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MEASURING KNOWLEDGE IN THE WORLD'S ECONOMIES

Knowledge Assessment Methodology and Knowledge Economy Index

KNOWLEDGE FOR DEVELOPMENT PROGRAM



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Measuring Knowledge in the World's Economies

THE APPLICATION OF KNOWLEDGE—as manifested in entrepreneurship and innovation, research and development, and software and product design—is one of the key sources of growth in the global economy. But many developing countries fail to tap the vast stock of global knowledge and apply it to their needs. They need not deny themselves this vital tool for growth. By building on their strengths and carefully planning appropriate investments in human capital, effective institutions, relevant communications technologies, and innovative and competitive enterprises, developing countries can capitalize on the knowledge revolution. Countries such as Finland, Korea, Ireland, Malaysia, Singapore, Chile, and more recently, China and India illustrate the rapid progress that can be made.

The World Bank Institute's **Knowledge for Development Program (K4D)** helps build the capacity of client countries to access and use knowledge to become more competitive and improve growth and welfare. K4D helps client countries assess how they compare with others in their ability to compete in the global knowledge economy. It has developed a four-pillar framework that countries can use as the basis for their transition to a knowledge economy (figure 1).

Introducing the Knowledge Assessment Methodology

THE FIRST STEP IN BUILDING A NATIONAL KNOWLEDGE ECONOMY is to understand your country's strengths and weaknesses, as well as the strengths and weaknesses of actual and potential competitors. Countries must then articulate their goals and develop policies and investments to achieve them.

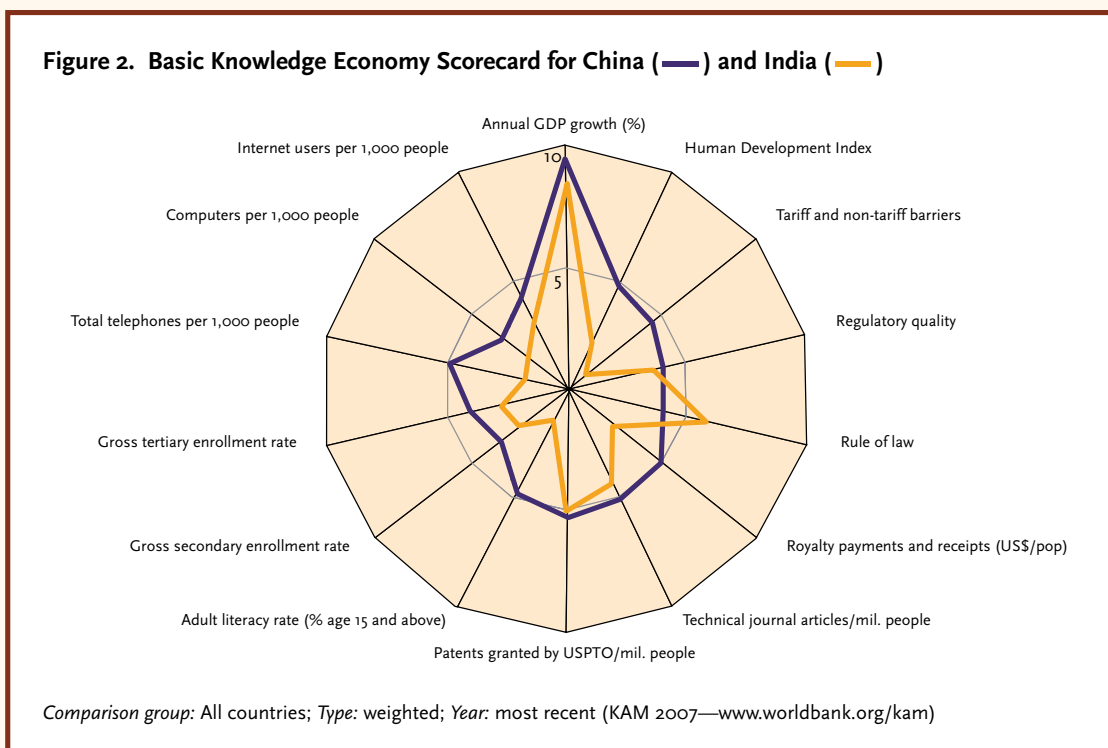
Figure 1 The four pillars of the knowledge economy

PILLAR 1 Economic and institutional regime	PILLAR 2 Education and skills	PILLAR 3 Information and communication infrastructure	PILLAR 4 Innovation system
The country's economic and institutional regime must provide incentives for the efficient use of existing and new knowledge and the flourishing of entrepreneurship.	The country's people need education and skills that enable them to create and share, and to use it well.	A dynamic information infrastructure is needed to facilitate the effective communication, dissemination, and processing of information..	The country's innovation system—firms, research centers, universities, think tanks, consultants, and other organizations—must be capable of tapping the growing stock of global knowledge, assimilating and adapting it to local needs, and creating new technology.

K4D has developed an interactive benchmarking tool that allows countries to identify the problems and opportunities that they face in making the transition to the knowledge economy, and where they may need to focus policy attention to encourage future investments. Although designed for planners and policy makers engaged in national knowledge assessments, the Knowledge Assessment Methodology (KAM: www.worldbank.org/kam) can be used by anyone with an Internet connection. In response to a user's selection, the KAM generates reports that reveal how an economy compares with other countries on various aspects of the knowledge economy.

The most recent version of the KAM, KAM 2008 makes comparisons based on 83 structural and qualitative variables that serve as proxies for the four knowledge-economy pillars described above. Some 140 countries can be compared—among them most of the developed economies of the Organisation for Economic Co-operation and Development (OECD) and about 100 developing countries. All 83 variables are normalized on a scale from 0 (weakest) to 10 (strongest), and all 140 countries are ranked on an ordinal scale. The KAM therefore reports the **relative** performance of countries on the knowledge economy.¹

Graphically, the KAM offers several options and pre-set display modes for simple visual representations, such as *basic scorecards* that reveal similarities, differences, strengths, and weaknesses across countries. The



¹ Some of the indicators used in the KAM are also used in the benchmarking systems of other institutions, such as UNIDO, which measures countries' potential to "catch up" with more developed countries, and the World Economic Forum, which looks at competitiveness as the set of institutions, policies, and factors that determine a country's productivity.

basic knowledge assessment scorecard for China and India is shown in figure 2. The KAM also can produce *customized country analysis* and cross-country comparisons on indicators selected by the user.

Each of the 12 knowledge indicators in the scorecard corresponds to one of the pillars of the K4D knowledge-economy framework (table 1). The same indicators are used to compile the Knowledge Economy Index (KEI), discussed in the next section.

The KAM is released annually on the Web and on CD-ROM. Data are updated throughout the year as they become available. Updated data are accessible on the Web.

Mining the KAM: the Knowledge Economy Index

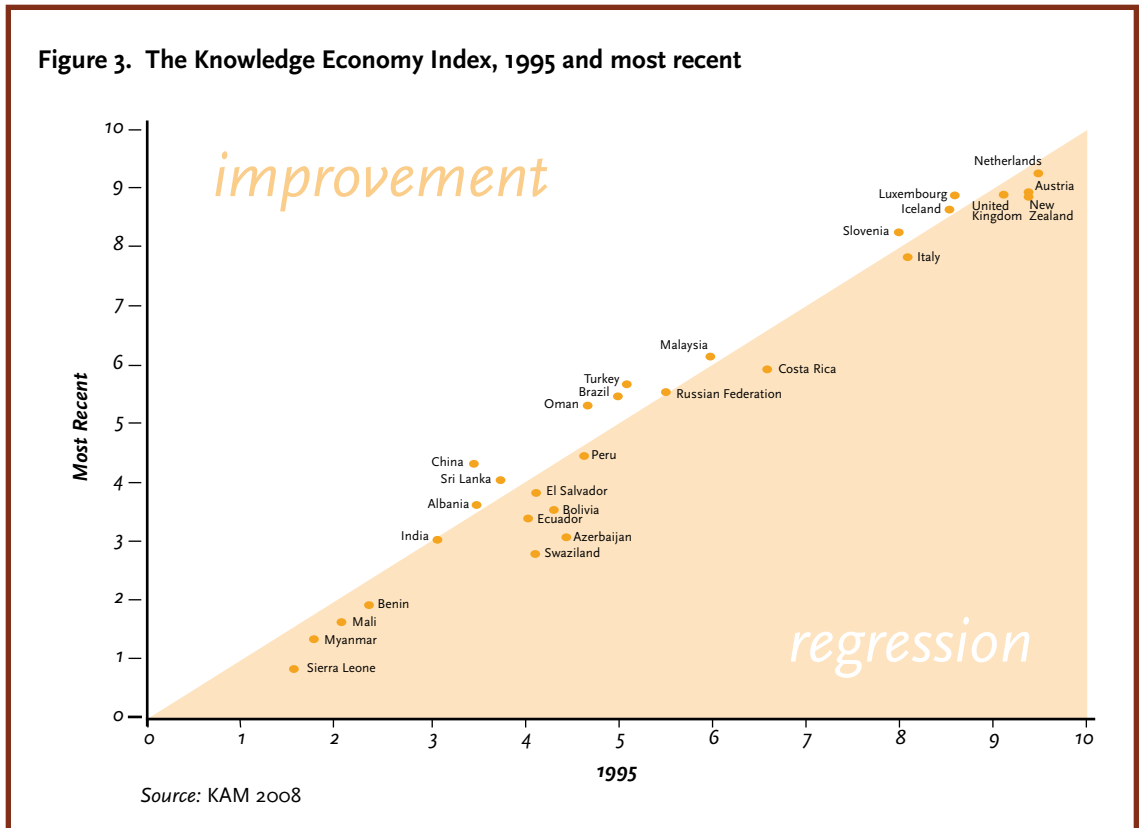
THE MOST COMMONLY CITED OF THE KAM'S SEVERAL INDEXES is the Knowledge Economy Index (KEI)—a broad measure of the overall level of preparedness of a country or region for the knowledge economy.² The KEI summarizes each country's performance on 12 variables corresponding to the four knowledge economy pillars (table 1). The KEI is constructed as the simple average of the normalized values of those indicators, from 0 to 10. A KEI score that is close to 10 implies relatively good development of the four knowledge economy pillars as compared to other countries, while a score close to 0 indicates relatively poor development.

The "over time comparison" mode of the KAM allows users to compare countries and regions in terms of their relative performance on the KEI for two points in time: 1995 and the most recent year covered by the data (figure 3). The user may opt to chart performance on the aggregate KEI index (consisting of all four pillars) or on individual pillars. KEI values for 1995 are plotted on the horizontal axis of figure 3; values for the most recent year are on the vertical axis. KEI values for 1995 and most recent year are equal along the diagonal line. Thus, countries and regions that appear above the diagonal line have made an improvement in the KEI since 1995, and countries that appear below the line have experienced a relative regression. Countries may have invested significantly in education, research, ICTs, and better institutions. But unless they are investing more than others, or unless their investments are paying off faster than those of others, they may lose ground on the KEI.

Table 1 Mapping the four pillars of the knowledge economy to the KAM basic scorecard

<i>Pillar</i>	<i>Indicator</i>
Economic and institutional regime	<ul style="list-style-type: none"> • Tariff and non-tariff barriers • Regulatory quality • Rule of law
Education and skill of population	<ul style="list-style-type: none"> • Adult literacy rate • Gross secondary enrollment rate • Gross tertiary enrollment rate
Information infrastructure	<ul style="list-style-type: none"> • Telephones per 1,000 people • Computers per 1,000 people • Internet users per 1,000 people
Innovation system	<ul style="list-style-type: none"> • Royalty payments and receipts, US\$ per person • Technical journal articles per million people • Patents granted to nationals by the U.S. Patent and Trademark Office per million people

² The other KAM indexes are the Knowledge Index (KI), economic and institutional pillar index, education pillar index, innovation pillar index, and the information and communications technologies (ICT) pillar index.



The most-developed countries score highest on the KEI; they are clustered at the upper right in figure 3. Low-income countries are concentrated at the lower left. Their low positions on the KEI suggest that they could do more to harness knowledge for development. Significantly, however, some countries that were low-income in 1995, including China and Sri Lanka, have most recently improved their relative position, reflecting a catch-up trend.

Remember that these are *relative* measures: If a country slipped on the basic scorecard or the KEI between 1995 and the most recent year, the number of countries that bested it during the period was greater than the number of countries that it bested.

Highlights of the 2008 Release of the KEI

DENMARK IS THE WORLD'S MOST ADVANCED KNOWLEDGE ECONOMY in 2008, as measured by the KEI (table 2). Its top position reflects strong performance on the EIR, innovation and education pillars. Sweden, Finland and the Netherlands occupy the next three spots on the rankings. The United States, which has lost ground all four pillars since 1995, has seen its position in the KEI fall from third in 1995 to eighth in

the current rankings. On the innovation pillar, the United States ranks seventh, but on the other three, it is no longer in the top 10.

Brazil, China, India, and Russia, all large, dynamic economies, show good performance on the KEI. Russia climbed 3 positions and India rose 4 positions compared to 1995. Brazil jumped up 11 positions, while China moved up 18 positions to come in second in the list of gainers in KEI rankings since 1995 (table 3). Mongolia, a low-income country, tops the list of gains with an improvement of 24 positions. Other top gainers include other low-income countries such as Mauritania, Vietnam, and Laos.

Applying the KAM and KEI

GIVEN ITS EASE OF USE, TRANSPARENCY, AND ACCESSIBILITY the KAM has been widely used by government officials, policy makers, researchers, representatives of civil society, and the private sector. It provides valuable background for policy dialogues on the knowledge economy between the World Bank and officials of client countries. Its easily understood graphical interface allows policy makers to quickly identify their country's challenges and opportunities, and to pinpoint areas where policy attention or investment may be required. Benchmarking analysis from the KAM has been used to produce reports on the knowledge

Table 2 2008 Knowledge Economy Index—top 10 countries plus Brazil, China, India, and Russia

Country	KEI Rank	KEI	EIR Rank	Economic Incentive Regime Index	Innovation Rank	Innovation Index	Education Rank	Education Index	ICT Rank	ICT Index
Denmark	1	9.58	2	9.66	4	9.57	2	9.79	7	9.32
Sweden	2	9.56	13	9.18	2	9.79	6	9.44	1	9.83
Finland	3	9.37	5	9.47	3	9.66	3	9.77	19	8.59
Netherlands	4	9.30	12	9.18	6	9.47	9	9.21	5	9.32
Norway	5	9.29	10	9.25	13	9.06	5	9.59	9	9.24
Canada	6	9.14	6	9.42	8	9.43	8	9.24	23	8.47
Switzerland	7	9.13	4	9.50	1	9.89	32	7.76	4	9.36
United States	8	9.10	14	9.16	7	9.45	15	8.79	13	9.02
Australia	9	9.09	19	8.66	19	8.71	4	9.66	6	9.32
Germany	10	9.01	15	8.99	15	9.00	10	9.17	15	8.86
<i>BRICs</i>										
Russian Federation	53	5.58	124	1.55	38	6.88	35	7.62	50	6.26
Brazil	55	5.50	73	4.30	49	6.06	54	5.78	58	5.87
China	77	4.36	80	4.01	64	5.10	87	4.06	78	4.28
India	100	3.04	91	3.67	81	3.95	106	2.11	108	2.45

Source: Reconstructed using data from KAM 2008, "KEI and KI indexes" mode (www.worldbank.org/kam).

Table 3 Changes in the KEI from 1995 - top gainers

Country	KEI Rank Change	KEI 2008 Rank	KEI 2007	EIR Rank Change	EIR 2007 Rank	Innovation Rank Change	Innovation 2007 Rank	Education Rank Change	Education 2007 Rank	ICT Rank Change	ICT 2007 Rank
Mongolia	+24	70	4.80	+25	66	+2	109	+40	42	+26	73
China	+18	77	4.36	+21	80	+17	64	+5	87	+34	78
Mauritania	+16	114	2.08	+38	86	+8	129	-1	126	-1	116
Lithuania	+14	30	7.70	+8	31	+20	44	+15	20	+28	29
Tunisia	+14	72	4.69	+11	65	+13	70	+7	88	+13	67
Dominican Republic	+14	86	3.71	+36	74	-3	103	-4	83	+7	95
Armenia	+13	61	5.41	+64	56	+6	48	+5	49	-12	87
Angola	+13	123	1.51	+16	120	+7	116	+11	122	+2	128
Romania	+12	45	6.18	+10	46	+13	58	0	50	+13	52
Turkey	+12	52	5.68	+5	41	+35	57	-8	84	-1	59
Algeria	+12	95	3.20	+7	114	+8	91	+3	93	+4	100
Vietnam	+12	96	3.17	+4	107	+25	104	-1	94	+24	94
Latvia	+11	32	7.61	+9	29	+21	46	+14	18	+15	34
Brazil	+11	55	5.50	-6	73	+4	49	+32	54	+5	58
Lao PDR	+11	124	1.50	+6	132	+2	137	+9	108	+7	122

Source: Reconstructed using data from KAM 2008, "KEI and KI indexes" mode (www.worldbank.org/kam).

economy, such as K4D's *Building Knowledge Economies: Advanced Strategies for Development* (World Bank Institute, 2007), a regional report on the knowledge economy in the Middle East and North Africa, and detailed country reports on China, Finland, India, Japan, Korea, Mexico, Senegal, Tanzania, and Qatar.

Powering the KAM

THE KAM IS FED BY CONSISTENTLY MEASURED, REGULARLY UPDATED DATA from a variety of sources. The World Bank's internal databases and published datasets are particularly important, but publicly accessible data are obtained from other organizations as well—among them Freedom House, the Heritage Foundation, the International Labour Organisation, the International Telecommunication Union, the U.S. Patent and Trademark Office, UNESCO's Institute for Statistics, and the World Economic Forum. Because sources vary in the currency of their data, the KAM uses the most recent data from any given source. For the 2008 release of the KAM, the most recent data ranged from 2005 to 2007. The KAM on the Web is continuously updated as new data become available from sources.

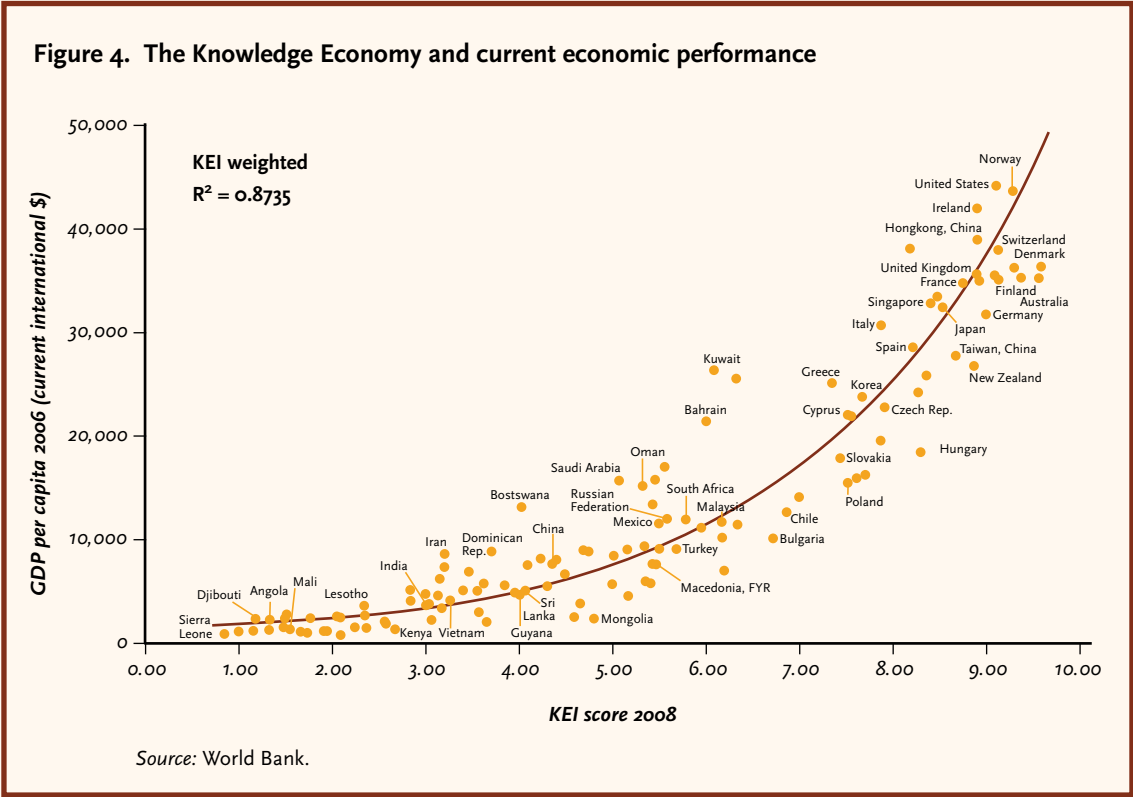
The KAM's coverage, in terms of countries and indicators, has grown over time. In 2001, the KAM contained data for only 60 indicators for 40 countries. KAM 2008 now includes 83 indicators for 140 countries. The enhanced coverage has led to a rapid rise in the use of the KAM, with the number of page views

increasing by more than 600 percent between 2003 and 2007. The methodology on which the KAM is based continues to evolve to better reflect the creation, applications, and growth-inducing power of knowledge. For example, K4D is developing additional indicators of growth-inducing forms of knowledge and skill found predominantly in low-income countries. Finally, K4D has succeeded in making the KAM's interface more user-friendly and more powerful over time.

The Knowledge Economy and Economic Performance

ECONOMIC DEVELOPMENT AND KNOWLEDGE ARE CLOSELY RELATED (figure 4). In fact, the correlation between the accumulation of knowledge, as measured by the KEI, and levels of economic development is around 87 percent.³ Countries with higher KEI values tend to have higher levels of economic development, and vice versa.

This positive correlation does not establish a causal relationship between the KEI and economic development. In fact, it is very plausible that high-income countries, because they are more affluent, are able to afford



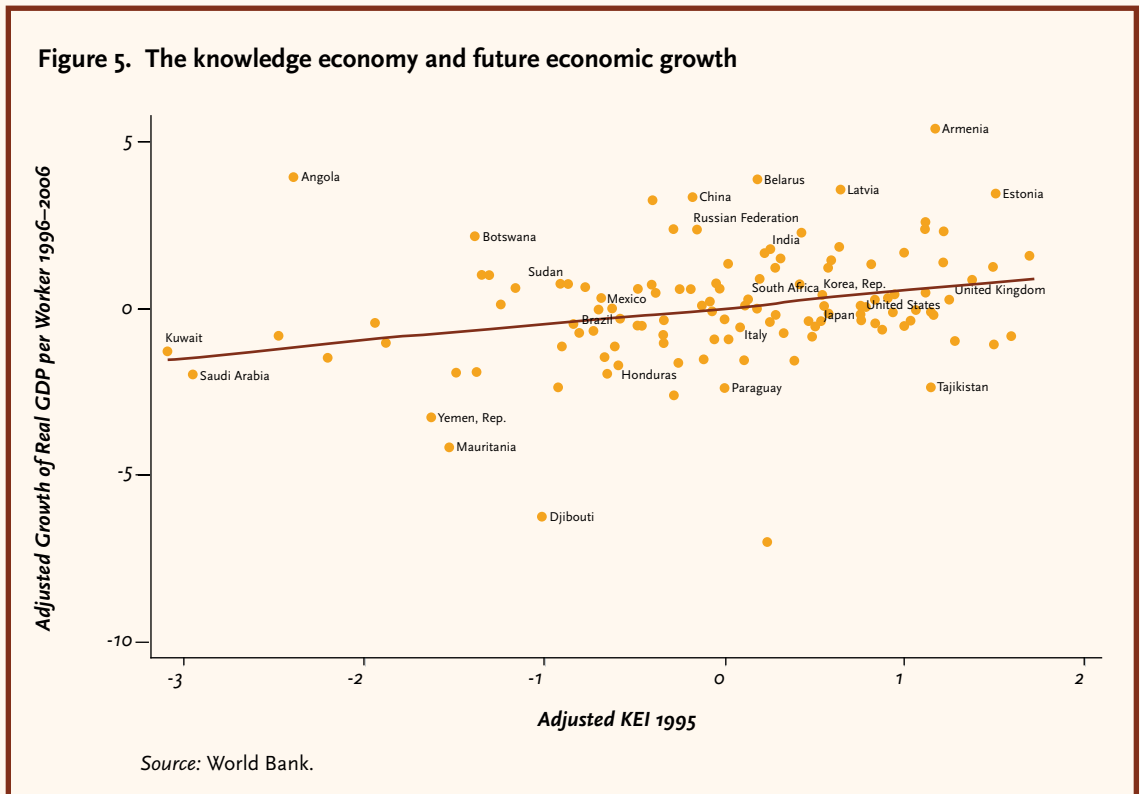
3 Regression results show a statistically significant positive correlation between the KEI and economic development.

more investments in knowledge. The correlation, by itself, does not permit us to predict with any degree of certainty that building up certain forms of knowledge in a poor country will be sure to produce economic growth anytime soon.

However, econometric tests actually do reveal a statistically significant causal relationship running from the level of knowledge accumulation, as measured by the KEI, to future economic growth. Figure 5 illustrates the relation between countries' KEI values and their average future growth rates of output per worker. The horizontal axis plots countries' KEI scores for 1995, after accounting for differences in initial real GDP per capita and the growth of capital per worker. The vertical axis plots the same countries' annual growth in output per worker, averaged over the years 1996–2006, and after accounting for differences in initial real GDP per capita and the growth of capital per worker.

That higher KEI values are associated with higher rates of future economic growth (with other factors held constant) suggests that larger stocks of knowledge stock do indeed cause higher levels of economic growth and development. A one-unit improvement in the KEI—equivalent to an increase in ranking of one decile or 13 positions—leads to an increase of 0.49 percentage points in economic growth, after accounting for initial conditions.

These important results confirm that knowledge and its applications have played a major role in growth processes. Knowledge-related policies and practices belong at the top of today's development agenda.



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The World Bank Institute's Knowledge for Development Program (K4D) helps client countries build their capacity to access and use knowledge to strengthen their competitiveness and increase their economic and social well-being. The program works with clients to design and develop realistic and achievable knowledge-based development strategies. It helps countries assess how they compare with others in their ability to compete in the knowledge economy and to identify appropriate policies to help them achieve their goals. K4D also offers recommendations for policy reform on the knowledge economy accompanied by complementary advice on what the country needs to do to develop appropriate capacity to deliver on these policies.



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