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Introduction To Economic Growth 2nd Edition

Chapter 1

Introduction: the Facts of Economic Growth

> The errors which arise from the absence of facts are far more numerous and more durable than those which result from unsound reasoning respecting true data.
>
> — CHARLES BABBAGE, quoted in Rosenberg (1994), p. 27.

> It is quite wrong to try founding a theory on observable magnitudes alone.... It is the theory which decides what we can observe.
>
> — ALBERT EINSTEIN, quoted in Heisenberg (1971), p. 63.

Speaking at the annual meeting of the American Economic Association in 1989, the renowned economic historian David S. Landes chose as the title of his address the fundamental question of economic growth and development: "Why Are We So Rich and They So Poor?"[1] This age-old question has preoccupied economists for centuries. It so fascinated the classical economists that it was stamped on the cover of Adam Smith's famous treatise *An Inquiry into the Nature and Causes of the Wealth of Nations*. And it was the mistaken forecast of Thomas Malthus in the early nineteenth century concerning the future prospects for economic growth that earned the discipline its most recognized epithet, the "dismal science."

[1] See Landes (1990).

The modern examination of this question by macroeconomists dates to the 1950s and the publication of two famous papers by Robert Solow of the Massachusetts Institute of Technology. Solow's theories helped to clarify the role of the accumulation of physical capital and emphasized the importance of technological progress as the ultimate driving force behind sustained economic growth. During the 1960s and to a lesser extent the 1970s, work on economic growth flourished.[2] For methodological reasons, however, important aspects of the theoretical exploration of technological change were postponed.[3]

In the early 1980s, work at the University of Chicago by Paul Romer and Robert Lucas re-ignited the interest of macroeconomists in economic growth, emphasizing the economics of "ideas" and of human capital. Taking advantage of new developments in the theory of imperfect competition, Romer introduced the economics of technology to macroeconomists. Following these theoretical advances, empirical work by a number of economists, such as Robert Barro of Harvard University, quantified and tested the theories of growth. Both theoretical and empirical work has since continued with enormous professional interest.

The purpose of this book is to explain and explore the modern theories of economic growth. This exploration is an exciting journey, in which we encounter several ideas that have already earned Nobel Prizes and several more with Nobel potential. The book attempts to make this cutting-edge research accessible to readers with only basic training in economics and calculus.[4]

The approach of this book is similar to the approach scientists take in studying astronomy and cosmology. Like economists, astronomers are unable to perform the controlled experiments that are the hallmark of chemistry and physics. Astronomy proceeds instead through an interplay between observation and theory. There is observation: planets, stars, and galaxies are laid out across the universe in a particular way. Galaxies are moving apart, and the universe appears to be sparsely populated with occasional "lumps" of matter. And there is theory: the theory of the Big Bang, for example, provides a coherent explanation for these observations.

[2] A far from exhaustive list of contributors includes Moses Abramovitz, Kenneth Arrow, David Cass, Tjalling Koopmans, Simon Kuznets, Richard Nelson, William Nordhaus, Edmund Phelps, Karl Shell, Eytan Sheshinski, Trevor Swan, Hirofumi Uzawa, and Carl von Weizsacker.

[3] Romer (1994) provides a nice discussion of this point and of the history of research on economic growth.

[4] The reader with advanced training is referred also to the excellent presentations in Barro and Sala-i-Martin (1998) and Aghion and Howitt (1998).

This same interplay between observation and theory is used to organize this book. This first chapter will outline the broad empirical regularities associated with growth and development. How rich are the rich countries, how poor are the poor? How fast do rich and poor countries grow? The remainder of the book consists of theories to explain these observations. In the limited pages we have before us, we will not spend much time on the experiences of individual countries, although these experiences are very important. Instead, the goal is to provide a general economic framework to help us understand the process of growth and development.

A critical difference between astronomy and economics, of course, is that the economic "universe" can potentially be re-created by economic policy. Unlike the watchmaker who builds a watch and then leaves it to run forever, economic policy makers constantly shape the course of growth and development. A prerequisite to better policies is a better understanding of economic growth.

1.2 THE DATA OF GROWTH AND DEVELOPMENT

The world consists of economies of all shapes and sizes. Some countries are very rich, and some are very poor. Some economies are growing rapidly, and some are not growing at all. Finally, a large number of economies — most, in fact — lie between these extremes. In thinking about economic growth and development, it is helpful to begin by considering the extreme cases: the rich, the poor, and the countries that are moving rapidly in between. The remainder of this chapter lays out the empirical evidence — the "facts" — associated with these categories. The key questions of growth and development then almost naturally ask themselves.

Table 1.1 displays some basic data on growth and development for seventeen countries. We will focus our discussion of the data on measures of per capita income instead of reporting data such as life

TABLE 1.1 STATISTICS ON GROWTH AND DEVELOPMENT

	GDP per capita, 1997	GDP per worker, 1997	Labor force participation rate, 1997	Average annual growth rate, 1960–97	Years to double
"Rich" countries					
U.S.A.	$20,049	$40,834	0.49	1.4	50
Japan	16,003	25,264	0.63	4.4	16
France	14,650	31,986	0.46	2.3	30
U.K.	14,472	29,295	0.49	1.9	37
Spain	10,685	29,396	0.36	3.5	20
"Poor" countries					
China	2,387	3,946	0.60	3.5	20
India	1,624	4,156	0.39	2.3	30
Zimbabwe	1,242	2,561	0.49	0.4	192
Uganda	697	1,437	0.49	0.5	146
"Growth miracles"					
Hong Kong	18,811	28,918	0.65	5.2	13
Singapore	17,559	36,541	0.48	5.4	13
Taiwan	11,729	26,779	0.44	5.6	12
South Korea	10,131	24,325	0.42	5.9	12
"Growth disasters"					
Venezuela	6,760	19,455	0.35	−0.1	−517
Madagascar	577	1,334	0.43	−1.5	−46
Mali	535	1,115	0.48	−0.8	−85
Chad	392	1,128	0.35	−1.4	−48

SOURCE: Author's calculations using Penn World Tables Mark 5.6, an update of Summers and Heston (1991), and the World Bank's Global Development Network Growth Database, assembled by William Easterly and Hairong Yu.

Notes: The GDP data are in 1985 dollars. The growth rate is the average annual change in the log of GDP per worker. A negative number in the "Years to double" column indicates "years to halve."

expectancy, infant mortality, or other measures of quality of life. The main reason for this focus is that the theories we develop in subsequent chapters will be couched in terms of per capita income. Furthermore, per capita income is a useful "summary statistic" of the level of economic development in the sense that it is highly correlated with other measures of quality of life.[5]

We will interpret Table 1.1 in the context of some "facts," beginning with the first:[6]

FACT #1 **There is enormous variation in per capita income across economies. The poorest countries have per capita incomes that are less than 5 percent of per capita incomes in the richest countries.**

The first section of Table 1.1 reports real per capita gross domestic product (GDP) in 1997, together with some other data, for the United States and several other "rich" countries. The United States was the richest country in the world in 1997, with a per capita GDP of $20,049 (in 1985 dollars), and it was the richest by a substantial amount. Japan, for example had a per capita GDP of about $16,000.

These numbers may at first seem slightly surprising. One sometimes reads in newspapers that the United States has fallen behind countries like Japan or Germany in terms of per capita income. Such newspaper accounts can be misleading, however, because market exchange rates are typically used in the comparison. U.S. GDP is measured in dollars, whereas Japanese GDP is measured in yen. How do we convert the Japanese yen to dollars in order to make a comparison? One way is to use prevailing exchange rates. For example, in January 1997, the yen-to-dollar exchange rate was around 120 yen per dollar. However, exchange rates can be extremely volatile. Just a little over one year earlier, the rate was only 100 yen per dollar. Which of these exchange rates is "right"?

[5] See, for example, the World Bank's *World Development Report, 1991* (New York: Oxford University Press, 1991).

[6] Many of these facts have been discussed elsewhere. See especially Lucas (1988) and Romer (1989).

Obviously, it matters a great deal which one we use: at 100 yen per dollar, Japan will seem 20 percent richer than at 120 yen per dollar.

Instead of relying on prevailing exchange rates to make international comparisons of GDP, economists attempt to measure the actual value of a currency in terms of its ability to purchase similar products. The resulting conversion factor is sometimes called a purchasing power parity–adjusted exchange rate. For example, the *Economist* magazine produces a yearly report of purchasing power parity (PPP) exchange rates based on the price of a McDonald's Big Mac hamburger. If a Big Mac costs 2 dollars in the United States and 300 yen in Japan, then the PPP exchange rate based on the Big Mac is 150 yen per dollar. By extending this method to a number of different goods, economists construct a PPP exchange rate that can be applied to GDP. Such calculations suggest that 150 yen per dollar is a much better number than the prevailing exchange rates of 100 or 120 yen per dollar.[7]

The second column of Table 1.1 reports a related measure, real GDP per worker in 1997. The difference between the two columns lies in the denominator: the first column divides total GDP by a country's entire population, while the second column divides GDP by only the labor force. The third column reports the 1997 labor force participation rate — the ratio of the labor force to the population — to show the relationship between the first two columns. Notice that while Japan had a higher per capita GDP than France in 1997, the comparison for GDP per worker is reversed. The labor force participation rate is much higher in Japan than in the other industrialized countries.

Which column should we use in comparing levels of development? The answer depends on what question is being asked. Perhaps per capita GDP is a more general measure of welfare in that it tells us how much output per person is available to be consumed, invested, or put to some other use. On the other hand, GDP per worker tells us more about the productivity of the labor force. In this sense, the first statistic can be thought of as a welfare measure, while the second is a productivity measure. This seems to be a reasonable way to interpret these statistics, but one can also make the case for using GDP per worker as a welfare measure. Persons not officially counted as being in the labor force may be engaged in "home production" or may work in the underground

[7] *Economist*, April 19, 1995, p. 74.

economy. Neither of these activities is included in GDP, and in this case measured output divided by measured labor input may prove more accurate for making welfare comparisons. In this book, we will often use the phrase "per capita income" as a generic welfare measure, even when speaking of GDP per worker, if the context is clear. Whatever measure we use, though, Table 1.1 tells us one of the first key things about economic development: the more "effort" an economy puts into producing output, the more output there is to go around. "Effort" in this context corresponds to the labor force participation rate.

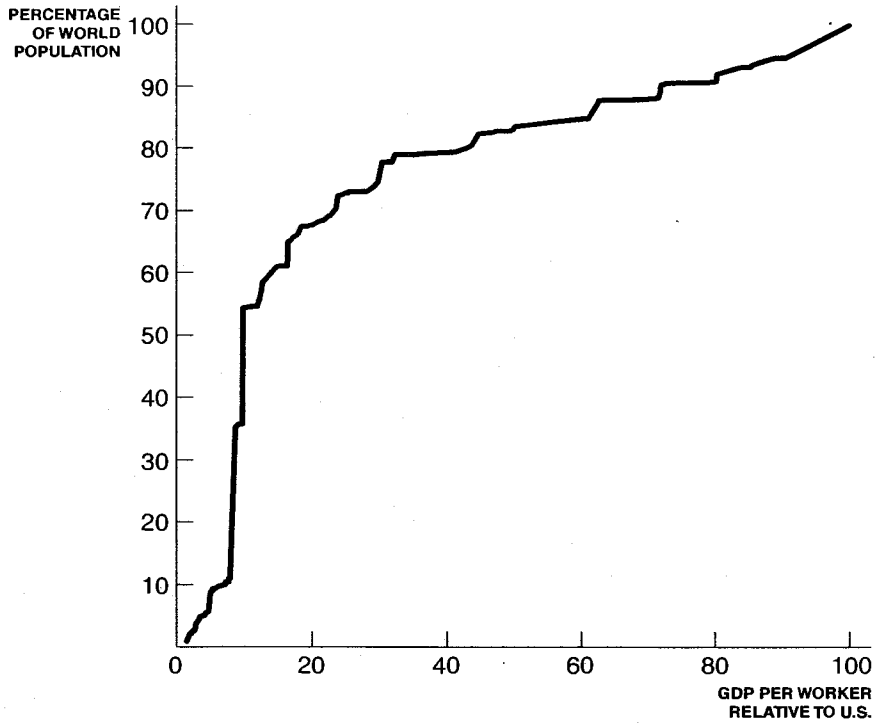
The second section of Table 1.1 documents the relative and even absolute poverty of some of the world's poorest economies. India and Zimbabwe had per capita GDPs around $1,500 in 1997, less than 10 percent of that in the United States. A number of economies in sub-Saharan Africa are even poorer: per capita income in the United States is more than 40 times higher than income in Ethiopia.

To place these numbers in perspective, consider some other statistics. The typical worker in Ethiopia or Uganda must work a month and a half to earn what the typical worker in the United States earns in a day. Life expectancy in Ethiopia is only two-thirds that in the United States, and infant mortality is more than 20 times higher. Approximately 40 percent of GDP is spent on food in Ethiopia, compared to about 7 percent in the United States.

What fraction of the world's population lives with this kind of poverty? Figure 1.1 answers this question by plotting the distribution of the world's population in terms of GDP per worker. In 1995, more than half of the world's population lived in countries with less than 10 percent of U.S. GDP per worker. The bulk of this population lives in only two countries: China, with nearly one-quarter of the world's population, and India, with one-sixth of the world's population. Together, these two countries account for more than 40 percent of the world's population. In contrast, the 39 countries that make up sub-Saharan Africa constitute about 10 percent of the world's population.

Figure 1.2 shows how this distribution has changed since 1960. Overall, the distribution has equalized as the share of the world's population living in countries whose GDP per worker is less than 30 percent of that in the United States has fallen. Of the poorest countries, both China and India have seen substantial growth in GDP per worker, even relative to the United States. China's relative income rose from 4 percent

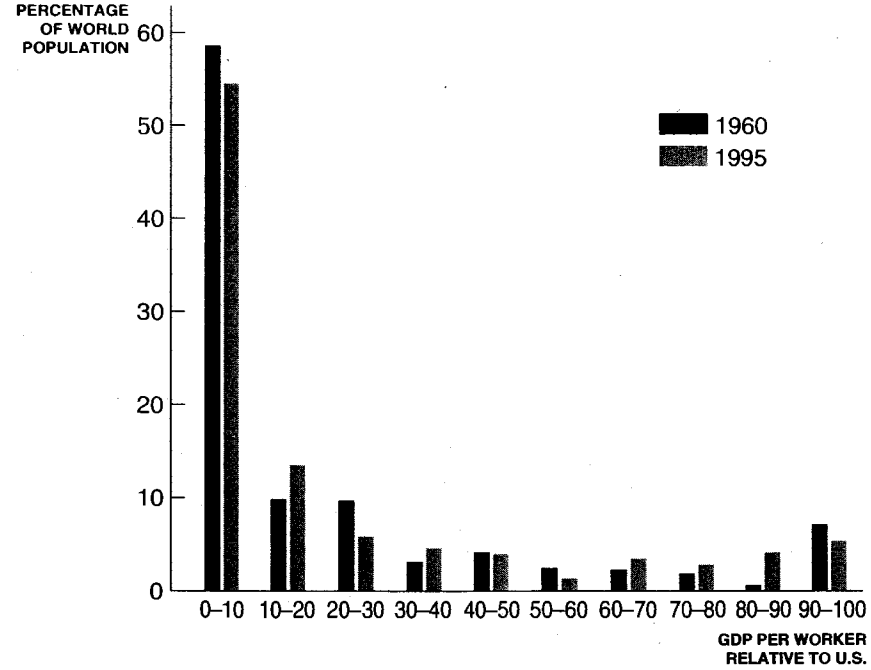
FIGURE 1.1 **CUMULATIVE DISTRIBUTION OF WORLD POPULATION BY GDP PER WORKER, 1995**



SOURCE: Penn World Tables Mark 5.6, Summers and Heston (1991), updated using Easterly and Yu (2000).

Note: A point (x, y) in the figure indicates that the fraction of the world's population living in countries with a relative GDP per worker less than x is equal to y. 136 countries are included.

FIGURE 1.2 **WORLD POPULATION BY GDP PER WORKER, 1960 AND 1995**



SOURCE: Penn World Tables Mark 5.6, Summers and Heston (1991), updated using Easterly and Yu (2000).

Note: The sample size has been reduced to 114 countries in order to incorporate the 1960 data.

of U.S. GDP per worker in 1960 to 9 percent in 1995, and India's relative income rose from 7 percent of U.S. GDP per worker to 10 percent over the same period.

The third section of Table 1.1 reports data for several countries that are moving from the second group to the first. These four so-called newly industrializing countries (NICs) are Hong Kong, Singapore, Taiwan, and South Korea. Interestingly, by 1997 Hong Kong had a per capita GDP of $18,811, higher than all of the industrialized countries in the table except for the United States. This per capita GDP was almost twice that of South Korea. However, as with Japan, Hong Kong's high per capita GDP is driven to a large extent by its high labor force participation rate. In terms of GDP per worker, Hong Kong comes in below the other industrialized economies. Singapore, on the other hand, has a GDP per worker of $36,541, one of the highest in the world.

An important characteristic of these NICs is their extremely rapid rates of growth, and this leads to our next fact:

Rates of economic growth vary substantially across countries.

The last two columns of Table 1.1 characterize economic growth. The fourth column reports the average annual change in the (natural) log of GDP per worker from 1960 to 1997.[8] Growth in GDP per worker in the United States averaged only 1.4 percent per year from 1960 to 1997. France, the United Kingdom, and Spain grew a bit more rapidly, while Japan grew at a remarkable rate of 4.4 percent. The NICs exceeded even Japan's astounding rate of increase, truly exemplifying what is meant by the term "growth miracle." The poorest countries of the world exhibited varied growth performance. China and India, for example, grew substantially faster than the United States from 1960 to 1997, but their growth rates were well below those of the NICs. Other developing countries such as Zimbabwe and Uganda experienced little or no growth over the period. Finally, growth rates in a number of countries were negative from 1960 to 1997, earning these countries the label "growth disasters." Real incomes actually declined in countries such as Venezuela, Madagascar, and Chad, as shown in the last panel of Table 1.1.

A useful way to interpret these growth rates was provided by Robert E. Lucas, Jr., in a paper titled "On the Mechanics of Economic Development" (1988). A convenient rule of thumb used by Lucas is that a country growing at g percent per year will double its per capita income every $70/g$ years.[9] According to this rule, U.S. GDP per worker will

[8] See Appendix A for a discussion of how this concept of growth relates to percentage changes.

[9] Let $y(t)$ be per capita income at time t and let y_0 be some initial value of per capita income. Then $y(t) = y_0 e^{gt}$. The time it takes per capita income to double is given by the time t^* at which $y(t) = 2y_0$. Therefore,

$$2y_0 = y_0 e^{gt^*}$$

$$\Longrightarrow t^* = \frac{\log 2}{g}.$$

The rule of thumb is established by noting that $\log 2 \approx .7$. See Appendix A for further discussion.

double approximately every 50 years, while Korean GDP per worker will double approximately every 12 years. In other words, if these growth rates persisted for two generations, the average American would be two or three times as rich as his or her grandparents. The average citizen of Taiwan, Hong Kong, or South Korea would be *twenty* times as rich as his or her grandparents. Over moderate periods of time, small differences in growth rates can lead to enormous differences in per capita incomes.

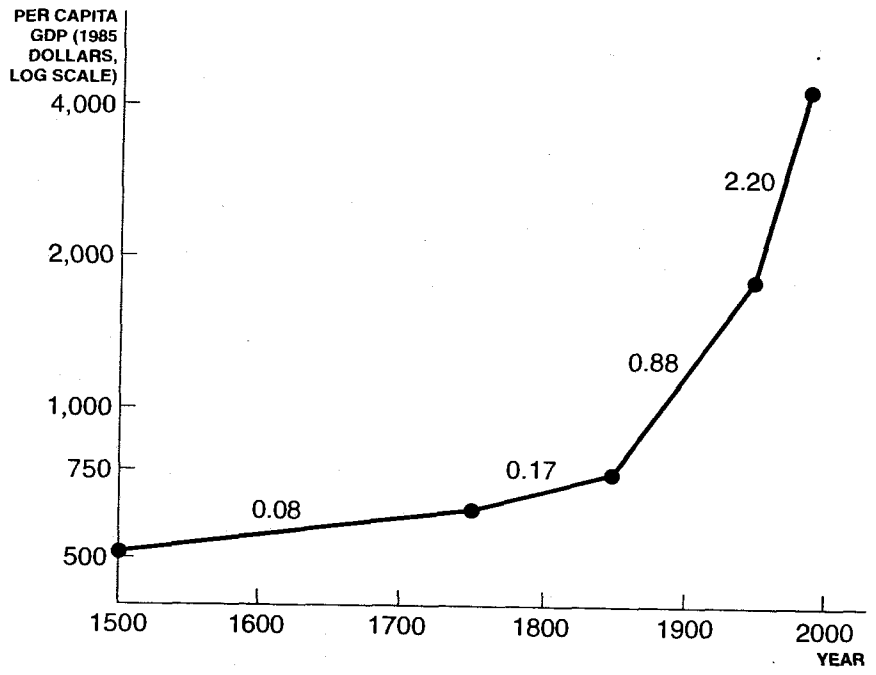
FACT #3 **Growth rates are not generally constant over time. For the world as a whole, growth rates were close to zero over most of history but have increased sharply in the twentieth century. For individual countries, growth rates also change over time.**

The rapid growth rates observed in East Asia—and even the more modest growth rates of about 2 percent per year observed throughout the industrialized world—are blindingly fast when placed in a broad historical context. Figure 1.3 illustrates this point by plotting a measure of world GDP per capita over the past five centuries. Notice that because the graph is plotted on a log scale, the slope of each line segment reflects the rate of growth: the rising slope over time indicates a rise in the world's economic growth rate.

Between 1950 and 1990, world per capita GDP grew at a rate of 2.2 percent per year. Between 1850 and 1950, however, the growth rate was only 0.88 percent, and before 1850 the growth rate was less than 0.2 percent per year. Angus Maddison (1995) goes so far as to suggest that during the millennium between 500 and 1500, growth was essentially zero. Sustained economic growth at rates of 2 percent per year is just as much a modern invention as is electricity or the transistor.

As a result of this growth, the world is substantially richer today than it has ever been before. A rough guess is that per capita GDP for the world as a whole in 1500 was $500 per person. Today, world per capita GDP is nearly ten times higher.

FIGURE 1.3 **WORLD PER CAPITA GDP AND GROWTH RATES, 1500–1990**



SOURCE: Computed from Lucas (1998) and Maddison (1995).
Note: The numbers above each line segment are average annual growth rates.

As a rough check on these numbers, consider the following exercise. Suppose we guess that the world, or even a particular country, has grown at a rate of 2 percent per year forever. This means that per capita income must have been doubling every 35 years. Over the last 250 years, income would have grown by a factor of about 2^7, or 128. In this case, an economy with a per capita GDP of $20,000 today would have had a per capita GDP of just over $150 in 1750, measured at today's prices—less than half the per capita GDP of the poorest countries in the world today. It is virtually impossible to live on 50 cents per day, and so we know that a growth rate of 2 percent per year could not have been sustained even for 250 years.

For individual countries, growth rates also change over time, as can be seen in a few interesting examples. India's average growth rate from 1960 to 1997 was 2.3 percent per year. From 1960 to 1980, however, its growth rate was only 1.3 percent per year; between 1980 and 1997 growth accelerated to 3.5 percent per year. Singapore did not experience particularly rapid growth until after the 1950s. The island country of Mauritius exhibited a strong *decline* in GDP per worker of 1.3 percent per year in the two decades following 1950. From 1970 to 1997, however, Mauritius grew at 3.6 percent per year. Finally, economic reforms in China have had a substantial impact on growth and on the economic well-being of one-quarter of the world's population. Between 1960 and 1978, GDP per worker grew at an annual rate of 1.9 percent in China. Since 1979, however, growth has averaged 5.0 percent per year.

The substantial variation in growth rates both across and within countries leads to an important corollary of Facts 2 and 3. It is so important that we will call it a fact itself:

FACT #4 **A country's relative position in the world distribution of per capita incomes is not immutable. Countries can move from being "poor" to being "rich," and vice-versa.**[10]

1.2 OTHER "STYLIZED FACTS"

Facts 1 through 4 apply broadly to the countries of the world. The next fact describes some features of the U.S. economy. These features turn out to be extremely important, as we will see in Chapter 2. They are general characteristics of most economies "in the long run."

[10]A classic example of the latter is Argentina. At the end of the nineteenth century, Argentina was one of the richest countries in the world. With a tremendous natural resource base and a rapidly developing infrastructure, it attracted foreign investment and immigration on a large scale. By 1990, however, Argentina's per capita income was only about one-third of per capita income in the United States. Carlos Diaz-Alejandro (1970) provides a classic discussion of the economic history of Argentina.

FACT **In the United States over the last century,**

1. **the real rate of return to capital, r, shows no trend upward or downward;**
2. **the shares of income devoted to capital, rK/Y, and labor, wL/Y, show no trend; and**
3. **the average growth rate of output per person has been positive and relatively constant over time — i.e., the United States exhibits steady, sustained per capita income growth.**

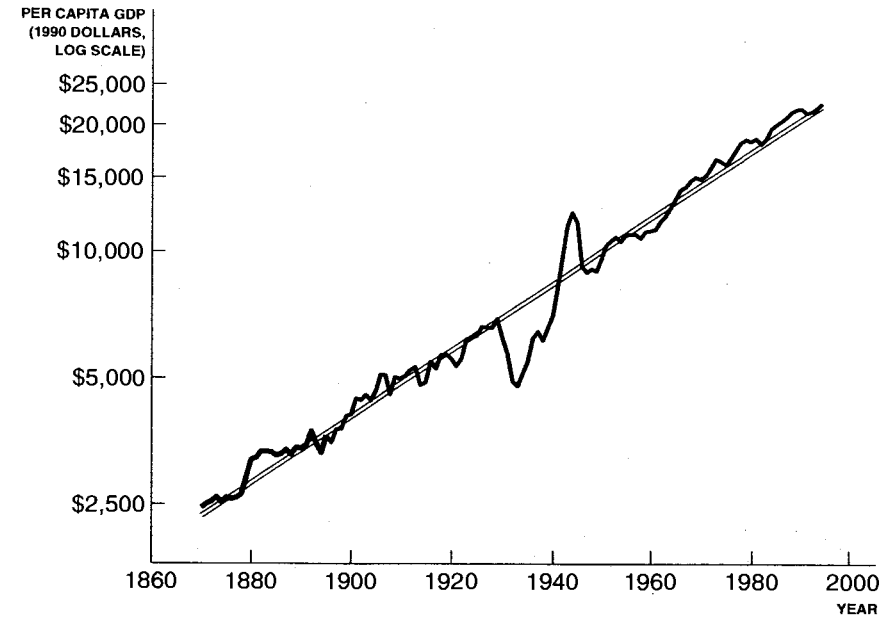
This stylized fact, really a collection of facts, is drawn largely from a lecture given by Nicholas Kaldor at a 1958 conference on capital accumulation (Kaldor 1961). Kaldor, following the advice of Charles Babbage, began the lecture by claiming that the economic theorist should begin with a summary of the "stylized" facts a theory was supposed to explain.

Kaldor's first fact — that the rate of return to capital is roughly constant — is best seen by noting that the real interest rate on government debt in the U.S. economy shows no trend. Granted, we do not observe real interest rates, but one can take the nominal interest rate and subtract off either the expected or the actual rate of inflation to make this observation.

The second fact concerns payments to the factors of production, which we can group into capital and labor. For the United States, one can calculate labor's share of GDP by looking at wage and salary payments and compensation for the self-employed as a share of GDP.[11] These calculations reveal that the labor share has been relatively constant over time, at a value of around 0.7. If we are focusing on a model with two factors, and if we assume that there are no economic profits in the model, then the capital share is simply 1 minus the labor share, or 0.3. These first two facts imply that the capital-output ratio, K/Y, is roughly constant in the United States.

[11] These data are reported in the National Income and Product Accounts. See, for example, the Council of Economic Advisors (1997).

FIGURE 1.4 **REAL PER CAPITA GDP IN THE UNITED STATES, 1870–1994**



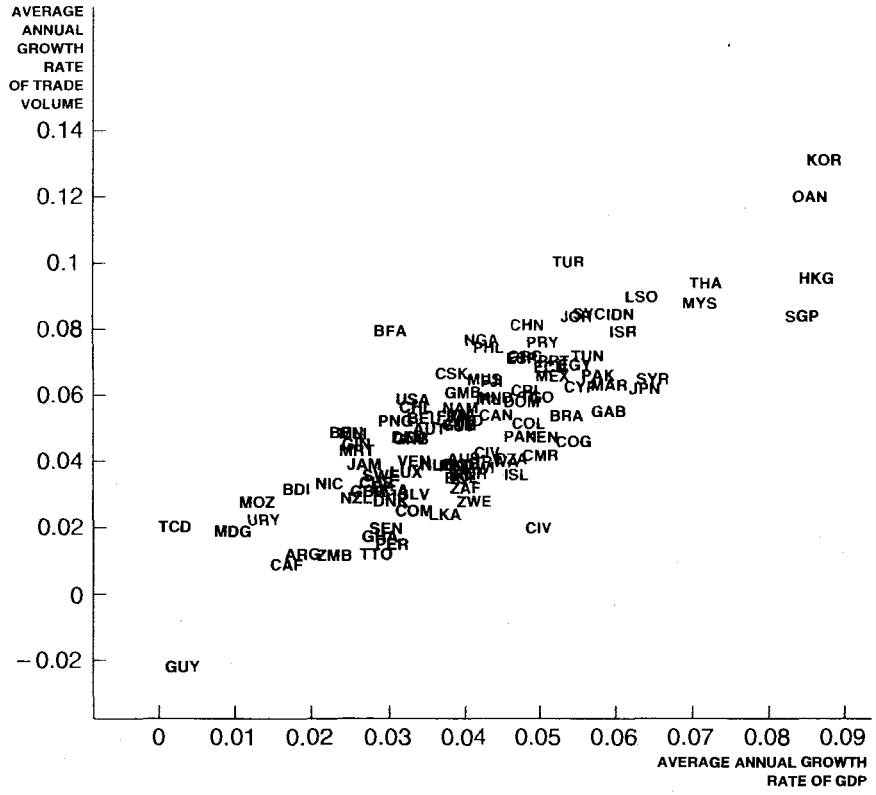
SOURCE: Maddison (1995) and author's calculations.

The third fact is a slight reinterpretation of one of Kaldor's stylized facts, illustrated in Figure 1.4. The figure plots per capita GDP (on a log scale) for the United States from 1870 until 1994. The trend line in the figure rises at a rate of 1.8 percent per year, and the relative constancy of the growth rate can be seen by noting that apart from the ups and downs of business cycles, this constant growth rate path "fits" the data very well.

FACT #6 **Growth in output and growth in the volume of international trade are closely related.**

Figure 1.5 documents the close relationship between the growth in a country's output (GDP) and growth in its volume of trade. Here, the

GROWTH IN TRADE AND GDP, 1960–90



SOURCE: Penn World Tables Mark 5.6, Summers and Heston (1991).

volume of trade is defined as the sum of exports and imports, but a similar figure could be produced with either component of trade. Notice that for many countries, trade volume has grown faster than GDP; the share of exports and imports in GDP has generally increased around the world since 1960.[12]

[12]On this point, it is interesting to note that the world economy was very open to international trade prior to World War I. Jeffrey Sachs and Andrew Warner (1995) argue that much of the trade liberalization since World War II, at least until the 1980s, simply re-establishes the global nature of markets that prevailed in 1900.

The relationship between trade and economic performance is complicated. Some economies, such as those of Hong Kong, Singapore, and Luxembourg, have flourished as regional "trade centers." The trade intensity ratio—the sum of exports and imports divided by GDP—for these economies *exceeds* 150 percent. How is this possible? These economies import unfinished products, add value by completing the production process, and then export the result. GDP, of course, is generated only in the second step. A substantial component of the strong growth performance turned in by these economies is associated with an increase in trade intensity.

On the other hand, trade intensity in Japan actually fell from around 21 percent in 1960 to around 18 percent in 1992 despite rapid per capita growth. And nearly all of the countries in sub-Saharan Africa have trade intensities higher than Japan's. A number of these countries also saw trade intensity increase from 1960 to 1990 while economic growth faltered.

FACT #7 **Both skilled and unskilled workers tend to migrate from poor to rich countries or regions.**

Robert Lucas emphasized this stylized fact in his aforementioned article. Evidence for the fact can be seen in the presence of in-migration restrictions in rich countries. It is an important observation because these movements of labor, which presumably are often very costly, tell us something about real wages. The returns to both skilled and unskilled labor must be *higher* in high-income regions than in low-income regions. Otherwise, labor would not be willing to pay the high costs of migration. In terms of skilled labor, this raises an interesting puzzle. Presumably, skilled labor is scarce in developing economies, and simple theories predict that factor returns are highest where factors are scarce. Why, then, doesn't skilled labor migrate from the United States to Zaire?

THE REMAINDER OF THIS BOOK

Three central questions of economic growth and development are examined in the remainder of this book.

The first question is the one asked at the beginning of this chapter: Why are we so rich and they so poor? It is a question about *levels* of development and the world distribution of per capita incomes. This topic is explored in Chapters 2 and 3 and then is revisited in Chapter 7.

The second question is, What is the engine of economic growth? How is it that economies experience sustained growth in output per worker over the course of a century or more? Why is it that the United States has grown at 1.8 percent per year since 1870? The answer to these questions is *technological progress*. Understanding why technological progress occurs and how a country such as the United States can exhibit sustained growth is the subject of Chapters 4 and 5.

The final question concerns *growth miracles*. How is it that economies such as Japan's after World War II and those of Hong Kong, Singapore, and South Korea more recently are able to transform rapidly from "poor" to "rich?" Such Cinderella-like transformation gets at the heart of economic growth and development. Chapters 6 and 7 present one theory that integrates the models of the earlier chapters.

The next two chapters depart from the cumulative flow of the book to explore new directions. Chapter 8 discusses influential alternative theories of economic growth. Chapter 9 examines the potentially important interactions between natural resources and the sustainability of growth. Chapter 10 offers some conclusions.

Three appendices complete this book. Appendix A reviews the mathematics needed throughout the book.[13] Appendix B lists a number of very readable articles and books related to economic growth that make excellent supplementary reading. And Appendix C presents a collection of the data analyzed throughout the book. The country codes used in figures such as Figure 1.5 are also translated there.

The facts we have examined in this chapter indicate that it is not simply out of intellectual curiosity that we ask these questions. The answers hold the key to unlocking widespread rapid economic growth. Indeed, the recent experience of East Asia suggests that such growth has the power to transform standards of living over the course of a single generation. Surveying this evidence in the 1985 Marshall Lecture at Cambridge University, Robert E. Lucas, Jr., expressed the sentiment that fueled research on economic growth for the next decade:

> I do not see how one can look at figures like these without seeing them as representing *possibilities*. Is there some action a government of India could take that would lead the Indian economy to grow like Indonesia's or Egypt's? If so, *what* exactly? If not, what is it about the "nature of India" that makes it so? The consequences for human welfare involved in questions like these are simply staggering: Once one starts to think about them, it is hard to think about anything else (Lucas 1988, p. 5).

[13] Readers with a limited exposure to calculus, differential equations, and the mathematics of growth are encouraged to read Appendix A before continuing with the next chapter.