Connectivity Scorecard 2010

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1 About this report

This report accompanies the release of the 2010 Connectivity Scorecard.

It has the following structure:

- Section 2 is designed to introduce the Connectivity Scorecard;
- Section 3 presents our findings from the previous iterations of the Scorecard;
- Section 4 summarises the 2010 Connectivity Scorecard, which not only updates previous data but also incorporates data from a newer (and better) set of sources. We have also included some new measures of connectivity that we believe are currently more relevant than ones used in previous iterations of the Scorecard. This summary is in the form of a series of questions and answers, with some of the questions and answers based upon the feedback that we have received in the last 12 months;
- Appendix 1 provides some notes on data sources and data concepts used in this Scorecard; and
- Appendix 2 reprises the questions and answers that we had provided regarding the methodology that went into the 2009 edition of the Scorecard.

Extensive discussion and details regarding the methodology can be found in the 2009 Connectivity Scorecard report, and we refer readers to the ConnectivityScorecard.org website for this report.

2 The Connectivity Scorecard Concept

Connectivity

It is widely accepted that most modern developed economies are *Information* economies, and that a significant amount of economic growth and productivity growth in the developed nations of Europe, North America and the Far East is driven by information and communications technology (ICT). What is less widely accepted and understood is that actually all economies are information economies. The free flow and availability of information lowers the barriers to economic activity and stimulates growth and productivity in even those economies that we do not normally regard as fully "developed".

Connectivity is usually understood to be the copper wires, fibre-optic cables and networked computers and more recently mobile phones and base stations that enable the fast flow of information regardless of distance, at costs that are much lower than the costs of physical travel and much lower than what these costs were just 15 or 20 years ago. Connectivity is the key enabler of the flow of information that defines modern economies, and it is also the key enabler of an ongoing (and sometimes overlooked) transformation in the economic fortunes of many Asian and African countries.

We define "connectivity" in a much broader way to embrace more than just infrastructure and hardware. The notion of connectivity should be expanded to include also the complementary assets (software) and skills — embodied in people, governments and businesses — that determine just how productively the hardware and infrastructure are used.

In summary, we use the term "connectivity" to refer to the totality of interaction between a nation's telecommunications infrastructure, hardware, software, networks, and users of these networks, hardware and software. Thus broadband lines, PCs, advanced corporate data networks and advanced use of wireless data services are certainly measures of connectivity, but so are human skills relevant to the usage of these infrastructures, technologies and networks.

"Useful connectivity"

The Connectivity Scorecard that we have designed is an attempt to rank countries according to a measure of what we call "useful connectivity". "Useful connectivity" or "usefully connected" are phrases that we use often in this report and in our presentational materials. They refer to the ability of connectivity to contribute to economic growth, especially through improvements in productivity that are widely held to be the key to sustained economic prosperity. The concept of "useful connectivity" is first and foremost an attempt to recognise that the economic value generated by connectivity depends not just on conventional measures such as broadband lines or computers connected, but also on who is using those lines — businesses or consumers — and how well they are able to use the lines (captured by measures such as user skills, software assets, use of voice-over-IP and the number of intranet hosts per capita).

The Scorecard aims to measure "useful connectivity" by making a link between connectivity and economic performance. We next explain how this linkage is made.

What makes this Scorecard different? The linkage between connectivity and economic performance

While there has been a significant body of academic research that looks at the relationship between various elements of connectivity (Computers, Telecommunications, or more generally "ICT") on the one hand, and economic growth and productivity on the other, the insights of this literature have not been crystallised in existing Scorecards or Indices or rankings of the Digital Economy. However, given our emphasis on "useful connectivity", we felt that our methodology must attempt to incorporate the findings of the academic research.

Some widely recognised facts that emerge from existing research are the following:

- The US has seen more clear-cut productivity gains from ICT than has Europe, and a major source of this US productivity advantage is the usage of ICT by businesses that are not themselves producers of ICT — for example, retailing.[1] Within Europe, Nordic countries have seen a greater contribution from ICT than other parts of Europe;

- The impacts of ICT are enhanced by investment in "complementary assets" such as worker training, learning and education; [2] and

- Productivity growth is the key to sustained improvements in living standards (productivity growth is one major way in which the "trend rate" of economic

1 Robert Inklaar, Bart Van Ark and Robert McGuckin, "ICT and Productivity in the United States and Europe: Where Do the Differences Come From?", Conference Board Working Paper, 03-05

2 Susanto Basu, John G. Fernald, Nicholas Oulton, and Sylaja Srinivasan, "Does Information Technology Explain Why Productivity Accelerated in the United States But Not the United Kingdom?", Federal Reserve

growth — the long-term potential growth rate of the economy — can be improved).

Thus in constructing a scorecard that purported to measure "useful connectivity", we wanted to take into account not just how many broadband lines were being deployed, but who was using those broadband lines — businesses or consumers? How smart were the users of these lines — for example, what proportion of the workforce was composed of university graduates and what proportion of the workforce were specialised in research or knowledge creation?

The results from academic research suggested that in order to construct an index or scorecard of connectivity that actually linked connectivity to economic performance, we needed to look at:

- whether countries were "connecting up" in the right places — e.g., countries were deploying infrastructure and making use of telecommunications and ICT in those activities and sectors that were most important to generating long-term economic growth;
- whether investment in infrastructure was being matched by investment in "usage or skills"; and
- how economically beneficial investment in infrastructure was as opposed to investment in usage and skills.

We therefore had to answer the following questions:

- If the economy were to be divided into its constituent actors — the government sector, the business sector and the consumer sector — how to weight the importance of these sectors in a way that captures the role of the business sector in terms of productivity contributions?
- How can we rank countries according to not just the availability of infrastructure and the penetration rate of infrastructure, but also the usage level of the infrastructure by consumers, businesses and governments? How can we factor in the complementary investments in human and organisational capital, particularly by businesses, i.e. in what we call "useful connectivity"?

Bank of Chicago, Working Paper 2003-08

Thus the Connectivity Scorecard methodology:

- divided the economy into the consumer sector, the business sector, and the government sector;
- gave weights to the consumer sector, business sector and government sector that matched their importance in economic activity;
- split each of the consumer, business and government categories into "infrastructure" and "usage and skills" components and allocated individual measures to either of these two sub-categories; [3] and
- allocated weights to the "infrastructure" and "usage and skills" categories.

A wide range of individual measures/metrics/indicators were selected, reflecting elements of both infrastructure and usage. A full list of these indicators is presented after the tables and figures in this section of the report.

The weighting of the infrastructure and usage and skills categories was based upon economic considerations and are unique in the literature. First, the weights for each sector are country-specific and are drawn from national GNP accounts. The weights for the infrastructure versus skills subcomponents used data from research into the sources of productivity enhancement.[4]

Thus the selection of categories, sub-categories and weights reflects an ambitious attempt to capture whether countries are investing in the right places, are matching their infrastructure investment with the right skills, and whether they are succeeding in enabling adequate levels of both access to and usage of key technologies.

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3 For example, education or skills measures or measures such as "minutes of usage" per customer were allocated to "usage and skills", while measures such as line counts or hardware investment were allocated to "infrastructure"

4 For example, businesses and governments are concerned with productivity and generating growth. Thus a theoretically sensible split between infrastructure and usage and skills would look at the contribution of investment in infrastructure relative to the contribution of human capital or investment in the "complementary capital" that we referred to above in generating economic growth. In practice, we used data drawn from the EU KLEMS database that allowed us to examine the relative importance of ICT investment and improvements in labour force skills to economic growth over a recent 10-year period. For consumers, "utility" or consumer welfare, is of paramount importance. Consumers can subscribe to telephone service (or broadband service) based upon two considerations: (a) the value that they place on having access to the network, which is often called an "option value", and (b) the value that they derive from actual usage of that network. Unfortunately, while the economics literature has ample theoretical discussion on the "option value" of access, there is little quantitative guidance about the proportion of consumer welfare derived from access versus the proportion derived from usage. In the absence of such evidence, we gave equal weights to the infrastructure and usage and skills sub-categories for consumers.

Comparisons with other composite indices

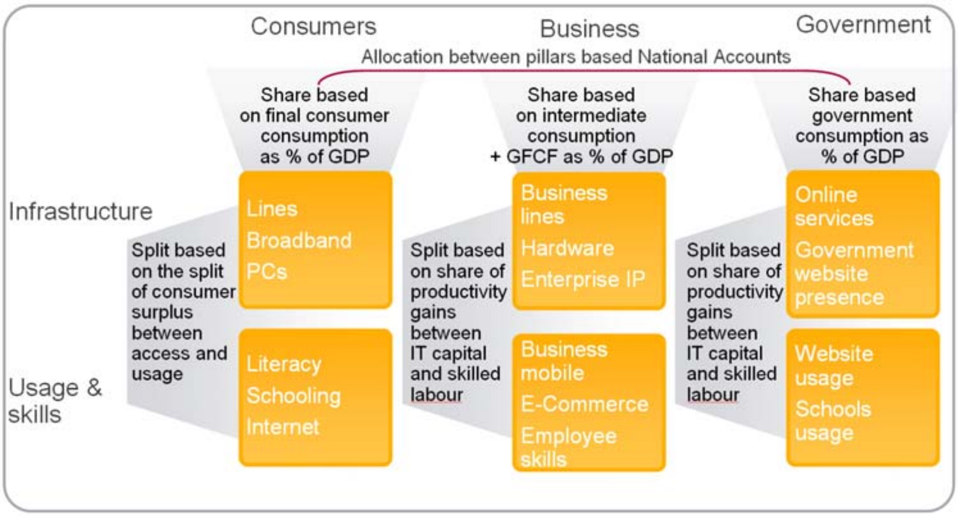
Other composite indices that we have reviewed tend to fall into two categories: (a) indices that look at “hard” variables on telecom and computer penetration, and perhaps also at prices and usage levels; and (b) indices that look at hard variables together with factors such as freedom, business environment economic stability and the like.

The Connectivity Scorecard looks at substantially more than just penetration rates and counts; it is distinguished by a focus on the business sector; it considers an extensive array of utilisation metrics — such as levels of Internet use, take-up of Internet-based services, and use of websites by businesses. At the same time, it remains very focussed on hard data, and although it looks at complementary factors, it avoids potentially subjective judgments regarding business environment, culture and the like.

As with all composite indices, the Scorecard is only able to utilise the data that are actually available to us, and particularly for measures of “usage” and for measures of “business connectivity” the data are not ideal. Data for the “developing” or “resource and efficiency” economies are also not ideal. All such composite indices are inevitably coloured by the availability of data and the choice of data by the researchers constructing the index. Such indexes are ultimately based upon subjective decisions about which indicators to include or exclude and how to weight these indicators. That said, there should be some logical or statistical merit to the choice of indicators and weights.

Figure 1 provides a schematic of our methodology, while Appendix 2 provides further amplification of the methodological concepts underpinning the Scorecard.

Schematic representation of methodology[5]



5 Note: in the above figure, GDP is used somewhat loosely. In reality, the consumer share of the economy was calculated as the share of final household consumption in "total use at purchaser's prices" (to use the terminology used in the UK Input-Output tables for 2003). Business share was gross fixed capital formation + intermediate consumption + exports. We believe that this "total use" measure gives an idea of the "supply" of goods in the economy, and thus reflects not just the components of final demand but the large amount of business-to-business activity in the economy. This in turn helps put the "weight" of business into perspective in terms of economic activity.

3 Connectivity Scorecard 2008/09/10: What we did and what we found

In January 2008 we computed two separate Connectivity Scorecards — the first for a group of 16 countries, covering mostly the innovation-driven (Tier 3) economies but also some economies that are making the transition towards being innovation-driven: Hungary, Poland, the Czech Republic and Korea are examples. The second Connectivity Scorecard covered 9 countries, and uses different assessment metrics. The countries covered by the second Scorecard are resource and efficiency-driven economies. The terms “resource and efficiency-driven” and “innovation-driven” are borrowed from the World Economic Forum (WEF)’s classification.

We looked at the scores for each country on each metric on a benchmarked basis (relative to “best in class” in its category). In this Scorecard, the highest theoretical score for any country is 10, although this would require the country to be the best on every single metric. The table below summarises the 2008 Connectivity Scorecard results. The US and Malaysia topped their respective categories. The major surprise in the Scorecard was the low ranking of Korea, which we discussed above.

The Connectivity Scorecard 2009 expanded coverage to 25 innovation-driven economies and 25 resource-and-efficiency driven economies. The scoring methodology remained the same, but there were some differences in the data sources and metrics by which individual countries were assessed. However, no major conceptual or methodological revisions were made to the Scorecard.

Connectivity Scorecard 2008: Results

Note: The data and metrics used to assess the resource and efficiency-driven economies are very different from those used to assess Innovation-driven economies. Were Malaysia to be benchmarked against the "innovation-driven" economies, it would finish in the bottom spot.

Innovation driven economies	Connectivity score
United States	6.97
Sweden	6.83
Japan	6.68
Canada	6.56
UK	6.13
Finland	6.10
Australia	5.90
Germany	5.52
France	5.07
Korea	4.73
Hong Kong SAR	4.46
Italy	3.85
Spain	3.56
Hungary	3.18
Czech Republic	3.10
Poland	2.33

Efficiency and resource driven economies	Connectivity score
Malaysia	7.59
Russia	6.60
Mexico	5.54
Brazil	5.28
South Africa	5.26
China	4.45
Philippines	3.00
India	1.83
Nigeria	1.07

Connectivity Scorecard 2009: Results

Innovation driven economies	Connectivity score
United States	7.71
Sweden	7.47
Denmark	7.18
Netherlands	6.75
Norway	6.51
United Kingdom	6.44
Canada	6.15
Australia	6.14
Singapore	5.99
Japan	5.87
Finland	5.82
Ireland	5.70
Germany	5.37
Hong Kong SAR	5.33
France	5.22
New Zealand	4.85
Belgium	4.65
Korea	4.17
Italy	3.99
Czech Republic	3.71
Spain	3.49
Portugal	3.02
Hungary	2.72
Greece	2.62
Poland	2.49

Resource & efficiency driven economies	Connectivity score
Malaysia	7.07
Turkey	6.71
Chile	6.59
South Africa	5.76
Mexico	5.39
Russia	5.37
Argentina	5.14
Brazil	5.12
Colombia	4.08
Botswana	3.98
Thailand	3.75
Iran	3.62
Ukraine	3.60
Tunisia	3.50
China	3.19
Philippines	3.17
Egypt	3.02
Sri Lanka	2.87
Vietnam	2.75
India	1.88
Indonesia	1.87
Kenya	1.75
Bangladesh	1.60
Pakistan	1.54
Nigeria	1.30

How does this version of the Scorecard differ from the first two versions?

This current version of the Connectivity Scorecard differs from the earlier versions in two principal ways:

- Some of the data sources and metrics that have been used to assess countries have been revised. While this creates some problems in generating direct comparisons (especially with regard to whether countries have "improved" or "deteriorated" in either absolute or relative terms) between the 2008, 2009 and 2010 scores, the main value of the Scorecard is as a relative ranking at a point in time. We believe that using both the latest and the most relevant data (measuring the most meaningful things at this point in time) is the best way to enhance the value of such a relative ranking system; and

- Specifically we have reviewed individual metrics and data sources, and where it has made sense have elected to utilise newer sources, or even measures that are conceptually somewhat different. For instance, we have incorporated data on ICT investment from the OECD directly into the Scorecard for the innovation-driven economies, in lieu of other estimates of corporate spending on various forms of ICT. The OECD data are public and we have better information about how they were derived and their provenance, so it makes sense to prioritise use of such data. At the same time, in previous iterations of the Scorecard, we had attempted to capture somewhat elusive aspects of business connectivity, such as business users' propensity to use mobile e-mail or mobile messaging services. We now think that a full treatment of mobility — a very important and fast-growing aspect of enterprise connectivity — requires extensive further study and review of data sources. The current data, however, are simply too patchy to provide reliable inferences. Appendix 1 contains a significant and detailed discussion of the data that we used.

Has the methodology used to create the Scorecard been altered?

The methodology behind the Scorecard has not been altered. The distinctive feature of the first version of the Scorecard was the weighting system. Recognising that the principal way in which connectivity impacts upon the wider economy is through its impact on business productivity, we had sought out a weighting system that captures this high impact of business. Thus rather than using shares of household consumption in GDP to weigh the consumer sector, for example, we used the share of household consumption in "total use."

The other "novelty" in the weighting system was the manner in which we allocated weights to the "business infrastructure" and "business usage and skills" sub-indices. These weights were based on the relative contribution of information technology investment and increases in the quality of the workforce to economic growth. Where such refined splits were not obtainable (e.g., for the resource and efficiency-driven economies) we used data on the relative contribution of overall capital investment and labour composition to overall economic growth. The idea behind this methodology was to utilise some notion of how much of economic growth has been driven by improvements in infrastructure versus how much has been driven by improvements in the quality of the users of that infrastructure (the work-force).

The major difference between the 2009 Scorecard and the first version was that we were fortunate to obtain a more complete set of relevant weights for the extended sample of countries. Many of the weights were supplied by Barry Bosworth from the Brookings Institution, whose co-operation we gratefully acknowledge. We continue to use the weights from the 2009 Scorecard in the 2010 Scorecard.

We then conducted an extensive set of sensitivities to respond to questions that have been raised about the methodology. These sensitivities and some further Q&A are explored in Appendix 2 to this report.

Have the results of the Scorecard changed?

The results of the Scorecard have indeed changed. Table 1 "Connectivity Scorecard 2010 results" summarises the "baseline" results that we report and refer to in the body of this report. As with last year's ranking, there are separate scores for innovation-driven and for resource and efficiency-driven economies. This year, Sweden takes the top spot among the innovation-driven economies, supplanting the US. The US, however, is only slightly behind Sweden and posts a very strong performance. As with previous iterations of the Scorecard, northern Europe puts in the strongest overall performance of any region — with the "Nordic" countries of Sweden, Norway, Denmark and Finland all finishing in the top six. The UK and the Netherlands were other Northern European countries that finished in the top 10. Asian countries, Korea, Japan, Singapore and Hong Kong perform less strongly than they tend to on other composite indices that have a heavy focus on what we label "consumer infrastructure." Although France and

Germany lose some ground in this year's ranking, they are middling rather than poor performers.

Among the innovation economies, the most prominent "connectivity gap" is between the bottom few countries of eastern and southern Europe and the other innovation-driven economies. Whereas most of the other innovation economies are at the point where half or more of households have access to broadband, and where majorities or near-majorities of the population regularly use Internet banking, Internet commerce and E-government services, the eastern and southern European countries still lag markedly in these respects. If anything, eastern European countries show greater signs of progress than their southern European counterparts. On the business front, these countries are also characterised by relatively low levels of ICT investment and relatively low spending levels on IT services.

Some other trends that are evident among the innovation-driven economies are:

- Higher average scores (exceeding 6.0 on a 0 to 10 scale) and significant amounts of "bunching together" of country scores. There are a number of countries whose rankings differ so little that they are in essence a matter of "measurement error."

    - The coefficient of variation for each metric was substantially less than for "corresponding" metrics used last year. Thus the coefficient of variation (standard deviation of a data series divided by the mean for that data series) for broadband penetration (as a % of households) and internet banking usage were a bit lower than they were last year. This was also true for PC penetration and for the penetration rate of secure Internet servers (although we used a different data source for PC penetration last year). The coefficient of variation is a commonly used summary of how much "inequality" there is in a data series. There is a trend towards less inequality in the data series this year, suggesting that there is indeed some degree of convergence happening between innovation-driven economies; and

    - We also used new metrics such as the proportion of businesses with websites, the proportion of businesses with broadband access, a new measure for teledensity and the UN E-Government Readiness Index instead of the previous E-Government measure that we were using last year; all these metrics showed less dispersion between "best" and "worst" and less inequality and skewness than conceptually similar metrics used last year.

- Resource and efficiency driven economies showed much more unevenness in performance. Some of this is understandable because the gap in basic human and economic development between sub-Saharan Africa and the more "developed" economies in the "resource-and-efficiency" grouping such as Malaysia or Chile is greater than the gap between any of the innovation-driven economies. However, and much more interestingly, there is a high incidence of "outliers" in this dataset: thus the Philippines uses text-messaging in vastly greater volume than any other resource-end-efficiency economy, while Chile has almost twice as much "international internet bandwidth" (in terms of bits per second per person) as its nearest Latin American neighbour.

How comparable are this year's scores to last year's? How should one interpret changes in a country's score from year-to-year?

The use of revised metrics and different data sources that use different estimates of the same metrics mean that it is not possible to interpret changes in country's scores from last year to the current year as being "improvements" or "deteriorations" in connectivity. This is for the following reasons:

- **The scorecard uses a relative scoring method**. On any individual metric — e.g., penetration of 3G handsets — a given country is scored relative to the "best in class." Over time, even if 3G penetration in the given country improves, the relative position of the country may not improve. Thus one could have situations in which connectivity — or the individual elements that comprise connectivity—shows improvement in absolute terms but not in relative terms. So a country could increase penetration of 3G handsets but still fall in the rankings or even in the score it receives on the Connectivity Scorecard because other countries improved at a faster rate. If the "best in class" represents the frontier of performance, the relative score that each country gets on each individual metric reflects the potential for that country to catch-up. When one uses relative scoring methods, the goalposts keep shifting, which limits the ease with which one can make comparisons over time;

- **New metrics have been included and the data sources used for existing measures have been revised.** The practical implication is the following: while the underlying methodology and conceptual basis underpinning this year's effort are identical to the methodology and conceptual basis for last year's effort, the fact that we have expanded the information base that we rely on to assess scores means that changes in scores are not necessarily a reflection of improved connectivity or reduced connectivity. The Scorecard essentially captures the extent to which nations are under-deploying and under-utilising ICT relative to the frontier of performance today. The Scorecard does not measure absolute levels of connectivity. Indeed there is no such thing as an absolute "level of connectivity", comparable to absolute levels of GDP, weight, height and other quantitative measures. Thus a more relevant way to assess country's performance from year-to-year would be to assess changes in rankings. Over a short period of time, one would expect a very good degree of stability in the rankings.

Can you comment more on the "backwards compatibility" between the different editions of the Connectivity Scorecard?

There is limited backwards compatibility — by design — between Connectivity Scorecard 2008, Connectivity Scorecard 2009 and Connectivity Scorecard 2010. First and foremost, a limitation of composite indices that produce relative rankings is that comparisons over time ("inter-temporal comparisons") are hard to make and absolute scores difficult to interpret. Connectivity is a composite of many different attributes, many of which have different units and different dimensions. For example, the United Nations' Human Development Index (HDI) is another composite index that uses a relative scoring system, as it must, to capture several attributes of a country. In both these cases, it is simply very difficult to talk of absolute levels of human development or connectivity, the way it is possible to talk about levels of simple measures such as height, weight or even GDP per capita.

This important conceptual point aside, Connectivity Scorecard 2008 was an ambitious initial effort, but we felt that it was imperative to accommodate both the feedback that we had received on Connectivity Scorecard 2008 and the continued evolution of technology and networks. In 2009, we added 25 new countries, which created its own set of research issues: for example, we could not continue to use some sources of data that were used for Connectivity Scorecard 2008 as they only covered a limited subset of the original 25 countries.

We also wanted to take into account several key realities of this technology sector. If one looks merely at mobile penetration and broadband penetration in OECD nations, there is a fair amount of convergence across these nations, with average penetration rates exceeding 90 percent for mobile, and 50 percent (by households) for broadband. However if one instead looked at the variables that reflect the most recent investment efforts in the most recent technologies, then this picture of convergence is disrupted. For instance, relatively few countries have high rates of fibre-to-the-home broadband penetration (greater than 5 percent), with many countries having a virtually zero penetration rate. 3G penetration rates are also highly variable, with most countries now catching up with the Far East, but from a much lower level of initial penetration. In much of the feedback and commentary that we obtained, there was a great deal of interest in our ability to capture these "forward-looking" dimensions of connectivity.

Connectivity Scorecard 2009 relied on data sources that offer wider country coverage and more up-to-date data. However, we felt that there was still a significant need to improve upon the data for Connectivity Scorecard 2009 by using more robust metrics. Thus, in Scorecard 2010, we eschewed use of data on average advertised speeds and instead use data on actual speed and network performance from Akamai's State of the Internet report for Q2 2009. Similarly, we felt that existing data on "fibre" penetration might fail to capture the fact that in some countries such as the US, Belgium, Netherlands, Canada and the UK, a high proportion of "ultra-high-speed" broadband offerings will be supplied by cable operators using Docsis 3.0 technology. Thus we used Akamai's data on the proportion of IP addresses that were able to attain a given file download speed as a proxy for the penetration of "fat pipes" whether Fibre-to-the-home, Fibre-to-the-curb, or cable. On the business front, previous measures of "ICT user skills" and "ICT specialist skills" in the workforce were supplanted with newer measures of workforce quality that have better comparability between countries; we added measures of businesses with broadband access and businesses using websites. We also added OECD data on investment in ICT and in R&D activities related to ICT by all economic sectors, replacing data that we had previously relied upon from Digital Planet. Appendix 1 contains extended notes on the data and indicators used.

Despite the use of new data sources, metrics and indicators, it should be noted that the country rankings show a great deal of stability. There were very few surprises in the Scorecard. The results from the Scorecard are largely consistent — in terms of the broad ordering of countries — with the results from other composite indices such as the

World Economic Forum's Networked Readiness Index or the Economist Intelligence Unit's E-Readiness Rankings.

How can one explain the fall of the US and the rise of Sweden?

Sweden and the US were close competitors in the 2009 Scorecard. Sweden's performance in 2009 was somewhat more consistent than that of the US. In particular, Sweden achieved good scores for consumer infrastructure, while the US and several other "western" countries lagged behind on this sub-component of the Scorecard. This year, it appears that Sweden's greater consistency has resulted in a slightly higher score for Sweden relative to the US, although this might be interpreted as the result of having measured Connectivity via metrics that are, in some cases, slightly different to last year's (although the underlying concept that they are trying to measure is very similar). It is important to note, however, that in areas where the US lags Sweden, it has not really closed the gap. Further, looked at over the long term, the US lead in Internet usage and in areas such as Internet banking, Internet commerce and e-business has eroded somewhat. In many of these cases, while the US remains a substantially strong performer, it is now one of many rather than a clear leader. In the current edition of the Scorecard, many of these deep-seated trends have come to the fore.

How can one interpret the significance of differences between the scores of individual countries on the current Scorecard? For example, Sweden scores a 7.95 and the US scores a 7.77. Are these countries really different?

Absolute differences in scores (e.g., the 0.18 difference between the US and Sweden) are admittedly difficult to analyse in any meaningful and rigorous way. Nevertheless, it is still worth asking — on the basis of rankings alone — whether Sweden is really more usefully connected than the US. An intuitive explanation of the distance between countries is provided by looking at "clusters" or "dissimilarity scores" between countries.

Figure 5 presents one possible clustering of countries. Thus the difference in scores between Sweden and the US is 0.18, and the US difference with Norway is very small (0.03). One potential choice for demarcating the boundaries of each cluster is the "span" of the cluster — thus, we can stipulate that the difference between members of the same cluster should never exceed a certain "cut point", say around 0.20.

Thus the US and Norway can be grouped together, and the distance between the top performer in this cluster and Sweden is less (0.18) than the distance between the bottom performer and the next country (the difference between Norway and Denmark) which is 0.20. One might group the US and Norway with Sweden (although equally Sweden might be seen as an outlier), and then group Denmark and the Netherlands together. It can be seen that the distance between Denmark and Netherlands and the next country on the list, Finland, is 0.26. But the difference between Finland and the next country (Australia) is 0.22. Thus, Australia violates our "rule" for membership of the same cluster, but is clearly clustered with the UK and Canada. However, this cluster is distinct from the next cluster, formed by Japan and Singapore, and so on. This type of intuitive analysis is one reasonable way of grouping countries, and can provide useful insights. Thus the gap between the cluster formed by France and Germany and the next cluster, the Czech Republic and Spain, is far larger than the gap between each pair of the preceding clusters considered so far. This makes some sense: in many respects, France and Germany put in a satisfactory overall performance. They show some signs of strength or catch-up relative to the best-performing countries. The Czech Republic and Spain are a distinct level below France and Germany. (Note: we have relaxed the clustering rule for the last few countries, for ease of visual presentation).

Clearly, one could define membership in the same cluster in a stricter or more lenient way — e.g., allow a cluster to contain countries that are as much as 0.4 or 0.5 distance apart, or instead just 0.1 distance apart. Thus the cluster analysis presented here is one way of grouping countries, but it is not the only way.

Another analysis of interest is "dissimilarity" analysis. Here we have defined the dissimilarity between Country A and Country B to be the "Euclidean distance" equal to the square root of the sum of squared differences between the (relative, on a 0 to 1 scale) scores that each country received on each indicator. Thus, if there were two indicators, labelled 1 and 2, the "dissimilarity" between A and B would equal $\sqrt{(x_{A,1} - x_{B,1})^2 + (x_{A,2} - x_{B,2})^2}$ where $x_{A,1}$ denotes the score received by Country A on Indicator 1, and so on.

This analysis is another intuitive way of looking at whether or not countries resemble each other, not so much in their final score, but in the pattern of their performance. Thus we find that the US has lowest dissimilarity with the UK, while Sweden has lowest dissimilarity with the Netherlands, followed by Finland, Norway and Denmark. This pattern makes some sense, as the US and the UK are relatively strong in the business areas and relatively weak on the consumer infrastructure front. The similarity between Sweden and the Netherlands owes to the fact that they are two of the strongest "western" countries in terms of consumer infrastructure. Korea is closest to Japan in overall performance, but it tends to be relatively dissimilar to all other countries.

Given that several countries receive a score above 7 out of 10, does the statement that every country "still have work to do" hold? Will any country ever get a "perfect 10"?

While the primary purpose of the Connectivity Scorecard is to generate rankings of countries at a given moment in time, there are some inferences that can be gleaned from looking at the actual country scores.

As discussed last year, it would be very difficult for a country to get a 10 out of 10, as it would have to be the best country on each metric to achieve this. However, if countries were generally performing "well" one would expect to see a lot of countries gaining relatively high scores and one would also expect to see less dispersion in the overall scores. One sees significant dispersion (as measured by the coefficient of variation) in all the six sub-indices of the Scorecard, especially in the consumer and business infrastructure categories. This dispersion is even more pronounced for the resource and efficiency-driven economies than for the innovation-driven economies.

Are there any insights from the new Scorecard specific to the resource and efficiency-driven economies?

Yes. There is significantly greater dispersion and skewness of performance among the "resource-and-efficiency" economies. There are also several instances of extreme outliers. Thus the Philippines has exceptional levels of text-messages sent per capita, even exceeding those of countries such as the US, and being multiples higher than most of the other resource-and-efficiency economies. Similarly Chile has the highest amount of international internet bandwidth per head of population according to the World Bank's World Development Indicators "ICT-at-a-glance" data (year 2007). It is several multiples that of many other otherwise similar economies. These patterns suggest that development of the information economy in the "emerging" world has been uneven and quite idiosyncratic.

For the bottom 5 or 6 performers, it is very difficult to separate out ICT or connectivity from the overall developmental challenges that these countries face. It may well be the case that any effort to kick-start economic growth by investing heavily in connectivity-related infrastructure may provide only a limited return as the human capital and infrastructural capital — roads, electricity, schools — that are required to successfully utilise infrastructure will remain under-developed. This is perhaps best illustrated by the case of India, which may be a “tech powerhouse” in some respects, but also suffers from enormous problems relating to basic infrastructure and services. Connectivity and ICT can be an important part of economic growth for India, but the country will find it difficult to achieve a more equal distribution of the economic benefits of ICT unless it is also able to improve other aspects of its infrastructure.

Other indexes measuring technological or Internet achievement also consider factors such as business environment, rule of law, and quality of institutions. Why does the Connectivity Scorecard not look at these factors?

In our view, the impact of these institutional and cultural factors is captured in the penetration rates and usage levels for technology, i.e. this impact is already embodied in the metrics that underpin the Connectivity Scorecard. Countries with good regulatory environments, good institutions and less corruption will tend to have higher connectivity. By adding in these factors as separate elements of the Scorecard, we would indeed be adding significant quantities of additional data, but not much more additional useful information.

Are the scores of the innovation-driven economies and resource and efficiency-driven economies comparable?

No. Our goal is to measure “useful connectivity”. Since the economic needs of the resource and efficiency-driven economies are different from those of the innovation-driven economies, it is appropriate to use different indicators/metrics for these countries. More extensive discussion of the methodological basis behind the Scorecard can be found in Appendix 2.

Where can I find more information on individual countries?

Country summaries will be made available on the website related to the Scorecard, www.connectivityscorecard.org.

4 Connectivity Scorecard 2010

Table 1: Connectivity Scorecard 2010 results

Rank	Country	Final Score
1	Sweden	7.95
2	United States	7.77
3	Norway	7.74
4	Denmark	7.54
5	Netherlands	7.52
6	Finland	7.26
7	Australia	7.04
8	United Kingdom	7.03
9	Canada	7.02
10	Japan	6.73
11	Singapore	6.68
12	Ireland	6.37
13	Korea	6.33
14	Hong Kong SAR	6.10
15	Belgium	6.08
16	New Zealand	6.07
17	Germany	5.77
18	France	5.65
19	Czech Republic	5.03
20	Spain	4.79
21	Portugal	4.45
22	Italy	4.35
23	Hungary	4.31
24	Poland	4.06
25	Greece	3.44

Rank	Country	Final Score
1	Malaysia	7.14
2	South Africa	6.18
3	Chile	6.06
4	Argentina	5.90
5	Russia	5.82
6	Brazil	5.32
7	Turkey	5.09
8	Mexico	5.00
9	Colombia	4.76
10	Ukraine	4.67
11	Botswana	4.30
12	Thailand	4.11
13	Tunisia	3.87
14	Iran	3.59
15	Vietnam	3.42
16	Sri Lanka	3.18
17	China	3.14
18	Egypt	2.97
19	Philippines	2.92
20	Indonesia	2.13
21	India	1.82
22	Kenya	1.80
23	Nigeria	1.78
24	Bangladesh	1.69
25	Pakistan	1.53

Figure 1: Correlation between Connectivity Scorecard 2010 and GDP per capita (at PPP rates) — Innovation-driven economies

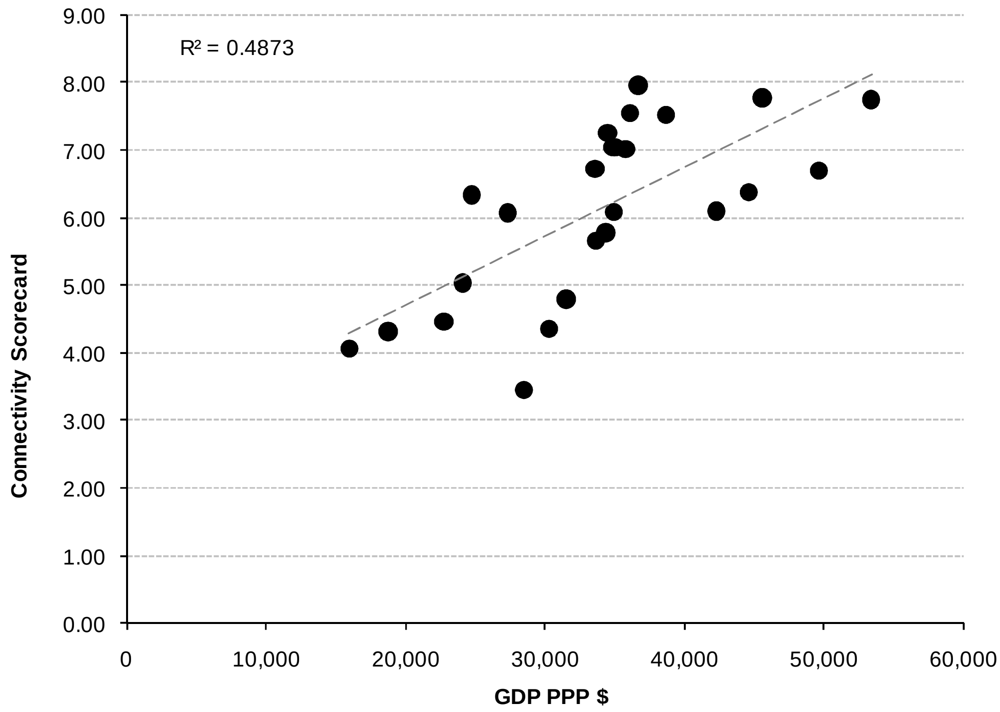


Figure 2: Correlation between Connectivity Scorecard 2010 and GDP per capita (at PPP rates) — Resource and efficiency-driven economies

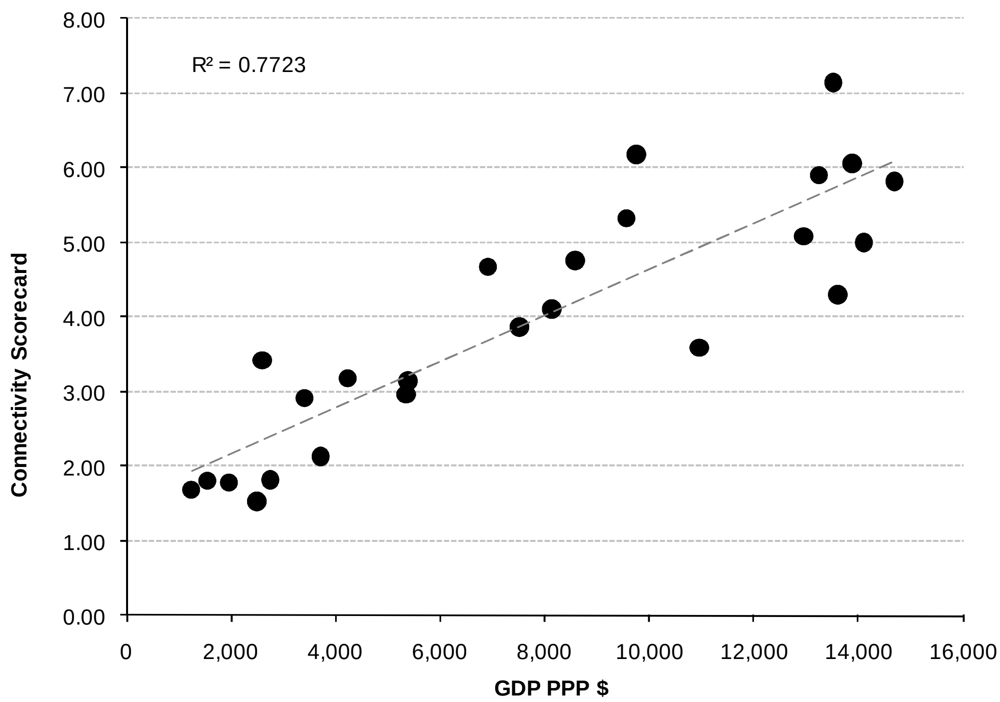


Figure 3: Correlation between Connectivity Scorecard 2010 and UN Human Development Index — Innovation-driven economies

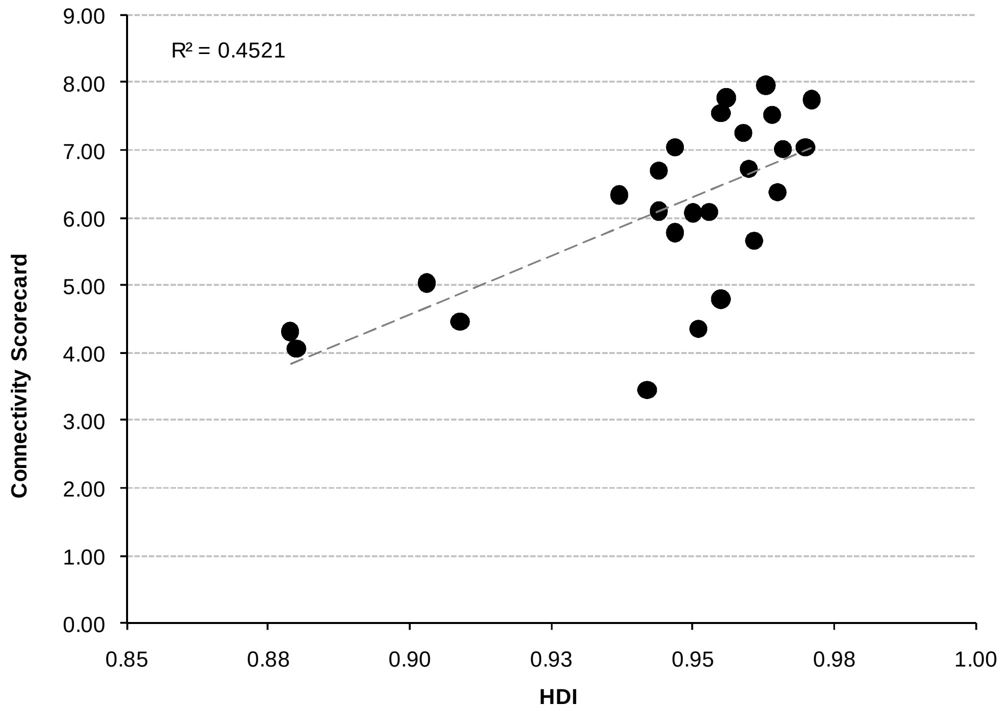


Figure 4: Correlation between Connectivity Scorecard 2010 and UN Human Development Index — Resource and efficiency-driven economies

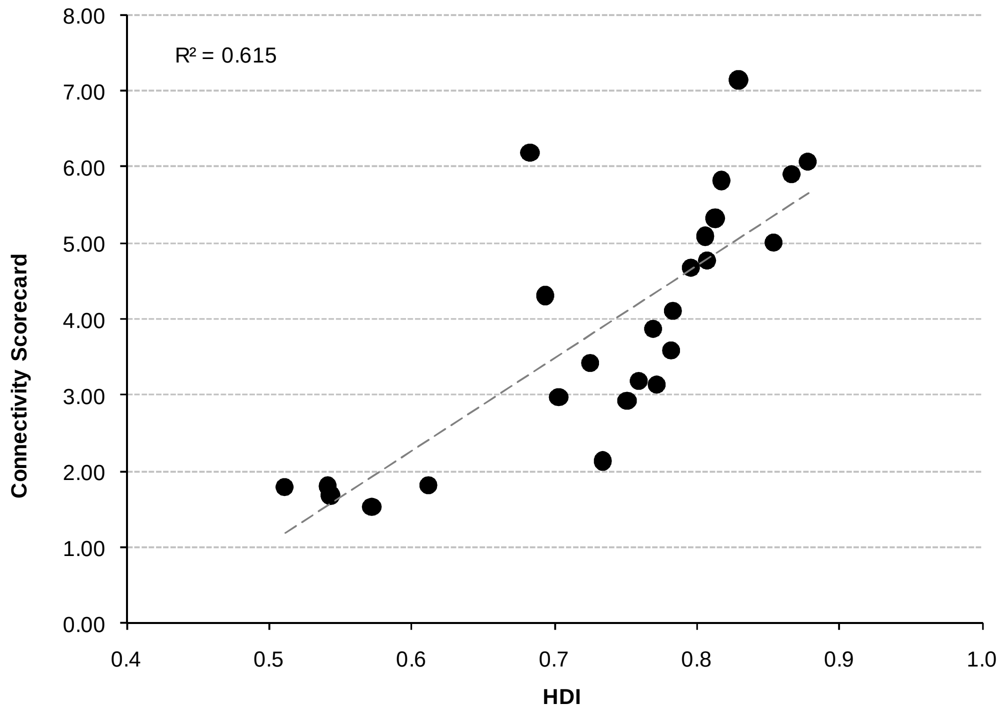


Figure 5: Cluster analysis of "Innovation-driven" economies

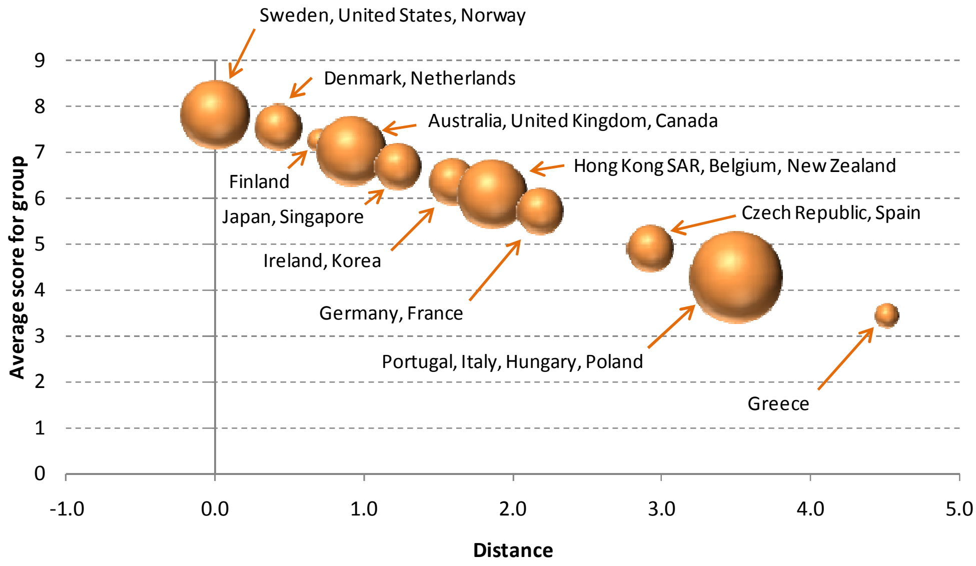


Table 2: Dissimilarity matrix for Innovation economies

Rank		Sweden	United States	Norway	Denmark	Netherlands	Finland	Australia	United Kingdom	Canada	Japan	Singapore	Ireland	Korea	Hong Kong SAR	Belgium	New Zealand	Germany	France	Czech Republic	Spain	Portugal	Italy	Hungary	Poland	Greece
1	**Sweden**	0.00	1.06	0.97	0.99	0.68	0.85	1.08	1.16	1.05	1.24	1.59	1.64	1.55	1.80	1.36	1.44	1.30	1.33	1.96	1.87	2.27	2.12	2.04	2.24	2.63
2	**United States**	1.06	0.00	1.27	1.10	1.11	1.20	1.14	1.03	1.11	1.80	1.33	1.44	1.95	1.65	1.67	1.31	1.49	1.52	2.15	1.95	2.39	2.23	2.32	2.48	2.72
3	**Norway**	0.97	1.27	0.00	0.67	0.82	0.77	0.99	0.94	1.15	1.29	1.34	1.45	1.49	2.02	1.54	1.13	1.25	1.34	2.02	1.93	2.16	2.27	2.20	2.35	2.70
4	**Denmark**	0.99	1.10	0.67	0.00	0.67	0.65	0.93	0.80	1.06	1.41	1.40	1.31	1.67	1.99	1.44	1.15	1.11	1.31	1.92	1.75	2.11	2.12	2.16	2.41	2.67
5	**Netherlands**	0.68	1.11	0.82	0.67	0.00	0.77	0.98	1.02	0.97	1.36	1.50	1.66	1.51	1.99	1.44	1.29	1.13	1.30	1.97	1.79	2.28	2.09	2.11	2.33	2.63
6	**Finland**	0.85	1.20	0.77	0.65	0.77	0.00	0.94	0.98	1.05	1.28	1.17	1.38	1.56	1.88	1.27	1.12	1.05	1.10	1.78	1.53	1.98	1.95	1.97	2.17	2.43
7	**Australia**	1.08	1.14	0.99	0.93	0.98	0.94	0.00	0.80	0.93	1.23	1.26	1.22	1.66	1.72	1.27	0.84	1.04	0.95	1.61	1.45	1.91	1.66	1.71	1.88	2.16
8	**United Kingdom**	1.16	1.03	0.94	0.80	1.02	0.98	0.80	0.00	1.06	1.46	1.17	1.00	1.94	1.80	1.20	0.88	0.90	1.06	1.54	1.54	1.83	1.78	1.80	1.91	2.21
9	**Canada**	1.05	1.11	1.15	1.06	0.97	1.05	0.93	1.06	0.00	1.47	1.43	1.43	1.69	1.50	1.28	1.11	1.02	1.05	1.80	1.48	2.09	1.78	1.85	2.10	2.28
10	**Japan**	1.24	1.80	1.29	1.41	1.36	1.28	1.23	1.46	1.47	0.00	1.70	1.46	1.22	1.98	1.30	1.38	1.37	1.32	1.89	1.66	1.92	1.85	1.89	1.91	2.19
11	**Singapore**	1.59	1.33	1.34	1.40	1.50	1.17	1.26	1.17	1.43	1.70	0.00	1.11	1.97	1.21	1.34	1.42	1.26	1.17	1.63	1.37	1.55	1.65	1.58	1.85	2.02
12	**Ireland**	1.64	1.44	1.45	1.31	1.66	1.38	1.22	1.00	1.43	1.46	1.11	0.00	1.83	1.53	0.95	0.85	1.16	1.13	1.22	1.34	1.18	1.39	1.55	1.44	1.74
13	**Korea**	1.55	1.95	1.49	1.67	1.51	1.56	1.66	1.94	1.69	1.22	1.97	1.83	0.00	2.03	1.79	1.79	1.72	1.73	2.21	1.92	2.16	2.20	1.88	2.17	2.64
14	**Hong Kong SAR**	1.80	1.65	2.02	1.99	1.99	1.88	1.72	1.80	1.50	1.98	1.21	1.53	2.03	0.00	1.60	1.86	1.66	1.46	1.85	1.65	1.66	1.76	1.58	1.99	2.24
15	**Belgium**	1.36	1.67	1.54	1.44	1.44	1.27	1.27	1.20	1.28	1.30	1.34	0.95	1.79	1.60	0.00	1.32	0.93	0.80	0.96	0.98	1.20	1.16	1.00	1.22	1.57
16	**New Zealand**	1.44	1.31	1.13	1.15	1.29	1.12	0.84	0.88	1.11	1.38	1.42	0.85	1.79	1.86	1.32	0.00	0.92	1.01	1.71	1.33	1.72	1.55	1.77	1.83	1.85
17	**Germany**	1.30	1.49	1.25	1.11	1.13	1.05	1.04	0.90	1.02	1.37	1.26	1.16	1.72	1.66	0.93	0.92	0.00	0.67	1.10	0.98	1.51	1.32	1.28	1.46	1.73
18	**France**	1.33	1.52	1.34	1.31	1.30	1.10	0.95	1.06	1.05	1.32	1.17	1.13	1.73	1.46	0.80	1.01	0.67	0.00	1.06	0.84	1.39	1.10	1.05	1.32	1.62
19	**Czech Republic**	1.96	2.15	2.02	1.92	1.97	1.78	1.61	1.54	1.80	1.89	1.63	1.22	2.21	1.85	0.96	1.71	1.10	1.06	0.00	0.96	0.93	0.81	0.75	0.80	1.23
20	**Spain**	1.87	1.95	1.93	1.75	1.79	1.53	1.45	1.54	1.48	1.66	1.37	1.34	1.92	1.65	0.98	1.33	0.98	0.84	0.96	0.00	1.12	0.81	0.89	1.27	1.30
21	**Portugal**	2.27	2.39	2.16	2.11	2.28	1.98	1.91	1.83	2.09	1.92	1.55	1.18	2.16	1.66	1.20	1.72	1.51	1.39	0.93	1.12	0.00	0.96	1.26	1.15	1.49
22	**Italy**	2.12	2.23	2.27	2.12	2.09	1.95	1.66	1.78	1.78	1.85	1.65	1.39	2.20	1.76	1.16	1.55	1.32	1.10	0.81	0.81	0.96	0.00	0.84	0.94	0.93
23	**Hungary**	2.04	2.32	2.20	2.16	2.11	1.97	1.71	1.80	1.85	1.89	1.58	1.55	1.88	1.58	1.00	1.77	1.28	1.05	0.75	0.89	1.26	0.84	0.00	0.84	1.14
24	**Poland**	2.24	2.48	2.35	2.41	2.33	2.17	1.88	1.91	2.10	1.91	1.85	1.44	2.17	1.99	1.22	1.83	1.46	1.32	0.80	1.27	1.15	0.94	0.84	0.00	0.90
25	**Greece**	2.63	2.72	2.70	2.67	2.63	2.43	2.16	2.21	2.28	2.19	2.02	1.74	2.64	2.24	1.57	1.85	1.73	1.62	1.23	1.30	1.49	0.93	1.14	0.90	0.00
	Sum	**36.25**	**39.41**	**36.03**	**34.79**	**35.39**	**32.85**	**31.34**	**31.79**	**33.73**	**37.56**	**35.00**	**32.39**	**44.27**	**42.38**	**30.58**	**32.55**	**29.35**	**28.61**	**35.84**	**33.70**	**40.22**	**37.28**	**37.47**	**40.95**	**47.00**

Table 3: 2010 Innovation Economy indicators

Indicator	Notes	Source
3G subscribers as % of total mobile	Wireless Intelligence breaks down subscriptions by technology; 3G subscribers were on one of the following: CDMA 2000-EVDO (and Rev (A)), WCDMA, or WCDMA HSPA (includes subsequent evolutions).	Wireless Intelligence; Q3 2009.
Teledensity	Defined as 100 + Peak Fixed Line Penetration for countries where mobile "penetration" > 100; otherwise defined as mobile penetration plus peak fixed line penetration.	Mainly from ITU data; 2008.
Fixed broadband household penetration	May include some element of wireless access, which is inconsistently defined; but "wireless-only" broadband households are still mostly rare.	i2010 Country Profiles (European Commission); Pew Foundation; ABS; Estimates for NZ, Canada.
Average actual download speed	This reflects actual file download times from Akamai's servers. It thus captures both "speed", but also network congestion and other factors that affect download times.	Akamai State of the Internet; Q2 2009.
High broadband IP addresses per capita	IP addresses downloading at more than 5 Mbps divided by population. Intended as a proxy measure of deployment of next-generation telco and cableco technologies.	Akamai State of the Internet; Q2 2009.
Frequent Internet users per 100 adults	Proportion of adult population who use the Internet every day or "almost every day" (Europe); "on a typical day" or "everyday" (USA); or based on proportion of population that has at least 5 hours of online time per week (NZ, Can, other countries). May be minor definitional differences -— e.g., Europe asks 16-74 year olds to respond; Pew Foundation (USA) asks "18 and over" adults.	i2010; Pew Foundation; World Internet Project; Reflecting predominantly 2008 data (Europe), but some 2007 data has been used as the basis of estimates for other countries (internet usage is growing slowly in most of the more mature markets, where saturation is imminent).
Internet banking (% of adult population)	Proportion of adults using Internet banking (European Commission: “within last 3 months”).	i2010; various other sources including World Internet Project; Digital Futures Project from Annenberg School at U.S.C., specific country-level presentations etc.

Indicator	Notes	Source
Fixed and mobile outgoing minutes per capita (monthly)	Defined as aggregate outgoing voice minutes calculated (average mobile minutes per mobile subscriber x mobile subscribers/population) + (average fixed minutes per fixed subscriber x fixed subscribers/population). Fixed average is calculated taking into account both PSTN and VoIP users.	NSN data based on NRA figures; Reflects 2008 data.
Internet commerce (% of adult population)	Proportion of adults who have ordered goods over the Internet (within a defined time period — e.g., last several months).	i2010; Digital Futures programme (USC Annenberg School); estimates for Canada, USA, Australia, NZ; Singapore. Cross-checked with data from other sources (e.g. IDA Singapore); Mostly reflects 2008 data.
Annual SMS messages per capita	Calculated based on per subscriber SMS data calculated for available operators from Informa database.	Informa database based on extrapolation of existing operator information; supplemented with Wireless Intelligence where possible; Annual data for 2008 used.
PCs per 1000 population	Includes both business and residential users.	Economist Intelligence Unit; Estimates for 2009.
Secure internet servers per million population		World Bank, World Development Indicators (WDI), ICT-at-a-Glance; 2008 data.
ICT investment + Business R&D spending on ICT per capita	Average of ICT investment in GFCF from 1999-2006 (typically the latest available year); multiplied by share of GFCF in GDP; then converted to per capita using PPP conversion rate. To investment add private-sector R&D in ICT as share of GDP before multiplying everything out by GDP per capita.	OECD ICT Key Indicators.
Business uptake of broadband (% of business)	Proportion of business enterprises using broadband.	OECD STI 2009 Scoreboard; Predominantly 2008 data.

Indicator	Notes	Source
Use of new data protocols for enterprise connectivity	Ethernet plus IP VPN revenue divided by total corporate data revenue (including broadband).	Yankee Group; Global Enterprise Forecast; 2009.
Enterprise switched and mobile lines per population		Yankee Group; Global Enterprise Forecast; 2009.
IT services spending ($ per capita)		Economist Intelligence Unit; Estimates for 2009.
Corporate Data Services spending per capita ($)	Expressed in US$ at PPP by first taking local currency spending levels.	Yankee Group (as above).
E-Commerce as % of business turnover		i2010; US Department of Commerce 2007 E-statistics.
% Businesses with websites		OECD STI 2009 Scoreboard; Predominantly 2008 data.
Graduates and private-sector researchers	Share of graduates in total employment plus number of researchers per 100 population.	OECD Science, Technology and Industry Scoreboard; Pertains to 2004 data.
UN e-government readiness ranking		UNPAN report pertaining to 2008.
% of schools with broadband access		OECD; Mainly 2006 data.

Indicator	Notes	Source
Government civil R&D as % of GDP		OECD STI Scoreboard, pertaining mainly to 2006 and 2007.
% of population using e-government services	Several comparability issues for non-European countries: European survey asks "have you used such services within the last 3 months", whereas other countries (e.g., USA) have some surveys that report usage over a year.	Estimated data for non-European nations; i2010 data for Europe. Primarily 2008 data.
% of enterprises using e-government services	Several comparability issues for non-European countries: European survey asks "have you used such services within the last 3 months", whereas other countries (e.g., USA) have some surveys that report usage over a year.	Estimated data for non-European countries; i2010 data for Europe. Primarily 2008 data.

Table 4: 2010 Resource and efficiency Economy indicators

Indicator	Notes	Source
PSTN subscriptions per 100 inhabitants	Main fixed telephone line per 100 inhabitants.	ITU, ICT Statistics Database; Primarily 2008 data. (www.itu.int/ITU-D/icteye/Indicators/Indicators.aspx#)
Mobile cellular subs per 100 population		ITU, ICT Statistics Database; Primarily 2008 data.
Internet subscribers per 100 inhabitants	Internet subscribers per 100 inhabitants.	ITU, ICT Statistics Database; Primarily 2008 data.
Fixed broadband per 100 inhabitants	Broadband subscribers per 100 inhabitants.	ITU, ICT Statistics Database; Primarily 2008 data.
Population covered by mobile telephony (%)	Population covered by mobile telephony (%).	World Bank, WDI, ICT-at-a-glance; Primarily 2007 data.
Literacy rate	National literacy rates for youths (15-24) and adults (15+).	UNESCO, Institute for Statistics; Primarily 2007 data. (stats.uis.unesco.org)
Internet users per 100 inhabitants	Internet users per 100 inhabitants. Note that users is distinct from subscribers.	ITU, ICT Statistics Database; Primarily 2008 data.
Fixed and Mobile Outgoing Minutes per capita (Monthly)	Calculated on same basis as corresponding indicator for the Innovation Economies.	National Regulatory Authority information received by NSN; Primarily 2008 data.

Indicator	Notes	Source
Annual SMS messages per capita		Informa database; Primarily 2008 data.
Secure Internet Servers per million population		World Bank, WDI, ICT-at-a-glance; Primarily 2008 data.
PCs per 1000 population		Economist Intelligence Unit; Estimates for 2008. Some data points from World Bank, WDI, ICT-at-a-glance.
International Internet bandwidth bits per second per capita	International Internet bandwidth (bits per person).	World Bank, WDI, ICT-at-a-glance; Primarily 2007 data.
Enterprise fixed and mobile lines per population		Yankee Group, Global Enterprise Forecast; Forecast values for 2009.
IT hardware and software spending per capita	IT hardware spending & Packaged software sales (% of GDP) converted to PPP per capita.	Economist Intelligence Unit; Estimates for 2008.
Net secondary school enrolment, % of eligible population		UNESCO, Institute for Statistics, stats.uis.unesco.org; Primarily 2008 data. Some data points from World Bank, WDI.
International outgoing voice traffic minutes per capita	International outgoing fixed telephone traffic (minutes) per capita.	ITU; Primarily 2008 data, some 2007, 2006 and 2005 data.
Spending on fixed and mobile telecoms services	Telecom services spending (% of GDP) converted to PPP per capita.	Economist Intelligence Unit; Estimates for 2008.

Indicator	Notes	Source
IT services spending per capita	IT services spending (% of GDP) converted to PPP per capita.	Economist Intelligence Unit; Estimates for 2008.
Government software and hardware spending per capita	Estimated based on 2008 data from Digital Planet.	WITSA, Digital Planet 2008.
e-Government Web measure index	This is a subcomponent of the overall E-Government Readiness index, measuring the extent of government services provided over the web.	United Nations, UN e-Government Survey 2008.
Computer services spending by Government per capita	Estimated based on 2008 data from Digital Planet.	WITSA, Digital Planet 2008.
e-Participation index	This is a subcomponent of the overall E-Government Readiness index, measuring the "interactivity"/scope for feedback/scope for citizen participation on government websites. Likely to be related to effective utilisation of government websites.	United Nations, UN e-Government Survey 2008.

Table 5: Sources for Connectivity Scorecard 2009 – Innovation Economies

Indicator	Main Source
Population	"World Telecommunication/ICT Indicators", International Telecommunication Union, 2007.
Number of 3G subscribers per 100 inhabitants	Informa, 2007.
Average teledensity	Various national (regulatory) authorities.
Broadband household penetration	Various national (regulatory) authorities.
Fastest advertised broadband	OECD Broadband Statistics portal, Table 5e, 2007.
Fibre broadband per 100 inhabitants	Various national (regulatory) authorities.
Internet users per 100 inhabitants	"World Telecommunication/ICT Indicators", International Telecommunication Union, 2007.
Internet banking (% of population)	"Preparing Europe's digital future i2010 Mid-Term Review, Volume 3: ICT Country Profiles", Commission to the European Communities, April 2008.
PSTN, mobile and VOIP minutes per capita	Various national (regulatory) authorities.
SMS messages per capita	Informa, 2007.
Adjusted software spending by consumers	"Digital Planet 2008", World Information Technology and Services Alliance.
Personal computers per 100 inhabitants	"ICT at a Glance Tables", from "Information and Communications for Development 2006: Global Trends and Policies", The World Bank, 2006.
Application secure internet servers per million	"2007 World Development Indicators, Table 5.11: The Information Age", The World Bank.
Adjusted business software and hardware spending per capita	"Digital Planet 2008", World Information Technology and Services Alliance.
Enterprise access lines per 1,000 inhabitants	The Yankee Group, Global Enterprise Forecast, October 2008 update.

Indicator	Main Source
Internet selling, % of businesses with 10 or more employees	"OECD Key ICT Indicators, Table 7b. Internet selling and purchasing by industry, 2007".
Internet buying, % of businesses with 10 or more employees	"OECD Key ICT Indicators, Table 7b. Internet selling and purchasing by industry, 2007".
% of persons employed with ICT user skills	"Preparing Europe's digital future i2010 Mid-Term Review, Volume 3: ICT Country Profiles", Commission to the European Communities, April 2008.
% of persons employed with ICT specialist skills	"Preparing Europe's digital future i2010 Mid-Term Review, Volume 3: ICT Country Profiles", Commission to the European Communities, April 2008.
Ratio of corporate data revenue to switched access revenue	The Yankee Group, Global Enterprise Forecast, October 2008 update.
Adjusted computer services spending by business per capita	"Digital Planet 2008", World Information Technology and Services Alliance.
Share of IP and ethernet in corporate data revenue	The Yankee Group, Global Enterprise Forecast, October 2008 update.
Mobile enterprise messaging B2B ARPU	The Yankee Group, Global Enterprise Forecast, October 2008 update.
e-Government ranking	"Improving Technology Utilization in Electronic Government around the World, 2008", Darrell M. West, Governance Studies, The Brookings Institution.
% of schools with broadband access	"Preparing Europe's digital future i2010 Mid-Term Review, Volume 3: ICT Country Profiles", Commission to the European Communities, April 2008.
Adjusted government software and hardware spending per capita	"Digital Planet 2008", World Information Technology and Services Alliance.
Adjusted computer services spending by government per capita	"Digital Planet 2008", World Information Technology and Services Alliance.

Indicator	Main Source
% of population using e-government services	"Preparing Europe's digital future i2010 Mid-Term Review, Volume 3: ICT Country Profiles", Commission to the European Communities, April 2008.
% of enterprises using e-government services	"Preparing Europe's digital future i2010 Mid-Term Review, Volume 3: ICT Country Profiles", Commission to the European Communities, April 2008.

Table 6: Sources for Connectivity Scorecard 2009 – Resource and efficiency Economies

Indicator	Main Source
PSTN subscriptions per capita	Various national (regulatory) authorities.
Mobile cellular subscribers per 100 inhabitants	"World Telecommunication/ICT Indicators", International Telecommunication Union, 2007.
Internet subscribers per 100 inhabitants	"World Telecommunication/ICT Indicators", International Telecommunication Union, 2007.
Broadband household penetration (%)	Various national (regulatory) authorities.
Population covered by mobile telephony (%)	"ICT at a Glance Tables", The World Bank, 2006.
Literacy rate	UNESCO Institute for Statistics, Data Centre.
Internet users per 100 inhabitants	"World Telecommunication/ICT Indicators", International Telecommunication Union, 2007.
% of internet users who are female	"Female internet users as % of total internet users", International Telecommunication Union, 2002.
PSTN, mobile and VOIP minutes per capita	Various national (regulatory) authorities.
SMS messages per capita	Informa, 2007.
Secure internet servers per million inhabitants	"ICT at a Glance Tables", The World Bank, 2006.
Personal computers per 100 inhabitants	"ICT at a Glance Tables", The World Bank, 2006.
International internet bandwidth bits per capita	"2007 World Development Indicators, Table 5.11: The Information Age", The World Bank.
Adjusted business software and hardware spending per capita	"Digital Planet 2008", World Information Technology and Services Alliance.
School enrolment, secondary (% net)	UNESCO Institute for Statistics, Data Centre.

Indicator	Main Source
International outgoing fixed telephone traffic (minutes per person)	"World Telecommunication/ICT Indicators", International Telecommunication Union, 2007.
Adjusted computer services spending by business per capita	"Digital Planet 2008", World Information Technology and Services Alliance.
e-Government ranking	"Improving Technology Utilization in Electronic Government around the World, 2008", Darrell M. West, Governance Studies, The Brookings Institution.
Adjusted government software and hardware spending per capita	"Digital Planet 2008", World Information Technology and Services Alliance.
Adjusted computer services spending by government per capita	"Digital Planet 2008", World Information Technology and Services Alliance.
Government services online	"Improving Technology Utilization in Electronic Government around the World, 2008", Darrell M. West, Governance Studies, The Brookings Institution.

Appendix 1: Notes on data

Notes on Innovation Economies data

Broadband penetration: The UK reported around 62% of households with broadband, and France and Germany were in the high-50s, according to the European Commission's i2010 report for 2009. April 2009 data from the Pew Foundation's Americans and the Internet Survey estimated a household broadband penetration rate of 63% for the US, while that same month, the ONS in the UK estimated an identical penetration rate for the UK. It is unclear as to how "mobile-only" broadband households have been classified, but at this point, relatively few households are using mobile-only services as their primary broadband connection. In some parts of Northern Europe and in Korea, Hong Kong and Singapore, 70%+ of households have broadband services. We have used household measures of broadband penetration for two reasons: (a) "per 100 population" measures of broadband subscription may produce somewhat distorted inferences because they fail to account for differences in household size, and for the most part, fixed broadband connections are taken at the household level rather than the individual level; and (b) household-level data provide a cleaner separation between business and residential users.

It is problematic to mix business broadband subscriber lines with residential subscriber lines because there are significant cross-country differences in the way that businesses connect to the Internet. For example, consider two hypothetical economies in which all businesses have broadband, and there are 100 workers. In economy A, there is just one large firm that employs all 100 potential workers, while in economy B, there are 50 firms, each employing 2 workers. In economy A, the single large firm has a dedicated Internet access connection over a very high capacity line, whereas in economy B, the 50 small firms each have residential-style broadband connections. However, a conventional counting of "broadband penetration" will result in much higher broadband penetration in economy B than in economy A, despite economy A having equivalent or better business connectivity.[6] In short, if the basis for doing so exists, one should measure (fixed) broadband penetration at a per-household level.

6 At least some data we have seen suggest that these potential cross-country differences are not merely hypothetical. Thus, recent data from Yankee Group suggest that Spain has 1.9 million DSL business lines, while the US, with a much larger population has 2.7 million DSL business lines. This is despite the fact that monthly ARPU per business DSL line (a rough indicator of pricing) in the US is $92 versus $120 in Spain (at nominal exchange rates, however, which possibly overstate Spanish prices relative to

3G subscribers: We use the proportion of connections that are 3G, given that there are generally now only very small differences in the percentage of adults that use mobile phones. Most conventional mobile penetration measures count SIM cards, rather than unique users. In several countries where pre-paid subscribers predominate, there is thus a substantial disconnect between unique users and “subscribers” owing to operators failing to remove frequently churning but currently inactive subscribers from their subscriber counts, and because many subscribers swap between several different SIM cards. Looking at unique users — the proportion of the population above a certain age that has access to a mobile phone — would be a more useful way of looking at mobile penetration. This is especially the case because European data on usage and ARPU strongly suggest that people who subscribe to multiple operators/SIM cards essentially divide their usage up between these operators — i.e., having two SIM cards does not mean twice the usage or twice the connectivity. Looking at just unique users in the adult population, various estimates suggest that 85% or more of US adults use mobile phones,[7] and that in several European countries, this number is somewhat higher (exceeds 90%). However, the “headline” penetration rate in Europe is often 1.5 times or more of the US level, or indeed the Japanese and Korean levels, which provides a seriously distorted picture of market development, especially when we consider usage levels.

It could be argued that the same distortion does not apply to 3G subscribers and thus we should measure 3G subscribers per 100 inhabitants. Yet the mismatch between unique users and subscribers arises because of the pre-paid model which incentivises SIM-swapping and results in counting of inactive subscribers. It is plausible that the ratio of pre-paid subscribers in all 3G subscriptions is lower than it is for the general population of mobile users, given that 3G handsets are more expensive and may require

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purchasing power). However, the market for dedicated Internet access in the US seems to be about 30 times larger — by revenue — than in Spain. The most likely explanation for this discrepancy is that even relatively small businesses in the US might be connecting via dedicated Internet access products comparative to some other economies. Data on business connectivity are not ideal.

7 Carphone Warehouse in the UK commissioned a “Mobile Life” study looking at the UK and US in 2007/08. According to their survey, around 90% of US adults had a mobile phone (i.e., 10% did not), and around 96% of UK adults did. There was higher prevalence of multiple handset ownership among UK respondents, and higher ownership among “kids” in the UK (although again, in both countries mobile ownership levels are very high). See http://www.mobilelife2007.co.uk for details of the surveys. Also although text usage is skewed in the US, the overall volume of text messaging in the US now exceeds that of most European nations by a comfortable margin. This is primarily the consequence of exceptionally heavy usage among some demographics that do use text messaging. Thus, data from Informa from US carriers suggest 856 billion messages were recorded in 2008, compared to 78 billion for the UK. Even divided the US messaging volumes by two, to account for the possibility that carriers are recording all “billable” events (which includes incoming text), per capita text message volumes in the US now exceed those in the UK. Similarly, Japan is reputed to be a world leader in many aspects of mobile usage (systematic and reliable data on which are hard to come by), but it would languish in a ranking of mobile users per 100 population.

subsidies in order to sell. However, while the share of pre-paid subscribers for Hutchison's "3" operation in Italy and UK is lower than the share of pre-paid subscribers for the market as a whole, it is far higher than the share of pre-paid subscribers in the US market. Indeed, in Italy, around 2/3rds of 3's subscribers are pre-paid subscribers. Thus relative to the US and Japan, there is still likely to be significant upward distortion of the European numbers if we used a measure such as "3G subscribers per 100 inhabitants." Since 90% of Japanese subscribers are connected via a 3G standard (Japan, like the US, has permitted a multiplicity of standards to compete), Japan would still appear ahead of all European countries, but by a significantly lower margin than might truly be the case.

Data on speeds and network deployment: We use Akamai data on average download speed and on the penetration rate of what they term "high broadband IP addresses" (those that download files at transfer rates of more than 5 Mbps). Akamai is a leading provider of content caching services, and has servers located around the world. The Akamai data are based upon actual observed file transfer times and thus capture factors such as network congestion that also affect the user experience. The Akamai data would appear to provide an excellent real-world basis for assessing network quality and underlying infrastructure. Using advertised speeds can lead to highly misleading inferences because there are substantial differences in the way that broadband services are marketed and sold across countries. For instance, in many countries it is standard to advertise DSL services of "up to 20 Mbps" for an attractive price, based largely on the fastest possible speed that can be delivered to subscribers connected to a given exchange. However, for many (or even most) users served by the exchange, the actual speeds that can be provisioned over their lines may not be even 50% of 20 Mbps. Against this, there is no additional price charged for higher speeds.

In other countries, by contrast, ISPs offer tiered pricing, charging more for higher speeds. As a result, the gap between advertised speeds and actual speeds is narrower in the US than in other countries,[8] since ISPs will frequently be cautious in provisioning lines. It also appears to be the case that cable operators' achieved speeds are significantly closer to the actual speeds that users experience. Given the sometimes vast gap between what is promised and what is delivered, and the fact that this gap is variable across different countries and industry environments, it is unquestionably

8 http://www.dslprime.com/docsisreport/163-c/2469-netherlands-confirms-cable-lies-less-than-dsl-on-speeds. Research commissioned by Ofcom in the UK reports similar conclusions.

preferable to use some measure of actual user experiences.[9] The one drawback of the Akamai data is that they do not distinguish between corporate, university and residential users.

Prices: Some other indices use prices as an indicator. Price comparisons are even more difficult than speed comparisons. In some countries, ISPs may attempt to sell broadband service in the way that other goods are sold — i.e., they may have a high list price, but frequently offer discounts or promotions off of those list prices. In many cases, broadband is sold as part of a bundle, and especially with regard to TV programming, one would need to pay attention to the amount and quality of content that is sold as part of the TV/broadband bundle. A systematic and meaningful price comparison that looks at effective quality-adjusted prices would require substantial work in its own right. To see the amount of room for disagreement on price comparisons, it is worth considering the massive discrepancy between the OECD's conclusion that the US has the most expensive mobile service for "high intensity" users with the fact that the effective price per minute of mobile service in the US is the lowest in the developed world.

Further, we already have data on penetration rates and usage. These "take rates" and "utilisation rates" for services reflect the availability and the value proposition of telephone and broadband services for consumers. Countries where services are not available, and/or subscription and usage packages do not represent good value for consumers (taking into account the incomes and tastes of such consumers) should see lower penetration and lower usage rates.

Voice and SMS usage: While much discussion focuses on broadband and data consumption, voice and SMS remain very important and very mainstream ways of communicating — popular in almost all countries. Voice and SMS usage reflect an important element of network utilisation by consumers, and a crucial dimension of connectivity. We would ideally like to have used data similar to that presented in Cisco

[9] Some observers have claimed that "speed tests" are misleading because many such tests cannot pick up very high speeds. It is true that 100 Mbps or 200 Mbps speeds cannot be supported by many modems and computers, and (more credibly) cable operators such as Virgin Media have also pointed out limitations with speed testing websites. However, Akamai's reported "speeds" are based upon observed download times, rather than "speed testing" per se. While network congestion and other factors (and not just the quality of the last mile connection) do influence observed download times, this doesn't explain why the great majority of IP addresses are downloading files at less than 5 Mbps, even in countries where advertised speeds (according to the OECD) are 50 Mbps or more. It seems unlikely that outdated computers and modems can explain such a large gap; rather network congestion and the vast gulf between advertised and achieved speeds are the most likely explanations. The susceptibility of DSL based services to variations in line quality and length of the copper wire between the modem and the DSLAM means that the "gulf" between actual and achieved speeds is most pronounced in countries where

System's VNI index for consumer and business data consumption. Similar to data on minutes of use or SMS usage, there is data on consumer and business data consumption, but it only exists for a limited number of individual countries. Note: We calculated aggregate minutes and aggregate SMS volumes based on per subscriber data multiplied through by number of subscribers. For this calculation, it is appropriate to use the "headline" mobile penetration rates.

Data on applications, social networks, etc: We have eschewed using highly specific data on the popularity of various elements of Internet usage such as use of social networking sites, Twitter, and the like. The Internet as a whole is a highly useful and increasingly universally accepted medium for gathering information, accessing content and communicating with others, in real-time or otherwise. However, there are increasingly many ways of doing the above activities, and increasingly many applications and platforms that enable such activities; the use and adoption of specific applications or features may be highly dependent on perceived relevance and on cultural factors. Thus while one might be comfortable in saying that a country where business and personal Internet use is high is making better use of ICT and arguably deriving greater economic benefit than a country where such use is low, one hesitates to apply the same logic to "tweets per capita" or "Facebook users per capita." We include use of Internet banking and Internet purchasing in the Scorecard, however, because these seem like activities whose popularity may be less driven by specific and highly personal tastes than by factors such as availability of services, home Internet use, and trust in the security of electronic commerce systems.

PC penetration: It is arguable that this metric could be included in the "consumer infrastructure" category. If we assume that the average household is 2.5 persons, has a 70% probability of owning a personal computer, and there are on average 1.5 PCs in households that do have personal computers, there would be roughly 40 PCs per 100 population. These numbers might be typical for a relatively advanced OECD economy. Yet in many such advanced OECD economies, there are now 70, 80 or 90 PCs per 100 population, suggesting that 50% of the installed base of PCs might reside in the business sector. As with broadband, and perhaps even more so, the "counting" of PCs must be problematic, and is only getting more so, with the proliferation of PC-like products.

xDSL over copper is the dominant delivery platform.

ICT investment data: In previous iterations of the Scorecard, we had estimated business spending on software and hardware from the Digital Planet publication. For this version of the Scorecard, we decided to rely upon publicly available data on ICT investment from the OECD. Taking into account the internationalised nature of markets for ICT capital equipment, we estimated the $ per capita investment by business in ICT hardware and software and ICT-related R&D (which is a much smaller figure). This metric effectively captures the "amount of capital equipment" that is purchased by businesses on a per capita basis. The R&D element is relatively small, and captures further investment in innovative activities by the business sector. Investment data goes into the infrastructure category because investment adds to the overall capital base of ICT. (Note: firms usually expense R&D expenditure, rather than capitalise it).

"**Use of new data protocols for enterprise connectivity**": This metric is intended to capture the extent to which business data connectivity is provided through new IP and Ethernet data services. It is a "quality of infrastructure" metric similar to the Akamai metrics used in the consumer section of the Scorecard. However, the only basis upon which we could capture this was to look at the revenue share of such services in total data services. This would be problematic if demand for such services were more inelastic than demand for "legacy" services (e.g., traditional leased lines) and thus a higher revenue share reflected higher prices rather than modern infrastructure. There is scant empirical evidence on this front, but what evidence we have suggests that elasticity for business data services might be at least unitary.[10] That said, a conceptually better measure of business usage is provided by Cisco's VNI Usage index, which provides data on Internet Protocol (IP) traffic generated over business Internet and IP Wide Area Network (WAN) networks. Sadly, such estimates exist for only a handful of countries.[11]

IT Services spending ($ per capita): This metric is in the usage category, rather than the infrastructure category. It reflects purchases of services that are related to the level and sophistication of infrastructure utilisation. Services spending is usually not capitalised, whereas IT hardware — and quite often software too — are capitalised in national income accounts; thus, as an accounting convention such spending does not

[10] Paul N. Rappaport, Lester D. Taylor, Arthur S. Menko, and Thomas L. Brand, "Macroeconomic Benefits from a Reduction in Special Access Prices," June 12, 2003

[11] Cisco VNI data show that the US and Canada have the highest level of business IP (Internet and IP WAN) traffic per head of population. Korea has the highest level of consumer IP traffic per capita, but is behind most other countries in terms of business IP traffic per capita. Since Cisco bases its calculations on the number of network-connected computers in each country, these data might give a picture of both business network connectivity and business Internet utilisation.

add to the stock of infrastructure available to use. Note: **Corporate Data Services** spending captures the telephony analogue to IT services spending, although a more substantial part of this expenditure might be capitalised.

E-Commerce as % of business turnover: Here it is important to note that this metric captures both B2B and B2C activity. Thus a shipment of raw materials ordered over the Internet by a manufacturing business from a raw materials supplier counts as part of the latter's turnover, even though the transaction does not show up in value-added, GDP or retail sales.

Graduates and private-sector researchers: This metric is designed to give an indication of the prevalence of "knowledge workers" or those with at least the capability to effectively utilise ICT. We had previously used OECD data on the share of employment that required ICT user skills or ICT specialist skills. However, the data for non-European countries seemed not to be very comparable to that for European countries, so we have superseded those two measures with this combined measure. We have not used a narrower measure of human capital such as Science, Technology and Engineering graduates, since one of the key assumptions is that usage of ICT by sectors such as finance, healthcare, marketing, education and the like matters just as much as usage or production within the ICT sector. Indeed, this appears to be a finding of the literature of the early 2000s, which estimated the impact of ICT on economic growth.

Notes on "Resource and efficiency" Economies data

Broadband penetration: In this instance, we have used the "per 100" subscribers metric to represent broadband penetration. This is a consequence of particularly limited data availability.

Mobile and PSTN penetration: For the resource and efficiency economies, we have not used measures of 3G penetration, but of mobile cellular penetration per 100 individuals. For the innovation economies, teledensity — defined in terms of fixed and mobile subscriptions — is an increasingly uninteresting variable, as even in the worst-performing innovation economies, access to basic telephony (through either fixed or mobile means) is almost ubiquitous. This is not the case in the resource and efficiency economies. In many cases, mobile penetration far exceeds fixed penetration, but in other countries, fixed penetration and mobile penetration are both substantial. Also, relative to countries such as India and China, subscriber counts for mobile subscribers in countries that use only the GSM standard might be inflated due to over-counting of inactive subscribers and "SIM-swapping" users. Thus, China's seemingly low mobile penetration (below that of Pakistan) is belied by its high fixed line penetration rate. Lacking data on unique mobile users, we have used separate metrics of fixed and mobile penetration to address the teledensity picture in resource and efficiency economies. 3G licensing is a problematic issue in many developing nations such as India and Thailand, and mobile broadband services are in a relatively nascent stage of development.

Internet and broadband subscriptions/users: Given the relative infancy of broadband (in particular) in many resource and efficiency economies, we have used separate measures of both internet subscribers (including narrowband) and broadband subscribers. Also the metric of Internet users is a distinct one from Internet subscribers. Usage of shared Internet facilities — such as public access points or Internet cafes — is an important part of connectivity in many resource and efficiency economies.

Literacy rate and secondary school enrolment rates: We have included "literacy rates" as a measure of consumer "usage and skills", as basic literacy is an important element in being able to utilise at least basic ICT. The secondary school enrolment rate is used in the business "usage and skills" category, as a further measure of the presence of more advanced skills that are relevant to utilising ICT to at least a basic level that might be required in working environments. In the first iteration of the

Scorecard, we had used data from the Barro-Lee dataset on the proportion of the 15-and-over population that had achieved certain levels of education. While on a purely conceptual basis, we would prefer to use data that captures the quality of people working today (i.e., the workforce), such as the Barro-Lee data, the latest year for which we had data was 2000.

Note on estimated data

As much as possible, we have attempted to avoid estimating data values. This is a challenge for a Scorecard that wishes to go beyond looking at headline penetration rates, and instead look at aspects of consumer behaviour. For the European Union nations, the i2010 reports from the European Commission provide a basis for a comparable assessment of countries that enables us to look at the development of online commerce, online banking, and online business. Going beyond the European nations is challenging, as one has to rely on survey data, and the questions posed to respondents are not identical across countries. However, where reasonably comparable surveys have existed we have (with due caution) used the results from such surveys rather than estimating data values.

Only where there was both a lot of sense and a necessity for estimating data have we done so, and then only on the basis of very strong correlation patterns—for instance, if we have missing data on Series A which is part of "consumer usage" (say) for Country A, and there was a very strong relationship between Series A and Series B (a correlation of 0.9 or more) then we have considered estimating the value for Series A based on that country's relative performance on Series B. We have done this in only a limited number of cases and only where there was a serious data paucity for a country within a particular category—thus, if we were missing a significant number of indicators on "consumer usage" for Country A, then the case for using an estimated value for Series A was stronger. Leaving values as missing could generate bias in the Scorecard results, but so could using estimates that are far from "true" values.

Notes on weights

The methodology used to assign weights to the Consumer, Business and Government categories has been extensively discussed in the 2009 edition of the Connectivity Scorecard report. In that report, we explored the effect of using different weighting schemes (e.g., simple averages and principal components analysis) and different scoring schemes (e.g., a "distance from frontier" scoring scheme similar to that used in the UN Human Development Index). A further aspect of the weighting system is the allocation of weights between “infrastructure” and “usage and skills” in the business category. Previously we had allocated weights based on the relative contributions of ICT capital (infrastructure) and improvements in labour composition (usage and skills) to growth in market value-added. We retain this method for allocating weights. However, we also consider an alternative method of splitting between infrastructure and usage/skills, based on Tobin’s Q, which is a ratio of the market value of a firm relative to the “book value” of its assets. In other words, Tobin’s Q captures the ability of a firm to generate value beyond that of the physical and tangible assets that it owns. It might also be viewed as an indicator of the contribution of “intangible capital” such as intellectual property, knowledge and skill in using physical capital to generate value. Tobin’s Q for the aggregate economy is often estimated at around 1.25. This would suggest that “intangible capital” contributes 20% (0.25/1.25) of “value”, whereas 80% is generated by physical assets.

Using an 80/20 split between infrastructure and usage and skills in the business category, we obtain rankings that are somewhat different from those that we report elsewhere, but not fundamentally different except in one or two cases. Singapore and Norway are the most affected by the change in the weighting scheme. In other cases, the scores and ranks are close to what they otherwise were.

Table A-1: Rankings based on "Tobin's Q" weighting

Rank	Country	Score
1	Sweden	8.10
2	United States	7.77
3	Netherlands	7.54
4	Denmark	7.53
5	Canada	7.20
6	Finland	7.16
7	Norway	7.10
8	Australia	7.04
9	United Kingdom	6.95
10	Japan	6.61
11	Korea	6.38
12	Hong Kong SAR	6.34
13	Ireland	6.17
14	Belgium	6.08
15	New Zealand	5.90
16	Germany	5.85
17	Singapore	5.84
18	France	5.74
19	Czech Republic	5.00
20	Spain	4.77
21	Italy	4.57
22	Portugal	4.46
23	Hungary	4.28
24	Poland	4.02
25	Greece	3.46

Appendix 2: Excerpt from methodology Q&A from 2009 Scorecard

What is the merit of preparing separate scorecards for the innovation-driven and resource and efficiency-driven economies?

By separating out innovation-driven from resource and efficiency-driven economies, we have been able to incorporate variables for the innovation-driven economies that would not have been usable in a combined Scorecard for both innovation-driven and resource and efficiency-driven economies. This has allowed us to avoid falling into the trap of focussing only on basic connectivity metrics — such as mainline and mobile telephones — that are available for all countries, and including measures such as fibre-to-the-home penetration and 3G penetration in the Scorecard, measures on which even the advanced countries show significant levels of heterogeneity. One of the early criticisms of the United Nations' Human Development Index (HDI) was that it focussed too much on basic development needs, and thus it was difficult to separate out performance between the advanced (what we call innovation-driven) nations. For instance, the adult literacy rate in most advanced nations exceeded 95 percent, and life expectancy levels were quite similar. Sen and Anand (1994) suggested using an augmented HDI that was better able to capture the heterogeneities that were relevant to assessing advanced nations' performance.[12]

As an example of just how non-comparable the scores between countries are, we looked at the ranking and the score that Malaysia would have received had it been ranked using the same measures as the innovation-driven economies. <u>Malaysia would have scored below Poland, which was then the worst-performing economy in the innovation Scorecard.</u>

[12] Amartya Sen and Sudhir Anand, "Human Development Index: Methodology and Measurement", United Nations Human Development Report Office, Occasional Paper, 1994

Is the Connectivity Scorecard measuring an absolute level of connectivity?

The Connectivity Scorecard has a primary goal of providing information about the relative performance of countries, with the emphasis being on the ranking of countries. The absolute scores that countries achieve are secondary in importance, although there is significant information contained in the absolute scores — for instance, the relatively low average absolute scores and the dispersion of these scores provide significant evidence that countries are under-performing in terms of utilising the full potential of computers, telecommunications and software. In this sense, the Connectivity Scorecard is very similar to the UN Human Development Index and other indices that are essentially relative rankings. Connectivity is not a concept that can be easily defined in terms of units — for instance, it makes no sense to talk about a *connectivity level* of 6.7, just at it makes no sense to talk about a *Human Development level* of 6.7. However it makes eminent sense to talk of a broadband penetration rate of 16 lines per 100 inhabitants, or GDP per capita of $15,000, for example. Connectivity and human development are composites of many different attributes with different units, and thus are not absolute measures. In this sense, the Connectivity Scorecard is no different from a "Beauty Scorecard" or a "Humanity Scorecard."

Given the above, does it make sense to even talk about connectivity if it is such a subjective concept? How do we know that the Scorecard is measuring anything meaningful?

The issues that we are dealing with in defining connectivity are no different from those that other researchers face in combining several different attributes (or "metrics" or "indicators") into a composite attribute. Fortunately, there are statistical measures that can be utilised to measure whether the attributes are measuring the same underlying concept. One such measure is called the Cronbach Alpha reliability test, which yields an "Alpha Statistic" of 0.867 when performed on the indicators that make up the Scorecard for innovation-driven economies. Values of 0.70 or above are normally considered as acceptable evidence that the underlying indicators are measuring the same latent construct or are "uni-dimensional." Thus, at the very least, the Scorecard is not a collection of random indicators that we have grouped together. Rather these indicators are measuring well the same underlying phenomenon, which we label "connectivity."

However, is it still not true that the Connectivity Scorecard is a collection of subjectively chosen indicators that are then combined and weighted subjectively?

Yes, the Connectivity Scorecard is ultimately based upon subjective decisions about which indicators to include or exclude and how to weight these indicators. However, this is true of virtually any composite Scorecard or index. That said, there should be some logical or statistical merit to the choice of indicators and weights.

Why did you not use conventional statistical techniques to generate weightings?

Conventional statistical techniques do not always have an appealing intuitive basis. As mentioned previously, we looked at using Principal Components Analysis to look at appropriate weightings for the six major sub-segments. Principal Components Analysis suggested that the highest weight should be put on government usage, but this has little intuitive appeal and no basis in economics. The fact that the rankings of countries are fairly similar when we do use PCA was, however, reassuring (see Table 3 of the 2009 Scorecard report).

Intermediate consumption is not part of GDP. Why are you using it in your weightings for the consumer, business and government segments?

Intermediate consumption is one indication of the level of business-to-business activity which GDP does not measure. Had we simply used shares of GDP in the weights, then the only “business” component would have been investment or gross fixed capital formation (GFCF), and the consumer segment would have accounted for 50% to 70% weight in most countries. Given that business usage of ICT and telecommunications is the key driver of productivity and that productivity gains are the key driver of sustainable long-term growth, rewarding countries for high levels of consumer-oriented technology deployment would have missed out on this obvious link to economic performance.

The split between infrastructure and usage/skills is based upon the historical contribution to growth/productivity of ICT capital deepening relative to improvements in the composition of labour effort supplied. Please comment on this choice.

An ideal measure of the split between infrastructure and usage/skills would have involved utilising information about the relative marginal returns from ICT capital relative to labour composition. However such data are not available especially at a country-by-country level. Thus information about the contribution to growth of capital relative to labour composition provided at least one way of making a linkage to economic performance.

The weights placed on individual categories vary by country. In many other Scorecards and composite indices weights are constant across countries. Please comment on the effect that this has on the Scorecard?

The overall effect of the weighting system on the Scorecard is simply not that great. This can be seen either by looking at the results when we use Principal Components Analysis to weight the major sub-categories, or by looking at the results when we use simple un-weighted scores (i.e., all indicators are given equal weights). Table A-1 shows the results for the Innovation-driven economies if we simply used an un-weighted approach. There are some differences than with the scorecard results that we get using our weighted approach, but since the emphasis is on rankings rather than absolute scores, it is worth noting that the general findings from the Scorecard still hold true. In any case, the use of individual country-level weights is economically more sensible than the use of uniform weights. Countries simply have different economic structures and different needs and priorities. (Results from the Principal Components Analysis are reported in more detail in the 2008 and 2009 Scorecards).

Table A-2: Scorecard results using “un-weighted” approach

Rank	Country	Final Score
1	United States	7.80
2	Sweden	7.11
3	Denmark	6.70
4	Netherlands	6.51
5	Norway	6.51
6	Canada	6.15
7	Finland	6.03
8	Singapore	5.98
9	United Kingdom	5.77
10	Hong Kong SAR	5.76
11	Australia	5.71
12	Japan	5.67
13	Korea	5.56
14	France	5.32
15	Ireland	5.09
16	Germany	5.07
17	New Zealand	4.51
18	Belgium	4.45
19	Italy	4.17
20	Spain	3.73
21	Portugal	3.54
22	Czech Republic	3.49
23	Hungary	3.01
24	Greece	2.73
25	Poland	2.51

Can you comment on the allocation of indicators to the consumer, business or government categories?

There are some indicators — e.g., broadband penetration, minutes of use for telephony services, and PC penetration — that likely reflect both business and consumer infrastructure uptake or usage. Thus there were some choices involved in allocating these categories to different buckets. A measurement issue that we and other researchers have to contend with is incredibly poor data relating to business users, particularly with respect to broadband lines.

Moving on to the scoring system, can you explain why you used a “relative to best in class” approach? How sensitive are your results to this approach?

As with every composite index that includes many different indicators that are denominated in different units, we had to use some form of normalisation in constructing the score. The formulation that we used had some intuitive appeal for the following reasons: a country’s score is measured by where it stands on a continuum ranging from zero to the best known performance by any country. The best known performance can be seen as a "frontier", while the country's relative performance can be seen as one indication of how close it is to this frontier. The frontier itself might be seen as representing "potential performance", and thus the country's normalised score can be seen as an indicator of how much potential the country has for improvement. This scoring method is actually quite similar to the scoring method used in the UN Human Development Index. There the normalised score that a country, denoted by i, receives on a particular indicator x is given by

$$\frac{x_i - x_{\min}}{x_{\max} - x_{\min}} = x_{score,i}$$

In this method (the "HDI method") the score is basically the ratio of the difference between an individual country's distance from the "worst" country to the best-performing country's difference from the worst-performing country. In other words, the worst performing country is set as a reference point. The practical effect of using this UN Human Development Index approach in our Connectivity Scorecard would have been to increase dispersion on those metrics where the average scores that countries achieved were high and where the standard deviation of country scores was relatively low. Thus for instance if the average level of a variable was 65 percent, with the worst country scoring 30 percent, and the best country 90 percent, then under the HDI scoring system the average country would receive a score of (65-30)/(90-30) = 35/60 =0.58. Under the scoring system that we have used, the score would be 65/90 or 0.73. The UN HDI system results in a 0 to 1 continuum on each variable, which our methodology does not. The result is that using the former method significantly increases the dispersion of the country scores. Table A-2 provides these results. The methodology used by the UN Human Development Index might be more appropriate if there is a high degree of heterogeneity among groups of countries (e.g., as there is among advanced nations on basic literacy metrics) on certain variables.

Table A-3: Results from Connectivity Scorecard 2009 using UN Human Development Index scoring method

Innovation Scorecard

Rank	Country	Final Score
1	**United States**	7.23
2	**Sweden**	7.00
3	**Denmark**	6.67
4	**Netherlands**	6.16
5	**Norway**	5.73
6	**United Kingdom**	5.65
7	**Singapore**	5.38
8	**Canada**	5.35
9	**Australia**	5.30
10	**Finland**	5.08
11	**Japan**	4.86
12	**Ireland**	4.81
13	**Hong Kong SAR**	4.52
14	**Germany**	4.29
15	**France**	4.22
16	**New Zealand**	3.57
17	**Belgium**	3.54
18	**Italy**	2.96
19	**Korea**	2.87
20	**Czech Republic**	2.76
21	**Spain**	2.27
22	**Portugal**	1.67
23	**Hungary**	1.33
24	**Greece**	1.16
25	**Poland**	1.02

Resource and efficiency Scorecard

Rank	Country	Final Score
1	**Malaysia**	6.76
2	**Turkey**	6.11
3	**Chile**	6.03
4	**South Africa**	5.42
5	**Russia**	4.84
6	**Argentina**	4.66
7	**Mexico**	4.65
8	**Brazil**	4.57
9	**Colombia**	3.75
10	**Thailand**	3.48
11	**Botswana**	3.34
12	**Ukraine**	3.30
13	**Iran**	3.28
14	**Tunisia**	3.02
15	**China**	2.92
16	**Philippines**	2.85
17	**Egypt**	2.61
18	**Sri Lanka**	2.49
19	**Vietnam**	2.07
20	**Indonesia**	1.62
21	**India**	1.34
22	**Kenya**	1.08
23	**Nigeria**	0.75
24	**Bangladesh**	0.69
25	**Pakistan**	0.66

In both these scoring methods, the "goalposts" keep shifting. That is countries are affected by other countries' performance. Is this not a problem?

The use of normalised scoring techniques that look at distance from a reference point that changes over time does make certain inter-temporal comparisons quite difficult. For instance, if one country improves its broadband penetration and other countries do not, then that country scores more highly on the Connectivity Scorecard. But, if as is more realistic, most countries improve their performance on broadband penetration, then this may even mean that an improvement in the absolute score of a given country could be dwarfed by a deterioration in the country's relative position, and it is this relative position that is important in indexes such as the Connectivity Scorecard or the UN HDI. The practical implication is that it is hard to make comparisons of absolute scores over time. The reality is that ultimately the purpose of the Connectivity Scorecard is to provide an indication of rankings of countries on a construct called "connectivity", but there is ultimately no absolute level of connectivity that one can talk about. Thus the Scorecard is best viewed as a snapshot of where countries stand relative to each other at this moment in time, and not as an indicator of an absolute level of achievement.

Two particular problems (already discussed in the body of the report) with respect to comparisons of Connectivity Scorecard 2009 with Connectivity Scorecard 2008 are that

- whether we used different indicators and different data sources, and
- we added 25 more countries to our sample.

These factors make comparisons of absolute scores even more hazardous than usual.

Given this information, is there are any merit to updating the data?

Yes. Countries' relative rankings change over time. In a dynamic setting such as the telecommunications and technology sector, countries frequently catch-up and leapfrog each other at rapid rates. For example, the US' relative position on broadband penetration has declined greatly since 2000/2001, when it was fourth in the world. The Connectivity Scorecard picks up on such changes in relative position.

Is there no rigorous way to provide meaningful inter-temporal comparisons?

Sen and Anand (1994) suggest that a logical way to make inter-temporal comparisons for indexes such as the Human Development Index and the Connectivity Scorecard is to “fix the goalposts.” They propose doing this by looking at maximum and minimum values for individual variables over the entire period of time that is one is analysing. For example, if there were two variables in the index — telephone mainline penetration and adult literacy rates — one could fix the goalposts so that the maximum to which we were referring to was the maximum for the entire period under consideration. If country i increased its mainline telephone penetration rate from 5 lines per 100 population to 15 lines per 100 population over the period from 1980 to 2009, and the maximum penetration rate that any country achieved over this period was 50 per 100 population, country i’s score on mainline telephone penetration would have increased from 0.1 to 0.3 (on a 0 to 1 scale). This would arguably be a measure of absolute progress against a fixed reference point. Likewise, literacy rates could be referenced against a maximum in the same manner. The complication with the Sen and Anand methodology is that they state that it is necessary to consider not just the maximum (and minimum, if relevant) over the entire period to date, but also to consider the theoretical maximum and minimum achievable in the foreseeable future. In any case, inter-temporal comparisons may only make sense when one has several years of data that one can track. Thus it may not be worth comparing countries between 2007 and 2008, but between 2005 and 2010 the exercise may make more sense.