Finally, we evaluate a range of alternative policy options that developing countries may wish to adopt to influence the size and growth of their populations, as well as ways in which industrialized countries can contribute to a more manageable global population and resource environment. Population policies in China and India, the nations with the largest populations in the world, are the focus of this chapter's case study.

Every year, more than 75 million people are being added to the world's population. Almost all of this net population increase—97%—is in developing countries. Increases of such magnitude are unprecedented. But the problem of population growth is not simply a problem of numbers. It is a problem of human welfare and of development, as defined in Chapter 1. Rapid population growth can have serious consequences for the well-being of all humanity. If development entails the improvement in people's levels of living—their incomes, health, education, and general well-being—and if it also encompasses their capabilities, self-esteem, respect, dignity, and freedom to choose, then the really important question about population growth is this: How does the contemporary population situation in many developing countries contribute to or detract from their chances of realizing the goals of development, not only for the current generation but also for future generations? In addressing this central issue, we examine the reasons and consequences for the positive relationship between poverty and family size. More broadly, we examine what drives high population growth in developing (particularly low-income) countries, why population growth in general subsequently falls as countries grow and develop, and the causes and implications of these patterns.

6.2 Population Growth: Past, Present, and Future

World Population Growth throughout History

For most of human existence on earth, humanity's numbers have been few. When people first started to cultivate food through agriculture some 12,000 years ago, the estimated world population was no more than 5 million (see Table 6.1). Two thousand years ago, world population had grown to nearly 250 million, less than a fifth of the population of China today. From year 1 on our calendar to the beginning of the Industrial Revolution around 1750, it tripled to 728 million people, less than three-quarters of the total number living in India today. During the next 200 years (1750–1950), an additional 1.7 billion people were added to the planet's numbers. But in just four decades thereafter (1950–1990), the earth's human population more than doubled again, bringing the total figure to around 5.3 billion. The world entered the twenty-first century with over 6 billion people.

As seen in Figure 6.1, in 1950 about 1.7 billion people lived in developing countries, representing about two-thirds of the world total; by 2050, the population of less developed countries will reach over 8 billion, nearly seven-eighths of the world's population. In the corresponding period,

TABLE 6.1 Estimated World Population Growth

Year	Estimated Population (millions)	Estimated Annual Increase in the Intervening Period (%)	Doubling Time (years)
10,000 B.C.E.	5		
1 C.E.	250	0.04	1,733
1650	545	0.04	1,733
1750	728	0.29	239
1800	906	0.45	154
1850	1,171	0.53	130
1900	1,608	0.65	106
1950	2,576	0.91	76
1970	3,698	2.09	33
1980	4,448	1.76	39
1990	5,292	1.73	40
2000	6,090	1.48	47
2010	6,892	1.22	57
2050 (projected)	9,600	0.98	71

Sources: Population Reference Bureau, *World Population Data Sheet* (Washington, D.C.: Population Reference Bureau, 2010 and previous annuals); Warren S. Thompson and David T. Lewis, *Population Problems*, 5th ed. (New York: McGraw-Hill, 1965), p. 384; United Nations, *Demographic Yearbook for 1971* (New York: United Nations, 1971); United Nations, *Report on the World Social Situation, 1997* (New York: United Nations, 1997), p. 14; and United Nations Population Division, *World Population Prospects: The 2012 Revision*. New York: United Nations (2013). An alternate system of broadly comparable and earlier estimates is found in Michael Kremer, "Population growth and technological change: One million B.C. to 1990," *Quarterly Journal of Economics* 108 (1993): 681–716.

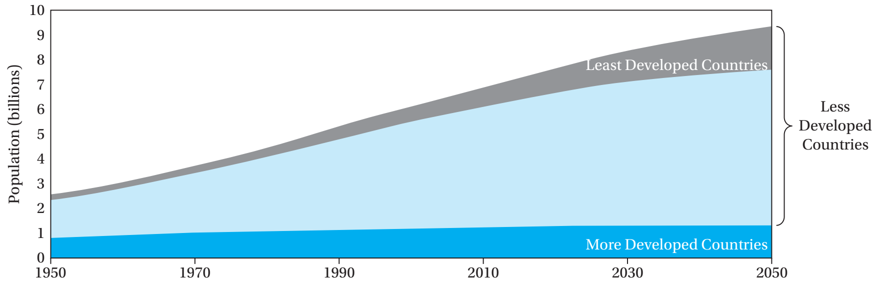
the population of the least developed countries will increase by tenfold, from about 200 million to 2 billion people. In contrast, the population of the developed countries will grow very little between now and 2050, even accounting for immigration from developing countries.

Turning from absolute numbers to percentage growth rates, for almost the whole of human existence on earth until approximately 300 years ago, population grew at an annual rate not much greater than zero (0.002%, or 20 per million). Naturally, this overall rate was not steady; there were many ups and downs as a result of natural catastrophes and variations in growth rates among regions. By 1750, the population growth rate had accelerated to 0.3% per year. By the 1950s, the rate had again accelerated, tripling to about 1.0% per year. It continued to accelerate until around 1970, when it peaked at 2.35%.[1] Today the world's population growth rate remains at a historically high rate of nearly 1.2% per year, but the rate of increase is slowing. However, the population growth rate in Africa is still an extremely high 2.3% per year. (Note that estimates of population numbers and growth rates differ according to research methods, but the broad trends are similar across major studies.)

Doubling time Period that a given population or other quantity takes to increase by its present size.

The relationship between annual percentage increases and the time it takes for a population to double in size, or **doubling time**,[2] is shown in the rightmost column of Table 6.1 (calculation of doubling time is explained in endnote 2). We see that before 1650, it took nearly 36,000 years, or about

FIGURE 6.1 World Population Growth, 1950–2050



Source: Population Reference Bureau World Population Data Sheet 2012, page 4; data are drawn from United Nations Population Division, World Population Prospects: The 2010 Revision (2011), medium-variant estimates.

1,400 generations, for the world population to double. Today it would take about 58 years, or two generations, for world population to double at current growth rates. Moreover, whereas it took 1,750 years to add 480 million people to the world's population between year 1 and the onset of the Industrial Revolution, this same number of people is today being added in less than 7 years.

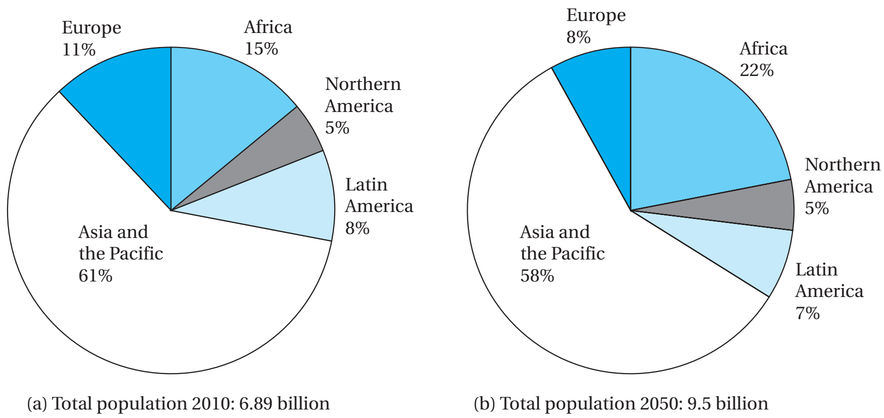
The reason for the sudden change in overall population trends is that for almost all of recorded history, the rate of population change, whether up or down, had been strongly influenced by the combined effects of famine, disease, malnutrition, plague, and war—conditions that resulted in high and fluctuating death rates. In the twentieth century, such conditions came increasingly under technological and economic control. As a result, human mortality (the death rate) is now lower than at any other point in human existence. It is this decline in mortality resulting from rapid technological advances in modern medicine, improved nutrition, and the spread of modern sanitation measures throughout the world, particularly within the past half-century, that has resulted in the unprecedented increases in world population growth, especially in developing countries. In short, population growth today is primarily the result of a rapid transition from a long historical era characterized by high birth and death rates to one in which death rates have fallen sharply but birth rates, especially in the least developed countries, have fallen more slowly from their historically high levels.

Structure of the World's Population

The world's population is very unevenly distributed by geographic region, by fertility and mortality levels, and by age structures.

Geographic Region More than three-quarters of the world's people live in developing countries; fewer than one person in four lives in an economically developed nation. Figure 6.2 shows the regional distribution of the world's population as it existed in 2010 and as it is projected for 2050.

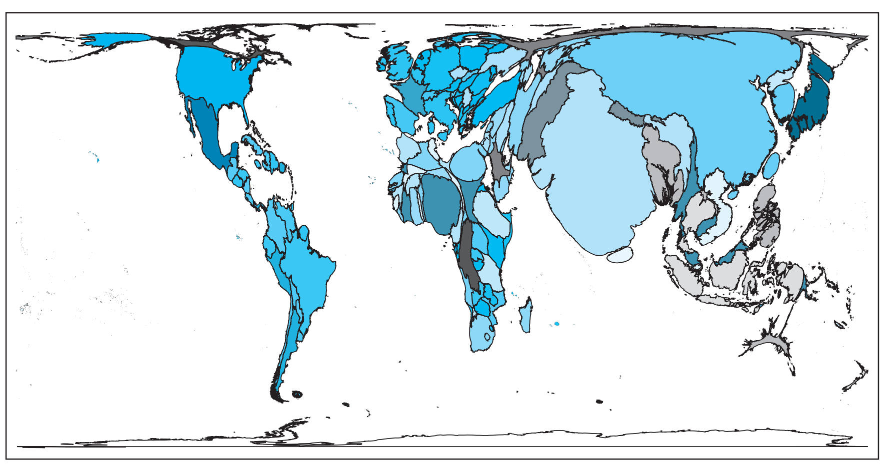
FIGURE 6.2 World Population Distribution by Region, 2010 and 2050



Source: Data from Population Reference Bureau, *World Population DataSheet*, 2010.

World population distribution is put into dramatic perspective by the map in Figure 6.3. Attention is drawn to the large size of India in comparison with Europe. China is bordered on the north and west by a thin strip of land that represents Russia. Mexico looms very large in comparison with Canada—a dramatic reversal of conventional maps; taken together, even the Caribbean islands are larger than Canada. Bangladesh, smaller in size than the state of Wisconsin, is larger than Germany and France combined. In Africa, the prominence of Nigeria stands out. Indonesia, which gets comparatively little

FIGURE 6.3 Map with Country Sizes Proportional to Their Fraction of World Population



Source: worldmapper.org:http://www.worldmapper.org/display.php?selected=2).

international attention, dwarfs its neighbor Australia while appearing nearly as large as the United States.

Fertility and Mortality Trends The **rate of population increase** is quantitatively measured as the percentage yearly net relative increase (or decrease, in which case it is negative) in population size due to **natural increase** and **net international migration**. Natural increase simply measures the excess of births over deaths or, in more technical terms, the difference between fertility and mortality. Net international migration is of very limited, though growing, importance today (although in the nineteenth and early twentieth centuries it was an extremely important source of population increase in North America, Australia, and New Zealand and corresponding relative decrease in western Europe). Population increases in developing countries therefore depend almost entirely on the difference between their **crude birth rates** (or simply **birth rates**) and **death rates**.

Rate of population increase The growth rate of a population, calculated as the natural increase after adjusting for immigration and emigration.

Natural increase The difference between the birth rate and the death rate of a given population.

Net international migration The excess of persons migrating into a country over those who emigrate from that country.

Recall from Chapter 2 that most developing nations have birth rates ranging from 15 to 45 per 1,000. By contrast, in almost all developed countries, the rate is less than 15 per 1,000. Moreover, developing country birth rates today are still often higher than they were in preindustrial western Europe. But there has been a substantial decline in fertility over the past three decades, not only in countries like Taiwan, South Korea, and China, where rapid economic and social development have taken place, but also in nations where economic growth has been less rapid, including Mexico and Bangladesh, and in some where growth has stagnated, such as Zimbabwe. The **total fertility rate (TFR)**—the average number of children a woman would have, assuming that current age-specific birth rates remain constant throughout her childbearing years—has fallen dramatically in many countries since 1970, as the examples in Table 6.2 demonstrate, but remains high in sub-Saharan Africa (5.1 in 2012) and western Asia (2.9). Niger with 7.1 and Afghanistan with 6.2 were among the highest in the world.[3]

Crude birth rate The number of children born alive each year per 1,000 population (often shortened to *birth rate*).

Death rate The number of deaths each year per 1,000 population.

Total fertility rate (TFR) The number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with the prevailing age-specific fertility rates.

Modern vaccination campaigns against malaria, smallpox, yellow fever, and cholera as well as the proliferation of public health facilities, clean water supplies, improved nutrition, and public education have all worked together over the past three decades to lower death rates by as much as 50% in parts of Asia and Latin America and by over 30% in much of Africa and the Middle East. Death rates have fallen for all age groups. Nevertheless, the average life span remains about 12 years greater in the developed countries. This gap has been sharply reduced in recent decades. For example, in 1950, **life expectancy at birth** for people in developing countries averaged 35 to 40 years, compared with 62 to 65 years in the developed world. Considerable progress has been made on reducing the **under-5 mortality rate**. For example, according to UN compilations between 1990 and 2008, it fell from 121 per 1,000 to 74 per 1,000 in South Asia, from 73 to 38 per 1,000 in Southeast Asia and from 52 to 23 per 1,000 in Latin America and the Caribbean. Although the under-5 mortality rate declined from 184 to 144 per 1,000 in sub-Saharan Africa in this period, progress in the region continued to lag. In 2009, because of still relatively high under-5 mortality rates and the AIDS epidemic, sub-Saharan Africa had the lowest life expectancy, 51 years, while in the high-income countries, life expectancy at birth averaged nearly 78 years. In East Asia and Latin America, life

Life expectancy at birth The number of years a newborn child would live if subjected to the mortality risks prevailing for the population at the time of the child's birth.

Under-5 mortality rate Deaths among children between birth and 5 years of age per 1,000 live births.

TABLE 6.2 Fertility Rate for Selected Countries, 1970 and 2009

Country	Total Fertility Rate 1970	Total Fertility Rate 2012
Bangladesh	7.0	2.3
Colombia	5.3	2.1
Indonesia	5.5	2.3
Jamaica	5.3	2.1
Mexico	4.9	2.3
Thailand	5.5	1.6
Zimbabwe	7.7	4.1

Sources: World Bank, *World Development Report, 1994* (New York: Oxford University Press, 1994), tab. 26; Population Reference Bureau, *World Population Data Sheet* (Washington, D.C.: Population Reference Bureau, 2012).

expectancies have now reached an impressive 74 and 73 years, respectively. Finally, note that there remains a biological susceptibility for old people to die at higher rates than young people due to aging. Although death rates of children and younger people are higher on average in a developing country with rapid population growth, the fact that their populations are so youthful on average explains why they may have an overall population-average death rate that is lower than that of a developed country with a much older average population. You may notice this possibly unexpected relationship when you look at demographic statistics.

Some of the striking population projections issued by the United Nations in 2013 are reported in Box 6.1.

Youth dependency ratio The proportion of young people under age 15 to the working population aged 16 to 64 in a country.

Age Structure and Dependency Burdens Population is relatively youthful in the developing world. As of 2011, children under the age of 15 constitute more than 40% of the total population of the low-income countries, 32% of the lower-middle income countries, but just 17% of high-income countries.[4] In countries with such an age structure, the **youth dependency ratio**—the proportion of youths (under age 15) to economically active adults (ages 15 to 64)—is very high. Thus, the workforce in developing countries must support almost twice as many children as it does in the wealthier countries. In the United Sates, the workforce age group (15 to 64) amounts to about 67% of the total population, with 20% under age 15 and 13% over age 65 as of 2011; the corresponding ratios in the United Kingdom are similar: 66%, 18%, and 17% respectively. In the euro area, some 19% of the population is over age 65; and in Japan nearly one-quarter of the population already has reached age 65. The main problems in more developed countries relate more to their low population growth and old-age dependents (over age 65). By contrast, in sub-Saharan Africa, the economically active workforce makes up about 54% of the total population (just 3% of the population is over age 65) as of 2011. In general, the more rapid the population growth rate is, the greater the proportion of dependent children in the total population and the more difficult it is for people who

BOX 6.1 FINDINGS The 2012 Revised United Nations Population Projections

Here is a summary of some of the main findings found in the UN's *World Population Prospects 2012 Revision,* published in June 2013.

- World population is now projected at 8.1 billion by 2025; and 9.6 billion by 2050.
- Most population growth will continue to occur in developing regions where population will grow from 5.9 billion in 2013 to about 8.2 billion in 2050.
- "Give or take a billion": The projections depend on assumptions—the 2050 population could turn out to be as little as 8.3 billion or as many as 10.9 billion.
- Most population growth will occur in Africa.
- The 49 least developed countries are projected to double in size from 900 million in 2013 to 1.8 billion in 2050.
- Beyond Africa, projected population growth in the rest of world is just over 10% for 2013–2100.
- New projected total population is higher, particularly after 2075 because:
  - Current fertility level estimates are higher in some countries with better information (in particular, in 15 high-fertility sub-Saharan African countries, estimated births per woman were adjusted upwards more than 5%).
  - In some cases, the actual level of fertility appears to have risen in recent years.
  - In other cases, the previous estimate was too low.
- Other projections include:
  - Developed region population will be little changed at 1.3 billion–even with immigration.
  - India will become the world's most populous country, passing China around 2028, when each will have about 1.45 billion people.
  - The population of Nigeria could pass that of the United States by 2050; by 2100 it could rival China as the second most populous country.
  - By 2100, several other countries are projected to have populations over 200 million: Indonesia Tanzania, Pakistan, Congo, Ethiopia, Uganda, and Niger.

Source: United Nations Population Division, World Population Prospects: The 2012 Revision. New York: United Nations, Department of Economic and Social Affairs, 13 June 2013; downloaded from www.unpopulation.org. For a summary see http://www.un.org/apps/news/story.asp?NewsID=45165#.UlAkZmRVRz0.

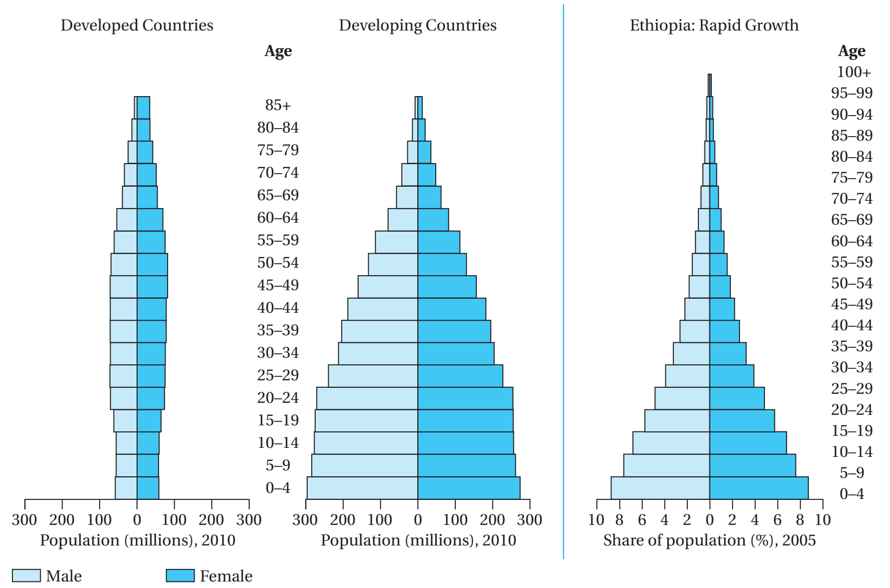
are working to support those who are not. This phenomenon of youth dependency also leads to an important concept, the **hidden momentum of population growth**.

Hidden momentum of population growth The phenomenon whereby population continues to increase even after a fall in birth rates because the large existing youthful population expands the population's base of potential parents.

The Hidden Momentum of Population Growth

Perhaps the least understood aspect of population growth is its tendency to continue even after birth rates have declined substantially. Population growth has a built-in tendency to continue, a powerful momentum that, like a speeding automobile when the brakes are applied, tends to keep going for some time before coming to a stop. In the case of population growth, this momentum can persist for decades after birth rates drop.

FIGURE 6.4 Population Pyramids: All Developed and Developing Countries and the Case of Ethiopia



Source: Graphs detailing Developed Countries from *World Population Data Sheet of the Population Reference Bureau, Inc.*, by Population Reference Bureau. Copyright 2010 by Population Reference Bureau, Inc. Reproduced with permission of Population Reference Bureau, Inc., via Copyright Clearance Center. Graph detailing Ethiopia from *Population Bulletin* 62 (2007), p. 6. Reprinted with permission from Population Reference Bureau, Inc.

There are two basic reasons for this. First, high birth rates cannot be altered substantially overnight. The social, economic, and institutional forces that have influenced fertility rates over the course of centuries do not simply evaporate at the urging of national leaders. We know from the experience of European nations that such reductions in birth rates can take many decades. Consequently, even if developing countries assign top priority to the limitation of population growth, it will still take many years to lower national fertility to desired levels.

The second and less obvious reason for the hidden momentum of population growth relates to the age structure of many developing countries' populations. Figure 6.4 illustrates the great difference between age structures in less developed and more developed countries by means of two **population pyramids** for 2010. Each pyramid rises by five-year age intervals for both males and females, with the total number in each age cohort measured on the horizontal axis. Panel A (the left and middle panels) show population pyramids for developed and developing countries, respectively (the age scale is that listed between these two figures). Expressed in millions of people, rather than percentages, the figure clearly reveals that most future population growth will take place in the developing world. The steeper bottom rungs for the developing world as a whole, in contrast to a very low-income country such as Ethiopia (right panel),

Population pyramid A graphic depiction of the age structure of the population, with age cohorts plotted on the vertical axis and either population shares or numbers of males and females in each cohort on the horizontal axis.

reflect the large declines in population growth in lower-middle income developing countries over the past quarter century, and particularly in China (see the case study at the end of this chapter). For developed countries, in the contemporary period the population in middle cohorts is typically greater than that of young cohorts; this is partly but certainly not exclusively viewed as a transitional feature of a period in which women have been delaying births until later in life.

From the Ethiopia pyramid (Panel B) expressed as share of population, young people greatly outnumber their parents (the age scale in this case is found to the right of the figure). When their generation reaches adulthood, the number of potential parents will inevitably be much larger than at present. It follows that even if these new parents have only enough children to replace themselves (two per couple, as compared with their parents, who may have had four or more children), the fact that the total number of couples having two children is much greater than the number of couples who previously had more children means that the total population will still increase substantially before leveling off.[5]

Panel A also focuses attention on the fact that some age brackets are increasing in size in some countries, while they are decreasing in others. This reflects that in the demographic transition, the fraction of the population of working age first rises and then falls. On the one hand, countries where the fraction of prime working-age citizens is rising face a potential crisis if many remain unemployed, as this is associated with inequality and (especially among males) social unrest, not to mention the potential output loss. On the other hand, this rise is also an important window of opportunity for strong income and productivity gains, referred to as the *demographic dividend*—a period in which there are fewer children to support, a larger fraction of women join or remain in the workforce for longer periods of time, and there are more available resources to invest in human capital (see Chapter 8).

In contrast, where the fraction of people of working age is falling as a result of population aging, the resources needed for old-age support are increasing. This is already a challenge for most high-income countries. Leading up to this period, a higher savings rate is required; but then allowing more immigration can also help. The transition is likely to pose an even greater challenge for some middle-income countries with big drops in fertility ahead of previous historical patterns, most notably China (see the case study at the end of the chapter), but also in several other Asian countries.[6]

6.3 The Demographic Transition

The process by which fertility rates eventually decline to low and stable levels has been portrayed by a famous concept in economic demography called the **demographic transition**.

Demographic transition The phasing-out process of population growth rates from a virtually stagnant growth stage, characterized by high birth rates and death rates through a rapid-growth stage with high birth rates and low death rates to a stable, low-growth stage in which both birth and death rates are low.

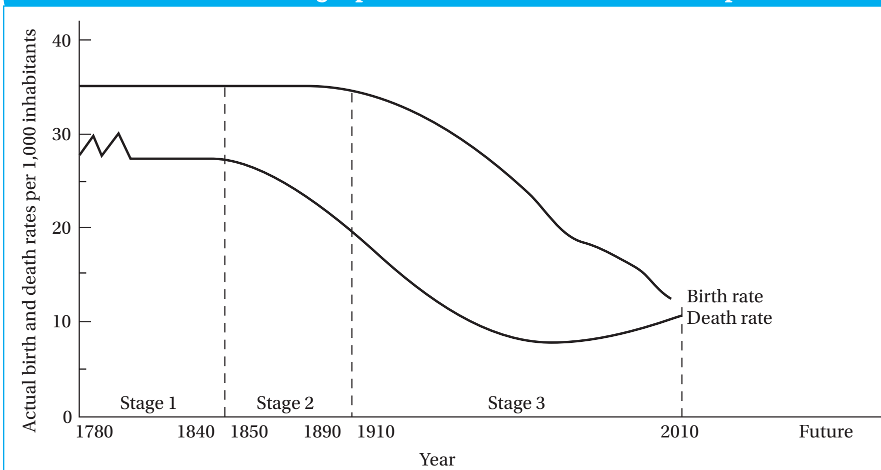
The demographic transition attempts to explain why all contemporary developed nations have more or less passed through the same three stages of modern population history. Before their economic modernization, these countries for centuries had stable or very slow-growing populations as a result of a combination of high birth rates and almost equally high death rates. This was stage 1. Stage 2 began when modernization, associated with better public health methods, healthier diets, higher incomes, and other improvements led to a marked reduction in mortality that gradually raised life expectancy from under 40 years to over 60 years. However, the decline in death rates was not immediately accompanied by a decline in fertility. As a result, the growing divergence between high birth rates and falling death rates led to sharp increases in population growth compared to past centuries. Stage 2 thus marks the beginning of the demographic transition (the transition from stable or slow-growing populations first to rapidly increasing numbers and then to declining rates). Finally, stage 3 was entered when the forces and influences of modernization and development caused the beginning of a decline in fertility; eventually, falling birth rates converged with lower death rates, leaving little or no population growth.

Replacement fertility The number of births per woman that would result in stable population levels.

This process implies movement from a relatively high number of births per woman to a population **replacement fertility** level that can be calculated to reach about 2.05 to 2.1 births per woman when nearly all women survive to the mean age of childbearing, as they do in developed countries. In developing countries with much lower survival rates, replacement fertility can be well over 3 births per woman.[7]

Figure 6.5 depicts the three historical stages of the demographic transition in western Europe. Before the early nineteenth century, birth rates hovered around 35 per 1,000, while death rates fluctuated around 30 per 1,000. This resulted in population growth rates of around 5 per 1,000, or less than 0.5% per year. Stage 2, the beginning of western Europe's demographic transition, was initiated around the first quarter of the nineteenth century by slowly falling death rates as a result of improving economic conditions and the gradual development of disease and death control through modern medical and public health technologies. The decline in birth rates (stage 3) did not really begin until late in the nineteenth century, with most of the reduction many decades occurring after modern economic growth had begun and long after death rates began their descent. But since the initial level of birth rates was generally low

FIGURE 6.5 The Demographic Transition in Western Europe



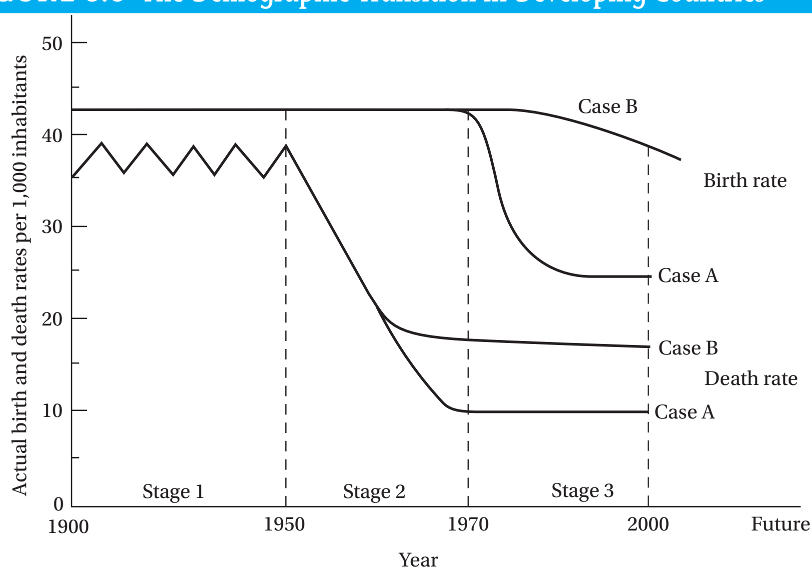
in western Europe as a result of either late marriage or celibacy, overall rates of population growth seldom exceeded the 1% level, even at their peak. By the end of western Europe's demographic transition in the second half of the twentieth century, the relationship between birth and death rates that marked the early 1800s had reversed, with birth rates fluctuating and death rates remaining fairly stable or rising slightly. This latter phenomenon was simply due to the older age distributions of contemporary European populations. The patterns of the demographic transition in Europe are clear, though research continues to better identify the causal factors at work.[8]

Figure 6.6 shows the population histories of contemporary developing countries, which contrast with those of western Europe and fall into two patterns.

Birth rates in many developing countries today are considerably higher than they were in preindustrial western Europe. This is because women tend to marry at an earlier age. As a result, there are both more families for a given population size and more years in which to have children. In the 1950s and 1960s, stage 2 of the demographic transition occurred throughout most of the developing world. The application of highly effective imported modern medical and public health technologies caused death rates in developing countries to fall much more rapidly than in nineteenth-century Europe. Given their historically high birth rates (still over 35 per 1,000 in many countries), this has meant that stage 2 of the demographic transition has been characterized by peak population growth rates well in excess of 2.0% per annum in most developing countries.

With regard to stage 3, we can distinguish between two broad classes of developing countries. In case A in Figure 6.6, modern methods of death

FIGURE 6.6 The Demographic Transition in Developing Countries



Source: Based on National Academy of Sciences, *The Growth of World Population* (Washington, D.C.: National Academy of Sciences, 1963), p. 15.

control, combined with rapid and widely distributed rises in levels of living, have resulted in death rates falling as low as 10 per 1,000 and birth rates also falling rapidly, to levels between 12 and 25 per 1,000. These countries, including Taiwan, South Korea, Costa Rica, China, Cuba, Chile, and Sri Lanka, have thus entered stage 3 of their demographic transition and have experienced rapidly falling rates of overall population growth.

But some developing countries fall into case B of Figure 6.6. After an initial period of rapid decline, death rates have failed to drop further, largely because of the persistence of widespread absolute poverty and low levels of living and more recently because of the AIDS epidemic. Moreover, the continuance of still quite high birth rates as a result of these low levels of living causes overall population growth rates to remain relatively high. These countries, including many of those in sub-Saharan Africa and the Middle East, are still in stage 2 of their demographic transition. Though fertility is declining, it remains very high in these parts of the world.

The important question, therefore, is this: When and under what conditions are developing nations likely to experience falling birth rates and a slower expansion of population? To answer this question, we need to ask a prior one. What are the principal determinants or causes of high fertility rates in developing countries, and can these determinants of the "demand" for children be influenced by government policy? To try to answer this critical question, we turn to a very old and famous classical macroeconomic and demographic model, the Malthusian "population trap," and a contemporary and highly influential neoclassical microeconomic model, the household theory of fertility.

6.4 The Causes of High Fertility in Developing Countries: The Malthusian and Household Models

The Malthusian Population Trap

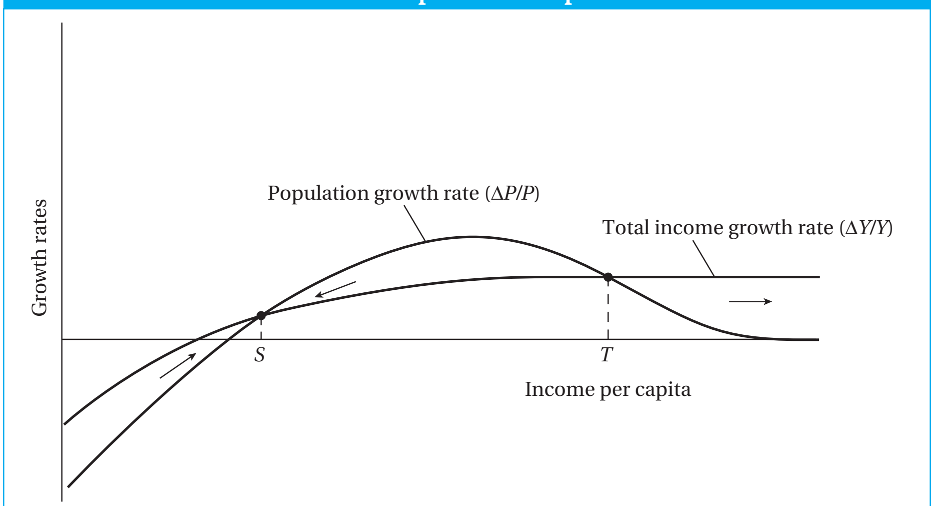
More than two centuries ago, the Reverend Thomas Malthus put forward a theory of the relationship between population growth and economic development that is influential today. Writing in his 1798 *Essay on the Principle of Population* and drawing on the concept of diminishing returns, Malthus postulated a universal tendency for the population of a country, unless checked by dwindling food supplies, to grow at a geometric rate, doubling every 30 to 40 years.[9] At the same time, because of diminishing returns to the fixed factor, land, food supplies could expand only at a roughly arithmetic rate. In fact, as each member of the population would have less land to work, his or her marginal contribution to food production would actually start to decline. Because the growth in food supplies could not keep pace with the burgeoning population, per capita incomes (defined in an agrarian society simply as per capita food production) would have a tendency to fall so low as to lead to a stable population existing barely at or slightly above the subsistence level. Malthus therefore contended that the only way to avoid this condition of chronic low levels of living or absolute poverty was for people to engage in "moral restraint" and limit the number of their progeny. Hence, we might regard Malthus, indirectly and inadvertently, as the father of the modern birth control movement.

Modern economists have given a name to the Malthusian idea of a population inexorably forced to live at subsistence levels of income. They have called it the *low-level equilibrium population trap* or, more simply, the **Malthusian population trap**. Diagrammatically, the basic Malthusian model can be illustrated by comparing the shape and position of curves representing population growth rates and aggregate income growth rates when these two curves are each plotted against levels of per capita income. An example of this is presented in Figure 6.7.

Malthusian population trap The threshold population level anticipated by Thomas Malthus (1766–1834) at which population increase was bound to stop because life-sustaining resources, which increase at an arithmetic rate, would be insufficient to support human population, which would increase at a geometric rate.

On the vertical axis, we plot numerical percentage changes, both positive and negative, in the two principal variables under consideration (total population and aggregate income). On the horizontal axis are levels of per capita income. Figure 6.7 depicts the basic ideas. The x-axis shows the level of income per capita. The y-axis shows two rates—of population growth and of total income growth. Per capita income growth is, by definition, the difference between income growth and population growth—hence the vertical difference between these two curves. Thus, as we saw in Chapter 3 in our discussion of the Harrod-Domar (or AK) model, whenever the rate of total income growth is greater than the rate of population growth, income per capita is rising; this corresponds to moving to the right along the x-axis. Conversely, whenever the rate of total income growth is less than the rate of population growth, income per capita is falling, moving to the left along the x-axis. When these rates are equal, income per capita is unchanging. We can then explore the shapes of population growth and growth of income to understand potential implications of this relationship.

FIGURE 6.7 The Malthusian Population Trap



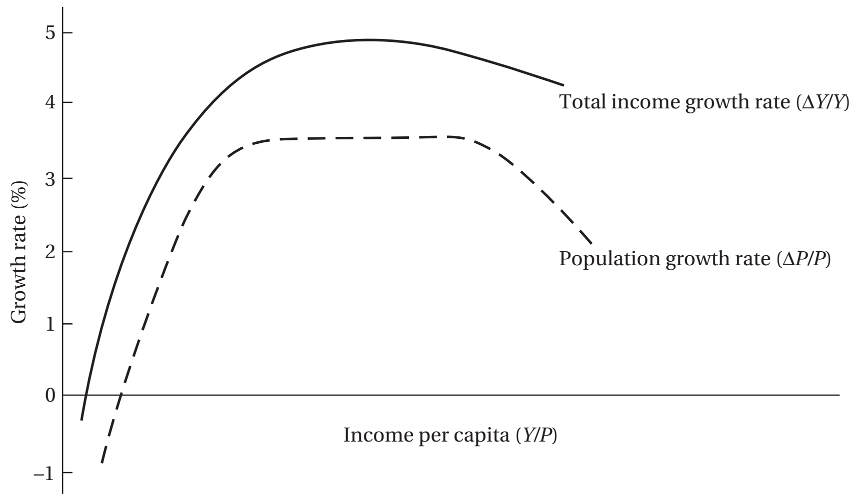
First consider population growth. When income is very low, say, below $250 per year at purchasing power parity, nutrition is so poor that people become susceptible to fatal infectious diseases; pregnancy and nursing become problematic; and, ultimately, outright starvation may occur. This is shown on the left in Figure 6.7. But after this minimum level of income per capita is reached, population begins to grow, eventually reaching a peak rate (perhaps at 3% to 4% per year); and then the population growth rate begins to fall until at last a fairly stable population is reached (a growth rate close to zero). Note that this pattern of population growth first increasing and then decreasing as per capita income rises corresponds to the pattern of the demographic transition, explained in section 6.3.

In Figure 6.7, total income growth becomes greater as the economy develops (and income per capita rises). An economic reason for this positive relationship is the assumption that savings vary positively with income per capita. Countries with higher per capita incomes are assumed to be capable of generating higher savings rates and thus more investment. Again, given a Harrod-Domar-type model of economic growth (see Chapter 3), higher savings rates mean higher rates of aggregate income growth. Eventually, however, growth levels off at a maximum. (Incomes of middle-income countries might grow fastest as they borrow technology to catch up—not shown in this diagram—but these higher rates cannot be continued once the technology frontier is reached.)

As drawn, the curves first cross at a low level of income, labeled S (for subsistence). This is a stable equilibrium: If per capita income levels become somewhat larger than (to the right of) S, it is assumed that population size will begin to increase in part because higher incomes improve nutrition and reduce death rates. But then, as shown in the figure, population is growing faster than income (the $\Delta P/P$ curve is vertically higher than the $\Delta Y/Y$ curve), so income per capita is falling, and we move to the left along the x-axis. The arrow pointing in the direction of S from the right therefore shows per capita income falling back to this very low level. On the other hand, if income per capita were a little less than S, the total income curve would be above the population growth curve and so income per capita would be rising. This corresponds to a move to the right along the x-axis. Thus, our conclusion is that point S represents a stable equilibrium (much as in our study of stable equilibria in Figure 4.1). This very low population growth rate along with a very low income per person is consistent with the experience of most of human history prior to the modern era.[10]

According to modern-day neo-Malthusians, poor nations will never be able to rise much above their subsistence levels of per capita income unless they initiate preventive checks (birth control) on their population growth. In the absence of such preventive checks, Malthusian positive checks (starvation, disease, wars) on population growth will inevitably provide the restraining force. However, if per capita income can somehow reach a threshold level, labeled T in Figure 6.7, from that point population growth is less than total income growth, and thus per capita income grows continually, at a rate such as 2% per year (the approximate U.S. per capita growth rate from 1870 to 2010).

FIGURE 6.8 How Technological and Social Progress Allows Nations to Avoid the Population Trap



Countries or regions in such a population trap can also escape it by achieving technological progress that shifts the income growth rate curve up at any level of per capita income. And it may be able to achieve changes in economic institutions and culture ("social progress") that shifts the population growth curve down. In this way, the population trap equilibrium is eliminated altogether, and the economy is able to proceed with self-sustaining growth. An example of such a result is depicted in Figure 6.8. Total income growth is now greater than population growth at each level of per capita income. As a result, income per capita now grows steadily.

We have examined strategies for accelerating income growth in Chapters 3 (including its appendices) and 4, and we will examine specific growth policies further in Chapters 7, 9, 12, and 14. The main focus of the remainder of this chapter is on changes in economic institutions, economic power in households, and cultural norms, to reduce fertility to maintain population growth below income growth, and eventually to achieve population stability.

In addition to the classic Malthusian model, the multiple equilibrium analysis of Chapter 4, Figure 4.1, is also relevant to understanding high-fertility traps. In the diagram, we can take the x-axis to represent (expected) fertility and the y-axis, the family's own fertility decision. The upward-sloping response (along the S-shaped curve) of the individual family fertility decision to average fertility may be caused by at least two important complementarities—a basis for possible multiple equilibria. First, if others have high fertility, this may increase the number of formal-sector job seekers without (proportionally) increasing the number of (higher-paying) formal-sector jobs. Each family may feel it needs a larger number of children to raise the probability that at least one child will get a modern job. In addition, families often follow local social norms about fertility and tend to model their own behavior on the behavior of others in their community.

It is plausible that the resulting positively sloped response curve also has an S-shape, similar to the one in Figure 4.1[10a]. If the fertility response curve cuts the 45-degree line from above at least twice, then there are at least two stable equilibria (see Chapter 4, section 4.2): one with high and another with low levels of average fertility.[11] Some findings on the effects of changing norms on fertility decisions is presented in Box 6.2.

BOX 6.2 FINDINGS Social Norms and the Changing Patterns of Fertility in Bangladesh

In this chapter, we describe an idea—presented in part by Partha Dasgupta—that social norms play a role in setting an equilibrium fertility rate: If families followed local customs about fertility—modeling their own behavior on that of their neighbors—the community might be trapped at a higher fertility rate than would prevail if they could manage a change in social expectations. The idea was also a starting point for empirical research by Kaivan Munshi and Jacques Myaux on the uneven transition to lower fertility in rural developing areas.

Munshi and Myaux applied their research to the experience of the Matlab area of Bangladesh. Fertility reduction varied greatly across apparently similar villages. In addition, response to the same family-planning program also varied greatly in the magnitude of their effects and time lags before these effects were realized. Data on fertility collected twice annually over an 11-year period offered a unique chance to learn about this process. (The data set included contraceptive use and demographic and socioeconomic characteristics for all women living in all 70 villages in the Matlab area who took part in the program and were followed throughout the 11-year period.)

Munshi and Myaux offered an explanation for widely varying local patterns: "Most societies have traditionally put norms into place to regulate fertility. When the economic environment changes, individuals gradually learn through their social interactions about the new reproductive equilibrium that will emerge in their community." In this case, the change was in the availability of modern contraception. There is likely some proportion of people who will be perpetually resistant to contraception; the remainder will be open-minded about it but may not want to behave too differently than local norms dictate. Until this process plays out, people will not know how many of their neighbors will be firmly resistant to change and thus whether contraceptive use will ultimately be socially acceptable overall. Munshi and Myaux propose that families' uncertainty about what potential new equilibrium (what level of contraceptive prevalence) in their villages will emerge leads to caution, giving rise to slow and different rates of fertility transition in otherwise apparently similar villages. They developed a model to demonstrate the underlying logic of this explanation and concluded that social norms do make a difference; the process of moving to a better equilibrium can be slow. In some cases, movement out of the high fertility equilibrium (too high for many who are stuck there) can be prevented indefinitely.

In rural Bangladesh, which has a large majority Muslim population but also a minority Hindu population, social norms correspond to religious groups. Women are secluded generally (through purdah) and almost never interact with anyone (including women) from another religious group.