

The goalpost for affordability is 0.1 : $1 - (0.2998 / 100) = 0.998$.

Knowledge

The goalpost for literacy and enrolment is 100³⁹: $93.5 / 100 = 0.935$ and $63 / 100 = 0.63$.

Literacy is given two-thirds weight and enrolment one third: $0.935 \times (2/3) + 0.63 \times (1/3) = 0.83$.

Quality

The goalpost for bits per capita is 10'000. Because of the extreme range among economies and the fact that international bandwidth is more critical at early stages of development, logarithms are used to transform the values: $(\text{LOG}(1'866.8) - \text{LOG}(0.01)) / (\text{LOG}(10'000) - \text{LOG}(0.01)) = 0.88$.

The goalpost for broadband subscribers per 100 inhabitants is 30: $14.6 / 30 = 0.49$.

Each indicator is weighed equally: $0.88 \times (1/2) + 0.49 \times (1/2) = 0.44 + 0.24 = 0.68$.

Usage

The goalpost for Internet users per 100 inhabitants is 85: $43.0 / 85 = 0.51$.

DAI

The Digital Access Index is the average of the five categories above:

$$(0.93 \times 0.2) + (0.998 \times 0.2) + (0.83 \times 0.2) + (0.68 \times 0.2) + (0.51 \times 0.2) = \mathbf{0.79}.$$

Table 5.4: DAI results

Economy	Sub. lines p. 100 inhab.	Mobile sub. p. 100 inhab.	Internet tariff as % of GNI	Adult literacy	School enrolment	Int'l Internet bandwidth P. 100 inhab.	Broad-band sub-scribers p. 100 inhab.	Internet users p. 100 inhab.	INFRA-STRUCTURE	AF-FOR-DABILITY	KNOWLEDGE	QUALITY	USAGE	DAI
HIGH														
Sweden	65.2	88.9	1.1	98.5	113	10'611.2	8.0	57.3	0.94	0.99	0.99	0.64	0.67	0.85
Denmark	57.4	83.2	0.7	99.5	98	20'284.9	8.2	51.2	0.89	0.99	0.99	0.66	0.60	0.83
Iceland	51.9	90.7	0.9	98.5	91	236.5	8.2	64.9	0.89	0.99	0.96	0.50	0.76	0.82
Korea (Rep.)	48.6	67.9	1.2	97.9	91	361.5	21.9	55.2	0.74	0.99	0.96	0.74	0.65	0.82
Norway	50.4	84.3	0.8	99.5	98	4'981.6	4.5	50.2	0.84	0.99	0.99	0.55	0.59	0.79
Netherlands	48.5	74.5	1.2	99.0	99	10'327.5	6.6	50.6	0.78	0.99	0.99	0.61	0.60	0.79
Hong Kong, China	56.6	91.6	0.2	93.5	63	1'866.8	14.6	43.0	0.93	1.00	0.83	0.68	0.51	0.79
Finland	46.3	84.5	1.1	98.5	103	3'185.5	5.3	50.9	0.81	0.99	0.99	0.55	0.60	0.79
Taiwan, China	57.4	106.4	0.7	96.0	93	658.6	9.4	38.3	0.98	0.99	0.95	0.56	0.45	0.79
Canada	61.3	37.7	0.7	98.5	94	2'841.8	11.1	51.3	0.69	0.99	0.97	0.64	0.60	0.78
United States	65.0	47.3	0.5	98.5	94	1'323.6	6.9	55.1	0.74	0.99	0.97	0.54	0.65	0.78
United Kingdom	53.4	83.9	1.1	98.5	112	5'402.8	3.1	42.2	0.86	0.99	0.99	0.53	0.50	0.77
Switzerland	55.7	78.4	0.7	98.5	88	8'991.7	6.2	34.9	0.86	0.99	0.95	0.60	0.41	0.76
Singapore	46.2	79.4	0.6	92.5	75	1'414.0	6.5	50.3	0.78	0.99	0.87	0.54	0.59	0.75
Japan	47.7	63.7	0.8	99.5	83	237.7	6.2	54.5	0.72	0.99	0.94	0.47	0.64	0.75
Luxembourg	53.4	105.3	0.9	98.5	73	3'271.7	1.3	36.7	0.94	0.99	0.90	0.48	0.43	0.75
Austria	40.4	80.9	1.7	99.5	92	4'421.6	5.5	40.9	0.74	0.98	0.97	0.56	0.48	0.75
Germany	48.2	72.7	0.7	99.5	89	3'155.8	3.9	41.2	0.76	0.99	0.96	0.52	0.48	0.74
Australia	51.7	64.0	1.1	98.5	114	533.9	1.8	48.2	0.75	0.99	0.99	0.42	0.57	0.74
Belgium	42.4	78.6	1.5	98.5	107	8'121.4	8.4	30.9	0.75	0.99	0.99	0.63	0.36	0.74
New Zealand	45.3	62.2	1.1	99.0	99	584.7	1.4	45.7	0.69	0.99	0.99	0.42	0.54	0.72
Italy	41.5	92.5	1.0	98.5	82	1'179.8	1.9	34.7	0.81	0.99	0.93	0.45	0.41	0.72
France	52.0	64.7	0.8	98.5	91	3'269.8	2.8	31.4	0.76	0.99	0.96	0.51	0.37	0.72
Slovenia	44.0	83.5	3.1	99.6	83	539.7	2.8	37.6	0.78	0.97	0.94	0.44	0.44	0.72
Israel	43.5	95.5	2.1	95.1	90	213.7	2.0	30.1	0.84	0.98	0.93	0.39	0.35	0.70
UPPER														
Ireland	40.1	76.3	1.4	98.5	91	3'434.5	0.3	27.1	0.72	0.99	0.96	0.47	0.32	0.69
Cyprus	62.4	58.5	1.7	97.2	74	236.4	0.8	29.4	0.79	0.98	0.89	0.38	0.35	0.68
Estonia	35.1	65.0	3.9	99.8	89	409.6	3.4	32.8	0.62	0.96	0.96	0.44	0.39	0.67
Spain	44.6	80.1	1.7	97.7	92	1'112.7	3.0	15.2	0.77	0.98	0.96	0.47	0.18	0.67
Malta	52.3	69.9	2.3	92.3	76	391.4	4.5	20.9	0.79	0.98	0.87	0.46	0.25	0.67
Czech Republic	33.4	84.9	4.5	98.5	76	2'189.1	0.2	25.6	0.70	0.96	0.91	0.45	0.30	0.66
Greece	52.4	84.5	2.4	97.3	81	222.0	0.0	15.5	0.86	0.98	0.92	0.36	0.18	0.66
Portugal	35.4	81.9	2.3	92.5	93	386.2	2.5	19.2	0.71	0.98	0.93	0.42	0.23	0.65
United Arab Emirates	34.2	75.9	0.8	76.7	67	339.1	0.5	36.7	0.66	0.99	0.73	0.39	0.43	0.64
Macao, China	39.8	62.5	1.0	91.3	55	489.1	3.8	26.0	0.64	0.99	0.79	0.45	0.31	0.64
Hungary	32.6	67.6	4.1	99.3	82	1'048.3	1.1	15.8	0.61	0.96	0.94	0.44	0.19	0.63
Bahamas	40.6	39.0	2.0	95.5	74	464.7	6.3	19.2	0.53	0.98	0.88	0.49	0.23	0.62
Bahrain	26.3	58.3	4.1	87.9	81	292.4	0.7	24.7	0.51	0.96	0.86	0.38	0.29	0.60
St. Kitts and Nevis	50.0	31.9	4.2	97.8	70	42.2	1.1	21.3	0.58	0.96	0.89	0.32	0.25	0.60
Poland	29.5	36.3	4.1	99.7	88	163.6	0.0	23.0	0.43	0.96	0.96	0.35	0.27	0.59
Slovak Republic	26.8	54.4	6.3	100.0	73	1'516.0	0.0	16.0	0.50	0.94	0.91	0.43	0.19	0.59
Croatia	39.0	53.5	4.4	98.4	68	41.2	0.3	18.0	0.59	0.96	0.88	0.31	0.21	0.59
Chile	23.0	42.8	6.1	95.9	76	131.6	1.3	23.8	0.41	0.94	0.89	0.36	0.28	0.58
Antigua & Barbuda	47.8	32.1	2.8	86.6	69	359.0	0.0	12.8	0.56	0.97	0.81	0.38	0.15	0.57
Barbados	47.9	19.7	3.2	99.7	89	24.2	0.0	11.2	0.50	0.97	0.96	0.28	0.13	0.57
Malaysia	19.3	37.7	2.9	87.9	72	53.8	0.1	32.0	0.35	0.97	0.83	0.31	0.38	0.57
Lithuania	26.4	47.6	11.2	99.6	85	94.8	0.6	14.5	0.46	0.89	0.95	0.34	0.17	0.56
Qatar	28.9	43.8	0.9	81.7	81	254.1	0.0	11.5	0.46	0.99	0.81	0.37	0.14	0.55
Brunei Darussalam	25.1	38.9	1.4	91.6	83	170.5	0.0	9.9	0.40	0.99	0.89	0.35	0.12	0.55
Latvia	30.1	39.4	20.0	99.8	86	181.6	0.4	13.3	0.45	0.80	0.95	0.36	0.16	0.54
Uruguay	28.0	19.3	7.3	97.6	84	128.9	0.0	13.6	0.33	0.93	0.93	0.34	0.16	0.54
Seychelles	26.2	53.9	16.9	91.0	79	72.3	0.1	14.1	0.49	0.83	0.87	0.32	0.17	0.54
Dominica	33.3	13.1	6.3	96.4	65	70.2	0.8	17.5	0.34	0.94	0.86	0.33	0.21	0.54
Argentina	21.9	17.8	3.9	96.9	89	149.6	0.3	11.2	0.27	0.96	0.94	0.35	0.13	0.53
Trinidad & Tobago	25.0	27.8	2.5	98.4	67	73.8	0.0	10.6	0.35	0.98	0.88	0.32	0.12	0.53
Bulgaria	36.8	33.3	8.3	98.5	77	10.1	0.0	8.1	0.47	0.92	0.91	0.25	0.10	0.53
Jamaica	17.2	53.5	16.9	87.3	74	28.0	1.0	22.9	0.41	0.83	0.83	0.30	0.27	0.53
Costa Rica	25.1	11.1	7.6	95.7	66	114.7	0.0	19.3	0.26	0.92	0.86	0.34	0.23	0.52
St. Lucia	32.0	8.9	6.9	90.2	82	93.8	0.0	11.3	0.31	0.93	0.87	0.33	0.13	0.52
Kuwait	20.4	51.9	2.0	82.4	54	25.0	0.0	10.6	0.43	0.98	0.73	0.28	0.12	0.51
Grenada	31.6	7.1	7.6	94.4	63	37.7	0.5	14.2	0.30	0.92	0.84	0.31	0.17	0.51
Mauritius	27.0	28.9	4.7	84.8	69	28.1	0.0	9.9	0.37	0.95	0.80	0.29	0.12	0.50
Russia	23.9	12.0	5.6	99.6	82	61.2	0.0	4.1	0.26	0.94	0.94	0.32	0.05	0.50
Mexico	14.6	25.3	4.6	91.4	74	56.9	0.2	9.8	0.25	0.95	0.86	0.32	0.12	0.50
Brazil	22.3	20.1	11.8	87.3	95	53.7	0.4	8.2	0.29	0.88	0.90	0.32	0.10	0.50

Table 5.4: DAI results (cont'd)

Economy	Sub. lines p. 100 inhab.	Mobile sub. p. 100 inhab.	Internet tariff as % of GNI	Adult literacy	School enrolment	Int'l Internet bandwidth P. 100 inhab.	Broad-band sub-scribers p. 100 inhab.	Internet users p. 100 inhab.	INFRA-STRUCTURE	AF-FOR-DABILITY	KNOW-LEDGE	QUAL-ITY	USAGE	DAI
MEDIUM														
Belarus	29.9	4.7	11.3	99.7	86	4.4	0.0	8.2	0.27	0.89	0.95	0.22	0.10	0.49
Lebanon	19.9	22.7	11.1	86.5	76	17.6	1.0	11.7	0.28	0.89	0.83	0.29	0.14	0.48
Thailand	10.4	26.0	4.2	95.7	72	16.3	0.0	7.8	0.22	0.96	0.88	0.27	0.09	0.48
Romania	18.7	22.9	16.4	98.2	68	87.2	0.1	8.1	0.27	0.84	0.88	0.33	0.09	0.48
Turkey	26.9	33.6	9.5	85.5	60	10.6	0.0	7.0	0.39	0.90	0.77	0.25	0.08	0.48
TFYR Macedonia	27.1	17.7	13.3	94.0	70	24.2	0.0	4.8	0.31	0.87	0.86	0.28	0.06	0.48
Panama	12.4	19.2	10.7	92.1	75	210.1	0.0	4.1	0.20	0.89	0.86	0.36	0.05	0.47
Venezuela	11.2	25.5	5.7	92.8	68	27.3	0.3	5.0	0.22	0.94	0.85	0.29	0.06	0.47
Belize	12.4	20.4	23.1	93.4	76	181.8	0.0	11.9	0.21	0.77	0.88	0.36	0.14	0.47
St. Vincent	23.4	8.5	9.5	88.9	58	34.2	0.9	6.0	0.24	0.91	0.79	0.31	0.07	0.46
Bosnia	22.0	18.3	6.9	93.0	64	6.1	0.0	2.4	0.27	0.93	0.83	0.23	0.03	0.46
Suriname	16.5	22.8	18.5	94.0	77	25.2	0.0	4.2	0.25	0.82	0.88	0.28	0.05	0.46
South Africa	9.5	30.4	15.4	85.6	78	12.4	0.0	6.8	0.23	0.85	0.83	0.26	0.08	0.45
Colombia	17.4	10.6	12.2	91.9	71	12.7	0.1	4.6	0.20	0.88	0.85	0.26	0.05	0.45
Jordan	12.7	22.9	18.0	90.3	77	16.9	0.0	5.8	0.22	0.82	0.86	0.27	0.07	0.45
Serbia & Montenegro	23.1	25.7	11.3	91.7	52	0.9	0.0	6.0	0.32	0.89	0.78	0.16	0.07	0.45
Saudi Arabia	14.4	21.7	4.9	77.1	58	12.9	0.0	6.2	0.23	0.95	0.71	0.26	0.07	0.44
Peru	7.6	8.6	19.2	90.2	83	45.6	0.1	9.3	0.11	0.81	0.88	0.31	0.11	0.44
China	16.7	16.1	12.9	85.8	64	7.3	0.2	4.6	0.22	0.87	0.79	0.24	0.05	0.43
Fiji	11.7	10.8	17.6	93.2	76	9.6	0.0	6.0	0.15	0.82	0.87	0.25	0.07	0.43
Botswana	8.3	24.1	10.9	78.1	80	15.1	0.0	2.9	0.19	0.89	0.79	0.26	0.03	0.43
Iran (I.R.)	18.7	3.3	4.2	77.1	64	8.4	0.0	4.8	0.17	0.96	0.73	0.24	0.06	0.43
Ukraine	21.6	8.4	26.0	99.6	81	6.3	0.0	1.8	0.22	0.74	0.93	0.23	0.02	0.43
Guyana	9.2	9.9	29.8	98.6	84	3.5	0.0	14.2	0.13	0.70	0.94	0.21	0.17	0.43
Philippines	4.2	19.4	20.1	95.1	80	11.2	0.1	4.4	0.13	0.80	0.90	0.26	0.05	0.43
Oman	8.4	17.1	3.8	73.0	58	14.0	0.0	6.6	0.16	0.96	0.68	0.26	0.08	0.43
Maldives	10.2	14.9	29.6	97.0	79	32.0	0.1	5.3	0.16	0.70	0.91	0.29	0.06	0.43
Libya	11.9	1.3	3.8	80.8	89	1.1	0.0	2.3	0.11	0.96	0.84	0.17	0.03	0.42
Dominican Rep.	10.4	19.5	17.1	84.0	74	5.9	0.0	3.4	0.18	0.83	0.81	0.23	0.04	0.42
Tunisia	11.7	5.1	10.4	72.1	76	7.6	0.0	5.2	0.12	0.90	0.73	0.24	0.06	0.41
Ecuador	11.4	12.6	26.3	91.8	72	6.1	0.1	4.3	0.16	0.74	0.85	0.23	0.05	0.41
Kazakhstan	13.0	6.4	27.4	99.4	78	4.3	0.0	1.6	0.14	0.73	0.92	0.22	0.02	0.41
Egypt	11.5	6.7	4.5	56.1	76	10.9	0.0	2.8	0.13	0.96	0.63	0.25	0.03	0.40
Cape Verde	15.6	9.5	28.4	74.9	80	17.8	0.0	3.6	0.18	0.72	0.77	0.27	0.04	0.39
Albania	7.1	25.9	24.8	85.3	69	3.9	0.0	0.4	0.19	0.75	0.80	0.22	0.00	0.39
Paraguay	4.7	28.8	37.3	93.5	64	17.3	0.0	1.7	0.18	0.63	0.84	0.27	0.02	0.39
Namibia	6.5	10.7	22.5	82.7	74	4.5	0.0	2.7	0.11	0.77	0.80	0.22	0.03	0.39
Guatemala	7.1	13.1	21.4	69.2	57	72.9	0.0	3.3	0.12	0.79	0.65	0.32	0.04	0.38
El Salvador	10.3	13.8	27.8	79.2	64	6.7	0.0	4.6	0.15	0.72	0.74	0.24	0.05	0.38
Palestine	8.7	9.3	32.8	89.2	77	5.8	0.0	3.0	0.12	0.67	0.85	0.23	0.04	0.38
Sri Lanka	4.7	4.9	21.5	91.9	63	4.8	0.0	1.1	0.06	0.79	0.82	0.22	0.01	0.38
Bolivia	6.8	10.5	29.8	86.0	84	2.2	0.0	3.2	0.11	0.70	0.85	0.19	0.04	0.38
Cuba	5.1	0.2	29.8	96.8	76	4.6	0.0	1.1	0.04	0.70	0.90	0.22	0.01	0.38
Samoa	5.7	1.5	36.3	98.7	71	11.1	0.0	2.2	0.06	0.64	0.89	0.25	0.03	0.37
Algeria	6.1	1.3	12.4	67.8	71	5.0	0.0	1.6	0.06	0.88	0.69	0.22	0.02	0.37
Turkmenistan	7.7	0.2	20.0	98.0	81	0.1	0.0	0.2	0.07	0.80	0.92	0.06	0.00	0.37
Georgia	13.1	10.2	46.4	100.0	69	6.1	0.0	1.5	0.16	0.54	0.90	0.23	0.02	0.37
Swaziland	3.3	6.1	21.0	80.3	77	1.0	0.0	1.9	0.06	0.79	0.79	0.17	0.02	0.37
Moldova	17.0	7.7	49.6	99.0	61	7.7	0.0	3.4	0.18	0.50	0.86	0.24	0.04	0.37
Mongolia	5.3	8.9	48.6	98.5	64	7.0	0.0	2.1	0.09	0.51	0.87	0.24	0.02	0.35
Indonesia	3.7	5.5	37.6	87.3	64	2.7	0.0	3.8	0.06	0.62	0.80	0.20	0.04	0.34
Gabon	2.5	21.6	46.9	71.0	83	12.6	0.0	1.9	0.13	0.53	0.75	0.26	0.02	0.34
Morocco	3.8	20.9	25.5	49.8	51	10.5	0.0	2.4	0.14	0.74	0.50	0.25	0.03	0.33
India	4.0	1.2	21.9	58.0	56	1.6	0.0	1.6	0.04	0.78	0.57	0.18	0.02	0.32
Kyrgyzstan	7.9	1.1	54.0	97.0	79	0.2	0.0	3.0	0.07	0.46	0.91	0.10	0.04	0.32
Uzbekistan	6.6	0.7	53.8	99.2	76	0.2	0.0	1.1	0.06	0.46	0.91	0.11	0.01	0.31
Viet Nam	4.8	2.3	55.4	92.7	64	1.8	0.0	1.8	0.05	0.45	0.83	0.19	0.02	0.31
Armenia	14.3	1.9	68.0	98.5	60	2.1	0.0	1.6	0.13	0.32	0.86	0.19	0.02	0.30

Table 5.4: DAI results (cont'd)

Economy	Sub. lines p. 100 inhab.	Mobile sub. p. 100 inhab.	Internet tariff as % of GNI	Adult literacy	School enrolment	Int'l Internet bandwidth P. 100 inhab.	Broad-band sub-scribers p. 100 inhab.	Internet users p. 100 inhab.	INFRA-STRUCTURE	AF-FOR-DABILITY	KNOWLEDGE	QUALITY	USAGE	DAI
LOW														
Zimbabwe	2.5	3.0	58.3	89.3	59	0.9	0.0	4.3	0.04	0.42	0.79	0.16	0.05	0.29
Honduras	4.8	4.9	52.9	75.6	62	1.5	0.0	2.5	0.06	0.47	0.71	0.18	0.03	0.29
Syria	12.3	2.3	58.6	75.3	59	0.9	0.0	1.3	0.11	0.41	0.70	0.16	0.02	0.28
Papua New Guinea	1.1	0.2	45.3	64.6	41	1.1	0.0	1.4	0.01	0.55	0.57	0.17	0.02	0.26
Vanuatu	3.2	2.4	51.9	34.0	54	9.8	0.0	3.4	0.04	0.48	0.41	0.25	0.04	0.24
Pakistan	2.5	0.8	45.7	44.0	36	2.8	0.0	1.0	0.03	0.54	0.41	0.20	0.01	0.24
Azerbaijan	12.2	10.7	183.0	97.0	69	0.3	0.0	3.7	0.15	0.00	0.88	0.12	0.04	0.24
S. Tomé & Príncipe	4.1	1.3	287.7	83.1	58	13.2	0.0	7.3	0.04	0.00	0.75	0.26	0.09	0.23
Tajikistan	3.7	0.2	362.3	99.3	71	0.3	0.0	0.1	0.03	0.00	0.90	0.12	0.00	0.21
Equatorial Guinea	1.8	6.4	177.1	84.2	58	2.0	0.0	0.4	0.05	0.00	0.75	0.19	0.00	0.20
Kenya	1.0	4.2	152.4	83.3	52	1.8	0.0	1.3	0.03	0.00	0.73	0.19	0.01	0.19
Nicaragua	3.2	3.8	138.6	66.8	65	6.0	0.0	1.7	0.05	0.00	0.66	0.23	0.02	0.19
Lesotho	1.6	4.2	110.7	83.9	63	0.5	0.0	1.0	0.03	0.00	0.77	0.14	0.01	0.19
Nepal	1.4	0.1	70.3	42.9	64	0.4	0.0	0.3	0.01	0.30	0.50	0.14	0.00	0.19
Bangladesh	0.5	0.8	66.8	40.6	54	0.3	0.0	0.2	0.01	0.33	0.45	0.12	0.00	0.18
Yemen	2.8	2.1	75.3	47.7	52	0.3	0.0	0.5	0.03	0.25	0.49	0.12	0.01	0.18
Togo	1.1	3.6	134.9	58.4	67	2.6	0.0	4.3	0.03	0.00	0.61	0.20	0.05	0.18
Solomon Islands	1.5	0.2	191.9	76.6	50	1.2	0.1	0.5	0.01	0.00	0.68	0.17	0.01	0.17
Cambodia	0.3	2.8	212.8	68.7	55	1.5	0.0	0.2	0.02	0.00	0.64	0.18	0.00	0.17
Uganda	0.2	2.0	464.4	68.0	71	0.4	0.0	0.4	0.01	0.00	0.69	0.13	0.00	0.17
Zambia	0.8	1.3	118.7	79.0	45	0.5	0.0	0.5	0.01	0.00	0.68	0.14	0.01	0.17
Myanmar	0.7	0.1	180.9	85.0	47	0.2	0.0	0.1	0.01	0.00	0.72	0.11	0.00	0.17
Congo	0.7	6.7	207.8	81.8	57	0.0	0.0	0.2	0.04	0.00	0.74	0.05	0.00	0.17
Cameroon	0.7	4.3	110.7	72.4	48	0.6	0.0	0.4	0.03	0.00	0.64	0.15	0.00	0.16
Ghana	1.3	2.4	177.8	72.7	46	0.6	0.0	0.8	0.02	0.00	0.64	0.15	0.01	0.16
Lao P.D.R.	1.1	1.0	123.4	65.6	57	0.3	0.0	0.3	0.01	0.00	0.63	0.12	0.00	0.15
Malawi	0.7	0.8	465.0	61.0	72	0.2	0.0	0.3	0.01	0.00	0.65	0.11	0.00	0.15
Tanzania	0.5	1.9	501.4	76.0	31	0.5	0.0	0.2	0.01	0.00	0.61	0.14	0.00	0.15
Haiti	1.6	1.7	354.5	50.8	52	4.2	0.0	1.0	0.02	0.00	0.51	0.22	0.01	0.15
Nigeria	0.6	1.3	353.7	65.4	45	0.6	0.0	0.3	0.01	0.00	0.59	0.15	0.00	0.15
Djibouti	1.5	2.3	153.2	65.5	21	3.1	0.0	0.7	0.02	0.00	0.51	0.21	0.01	0.15
Rwanda	0.3	1.4	348.3	68.0	52	0.2	0.0	0.3	0.01	0.00	0.63	0.10	0.00	0.15
Madagascar	0.4	1.0	336.7	67.3	41	0.4	0.0	0.3	0.01	0.00	0.59	0.13	0.00	0.15
Mauritania	1.2	9.2	113.1	40.7	43	3.5	0.0	0.4	0.06	0.00	0.41	0.21	0.00	0.14
Senegal	2.3	5.6	103.7	38.3	38	8.1	0.0	1.1	0.05	0.00	0.38	0.24	0.01	0.14
Gambia	2.8	7.3	116.2	37.8	47	1.5	0.0	1.8	0.06	0.00	0.41	0.18	0.02	0.13
Bhutan	2.8	0.0	148.5	47.0	33	2.9	0.0	1.4	0.02	0.00	0.42	0.21	0.02	0.13
Sudan	2.1	0.6	550.8	58.8	34	0.3	0.0	0.3	0.02	0.00	0.51	0.12	0.00	0.13
Comoros	1.4	0.0	206.0	56.0	40	0.3	0.0	0.4	0.01	0.00	0.51	0.13	0.00	0.13
Côte d'Ivoire	2.0	6.2	132.1	49.7	39	0.4	0.0	0.5	0.05	0.00	0.46	0.13	0.01	0.13
Eritrea	0.9	0.0	200.9	56.7	33	0.5	0.0	0.2	0.01	0.00	0.49	0.14	0.00	0.13
D.R. Congo	0.0	1.1	986.7	62.7	27	0.2	0.0	0.1	0.01	0.00	0.51	0.11	0.00	0.12
Benin	1.0	3.3	146.5	38.6	49	0.3	0.0	0.8	0.02	0.00	0.42	0.13	0.01	0.12
Mozambique	0.5	1.4	233.1	45.2	37	0.5	0.0	0.2	0.01	0.00	0.42	0.14	0.00	0.12
Angola	0.6	0.9	143.3	42.0	29	0.5	0.0	0.3	0.01	0.00	0.38	0.14	0.00	0.11
Burundi	0.3	0.7	703.2	49.2	31	0.1	0.0	0.1	0.01	0.00	0.43	0.08	0.00	0.10
Guinea	0.3	1.2	185.2	41.0	34	0.2	0.0	0.5	0.01	0.00	0.39	0.11	0.01	0.10
Sierra Leone	0.5	1.3	857.1	36.0	51	0.1	0.0	0.2	0.01	0.00	0.41	0.08	0.00	0.10
Central African Rep.	0.2	0.3	807.9	48.2	24	0.1	0.0	0.1	0.00	0.00	0.40	0.09	0.00	0.10
Ethiopia	0.5	0.1	329.0	40.3	34	0.1	0.0	0.1	0.00	0.00	0.38	0.10	0.00	0.10
Guinea-Bissau	0.9	0.0	840.0	39.6	43	0.1	0.0	0.4	0.01	0.00	0.41	0.06	0.00	0.10
Chad	0.2	0.4	375.7	44.2	33	0.1	0.0	0.2	0.00	0.00	0.40	0.07	0.00	0.10
Mali	0.5	0.5	289.8	26.4	29	0.6	0.0	0.2	0.01	0.00	0.27	0.15	0.00	0.09
Burkina Faso	0.5	0.8	247.5	24.8	22	0.7	0.0	0.2	0.01	0.00	0.24	0.15	0.00	0.08
Niger	0.2	0.1	683.6	16.5	17	0.0	0.0	0.1	0.00	0.00	0.17	0.05	0.00	0.04

Note: DAI values are shown to hundreds of a decimal point. Economies with the same DAI value are ranked by thousands of a decimal point.
Source: ITU.

- ¹ For example, measuring per capita computer numbers or mobile phone penetration alone provides only a partial, and potentially misleading, glimpse of the whole picture (as described in Chapter two of this report). A combination of such indicators, on the other hand, can be a very valuable tool.
- ² For detailed examinations of ICT indices see UNCTAD. (2003). *Information and communication technology development indices*. Available from: www.unctad.org/en/docs/iteipc20031_en.pdf; accessed November 11, 2003. Also see Reynolds, T. (2003). "Quantifying the evolution of copyright and trademark law." American University (USA).
- ³ World Economic Forum. (2002-2003). The Global Information Technology Report: Readiness for a Networked World. Available from : www.weforum.org/site/homepublic.nsf/Content/Global+Competitiveness+Programme%5CGlobal+Information+Technology+Report%5CGlobal+Information+Technology+Report+2002-2003+-+Readiness+for+the+Networked+World-index; accessed November 11, 2003.
- ⁴ IDC. *Building a Brave New World. The IDC Information Society Index 2003*. June 2003. <www.idc.com/getdoc.jhtml?containerId=TB20030619>, accessed December 8, 2003.
- ⁵ Economist Intelligence Unit. (2003, March). "The 2003 E-Readiness Rankings". eBusiness Forum. Available from: www.ebusinessforum.com/index.asp?layout=rich_story&doc_id=6427; accessed November 11, 2003.
- ⁶ Mosaic Group. The Global Diffusion of the Internet Project. Available from: <http://mosaic.unomaha.edu/gdi.html>; accessed November 11, 2003. Also see McHenry, W. (2003, January). "Studying the Digital Divide with the Mosaic group Methodology". 3rd World Telecommunication/ICT Indicators Meeting. Available from: http://www.itu.int/ITU-D/ict/WICT02/doc/pdf/Doc28_Erev1.pdf; accessed November 11, 2003.
- ⁷ Orbicom. (2003). *Monitoring the Digital Divide ... and beyond*. Available from: <http://www.orbicom.uqam.ca>; accessed December 1, 2003.
- ⁸ UNDP. (2001). *Human Development Report 2001*. Chapter 2, "Today's technological transformations — creating the network age". Available from: <http://hdr.undp.org/reports/global/2001/en/pdf/chaptertwo.pdf>; accessed November 11, 2003.
- ⁹ Biggs, P. (2003, January). "ICT Development Indices". 3rd World Telecommunication/ICT Indicators Meeting. Available from: http://www.itu.int/ITU-D/ict/WICT02/doc/pdf/Doc40_E.pdf; accessed November 11, 2003.
- ¹⁰ ITU. (2002). *Internet Report: Internet for a Mobile Generation*. Available from: <http://www.itu.int/osg/spu/publications/sales/mobileinternet/index.html>; accessed November 11, 2003.
- ¹¹ ITU. Internet Country Case Studies. Available from: <http://www.itu.int/ITU-D/ict/cs>; accessed November 11, 2003.
- ¹² The phrase lumps statistics in with lies implying that the former can be used misleadingly. Leonard Henry Courtney, a British Baron, coined the term. See University of York (UK). "Lies, Damned Lies and Statistics". Available from: www.york.ac.uk/depts/math/histstat/lies.htm; accessed November 11, 2003.
- ¹³ Indeed the Swiss themselves are concerned about the results of various rankings: "This respectable ranking, however, should be treated with caution". R. Gerster and A. Haag. (2003, October). *Diminishing the Digital Divide in Switzerland*. Swiss Agency for Development and Cooperation. Available from: <http://www.gersterconsulting.ch/asp/NCurrent.asp>; accessed December 4, 2003.
- ¹⁴ For example Australia's level of adult literacy is reported as close to 100 per cent. However an assessment carried out in 1996 found that "about 20 per cent of Australians aged 15-74 had very poor literacy skills and could be expected to experience considerable difficulties in using many of the texts and documents...that they encounter in daily life". Australian Bureau of Statistics. (1998). "Educational Attainment: Literacy Skills". Available from: <http://www.abs.gov.au/Ausstats/abs@.nsf/0/7551ea164d95600cca2569ad000402b4?OpenDocument>; accessed November 15, 2003.

- ¹⁵ Gray, V. (2003, June). "Knowledge indicators: measuring information societies in Asia-Pacific". International Telecommunications Society. Asia-Australasian Regional Conference. Perth, Australia. Available from: <http://www.itu.int/ITU-D/ict/papers/2003/Knowledge%20indicators%20-%20measuring%20information%20societies%20in%20AP.pdf>; accessed November 15, 2003.
- ¹⁶ "One indicator that is becoming increasingly popular is the amount of international Internet bandwidth used by a country — the 'size of the pipe', most often measured in Kilobits per second (Kbps), or Megabits per second (Mbps). Most of the Internet traffic in a developing country is international (75-90 per cent), so the size of its international traffic compared to population size provides a ready indication of the extent of Internet activity in a country". See International Development Research Centre. "The Internet: Out of Africa" available from http://web.idrc.ca/ev.php?ID=6568_201&ID2=DO_TOPIC; accessed November 15, 2003.
- ¹⁷ For example, take mobile telephone penetration. Taiwan, China has the highest mobile penetration rate in the world at 106 per 100 inhabitants. An absolute goalpost chosen in the early 1990's would have assumed that the highest possible penetration rate was 100 mobile phones per 100 inhabitants.
- ¹⁸ ISDN is a technology that increases the capacity of a standard telephone line. Basic rate ISDN converts a telephone line into two lines or "channels" whereas primary rate adds 30 channels. Many European nations include the number of channels in their main line statistics even though there is no increase in actual physical telephone lines.
- ¹⁹ World Bank. "GNI per capita 2002". Available from: <http://www.worldbank.org/data/databytopic/GNIPC.pdf>; accessed November 11, 2003.
- ²⁰ UNDP. *Human development Report 2003*. "Technical Note". Available from: http://www.undp.org/hdr2003/pdf/hdr03_backmatter_2.pdf; accessed November 11, 2003.
- ²¹ A number of primarily developed nations do not compile aggregated figures for the international bandwidth of all Internet connectivity providers. Data for these economies was provided by TeleGeography. See TeleGeography. (2003, August). *Global Internet Geography Database and Report*. Available from http://www.telegeography.com/pubs/internet/reports/ig_gbl/index.html; accessed December 1, 2003.
- ²² This is not a phenomenon restricted to developed nations. Fixed telephone lines declined in 29 developing nations between 2001 and 2002.
- ²³ For methodology, see UNDP. *Human development Report 2003*. "Technical Note". Available from: http://www.undp.org/hdr2003/pdf/hdr03_backmatter_2.pdf; accessed November 11, 2003.
- ²⁴ For more on ICT developments in the Republic of Korea, see ITU. (2003, March). *Broadband Korea: Internet Case Study*. Available from: http://www.itu.int/ITU-D/ict/cs/korea/material/CS_KOR.pdf; accessed November 11, 2003.
- ²⁵ Ministry of Information Society, Slovenia, at www2.gov.si/mid/mideng.nsf; accessed November 11, 2003.
- ²⁶ For more on ICT developments in Slovenia see University of Ljubljana (Slovenia). (2003, July). *SIBIS Country Report*. Available from: http://www.sisplet.org/ris/uploads/publikacije/2003/slovenia_cremonti.pdf; accessed November 11, 2003.
- ²⁷ For example the eEurope+ initiative reflects EU ICT objectives and targets for candidate countries. See European Union. (2001, June). *eEurope+ Action Plan*. Available from: europa.eu.int/information_society/topics/international/regulatory/eeuropeplus/doc/eEurope_june2001.pdf; accessed November 11, 2003.
- ²⁸ According to its website <www.dubaiinternetcity.com> the Dubai Internet City "provides a Knowledge Economy Ecosystem that is designed to support the business development of Information and Communications Technology (ICT) companies. It is the Middle East's biggest IT infrastructure, built inside a free trade zone, and has the largest

- commercial Internet Protocol Telephony system in the world”. For more on the Malaysian Multimedia Super Corridor and the Mauritius Cyber Park see the country reports on the ITU Internet Case Study page at <http://www.itu.int/ITU-D/ict/cs/>; accessed November 11, 2003.
- ²⁹ One cause for the high retail Internet access prices in this group of economies is the relatively steep prices they pay for wholesale international Internet connections. This stems from having to pay the full cost of the connection though the country on the other end of the link benefits. Other contributory factors to the high prices are constrained domestic competition, lack of traffic exchanges and small economies of scale. Landlocked countries are at an even greater disadvantage since their international connectivity options are restricted to satellite. For more on problems low income nations face in reducing international Internet connectivity costs and possible solutions see the “Improving IP Connectivity in the least developed countries” web page at <http://www.itu.int/osg/spu/ni/ipdc/index.html>; accessed November 11, 2003.
- ³⁰ According to the manager of a Zimbabwean information technology company, “There is tremendous intellectual talent in Zimbabwe ...”. See Center for International Development at Harvard University. “ZW”. Available from: <http://www.cid.harvard.edu/cr/profiles/Zimbabwe.pdf>; accessed November 11, 2003.
- ³¹ Subsecretaría de Telecomunicaciones (Chile). (2003, September). *Informe de Estadísticas Septiembre 2003 (Informe N°8)*. Available from <http://www.subtel.cl>; accessed November 30, 2003.
- ³² UNDP (Chile). (2000). *Desarrollo Humano en Las Comunas de Chile*. Available from: http://www.desarrollohumano.cl/otraspub_grl.htm; accessed December 1, 2003.
- ³³ The gender-disaggregated DAI sub-index is based on the methodology used by the UNDP for the Gender-related development index.
- ³⁴ UNDP and UNIFEM. (2000). *Gender and Development: Facts and Figures in Thailand*.
- ³⁵ “Current research in France and Germany informs that women use the domestic telephone twice as much as men...” http://www.telegeography.com/resources/essay_archive/telephony/tg1992_women_calling.html. A 1996 French study found that women originated 63 per cent of calls from home telephones. Z. Smoreda and C. Licoppe. (2000). “Gender-Specific Use of the Domestic Telephone”. *Social Psychology Quarterly*.
- ³⁶ Infocomm Development Authority of Singapore. (2002). “Survey on Broadband and Wireless Usage”. Available from: http://www.ida.gov.sg/idaweb/doc/download/I2389/Survey_on_BB_and_wireless_usage_in_Spore_2002.pdf; accessed November 11, 2003.
- ³⁷ ITU. (2002, December). *Asia-Pacific Telecommunication Indicators 2002*. Available from: <http://www.itu.int/ITU-D/ict/publications/asia/2002/index.html>; accessed December 1, 2003.
- ³⁸ Apart from featuring monthly time series OFTA is one of the few regulators that also compiles international Internet bandwidth. See the “Data and Statistics” web page under the “Telecom Facts” menu on the OFTA website. www.ofta.gov.hk; accessed November 15, 2003. Bi-annual (mid and end of year) population data and annual survey data on Internet users are available from the C&SD website at www.info.gov.hk/censtatd/eng/hkstat/hkinf/it_it_2_index.html; accessed November 15, 2003. Internet access prices are from i-Cable’s website: <http://www.i-cable.com/ourservices/dialup/e-home.html>; accessed November 15, 2003.
- ³⁹ The United Nations Development Programme establishes the goalposts and weights for the indicators in the Knowledge category. See http://www.undp.org/hdr2003/pdf/hdr03_backmatter_2.pdf; accessed November 15, 2003.

