The Reality of Economic Growth: History and Prospect

CHAPTER 5

QUESTIONS

What is modern economic growth?

What was the post-1973 productivity slowdown? What were its causes? Is the productivity slowdown now over?

Why are some nations so (relatively) rich and other nations so (relatively) poor?

What policies can speed up economic growth?

What are the prospects for successful and rapid economic development in tomorrow's world?

5.1 BEFORE MODERN ECONOMIC GROWTH

Before the Industrial Revolution

If we take the scattered and imperfect information we have about the global economy from the distant past to today, we see a pattern like that depicted in Table 5.1.

Until 1800 the growth rates of human populations were glacial. Population growth between 5000 B.C. and 1800 averaged less than one-tenth of a percent per year. (Nevertheless, the cumulative magnitude of population growth was impressive, carrying the number of human beings alive on the planet from perhaps 5 million in 5000 B.C. to 900 million in 1800 — 7000 years is a long time.) Until 1500, as best we can tell, there had been next to *no* growth in output per worker for the average human for millennia. Even in 1800 the average human had a material standard of living (and an economic productivity level) at best twice that of the average human in the year 1. The problem was not that there was no technological progress. There was. Humans have long been ingenious. Warrior, priestly, and bureaucratic elites in 1800 lived much better than their counterparts in previous millennia had lived. But just because the ruling elite lived better does not mean that other people lived any better.

Only after 1800 do we see large sustained increases in worldwide standards of living. After 1800 human numbers grew as the population explosion took hold. It carried the total population to 6 billion in October 1999. Population growth on a world scale accelerated from a rate of 0.2 percent per year between 1500 and 1800 to 0.6 percent per year between 1800 and 1900, 0.9 percent per year between 1900 and 1950, and 1.9 percent per year between 1950 and 1975 before the first slowing of the global rate of population growth — 1.6 percent per year from 1975 to 2000.

Average rates of material output per capita, which grew at perhaps 0.15 percent per year between 1500 and 1800, grew at roughly 1 percent per year worldwide between 1800 and 1900 and at an average pace of about 2 percent per year worldwide between 1900 and 2000, as Figure 5.1 shows.

TABLE 5.1
Economic Growth through Deep Time

Year	Population*	GDP per Capita†
–5000	5	$ 130
–1000	50	160
1	170	135
1000	265	165
1500	425	175
1800	900	250
1900	1625	850
1950	2515	2030
1975	4080	4640
2000	6120	8175

* Millions.

† In year-2000 international dollars.

Source: Joel Cohen, *How Many People Can the Earth Support?* (New York: Norton, 1995).

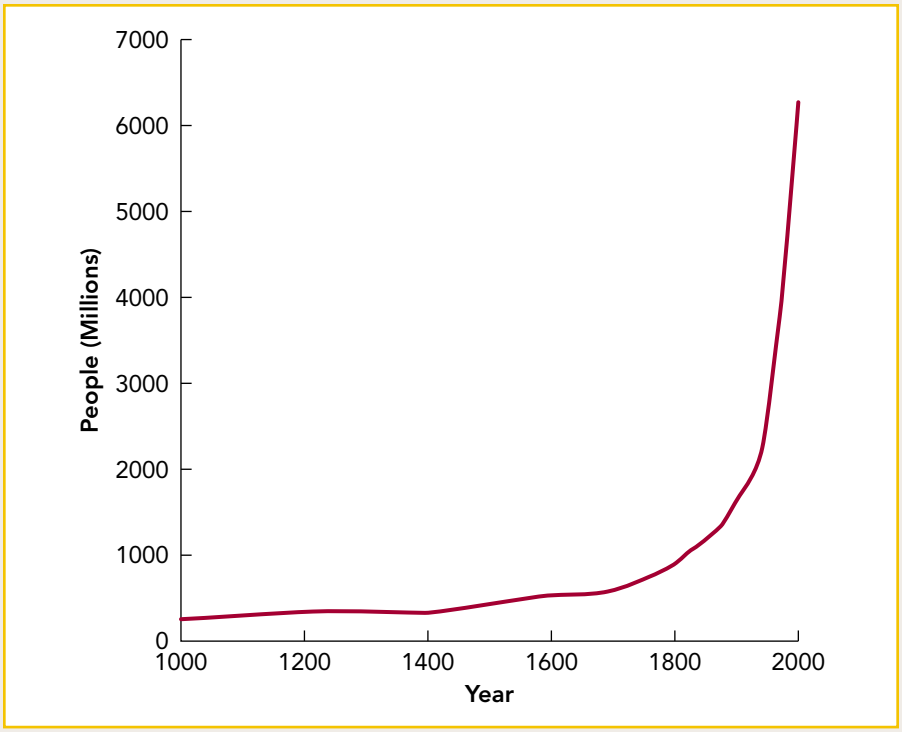


FIGURE 5.1
World Population Growth since 1000
The growth of human populations since 1800 is called, not surprisingly, the *population explosion.*

Source: Joel Cohen, *How Many People Can the Earth Support?* (New York: Norton, 1995); United Nations and Michael Kremer of MIT.

Premodern Economic "Growth"

Why were there no sustained increases in the material productivity of human labor before 1500? Because improved technology quickly ran aground on resource scarcity. As human populations grew, the stocks of known natural resources had to be divided among more and more people: Miners had to exploit lower-quality metal ores, farmers had to farm lesser-quality agricultural land, and forests vanished. Who alive today has ever seen one of the cedars of Lebanon? In spite of technological progress, resource scarcity meant that the efficiency of labor was little, if any, greater in A.D. 1500 than in 1500 B.C.

One of the oldest ideas in economics is that increases in technology inevitably run into natural-resource scarcity and so lead to increases in the numbers of people but not in their standard of living or productivity. This idea was introduced late into economics by Thomas R. Malthus, who was to become the first academic professor of economics (Adam Smith had been a professor of moral philosophy) at the East India Company's Haileybury College.

Malthus saw a world in which inventions and higher living standards led to increases in the rate of population growth. With higher living standards women ovulated more frequently, and more pregnancies were successfully carried to term. Better-nourished children (and adults) had a better chance of resisting diseases. Moreover, when incomes were high, new farmsteads were relatively plentiful, and getting the permission of one's father or elder brother to marry was easier. For these reasons, both social and biological, a higher standard of living before 1800 led to a

faster rate of population increase. And the faster rate of population growth increased natural-resource scarcity and lowered productivity until once again people were so poor and malnourished that population growth was roughly zero.

The End of the Malthusian Age

Technology

We clearly no longer live in a **Malthusian age.** For at least 200 years improvements in the efficiency of labor made possible by new technologies and better organizations have *not* been neutralized by natural-resource scarcity. (But a Malthusian age may return: Project twentieth-century population growth rates forward and calculate that the year 2200 population of the earth will be 93 billion; it requires skill and ingenuity to argue today that **resource scarcity** will not be a dominant feature of such a world).

What caused the end of the Malthusian age? How did humanity escape from the trap in which invention and ingenuity increased the numbers but not the material well-being of humans?

The key is that even in the Malthusian age the pace at which inventions occurred increased steadily. First of all, the population grew. Inventions made communication easier; especially after the invention of printing, knowledge could spread widely and quickly. More people meant more inventions: Two heads are greater than one. The rate of technological progress slowly increased over the millennia. By about 1500 it passed the point at which **natural-resource scarcity** could fully offset it. Sustained increases not just in population but in the productivity of labor followed.

The Demographic Transition

At first the rise in material standards of living brought sharp increases in the rate of population growth: the population explosion. But as material standards of living rose far above subsistence, countries began to undergo the **demographic transition,** sketched out in Figure 5.2.

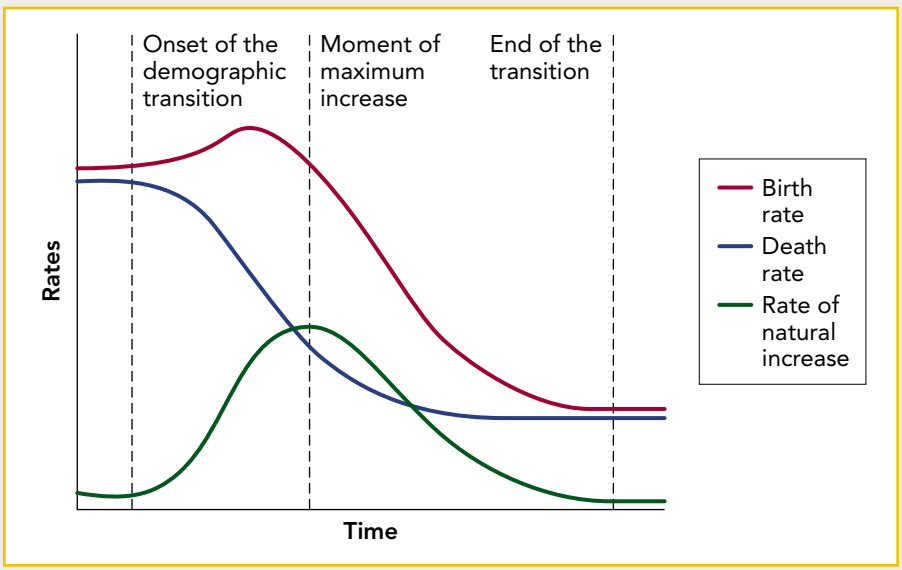


FIGURE 5.2
Stylized Picture of the Demographic Transition
The demographic transition sees, first, a rise in birth rates and a sharp fall in death rates as material standards of living increase above subsistence levels. But after a while birth rates start to decline rapidly too. The end of the demographic transition sees both birth and death rates at a relatively low level and the population nearly stable.

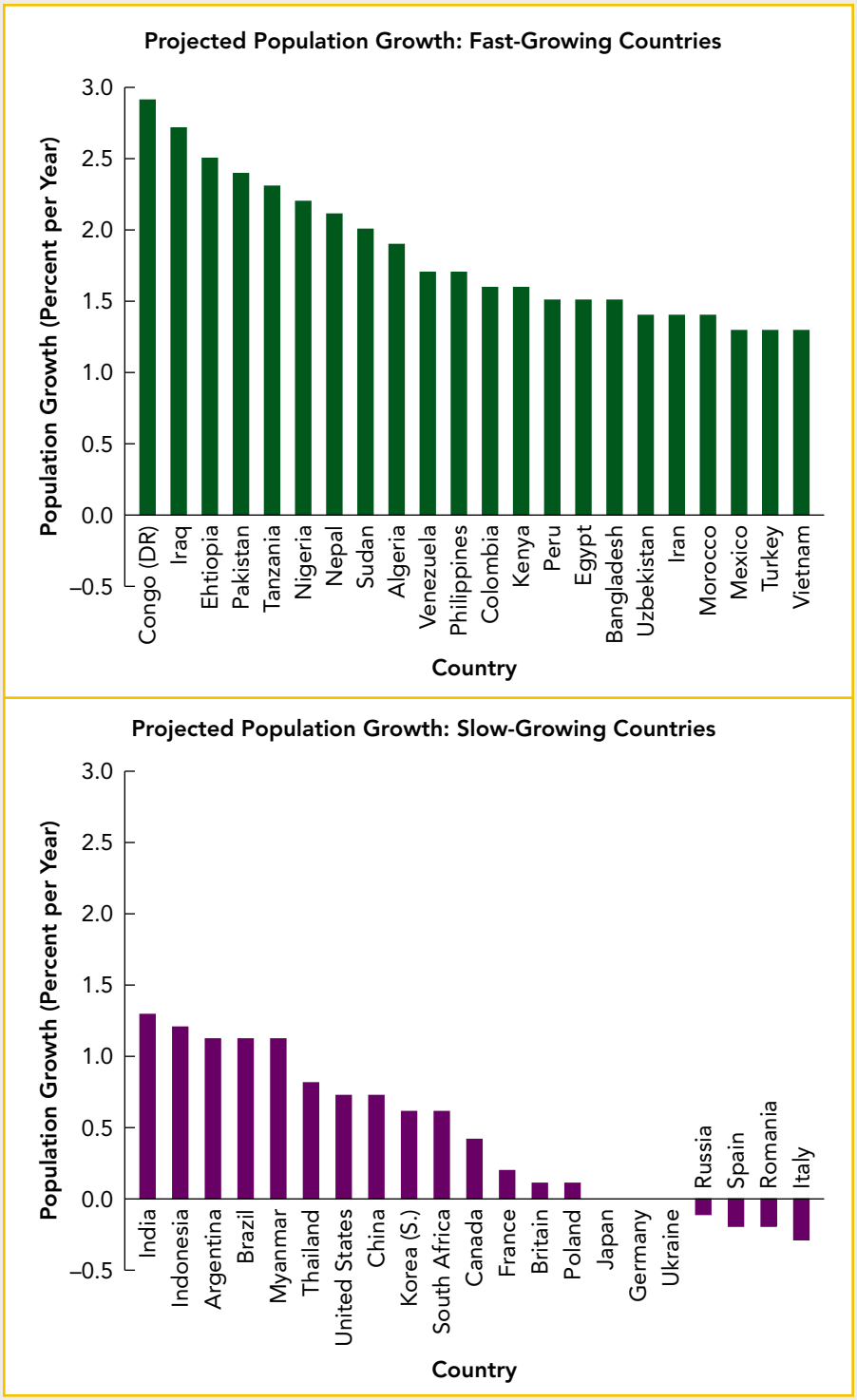


FIGURE 5.3
Expected Population Growth Rates, 1997–2015

The population of India is projected to grow at 1.3 percent and that of China at 0.7 percent per year over the next generation. Demographers today believe that the world population has at most one more doubling to undergo before the demographic transition will have taken hold throughout the world.

Source: United Nations.

Birth control meant that those who did not wish to have more children could exercise their choice. Parents began to find more satisfaction in having a few children and paying a great deal of attention to each. The resources of the average household continued to increase, but the number of children born fell. The long-run relationship between levels of productivity and population growth rates was not — as Malthus thought — a spiral of ever-faster population growth rates as material standards of living increased. Instead, population growth rates peaked and began to decline.

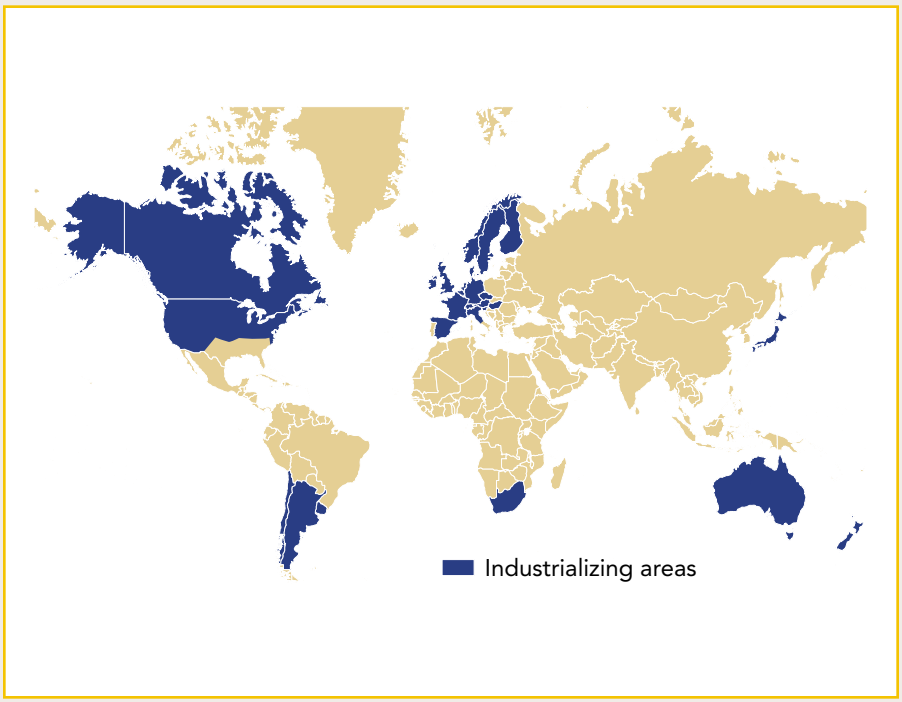
In the world today not all countries have gone through their demographic transitions. Many countries are not rich enough to have begun the population growth declines seen in the second half of the demographic transition. Countries such as Nigeria, Iraq, Pakistan, and the Congo are currently projected to have population growth rates in excess of 2 percent per year over the next generation, as Figure 5.3 shows. But there is also a large group of developing countries like Thailand, China, Korea, and South Africa in which population growth over the next generation is projected to be less than 1 percent per year. And in the industrialized countries — like Japan, Italy, and Germany — populations are projected to stay nearly the same over the next generation.

The Industrial Revolution

The century after 1750 saw the **Industrial Revolution** proper: the invention of the steam engine, the spinning jenny, the power loom, the hydraulic press, the railroad locomotive, the water turbine, and the electric motor, as well as the hot-air balloon, gas lighting, photography, and the sewing machine. But the Industrial Revolution

FIGURE 5.4
Industrialized Areas of the World, 1900

Perhaps the most important lesson to draw from this short look at economic history is that economists' standard growth models apply to a relatively narrow slice of time. For instance, the growth model discussed in Chapter 4 does not illuminate very much regarding the period before 1800, yet it is very useful in analyzing what has happened over the past two centuries, as well as what is going on today with respect to the growth of different national economies.



Source: Steven Dorwick and J. Bradford DeLong, "Globalization and Convergence," in Jeffrey Williamson et al., eds. *Globalization in Historical Perspective* (Chicago: University of Chicago Press, forthcoming).

was not just a burst of inventions. It was an economic transformation that revolutionized the *process* of invention as well. Since 1850 the pace of invention and innovation has further accelerated: steel making, the internal combustion engine, pasteurization, the typewriter, the cash register, the telephone, the automobile, the radio, the airplane, the tank, the limited-access highway, the photocopier, the computer, the pacemaker, nuclear weapons, superconductivity, genetic fingerprinting, and the human genome map. The coming of the Industrial Revolution marked the beginning of the era of modern economic growth: the era in which it was expected that new technological leaps would routinely revolutionize industries and generate major improvements in living standards.

The fact that Britain was the center of the Industrial Revolution meant that for a century, from 1800 to 1900, British levels of industrial productivity and British standards of living were the highest in the world. It also meant that English (rather than Hindi, Mandarin, French, or Spanish) became the world's de facto second language. But the technologies of the Industrial Revolution did not remain narrowly confined to Britain. Their spread was rapid to western Europe and the United States. It was less rapid — but still relatively thorough and complete — to southern and eastern Europe and, most interesting perhaps, Japan, as shown in Figure 5.4.

RECAP BEFORE MODERN ECONOMIC GROWTH

Up until 1800 human populations grew very slowly, and human living standards were stagnant. After 1800 we see sustained rises in living standards. And after 1800 human numbers grew as the population explosion took hold and carried our total population to 6 billion in October 1999. At first the rise in material standards of living brought sharp increases in the rate of population growth: The population explosion. But as material standards of living rose far above subsistence, countries began to undergo the *demographic transition,* population growth rates peaked, and began to decline toward stability.

5.2 MODERN AMERICAN ECONOMIC GROWTH

Before 1500 human material standards of living and productivity levels rose at perhaps 0.01 percent per year. Between 1500 and 1800 they rose faster in the areas that were to become the industrial core of the modern world economy — first northwestern Europe and then northwestern Europe's settler colonies in North America — rising at a rate of perhaps 0.2 percent per year. The first half of the nineteenth century saw leading-edge economies' levels of productivity rise at about 0.5 percent per year, and the second half of the century saw productivity accelerate still further.

American Long-Run Growth, 1800–1973

The Pace of Economic Growth

Focus on the pace of long-run growth in what has been the world's leading-edge economy for the past 100 years: the United States. Growth in the years before and after the Civil War was faster than it had been in the first half of the nineteenth century. It accelerated still further as a second wave of industrialization took hold,

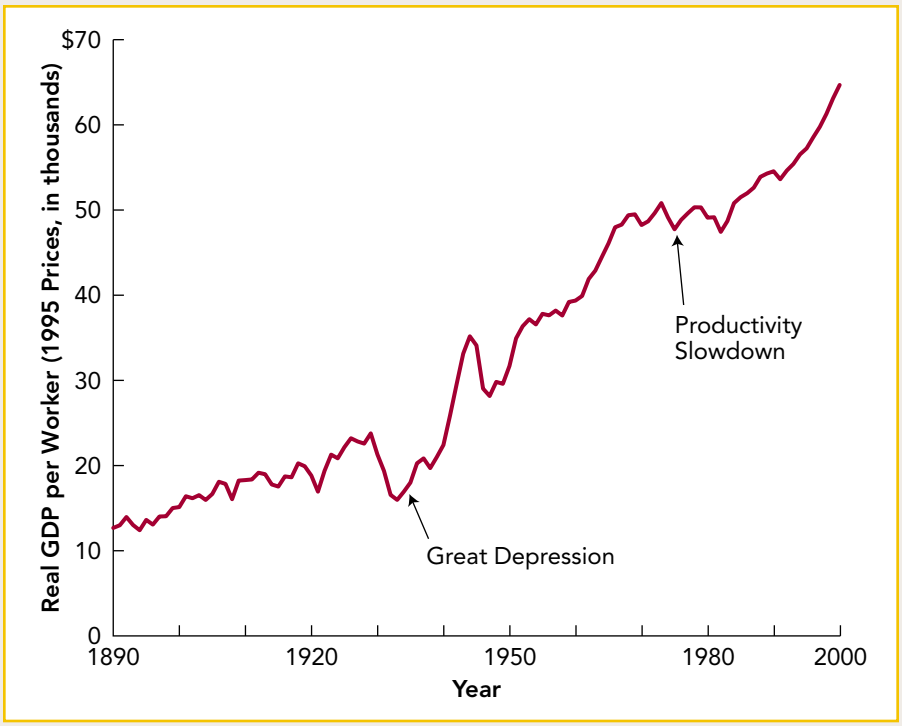
fueled by new inventions and innovations such as steel making, organic chemicals manufacture, oil, the internal combustion engine, pasteurization, the typewriter, the cash register, and the telephone. The accelerated pace of invention and economic growth has been maintained ever since.

Throughout the nineteenth century and the first three-quarters of the twentieth century the *measured* pace of **productivity growth** continued to accelerate. The measured growth rate of output per worker rose from perhaps 0.5 percent per year between 1800 and 1870 to about 1.6 percent per year between 1870 and 1929, on the eve of the Great Depression, as is shown in Figure 5.5. Growth slowed slightly during the Great Depression and World War II decades — a measured growth rate of 1.4 percent per year from 1929 to 1950. But then it accelerated: The growth rate of output per worker between 1950 and 1973 in the United States was 2.1 percent per year.

Moreover, it is likely that *true* output-per-worker growth since 1870 has been even faster. Many economists believe that official estimates overstate inflation and understate real economic growth by 1 percent per year, in large part because national income accountants have a very hard time valuing the boost to productivity and standards of living generated by the invention of new goods and services. So for the rate of output per worker growth since 1870, perhaps we should be thinking of 2 to 2.5 percent per year instead of 1.5 percent per year.

If so, then those of us living in the United States today have a level of productivity — a material standard of living — somewhere between 14 and 25 times that of

FIGURE 5.5
U.S. Measured Economic Growth: Real GDP per Worker 1995 Prices, 1890–1995
With the exception of the Great Depression of the 1930s and the productivity slowdown period of the 1970s and 1980s, measured real GDP per worker in the United States has grown steadily with only minor interruptions.



Source: Author's calculations from the 2001 edition of *The Economic Report of the President* (Washington, DC: Government Printing Office) and from *Historical Statistics of the United States* (Washington, DC: Government Printing Office, 1975).

TABLE 5.2
Labor-Time Costs of Commodities, 1895–1997

Commodity	Time to Earn (Hours)*		Productivity Multiple
	1895	1997	
Horatio Alger books (6 vols.)	21.0	0.6	35.0
One-speed bicycle	260.0	7.2	36.1
Cushioned office chair	24.0	2.0	12.0
100-piece dinner set	44.0	3.6	12.2
Hairbrush	16.0	2.0	8.0
Cane rocking chair	8.0	1.6	5.0
Solid gold locket	28.0	6.0	4.7
Encyclopedia Britannica	140.0	4.0	35.0
Steinway piano	2400.0	1107.6	2.2
Sterling silver teaspoon	26.0	34.0	0.8
Oranges (dozen)	2.0	0.1	20.0
Ground beef (1 lb.)	0.8	0.2	4.0
Milk (1 gal.)	2.0	0.25	8.0
Television	∞	15.0	∞
Plane ticket: SFO-BOS	∞	20.0	∞
Antibiotic strep-throat cure	∞	1.0	∞
Dental x-ray	∞	2.0	∞
Laptop computer	∞	70.0	∞

* Time needed for an average worker to earn the purchase price of the commodity.

Source: 1895 Montgomery Ward catalogue.

our counterparts in the late nineteenth century. For middle-class and richer consumers today such an estimate does not seem at all unreasonable. It takes only one-eighth as much time to earn the money to buy a hairbrush, one-twelfth as much time to earn the money to buy a chair, and one-thirty-fifth as much time to earn the money to buy a book today as it did in 1895 (see Table 5.2). And in 1895, no matter how long you worked, you couldn't earn enough money to buy a plane ticket, a TV, a portable CD player, a laptop computer, an automatic washing machine, an electric blender, or a microwave oven.

For the relatively poor of the world, or even of the United States, it is not reasonable to say that their incomes and material standards of living have multiplied to so great an extent. An invention or innovation has no effect on people's material standard of living if they cannot afford to acquire it.

Structural Change

Modern economic growth is also a shift in the kinds of things we do at work and play and in the way we live. In the immediate aftermath of the Civil War perhaps half of all Americans were farmers. Today less than 2 percent of American workers are farmers and farm laborers: There are more gardeners, groundskeepers, and growers and maintainers of ornamental plants in the United States today than there are food-growing farmers and farm laborers. In the second half of the nineteenth century

Americans traveled by foot, horse, wagon, train, and riverboat; at the end of the twentieth century, they traveled by foot (rarely), bicycle (rarely), automobile, bus, train, boat, and plane. Most Americans in the second half of the nineteenth century were literate, but very few had finished anything equivalent to today's high school. Modern economic growth is the large-scale shift of employment from agriculture to manufacturing and now to services. And it is the creation of large business organizations. At the start of the nineteenth century, a business with 100 people was a very large organization for its time.

Between approximately 1890 and 1930, or perhaps 1890 and 1950, a host of innovative technologies and business practices were adopted in the United States. Europeans speak of "Fordism": taking the part — Henry Ford's assembly lines in Detroit and his mass production of the Model-T Ford — for the whole. The fact that other industrial economies were unable to fully adopt American technologies of mass production and mass distribution in the first half of the twentieth century gave the United States a unique level of industrial dominance and technological leadership in the years after 1950.

Three main factors explain America's position at the leading edge of technology in the world economy throughout the twentieth century:

- *The United States had an exceptional commitment to education* — to schooling everyone (everyone who was white, that is; and boys more than girls) even in the largely rural economy of the nineteenth century and to making the achievement of a high school diploma the rule rather than the exception in the cities of the early twentieth century.
- *The United States was of extraordinarily large size* — the largest market in the world. Thus the nation could take advantage of potential economies of scale in ways that other, smaller economies could not match.
- *The United States was extraordinarily rich in natural resources,* particularly energy. To the extent that energy-intensive and natural-resource-intensive industries were at the heart of early-twentieth-century industrial growth, the U.S. was again well-positioned.

American Economic Growth Since 1973

The Productivity Growth Slowdown

In 1973 the steady trend of climbing rates of productivity growth stopped cold. Between 1973 and 1995 *measured* growth in output per worker in the U.S. economy grew at only 0.6 percent per year. The slowdown did not affect the U.S. economy alone: It hit — to different degrees and with different effects — the other major economies of the world's industrial core in western Europe, Japan, and Canada as well (see Table 5.3).

What caused the **productivity slowdown**? Observers have pointed to four factors — oil prices, the baby boom, increased problems of economic measurement, and environmental protection expenditures — and there are no doubt others.

The argument that the productivity slowdown can be explained by expenditures on environmental protection is a branch of the "problems-of-measurement" argument. When the price of electricity goes up because power companies switch to burning higher-priced low-sulfur coal or install sulfur-removing scrubbers in their chimneys, they are producing not just electric power but electric power plus cleaner air. But the NIPA does not count pollution reduction as a valued economic output.

TABLE 5.3
The Magnitude of the Post-1973 Productivity Slowdown in the G-7 Economies

	Output-per-Worker Annual Growth (%)	
Country	**1950–1973**	**1973–1995**
United States	2.1	0.6
Canada	2.7	1.6
Japan	7.4	2.6
Britain	2.4	1.8
Germany (West)	5.7	2.0
France	4.4	1.5
Italy	4.9	2.3

Source: Author's calculations from the 2001 edition of *The Economic Report of the President* (Washington, DC: Government Printing Office).

America has spent a fortune on environmental protection in the past generation, and has in gross received big benefits from this investment, but the gains aren't included in measured GDP.

The argument that the productivity slowdown can be explained by problems of economic measurement is a bit subtle. Few doubt that these problems lead to understatements of the rate of economic growth. But to account for a *slowdown* in economic growth, the problems of measurement must have gotten *worse*. They must be worse now than they were three decades ago.

In the 1970s the baby-boom generation of Americans began to enter the labor force. This generation is very large. I should know: I was born in 1960, the year in which more Americans were born than in any year either before or since. The relatively young labor force had many more workers with little experience than did the labor force of the 1960s and 1950s. Some economists argue that this fall in the average level of labor-force experience generated the productivity slowdown. Others point out that the baby-boom generation had little experience but a lot of education and that in the past education had been a powerful *booster* of productivity. The average level of education in the labor force increased quite rapidly as the baby-boom generation entered the economy.

The last explanation of the productivity slowdown is the tripling of world oil prices by the OPEC cartel in 1973, in the wake of the third Arab-Israeli war. Productivity growth slowed at almost exactly the same time that oil prices skyrocketed. Economists hypothesized that in response to the tripling of world oil prices firms began redirecting their capital expenditures from capital that produced more output to capital that used less energy; firms retired a large share of their most energy-intensive capital and began to substitute workers for energy use wherever possible.

The problem with this explanation is twofold. First, since 1986 real oil prices have been *lower* than they were before 1973; hence the productivity slowdown should have ended a decade ago. Second, energy costs are not *that* large a share of the typical business's costs. By now the productivity slowdown has mounted to more than one-quarter of total output. How can even the tripling of the price of a commodity that accounts for less than 4 percent of costs lead to a more than 25 percent reduction in output? This makes no sense.

The causes of the productivity slowdown remain uncertain, and the slowdown itself remains a mystery.

Effects of the Productivity Slowdown

At a growth rate of 2.1 percent per year, output per worker doubles every 34 years. At a growth rate of 0.6 percent per year, output per worker takes 120 years to double — three and a half times as long. Social psychologists tell us that 40-year-olds feel happiest not when their incomes are high but when their incomes are high relative to those of their households when they were growing up. Before 1973, when economic growth was more rapid, most American voters felt much richer than their parents and hence were more willing to invest in social welfare programs and other liberal political initiatives. Since 1973, slower growth has made Americans feel much less well off than they had expected they would be. It is clear that growth slowed sharply as a result of the productivity slowdown. But it is not clear whether growth stopped for large numbers of Americans. Box 5.1 analyzes what we know about the

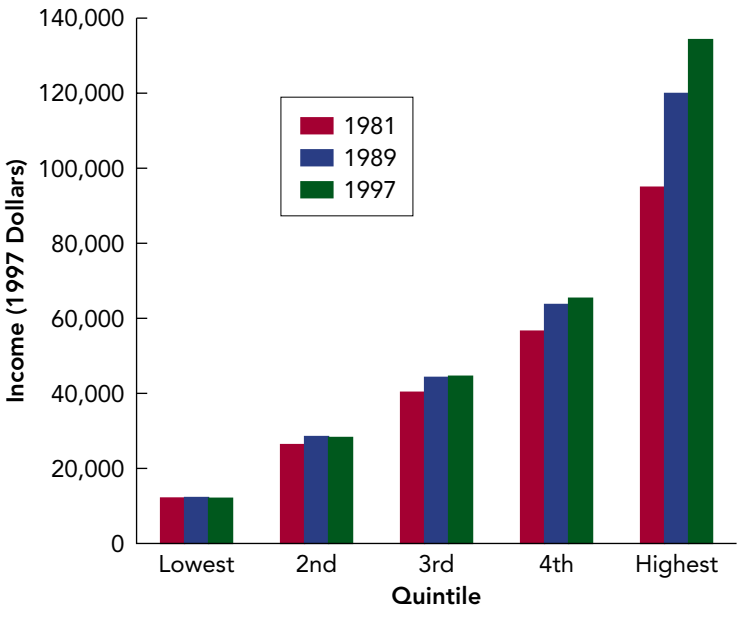
BOX 5.1

HAVE REAL STANDARDS OF LIVING BEEN DECLINING? THE DETAILS

For some categories of workers (such as males in their twenties with just a high school education), the post-1973 productivity slowdown has been accompanied by stagnant or declining real wages. Yet offsetting this are many improvements in the

FIGURE 5.6

Measured Real Mean Household Income, by Quintile The era of the productivity slowdown saw not just slow growth but a widening of the American distribution of income.



Source: Economic Policy Institute, www.epinet.org/.

quality of life — from cleaner air to the convenience of automated teller machines — that the NIPA system cannot measure. If we accept the Boskin Commission estimates of unmeasured growth in material well-being that centered around 1 percent per year, then true total product-per-worker growth in the United States has slowed not to the 0.6 percent per year recorded in official statistics for 1973–1995 but to 1.6 percent per year.

This is still a substantial drop from the estimated 3.1 percent per year that the same adjustment produces for growth before 1973. And increased income inequality has produced declines in real income or near stagnation for some groups (see Figure 5.6). But it is not true that America's output per worker has stagnated over the past generation. Whether we as a society have distributed the gains in productivity to persons and households and to private and public uses wisely and appropriately — that is another question.

"true" pace of economic growth during the productivity slowdown. The consequences of this are uncertain: Former president Jimmy Carter saw it as the origin of a national "malaise." Liberals have blamed it for a rightward shift in politics. Conservatives have blamed it for a rush to security and an unwillingness to undertake bold libertarian experiments. All have seen it as a cause of more (not necessarily unjustified) skepticism toward the government and its programs.

The End of the Productivity Slowdown

As computers improved and spread throughout the U.S. economy in the 1970s and 1980s, economists kept waiting to see the wonders of computing show through in national productivity. But that didn't happen. The productivity growth slowdown continued throughout the 1970s and 1980s. This surprising phenomenon came to be called the "computer paradox" after Robert Solow's famous 1987 observation: "We see the computer age everywhere except in the productivity statistics."

Since 1995, however, productivity growth in the American economy has accelerated once again to a pace of 2.1 percent per year. Half a decade is a very short time on which to pin any long-run trend, but there is certainly reason to hope that the productivity slowdown has come to an end.

The U.S. economy has benefited from a stunning investment boom since 1992. Between 1992 and 1998 real GDP rose by an average of 3.6 percent per year, and business fixed investment soared at a 10.1 percent average rate — almost three times as fast. As a consequence, the share of business fixed investment in GDP jumped from 9.2 percent to 13.2 percent, with much of the additional investment going into computers and related equipment. At least one major economic forecasting business attributes the recent acceleration in productivity growth to this investment boom, a huge share of which is driven by the rapidly falling price of computers.

There is every reason to expect that technological progress in the computer and communications sectors will continue, and there is every reason to expect that these useful technologies will continue to diffuse throughout the economy. Thus the best bet in forecasting future productivity growth is to make future projections on the basis of what has happened in the past half-decade. If these projections are accurate, then the productivity slowdown has been brought to an end, and it is the technological revolution in computers and communications that has ended it. But that is a subject for the end of this book.

RECAP MODERN AMERICAN ECONOMIC GROWTH

Over the past two centuries measured economic growth in the United States has raised output per worker at an average pace of between 1.5 and 2.0 percent per year. Moreover, it is likely that *true* output per worker growth since 1890 has been even faster. Many economists believe that official estimates overstate inflation and understate real economic growth by 1.0 percent per year, in large part because national income accountants have a very hard time valuing the boost to productivity and standards of living generated by the invention of new goods and services, and new types of goods and services.

Accompanying this increase in productivity and living standards is structural change: The move from the country to the city, the large-scale shift of employment from agriculture to manufacturing and now to services, and the creation of large business organizations. Starting in 1973 the steady trend of climbing rates of productivity growth stopped cold: Between 1973 and 1995 measured growth in output per worker in the U.S. economy grew at only 0.6 percent per year. Since 1995, however, productivity growth in the American economy has accelerated once again to a pace of 2.1 percent per year, the result of an investment boom, the rapidly-falling prices of data processing and data communications equipment, and technological advances.

5.3 MODERN ECONOMIC GROWTH AROUND THE WORLD

Divergence, Big Time

The industrial core of the world economy saw its level of material productivity and standard of living explode in the nineteenth and twentieth centuries. Elsewhere the growth of productivity levels and standards of living and the spread of industrial technologies were slower. As the industrialized economies grew while industrial technologies spread slowly elsewhere, the world became a more and more unequal place. As development economist Lant Pritchett puts it, the dominant feature of world economic history is "**divergence**, big time." In terms of relative incomes and productivity levels, the world today is more unequal and more *divergent* than ever before, as Figure 5.7 shows.

Those who live in relatively poor regions of the world today have higher material living standards than did their predecessors who lived in those regions a century ago. But the relative gap vis-à-vis the industrial core has grown extraordinarily and extravagantly. In the first half of the nineteenth century the average inhabitant of an average country had perhaps one-half the material standard of living of a citizen of the world's leading industrial economy. Today the average inhabitant of an average country has only one-sixth the material standard of living and productivity level of the leading nation. (Box 5.2 provides some insight into the difficulties of making such comparisons.)

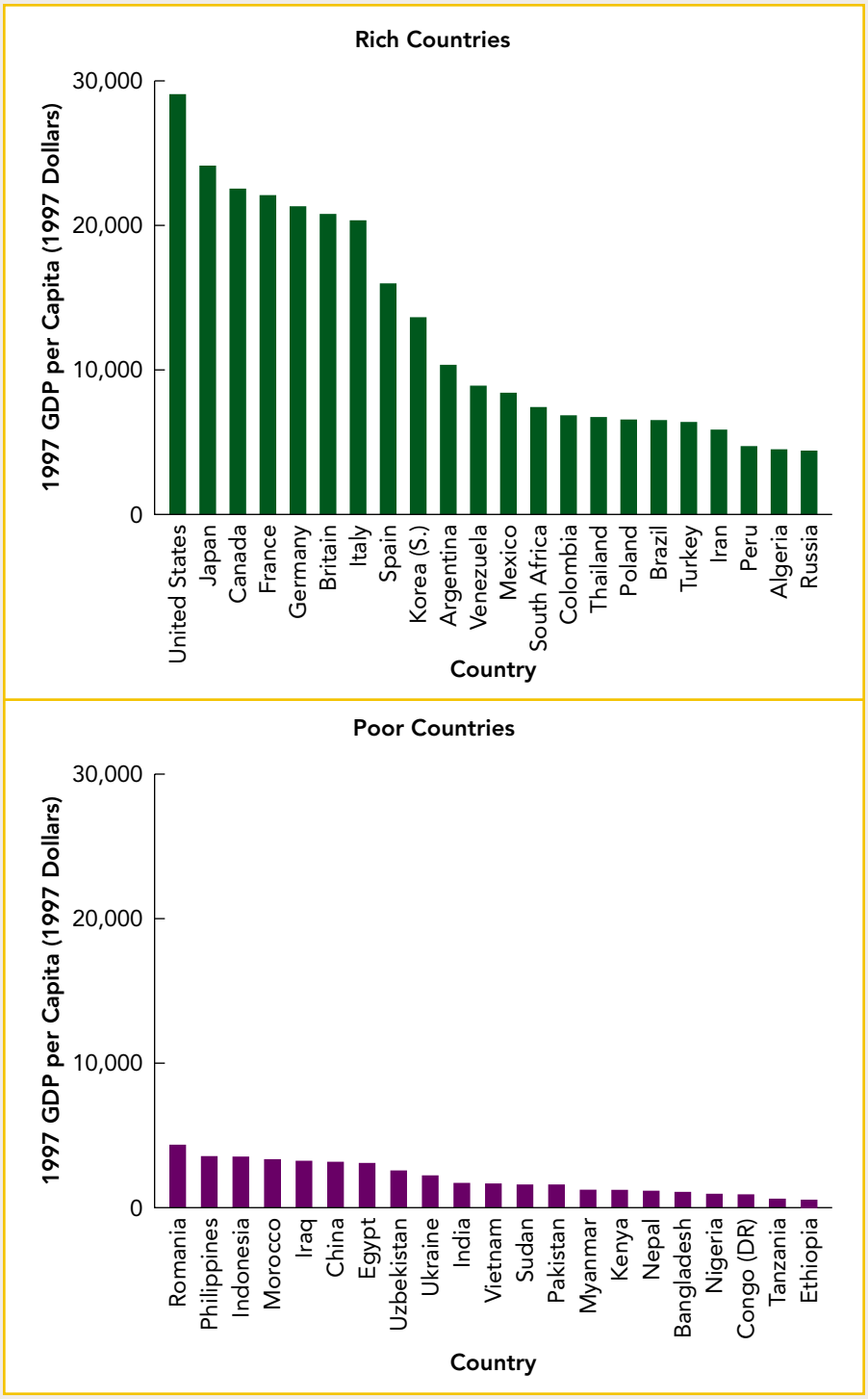


FIGURE 5.7
World Distribution of Income, Selected Countries

In some places modern economic growth has taken hold and propelled levels of productivity and living standards upward. In other places people on average live little, if any, better than their ancestors did. The world is a more unequal place, in relative income terms, than it has been since there were some human tribes that had fire and others that did not.

Source: Author's calculations from Alan Heston's and Robert Summer's Penn World Table, www.nber.org.

BOX 5.2

PURCHASING-POWER-PARITY AND REAL EXCHANGE RATE COMPARISONS: SOME TOOLS

When our focus is on comparing standards of living, either across time or across countries, we get much more meaningful figures by correcting current (and even average trend) exchange rates for differences in *purchasing power parity (PPP)*. The differences between estimates of relative income levels based on current exchange rates and estimates based on PPP calculations can be very large. On a purchasing-power-parity basis GDP per worker in the United States today is some 13 times GDP per worker in India; by contrast, on an average exchange rate basis GDP per worker in the United States today is more than 70 times the level in India.

PPP-based calculations attempt (as the name applies) to translate one currency into another at a rate that preserves average purchasing power. But current exchange rates do not preserve purchasing power. If you exchange your dollars in the United States for rupees in India you will find that your rupees in India will buy about the same amount of internationally traded manufactured goods as your dollars would have bought in the United States. (Unless, of course, you try to buy something that the Indian government has decided to put up a trade barrier against.) But your rupees in India will buy you vastly more in the way of personal services, the products of skilled craftspeople, and any other labor-intensive goods and services.

Why? International arbitrage keeps the exchange rate at the level that makes easily traded manufactured goods roughly equally expensive. If they weren't, someone could make an easy fortune by shipping them from where they were cheap to where they were dear. But how — in this world of stringent immigration restrictions — can a cook in Bangalore take advantage of the fact that there is fierce demand in Marin County, north of San Francisco, for caterers who can prepare a good curry? Because relative productivity levels in labor services are much more equal than relative productivity levels in manufacturing, living standards throughout the world are more equal than exchange rate–based calculations suggest.

The Exception: OECD Economies

It is not inevitable that there be such divergence. The United States — with its 14- to 25-fold increase in output per worker over the years since 1870 — has not been the fastest-growing economy in the world. A number of other economies at different levels of industrialization, development, and material productivity a century ago have now *converged,* and their levels of productivity, economic structures, and standards of living today are very close to those of the United States (see Box 5.3). The six largest of these converging economies and the United States make up the so-called Group of Seven, or G-7, economies, whose leaders gather for annual summit meetings. The six non-U.S. members' steady process of convergence to the U.S. level from 1950 until 1990 is shown in Figure 5.8.

Most of these economies were significantly poorer than the United States in 1870 and even in 1950. The Japanese economy, for example, went from a level of output per capita equal to 16 percent of the U.S. level in 1950 to 84 percent of the U.S. level in 1992 — before falling steeply backward during Japan's recent recession. Italian levels of GDP per capita have gone from 30 to 65 percent of the U.S. level; German

WHY HAVE THESE ECONOMIES CONVERGED?: A POLICY

BOX 5.3

By and large the economies that have converged are those that belong to the Organization for Economic Cooperation and Development (OECD), which was started shortly after World War II, in the days of the Marshall Plan, as a group of countries that received (or gave) Marshall Plan aid to help rebuild and reconstruct after the war. Countries that received Marshall Plan aid adopted a common set of economic policies: large private sectors freed of government regulation of prices, investment with its direction determined by profit-seeking businesses, large social insurance systems to redistribute income, and governments committed to avoiding mass unemployment.

The original OECD members all wound up with mixed economies. In these, markets direct the flow of resources, while governments stabilize the economy, provide social insurance safety nets, and encourage entrepreneurship and enterprise. The member nations arrived at this setup largely due to good luck, partly due to the Cold War, and partly as a result of post-World War II institutional reforms.

This configuration was essentially the price countries had to pay for receiving Marshall Plan aid. The U.S. executive was unwilling to send much aid to countries that it thought were likely to engage in destructive economic policies, largely because it did not believe that it could win funding from the Republican-dominated Congress for a Marshall Plan that did not impose such strict *conditionality* upon recipients. By contrast, countries that were relatively rich after World War II but did not adopt OECD-style institutional arrangements — such as Argentina and Venezuela — lost relative ground.

As the OECD economies became richer, they completed their demographic transitions: Population growth rates fell. The policy emphasis on entrepreneurship and enterprise boosted national investment rates, so the OECD economies all had healthy investment rates as well. These factors boosted their steady-state capital-output ratios. And the diffusion of technology from the United States did the rest of the job in bringing OECD standards of economic productivity close to the U.S. level.

levels, from 40 to 75 percent; Canadian levels, from 70 to 85 percent; and British levels, from 60 to 70 percent in the past half-century. Moreover, as Box 5.4 shows, the East Asian economies have also "conversed."

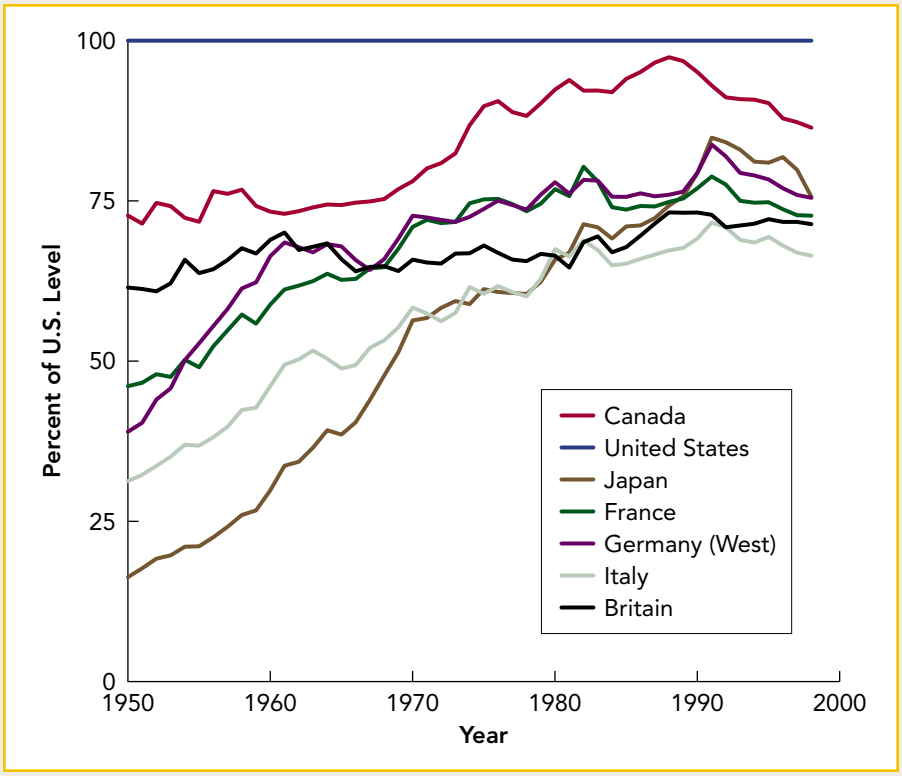
The Rule: Divergence behind the Iron Curtain

But convergence is the exception. Divergence is the rule. And perhaps the most important driving force behind divergence is communism: Being unlucky enough to have been ruled by communists in the twentieth century is a virtual guarantee of relative poverty.

There used to be a snaky geographic line across Eurasia that Winston Churchill had once called the "Iron Curtain." On one side were regimes that owed their allegiance to Karl Marx and to Marx's viceroys on earth. On the other side were regimes that claimed, in the 1946–1989 Cold War, to be of the "free world" — regimes that were, if not good, at least less worse. Walk this geographic line, shown in Figure 5.9, from Poland to Korea and then hop over to the only Western hemisphere communist satellite — Cuba — looking first left at the level of material welfare in the communist

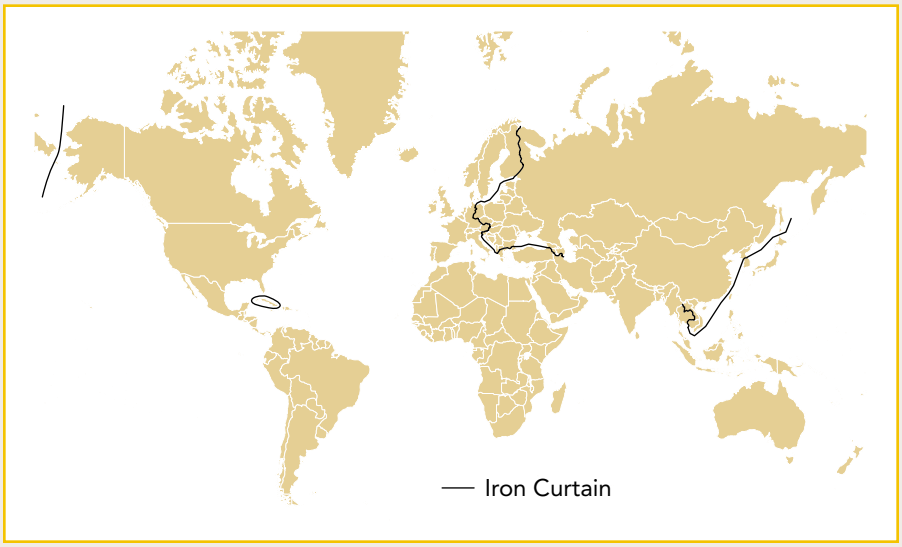
FIGURE 5.8
Convergence among the G-7 Economies: Output per Capita as a Share of U.S. Level

In 1950 GDP per capita levels in the six nations that now are America's partners in the G-7 varied from 20 percent of the U.S. level (Japan) to 70 percent of the U.S. level (Canada). Today estimates of GDP per capita place levels in all six at more than 65 percent of the U.S. level — and they would be even closer to the U.S. level if the measurements took account of the shorter average work year abroad.



Source: Author's calculations.

FIGURE 5.9
The Iron Curtain



THE EAST ASIAN MIRACLE: A POLICY

The story of extraordinarily successful economies goes beyond the original OECD nations. The economies of the "East Asian miracle" have over the past two generations exhibited stronger growth than has ever before been seen anywhere in the world. They have not yet converged to the standards of living and levels of economic productivity found in the world economy's industrial core, but they are converging.

Immediately before World War II the regions that are now South Korea, Hong Kong and Singapore, and Taiwan had output-per-worker levels less than one-tenth the level of the United States. Today Singapore's GDP per capita is 90 percent, Hong Kong's is 70 percent, Taiwan's is 50 percent, and South Korea's is 45 percent of the U.S. level. A second wave of East Asian economies — Malaysia and Thailand — now average more than one-quarter of the U.S. level of GDP per capita.

The successful East Asian economies share a number of similarities with the OECD economies in terms of economic policy and structure. Resource allocation decisions are by and large left to the market. Governments regard the encouragement of entrepreneurship and enterprise as a major goal. And high savings and investment rates are encouraged by a number of different government policies.

Yet there are also a number of differences vis-à-vis the OECD. Governments in East Asia have been more aggressive in pursuing *industrial policy* and somewhat less aggressive in establishing social insurance systems than have the OECD economies. However, they have also had more egalitarian income distributions and hence less need for redistribution and social insurance. They have subsidized corporations that they believe are strategic for economic development, thinking that their bureaucrats know better than the market — heresy to economists. (However, it is worth noting that they have focused subsidies on the companies that have proved successful at exporting goods to other countries, so their bureaucrats have in a sense been rewarding the judgment of *foreign* markets.) The examples of successful catching up suggest that growth could have been faster in the world economy. Economies — even very poor ones — *can* rapidly adopt modern machine technologies and move their productivity levels close to first-world leading-edge standards.

countries and then right at the level of material welfare in the noncommunist countries. The location of the Iron Curtain is a historical accident: It is where Stalin's Russian armies stopped after World War II, where Mao's Chinese armies stopped in the early 1950s, and where Giap's Vietnamese armies stopped in the mid-1970s.

Notice as you walk that to your right, outside the Iron Curtain, the countries are far better off in terms of GDP per capita (see Table 5.4). They are not necessarily better off in education, health care, or the degree of income inequality. If you were in the poorer half of the population, you probably received a better education and had access to better medical care in Cuba than in Mexico. But the countries fortunate enough to lie outside what was the Iron Curtain were and are vastly more prosperous. Depending on how you count and how unlucky you are, 40 and 94 percent of the potential material prosperity of a country was annihilated if it happened to fall under communist rule in the twentieth century. The fact that a large part of the globe was under Communist rule in the twentieth century is one major reason for the world's *divergence*. A failure to successfully aid post-Communist economies

TABLE 5.4
The Iron Curtain: GDP-per-Capita Levels of Matched Pairs of Countries

East-Bloc Country	GDP per Capita	Matched West-Bloc Country	GDP per Capita	Relative Gap (%)
North Korea	$ 700	South Korea	$13,590	94
China	3,130	Taiwan	14,170	78
Vietnam	1,630	Philippines	3,520	54
Cambodia	1,290	Thailand	6,690	81
FSR Georgia	1,960	Turkey	6,350	69
Russia	4,370	Finland	20,150	78
Bulgaria	4,010	Greece	12,769	69
Slovenia	11,800	Italy	20,290	42
Hungary	7,200	Austria	22,070	67
Czech Republic	10,510	Germany	21,260	51
Poland	6,520	Sweden	19,790	67
Cuba	3,100	Mexico	8,370	63

Source: Author's calculations from Alan Heston's and Robert Summer's Penn World Table, www.nber.org.

BOX 5.5

POSTCOMMUNISM: A POLICY

The demolition of the Berlin Wall and the elimination of the Iron Curtain have not significantly improved the situation in what are euphemistically and optimistically called "economies in transition" (from socialism to capitalism, that is). Figuring out how to move from a stagnant, ex-Communist economy to a dynamic, growing one is very difficult, and no one has ever done it before.

A few of the economies in transition appear to be on the path toward rapid convergence with western Europe: Slovenia, Hungary, the Czech Republic, and Poland have already successfully maneuvered through enough of the transition phase to have advanced their economies beyond the point reached before 1989. It seems clear that their economic destiny is to become, effectively, part of western Europe. Slovakia, Lithuania, Latvia, and Estonia appear to have good prospects of following their example.

Elsewhere, however, the news is bad. Whether reforms have taken place step-by-step or all at once, whether ex-communists have been excluded from or have dominated the government, and whether governments have been nationalist or internationalist, the results have been similar. Output has fallen, corruption has been rife, and growth has not resumed. Material standards of living in the Ukraine today are less than half of what they were when General Secretary Gorbachev ruled from Moscow.

Economists debate ferociously the appropriate economic strategy for unwinding the inefficient centrally planned Soviet-style economy. The fact that such transition has never been undertaken before should make advice-givers cautious. And one other observation should make advice givers depressed: The best predictor of whether an eastern European country's transition will be rapid and successful or not appears to be its distance from western European political and financial capitals like Vienna, Frankfurt, and Stockholm.

in their transition would be a further blow, and as Box 5.5 discusses, "transition" is not going well.

The Rule: Divergence in General

Even if attention is confined to noncommunist-ruled economies, there still has been enormous divergence in relative output-per-worker levels over the past 100 years. Since 1870, the ratio of richest to poorest economies has increased sixfold. In 1870 two-thirds of all countries had GDP per capita levels between 60 and 160 percent of the average. Today the range that includes two-thirds of all countries extends from 35 to 280 percent of the average.

Sources of Divergence

The principal cause of the extraordinary variation in output per worker between countries today is differences in their respective steady-state capital-output ratios. Two secondary causes are, first, openness to creating and adapting the technologies that enhance the efficiency of labor as measured by levels of development two generations ago and, second, the level of education today.

Productivity two generations ago is a good indicator of the level of technological knowledge that had been acquired as of a half-century ago. The level of education today captures the country's ability to invent and acquire further technological expertise today. Without education, inventing new and adopting foreign technological knowledge are simply not possible.

Global Patterns

Together these factors — the determinants of capital-output ratios, and the two determinants of access to technology — account for the bulk of the differences between countries in their relative productivity levels.

The determinants of the steady-state balanced-growth capital-output ratio play a very powerful role. A higher share of investment in national product is powerfully correlated with relative levels of output per worker. No country with an investment rate of less than 10 percent has an output-per-worker level even 20 percent of that of the United States. No country with an investment share of less than 20 percent has an output-per-worker level greater than 75 percent of the U.S. level.

A high level of labor-force growth is correlated, albeit less powerfully, with a low level of output per worker. The average country with a labor-force growth rate of more than 3 percent per year has an output-per-worker level of less than 20 percent of the U.S. level. The average country with a labor-force growth rate of less than 1 percent has an output-per-worker level that is greater than 60 percent of the U.S. level.

Together these determinants of the steady-state capital-output ratio can, statistically, account for up to half of the variation in national economies' levels of productivity per worker in the world today. The power of these factors is central to the theoretical model of economic growth presented in Chapter 4 and should not be underestimated. Indeed, their power is the reason we spent so much space on the standard growth model in Chapter 4.

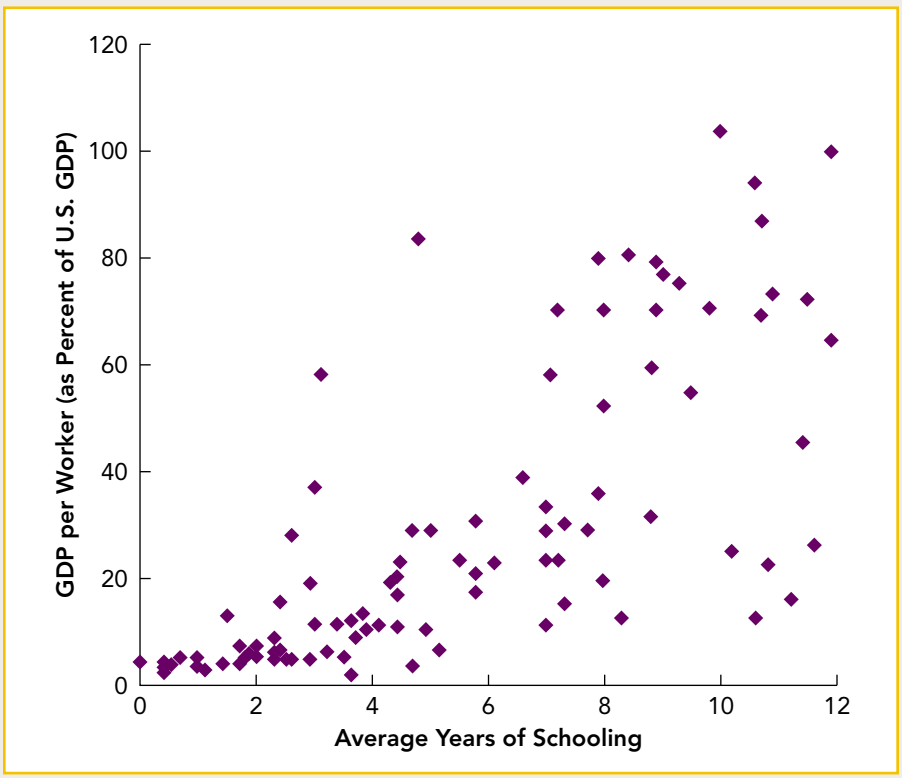
But the factors stressed in Chapter 4 are not the only major determinants of relative wealth and poverty in the world today. Differences in the efficiency of labor are as important as differences in steady-state capital-output ratios. Differences in the efficiency of labor arise from the differential ability of workers to handle and utilize modern technologies. The efficiency of labor is high where education levels are high

— so workers can use the modern technologies they are exposed to — and where economic contact with the industrial core is high — so workers and managers are exposed to the modern technologies invented in the world's R&D laboratories.

Schooling is the variable that has the strongest correlation with output per worker. Countries that have an average of four to six years of schooling have output-per-worker levels that average 20 percent of the U.S. level. Those with an average level of schooling of more than 10 years have output-per-worker levels of 65 percent of the U.S. level, as Figure 5.10 shows.

There is no single best indicator of a country's exposure to — and thus ability to adopt and adapt — the technologies invented in the industrial core that amplify the efficiency of labor. Some economists like Jeffrey Sachs and Andrew Warner of Harvard focus on trade and foreign investment as the main sources of increased efficiency and technological capability. Others like Charles Jones and Robert Hall of Stanford focus on geographic and climatic factors that have influenced migration and still influence trade and intellectual exchange. Still others like Ken Sokoloff and Stan Engerman or Andrei Shleifer, Rafael La Porta, Florencio Lopez-di-Silanes, and Robert Vishny focus on institutions of governance and their effect on entrepreneurship as the key variable. But as much as economists dispute which variables are most important as determinants of technology transfer and the efficiency of labor, all agree that all these variables are important indeed to understanding why our world today is the way it is.

FIGURE 5.10
GDP-per-Worker Levels and Average Years of Schooling
Countries with a high number of average years of schooling have a better chance of being relatively well off. Education opens the door to acquiring the technologies of the Industrial Revolution.



Source: Author's calculations from Penn World Table data constructed by Alan Heston and Robert Summers, www.nber.org/.

Cause and Effect, Effect and Cause

All the factors discussed above are both causes and effects. High population growth and low levels of output per worker go together both because rapid population growth reduces the steady-state capital-output ratio and because poor countries have not yet undergone their demographic transitions. This interaction — in which a high rate of population growth reduces the steady-state capital-output ratio and a low steady-state capital-output ratio means that the demographic transition is not far advanced — creates a vicious spiral that reinforces relative poverty.

Moreover, demography is not the only vicious spiral potentially present. A poor country must pay a high relative price for the capital equipment it needs to acquire in order to turn its savings into productive additions to its capital stock. This should come as no surprise. The world's most industrialized and prosperous economies are the most industrialized and prosperous because they have attained very high levels of manufacturing productivity: Their productivity advantage in unskilled service industries is much lower than that in capital- and technology-intensive manufactured goods. The higher relative price of machinery in developing countries means that poor countries get less investment — a smaller share of total investment in real GDP — out of any given effort at saving some fixed share of their incomes.

Moreover, to the extent that education is an important kind of investment, a good education is much harder to provide in a poorer country. Even primary education requires at its base a teacher, some books, and a classroom — things that are relatively cheap and easy for a rich country to provide but expensive for a poor country. In western Kenya today the average primary school classroom has 0.4 book per pupil.

But there is also the possibility for virtuous circles. Anything that increases productivity and sets the demographic transition in motion will reduce the rate of growth of the labor force, increase the amount of investment bought by any given amount of savings, and make education easier.

How important are these vicious spirals and virtuous circles? It is hard to look at the cross-country pattern of growth over the past century without thinking that such vicious spirals and virtuous circles *must* have been very important. Otherwise, the massive divergence in relative productivity levels seems inexplicable.

RECAP MODERN ECONOMIC GROWTH AROUND THE WORLD

The industrial core of the world economy saw its level of material productivity and standards of living explode in the nineteenth and twentieth centuries. Elsewhere the growth of productivity levels and standards of living and the spread of industrial technologies was slower, and the gap between rich and poor countries has widened enormously over the past century.

High population growth and low levels of output per worker go together both because rapid population growth reduces the steady-state capital-output ratio, and because poor countries have not yet undergone their demographic transitions which lower population growth. Low investment rates and low levels of output per worker go together both because low investment reduces the steady-state capital output ratio, and because poor countries face adverse terms of trade and high prices for capital goods that make investment difficult and expensive. Thus the obstacles to rapid growth in many poor countries in the world today are overwhelming.

5.4 POLICIES AND LONG-RUN GROWTH

Hopes for Convergence

Relative and Absolute Stagnation

Always keep in mind that in the context of economic growth "stagnation" and "failure" are relative terms. Consider Argentina once again, for it has been one of the world's most disappointing performers in terms of economic growth in the twentieth century. Argentina has experienced substantial economic growth. *Officially measured* labor productivity or national product per capita in Argentina today is perhaps three times what it was in 1900. True productivity, taking adequate account of the value of new commodities, is higher. But the much more smoothly running engine of capitalist development in Norway — no more, and probably less, rich and productive than Argentina in 1900 — has multiplied *measured* national product per capita there by a factor of nine.

A pattern of productivity growth like Argentina's is heartbreakingly slow when compared to what, reasonably, might have been and was achieved by the world's industrial leaders. What is bad about falling behind, or falling further behind, is not that second place is a bad place to be — it is false to think that the only thing that matters is to be top nation and that it is better to be poor but first than rich but second. What is bad about falling behind is that the world's industrial leaders provide an easily viewable benchmark of how things might have been different and of how much better things might have been. There was no destiny keeping Buenos Aires today from looking like and having its people as rich as those of Paris, Toronto, or Sidney.

Half Empty and Half Full

In many respects, it is decidedly odd that the world distribution of output per worker is as unequal as it is. World trade, migration, and flows of capital should all work to move resources and consumption goods from where they are cheap to where they are dear. As they travel with increasing speed and increasing volume as transportation and communication costs fall, these commodity and factor-of-production flows should erode differences in productivity and living standards between national economies. Moreover, most of the edge in standards of living and productivity levels held by the industrial core is no one's private property but, instead, is the common intellectual and scientific heritage of humankind. Hence every poor economy has an excellent opportunity to catch up with the rich by adopting and adapting from this open storehouse of modern machine technology.

We can view this particular glass either as half empty or as half full. Half full is that much of the world has already made the transition to sustained economic growth. Most people today live in economies that, while far poorer than the leading-edge postindustrial nations of the world's economic core, have successfully climbed onto the escalator of economic growth and thus the escalator to modernity. The economic transformation of most of the world is less than a century behind that of the leading-edge economies — only an eyeblink behind from the perspective of the six millennia since the spread of agriculture out of the Middle East's fertile crescent.

Moreover, perhaps we can look forward to a future in which convergence of relative income levels will finally begin to take place. The bulk of humanity is now achieving material standards of living at which the demographic transition takes hold. As population growth rates in developing countries fall, their capital-output

ratios will begin to rise quickly. With tolerable government, reasonable security of property, and better ways of achieving an education, their output-per-worker levels and material standards of living will converge to the world's leading edge.

Half empty is that we live today in the most unequal age — in terms of the divergence in the life prospects of children born into different economies — that the world has ever seen. One and a half billion people today live in economies that have *not* made the transition to intensive economic growth and have *not* climbed onto the escalator to modernity. It is very hard to argue that the median inhabitant of Africa is *any* better off in material terms than his or her counterpart of a generation ago.

Policies for Saving, Investment, and Education

It is certainly possible for a government to adopt policies that boost national savings, improve the ability to translate savings into productive investment, and accelerate the demographic transition.

Savings and Investment

Policies that ensure savers get reasonable rates of return on their savings have the potential to boost the savings rate. By contrast, systems of economic governance in which profits are diverted into the hands of the politically powerful through restrictions on entrepreneurship tend over time to diminish savings, as do economic policies that divert the real returns to savings into the hands of financiers or the government through inflation. Government deficits also have the potential to reduce the savings rate: Unless consumers and investors are farsighted enough to recognize that a government deficit now means a tax increase later, a government that spends more than it raises in revenue must borrow — and the amount borrowed is not a contribution to total national savings because it is not available to fund investment.

A number of potential policies work to boost investment for a given amount of savings. Policies that welcome foreign investors' money have the potential to cut a decade or a generation off the time needed to industrialize — if the foreign-funded capital is used wisely. Free-trade policies that allow businesses to freely earn and spend the foreign exchange they need to purchase new generations of machinery and equipment are an effective way of boosting investment. Policies that impose heavy tariffs or require scarce import licenses in order to purchase foreign-made capital equipment are a sure sign that a country will not get its money's worth out of a given nominal savings share but will, instead, find that real investment remains low. Indeed, many of the most successful *developmental states* have done the opposite. They have provided large subsidies to fund investment and expansion by businesses that have demonstrated their competence and productivity by successfully exporting and thus competing in the world market.

Education

Universal education, especially of girls, pays a twofold benefit. Investments are more likely to be productive with a better-educated workforce to draw on; hence investments are more likely to be made. Educated women are likely to want at least as much education for their children as they had, and they are likely to have relatively attractive opportunities outside the home — so the birthrate is likely to fall.

It is certainly the case that the developing countries of the world appear, for the most part, to be going through the demographic transition faster than the economies of today's industrial core did in the past three centuries. Thus current estimates of

the world's population in 2050 are markedly lower than the estimates of a decade ago. Ten years ago the projected global population in 2050 was 16 billion or more; today it is 12 billion or less. This is due, in part at least, to rapid expansions in educational attainment in today's developing economies.

A high level of educational attainment also raises the efficiency of labor both by teaching skills directly and by making it easier to advance the general level of technological expertise. A leading-edge economy with a high level of educational attainment is likely to have more inventions. A follower economy with a high level of educational attainment is likely to have a more successful time at adapting to local conditions the inventions and innovations from the industrial core of the world economy. How large these effects are at the macroeconomic level is uncertain, but that they are there nobody doubts.

The East Asian economies, especially, provide examples of how uncorrupt and well-managed developmental states can follow macroeconomic policies that accelerate economic growth and convergence. These economies, which have provided incentives to accelerate the demographic transition and boost savings and investment, have managed to close the gap vis-à-vis the world economy's industrial core faster than anyone would have believed possible.

Policies for Technological Advance

Without better technology, increases in capital stock produced by investment rapidly run into diminishing returns. And without improvements in the "technologies" of organization, government, and education, productivity stagnates.

Somewhat surprisingly, economists have relatively little to say about what governs technological progress. Why did better technology raise living standards by 2 percent annually a generation ago but by less than 1 percent today? Why did technology progress by only 0.25 percent per year in the early 1800s? Improving literacy, communications, and research and development may help explain faster progress since the Industrial Revolution than before it and faster progress in the twentieth than in the nineteenth century. Yet, as noted above, as important a feature of recent economic history as the post-1973 productivity slowdown remains largely a mystery.

Invention and Innovation

Economists note that technological progress has two components: science (solid-state physics and the invention of the transistor, the mapping of the human genome, the discovery that potassium nitrate, sulfur, and charcoal when mixed together and exposed to heat have interesting properties) and research and development that leads to successful innovation. About pure science economists have almost nothing to say. About research and development, and the innovations it generates, economists have rather more to say.

Economists note that perhaps 75 percent of all U.S. scientists and engineers work on research and development for private firms. R&D spending amounts to about 3 percent of GDP in the United States and other advanced industrial economies. One-fifth of total gross investment is research and development. More than half of net investment is research and development — investments in knowledge, as opposed to investments in machinery, equipment, structures, and infrastructure.

Businesses conduct investments in R&D to increase their profits. Firms spend money on R&D for reasons analogous to those that lead them to expand their capacity or improve their factories. If the expected present value of profits from an

R&D project at the prevailing rate are greater than the costs of the project, then the business will spend money on the project. If not, then it will not.

Rivalry and Excludibility

But there are features of technology that make thinking about the R&D process more complicated than thinking about other types of investment. First and most important, research and development is a public good. A firm that has discovered something — a new and more profitable process, a new and better way of organizing the factory, a new type of commodity that can be produced — will not reap the entire social benefit from its discovery. Other businesses can examine the innovation — the product, the process, the method of organization — and copy it. They can probably do so for a much lower cost than it took to research and develop the innovation in the first place.

By contrast, a firm that has just spent a large sum to buy and move into a new building does not have to worry that any firm will use that building as well. As a commodity, a building — or a machine, or even the skills and experience inside a worker's head — is both rival and excludable. To say that a commodity is *rival* means that if one firm is using it, another firm cannot do so: I cannot use that hammer to pound this nail if you are now using it to pound that other nail. To say that a commodity is *excludable* means that the "owner" of the commodity can easily monitor who is using it and can easily keep those whom he or she does not authorize from using it.

Most physical commodities are (or, with the assistance of the legal system, can easily be made) both rival and excludable. But by their nature ideas are not. Ideas are definitely not rival — there is nothing in the physical universe that makes it impossible for me to use the same idea you are using. And ideas are hard to make excludable as well: How can you keep me from thinking what I want to think?

Patents and Copyrights

To protect ideas, countries have **patent laws and copyrights.** In fact, one of the few enumerated powers that the U.S. Constitution gives Congress is the power to set up limited-term patent and copyright laws. *Patents* give a firm that has discovered something new the right to exclude anyone else from using that discovery for a period of years. But even the strictest patent and copyright laws are incomplete. Often the most valuable part of the R&D process is figuring out not how to do something but whether or not it (or something very close to it) can be done at all. Once a patent has been granted, other firms can and do search for alternative ways of making it or ways of making something close to it that are not covered by the patent.

Governments seeking to establish patent laws face a difficult dilemma. If their patent laws are strong, then much of the modern technology in the economy will be restricted in use: either restricted to being used only by the inventor or restricted because the inventor is charging other firms high licensing fees to use the technology (or not letting them use it at all). There is no social cost involved in letting everyone use the idea or the process or the innovation, once it is discovered. Information, after all, wants to be free. Thus a government that enacts strict patent laws is pushing the average level of technology used in its factories and businesses at some particular moment far below the level that could be achieved at that particular moment.

On the other hand, if the patent laws are weak and thus provide little protection to inventors and innovators, then the profits that inventors and innovators earn will be low. Why then should businesses devote money and resources to research and development? They will not. And the pace of innovation, and thus of technological improvement, will slow to a crawl.

This dilemma cannot be evaded. The profits from innovation come because the innovator has a monopoly right to the innovation — and hence the rest of the economy is excluded from using that item of technology. Reduce the degree of exclusion to lower the deadweight loss from using less-than-best-practice technology, and you will find that you have reduced the rewards to research and development (and thus presumably the pace of R&D as well). Increase the strength of the patent system to raise the rewards to research and development, and you will find that you have increased the gap between the average technology used in the economy and the feasible best practice.

Moreover, technological progress depends on more than the *appropriability* of research — the extent to which the increased productivity made possible by innovation boosts the profits of the innovating firm. It also depends on the productivity of research: how much in the way of new productivity-enhancing inventions is produced by a given investment in R&D? Economists don't know much about the interactions among product development, applied research, and basic research, so they have little to say about how to improve the productivity of research and the pace of productivity growth.

Will Governments Follow Good Policies?

That governments *can* assist in growth and development does not mean that governments *will*. The broad experience of growth in developing economies — outside the East Asian Pacific Rim, outside the OECD — has been that governments often *won't*. Over the past two decades many have argued that typical systems of regulation in developing countries have retarded development by

- Embarking on "prestige" industrialization programs that keep resources from shifting to activities in which the country had a long-run comparative advantage.
- Inducing firms and entrepreneurs to devote their energies to seeking rents by lobbying governments, instead of seeking profits by lowering costs.
- Creating systems of regulation and project approval that have degenerated into extortion machines for manufacturing bribes for the bureaucrats.

Many governments — particularly unelected governments — are not *that* interested in economic development. Giving valuable industrial franchises to the nephews of the dictator; making sure that members of your ethnic group are in key places to extort bribes; or taking the foreign exchange that would have been spent importing productive machinery and equipment and using it instead to buy more modern weapons for the army — these can seem more attractive options. In the absence of political democracy, the checks on a government that does not seek economic development are few.

Moreover, checks on government that do exist may not be helpful. In a nondemocracy, or a shaky semidemocracy, there are two possible sources of pressure on the government: riots in the capital and coups by the soldiers. Even a government that seeks only the best for its people in terms of economic growth will have to deal with these sources of pressure and will have to avoid riots in the capital and coups by the soldiers.

Coups by the soldiers are best avoided by spending money on the military. Riots in the capital are best avoided by making sure that the price of food is low and that influential opinion leaders in the capital are relatively happy with their material

standards of living. Thus governments find themselves driven to policies that redistribute income from the farms to the cities, from exporting businesses to urban consumers of imported goods, from those who have the power to invest and make the economy grow to those who have the power to overthrow the government.

If the rulers have the worst of motives, government degenerates into *kleptocracy:* rule by the thieves. If government has the best of motives, it is still hard to avoid policies that diminish saving and retard the ability to translate savings into productive investment. W. W. Rostow recounts a visit by President Kennedy to Indonesia in the early 1960s; Kennedy talked about economic development and a South Asian Development Bank to provide capital for Indonesia's economic growth. Indonesia's then-dictator Sukarno responded, "Mr. President, development takes too long. Give me West Irian [province, the western half of the island of New Guinea, to annex] instead."

Taken as a group, the poor countries of the world have *not* closed any of the gap relative to the world's industrial leaders since World War II.

Neoliberalism

Much thinking about the proper role of government in economic growth over the past two decades has led to conclusions that are today called *neoliberal.* The government has a sphere of core competencies — administration of justice, maintenance of macroeconomic stability, avoidance of deep recessions, some infrastructure development, provision of social insurance — at which it is effective. But there is a large area of potential activities in which governments (or, at least, governments that do not have the bureaucratic honesty and efficiency needed for a successful *developmental state*) are more likely to be destructive than constructive — hence the neoliberal recommendation that governments attempt to shrink their role back to their core competencies and thus to deregulate industries and privatize public enterprises. Whether such policies will in fact lead to convergence rather than continued divergence is still an open question.

RECAP POLICIES AND LONG-RUN GROWTH

Most people today live in economies that, while far poorer than the leading-edge post-industrial nations of the world's economic core, have successfully climbed onto the escalator of economic growth and thus the escalator to modernity. A follower economy with a higher level of educational attainment is likely to have a much more successful time at adapting to local conditions inventions and innovations from the industrial core of the world economy. Thus education appears to be a key policy for successful economic growth outside the industrial core. Inside the industrial core, without better technology increases in the capital stock produced by investment rapidly run into diminishing returns. One-fifth of total gross investment is research and development. More than half of net investment is research and development — investments in knowledge, as opposed to investments in machinery, equipment, structures, and infrastructure.

That governments *can* assist in growth and development does not mean that governments *will.* Many governments — particularly unelected governments — are not *that* interested in economic development. In the absence of political democracy, the checks on a government that does not seek economic development are few.

Chapter Summary

1. Before the commercial revolution — before 1500 or so — economic growth was very slow. Populations grew at a glacial pace. And as best we can tell there were no significant increases in standards of living for millennia before 1500: Humanity was caught in a Malthusian trap.
2. The way out of the Malthusian trap opened about 1500. Thereafter populations grew, and standards of living and levels of material productivity grew as well.
3. The Industrial Revolution was the start of the current epoch: the epoch of modern economic growth. Beginning in the mid-eighteenth century the pace of invention and innovation ratcheted up. Key inventions replaced muscle with machine power, and material productivity levels boomed.
4. Modern economic growth is well-described by the growth model in Chapter 4, which is why we spent so much time on it. Output per worker and capital per worker increase at a pace measured in percent per year, a pace that is extraordinarily rapid in long-term historical perspective.
5. Looking across nations, the world today is an astonishingly unequal place in relative terms. The relative gap between rich and poor nations in material productivity is much greater than it has ever been before.
6. Combining the determinants of the steady-state capital-output ratio with the proximate determinants — the level of technological knowledge in a country after World War II and its average level of educational attainment — accounts for the overwhelming bulk of variation in the relative wealth and poverty of nations today.
7. Macro policies to increase economic growth are policies to accelerate the demographic transition (through education), to boost savings rates, to boost the amount of real investment that a country gets for a given savings effort, and (again through education) to boost the rate of invention or of technology transfer.
8. What are the prospects for successful rapid development in tomorrow's world? Do you see the glass as half empty or half full?

Policy Exercises

1. Look in the back of this book at the rate of growth of real GDP per worker in the United States over the past 10 years. Guess what the average magnitude of annual fluctuations in growth about its trend rate are. How large was the "trend" component of growth in the past year? How large was the "cycle" component of growth in the past year?
2. Pick an industrialized country, an upper-middle-income developing country, a lower-middle-income developing country, and a poor country from the tables in the back of the book. What have been their relative rates of economic growth over the past five years? Are your countries representative in light of the discussion in this chapter?
3. Look at the relative purchasing-power-parity levels of GDP per worker for the G-7 economies — Germany, France, Britain, Italy, Canada, Japan, and the United States. Have the nations drawn closer together in levels of GDP per worker in the past five years?
4. What items of news have you read about in the past week that you would classify as shifts in macro policies that encourage growth?
5. What items of news have you read about in the past week that you would classify as shifts in macro policies that discourage growth?
6. What items of news have you read about in the past week that you would classify as shifts in micro policies that encourage growth?
7. What items of news have you read about in the past week that you would classify as shifts in micro policies that discourage growth?
8. Do you believe that over the next three decades the lower-income countries of the world will catch up to — or at least draw nearer in relative terms to — the high-income countries? Why or why not?

Key Terms

Malthusian age (p. 122)
resource scarcity (p. 122)
natural-resource scarcity (p. 122)
demographic transition (p. 122)
Industrial Revolution (p. 124)
productivity growth (p. 126)
productivity slowdown (p. 128)
divergence (p. 132)
patent laws and copyrights (p. 145)
commercial revolution (p. 148)
intellectual property (p. 149)

Analytical Exercises

1. Why do many economists think that the consumer price index overstates the true rate of inflation?
2. Would an increase in the saving and investment share of U.S. total output raise growth in productivity and living standards?
3. Many observers project that by the end of the twenty-first century the population of the United States will be stable. Using the Solow growth model, what would such a downward shift in the growth rate of the labor force do to the growth of output per worker and to the growth of total output (consider both the effect on the steady-state growth path and the transition from the "old" positive population growth to the "new" zero population growth steady-state growth path)?
4. What are the arguments for having a strong patent system to boost economic growth? What are the arguments for having a weak system of protections of intellectual property? Under what systems do you think that the first will outweigh the second? Under what circumstances do you think that the second will outweigh the first?
5. What steps do you think that international organizations — the UN, the World Bank, or the IMF — could take to improve political leaders' incentives to follow growth-promoting policies?
6. Suppose somebody who hasn't taken any economics courses asks you why humanity escaped from the Malthusian trap — of very low standards of living and slow population growth rates that nevertheless put pressure on available natural resources and kept output per worker from rising — in which humanity found itself between 8000 B.C. and 1800. What answer would you give?
7. Suppose somebody who hasn't taken any economics courses asks you why some countries are so very, very much poorer than others in the world today. What answer would you give?
8. The *endogenous growth theorists*, led by Stanford's Paul Romer, argue that it is a mistake to separate the determinants of the efficiency of labor from investment — that investments both raise the capital-worker ratio and increase the efficiency of labor as workers learn about the new technology installed with the purchase of new, modern capital goods. If the endogenous growth theorists are correct, is the case for government policies to boost national savings and investment rates strengthened or weakened? Why?
9. Suppose that population growth depends on the level of output per worker, so

$$n = 0.0001 \times \left[\left(\frac{Y}{L}\right) - \$200\right] \qquad (1)$$

The population growth rate n is zero if output per worker equals \$200, and each \$100 increase in output per worker raises the population growth rate by 1 percent per year. Suppose also that the economy is in its Malthusian regime, so the rate of increase of the efficiency of labor E is zero and output per worker is given by

$$\frac{Y_t}{L_t} = \left(\frac{s}{n+\delta}\right)^{\frac{\alpha}{1-\alpha}} E_0 \qquad (2)$$

with the diminishing-returns-to-investment parameter $\alpha = 0.5$, the depreciation rate $\delta = 0.04$, and the efficiency of labor $E_0 = \$100$.

a. Suppose that the savings rate s is equal to 8 percent per year. Graph (on the same set of axes) steady-state output-per-worker (Y/L) as a function of the population growth rate n from equation (2) and the population growth rate n as a function of output per worker (Y/L) from equation (1).

b. Where do the curves cross? For what levels of output per worker *Y/L* and population growth n is the economy (i) on its steady-state path and (ii) at its Malthusian rate of population growth?

c. Suppose that the savings rate rises by an infinitesimal amount — say, by one-hundredth of 1 percentage point, from 0.08 to 0.0801. Calculate approximately how the equilibrium position of the economy will change. By how much, and in which direction, will steady-state output per worker change? By how much, and in which direction, will the population growth rate change?

10. Suppose we have our standard growth model with s = 20 percent, n = 1 percent, g = 1 percent, and α = 3 percent. Suppose also that the current level of the efficiency of labor E is $10,000 per year and the current level of capital per worker is $50,000. Suppose further that the parameter α in the production function

$$\frac{Y_t}{L_t} = \left(\frac{K_t}{L_t}\right)^{\alpha} \times E_t^{1-\alpha}$$

is equal to 1: $\alpha = 1$.

a. What can you say about the future growth of output per worker in this economy? Can you write down an equation for what output per worker will be at any date in the future?

b. Suppose that the savings rate s is not 20 but 15 percent. How will the future growth of output per worker be different?

c. Why aren't the normal tools of analysis and rules of thumb of the growth model of much use when $\alpha = 1$? (Consider the shape of the production function and what that says about diminishing returns to investment.)