

chapter 9 (25)

Long-Run Economic Growth

Chapter Objectives

Students will learn in this chapter:

- Why long-run growth is measured as the increase in real GDP per capita, how this measure has changed over time, and how it varies across countries.
- Why productivity is the key to long-run growth and how productivity is driven by physical capital, human capital, and technological progress.
- The factors that explain why growth rates differ so much among countries.
- How growth has varied among several important regions of the world and why the convergence hypothesis applies to economically advanced countries, but only conditionally to many poorer countries.
- The question of sustainability and the challenges to growth posed by scarcity of natural resources and environmental degradation.

Chapter Outline

Opening Example: The link between long-run economic growth and average height is presented using the examples of Japan in the 1900's and China today.

I. Comparing Economies Across Time and Space

- A. Economists measure economic growth using real GDP per capita.
- B. The annual growth rate in real GDP for, say, year 2 is calculated as follows:

$$\text{Annual growth in real GDP} = \frac{\text{Real GDP in year 2} - \text{Real GDP in year 1}}{\text{Real GDP in year 1}}$$

- C. In the United States, real GDP per capita increased seven-fold during the twentieth century, resulting in a large increase in the standard of living. However, real GDP growth rates can vary widely across countries.
- D. In many countries, real GDP per capita is far lower than it is in the United States.
- E. More than half the world's population has living standards that are worse than those existing in the United States in 1900.
- F. *Definition:* The **Rule of 70** tells us that the time it takes a variable that grows gradually over time to double is approximately 70 divided by that variable's annual growth rate.

$$\text{Number of years for variable to double} = \frac{70}{\text{Annual growth rate of variable}}$$

II. The Sources of Long-Run Growth

A. Productivity

1. Long-run increases in living standards arise almost entirely from growing labor productivity.
2. *Definition: Labor productivity*, often referred to simply as productivity, is measured as output per worker.
3. *Definition: Physical capital* consists of human-made resources such as buildings and machines.
4. An increase in physical capital is one source of higher productivity, but it is subject to diminishing returns to physical capital.
5. *Definition: Human capital* is the improvement in labor created by education and knowledge embodied in the workforce.
6. *Definition: Technology* is the technical means for the production of goods and services.
7. Human capital and new technology are also sources of increases in productivity.

B. Aggregate production function

1. *Definition: The aggregate production function* is a hypothetical function that shows how productivity (real GDP per worker) depends on the quantities of physical capital per worker and human capital per worker as well as the state of technology. The aggregate production function is illustrated in Figure 9-4 (Figure 25-4) in the text.
2. *Definition: An aggregate production function exhibits diminishing returns to physical capital* when, holding the amount of human capital and the state of technology fixed, each successive increase in the amount of physical capital leads to a smaller increase in productivity.
3. The aggregate production function is used to estimate the sources of increases in productivity.
4. *Definition: Growth accounting* estimates the contribution of each major factor in the aggregate production function to economic growth.
5. *Definition: Total factor productivity* is the amount of output that can be achieved with a given amount of factor inputs.

C. Natural resources are less important than physical and human capital as sources of productivity growth in most countries.

III. Why Growth Rates Differ

- A. Countries differ greatly in their growth rates of real GDP per capita, largely due to differences in policies and institutions that affect savings and investment spending.
- B. Foreign investment can be an important source of funds for investment spending and often brings useful knowledge.
- C. *Definition: Roads, power lines, ports, information networks, and other underpinnings for economic activity are known as infrastructure.*
- D. Education and infrastructure, both provided largely through government spending, are important contributors to growth.
- E. *Definition: Research and development* is spending to create and implement new technologies.
- F. Technological progress is made possible by research and development.

- G. Political stability as well as laws and institutions that protect private property are necessary for long-run economic growth.

IV. Success, Disappointment, and Failure

A. Success in Economic Growth

1. East Asia's spectacular growth was generated by high savings and investment spending rates, emphasis on education, and adoption of technological advances from other countries.
2. *Definition:* According to the **convergence hypothesis**, international differences in real GDP per capita tend to narrow over time.
3. The convergence hypothesis seems to hold only when other things—such as education, infrastructure, property rights, etc.—that affect economic growth, are held equal across countries. Thus, data seem to show the convergence hypothesis primarily applies among wealthy countries, such as the United States, Britain, Japan, Italy, Spain, France, and Germany, but not among countries with very different levels of economic development.

B. Disappointment in Economic Growth

1. Economic growth in Latin America has been relatively slow since the 1920s.
2. The slow rate of economic growth in Latin America is mainly attributable to poor education, political instability, and irresponsible government policies.

C. Failure in Economic Growth

1. Sub-Saharan Africa has been a failure in terms of economic growth due to severe political and economic instability, disease, war, unfavorable geographic conditions, and poor infrastructure, particularly that affecting public health.
2. Real per capita GDP in sub-Saharan Africa fell 13% from 1980 to 1994.

V. Is World Growth Sustainable?

- A. *Definition:* Long-run economic growth is **sustainable** if it can continue in the face of the limited supply of natural resources and the impact of growth on the environment.
- B. Views of the impact of limited natural resources on long-run economic growth differ based on the answers to three questions:
 1. How large are the supplies of key natural resources?
 2. How effective will technology be at finding alternatives to natural resources?
 3. Can long-run economic growth continue in the face of resource scarcity?
- C. It is possible to reconcile long-run economic growth with environmental protection.

Teaching Tips

Comparing Economies Across Time and Space

Creating Student Interest

Present the following statistics from the Population Reference Bureau to open a discussion of developed versus developing countries.

More than **one-half of the world's people live below the internationally defined poverty line** of less than U.S. \$2 a day—including 97% in Uganda, 80% in Nicaragua, 66% in Pakistan, and 47% in China, according to data from the World Bank.

Nearly **one-third** of rural residents worldwide **lack access to safe drinking water**.

Africa's **infant mortality rate** is nearly 15 times that of the developed world.

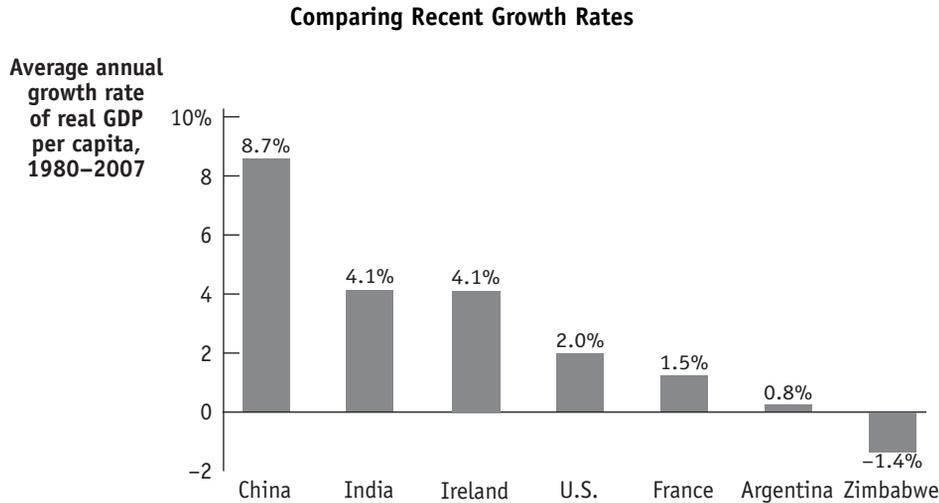
The more developed world uses over **5 times the energy per capita** used by the less developed world. North America uses over 8 times as much energy per person as does Latin America.

Figure 9-1 (Figure 25-1) in the text is a great place to initially focus students' attention when introducing the topic of differences in the rate of growth of real GDP per capita over time. Not only does this figure allow for international comparisons across three countries—the United States, China, and India—it also allows students to get a grasp of the rates of real GDP per capita growth over time for each of these countries. Students may have heard of the rapid rate of economic growth in China or India; however, this graph clearly illustrates the large gap that still exists between these countries' level of real GDP per capita and that of the United States.

Economic Growth in the United States, India, and China over the Past Century



The data in Figure 9-3 (Figure 25-3) of the text, which describe differences in the average annual growth rates of real GDP per capita for selected countries, can also be used to illustrate recent international differences in economic growth.



The calculation of the number of years that it takes for a variable to double in value—the Rule of 70—is an important tool students should learn and attempt to use in practice. Specifically,

$$\text{Number of years for variable to double} = \frac{70}{\text{Annual growth rate of variable}}$$

The Sources of Long-Run Growth

Creating Student Interest

Ask students why they chose to go to college. Undoubtedly, at least one person will respond that the reasons she enrolled in college is to gain additional knowledge and skills that will enable her to get a particular type of job. Explain that while students are in college they are acquiring human capital that will make them more productive members of society.

Presenting the Material

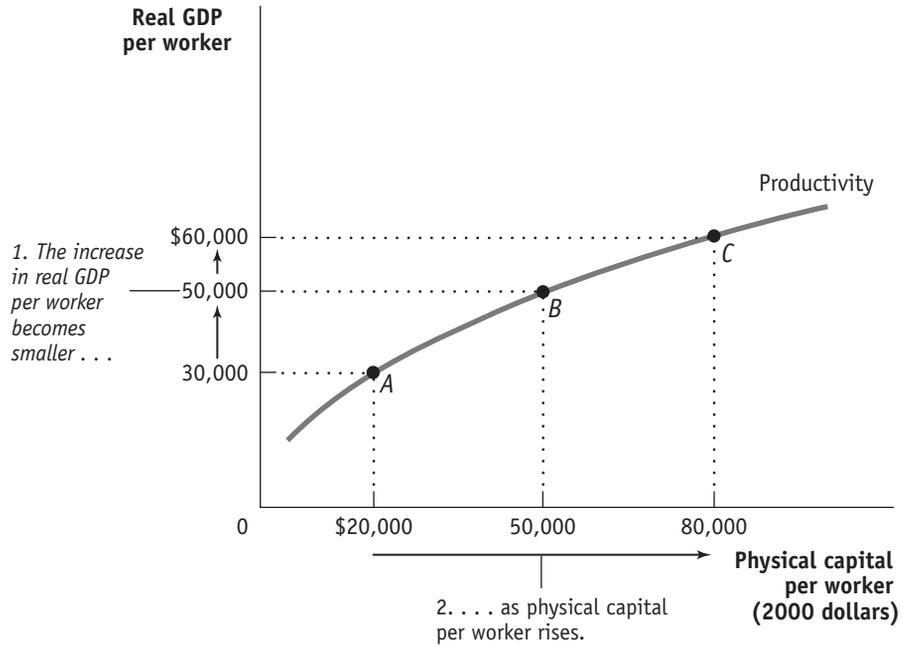
Begin this section by emphasizing the crucial importance of productivity in achieving long-run economic growth in an economy. Also, spend some time early in the lecture explaining the meaning and significance of key terms, including:

- Labor productivity
- Physical capital
- Human capital
- Technology

After students have acquired a working vocabulary and notion of productivity, proceed with explaining the Aggregate Production Function. Using the graph of the Aggregate Production Function, shown in Figure 9-4 (Figure 25-4) in the text, emphasize the following important points:

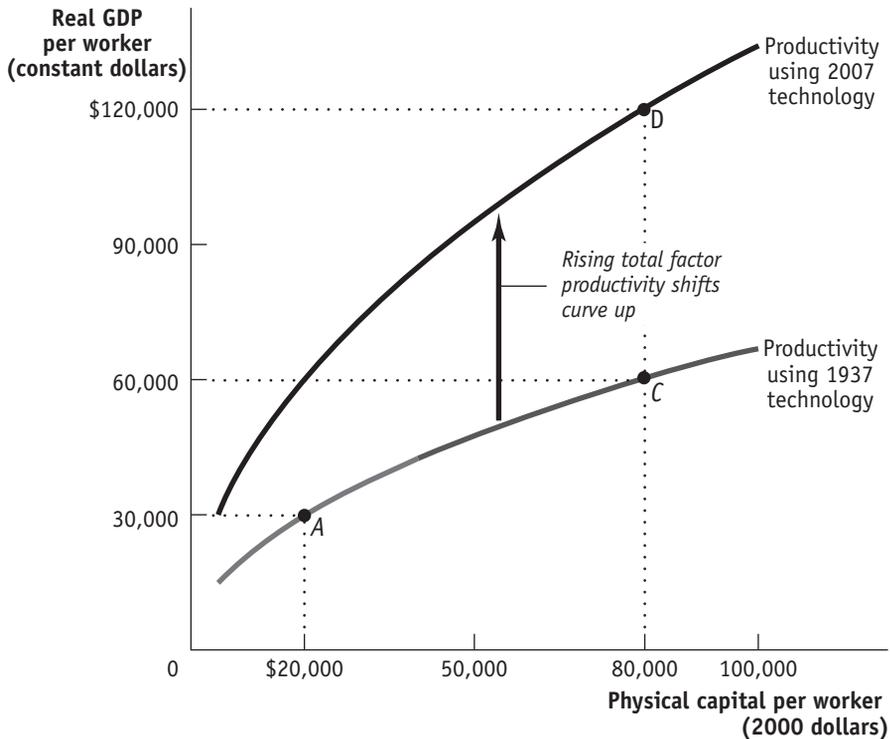
- There is a direct relationship between the amount of capital per worker and real GDP per worker.
- The slope of the Aggregate Production Function is not constant; rather, the slope increases at a decreasing rate. Explain that this slope reveals that the increase in real GDP per worker becomes smaller and smaller as the amount of physical capital per worker increases. This phenomenon is known as diminishing returns to physical capital. Note that other factors in the aggregate production function, human capital and the state of technology, are held constant.

Physical Capital and Productivity



Technological progress is an extremely important issue in today's economy. The concept of technological progress is illustrated in Figure 9-5 (Figure 25-5) in the text. Explain that the entire Aggregate Production Function will shift upward in response to technological progress. The resulting effect is that even when the level of physical capital per worker is held constant, a greater level of real GDP per worker can be achieved after technological progress occurs.

Technological Progress and Productivity Growth



Why Growth Rates Differ

Creating Student Interest

Use the example in the introduction to this section of the book to illustrate the substantial effect that seemingly small differences in annual real GDP per capita growth rates can have on long-run growth. Specifically, in 1820 Mexico's real GDP per capita was higher than that of Japan. However, due to the fact that Japan's real GDP per capita grew at an annual rate of 1.9%, as compared with Mexico where the annual real GDP per capita growth rate was 1.2%, Japanese real GDP per capita today is much higher than that in Mexico.

Presenting the Material

Outline the various factors that can create differences in the rate of long-run economic growth across countries. These factors include:

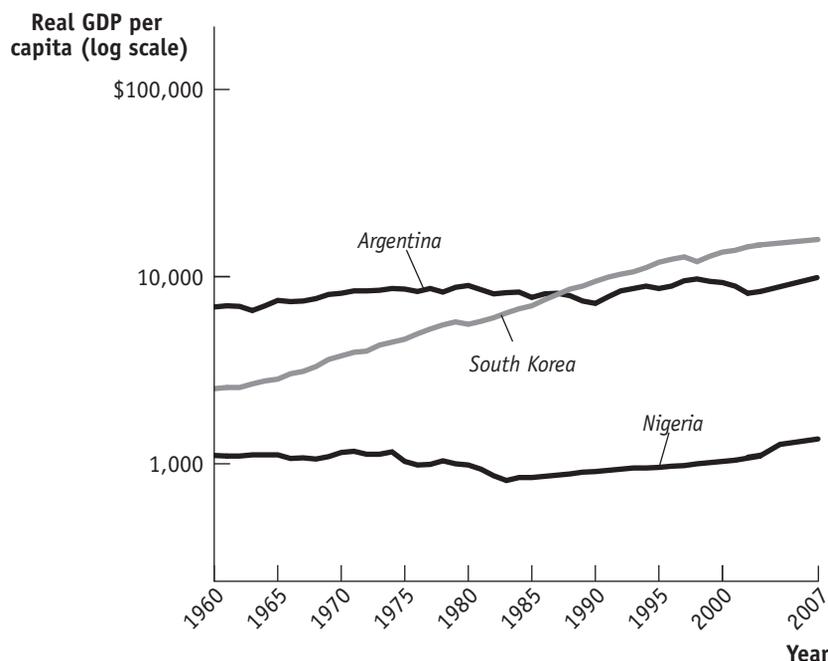
- Differences in savings and investment: High rates of investment in capital lead to higher rates of economic growth. Domestic savings can be a source of funding of new investment.
- Foreign Investment: Foreign sources of savings can also be used to fund investment. Foreign investment can be an important way to fund investment spending in those countries where real per capita GDP is low and hence, savings are low.
- Education: Spending on education correlates with a population possessing higher levels of human capital and, therefore, higher rates of labor productivity.
- Infrastructure and Public Goods: Infrastructure, such as bridges, roads, power lines, ports, water and waste systems, and information networks, aid in the production of goods and services. Due to the costly nature of these capital investments, governments are often the providers of infrastructure in an economy.
- Research and Development: For an economy to continue to grow, it is necessary to develop and implement new technologies that will improve the manner in which goods and services are produced. Research and development can be funded and carried out by governments or private firms.
- Political Stability, Property Rights, and Limited Government Intervention: All these factors will serve to promote investment in physical and human capital in an economy, which will lead to higher rates of long-run economic growth.

Success, Disappointment, and Failure

Creating Student Interest

Use Figure 9-7 (Figure 25-7) in the text to stimulate some early discussion on differences in real GDP per capita for three countries—Argentina, South Korea, and Nigeria—which are representative of the rates of economic growth in their region of the world.

Success and Disappointment

**Presenting the Material**

Perhaps the most direct and clear way to present the information in this section is to discuss countries falling into one of the three categories outlined in the text with regard to rates of long-run economic growth—successes, disappointments, and failures.

- **Successes:** They include most countries in East Asia, such as South Korea, China, Taiwan, Hong Kong, and Singapore. Such countries have achieved high rates of long-run economic growth with high rates of savings. These savings have funded new investment in physical and human capital, as well as the rapid implementation of new technologies.
- **Disappointments:** Many countries in Latin America, with the exception of Chile and Brazil, have experienced economic stagnation. Excessive government intervention in most Latin American economies, political instability, low rates of saving and investment in physical capital, and failure to invest in the educational system are cited as reasons for this area's economic stagnation.
- **Failures:** Most countries in Africa south of the Sahara are regarded as economic failures in terms of long-run economic growth. Political instability, civil wars, health problems, poverty, and poor geographic conditions have contributed to the poor growth performance in this area of the world.

Is World Growth Sustainable?**Creating Student Interest**

Ask students whether they think that this generation has any responsibility to future generations as far as the natural resources we use. Is there a difference in their views of renewable versus nonrenewable resources (you may want to explain the difference)? How should we balance using natural resources (including the environment) versus saving them for future generations? What can happen in the future that would change their views (e.g., technological advances or the world coming to an end!).

Presenting the Material

Focus on each of the three key questions in the section:

1. How large are the supplies of key natural resources?
2. How effective will technology be at finding alternatives to natural resources?
3. Can long-run economic growth continue in the face of resource scarcity?

For each question, discuss how extreme optimists and extreme pessimists might answer the questions.

Common Student Pitfalls

- **Change in Levels Versus Rate of Change.** Statements by economists about economic growth over time almost always refer to changes in the growth rate. Make sure students understand the difference between a fall in the growth rate and a fall in the level of GDP.
- **It May be Diminished . . . But It's Still Positive.** Students need to understand that *diminishing returns* means that the increase in MP decreases—not that MP becomes negative.

Case Studies in the Text

Economics in Action

India Takes Off—This EIA discusses India's economic progress since it achieved independence in 1947. Economic development was disappointing until 1980. Since then, India has experienced accelerating economic growth.

Ask students the following questions:

1. What happened to the gap between India's standard of living and standards of living in developed countries between 1947 and 1980? (Answer: It increased)
2. Describe India's economic growth since 1980. (Answer: GDP per capita has grown 4.1% per year, and tripled between 1980 and 2007)
3. To what do economists attribute the change in India's economic growth since 1980? (Answer: Policy reforms)

The Information Technology Paradox—This EIA compares the spread of electric power in the economy and its effect on productivity, to the introduction of modern information technology to the economy and its effect on productivity. In each case, it took time for the potential of the new technology to be realized.

Ask students the following questions:

1. Why did U.S. labor productivity growth stagnate from the early 1970s through the mid-1990s despite the rapid development of new technology during this period? (Answer: Economists contend that during this period the new and available technology was not used in radically new ways to replace old methods of doing business. Therefore, the effect of new technology on labor productivity was not truly realized during this period.)
2. When were the effects of new technology realized in the U.S. economy? (Answer: Labor productivity soared in the United States in the mid-1990s due to many firms, including Wal-Mart, dramatically

changing the manner in which they conducted business by incorporating new technology to increase productivity.)

The Brazilian Breadbasket—This EIA uses Brazil as an example of how a country can grow using technology developed through research and development, economic policies, and physical capital.

Ask students the following questions:

1. What factors have helped to expand Brazilian agricultural production in recent years? (Answer: The Brazilian government funded new research and development projects aimed at increasing agricultural production. In addition, the Brazilian government instituted new trade policies aimed at increasing exports of agricultural commodities. Higher profitability in the agricultural sector also attracted additional investment in new capital, which has enhanced agricultural output.)
2. What are the largest impediments to agricultural growth in Brazil? (Answer: The lack of reliable transportation systems, including barge, road, and railway routes, are the greatest barriers to Brazil's future agricultural growth.)

Are Economies Converging?—This EIA presents data that supports the convergence hypothesis as well as data that tends to refute.

Ask students the following questions:

1. Is the convergence hypothesis supported by real GDP-per-capita data from developed nations? (Answer: Data from developed countries support the convergence hypothesis. Specifically, data for Japan, Spain, Italy, France, Germany, the United States, and Britain show that those countries that had low levels of real GDP per capita in 1955 have had high growth rates since then, while those countries that had high levels of real GDP per capita in 1955 have had lower growth rates since then.)
2. Is the convergence hypothesis supported by real GDP per capita data from less-developed nations? (Answer: Data from less-developed countries do not support the convergence hypothesis.)

The Cost of Climate Protection—This EIA considers proposals to reduce greenhouse gas emissions and their potential effect on long-run economic growth.

Ask students the following questions:

1. What are the costs to an economy of reducing greenhouse gas emissions? (Answer: The economy must switch to alternative energy sources or use alternative production methods to reduce emissions)
2. What is the size of the estimated cost of the bills mentioned in the article? Would they significantly effect long-run economic growth? (Answer: 1.11 or 1.70% of real GDP per capital in 2050. This means giving up a year's growth over 40 years.)

For Inquiring Minds

The Wal-Mart Effect—This FIM presents research attributing U.S. productivity growth starting in the late 1990's to an increase in output per worker in retailing, i.e., the "Wal-Mart effect."

Inventing R&D—This FIM discusses the "invention" of research and development by Thomas Edison.

Coal Comfort on Resources—This FIM uses the work of William Stanley Jevons in 1965 to address questions of resource exhaustion and economic growth today.

Global Comparison

Old Europe and New Technology—This Global Comparison presents factor productivity growth for three European countries and the United States.

Activities

Using the Rule of 70 (15 minutes)

Ask students to use the Rule of 70 to answer the following questions.

1. How long will it take U.S. real GDP per capita to double if it is currently growing at a rate of 2% per year?

Answer:

$$\text{Number of years for real GDP to double} = \frac{70}{2} = 35 \text{ years}$$

2. If real GDP per capita doubled in 44 years, then what was the annual rate of growth of real GDP per capita?

Answer:

$$44 \text{ years} = \frac{70}{\text{Annual rate of growth of real GDP per capita}}$$

Or

$$\text{Annual rate of growth of real GDP per capita} = \frac{70}{44} = 1.59\%$$

New Ways of Doing Business (15 minutes)

Pair students and ask them to list five ways firms use technology to increase productivity.

Possible answers:

1. Conducting business meetings via video conferencing rather than by traveling to a destination for a meeting.
2. Computer-aided design programs used by architects and engineers to create and test their designs.
3. Computerized inventory control systems that are linked to check-out stations in stores.
4. Email used in place of traditional mail or paper documents.
5. Use of company or university web pages to display information and reduce the need for printed documents.

Long-Run Economic Growth and Natural Resources (15 minutes)

Pair students and ask them to list four reasons why some countries with limited natural resources, such as Japan and Singapore, have been able to achieve high rates of long-run economic growth.

Possible answers:

1. Increases in human capital have made labor more productive.
2. Increases in physical capital have made labor more productive.
3. Technological improvements have increased total factor productivity.
4. Improvements in health care have increased labor productivity.
5. Improvements in infrastructure have increased total factor productivity.
6. Development and use of new technologies have reduced the need for natural resources, such as energy-saving capital, or use of fertilizers on inferior agricultural land.

Some Economic Advice, Please (20 minutes)

Pair students and ask them to develop a list of five economic policies that will increase the rate of long-run economic growth in the following nations:

1. A developed nation, such as the United States
2. A less developed nation, such as Iraq

Possible Answers:

1. For a developed nation, the following policies should be pursued:
 - Limit government restrictions on private businesses
 - Maintain economic stability with respect to inflation and unemployment
 - Invest in higher education to increase the human capital of its citizens
 - Encourage businesses to update their capital stock with tax incentives
 - Invest in new infrastructure
2. For a less developed nation, the following policies should be pursued:
 - Encourage political and economic stability
 - Seek foreign sources of investment to build capital stock
 - Invest in a public health-care system to improve workers' health and thus increase labor productivity
 - Increase exports of goods and services
 - Invest in necessary infrastructure to aid in the production and transportation of goods and services

Make a List (20 minutes)

Divide the class into approximately five or six groups and instruct students to select a spokesperson for each group. Ask each group to create a prioritized list of five actions that should be taken to address the problems plaguing Africa's poorest nations. Afterward, ask the spokesperson from each group to present and defend the choices of the group. Also encourage all students to question the responses made by members of other groups.

Possible Answers:

1. Improve public health care system
2. Encourage political stability
3. Seek foreign sources of capital investment
4. Improve public education
5. Invest in infrastructure

Introduce Students to the \$2 A Day Challenge (15 minutes)

Go to Americans for Informed Democracy: \$2 A Day Challenge
<http://www.aidemocracy.org/2DollarDay.php>

Web Resources

The following website provides information related to topics in this chapter:

The Population Reference Bureau has worldwide data and information on demographic and economic variables:

<http://www.prb.org/Journalists/PressReleases/2005/MoreThanHalftheWorldLivesonLessThan2aDayAugust2005.aspx>.

The United States Geological Survey has information on the supply of natural resources:

<http://www.usgs.gov/>.

Americans for Informed Democracy has information about their \$2 per day challenge:

<http://www.aidemocracy.org/2DollarDay.php>.

