

Accordingly, economies of scale result in greater real GDP and thus contribute to economic growth.

**Improved Resource Allocation** Improved resource allocation means that workers over time have moved from low-productivity employment to high-productivity employment. Historically, many workers have shifted from agriculture, where labor productivity is low, to manufacturing, where it is quite high. More recently, labor has shifted away from some manufacturing industries to even higher-productivity industries such as computer software, business consulting, and pharmaceuticals. As a result of such shifts, the average productivity of U.S. workers has increased.

Also, discrimination in education and the labor market has historically deterred some women and minorities from entering high-productivity jobs. With the decline of such discrimination over time, many members of those groups have shifted from lower-productivity jobs to higher-productivity jobs. The result has been higher overall labor productivity and real GDP.

Finally, we know from discussions in Chapter 5 that tariffs, import quotas, and other barriers to international trade tend to relegate resources to relatively unproductive pursuits. The long-run movement toward liberalized international trade through international agreements has improved the allocation of resources, increased labor productivity, and expanded real output, both here and abroad. **(Key Question 8)**

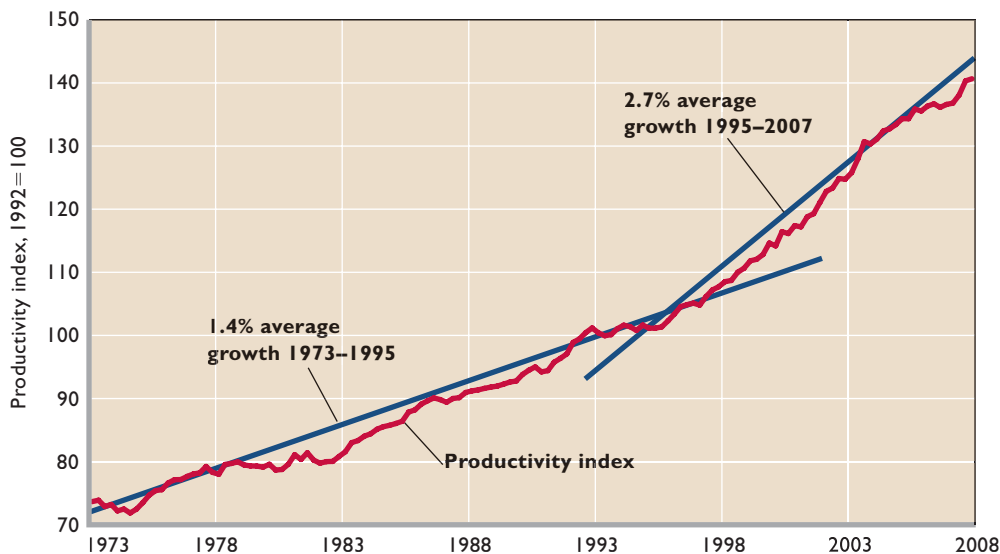
### QUICK REVIEW 25.3

- Institutional structures that promote growth include strong property rights, patents, efficient financial institutions, education, and a competitive market system.
- The “ingredients” of economic growth to which we can attribute changes in growth rates include four supply factors (increases in the quantity and quality of natural resources, increases in the quantity and quality of human resources, increases in the stock of capital goods, and improvements in technology); one demand factor (increases in total spending); and one efficiency factor (achieving allocative and productive efficiency).
- Improvements in labor productivity accounted for about two-thirds of the increase in U.S. real GDP between 1990 and 2007; the use of more labor inputs accounted for the remainder.
- Improved technology, more capital, greater education and training, economies of scale, and better resource allocation have been the main contributors to U.S. productivity growth and thus to U.S. economic growth.

## The Recent Productivity Acceleration

Figure 25.5 shows the growth of labor productivity (as measured by changes in the index of labor productivity) in the United States from 1973 to 2007, along with separate trend

**FIGURE 25.5 Growth of labor productivity in the United States, 1973–2007.** U.S. labor productivity (here, for the business sector) increased at an average annual rate of only 1.4 percent from 1973 to 1995. But between 1995 and 2007 it accelerated to an annual rate of 2.7 percent.



Source: U.S. Bureau of Labor Statistics, [www.bls.gov](http://www.bls.gov).

lines for 1973–1995 and 1995–2007. Labor productivity grew by an average of only 1.4 percent yearly over the 1973–1995 period. But productivity growth averaged 2.7 percent between 1995 and 2007. Many economists believe that this higher productivity growth resulted from a significant new wave of technological advance, coupled with global competition. Some economists are hopeful that the higher trend rates of productivity growth may be permanent.

This increase in productivity growth is important because real output, real income, and real wages are linked to labor productivity. To see why, suppose you are alone on an uninhabited island. The number of fish you can catch or coconuts you can pick per hour—your productivity—is your real wage (or real income) per hour. By *increasing* your productivity, you can improve your standard of living because you can gather more fish and more coconuts (goods) for each hour of work.

So it is for the economy as a whole: Over long periods, the economy’s labor productivity determines its average real hourly wage. The economy’s income per hour is equal to its output per hour. Productivity growth therefore is its main route for increasing its standard of living. It allows firms to pay higher wages without lowering their business profits. As we demonstrated in this chapter’s first Consider This box, even a seemingly small percentage change in productivity growth, if sustained over several years, can make a substantial difference as to how fast a nation’s standard of living rises. We know from the *rule of 70* that if a nation’s productivity grows by 2.7 percent annually rather than 1.4 percent annually, its material standard of living will double in 26 years rather than 50 years.

## Reasons for the Productivity Acceleration

Why has productivity growth increased relative to earlier periods?

### The Microchip and Information Technology

The core element of the productivity speedup is an explosion of entrepreneurship and innovation based on the microprocessor, or *microchip*, which bundles transistors on a piece of silicon. Some observers liken the invention of the microchip to that of electricity, the automobile, air travel, the telephone, and television in importance and scope.

The microchip has found its way into thousands of applications. It has helped create a wide array of new products and services and new ways of doing business. Its immediate results were the pocket calculator, the bar-code scanner, the personal computer, the laptop computer, and more powerful business computers. But the miniaturization

of electronic circuits also advanced the development of many other products such as cell phones and pagers, computer-guided lasers, global positioning equipment, energy conservation systems, Doppler radar, digital cameras, and machines to decipher the human genome.

Perhaps of greatest significance, the widespread availability of personal and laptop computers stimulated the desire to tie them together. That desire promoted rapid development of the Internet and all its many manifestations, such as business-to-household and business-to-business electronic commerce (e-commerce). The combination of the computer, fiber-optic cable, wireless technology, and the Internet constitutes a spectacular advance in **information technology**, which has been used to connect all parts of the world.

### New Firms and Increasing Returns

Hundreds of new **start-up firms** advanced various aspects of the new information technology. Many of these firms created more “hype” than goods and services and quickly fell by the wayside. But a number of firms flourished, eventually to take their places among the nation’s largest firms. Examples of those firms include Intel (microchips); Apple and Dell (personal computers); Microsoft and Oracle (computer software); Cisco Systems (Internet switching systems); America Online (Internet service provision); Yahoo and Google (Internet search engines); and eBay and Amazon.com (electronic commerce). There are scores more! Most of these firms were either “not on the radar” or “a small blip on the radar” 30 years ago. Today each of them has large annual revenue and employs thousands of workers.

Successful new firms often experience **increasing returns**, a situation in which a given percentage increase in the amount of inputs a firm uses leads to an even larger percentage increase in the amount of output the firm produces. For example, suppose that a company called Techco decides to double the size of its operations to meet the growing demand for its services. After doubling its plant and equipment and doubling its workforce, say, from 100 workers to 200 workers, it finds that its total output has tripled from 8000 units to 24,000 units. Techco has experienced increasing returns; its output has increased by 200 percent, while its inputs have increased by only 100 percent. That is, its labor productivity has gone up from 80 units per worker (= 8000 units/100 workers) to 120 units per worker (= 24,000 units/200 workers). Increasing returns boost labor productivity and reduce per-unit production costs. Since these cost reductions result from increases in output levels, they are examples of *economies of scale*.

Both emerging firms as well as established firms can exploit several different sources of increasing returns and economies of scale:

- **More specialized inputs** Firms can use more specialized and thus more productive capital and workers as they expand their operations. A growing new e-commerce business, for example, can purchase highly specialized inventory management systems and hire specialized personnel such as accountants, marketing managers, and system maintenance experts.
- **Spreading of development costs** Firms can spread high product development costs over greater output. For example, suppose that a new software product costs \$100,000 to develop and only \$2 per unit to manufacture and sell. If the firm sells 1000 units of the software, its per-unit cost will be \$102 [=  $(\$100,000 + \$2000)/1000$ ], but if it sells 500,000 units, that cost will drop to only \$2.20 [=  $(\$100,000 + \$1 \text{ million})/500,000$ ].
- **Simultaneous consumption** Many recently developed products and services can satisfy large numbers of customers at the same time. Unlike a gallon of gas that needs to be produced for each buyer, a software program needs to be produced only once. It then becomes available at very low expense to thousands or even millions of buyers. The same is true of entertainment delivered on CDs, movies distributed on DVDs, and information disseminated through the Internet.
- **Network effects** Software and Internet service become more beneficial to a buyer the greater the number of households and businesses that also buy them. When others have Internet service, you can send e-mail messages to them. And when they also have software that allows display of documents and photos, you can attach those items to your e-mail messages. These interconnectivity advantages are called **network effects**, which are increases in the value of the product to each user, including existing users, as the total number of users rises. The domestic and global expansion of the Internet in particular has produced network effects, as have cell phones, pagers, palm computers, and other aspects of wireless communication. Network effects magnify the value of output well beyond the costs of inputs.
- **Learning by doing** Finally, firms that produce new products or pioneer new ways of doing business experience increasing returns through **learning by doing**. Tasks that initially may have taken firms hours may take them only minutes once the methods are perfected.

**TABLE 25.4** Examples of Cost Reductions from Technology

- The cost of storing one megabit of information—enough for a 320-page book—fell from \$5257 in 1975 to 17 cents in 1999.
- Prototyping each part of a car once took Ford weeks and cost \$20,000 on average. Using an advanced 3-D object printer, Ford cut the time to just hours and the cost to less than \$20.
- Studies show that telecommuting saves businesses about \$20,000 annually for a worker earning \$44,000—a saving in lost work time and employee retention costs, plus gains in worker productivity.
- Using scanners and computers, Weyerhaeuser increased the lumber yield and value from each log by 30 percent.
- Amoco used 3-D seismic exploration technology to cut the cost of finding oil from nearly \$10 per barrel in 1991 to under \$1 per barrel in 2000.
- Wal-Mart reduced the operating cost of its delivery trucks by 20 percent through installing computers, global positioning gear, and cell phones in 4300 vehicles.
- Banking transactions on the Internet cost 1 cent each, compared with \$1.14 for face-to-face, pen-and-paper communication.

Source: Compiled and directly quoted from W. Michael Cox and Richard Alm, “The New Paradigm,” Federal Reserve Bank of Dallas Annual Report, May 2000, various pages. Used by permission.

Whatever the particular source of increasing returns, the result is higher productivity, which tends to reduce the per-unit cost of producing and delivering products. Table 25.4 lists a number of specific examples of cost reduction from technology in recent years.

**Global Competition** The recent economy is characterized not only by information technology and increasing returns but also by heightened global competition. The collapse of the socialist economies in the late 1980s and early 1990s, together with the success of market systems, has led to a reawakening of capitalism throughout the world. The new information technologies have “shrunk the globe” and made it imperative for all firms to lower their costs and prices and to innovate in order to remain competitive. Free-trade zones such as NAFTA and the European Union (EU), along with trade liberalization through the World Trade Organization (WTO), have also heightened competition internationally by removing trade protection from domestic firms. The larger geographic markets, in turn, have enabled firms to expand beyond their national borders.

## Implication: More Rapid Economic Growth

Other things equal, stronger productivity growth and heightened global competition allow the economy to achieve a higher rate of economic growth. A glance back

at Figure 25.2 will help make this point. Suppose that the shift of the production possibilities curve from  $AB$  to  $CD$  reflects annual changes in potential output levels before the recent increase in growth rates. Then the higher growth rates of the more recent period of accelerated productivity growth would be depicted by a *larger* outward shift of the economy's production possibilities from  $AB$  to a curve beyond  $CD$ . When coupled with economic efficiency and increased total spending, the economy's real GDP would rise by even more than what is shown.

A caution: Economists who believe that the higher productivity growth rates experienced in recent years are likely to continue do not believe that the business cycle is dead. Their contention is limited to the belief that the *trend lines* of productivity growth and economic growth have become steeper. Real output may periodically deviate below and above the steeper trend—as it did when the economy slowed in the first two months of 2001 and receded over the following eight months of that year.

### Skepticism about Permanence

Although most macroeconomists have revised their forecasts for long-term productivity growth upward, at least slightly, others are still skeptical and urge a “wait-and-see” approach. These macroeconomists acknowledge that the economy has experienced a rapid advance of new technology, some new firms have experienced increasing returns, and global competition has increased. But they wonder if these factors are sufficiently profound to produce a permanent new era of substantially higher rates of productivity growth and real GDP growth.

They also point out that productivity surged between 1975 and 1978 and between 1983 and 1986 but in each case soon reverted to its lower long-run trend. The higher trend line of productivity inferred from the short-run spurt of productivity could prove to be transient. Only by looking backward over long periods can economists distinguish the start of a new long-run trend from a shorter-term boost in productivity related to the business cycle and temporary factors.

### What Can We Conclude?

Given the different views on the recent productivity acceleration, what should we conclude? Perhaps the safest conclusions are these:

- The prospects for a lasting increase in productivity growth are good (see Global Perspective 25.2).



## GLOBAL PERSPECTIVE 25.2

### Global Competitiveness Index

The Global Competitiveness Index published annually by the World Economic Forum measures each country's potential for economic growth. The index uses various factors—such as innovativeness, the capability to transfer technology among sectors, the efficiency of the financial system, rates of investment, and the degree of integration with the rest of the world—to measure a country's ability to achieve economic growth over time. Here is the top 10 list for 2007.

Country	Global Competitiveness Ranking, 2007
United States	1
Switzerland	2
Denmark	3
Sweden	4
Finland	5
Germany	6
Singapore	7
Japan	8
United Kingdom	9
Netherlands	10

Source: Copyright World Economic Forum, [www.weforum.org](http://www.weforum.org).

Studies indicate that productivity increases related to information technology have spread to a wide range of industries, including services. Even in the recession year 2001 and then in 2002, when the economy was sluggish, productivity growth remained strong. Specifically, it averaged about 3.3 percent in the business sector over those two years. Productivity rose by 3.8 percent in 2003, 2.9 percent in 2004, and 2.0 percent in 2005, as the economy vigorously expanded.

- Time will tell. Productivity growth was just 1.0 percent in 2006 and 1.9 percent in 2007. Whether this is a temporary decline or not is uncertain. Thus, several more years must elapse before economists can declare the productivity acceleration seen after 1995 to be a long-run, sustainable trend. (**Key Question 11**)

**QUICK REVIEW 25.4**

- Over long time periods, labor productivity growth determines an economy's growth of real wages and its standard of living.
- Many economists believe that the United States has entered a period of faster productivity growth and higher rates of economic growth.
- The productivity acceleration is based on rapid technological change in the form of the microchip and information technology, increasing returns and lower per-unit costs, and heightened global competition that helps hold down prices.
- More-rapid U.S. productivity growth means that the U.S. economy can grow at higher annual rates than it could with less-rapid productivity growth. Nonetheless, many economists caution that it is still too early to determine whether the recent higher rates of productivity growth are a lasting long-run trend or a fortunate short-lived occurrence.

## Is Growth Desirable and Sustainable?

Economists usually take for granted that economic growth is desirable and sustainable. But not everyone agrees.

### The Antigrowth View

Critics of growth say industrialization and growth result in pollution, global warming, ozone depletion, and other environmental problems. These adverse negative externalities occur because inputs in the production process reenter the environment as some form of waste. The more rapid our growth and the higher our standard of living, the more waste the environment must absorb—or attempt to absorb. In an already wealthy society, further growth usually means satisfying increasingly trivial wants at the cost of mounting threats to the ecological system.

Critics of growth also argue that there is little compelling evidence that economic growth has solved sociological problems such as poverty, homelessness, and discrimination. Consider poverty: In the antigrowth view, American poverty is a problem of distribution, not production. The requisite for solving the problem is a firm commitment to redistribute wealth and income, not further increases in output.

Antigrowth sentiment also says that while growth may permit us to “make a better living,” it does not give us “the good life.” We may be producing more and enjoying it less. Growth means frantic paces on jobs, worker burnout, and alienated employees who have little or no control over

decisions affecting their lives. The changing technology at the core of growth poses new anxieties and new sources of insecurity for workers. Both high-level and low-level workers face the prospect of having their hard-earned skills and experience rendered obsolete by onrushing technology. High-growth economies are high-stress economies, which may impair our physical and mental health.

Finally, critics of high rates of growth doubt that they are sustainable. The planet Earth has finite amounts of natural resources available, and they are being consumed at alarming rates. Higher rates of economic growth simply speed up the degradation and exhaustion of the earth's resources. In this view, slower economic growth that is environmentally sustainable is preferable to faster growth.

### In Defense of Economic Growth

The primary defense of growth is that it is the path to the greater material abundance and higher living standards desired by the vast majority of people. Rising output and incomes allow people to buy

more education, recreation, and travel, more medical care, closer communications, more skilled personal and professional services, and better-designed as well as more numerous products. It also means more art, music, and poetry, theater, and drama. It can even mean more time and resources devoted to spiritual growth and human development.<sup>1</sup>

Growth also enables society to improve the nation's infrastructure, enhance the care of the sick and elderly, provide greater access for the disabled, and provide more police and fire protection. Economic growth may be the only realistic way to reduce poverty, since there is little political support for greater redistribution of income. The way to improve the economic position of the poor is to increase household incomes through higher productivity and economic growth. Also, a no-growth policy among industrial nations might severely limit growth in poor nations. Foreign investment and development assistance in those nations would fall, keeping the world's poor in poverty longer.

Economic growth has not made labor more unpleasant or hazardous, as critics suggest. New machinery is usually less taxing and less dangerous than the machinery it replaces. Air-conditioned workplaces are more pleasant than steamy workshops. Furthermore, why would an end to economic growth reduce materialism or alienation? The loudest protests against materialism are heard in those nations and

<sup>1</sup>Alice M. Rivlin, *Reviving the American Dream* (Washington, D.C.: Brookings Institution, 1992), p. 36.

### China's Economic Growth Rate in the Past 25 Years Is Among the Highest Recorded for Any Country During Any Period of World History.

Propelled by capitalistic reforms, China has experienced nearly 9 percent annual growth rates over the past 25 years. Real output has more than quadrupled over that period. In 2006, China's growth rate was 10.7 percent and in 2007 it was 11.3 percent. Expanded output and income have boosted domestic saving and investment, and the growth of capital goods has further increased productivity, output, and income. The rising income, together with inexpensive labor, has attracted more foreign direct investment (a total of over \$170 billion between 2005 and 2007).

China's real GDP and real income have grown much more rapidly than China's population. Per capita income has increased at a high annual rate of 8 percent since 1980. This is particularly noteworthy because China's population has expanded by 14 million a year (despite a policy that encourages one child per family). Based on exchange rates, China's per capita income is now about \$2500 annually. But because the prices of many basic items in China are still low and are not totally reflected in exchange rates, Chinese per capita purchasing power is estimated to be equivalent to \$5300 of income in the United States.

The growth of per capita income in China has resulted from increased use of capital, improved technology, and shifts of labor away from lower-productivity toward higher-productivity uses. One such shift of employment has been from agriculture toward rural and urban manufacturing. Another shift has been from state-owned enterprises toward private firms. Both shifts have raised the productivity of Chinese workers.

Chinese economic growth had been accompanied by a huge expansion of China's international trade. Chinese exports rose from \$5 billion in 1978 to \$1.2 trillion in 2007. These exports have provided the foreign currency needed to import consumer goods and capital goods. Imports of capital goods from industrially advanced countries have brought with them highly advanced technology that is embodied in, for example, factory design, industrial machinery, office equipment, and telecommunications systems.

China still faces some significant problems in its transition to the market system, however. At times, investment booms in China have resulted in too much spending relative to production

capacity. The result has been some periods of 15 to 25 percent annual rates of inflation. China confronted the inflation problem by giving its central bank more power so that, when appropriate, the bank can raise interest rates to damp down investment spending. This greater monetary control has reduced inflation significantly. China's inflation rate was a mild 1.2 percent in 2003, 4.1 percent in 2004, and 1.9 percent in 2005. More vigilance may be required, however, as inflation rebounded over the next two years, reaching 7.1 percent in 2007.

In addition, the overall financial system in China remains weak and inadequate. Many unprofitable state-owned enterprises owe colossal sums of money on loans made by the Chinese state-owned banks (an estimate is nearly \$100 billion). Because most of these loans are not collectible, the government may need to bail out the banks to keep them in operation.



Unemployment is also a problem. Even though the transition from an agriculture-dominated economy to a more urban, industrial economy has been gradual, considerable displacement of labor has occurred. There is substantial unemployment and underemployment in the interior regions of China.

China still has much work to do to integrate its economy fully into the world's system of international finance and trade. As a condition of joining the World Trade Organization in 2001, China agreed to reduce its high tariffs on imports and remove restrictions on foreign ownership. In addition, it agreed to change its poor record of protecting intellectual property rights such as copyrights, trademarks, and patents. Unauthorized copying of products is a major source of trade friction between China and the United States. So, too, is the artificially low international value of China's currency, which has contributed to a \$250 billion annual trade surplus with the United States.

China's economic development has been very uneven geographically. Hong Kong is a wealthy capitalist city with per capita income of about \$29,000. The standard of living is also relatively high in China's southern provinces and coastal cities, although not nearly as high as it is in Hong Kong. In fact, people living in these special economic zones have been the major beneficiaries of China's rapid growth. In contrast, the majority of people living elsewhere in China have very low incomes. Despite its remarkable recent economic successes, China remains a relatively low-income nation. But that status is quickly changing.

groups that now enjoy the highest levels of material abundance! The high standard of living that growth provides has increased our leisure and given us more time for reflection and self-fulfillment.

Does growth threaten the environment? The connection between growth and environment is tenuous, say growth proponents. Increases in economic growth need not mean increases in pollution. Pollution is not so much a by-product of growth as it is a “problem of the commons.” Much of the environment—streams, lakes, oceans, and the air—is treated as common property, with insufficient or no restrictions on its use. The commons have become our dumping grounds; we have overused and debased them. Environmental pollution is a case of negative externalities, and correcting this problem involves regulatory legislation, specific taxes (“effluent charges”), or market-based incentives to remedy misuse of the environment.

Those who support growth admit there are serious environmental problems. But they say that limiting growth is the wrong solution. Growth has allowed economies to reduce pollution, be more sensitive to environmental considerations, set aside wilderness, create national parks and monuments, and clean up hazardous waste, while still enabling rising household incomes. (See the Last Word in Chapter 15.)

Is growth sustainable? Yes, say the proponents of growth. If we were depleting natural resources faster than their discovery, we would see the prices of those resources rise. That has not been the case for most natural resources; in fact, the prices of most of them have declined (see Figure 15.1). And if one natural resource becomes too expensive, another resource will be substituted for it. Moreover, say economists, economic growth has to do with the expansion and application of human knowledge and information, not of extractable natural resources. In this view, economic growth is limited only by human imagination.

## Summary

1. A nation's economic growth can be measured either as an increase in real GDP over time or as an increase in real GDP per capita over time. Real GDP in the United States has grown at an average annual rate of about 3.5 percent since 1950; real GDP per capita has grown at roughly a 2.3 percent annual rate over that same period.
2. Sustained increases in real GDP per capita did not happen until the past two centuries, when England and then other countries began to experience modern economic growth, which is characterized by institutional structures that encourage savings, investment, and the development of new technologies. Institutional structures that promote growth include strong property rights, patents, efficient financial institutions, education, and a competitive market system.
3. Because some nations have experienced nearly two centuries of modern economic growth while others have only recently begun to experience modern economic growth, some countries today are much richer than other countries.
4. It is possible, however, for countries that are currently poor to grow faster than countries that are currently rich because the growth rates of rich country GDPs per capita are limited to about 2 percent per year because, in order to continue growing, rich countries must invent and apply new technologies. By contrast, poor countries can grow much faster because they can simply adopt the institutions and cutting-edge technologies already developed by the rich countries.
5. The “ingredients” of economic growth to which we can attribute changes in growth rates include four supply factors (changes in the quantity and quality of natural resources, changes in the quantity and quality of human resources, changes in the stock of capital goods, and improvements in technology); one demand factor (changes in total spending); and one efficiency factor (changes in how well an economy achieves allocative and productive efficiency).
6. The growth of a nation's capacity to produce output can be illustrated graphically by an outward shift of its production possibilities curve.
7. Growth accounting attributes increases in real GDP either to increases in the amount of labor being employed or to increases in the productivity of the labor being employed. Increases in U.S. real GDP are mostly the result of increases in labor productivity. The increases in labor productivity can be attributed to technological progress, increases in the quantity of capital per worker, improvements in the education and training of workers, the exploitation of economies of scale, and improvements in the allocation of labor across different industries.
8. Over long time periods, the growth of labor productivity underlies an economy's growth of real wages and its standard of living. U.S. productivity rose by 2.7 percent annually between 1995 and 2007, compared to 1.4 percent annually between 1973 and 1995.
9. This recent productivity acceleration is based on (a) rapid technological change in the form of the microchip and information technology, (b) increasing returns and lower per-unit costs, and (c) heightened global competition that holds down prices.