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THE KNOWLEDGE ECONOMY, THE KAM METHODOLOGY AND WORLD BANK OPERATIONS

Derek H. C. Chen[*] *and Carl J. Dahlman*[**]

Abstract

This paper highlights the importance of knowledge for long-term economic growth. It presents the concept of the knowledge economy, an economy where knowledge is the main engine of economic growth. The paper also introduces the knowledge economy framework, which asserts that sustained investments in education, innovation, information and communication technologies, and a conducive economic and institutional environment will lead to increases in the use and creation of knowledge in economic production, and consequently result in sustained economic growth. In order to facilitate countries trying to make the transition to the knowledge economy, the *Knowledge Assessment Methodology* (KAM) was developed. It is designed to provide a basic assessment of countries' readiness for the knowledge economy, and identifies sectors or specific areas where policymakers may need to focus more attention or future investments. The KAM is currently being widely used both internally and externally to the World Bank, and frequently facilitates engagements and policy discussions with government officials from client countries.

World Bank Institute
Washington, D.C.

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[*] Economist, Knowledge for Development Program, World Bank Institute.

[**] Luce Professor of International Affairs and Information Age Technologies, Georgetown University, and Expert Consultant, Knowledge for Development Program, World Bank Institute. The views expressed in this paper do not necessarily represent those of the World Bank. We are grateful to Robert Vitro, Aimilios Chatzinikolaou, Anuja Utz, Alexey Volynets and Yevgeny Kuznetsov for very helpful comments and suggestions.

The Knowledge Economy, The KAM Methodology And World Bank Operations
Derek H. C. Chen and Carl J. Dahlman
2006. 42 pages. Stock No. 37256

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1. Introduction

In the past decade or so, much research has been conducted on productivity-led economic growth and its determinants. A major reason is the widespread belief that economic growth due to rapid factor accumulation is subject to diminishing returns, and hence is not sustainable. Recently, there has been a growing interest in the contribution of knowledge to total factor productivity growth, and consequently to sustainable long-term economic development.

This paper highlights the importance of the use and creation of knowledge for long-term economic growth. It discusses the concept of the knowledge economy, which is essentially an economy where knowledge is the main engine of economic growth. The paper introduces the knowledge economy framework, which holistically encompasses elements or pillars such as education and training, innovation and technological adoption, the information infrastructure, and a conducive economic incentive and institutional regime. The framework asserts that sustained investments in these knowledge economy pillars will lead to the availability of knowledge and its effective use for economic production. This would tend to increase the growth rate of total factor productivity, and consequently result in sustained economic growth.

This paper also introduces a simple knowledge economy benchmarking tool, the *Knowledge Assessment Methodology* (KAM), which was developed by the World Bank Institute. The KAM is a user-friendly interactive Internet-based tool that provides a basic assessment of countries' and regions' readiness for the knowledge economy. It is designed to help client countries identify problems and opportunities that they may face, and where it may need to focus policy attention or future investments, with respect to making the transition to the knowledge economy. The unique strength of the KAM lies in its cross-sectoral approach that allows a holistic view of the wide spectrum of factors relevant to the knowledge economy. This, together with its transparency, simplicity and versatility, has led to the KAM being widely used both internally and externally to the World Bank, and it is frequently use for facilitating engagements and policy discussions with government officials from client countries.

This paper is organized as follows: Section 1 underscores the importance of knowledge to economic development. It also presents the knowledge economy framework and provides a brief survey of the literature showing the importance of the knowledge economy pillars for economic growth. Section 2 introduces the Knowledge Assessment Methodology and provides examples of its various modes using an array of countries from around the world. Following this, the features of the KAM that have led to its widespread use, especially in terms of facilitating policy dialogue with country clients are described in detailed in Section 3. Section 4 highlights the key points of the paper.

2. Knowledge and Economic Development

2.1 Knowledge Revolution and Global Competition

Over the past quarter century, the rate of knowledge creation and dissemination has increased significantly. One reason is due to the rapid advances in information and communications technologies (ICTs) that have significantly decreased the costs of computing power and electronic networking. With the increased affordability, the usage of computing power and electronic networking has surged, along with the efficient dissemination of existing knowledge. Modern ICTs also enable researchers in different locations to work together, which consequently enhance the productivity of researchers, resulting in rapid advances in research and development and the generation of new knowledge and technologies. One indicator of the creation of new knowledge and technologies is the number of patents granted by the United States Patent and Trademark Office (USPTO) each year. From Figure 1, it can be seen that the total number of patents granted by the USPTO increased from 71,114 in 1981 to 187,053 in 2003. Note that the share of patents granted to inventors outside of the United States has also grown from 39 percent in 1981 to 47 percent in 2003. The increased rate of creation of new knowledge and technologies thus reflects a recent global trend.

The increased speed in the creation and dissemination of knowledge has led to the rapid spread of modern and efficient production techniques, plus the increased probability of leapfrogging, which has consequently resulted in the world economy becoming much more competitive. The share of world trade (exports and imports) in world GDP, which is an indicator of globalization and competition in the global economy, has increased from 24 percent in 1960 to 47 percent in 2002 (Figure 2).[1] Thus, the knowledge revolution, together with increased globalization, presents significant opportunities for promoting economic and social development. However, countries also face the very real risk of falling behind if they are not able to keep up with the pace of rapid change.

In addition to the higher level of competition, the nature of competition has been changing. It has evolved from one that was just based on cost, to one where speed and innovation are also essential. Commodity production is usually allocated to lowest cost producers, but intense competition resulting from globalization tends to drive profits from commodity production to nearly zero. As such, it has become crucial to derive additional value added from various means of product differentiation via innovative designs, effective marketing, efficient distribution, reputable brand names, etc. Thus, to prosper it is critical to be able to contribute productively to global value chains and to generate own new value chains, and the key part of which is not necessarily production, but innovation and high-value services.

In light of the above, sustained economic growth in the era of this new world economy depends on developing successful strategies that involve the sustained use and creation of knowledge at the core of the development process. At lower levels of development, which typically implies lower levels of science and technology capability, knowledge strategies typically involve the tapping of existing

[1] International trade increases the number of consumers and producers participating in the market and hence increases the level of competition.

global knowledge and adoption of such foreign technologies to local conditions in order to enhance domestic productivity. At higher levels of development, which typically implies higher levels of science and technology capability, knowledge strategies also hinges critically on domestic innovative effort and underlie the move to produce products and services that higher value-added in order to be consistent with the high wages that are characteristic of these economies.

Figure 3 presents the decomposition of South Korea's economic growth over the past four decades, and clearly highlights the contribution of knowledge, represented here by total factor productivity (TFP), to South Korea's economic miracle.[2] In 1960, Korea's real GDP per capita was around US$1,110, and increased by eleven-fold to US$12,200 in 2003. In contrast, Mexico's real GDP per capita experienced a slightly more than two-fold increase, from US$2,560 to US$5,800 over the same period. Note that without the contribution of knowledge, Korea's real GDP per capita in 2003 would still be below that Mexico's.[3]

Similarly, Figure 4 demonstrates the enormous potential of knowledge use and creation in sustaining long-term economic growth by presenting alternative projections real GDP per capita for the years 2004 to 2020, assuming different TFP growth rates for Mexico. It can be seen that with a TFP growth rate of 3 percent per annum, Mexico would attain South Korea's 2003 real GDP per capita by 2020.[4]

[2] It is well accepted in the economics literature that total factor productivity depends on the availability of knowledge. For example, Romer (1986, 1990) and Lucas (1988) argued that TFP levels depend on the stock of knowledge or human capital. Grossman and Helpman (1991) postulated that imported goods embodied foreign technology and hence imports would lead to increases in TFP. Similarly, Coe and Helpman (1995) found that for a sample of developed countries both domestic and foreign R&D had significant impact on TFP.

[3] Technical details regarding the growth decomposition illustrated in Figure 3 are presented in the Annex.

[4] Note that for all 4 projections, capital, labor and population were all assumed to grow at their 1991-2003 average annual growth rates for Mexico, which are 3.68 percent, 2.70 percent and 1.59 percent, respectively. Technical details regarding the TFP and real GDP per capita projections illustrated in Figure 4 are presented in the Annex.

2.2 The Knowledge Economy Framework

With sustained use and creation of knowledge at the center of the economic development process, an economy essentially becomes a Knowledge Economy. A Knowledge Economy (KE) is one that utilizes knowledge as the key engine of economic growth. It is an economy where knowledge is acquired, created, disseminated and used effectively to enhance economic development.[5]

It has been found that the successful transition to the Knowledge Economy typically involves elements such as long-term investments in education, developing innovation capability, modernizing the information infrastructure, and having an economic environment that is conducive to market transactions. These elements have been termed by the World Bank as the pillars of the Knowledge Economy and together they constitute the Knowledge Economy framework.

More specifically, the four pillars of the Knowledge Economy (KE) framework are:

- An *economic incentive and institutional regime* that provides good economic policies and institutions that permit efficient mobilization and allocation of resources and stimulate creativity and incentives for the efficient creation, dissemination, and use of existing knowledge.
- *Educated and skilled workers* who can continuously upgrade and adapt their skills to efficiently create and use knowledge.
- An *effective innovation system* of firms, research centers, universities, consultants, and other organizations that can keep up with the knowledge revolution and tap into the growing stock of global knowledge and assimilate and adapt it to local needs.
- A *modern and adequate information infrastructure* that can facilitate the effective communication, dissemination, and processing of information and knowledge.

The Knowledge Economy framework thus asserts that investments in the four knowledge economy pillars are necessary for sustained creation, adoption, adaptation and use of knowledge in domestic economic production, which will consequently result in higher value added goods and services. This would tend to increase the probability of economic success, and hence economic development, in the current highly competitive and globalized world economy.

[5] Contrary to some beliefs, the concept of the Knowledge Economy does not necessarily revolve around high technology or information technology. For example, the application of new techniques to subsistence farming can increase yields significantly or the use of modern logistical services can enable traditional craft sectors to serve broader markets than before.

2.3 The Pillars of the Knowledge Economy

We elaborate in detail on each of the knowledge economy pillars in this section. We also briefly review empirical literature that shows that all of the pillars are important determinants of long-term economic growth, thereby lending empirical support to the knowledge economy framework.

Educated and Skilled Labor Force

A well-educated and skilled population is essential to the efficient creation, acquisition, dissemination and utilization of relevant knowledge, which tends to increase total factor productivity and hence economic growth.

Basic education is necessary to increase peoples' capacity to learn and to use information. On the other hand, technical secondary-level education, and higher education in engineering and scientific areas is necessary for technological innovation. Note that the production of new knowledge and its adaptation to a particular economic setting is generally associated with higher-level teaching and research. For example, in the industrial economies, university research accounts for a large share of domestic R&D. Technical secondary-level education is also required for the process of technological adaptation of foreign technologies for use in domestic production processes. Such training is necessary to monitor technological trends, assess what is relevant for the firm or economy, and assimilate new technologies. A more educated population also tends to be relatively more technologically sophisticated. This generates local quality sensitive demand for advanced goods, which in turns tends to stimulate local firms to innovate and design technologically sophisticated goods and production techniques.

Most empirical cross-country studies of long-run growth now include some measure of human capital and recent studies of international differences in output per worker[6] and economic growth rates have focused the role of human capital in economic development[7]. Regardless of the underlying model, it is a fairly robust finding that a country's human capital is almost always identified as an essential ingredient for achieving growth. For example, Barro (1991), using cross-section data for 98 countries for the period 1960 to 1985 and the 1960 values of school enrollment rates at the secondary and primary levels as proxies for initial human capital, found that both school enrollment rates had statistically significant positive effects on growth of per capita real GDP. Similarly, Cohen and Soto (2001), using cross-country time-series data on educational attainment or average years of school, finds statistically significant positive effects of education on economic growth. Hanushek and Kimko (2000) take an alternative approach by focusing on the effects of educational quality on economic growth. Using international test scores as a proxy for the quality of educational systems, they find that educational quality does exert positive effects on economic growth.

[6] See Temple (1999), Krueger and Lindal (2000).

[7] See Mankiw et al. (1992), Benhabib and Spiegel (1994), Hall and Jones (1999).

An Effective Innovation System

Economic theory indicates that technical progress is a major source of productivity growth and an effective innovation system is key for such technical advancement.[8] An innovation system refers to the network of institutions, rules and procedures that influences the way by which a country acquires, creates, disseminates and uses knowledge. Institutions in the innovation system include universities, public and private research centers and policy think tanks. Non-governmental organizations and the government are also part of the innovation system to the extent that they also produce new knowledge. An effective innovation system is one that provides an environment that nurtures research and development (R&D), which results in new goods, new processes and new knowledge, and hence is a major source of technical progress.[9]

There have been a number of studies that show that innovation or the generation of technical knowledge has substantial positive effects on economic growth or productivity growth. For example, Lederman and Maloney (2003), using regressions with data panels of five-year averages between 1975 to 2000 over 53 countries, finds that a one-percentage point increase in the ratio of total R&D expenditure to GDP increases the growth rate of GDP by 0.78 percentage points. Guellec and van Pottelsberghe (2001) investigated the long-term effects of various types of R&D on multifactor productivity growth using panel data for the OECD over the period 1980-98. They find that business, public and foreign R&D all have statistically significant positive effects on productivity growth[10]. Adams (1990), using the number count of academic scientific papers of various scientific fields[11] to proxy for the stock of knowledge, finds that technical knowledge contributed significantly to the total factor productivity growth of U.S. manufacturing industries for the period 1953-1980.

Currently, the majority of technical knowledge is produced in the developed countries: more than 70 percent of patenting and production of scientific and technical papers are accredited to researchers in industrialized countries. The disparity in the production of technical knowledge per capita between developed and developing countries is even greater than the disparity in income. However, note that domestic technological innovation is not the sole source of generation of technical knowledge. There are many ways for developing countries to avoid reinventing the wheel and tap into, adopt and adapt technical knowledge that was created in other developed countries. Therefore, a key element of a developing country's innovation strategy is to find the best ways to tap into the growing global knowledge base and to decide where and how to deploy its domestic R&D capability.

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[8] See Solow (1957) and Romer (1986, 1990).

[9] The OECD defines R&D to "comprise of creative work undertaken on a systemic basis in order to increase the stock of knowledge and the use of this stock of knowledge to devise new applications" (OECD, 1993).

[10] Guellec and van Pottelsberghe (2001) define public R&D as R&D performed by government and higher education sectors, and foreign R&D as business R&D performed in other 15 OECD countries.

[11] Adams (1990) used worldwide annual counts of publications in nine sciences: agriculture, biology, chemistry, computer science, engineering, geology, mathematics and statistics, medicine, and physics.

An Adequate Information Infrastructure

Information and communications technologies (ICT) infrastructure in an economy refers to the accessibility, reliability and efficiency of computers, phones, television and radio sets, and the various networks that link them. The World Bank Group defines ICT to consist of hardware, software, networks, and media for collection, storage, processing transmission, and presentation of information in the form of voice, data, text, and images. They range from the telephone, radio and television to the Internet (World Bank, 2003a and 2003b).

ICTs are the backbone of the knowledge economy and in recent years have been recognized as an effective tool for promoting economic growth and sustainable development. With relatively low usage costs and the ability to overcome distance, ICTs have revolutionized the transfer of information and knowledge around the world. Over the past decade, there has been a series of studies that show that both ICT production and ICT usage have contributed to economic growth[12]. ICT producing sectors have experienced major technological advancements, which have showed up as large gains in total factor productivity at the level of the economy. As for the non-ICT producing sectors, investment in ICT has resulted in capital deepening, and hence increases in labor productivity. More importantly, various studies have produced empirical evidence suggesting that substantial productivity gains have been experienced from ICT usage[13].

One of the most obvious benefits associated with ICT usage is the increased flow of information and knowledge. Because ICTs allow information to be transmitted relatively inexpensively and efficiently (in terms of cost), ICT usage tends to reduce uncertainty and transactions costs of participating in economic transactions. This, in turn, tends to lead to an increase in the volume of transactions leading to a higher level of output and productivity. Moreover, with the increased flow of information, technologies can be acquired and adapted more easily again leading to increased innovation and productivity.

Apart from increasing the supply of information and knowledge, ICTs are able to overcome geographic boundaries. Therefore, international buyers and sellers are increasingly able to share information, reduce uncertainty, reduce transactions costs, and increase competitiveness across borders, all of which results in a more efficient global marketplace. Also, production processes can be outsourced, based on comparative advantage, across national boundaries resulting in further global efficiency gains. Market access and coverage also tend to expand, along with increased access to global supply chains.

[12] See Pilat and Lee (2001), Jorgenson and Stiroh (2000), Oliner and Sichel (2000), Whelan (2000), and Schreyer (2000).

[13] Some national studies point to the use of ICT as an important factor in improved TFP growth. For example, see the Economic Report of the President (Council of Economic Advisors, 2000, 2001), Whelan (2000), Oliner and Sichel (2000), and Jorgenson and Stiroh (2000).

A Conductive Economic and Institutional Regime

The final pillar of the knowledge economy framework, but by no means the least, is the economic and institutional regime of the economy. The economic and institutional regime of an economy needs to be such that economic agents have incentives for the efficient use and creation of knowledge, and thus should have well-grounded and transparent macroeconomic, competition and regulatory policies.

A "knowledge-conducive" economic regime should be in general one that has the minimal number of the price distortions. For example, it should be open to international trade and be free from various protectionist policies in order to foster competition, which in turn will encourage entrepreneurship[14]. Government expenditures and budget deficits should be sustainable, and inflation should be stable and low[15]. Domestic prices should also be largely free from controls and the exchange rate should be stable and reflect the true value of the currency. The financial system should be one that is able to allocate resources to sound investment opportunities and redeploy assets from failed enterprises to more promising ones.[16]

Features of a conducive institutional regime include an effective, accountable and corrupt-free government and a legal system that supports and enforces the basic rules of commerce and protects property rights. Intellectually property rights should be also protected and strongly enforced. If intellectual property rights are not adequately protected and enforced, then researchers/scientists will have less incentive to create new technological knowledge and even in the event that knowledge is created, the lack of intellectual property rights protection will greatly hamper dissemination of such new knowledge.[17]

[14] See Sachs and Warner (1995) and Bosworth and Collins (2003).

[15] See Barro (1991).

[16] See Levine et al. (2000).

[17] See Knack and Keefer (1995) and Kaufmann et al. (2002, 2003)

3. The Knowledge Assessment Methodology (KAM)

The transition to becoming a knowledge economy requires long-term strategies that focus on developing the four KE pillars. Initially this means that countries need to understand their strengths and weaknesses, and then act upon them to develop appropriate policies and investments to give direction to their ambitions and mechanisms to enable the policy makers and leaders to monitor progress against the set of goals.

To facilitate this transition process, the World Bank Institute's Knowledge for Development (K4D) Program has developed the Knowledge Assessment Methodology (KAM - www.worldbank.org/kam), which is an Internet-based tool that provides a basic assessment of countries' and regions' readiness for the knowledge economy. The KAM is a user-friendly interactive diagnostic and benchmarking tool that is designed to help client countries understand their strengths and weaknesses by comparing themselves with neighbors, competitors, or other countries that they may wish to emulate based on the four KE pillars. The KAM is therefore useful for identifying problems and opportunities that a country may face, and where it may need to focus policy attention or future investments, with respect to making the transition to the knowledge economy. The unique strength of the KAM lies in its cross-sectoral approach that allows a holistic view of the wide spectrum of factors relevant to the knowledge economy.

Comparisons in the KAM are made on the basis of 80 structural and qualitative variables that serve as proxies for the four knowledge economy pillars. Currently, there are 128 countries and 9 regional groupings that are available in the KAM and these are listed in Table 1. The comparisons are presented in a variety of charts and figures that visibly highlight similarities and differences across countries and these will be discussed in some detail below. The data on which the KAM is based are all published by reputable institutions that are at the forefront of gathering and producing country statistics that is reliable and internationally consistent. The data are continuously updated and the country coverage is expanded whenever possible.

The most recent version of the KAM, *KAM 2005*, is able to provide assessments of a country or region position in terms the Knowledge Economy on:

- A global scale, when compared to all 128 countries that are available in the KAM database;
- A regional scale, when compared with countries in the same region
- The basis of human development, when compared with other countries in the same category of human development[18] and
- The basis on income levels, when compared with other countries of the same income level category.[19]

[18] The categories for human development are as follows: High human development (HDI >= 0.800); Medium human development (0.799 <= HDI <= 0.500); and Low human development (HDI < 0.500).

[19] Income-level categories are based on the 2004 World Development Indicator categories, which use the World Bank estimates of 2002 GNI per capita. The groupings are as follows: low income ($735 or less); lower middle income ($736-$2,935); upper middle income ($2,936-$9,075) and high income ($9,076 or more).

Because the 80 variables that are contained in the KAM span over different ranges of values, all variables are normalized from 0 (weakest) to 10 (strongest) and the 128 countries and 9 regions are ranked on an ordinal scale. The normalization procedure for the *KAM 2005* is presented in the Annex.

Given its ease of use, transparency, accessibility over the Internet, the KAM has been widely used by government officials, policy makers, researchers, representatives of civil society, and the private sector. The KAM has also been used by multilateral and bilateral aid agencies, research institutions, consultants and others to undertake preliminary single or multi-country knowledge economy assessments.

3.1 The Basic Scorecard

One of the more frequently used modes of the KAM is the basic scorecard. The KAM basic scorecard provides an overview of the performance of a specific country or region in terms of all 4 pillars of the knowledge economy. It includes 14 standard variables: two performance variables and 12 knowledge variables, with 3 variables representing each of the 4 pillars of the knowledge economy (Table 2). While there may be more robust data describing a country's preparedness for a knowledge-based economy, the 12 selected variables are generally available for a larger time series and remain regularly updated for the vast majority of the countries that are assessed by the KAM. The comparisons for the 14 basic scorecard variables can be made for the year 1995 or for the most recent period, or for both in order to show the movement over time.

There are various ways available to the use to illustrate the KAM basic scorecard, which includes the spider, diamond, and bar charts. Figure 5a illustrates the basic scorecard spider chart with Finland as an example. The center of the chart denotes the minimum normalized value of 0, while the outer perimeter of the chart denotes the maximum normalized value of 10. Thus, a "bigger" or "fuller" spider chart implies that the country or region is better positioned in terms of the knowledge economy. Both values for 1995 and the most recent year, which is currently 2002, are shown in Figure 5a. The actual or raw values of the variables for most recent year are provided in the parentheses.[20]

Finland is overall very strong in many of the knowledge indicators. For example, it is very strong in terms of regulatory quality with a normalized value of 9.92, which implies that Finland ranks in the 99th percentile in terms of regulatory quality. On the other hand, it is not as strong in terms of tariff and nontariff barriers with a normalized value of 6.59, implying that it ranks only in the 65th percentile. The innovation pillar is probably the strongest pillar for Finland, with rankings above the 90th percentile in all three innovation indicators. In terms of changes over time, Finland has made improvements in innovation pillar but has lost some ground for the ICT pillar.

Note that, because countries are ranked on an ordinal scale, the KAM illustrates the relative performance of a country as compared to other countries in the KAM database. As such, when a country's performance in a specific variable is indicated to have declined, it could have occurred for two reasons. First, the country's performance in that variable declined, resulting in lower values in absolute

[20] The KAM basic scorecard provides the option of displaying the actual, normalized or no values in the chart.

terms. Alternatively, the country's performance could have improved and resulted in large absolute values, but other countries experienced even larger improvements, leading to the country's ordinal ranking falling and resulting in a lower value in relative terms.[21]

Figure 5b presents the development of Slovakia in terms of the knowledge economy using the basic scorecard plotted with the diamond chart. Here only aggregate performance in each of the four KE pillars is shown. The value for each pillar is constructed as the simple average of the normalized values of the 3 knowledge indicators that proxy for each pillar in the basic scorecard. As it can been seen, Slovakia's performance in terms of the knowledge economy is relatively strong, with all of pillars ranking well above the 50th percentile. Slovakia's strongest pillar is the ICT pillar with its performance ranking above the 70th percentile, while its weakest is the economic incentive regime with a ranking around the 57th percentile. It also can be said that Slovakia has made significant progress towards the knowledge economy since 1995, especially in terms of the innovation and ICT pillars.

Another mode of the KAM enables the basic scorecards of up to three countries or regions to be plotted on one chart. Figure 5c illustrates this mode using the most recent data for Singapore, Malaysia and Indonesia as examples.

As can be seen, Singapore is the most developed in terms of the knowledge economy among the three East Asian countries, with all of its knowledge indicators being ranked in the 80th percentile or higher, except for those in the education pillar. Malaysia comes in next with its indicators coming in between the 30th and 80th percentiles. The ICT pillar appears to be Malaysia's strong point with all of the indicators being in the 60th to 80th percentile range. Indonesia is the weakest in terms of the knowledge economy, with all of its indicators ranking below the 45th percentile.

3.2 The Knowledge Economy Index

The KAM Knowledge Economy Index (KEI) is an aggregate index that represents the overall level of development of a country or region in the Knowledge Economy. It summarizes performance over the four KE pillars and is constructed as the simple average of the normalized values of the 12 knowledge indicators of the basic scorecard. The basic scorecard can be thus seen as a disaggregated representation of the Knowledge Economy Index.

While there are several ways to illustrate performance in the KEI, the Global Knowledge Economy Comparisons mode presents a simple way to visualize and comparing countries and regions, in terms of their development towards a knowledge economy, by plotting them in a scatter plot based on their relative performance in the KEI for two points in time: 1995 and most recent (Figure 6).[22] The horizontal axis plots countries' and regions' performance in the KEI in 1995, while the vertical axis plots

[21] For this reason, both actual and normalized values are available for each variable in the KAM.

[22] The user may opt to demonstrate performance in the aggregate Knowledge Economy Index (KEI) or the individual pillars that define them: Economic Incentive Regime, Education, Innovation and Information Infrastructure. Values for each pillar are constructed as the simple average of the normalized values of the respective 3 variables in the basic scorecard.

countries' and regions' performance in the KEI for the most recent year, currently 2002. The diagonal line represents the locus of points where the KEI values in 1995 and in the most recent year are equal. As such, countries and regions that appear above the diagonal line have made an improvement in the KEI since 1995, and countries that appear below diagonal line have experienced deterioration in terms of the KEI.

The countries that appear in the KEI scatter plot can be loosely grouped into three broad categories in terms of their development towards the knowledge economy. Firstly, located near the top-right corner of the scatter plot, are a group of countries that are in the advance stages of development in terms of the knowledge economy. These are mostly the economies of the OECD and those of the East Asian Newly Industrializing Economies (NIEs). Next, around the center of the scatter plot are a group of countries that are midway through the transition to the knowledge economy. Majority of the countries are in this category which typically includes the middle income countries from Europe and Central Asia, East Asia, Middle East and North Africa, and Latin America. Lastly, countries that have just embarked on the path to becoming a knowledge economy appear around the bottom-left portion of the scatter plot, and these typically include the low-income economies from Africa and South Asia.

Figure 6 highlights the relative KEI performance of a number of countries from the Middle East and North Africa region[23], and it can be seen that all of them fall between the 15thth and 60th percentile for both 1995 and the most recent year. In addition, note that Morocco, Tunisia, Egypt, Jordan and Saudi Arabia appear above the diagonal line, indicating that they have improved in the KEI since 1995. In contrast, Pakistan, Turkey and Lebanon appear below the diagonal line, indicating that their performance in the KEI has worsened since 1995.

3.3 Custom Scorecards

Apart from the basic scorecard, the KAM also provides the user with the flexibility to customize various combinations of variables to be included in benchmarking comparisons. The "Create Your Own Scorecard" mode allows the user to compare any two countries or regions for any of the 80 variables included in the KAM database (See Table 3 for a list of the 80 variables). Very frequently, this mode is used to generate scorecards that focus solely on individual pillars or sectors of the knowledge economy.

For example, Figure 7 presents all the available variables for the economic and institution regime for Brazil. We see that Brazil is relatively strong and performing better than the 50th percentile for indicators such as intellectually property protection, soundness of banks, local competition, voice and accountability, and press freedom. On the other hand, Brazil is relatively weak in areas such reduction in tariff and non-tariff barriers, and exports of goods and services. Figure 8 illustrates the KAM variables for education and training for Uruguay, and we see that Uruguay is relatively strong in indicators such as average years of schooling, secondary and tertiary enrollments. Ecuador's performance in the innovation and technological adoption pillar are shown in Figure 9. For most of the variables, Ecua-

[23] In the KAM Global Knowledge Economy Comparisons mode, the user can select up to five countries, in addition to a default selected group of countries and regions, to be plotted in the scatter plot.

dor ranks below the 50th percentile, with exceptions being the cost of registering a business, the level of foreign direct investment and the amount of royalty payments. Lastly, we use Venezuela as an example to illustrate the ICT pillar scorecard (Figure 10). As can be seen, Venezuela performs relatively well for e-government and the circulation of newspapers, and ranks at or below the 50th percentile for the rest of the ICT variables.

4. The KAM and World Bank Operations

The KAM has successfully been used in facilitating engagements with World Bank country teams as well as policy discussions with government officials from client countries. Moreover, the KAM has been broadly applied to various economic and sector work such as those for China, India, South Korea, Japan, Finland, Mexico, Argentina, Chile and Slovakia. We highlight in this section the features of the KAM as a tool that allows it to play a critical role in World Bank country operations.

Firstly, the KAM is based on the knowledge economy framework, which is holistic in nature as it identifies and integrates together four areas that are crucial for knowledge to contribute effectively to sustained economic growth. The KAM and this fresh approach to economic development tends to bring together specialists and policymakers in the fields of education and life long-learning, R&D and innovation, ICT infrastructure, and economic environment and institutions to work together on formulating integrative developmental strategies. In addition, the World Bank takes conscious efforts to include private sector executives, academics and representatives from think-tanks, so as to maximize civil participation in discussions relating to economic developing strategies. Discussions relating to the KAM and the knowledge economy therefore tend to be participated by diverse groups of individuals representing various fields of specialization and different facets of government and society. These groups typically do not interact together in a policy making environment. However, discussions relating to the KAM and knowledge economy approach presents an opportunity for these groups to come together to discuss, share and exchange ideas and viewpoints with the objective deriving coherent sets of policies or strategies that allow knowledge and its use to drive long-term economic development.

The user-friendliness of the KAM has certainly contributed to its widespread use. It requires virtually no training other than some basic familiarization that the users can undertake for themselves online. As illustrated above, results from the KAM can be presented in a range of comparative charts, figures and data tables that is clear and concise, with significant visual impact. Furthermore, given that data sources for all variables are clearly listed, the KAM is a very transparent tool that is constructed from data that is published by reputable sources. Adherence to reputable data sources ensures a certain level of consistency in the data collection across countries. Also, the KAM's ordinal normalization and ranking procedure is relatively transparent, straightforward and clearly described. These features, together with the unrestricted on-line access have contributed to Bank country teams and country clients finding the KAM to be a very useful tool for discussions and for use in highlighting strengths and weaknesses in various country policy reports, especially when coupled with more in-depth economic analysis. As such, results from the KAM have been routinely used to initiate policy dialogue within a country and to identify issues for further investigation.

Recall that the KAM has the ability to perform analysis or benchmarking using variables or indicators that are beyond the 14 pre-selected variables in the KAM basic scorecard. As it has been seen, the user has the flexibility to choose to benchmark countries using any of the 80 variables in the KAM database. This is an important feature as certain variables may be more relevant for some countries, but less relevant for other countries. This option significantly increases the versatility KAM by allowing the user to select the variables that are the most relevant for the country being analyzed. In addi-

tion, with this option, the KAM has the ability to perform analysis on a sectoral or individual KE pillar basis. As such, while the KAM is based on the holistic knowledge economy framework, it is sufficiently versatile to perform sectoral specific analysis.

Perhaps the most important feature of the KAM is its ability to place countries' and regions' performance in a global comparative context. The current version of the KAM, *KAM 2005*, has the ability to benchmark countries contemporaneously either using data for the most recent period or that for 1995. The ability to compare countries' performance across the two time periods is also useful for highlighting whether countries are catching up or falling behind over time. The KAM by highlighting areas in which countries have fallen behind, or equivalently, areas in which other countries have surged ahead, provides a reality check to countries with regard to their performance relative to other countries. Policymakers frequently, on realization of the relative global position in terms of the knowledge economy, bear a sense of urgency to develop coherent policies that place knowledge at the core of their development strategies.

5. Conclusion

With the spread of modern and efficient information and communication technologies, the world economy has become more competitive as well as interdependent. As such, economic survival made it essential to have knowledge creation and use play a focal point in long-term developmental strategies. In other words, it is critical for countries make the transition to become a Knowledge Economy.

This paper presents the Knowledge Economy framework thus asserts that investments in education and training, innovation and technological adoption, the information infrastructure, and a conducive economic incentive and institutional regime are necessary for sustained creation, adoption, adaptation and use of knowledge in domestic economic production, which will consequently result in higher value added goods and services. This would tend to increase the probability of economic success, and hence economic development, in the current highly competitive and globalized world economy.

In 1999, the Knowledge for Development Program of the World Bank Institute developed the Knowledge Assessment Methodology (KAM) with the objective of helping country clients make the transition to the knowledge economy. The KAM helps to identify problems and opportunities that a country may face, and where it may need to focus policy attention or future investments, with respect to making the transition to the knowledge economy. The unique strength of the KAM lies in its cross-sectoral approach that allows a holistic view of the wide spectrum of factors relevant to the knowledge economy. In addition, because of its transparency, simplicity and versatility, the KAM has been widely used and accepted for facilitating engagements with World Bank country team and policy discussions with government officials from client countries.

Annexes

Annex 1 KAM Normalization Procedure

The KAM consists of data for 128 countries for 80 variables, describing the four pillars of the knowledge economy, as well as economic and social performance, governance and gender issues. The normalization procedure used in the KAM is as follows:

1. The raw data (u) is collected from World Bank datasets and international literature for 80 variables and 128 countries.

2. Ranks are allocated to countries according based on the absolute values (raw data) that describe each and every one of the 80 variables (rank u). Countries with the same performance are allocated the same rank. Therefore, the rank equals 1 for a country that performs the best among the 128 countries in our sample on a particular variable (that is, it has the highest score), the rank equals to 2 for a country that performs second best, and so on.

3. For each specific country, the number of countries that ranks lower or below it (Nw) is calculated.

4. The following formula is used in order to normalize the scores for every country on every variable according to their ranking and in relation to the total number of countries in the sample (Nc) with available data:

$$Normalized(u) = 10\left(\frac{Nw}{Nc}\right) \quad \text{(A1)}$$

5. The above formula allocates a normalized score from 0-10 for each of the 128 countries with available data on the 80 variables. 10 is the top score for the top performers and 0 the worst for the laggards. The top 10% of performers gets a normalized score between 9 and 10, the second best 10% gets allocated normalized scores between 8 and 9 and so on. As mentioned, more than one country may be allocated either the top or worst of normalized scores. The 0-10 scale describes the performance of each country on each variable, relatively to the performance of the rest of the country sample.

Annex 2 Decomposition of Economic Growth for South Korea

For the growth decomposition exercise for South Korea illustrated in Figure 3, we considered a standard neoclassical aggregate production function that assumes a Cobb-Douglas specification together with perfect competition and constant returns to scale:

$$Y = AK^{\alpha}L^{1-\alpha} \tag{A2}$$

where

Y is the level of aggregate output
K is the level of the capital stock
L is the size of the labor force
A is total factor productivity
α is the share of capital in national income

Total factor productivity (TFP) was derived as the residual after accounting for the contribution of labor and capital to aggregate output. More specifically,

$$A = \frac{Y}{K^{\alpha}L^{1-\alpha}} \tag{A3}$$

Real GDP (in constant 2000 U.S. dollars), labor force and population figures were taken from the World Development Indicators 2005. The capital stock was constructed using gross fixed capital formation[24] (in constant 2000 U.S. dollars) also obtained from the World Development Indicators 2005. The perpetual inventory method was used with an assumed depreciation rate of 5 percent. To calculate the initial value of the capital stock, we used the average growth rate of gross capital formation for the first 5 years and applied the formula for the sum of an infinite geometric progressive series.

The estimates for labor share for South Korea and Mexico were 0.796 and 0.590, were taken from Gollin (2001) and Bernanke and Gürkaynak (2001), respectively. Invoking the assumption of constant returns to scale, the capital shares were obtained by taking 1 and subtracting the respective labor shares.

[24] Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. According to the 1993 System of National Accounts (SNA), net acquisitions of valuables are also considered capital formation.

Annex 3 Real GDP per Capita Projections for Mexico

Different TFP growth rates were assumed to produce the alternative projections of real GDP per capita for Mexico illustrated in Figure 4. We first derived the actual historical TFP growth rates by building on the computations already performed described in Section A2. Mathematically, by taking logs and time derivatives of equation (A3), and then rearranging, we obtained the estimate of growth rate of total factor productivity:

$$\hat{A} \quad = \quad \hat{Y} - \alpha \hat{K} - (1-\alpha)\hat{L} \qquad \text{(A4)}$$

where

$\hat{X}$ represents the growth rate of variable X

Table A1 presents the estimates of the growth rates of total factor productivity resulting from the growth decomposition exercise. The annual growth rates of TFP were averaged to produce decade averages.

Table A1
Annual Growth Rates of
Total Factor Productivity (in percent)

	South Korea	Mexico
1961-1970	2.08	1.02
1971-1980	1.48	0.90
1981-1990	4.28	-1.74
1991-2000	2.36	0.27
2001-2003	2.48	-2.39
1991-2003	2.38	-0.35

With reference to Figure 4, *Projection 1* plots the path of Mexico's real GDP per capita would take if the TFP growth rate were to take its 1991-2003 average value, i.e. –0.35 percent per annum. In this scenario, the real GDP per capita increases from US$5,792 in 2003 to US$7,026 in 2020, a 21 percent increase. *Projection 2* plots the path of Mexico's Real GDP per capita would take if the TFP growth rate were to take 1 percent annum, which is close to the 1961-1970 and 1971-1980 decade averages for Mexico. In this case, the real GDP per capita increases to US$8,828 in 2020. This represents a 52 percent increase.

Projection 3 plots the path of Mexico's real GDP per capita would take if the TFP were to grow at 2.38 percent annum, which is the 1991-2003 average for South Korea. Here real GDP per capita increases to US$11,118 in 2020, which represents an increase of 92 percent. Lastly, *Projection 4* plots the path of Mexico's real GDP per capita would take if the TFP growth rate were to take a hypothetical 3 percent per annum. Based on this assumption, the real GDP per capita increases by 113 percent to US$12,320 in 2020, and would allow Mexico to catch up with South Korea's current real GDP per capita.

Note that for all 4 projections, capital, labor and population were all assumed to grow at their 1991-2003 average annual growth rates for Mexico, which are 3.68 percent, 2.70 percent and 1.59 percent, respectively.

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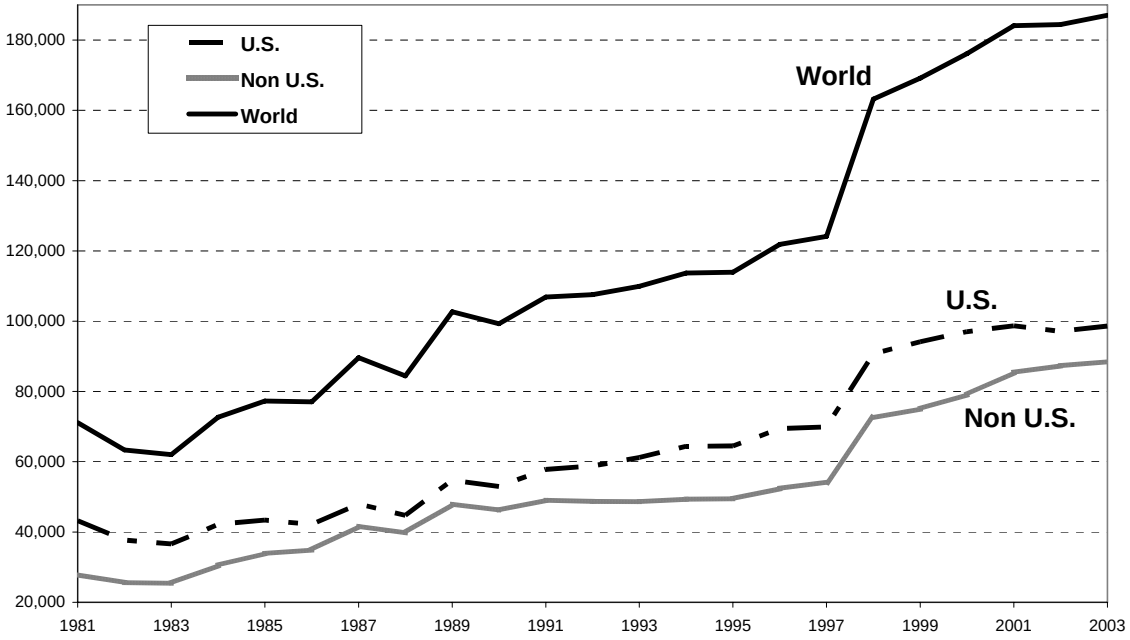
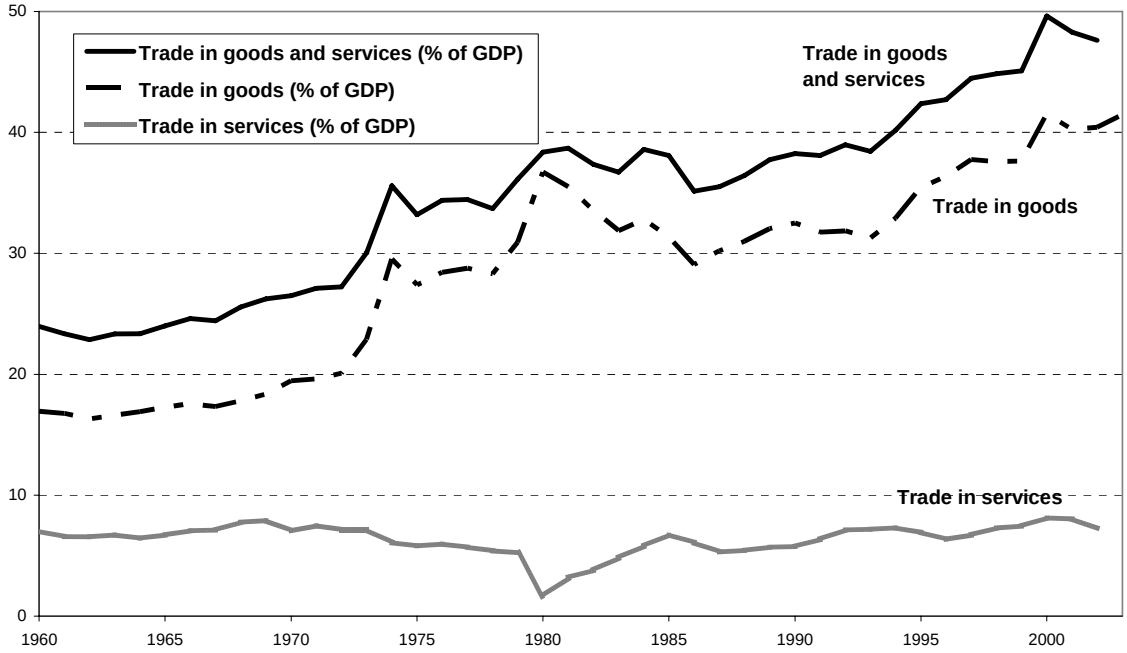
Figure 1
USPTO Patent Count (1981-2003)



Source: Authors' construction based on data from the USPTO website.

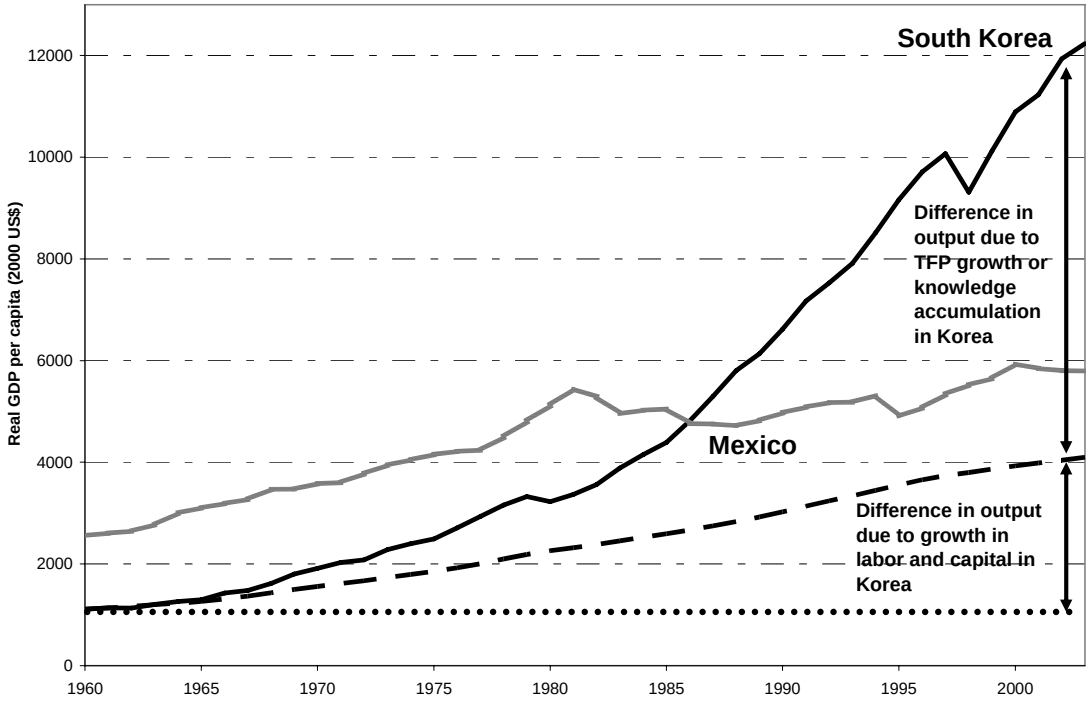
Figure 2
World Trade (1960 - 2003)



Source: Authors' construction based on data from the World Development Indicators

Figure 3

Knowledge Makes the Difference



Source: Authors' computations

Figure 4

Mexico: Real GDP Per Capita - Alternative Projections 2004-2020

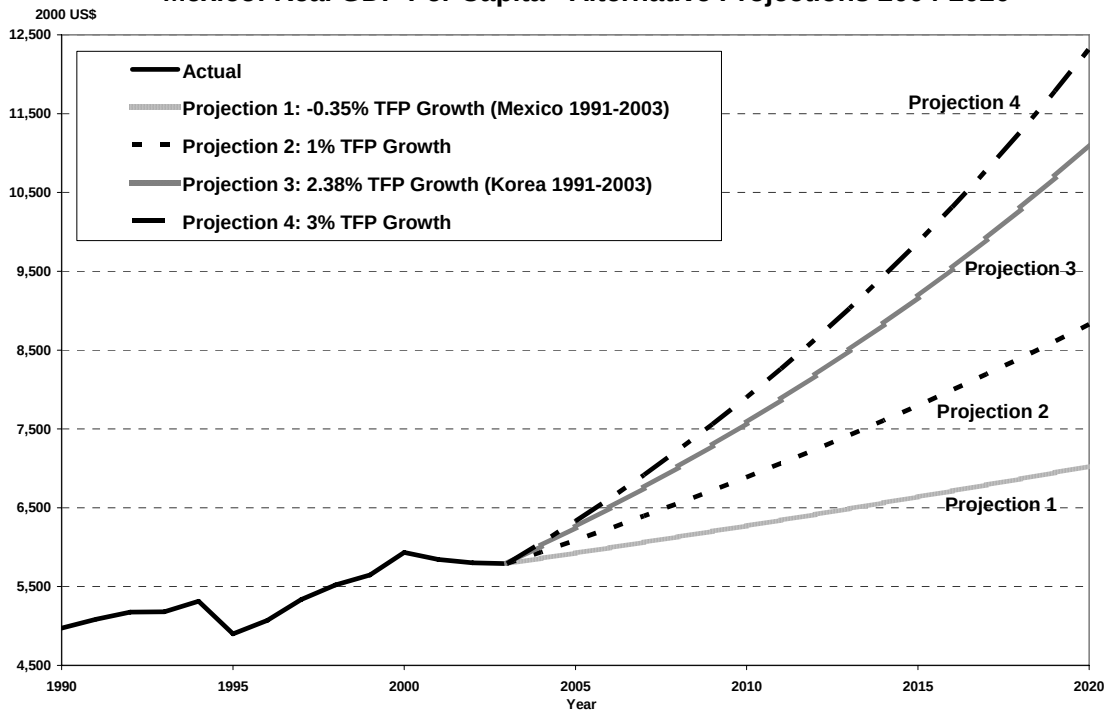
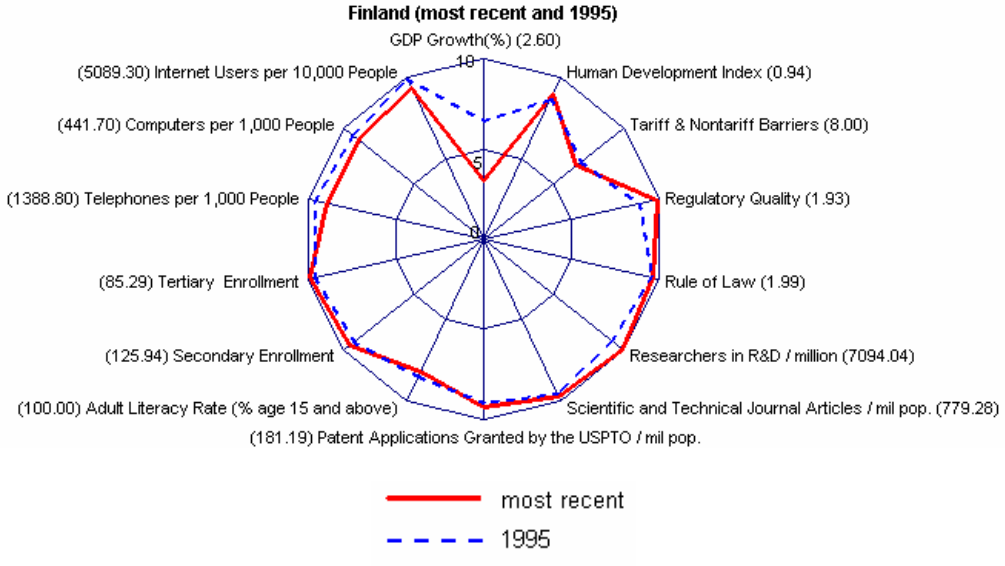
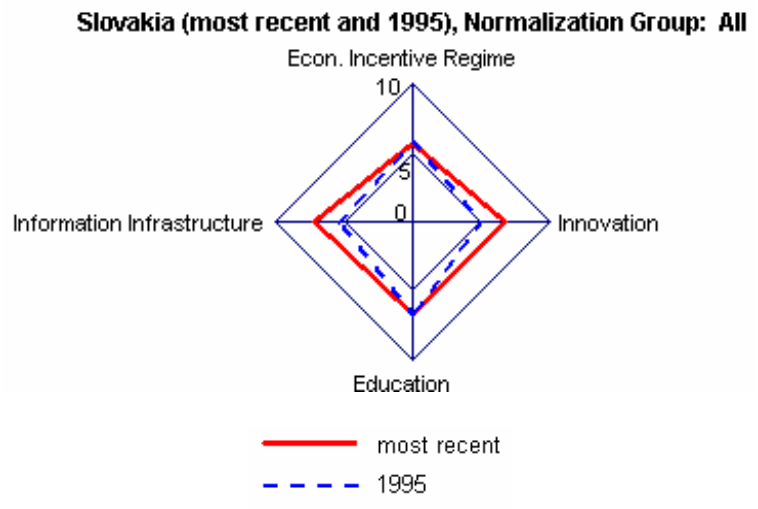


Figure 5a
The Basic Scorecard (Spider Chart) – Finland



Source: The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam)

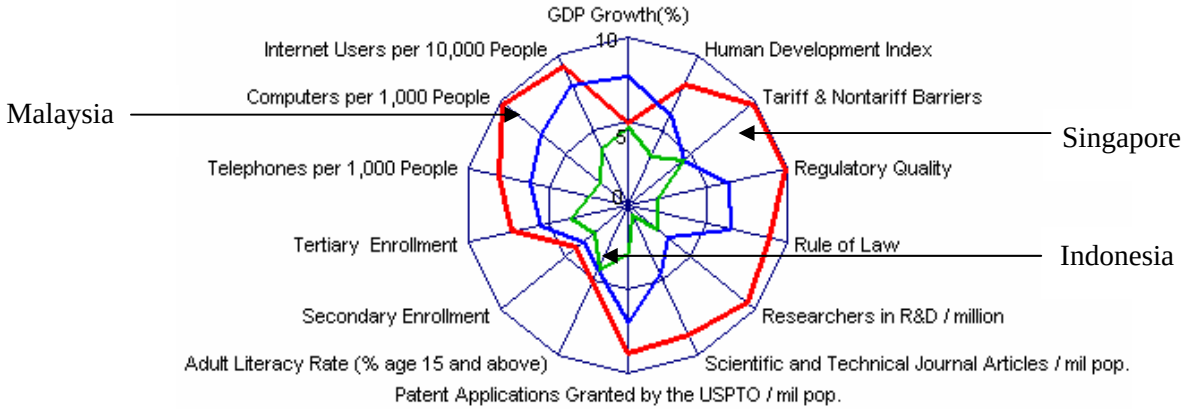
Figure 5b
The Basic Scorecard (Diamond Chart) - Slovakia



Index	Slovakia (most recent) Group: All	Slovakia (1995) Group: All
Econ. Incentive Regime	5.71	5.85
Innovation	6.76	5.02
Education	6.78	6.76
Information Infrastructure	7.26	5.39

Source: The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam)

Figure 5c
The Basic Scorecard
Singapore, Malaysia, Indonesia (most recent)

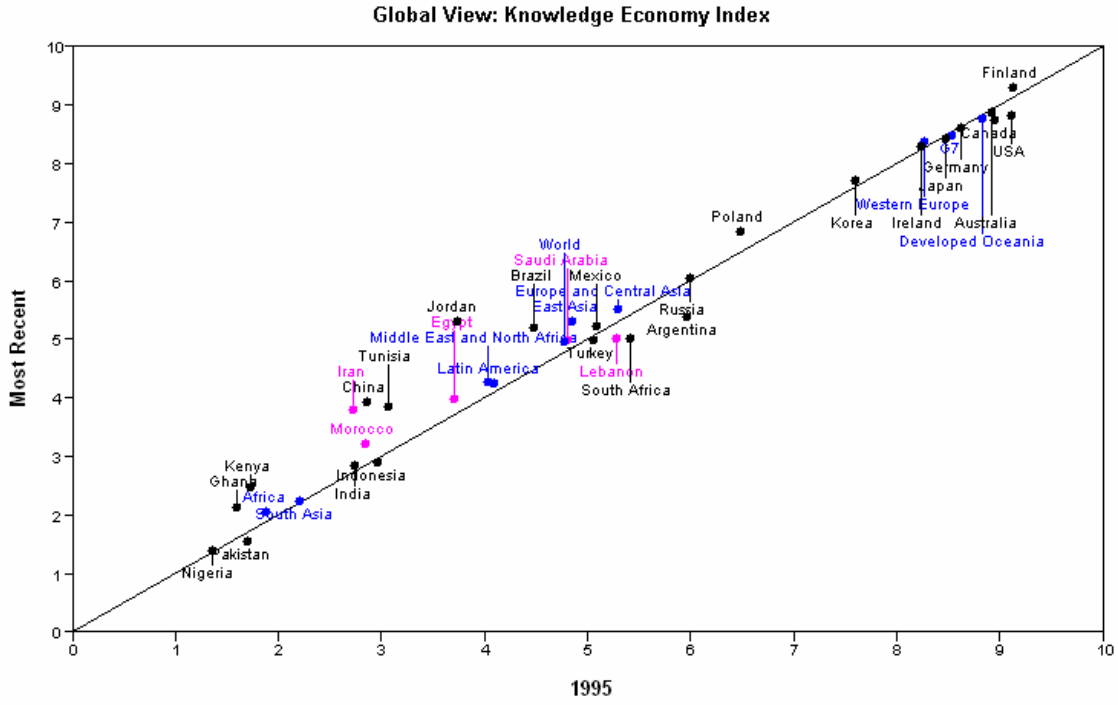


Average Annual GDP growth (most recent) is the average annual GDP growth for the period 1999-2003.

Variable	Singapore		Malaysia		Indonesia	
	actual	normalized	actual	normalized	actual	normalized
GDP Growth(%)	3.60	4.96	4.90	7.80	3.40	4.72
Human Development Index	0.90	8.02	0.79	6.03	0.69	3.33
Tariff & Nontariff Barriers	10.00	9.76	6.00	4.37	6.00	4.37
Regulatory Quality	1.89	9.84	0.58	6.30	-0.68	1.81
Rule of Law	1.75	8.90	0.58	6.46	-0.80	1.81
Researchers in R&D / million	4082.93	9.33	275.62	3.11	129.82	2.33
Scientific and Technical Journal Articles / mil pop.	418.27	8.66	18.32	4.57	0.70	0.63
Patent Applications Granted by the USPTO / mil pop.	108.24	8.91	2.54	7.00	0.06	2.91
Adult Literacy Rate (% age 15 and above)	92.60	5.04	88.00	4.33	87.87	4.25
Secondary Enrollment	74.09	4.14	69.62	3.59	57.91	2.73
Tertiary Enrollment	43.82	7.32	26.04	5.51	15.06	3.62
Telephones per 1,000 People	1258.50	8.05	623.60	6.17	91.70	2.50
Computers per 1,000 People	622.00	9.75	146.80	6.83	11.90	2.25
Internet Users per 10,000 People	5043.59	9.22	3453.31	8.05	377.16	3.83

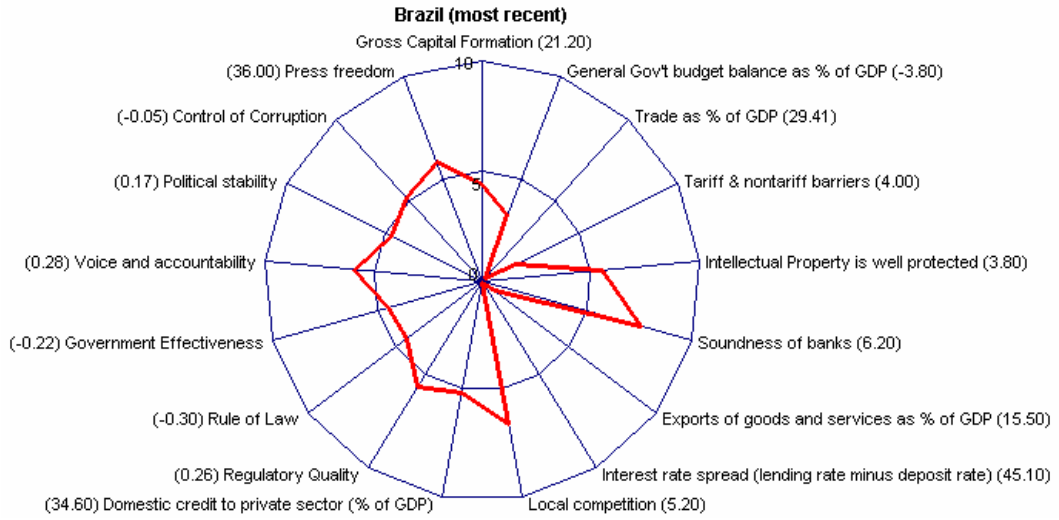
Source: The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam)

Figure 6
Knowledge Economy Index – 1995 and Most Recent Selected MENA Countries



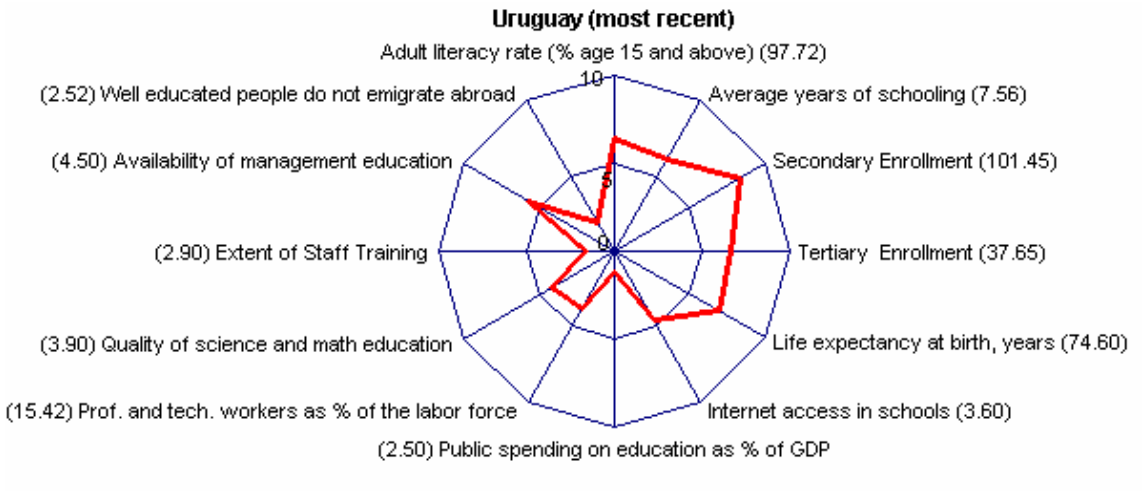
Source: The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam)

Figure 7
Economic and Institutional Regime – Brazil



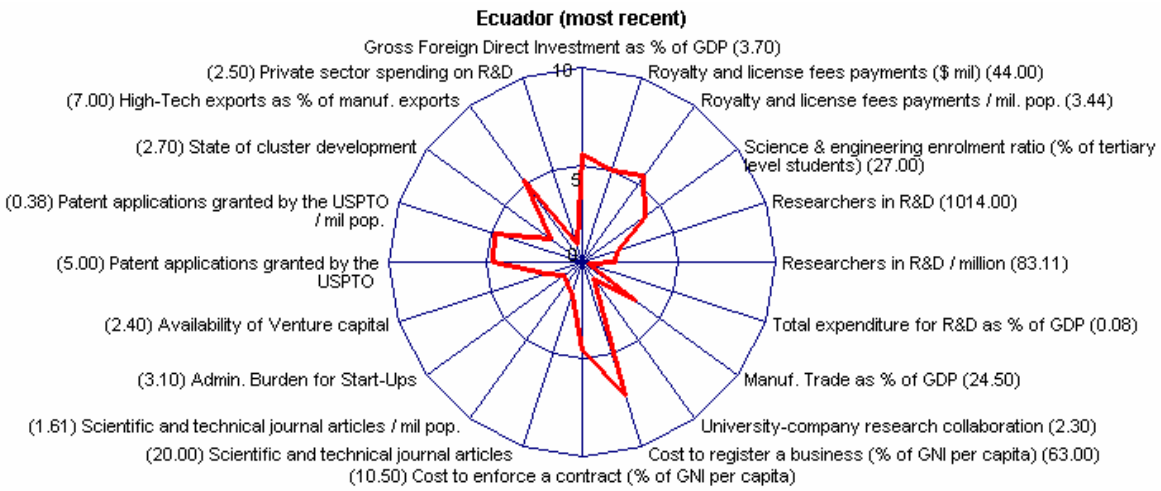
Source: The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam)

Figure 8
Education – Uruguay



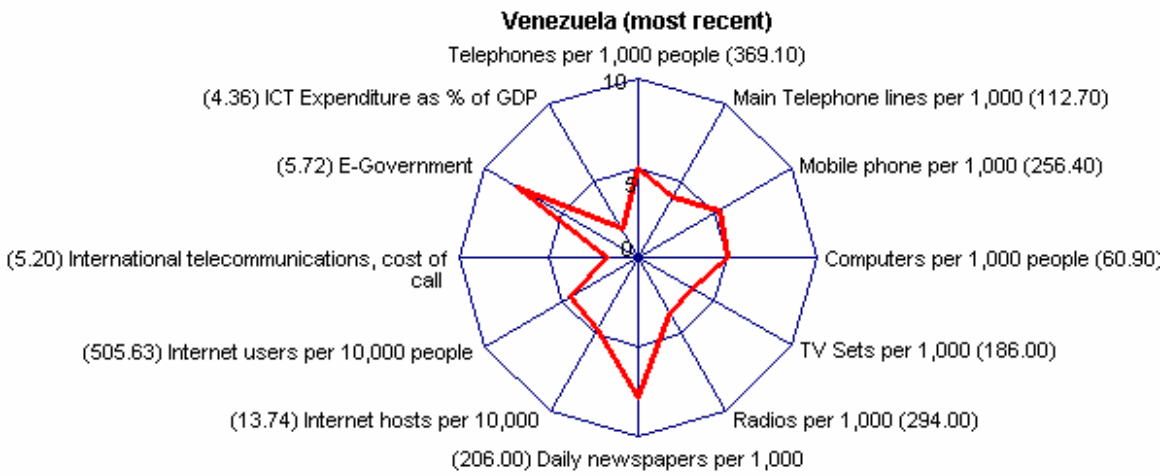
Source: The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam)

Figure 9
Innovation and Technology Adoption – Ecuador



Source: The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam)

Figure 10
Information Infrastructure – Venezuela



Source: The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam)

Table 1

Countries Included in KAM 2005

G7	Western Europe	Developed Oceania	East Asia	South Asia
Canada	Austria	Australia	China	Bangladesh
France	Belgium	New Zealand	Hong Kong	India
Germany	Cyprus		Indonesia	Nepal
Italy	Denmark		Korea	Pakistan
Japan	Finland		Laos	Sri Lanka
United Kingdom	Greece		Malaysia	
United States	Iceland		Mongolia	
	Ireland		Philippines	
	Luxemburg		Singapore	
	Netherlands		Taiwan	
	Norway		Thailand	
	Portugal		Vietnam	
	Spain			
	Sweden			
	Switzerland			
7	**15**	**2**	**12**	**5**

Europe and Central Asia	Latin America and the Caribbean	Middle East and North Africa	Sub-Saharan Africa
Albania	Argentina	Algeria	Angola
Armenia	Barbados	Bahrain	Benin
Belarus	Bolivia	Djibouti	Botswana
Bosnia and Herzegovina	Brazil	Egypt	Burkina Faso
Bulgaria	Chile	Iran	Cameroon
Croatia	Colombia	Israel	Cote D'Ivoire
Czech Republic	Costa Rica	Jordan	Eritrea
Estonia	Dominican Republic	Kuwait	Ethiopia
Georgia	Ecuador	Lebanon	Ghana
Hungary	El Salvador	Morocco	Kenya
Kazakhstan	Guatemala	Oman	Madagascar
Kyrgyz Republic	Haiti	Qatar	Malawi
Latvia	Honduras	Saudi Arabia	Mauritania
Lithuania	Jamaica	Syria	Mauritius
Moldova	Mexico	Tunisia	Mozambique
Poland	Nicaragua	United Arab Emirates	Namibia
Romania	Paraguay	Yemen	Nigeria
Russia	Peru		Senegal
Serbia and Montenegro	Uruguay		Sierra Leone
Slovakia	Venezuela		South Africa
Slovenia			Sudan
Tajikistan			Tanzania
Turkey			Uganda
Ukraine			Zambia
Uzbekistan			Zimbabwe
25	**20**	**17**	**25**

Total: 128 countries and 9 Regions

Source: The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam)

Table 2
The KAM Basic Scorecard

Performance
- Average annual GDP growth (%)
- Human Development Index

Economic Incentive and Institutional Regime
- Tariff and non-tariff barriers
- Regulatory Quality
- Rule of Law

Education and Human Resources
- Adult literacy rate (% age 15 and above)
- Secondary enrolment
- Tertiary enrolment

Innovation System
- Researchers in R&D, per million population
- Patent applications granted by the USPTO, per million population
- Scientific and technical journal articles, per million population

Information Infrastructure
- Telephones per 1,000 persons, (telephone mainlines + mobile phones)
- Computers per 1,000 persons
- Internet users per 10,000 persons

Source: The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam)

Table 3
Variables Available in the KAM

Performance Indicators
Average Annual GDP growth (%)
GDP per capita (International Current PPP)
Human Development Index
Poverty index
Composite ICRG risk rating
Average unemployment rate, % of total labor force
Employment in industry (% of total employment)
Employment in services (% of total employment)
GDP (current US$ bill)

Economic Regime
Average Gross capital formation as % of GDP
General government budget balance as % of GDP
Trade as % of GDP
Tariff & nontariff barriers
Intellectual Property is well protected
Soundness of banks
Exports of goods and services as % of GDP
Interest rate spread (lending minus deposit rate)
Intensity of local competition
Domestic credit to the private sector (% of GDP)

Institutions
Regulatory quality
Rule of law
Government Effectiveness
Voice and accountability
Political stability
Control of corruption
Press freedom

Education and Human Resources
Adult literacy rate (% age 15 and above)
Average years of schooling
Secondary enrolment
Tertiary enrolment
Life expectancy at birth, years

Internet access in schools
Public spending on education as % of GDP
Professional and technical workers as % of the labor force
8th grade achievement in mathematics
8th grade achievement in science
Quality of science and math education
Extent of staff training
Management education is locally available in first class business schools
Well educated people do not emigrate abroad

Innovation System
FDI as percentage of GDP
Royalty and license fees payments ($ millions)
Royalty and license fees payments in US$ millions / million population
Royalty and license fees receipts in US$ millions
Royalty and license fees receipts in US$ millions / million population
Science & engineering enrolment ratio (% of tertiary level students)
Researchers in R&D
Researchers in R&D / million
Total expenditure for R&D as percentage of GDP
Manufacturing. Trade as % of GDP

Research collaboration between companies and universities
Cost to register a business (% of GNI per capita)
Cost to enforce a contract (% of GNI per capita)
Scientific and technical journal articles
Scientific and technical journal articles per million people
Administrative burden for start-ups
Availability of venture capital
Patent Applications granted by the USPTO
Patent Applications granted by the USPTO (per million pop.)
State of cluster development
High-technology experts as percentage of manufactured exports
Private sector spending on R&D

Information Infrastructure
Telephones per 1,000 people (telephone mainlines + mobile phones)
Main Telephone lines per 1,000 people
65. Mobile phones per 1,000 people
Computers per 1,000 persons
TV Sets per 1,000 people
Radios per 1,000 people
Daily newspapers per 1,000 people

Internet hosts per 10,000 people
Internet users per 10,000 people
International telecommunications: cost of call to US in $ per 3 minutes
E-government
ICT Expenditures as a % of GDP

Gender Equality
Gender development Index
Females in labor force (% of total labor force)
Seats in Parliament held by women (as % of total)
Females Literacy Rate (% of females ages 15 and above)
School enrolment, secondary, female (% gross)
School enrolment, tertiary, female (% gross)

Source: The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam)