

## ICT Performance Measures: Methodology and Findings

Over the past few years, attempts have been made by many organizations to measure the relative level of development of the information and communication technology (ICT) sector in individual economies. The multitude of efforts is evidence of the importance of ICT in a country's economic and social transformation and as a cohesive force for integrating a country into the global economy. This report introduces a new approach—the World Bank's country ICT performance measures—and this section describes the methodology behind the measures and summarizes the findings.

The country ICT performance measures aim to provide a quick and effective way for policy makers to compare their countries' ICT performance against that of other countries and to benchmark progress over time. Rather than creating an aggregate ICT index, the World Bank's performance measures group indicators into various dimensions of ICT development, which allows users to see how a country has progressed within these dimensions relative to its peers, to use the measures as a tool to analyze relative ICT performance, and to understand the interrelations among various aspects of ICT development. More important, the measures are intended to stimulate policy dialogue about how to improve the scores through targeted sector policies and investments.

### Methodology

A total of 150 developing and developed economies with a population greater than 1 million are included in the

calculation of the country ICT performance measures, based on internationally recognized indicators for measuring ICT (see the annex to this section). These measures are calculated using the *average percentile method* and assess ICT capacities along three dimensions: (1) access to ICT, (2) affordability of ICT, and (3) adoption of ICT applications in government and business.

Specifically, the method for calculating scores for each dimension is as follows:

- *Indicator selection and data collection.* Between two and five indicators are selected that best represent and measure the dimension, subject to the availability of country-level data from international organizations, supplemented by World Bank staff estimates based on official national sources (table 2).
- The *access dimension* features five penetration indicators covering a range of ICT services and products. The *affordability dimension* consists of three indicators measuring a monthly basket of fixed-line telephone, mobile phone, and Internet service charges, expressed as a percentage of per capita income. The *applications dimension* consists of indicators measuring ICT adoption including the United Nations Web Measure Index and the number of secure Internet servers per 1 million inhabitants, a proxy for the availability of e-business services in an economy.

**Table 2 Indicators for the Country ICT Performance Measures**

Dimension	Indicator	Source
Access	A1. Telephone lines (per 100 people)	ITU
	A2. Mobile cellular subscriptions (per 100 people)	
	A3. Internet users (per 100 people)	
	A4. Personal computers (per 100 people)	
	A5. Households with a television set (%)	
Affordability	P1. Price basket for residential fixed line (% of monthly GNI per capita)	ITU and World Bank
	P2. Price basket for mobile call (% of monthly GNI per capita)	ITU and World Bank
	P3. Price basket for Internet (% of monthly GNI per capita)	ITU
Applications	AP1. United Nations Web Measure Index	UNPAN
	AP2. Secure Internet servers (per 1 million people)	Netcraft

**Table 3 Example of How a Country ICT Performance Measure Is Calculated (Mauritius)**

Dimension	Indicator	Data	Percentile	Score
Access	A1. Telephone lines (per 100 people)	28.51	73.83	
	A2. Mobile cellular subscriptions (per 100 people)	74.13	57.33	
	A3. Internet users (per 100 people)	10.97	73.15	
	A4. Personal computers (per 100 people)	17.55	74.32	
	A5. Households with a television set (%)	95.68	70.27	
	<i>Average</i>		69.78	
	<i>Percentile of the average (aggregate percentile)</i>		70.67	8
Affordability	P1. Price basket for residential fixed line (% of monthly GNI per capita)	1.18	75.00	
	P2. Price basket for mobile call (% of monthly GNI per capita)	0.91	81.21	
	P3. Price basket for Internet (% of monthly GNI per capita)	3.58	61.64	
	<i>Average</i>		72.62	
	<i>Percentile of the average (aggregate percentile)</i>		74.67	8
Applications	AP1. United Nations Web Measure Index	0.47	63.01	
	AP2. Secure Internet servers (per 1 million people)	44.81	70.92	
	<i>Average</i>		66.97	
	<i>Percentile of the average (aggregate percentile)</i>		70.67	8

Source: World Bank, World Development Indicators Database.

- *Aggregation.* The percentile of each indicator is calculated, and a simple average of the percentiles is taken. Then the percentile of the average is calculated.
- *Calculation of measures.* Economies are scored on a scale from 1 to 10 based on the aggregate percentile values, with 10 given to the highest performance decile and 1 to the lowest decile.

Where possible, indicators used for the access and affordability dimensions reflect 2007 data. Where data for 2007 are not available, earlier years have been used. Indicators for the adoption of ICT applications dimension use 2008 data. Table 3 uses Mauritius as an example of how the country ICT performance measures are calculated.

To avoid distortion of the results, the methodology does not “pre-judge” an economy’s ICT performance according to

its income level, sector structure, or knowledge capacity of its population. The country ICT performance measures, however, can easily be compared to income data (table 4) in order to examine the impact of economic development, level of competition, independent regulation, and literacy levels on ICT take-up and use, and vice versa.

This methodology has several advantages:

- It is robust. More than 95 percent of the scores using the average percentile method are identical to those calculated using other methodologies, including the matching percentile method and the unobserved component method.
- It is flexible enough to incorporate additional indicators for each dimension, or to include other core areas as new dimensions of ICT development unfold. This will allow the framework to evolve over time while ensuring comparability of the scores.
- It is straightforward, easy to explain, and transparent.
- It avoids subjective manipulation of data based on underlying assumptions about the data (for example, assigning weights). Subjective manipulation of data is particularly problematic for the ICT sector, where ongoing technical and market evolution make predictions difficult, and where weighting might express the prevailing view of a particular country or region.
- It deals with missing data relatively well, by averaging across indicators.

## Findings

The results of the country ICT performance measure calculations are summarized in table 5 (see pages 140–43).

### Overview

Overall, as would be expected, there is a close relationship between the country ICT performance measures and income levels (see table 4). The leading economies in ICT performance are mainly developed economies, attesting their high levels of accessibility, affordability, and ICT usage. Canada, Denmark, the Republic of Korea, the Netherlands, Norway, Sweden, and the United Kingdom score 10 (the maximum) on all three measures.

The highest-scoring developing economies are all upper middle income and mostly countries in Central and Eastern

**Table 4 Average Country ICT Performance Measures, by Income Level**

Income	Access to ICT services	Affordability of ICT services	Adoption of ICT applications in government and businesses
High	9.06	9.08	9.00
Upper middle	6.79	6.82	6.57
Lower middle	4.98	5.07	4.93
Low	2.27	2.14	2.50

Source: World Bank staff.

Europe (Croatia, Latvia, Lithuania, Poland, Serbia, and Turkey) and Latin America (Chile, Costa Rica, and Mexico), but they also include Malaysia and Mauritius. Most of these countries have effective regulation, competitive telecommunications markets, and strong governmental support for ICT. In the case of the Central and Eastern European countries, convergence of domestic legislation with the European Union (EU) telecommunications framework has led to more liberalized ICT industries. These countries have also benefited from the establishment and strengthening of robust institutions to enforce fair competition rules.

Among the high-scoring Latin American countries, results show that the early ICT sector reform practiced by Chile and Mexico is paying dividends. While Costa Rica historically has had a relatively uncompetitive sector, the government has dedicated resources to telecommunications, particularly fixed telephony, throughout the country. In addition, Costa Rica's comparatively high level of literacy and efforts to develop an export-oriented, IT-enabled services industry contribute to its high applications score. Similarly, Malaysia and Mauritius have pursued outward-looking export strategies for ICT goods and services and liberalized their telecommunications sectors to attract infrastructure investment.

Within the group of lower-middle-income countries, China, Jordan, Thailand, and Ukraine score highest, while Vietnam, Uzbekistan, and Pakistan have the highest performance measures in the low-income bracket.

At the bottom of the overall measures are seven countries with a score of 1 (the minimum) in all three dimensions, all of which are in sub-Saharan Africa. In each of these seven countries, access to telephony is below 5 percent of the population, access to the Internet and personal computers below 0.1 percent, and less than 10 percent of the households have a television. Combined tariffs on fixed and mobile phone

services and Internet services in these countries are two to five times the average income, and there are extremely low levels of ICT application use. Although weak ICT performance of these countries is partly the result of low average incomes, it is mainly due to weak regulation, limited competition, lack of private investment, and lack of supporting infrastructure such as electricity. In many other countries in the region, significant improvements have taken place, particularly in the access and affordability dimensions. In fact, sub-Saharan Africa has experienced the highest mobile phone growth rate of all regions since market reform began in about 2000.

Some developing countries—such as Serbia, Croatia, Ukraine, Macedonia, Syria, Jordan, Vietnam, and Moldova in terms of access and Malaysia, Jordan, Peru, Guatemala, India, and Mongolia in terms of adoption of ICT applications—stand out as better ICT performers than their incomes would suggest. However, some countries are not doing as well in ICT performance as they could be given their income level. Countries in this category include upper-middle-income economies such as Botswana, Cuba, Gabon, and Libya (figure 10).

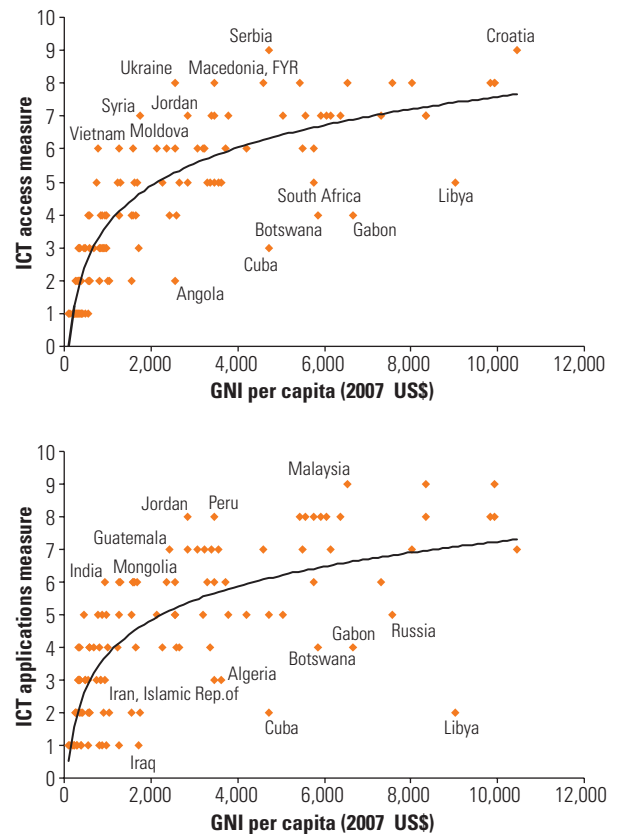
The country ICT performance measures also illustrate different levels of achievement for the various dimensions in each developing region (see figure 11). Europe and Central Asia scores highest in the access measure, whereas the Middle East and North Africa leads in affordability and Latin America and the Caribbean leads in adoption of ICT applications. The developing region with the lowest measures is Sub-Saharan Africa, scoring less than 3 on the 1–10 scale in all three dimensions.

### Access

Telecommunications infrastructure development has witnessed explosive growth over the past decade, due in part to the liberalization of the sector and the introduction of mobile technology. Hong Kong, China, leads in the access measure. This is a reflection of both the high level of competition in its ICT sector, particularly in proportion to its market size, and a population eager to adopt ICT technology.<sup>1</sup>

Croatia and Serbia are the top-scoring developing countries in terms of access. They both have a relatively high level of fixed-line access (more than 40 per 100 people), their inhabitants each have more than one cell phone on average, and the penetration of Internet subscribers is at par with countries in the Organisation for Economic Co-operation

**Figure 10 Relation between the Country ICT Performance Measures (for Access and Applications) and Income per Capita, Developing Countries**

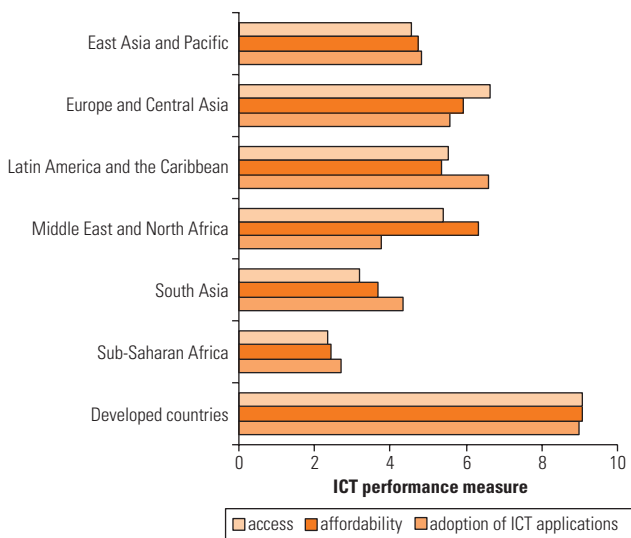


Sources: World Bank staff.

and Development (OECD). This is partly the result of low tariffs (2 percent of per capita income) on fixed and mobile phone service and Internet service.

Most countries have achieved a penetration of five telephone lines (fixed or mobile) per 100 people. Telecommunications equipment prices have fallen sharply, and wireless technologies allow quicker installation compared to the past. Remaining access gaps are therefore no longer primarily due to engineering challenges or capacity limitations. Supply constraints continue to exist in some developing countries because of market structures that inhibit access to ICT products and services and high costs of infrastructure development in remote and geographically challenging areas. Poor affordability (especially for more advanced ICT services and products such as Internet and personal computers) and low digital literacy are also constraining factors to enhanced access.

**Figure 11 Average Country ICT Performance Measures, by Region**



Sources: World Bank staff.

### Affordability

Affordability of ICT services around the world varies widely. Some 60 percent of the 150 economies included in the ICT performance measures have monthly fixed-line tariffs less than 5 percent of per capita income. Denmark, the United Arab Emirates, Singapore, the United States, and Norway—countries that have the most affordable ICT services in the world—have price baskets for ICT services equivalent to 0.5 percent or less of average income. However, close to 30 percent of the countries analyzed have monthly fixed-line tariffs that amount to more than 10 percent of income. The highest variation is in Internet pricing; here, more than one-third of the economies have monthly price baskets more than 25 percent of per capita income.

Interpreting the affordability measure is difficult because low tariffs increase access, but they also have the potential to reduce the likelihood of financial sustainability of the ICT sector. Several developing countries that do well in terms of ICT affordability (those with low tariffs relative to their income levels) are those that have not undertaken extensive sector liberalization. For example, Iraq, Libya, and Oman have telecommunications tariffs that make up a relatively low percentage of per capita income, yet until recently, they also had monopolistic telecommunications markets. One reason that tariff rebalancing has been limited is lack of political will, keeping tariffs on fixed lines (and consequently

dial-up Internet) relatively low. The downside of low tariffs is that relatively little capital for investment is generated, which also influences mobile pricing in these countries, since mobile operators must compete to some degree with low fixed-line tariffs. The challenge for developing countries is to strike a balance between affordability of ICT services to the users and sustainability of sector growth.

It is important to note that the affordability measure takes into account both the prices of ICT services and the income levels to reflect the financial ability to pay on the demand side. Therefore, countries with relatively low per capita income and relatively high tariffs (and therefore lower affordability) tend to have a bigger access gap beyond what a competitive market can deliver, which might require more public interventions.

### Applications

Governments and businesses are increasingly exploring the potential of high-speed networks to improve internal communications, increase the efficiency of transactions, and deliver better services to customers. Although most economies have established some basic level of e-government, in many developing economies, this is still often limited to a Web site displaying information. A growing number of countries also have some form of e-commerce, but at a rudimentary stage.

The United States has the highest score in the ICT applications measure, leading the world in the number of secure Internet servers per 1 million people. It also ranks high in the United Nations Web Measure Index, behind only Denmark and Sweden.

Among developing economies, Latin American countries perform relatively well in the applications area. Argentina, Brazil, Chile, Costa Rica, Mexico, Peru, and Uruguay, for example, all score 8 or higher out of 10 on applications; one reason is that common culture and heritage allow economies of scale and the ability to leverage the experience of neighboring nations. Another factor is the region's relatively high literacy rate and school enrollment, both of which are the highest among developing regions.

### Challenges

The task of capturing a country's ICT development in an aggregated measure remains a challenge. Aspects that are

worth revisiting in the future are the inclusion of measures of impact as well as a number of data-related issues and their influence on selecting indicators.

### **Impact Measures**

Currently, the country ICT performance measures focus mainly on output indicators. No impact metrics (for example, the impact of ICT development on economic growth, labor productivity, and employment opportunities) are incorporated in the framework.

Reliable impact measures (and evidence of causality) of ICT use are still being developed. In addition, the data required for impact indicators are usually collected through surveys, implying high collection costs in both developed and developing countries. Scarcity of data and inconsistent methodologies continue to make cross-country comparison difficult. Nevertheless, this is an important area for future research given the growing interest in understanding the role ICT plays in economic and social development.

### **Data Limitations**

Due to data limitations, the country ICT performance measures have incorporated only a core set of indicators for which reliable figures are readily available for the majority of the 150 economies included in this report.

Perhaps the most significant data limitation is to access indicators for emerging ICT technologies. Mobile broadband subscribers, voice-over-Internet protocol (VoIP) subscribers, and pay TV subscribers are such examples. Data for these indicators are available from several sources, though they have limited country coverage. In some cases, such as mobile broadband, limited coverage may suggest that the service is not yet widely used. Yet these cases may represent future trends of a dynamic and ever-evolving sector. A data consolidation effort has thus been initiated (see the annex) in anticipation that data for these important indicators will become more widely available in the near future.

Ongoing data collection efforts also include indicators for the usage and quality dimensions of ICT sector development. International voice traffic (minutes per person per month), mobile telephone usage (minutes per user per month), short message service (SMS) usage (messages per user per month), and Internet users (per 100 people) are grouped under the usage dimension. Telephone faults (per 100 main lines per year), broadband subscribers (percentage of total Internet subscribers), and international Internet bandwidth (bits per

person) are selected to reflect quality and capacity of ICT services. As the data availability of these indicators reaches a high threshold, usage and quality can be added as new dimensions to the country ICT performance measures.

Lack of data also limits the understanding of adoption of ICT applications across different sectors of an economy. Data on ICT expenditures—which reflect the purchase of software and hardware by businesses and consumers and hence their propensity to use it—are not available beyond developed countries and some large developing countries. Indicators that might measure take-up of ICT in the education and health sectors, for example, such as percentage of schools connected to the Internet and percentage of clinics with personal computers or Internet connections, are also not widely available for many developing countries. Relevant indicators for these areas have thus not yet been included in this edition of the country ICT performance measures.

The two indicators included in the applications measure, namely the United Nations Web Measure Index and the number of secure servers, might not be representative of the wider applications dimension, as they focus on the adoption of ICT applications in government and business. The World Bank and the United Nations are involved in ongoing discussions regarding the development of improved measures for e-government, such as the number of government services available online and the percentage of uptake of online service delivery. Statistics of business use of ICT are generally collected from special ICT business surveys or as a module in business surveys. Most OECD and EU countries already collect these data annually, and other countries are beginning to collect indicators such as percentage of businesses using computers, Internet, or with a Web presence and business use of Internet by type of activities with similar frequency (see annex tables A1 and A4).

As the availability, quality, and comparability of ICT data improve over time (see the annex about the global Partnership on Measuring ICT for Development), the country ICT performance measures will be able to incorporate additional indicators in each dimension, or even add new dimensions. The intention is to update the performance measures annually.

## **Conclusions**

ICT is a multifaceted sector. Measurement of its different aspects is necessary to give a diverse perspective across the

spectrum of ICT capabilities. The country ICT performance measures cover access, affordability, and applications as key dimensions in assessing ICT development across economies. A transparent and objective average percentile method has been applied for 150 economies.

Despite the challenges of creating such performance measures, benchmarking, if used wisely, can provide useful information and meaningful analysis for policy purposes. Although benchmarking often cannot establish the causal

link, comparisons with better-performing economies can nevertheless be a useful input in developing policy, drawing lessons for improvement and progress, and ultimately, promoting more effective ICT development. The categorization of indicators into different dimensions, for its part, helps countries recognize both the areas in which they are doing well and those in which they have room for improvement, thus allowing policy makers to focus resources on the appropriate dimension of ICT.

*(Section continues on the following page.)*

**Table 5 Country ICT Performance Measures, by Income Level and Economy, 2007**

Income level/economy	Access to ICT services	Affordability of ICT services	Adoption of ICT applications in government and business
<b>High income</b>			
Australia	10	9	10
Austria	10	9	10
Belgium	9	9	9
Canada	10	10	10
Czech Republic	9	8	9
Denmark	10	10	10
Estonia	10	8	10
Finland	9	10	9
France	9	10	10
Germany	10	10	9
Greece	9	9	7
Hong Kong, China	10	10	9
Hungary	9	8	9
Ireland	10	9	10
Israel	8	9	9
Italy	9	9	8
Japan	9	9	10
Korea, Rep. of	10	10	10
Kuwait	8	9	7
Netherlands	10	10	10
New Zealand	9	9	10
Norway	10	10	10
Oman	6	9	7
Portugal	9	7	9
Puerto Rico	6	5	8
Saudi Arabia	8	9	6
Singapore	10	10	9
Slovak Republic	8	8	8
Slovenia	9	9	8
Spain	9	8	9
Sweden	10	10	10
Switzerland	10	10	9
Trinidad and Tobago	7	8	7
United Arab Emirates	8	10	9
United Kingdom	10	10	10
United States	9	10	10
<b>Average</b>	<b>9.06</b>	<b>9.08</b>	<b>9.00</b>
<b>Upper middle income</b>			
Argentina	7	7	8
Belarus	6	7	5

<b>Table 5 continued</b>			
Income level/economy	Access to ICT services	Affordability of ICT services	Adoption of ICT applications in government and business
Botswana	4	6	4
Brazil	7	5	8
Bulgaria	8	6	7
Chile	7	7	8
Costa Rica	7	8	8
Croatia	9	7	7
Cuba	3	5	2
Gabon	4	6	4
Jamaica	6	5	6
Kazakhstan	7	7	5
Latvia	8	7	8
Lebanon	6	6	6
Libya	5	9	2
Lithuania	8	8	9
Malaysia	8	8	9
Mauritius	8	8	8
Mexico	7	7	9
Panama	6	6	7
Poland	8	8	8
Romania	7	7	7
Russia	8	7	5
Serbia	9	8	5
South Africa	5	5	8
Turkey	8	7	7
Uruguay	7	6	8
Venezuela, R.B. de	7	8	6
<b>Average</b>	<b>6.79</b>	<b>6.82</b>	<b>6.57</b>
<b>Lower middle income</b>			
Albania	5	6	6
Algeria	5	6	3
Angola	2	4	5
Armenia	5	5	4
Azerbaijan	6	4	5
Bolivia	4	4	6
Bosnia and Herzegovina	7	7	5
Cameroon	2	3	2
China	6	8	6
Colombia	6	6	7
Congo, Rep. of	2	3	2
Dominican Republic	5	5	7
Ecuador	6	4	7

(Table continues on the following page.)

**Table 5** *continued*

Income level/economy	Access to ICT services	Affordability of ICT services	Adoption of ICT applications in government and business
<b>Lower middle income</b> <i>continued</i>			
Egypt, Arab Rep. of	6	6	6
El Salvador	5	7	7
Georgia	6	4	5
Guatemala	4	4	7
Honduras	4	4	6
India	4	5	6
Indonesia	4	5	4
Iran, Islamic Rep. of	7	9	3
Iraq	3	8	1
Jordan	7	6	8
Lesotho	2	3	4
Macedonia, FYR	8	5	6
Moldova	6	3	5
Mongolia	5	5	6
Morocco	5	4	4
Namibia	5	4	4
Nicaragua	4	3	5
Paraguay	5	5	6
Peru	5	4	8
Philippines	5	5	6
Sri Lanka	4	6	5
Sudan	3	3	1
Swaziland	4	5	4
Syrian Arab Rep.	7	5	2
Thailand	7	7	7
Tunisia	6	7	5
Turkmenistan	4	4	1
Ukraine	8	6	6
West Bank and Gaza	5	6	4
<b>Average</b>	<b>4.98</b>	<b>5.07</b>	<b>4.93</b>
<b>Low income</b>			
Afghanistan	2	1	3
Bangladesh	3	3	3
Benin	2	2	2
Burkina Faso	1	1	2
Burundi	1	1	1
Cambodia	2	2	3
Central African Republic	1	1	1
Chad	1	1	1
Congo, Dem. Rep. of	1	1	1

**Table 5** *continued*

Income level/economy	Access to ICT services	Affordability of ICT services	Adoption of ICT applications in government and business
Côte d'Ivoire	3	2	2
Eritrea	1	1	1
Ethiopia	1	2	1
Gambia, The	3	2	4
Ghana	2	3	4
Guinea	1	3	1
Guinea-Bissau	1	1	1
Haiti	4	2	2
Kenya	3	1	4
Kyrgyzstan	4	3	4
Laos	3	3	2
Madagascar	2	1	3
Malawi	2	2	2
Mali	1	2	3
Mauritania	4	2	3
Mozambique	2	1	3
Myanmar	1	2	2
Nepal	2	3	4
Niger	1	1	1
Nigeria	3	3	3
Pakistan	4	4	5
Papua New Guinea	3	3	3
Rwanda	1	2	3
Senegal	3	3	4
Sierra Leone	1	2	2
Somalia	2	1	1
Tajikistan	3	4	5
Tanzania	2	1	2
Togo	3	2	3
Uganda	1	1	3
Uzbekistan	5	6	3
Vietnam	6	4	5
Yemen	3	4	1
Zambia	2	2	1
Zimbabwe	3	2	2
<b>Average</b>	<b>2.27</b>	<b>2.14</b>	<b>2.50</b>

Source: World Bank staff.

**Note:** Low-income economies are those with a GNI per capita of \$935 or less in 2007. Middle-income economies are those with a GNI per capita of more than \$936 but less than \$11,456. Lower-middle-income and upper-middle-income economies are separated at a GNI per capita of \$3,705. High-income economies are those with a GNI per capita of \$11,456 or more. Although the measures are presented in separate tables by income group, they were calculated using the full sample of 150 economies.