CHAPTER

25

Production and Growth

Goals

In this chapter you will

- See how much economic growth differs around the world
- Consider why productivity is the key determinant of a country's standard of living
- Analyze the factors that determine a country's productivity
- Examine how a country's policies influence its productivity growth

Outcomes

After accomplishing these goals, you should be able to

- List the countries with the highest GDP per person and the countries whose GDP per person is growing the fastest
- Explain why production limits consumption in the long run
- List and explain the factors of production
- Explain seven areas of policy action that may influence a country's productivity and growth

Chapter Overview

Context and Purpose

Chapter 25 is the first chapter in a four-chapter sequence on the production of output in the long run. Chapter 25 addresses the determinants of the level and growth rate of output. We find that capital and labor are among the primary determinants of output. In Chapter 26, we address how saving and investment in capital goods affect the production of output, and in Chapter 27, we learn about some of the tools people and firms use when choosing capital projects in which to invest. In Chapter 28, we address the market for labor.

The purpose of Chapter 25 is to examine the long-run determinants of both the level and the growth rate of real GDP per person. Along the way, we will discover the factors that determine the productivity of workers and address what governments might do to improve the productivity of their citizens.

Chapter Review

Introduction There is great variation in the standard of living across countries at a point in time and within a country across time—for example, between the United States and India today, and between the United States of today and the United States of 100 years ago. Growth rates also vary from country to country with East Asia growing quickly and Africa growing slowly. This chapter examines the long-run determinants of both the *level* and the *growth rate* of *real GDP per person*.

Economic Growth around the World

There is great variation across countries in both the *level* of real GDP per person and the *growth rate* of real GDP per person.

- At present, the *level* of real GDP per person in the United States is about 12 times that of India and 6 times that of China.
- However, since the *growth rate* of real GDP per person also varies across countries, the ranking of countries by real GDP per person changes over time. For example, over the past 100 years, the ranking of Japan has risen relative to others because it has had an above average growth rate while the ranking of the United Kingdom has fallen due to its below average growth rate.

Due to economic growth, the average American today enjoys conveniences such as television, air conditioning, cars, telephones, and medicines that the richest American didn't have 150 years ago. Since measures of inflation and output fail to fully capture the introduction of new goods, we overestimate inflation and underestimate economic growth.

Productivity: Its Role and Determinants

A country's standard of living depends directly on the productivity of its citizens because an economy's income is equal to an economy's output. Productivity refers to the quantity of goods and services produced from each unit of labor input. The productivity of a worker is determined by the available physical capital, human capital, natural resources, and technological knowledge. These inputs or *factors of production* are explained below:

- Physical capital per worker (or just capital): Physical capital is the stock of equipment and structures that are used to produce goods and services. Note that these tools and machines are themselves the output from prior human production.
- Human capital per worker: Human capital is the knowledge and skills that workers acquire through education, training, and experience. Note that human capital, like physical capital, is a human-made or produced factor of production.
- Natural resources per worker: Natural resources are inputs provided by nature's bounty, such as land, rivers, and mineral deposits. Natural resources come in two forms: *renewable* and *nonrenewable*.

- Technological knowledge: Technological knowledge is the understanding about the best ways to produce goods and services. Examples of advances in technology are the discovery and application of herbicides and pesticides in agriculture and of the assembly line in manufacturing.

Technological knowledge differs from human capital. Technological knowledge is society's understanding of the best production methods while human capital is the amount of understanding of these methods that has been transmitted to the labor force.

A *production function* establishes the relationship between the quantity of inputs used in production and the quantity of output from production. If a production function has *constant returns to scale,* then doubling all of the inputs doubles output.

In summary, output per worker (labor productivity) depends on physical capital per worker, human capital per worker, natural resources per worker, and the state of technology.

The only factor of production that is not a produced factor is natural resources. Since there is a fixed supply of nonrenewable natural resources, many people have argued that there is a limit to how much the world's economies can grow. So far, however, technological advances have found ways around these limits. Evidence of stable or falling prices of natural resources suggests that we are continuing to succeed at stretching our limited resources.

Economic Growth and Public Policy

Physical capital per worker, human capital per worker, natural resources per worker, and technological knowledge determine productivity. Productivity determines living standards. If a government wishes to raise the productivity and standard of living of its citizens, it should pursue policies that:

- *Encourage saving and investment.* If society consumes less and saves more, it has more resources available to invest in the production of capital. Additional capital increases productivity and living standards. This additional growth has an opportunity cost—society must give up current consumption in order to attain more growth. Investment in capital may be subject to diminishing returns: As the stock of capital rises, the extra output produced by an additional unit of capital declines. Thus, an additional increment of capital in a poor country increases growth more than the same increment in an already rich country. This is known as the catch-up effect because it is easier for a relatively poor country to grow quickly. However, because of diminishing returns to capital, higher saving and investment in a poor country will lead to higher growth only for a period of time, with growth slowing down again as the economy accumulates a higher level of capital stock.
- *Encourage investment from abroad,* by removing restrictions on the ownership of domestic capital and by providing a stable political environment. In addition to using domestic saving to invest in capital, countries can attract investment by foreigners. There are two categories of foreign investment. *Foreign direct investment* is capital investment that is owned and operated by a foreign entity. *Foreign portfolio investment* is capital investment that is financed with foreign money but is operated by domestic residents. Investment from abroad increases a country's GDP more than its GNP because the investing country earns the profits from the investment. The World Bank and the International Monetary Fund help channel foreign investment toward poor countries.
- *Encourage education.* Education is investment in human capital. Education not only increases the productivity of the recipient, it may provide a positive *externality.* An externality occurs when the actions of one person affect the well-being of a bystander. An educated individual may generate ideas that become useful to others. This is an argument for public education. Poor countries may suffer from *brain drain* when their educated workers emigrate to rich countries. Children in very poor countries may work instead of going to school because the opportunity cost of going to school is too great. Paying parents for sending their children to school may both reduce child labor and increase the education of very poor children.

- *Improve health and nutrition.* Expenditures on the health and nutrition of workers can significantly increase labor productivity. These expenditures are sometimes viewed as an investment in human capital, similar to expenditures on education.
- *Protect property rights and establish political stability. Property rights* refer to the ability of people to exercise control over their resources. For individuals to be willing to work, save and invest, and trade with others by contract, they must be confident that their production and capital will not be stolen and that their agreements will be enforced. Even a remote possibility of political instability creates uncertainty with regard to property rights because a revolutionary government might confiscate property—particularly capital.
- *Encourage free trade.* Free trade is like a technological advance. It allows a country to transform the output from its production into products that another country produces more efficiently. The *infant-industry argument* suggests that developing countries should pursue *inward-oriented policies* by restricting international trade to protect fledgling domestic industry from foreign competition. Most economists disagree with the infant-industry argument and promote *outward-oriented policies* that reduce or eliminate trade barriers. Advantageous natural geography, such as good natural seaports and long coastlines, promotes trade and growth.
- *Encourage research and development.* Most of the increase in the standard of living is due to an increase in technological knowledge that comes from research and development. After a time, knowledge is a *public good* in that we all can use it at the same time without diminishing another's benefits. Research and development might be encouraged with grants, tax breaks, and patents to establish temporary property rights to an invention. Alternatively, it might be encouraged by simply maintaining property rights and political stability.
- *Address population growth.* Population growth may affect productivity in both positive and negative ways. Rapid population growth may *stretch natural resources* across more people. Thomas Malthus (1766–1834) argued that population growth will always rise to the limit imposed by the food supply, causing mankind to live forever in poverty. Any attempt to alleviate poverty will simply cause the poor to have more children, returning them to subsistence living. Malthus' predictions have not come true because he underestimated the ability of technological progress to expand the food supply. Rapid population growth *dilutes the capital stock* (both physical and human capital) by spreading it across more workers. Educated women tend to have fewer children because the opportunity cost of having children increases as opportunities grow. However, a larger population may *promote technological progress.* Throughout history, most technological progress has come from larger population centers where there are more people who are able to discover things and exchange ideas.

Helpful Hints

1. A simple example more clearly defines the factors of production. The simpler the production process, the easier it is to separate and analyze the factors of production. For example, suppose output is "holes dug in the ground." Then the production function is:

$$Y = A\,F(L, K, H, N)$$

where Y is the number of holes dug, A is technological knowledge, L is labor, K is physical capital, H is human capital, and N is natural resources. If we have more workers, there is an increase in L and Y would increase. If we have more shovels, there is an increase in K and Y would increase. If workers are educated so that more of them dig with the spaded end of the shovel as opposed to digging with the handle, there is an increase in H and Y would increase. (Note: The number of workers and the number of shovels is unchanged.) If our country has softer soil so that digging is easier here, N is larger and, therefore, Y is larger. Finally, if we discover that it is more productive to dig after it rains rather than during a drought, there is an increase in A and Y should increase.

Terms and Definitions

Choose a definition for each key term.

Key Terms

_____ Real GDP per person
_____ Growth rate
_____ Productivity
_____ Physical capital
_____ Factors of production
_____ Human capital
_____ Natural resources
_____ Renewable resource
_____ Nonrenewable resource
_____ Technological knowledge
_____ Production function
_____ Constant returns to scale
_____ Diminishing returns
_____ Catch-up effect
_____ Foreign direct investment
_____ Foreign portfolio investment
_____ Externality
_____ Property rights
_____ Infant-industry argument
_____ Inward-oriented policies
_____ Outward-oriented policies
_____ Public good

Definitions

1. The knowledge and skills that workers acquire through education, training, and experience
2. Capital investment owned and operated by foreigners
3. The relationship between inputs and outputs from production
4. A good that we may all use at the same time without diminishing another's benefits
5. The ability of people to exercise control over their resources
6. The quantity of goods and services available for the average individual in the economy
7. The stock of equipment and structures used to produce output
8. When the incremental increase in output declines as equal increments of an input are added to production
9. A production process where doubling all of the inputs doubles the output
10. Natural resource that can be reproduced
11. Restricting international trade to protect fledgling domestic industry from foreign competition
12. Policies that decrease international trade restrictions
13. The property that poorer countries tend to grow more rapidly than richer countries
14. The annual percentage change in output
15. Inputs used in production, such as labor, capital, and natural resources
16. Natural resource that is limited in supply
17. When the actions of one person affect the well-being of a bystander
18. Policies that increase international trade restrictions
19. A society's understanding about the best ways to produce goods and services
20. The quantity of goods and services produced from each unit of labor input
21. Inputs into production provided by nature
22. Capital investment financed with foreign money but operated by domestic residents

Problems and Short-Answer Questions

Practice Problems

1.

Country	Current Real GDP/Person	Current Growth Rate
Northcountry	$15,468	1.98%
Southcountry	13,690	2.03
Eastcountry	6,343	3.12
Westcountry	1,098	0.61

a. Which country is richest? How do you know?

b. Which country is advancing most quickly? How do you know?

c. Which country would likely see the greatest benefit from an increase in capital investment? Why?

d. Referring to question *c* above: Would this country continue to see the same degree of benefits from an increase in capital investment forever? Why or why not?

e. Referring to question *d* above: Why might investment in human capital and research and development fail to exhibit the same degree of diminishing returns as investment in physical capital?

f. Which country has the potential to grow most quickly? List some reasons why it may not be living up to its potential.

g. If real GDP per person in Northcountry next year is $15,918, what is its annual growth rate?

2. Imagine a kitchen. It contains a cook, the cook's diploma, a recipe book, a stove and utensils, and some venison harvested from the open range.
   a. Link each object in the kitchen to a general category within the factors of production.

   b. While the different factors of production exhibit different levels of durability, which one is special in that it does not wear out?

3. a. List the policies governments might pursue to increase the productivity of their citizens.

   b. Which one is, at the very least, fundamentally necessary as a background in which the other policies may operate? Why?

   c. Does a growing population enhance or inhibit growth in productivity? Explain.

Short-Answer Questions

1. Economists measure both the level of real GDP per person and the growth rate of real GDP per person. What different concept does each statistic capture?

2. Must poor countries stay relatively poor forever and must rich countries stay relatively rich forever? Why?

3. What factors determine productivity? Which ones are human produced?

4. How does human capital differ from physical capital?

5. Explain the opportunity cost of investing in capital. Is there any difference in the opportunity cost of investing in human capital versus physical capital?

6. Why does an increase in the rate of saving and investment only increase the rate of growth temporarily?

7. If foreigners buy newly issued stock in General Motors, and General Motors uses the proceeds to expand capacity by building new plants and equipment, which will rise more in the future: GDP or GNP? Why? What do we call this type of investment?

8. Some economists argue for lengthening patent protection while some economists argue for shortening it. Why might patents increase productivity? Why might they decrease productivity?

Self-Test

True/False Questions

_____ 1. The United States should grow faster than Japan because the United States has a larger economy.

_____ 2. Evidence of rising prices for natural resources demonstrates that nonrenewable resources will become so scarce that economic growth will be limited.

_____ 3. The rate of economic growth is probably underestimated.

_____ 4. Human capital refers to human-made capital such as tools and machinery, as opposed to natural capital such as rivers and timber.

_____ 5. If a production function exhibits constant returns to scale, then doubling all of the inputs doubles output.

_____ 6. In very poor countries, paying parents to send their children to school may increase the education of poor children and decrease the use of child labor.

_____ 7. An increase in capital should cause the growth rate of a relatively poor country to increase more than that of a rich country.

_____ 8. An increase in the rate of saving and investment permanently increases a country's rate of growth.

_____ 9. A country can only increase its level of investment by increasing its saving.

_____ 10. The only factor of production that is not "produced" is natural resources.

_____ 11. Investment in human capital and technology may be particularly productive because of positive spillover effects.

_____ 12. If Germans invest in the U.S. economy by building a new Mercedes factory, in the future U.S. GDP will rise by more than U.S. GNP.

_____ 13. Most economists believe that inward-oriented policies that protect infant industries improve the growth rates of developing nations.

_____ 14. Economic evidence supports the predictions of Thomas Malthus regarding the effects of population growth and the food supply on the standard of living.

_____ 15. The opportunity cost of additional growth is that someone must forgo current consumption.

Multiple-Choice Questions

1. A reasonable measure of the standard of living in a country is
   a. real GDP per person.
   b. real GDP.
   c. nominal GDP per person.
   d. nominal GDP.
   e. the growth rate of nominal GDP per person.

2. Many East Asian countries are growing very quickly because
   a. they have enormous natural resources.
   b. they are imperialists and have collected wealth from previous victories in war.
   c. they save and invest an unusually high percentage of their GDP.
   d. they have always been wealthy and will continue to be wealthy, which is known as the "snowball effect."

3. When a nation has very little GDP per person,
   a. it is doomed to being relatively poor forever.
   b. it must be a small nation.
   c. it has the potential to grow relatively quickly due to the "catch-up effect."
   d. an increase in capital will likely have little impact on output.
   e. none of the above is true.

4. Once a country is wealthy,
   a. it is nearly impossible for it to become relatively poorer.
   b. it may be harder for it to grow quickly because of the diminishing returns to capital.
   c. capital becomes more productive due to the "catch-up effect."
   d. it no longer needs any human capital.
   e. none of the above is true.

5. The opportunity cost of growth is
   a. a reduction in current investment.
   b. a reduction in current saving.
   c. a reduction in current consumption.
   d. a reduction in taxes.

6. *For a given level of technology*, we should expect an increase in labor productivity within a nation when there is an increase in each of the following *except*
   a. human capital per worker.
   b. physical capital per worker.
   c. natural resources per worker.
   d. labor.

7. Which of the following statements is *true*?
   a. Countries may have a different level of GDP per person, but they all grow at the same rate.
   b. Countries may have a different growth rate, but they all have the same level of GDP per person.
   c. Countries all have the same growth rate and level of output because any country can obtain the same factors of production.
   d. Countries have great variance in both the level and growth rate of GDP per person; thus, poor countries can become relatively rich over time.

8. If a production function exhibits constant returns to scale,
   a. doubling all of the inputs has ahsolutely no impact on output because output is constant.
   b. doubling all of the inputs doubles output.
   c. doubling all of the inputs more than doubles output due to the catch-up effect.
   d. doubling all of the inputs less than doubles output due to diminishing returns.

9. Copper is an example of
   a. human capital.
   b. physical capital.
   c. a renewable natural resource.
   d. a nonrenewable natural resource.
   e. technology.

10. Which of the following statements regarding the impact of population growth on productivity is *true*?
    a. There is no evidence yet that rapid population growth stretches natural resources to the point that it limits growth in productivity.
    b. Rapid population growth may dilute the capital stock, lowering productivity.
    c. Rapid population growth may promote technological progress, increasing productivity.
    d. All of the above are true.

11. Thomas Malthus argued that
    a. technological progress will continuously generate improvements in productivity and living standards.
    b. labor is the only true factor of production.
    c. an ever-increasing population is constrained only by the food supply, resulting in chronic famines.
    d. private charities and government aid will improve the welfare of the poor.
    e. none of the above is true.

12. Madelyn goes to college and reads many books while at school. Her education increases which of the following factors of production?
    a. human capital
    b. physical capital
    c. natural resources
    d. technology
    e. All of the above would be increased.

13. Which of the following describes an increase in technological knowledge?
    a. A farmer discovers that it is better to plant in the spring rather than in the fall.
    b. A farmer buys another tractor.
    c. A farmer hires another day laborer.
    d. A farmer sends his child to agricultural college and the child returns to work on the farm.

14. Our standard of living is most closely related to
    a. how hard we work.
    b. our supply of capital because everything of value is produced by machinery.
    c. our supply of natural resources because they limit production.
    d. our productivity because our income is equal to what we produce.

15. Which of the following is an example of foreign portfolio investment?
    a. A naturalized U.S. citizen, who was originally born in Germany, buys stock in Ford, and Ford uses the proceeds to buy a new plant.
    b. Toyota builds a new plant in Tennessee.
    c. Toyota buys stock in Ford, and Ford uses the proceeds to build a new plant in Michigan.
    d. Ford builds a new plant in Michigan.
    e. None of the above is an example of foreign portfolio investment.

16. Which of the following government policies is *least* likely to increase growth in Africa?
    a. increase expenditures on public education
    b. increase restrictions on the importing of Japanese automobiles and electronics
    c. eliminate civil war
    d. reduce restrictions on foreign capital investment
    e. All of the above would increase growth.

17. If Mazda builds a new plant in Illinois,
    a. in the future, U.S. GDP will rise more than U.S. GNP.
    b. in the future, U.S. GDP will rise less than U.S. GNP.
    c. in the future, U.S. GDP and GNP will both fall because some income from this investment will accrue to foreigners.
    d. there has been an increase in foreign portfolio investment in the United States.
    e. none of the above is true.

18. If real GDP per person in 2006 is $18,073 and real GDP per person in 2007 is $18,635, what is the growth rate of real output over this period?
    a. 3.0 percent
    b. 3.1 percent
    c. 5.62 percent
    d. 18.0 percent
    e. 18.6 percent

19. Which of the following expenditures to enhance productivity is most likely to emit a positive externality?
    a. Megabank buys a new computer.
    b. Susan pays her college tuition.
    c. Exxon leases a new oil field.
    d. General Motors buys a new drill press.

20. To increase growth, governments should do all of the following *except*
    a. promote free trade.
    b. encourage saving and investment.
    c. encourage foreigners to invest in your country.
    d. encourage research and development.
    e. nationalize major industries.

Advanced Critical Thinking

You are having a discussion with other Generation Xers. The conversation turns to a supposed lack of growth and opportunity in the United States when compared to some Asian countries such as Japan, South Korea, Taiwan, and Singapore. Your roommate says, "These Asian countries must have cheated somehow. That's the only way they could have possibly grown so quickly."

1. Have you learned anything in this chapter that would make you question your roommate's assertion?

2. The phenomenal growth rate of Japan since World War II has often been referred to as the "Japanese miracle." Is it a miracle or is it explainable?

3. Are the high growth rates found in these Asian countries without cost?

Solutions

Terms and Definitions

6 Real GDP per person
14 Growth rate
20 Productivity
7 Physical capital
15 Factors of production
1 Human capital
21 Natural resources
10 Renewable resource
16 Nonrenewable resource
19 Technological knowledge
3 Production function
9 Constant returns to scale
8 Diminishing returns
13 Catch-up effect
2 Foreign direct investment
22 Foreign portfolio investment
17 Externality
5 Property rights
11 Infant-industry argument
18 Inward-oriented policies
12 Outward-oriented policies
4 Public good

Practice Problems

1. a. Northcountry, because it has the largest real GDP per person.
   b. Eastcountry, because it has the largest growth rate.
   c. Westcountry is the poorest and likely has the least capital. Since capital exhibits diminishing returns, it is most productive when it is relatively scarce.
   d. No. Because of diminishing returns to capital, the additional growth from increasing capital declines as a country has more capital.
   e. Human capital emits a positive externality. Research and development is a public good after dissemination.
   f. Westcountry, because it is currently the poorest and could easily benefit from additional capital. It may have trade restrictions (inward-oriented policies), a corrupt or unstable government, few courts, and a lack of established property rights, etc.
   g. ($15,918 − $15,468)/$15,468 = 0.029 = 2.9%
2. a. cook = labor, diploma = human capital, recipes = technological knowledge, stove and utensils = capital, venison = natural resource.
   b. Recipes (technological knowledge) never wear out. Labor and human capital die, the stove and utensils wear out slowly, and the venison is used up (although it is probably renewable).
3. a. Encourage saving and investment, investment from abroad, education, health and nutrition, free trade, research and development, protect property rights, and establish political stability.
   b. Property rights and political stability are necessary for there to be any incentive to save, invest, trade, or educate.
   c. The answer is uncertain. A rapidly growing population may reduce productivity by stretching natural resources across more people and by diluting the capital stock across more workers. However, there is evidence that more technological progress takes place in areas with large populations.

Short-Answer Questions

1. Level of real GDP per person measures standard of living. Growth rate measures rate of advance of the standard of living.
2. No. Since growth rates vary widely across countries, rich countries can become relatively poorer and poor countries can become relatively richer.
3. Physical capital per worker, human capital per worker, natural resources per worker, and technological knowledge. All except natural resources.
4. Human capital is the knowledge and skills of the worker. Physical capital is the stock of equipment and structures.
5. Someone must forgo current consumption. No, someone must save instead of consume regardless of whether education or machines are purchased with the saving.
6. Because there are diminishing returns to physical capital.
7. GDP. GNP measures only the income of Americans while GDP measures income generated inside the United States. Therefore, GDP will rise more than GNP because some of the profits from the capital investment will accrue to foreigners in the form of dividends. Foreign portfolio investment.
8. Patents provide a property right to an idea; therefore, people are willing to invest in research and development because it is more profitable. Research and development is a public good once the information is disseminated, and a patent restricts this public use.

True/False Questions

1. F; growth depends on the rate of increase in productivity.

2. F; the prices of natural resources, adjusted for inflation, are stable or falling, so our ability to conserve these resources is growing more rapidly than their supplies are dwindling.
3. T
4. F; human capital is the knowledge and skills of workers.
5. T
6. T
7. T
8. F; due to diminishing returns to capital, growth rises temporarily.
9. F; it can attract foreign investment.
10. T
11. T
12. T
13. F; most economists believe that outward-oriented policies improve growth.
14. F; Malthus underestimated technological improvements in food production. Thus, people are not doomed to live at subsistence.
15. T

Multiple-Choice Questions

1. a
2. c
3. c
4. b
5. c
6. d
7. d
8. b
9. d
10. d
11. c
12. a
13. a
14. d
15. c
16. b
17. a
18. b
19. b
20. e

Advanced Critical Thinking

1. Yes. There are many sources of growth and a country can influence all of them except natural resources.
2. Japan's growth is explainable. Indeed, all of the high-growth Asian countries have extremely high investment as a percentage of GDP.
3. No. The opportunity cost of investment is that someone must forgo current consumption in order to save and invest.