CHAPTER 5

One Billion and Counting: The Hidden Momentum of Population Growth in India

INTRODUCTION

At the end of 2008, about 6.75 billion people lived on planet Earth. After reaching the 1 billion mark somewhere around 1830, the world's population reached 2 billion around 1930 (100 years) and then, in each of the following years, added another billion: 1959 (29 years), 1974 (15 years), 1987 (13 years), and 1999 (12 years). Every second there are about 4.2 births and 1.8 deaths, and thus an additional 2.4 people on the planet. Most of the world's population lives in the less-developed countries of Asia, Africa, and Latin America. From 1950 to today, the combined populations of Asia, Africa, and Latin America have soared from 71 percent of the world's total to 83 percent, and they are expected to comprise 87 percent by 2050 (Figure 5.1). In this chapter you will learn why the world's population is growing so fast, why this growth is concentrated in less-developed countries, and what are some of the factors that go into population forecasting.

The size, composition, and growth of populations affect the economic and environmental well-being of nations. Rapid population growth in regions such as Asia, sub-Saharan Africa, and the Middle East requires huge commitments of national resources for food, housing, education, and health care and exacerbates problems of poor air and water quality, soil erosion, deforestation, and desertification. Not all countries today are growing too fast, however. Many European countries are experiencing negative growth or population decline. These countries devote considerable economic resources to support large elderly populations. About 17 percent of Western Europe's population currently is over 65 years of age and is increasing steadily over time.

First, here are a few basics about the dynamics of population growth. Population change in any country results from four demographic forces: (1) births, (2) deaths, (3) immigration (people moving to a country), and (4) emigration (people leaving a country):

$$P_2 = P_1 + B - D + I - O$$

where: P_1 = population in time 1
P_2 = population in time 2

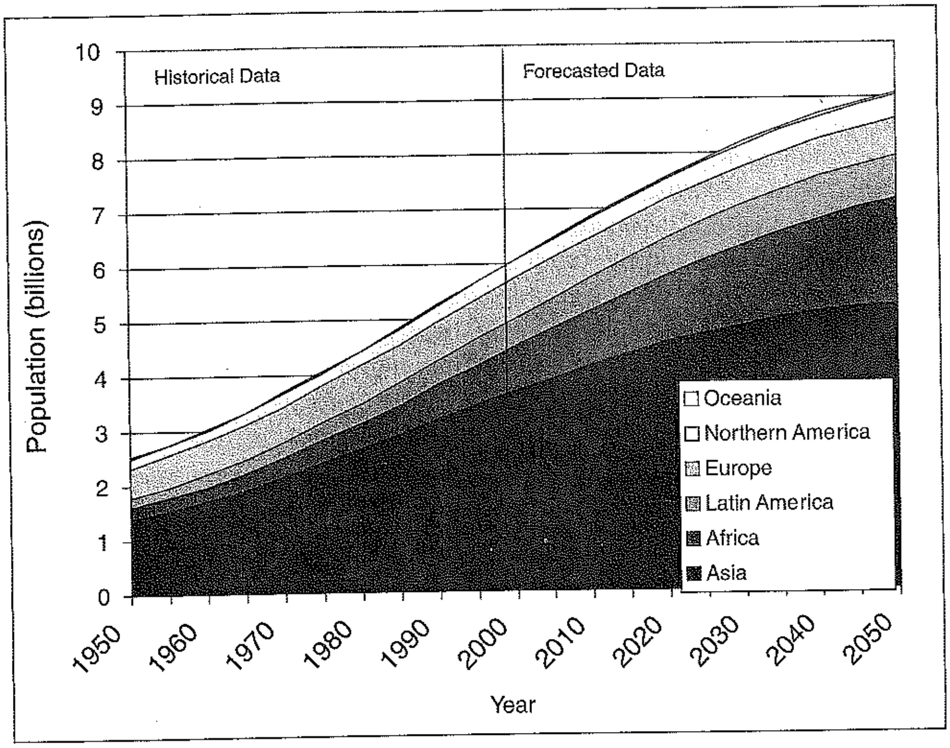

Figure 5.1 As you look at these historical data and the forecast to 2050, keep in mind that population forecasting is an inexact science. This graph shows the medium variant of the United Nations forecast, with a population of 9.1 billion in 2050. This medium variant is sandwiched between a high estimate of 10.6 billion and a low estimate of 7.67 billion. In the high variant, population would still be growing at almost 100 million per year in 2050; in the low variant, population would have peaked in 2040 and be starting a gradual decline.

Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2004 Revision and World Urbanization Prospects: The 2003 Revision, http://esa.un.org/unpp, 08 July 2005; 6:21:51 p.m.

B = births
D = deaths
I = in-migrants
O = out-migrants

The formula shows that births (B) and in-migration (I) add to the base population (P_1), while deaths (D) and out-migration (O) subtract from it. For many countries in the world (the United States is a notable exception), in-migration and out-migration do not contribute significantly to the overall balance sheet of population change, and we ignore them in discussions of current and future population change.

The **crude birth rate (CBR)**, the number of births per 1,000 persons, is a measure of the birth performance of a population. Similarly, the **crude death rate (CDR)**, the number of deaths per 1,000 persons, is an indicator of death experience of a population. Both measures are called crude because they fail to account for the different age structures of populations. This explains why Germany has a crude death rate of 10 while Mexico has a crude death rate of 5. You would be incorrect in concluding that life expectancy, medical care, and the overall quality of life are higher in Mexico. Germany's inflated crude death rate is a statistical artifact of its substantial elderly population. Some 19 percent of the German population is over 65 years of age, when the odds of dying are high. In Mexico a mere 6 percent of the population is older than 65 years. Relatively few Mexicans are in age classes where the likelihood of dying is high; thus, its crude death rate is low.

The **crude rate of natural increase** is the difference between the crude birth rate and the crude death rate. Take Burkina Faso in western Africa as an example. Burkina Faso's crude birth rate of 45 and the crude death rate of 15 yield a crude rate of natural increase of 30. Keep in mind that these are rates per 1,000, so an increase of 30 per 1,000 translates into a growth rate of 3.0 per 100, or 3.0 percent. The U.S. crude birth rate of 14 and death rate of 8 result in a crude rate of natural increase of 6 per 1,000, or 0.6 percent. Russia's rates are the reverse of those in the United States. The Russian crude birth rate of 12 and crude death rate of 15 produce a crude rate of natural increase of −3 per 1,000, or −0.3 percent (with rounding). If this rate were sustained, each year Russia's population would be 0.3 percent smaller.

As these examples indicate, birth, death, and growth rates across the world's countries vary markedly (Figure 5.2). (*Note*: These and other variables for every country can be found in the *Area and Demographic Data* on the *Human Geography in Action* Web site.) Geographers and demographers use the **demographic transition model** as a framework for understanding the dramatic variations in birth, death, and growth rates worldwide. Based on the demographic history of European countries, the demographic transition model offers a generalized perspective of the way birth, death, and growth rates change through time.

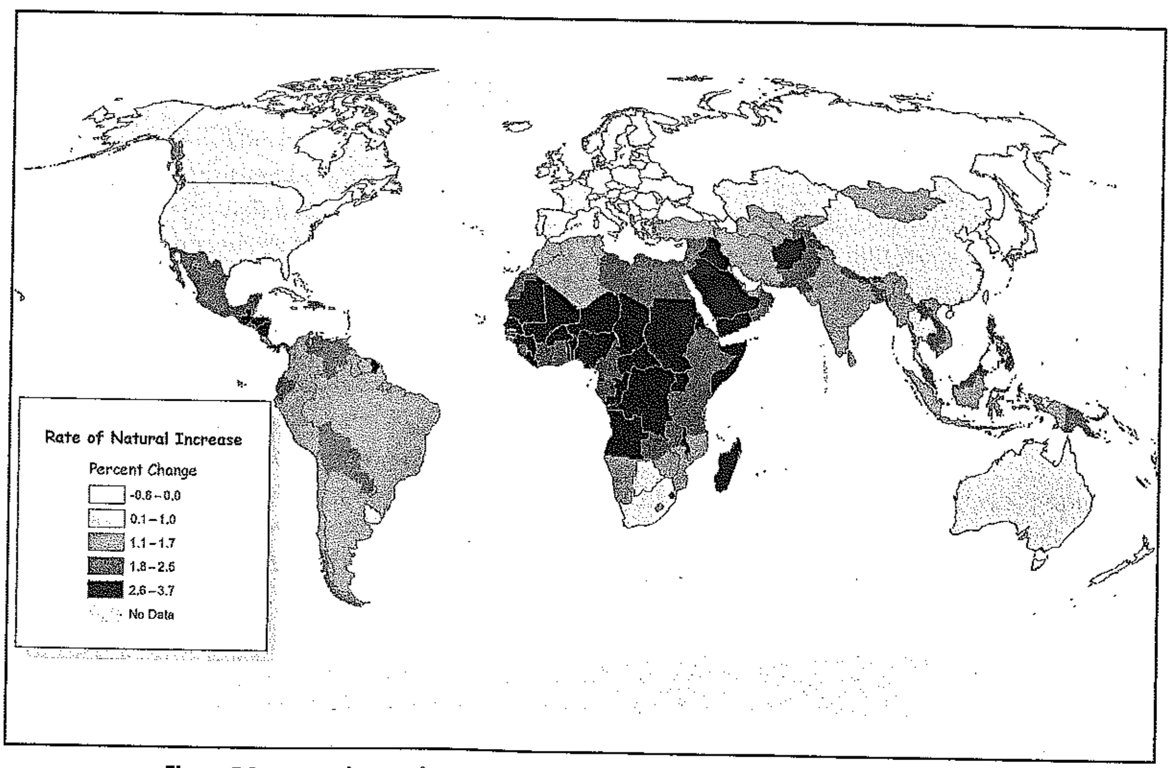

Figure 5.2 Annual rate of natural increase, 2004.
Source: Population Reference Bureau, *World Population Data Sheet 2004* (www.prb.org).

The demographic transition model says that preindustrial populations begin with high crude birth and death rates, somewhere between 40 and 50 per 1,000 (Figure 5.3). These conditions hold in primitive societies where people die young from poor diets, inadequate housing, rampant contagious disease, and the absence of modern medicine. To keep from becoming extinct, societies have many children and high birth rates. High birth rates and high death rates maintain an **equilibrium**, a state in which the forces making for change are in balance. This balance is reflected in extremely low rates of population growth.

Conditions of high birth and death rates and low growth prevailed for most of the time that humans occupied the earth. Populations eked by with infinitesimal growth rates of 0.56 per 1,000 from A.D. 1 to the time of the Industrial Revolution (Figure 5.4). High birth rates, high death rates, and low population growth characterize countries in the first stage of the demographic transition.

Modernization disrupts the balance between birth and death rates in the second stage of the demographic transition, which is characterized by declining death rates, continued high birth rates, and rapid rates of population growth. Death rates fall as food is transported from surplus to deficit regions, as housing improves, as knowledge about public health reduces contagious diseases, and as antibiotics, immunizations, and other innovations in science and medicine significantly prolong life. Birth rates, however, are slow to respond to the changing death situation because large family norms are deeply rooted in a society's cultural traditions. In addition, in agrarian areas, children are economic assets to the family, fetching water, gathering

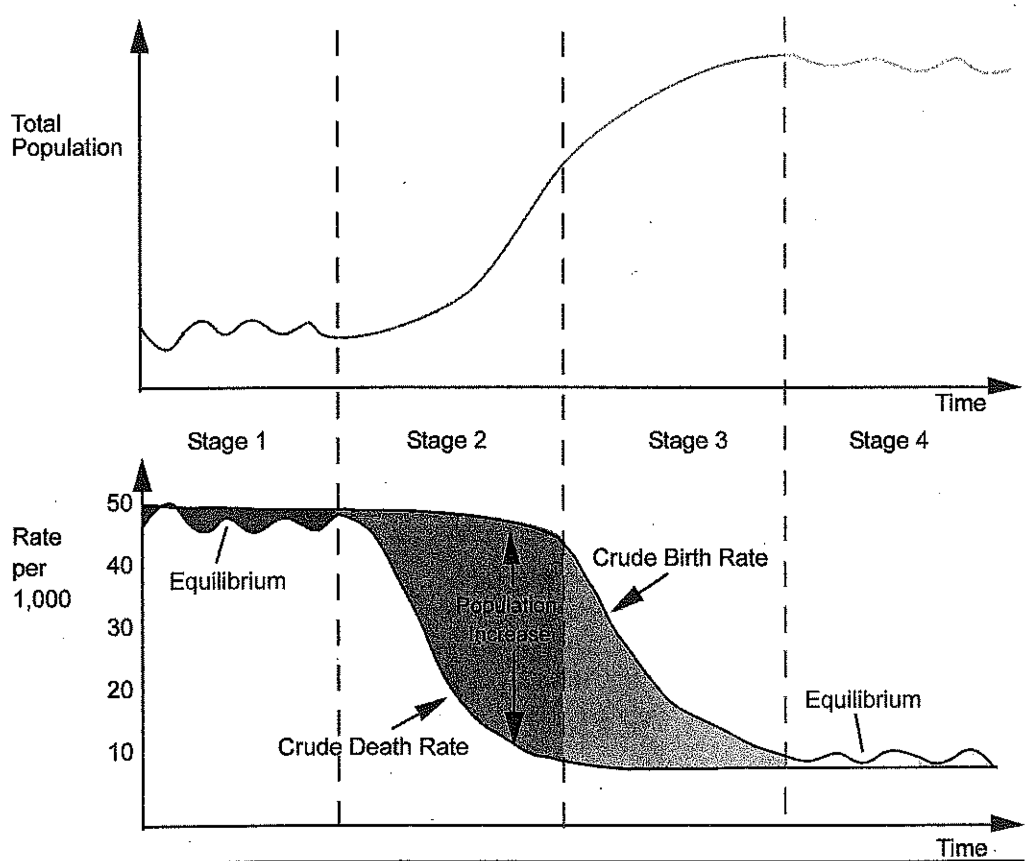

Figure 5.3 The demographic transition model.

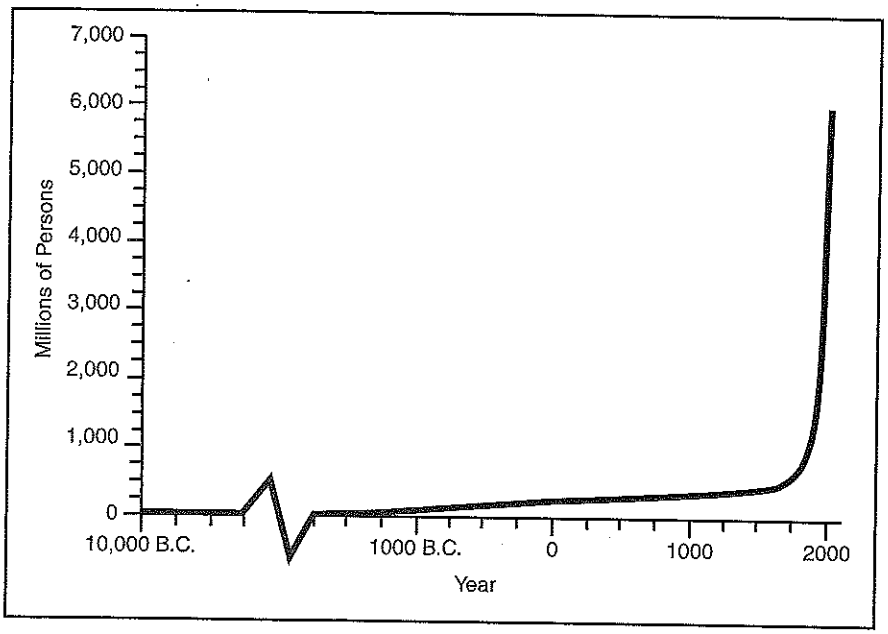

Figure 5.4 World population growth showing the rapid increase since the 1700s, which corresponds with the beginnings of the Industrial Revolution. Population growth before that time was very little. The zigzag you see shows a break in the data from 9250 B.C. until 1750 B.C. in order to extend the scale back to 10,000 B.C.

firewood, working the fields, tending the animals, looking after smaller children, and caring for aged parents. Because the world's population is still more than half (51 percent) rural, it is not surprising that many less-developed countries today are still in the second stage (Table 5.1).

In the third stage of the demographic transition, birth rates begin to fall in response to lower death rates, urbanization, and other changes associated with modernization. Fertility falls in modern societies as women derive status from activities other than childbearing and motherhood and as the cost of raising children mushrooms. Children in modern societies become economically active at much later ages than those in agrarian societies do, and they marry later. Families learn that it is no longer necessary to have six children if they want three of them to survive to adulthood. In addition, as literacy increases and contraceptive technology improves, people are better able to achieve their desired family size.

Ultimately, birth rates decline, and the demographic transition is complete. In the fourth stage, population returns to equilibrium, this time under conditions of low birth rates and low death rates. All more-developed countries are in the fourth stage of the demographic transition. In addition, China, with a crude birth rate of 12, crude death rate of 7, and growth rate of 0.5 percent, is moving rapidly toward stage 4.

Table 5.1 shows some of the range in birth, death, and natural increase rates. There are no countries in the world today still in stage 1 of the demographic transition, or even in early stage 2: crude death rates everywhere are below 32 per 1,000. The early twenty-first century finds countries in stage 2 that still have very high CBRs, countries in stage 3 with declining CBRs and low CDRs, and the more demographically stable countries in stage 4. Note the positive correlation between stage of the demographic transition and the percent urban, and the negative association between transition stage and the percentage of the workforce in agriculture.

TABLE 5.1 Key Population Indicators for Select Countries

Country	Demographic Transition Stage	Crude Birth Rate (per 1,000)	Crude Death Rate (per 1,000)	Rate of Natural Increase (percent)	Percent Urban	Percent of Workforce in Agriculture
Afghanistan		47	21	2.6	20	80
Nigeria	2	43	18	2.5	47	70
Palestinian Territory		37	4	3.3	72	15
Brazil		20	6	1.3	83	6
Mexico		20	5	1.6	76	15
Philippines	3	26	5	2.1	63	35
South Africa		23	15	0.8	59	9
Sri Lanka		19	7	1.2	15	34
Australia		14	7	0.7	87	4
Canada		11	7	0.3	81	2
Cuba	4	10	7	0.3	76	20
Germany		8	10	−0.2	73	2
Italy		9	10	0.0	68	4
United States		14	8	0.6	79	1
Bulgaria	Severe Population Decline	10	15	−0.5	71	9
Ukraine		10	16	−0.6	68	19

Sources: Population Reference Bureau, *World Population Data Sheet 2008*, http://www.prb.org; Central Intelligence Agency, *World Factbook 2008*, http://www.odci.gov/cia/publications/factbook
Natural increase does not always equal CBR-CDR/10 due to rounding.

Although the demographic transition is a compelling and extremely useful framework for viewing contemporary demographic change, it is not universally applicable. Some countries, such as Bulgaria and Ukraine (Table 5.1), do not fit in any stages of the demographic transition model. With high CDR and low CBR, they are losing about half of 1 percent of their population annually. Demographers do *not* consider their strongly negative population growth as a next stage beyond stage 4, because Russia and Ukraine are *not* more advanced economically and socially than Europe, North America, or Japan. Rather, the high death rates and low birth rates in Russia and Ukraine are viewed as a temporary anomaly resulting from the poverty, unemployment, and instability associated with their rocky transition from Soviet-style communism toward democracy and capitalism.

We must also be careful in using the demographic transition model to predict the future of less-developed countries currently in the second or third stages. Their economies and populations are so profoundly different from those of European countries when they went through the second or third stages of the demographic transition that we cannot be sure the demographic transition will be resolved in the same way. During the nineteenth century, most European countries experienced a massive exodus of population to the United States, Canada, Australia, New Zealand, and Latin America. Few such "migration escape hatches" exist now for rapidly growing less-developed countries.

In addition, populations in less-developed countries are much larger, densities are higher, and rates of growth are much faster. The death rates of less-developed countries fell much faster during stage 2 of their demographic transitions than they did for the more-developed countries (Figure 5.5). For instance, the death

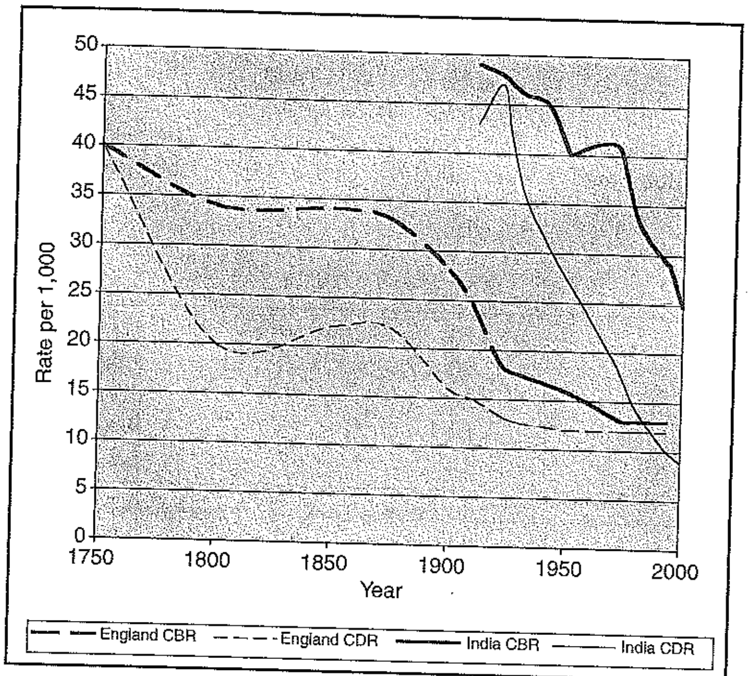

Figure 5.5 Contrasting demographic transitions of a more- and less-developed region: England and India. For both regions, the crude death rate (CDR) declined prior to the crude birth rate (CBR), but England started the demographic transistion much earlier and the changes occurred over a much longer time span. India is still undergoing the transition, so its CBR remains higher than the CDR.

rate of England declined gradually over a century or more with invention and diffusion of scientific improvements in agriculture, medicine, and modern sanitation. Comparable declines in less-developed countries such as India occur more quickly as countries acquire mortality-reducing technologies from more-developed countries. The steeper drop in death rates translates into growth rates that are higher than any experienced in the history of more-developed countries.

Also complicating completion of the demographic transition today is the nature of age structures in less-developed countries. There is momentum for continued population growth built into the extremely young age structures currently found in less-developed countries. Put simply, this means that future population growth cannot be avoided, even if countries are able to achieve small family sizes immediately. Take China as an example, Strict family-planning policies in China have reduced the average number of children to 1.6, lower than the 2.1 children per family average in North America. Still, the population of China continues to grow at a rate of 0.5 percent annually due to the large number of people in reproducing age groups.

The age structure of a population often is depicted in a **population pyramid**, a two-sided bar chart showing the distribution of population in various age categories, or **cohorts** as demographers call them (Figure 5.6). The horizontal axis shows the percentage of the population in a particular age group. The vertical axis shows ages, typically represented in 5-year intervals. Males are represented on the left side of the pyramid and females on the right. The term *pyramid* comes from times past, when there were more young than old people in national populations. Thus, the younger bars near the bottom were longer than the older ones near the top,

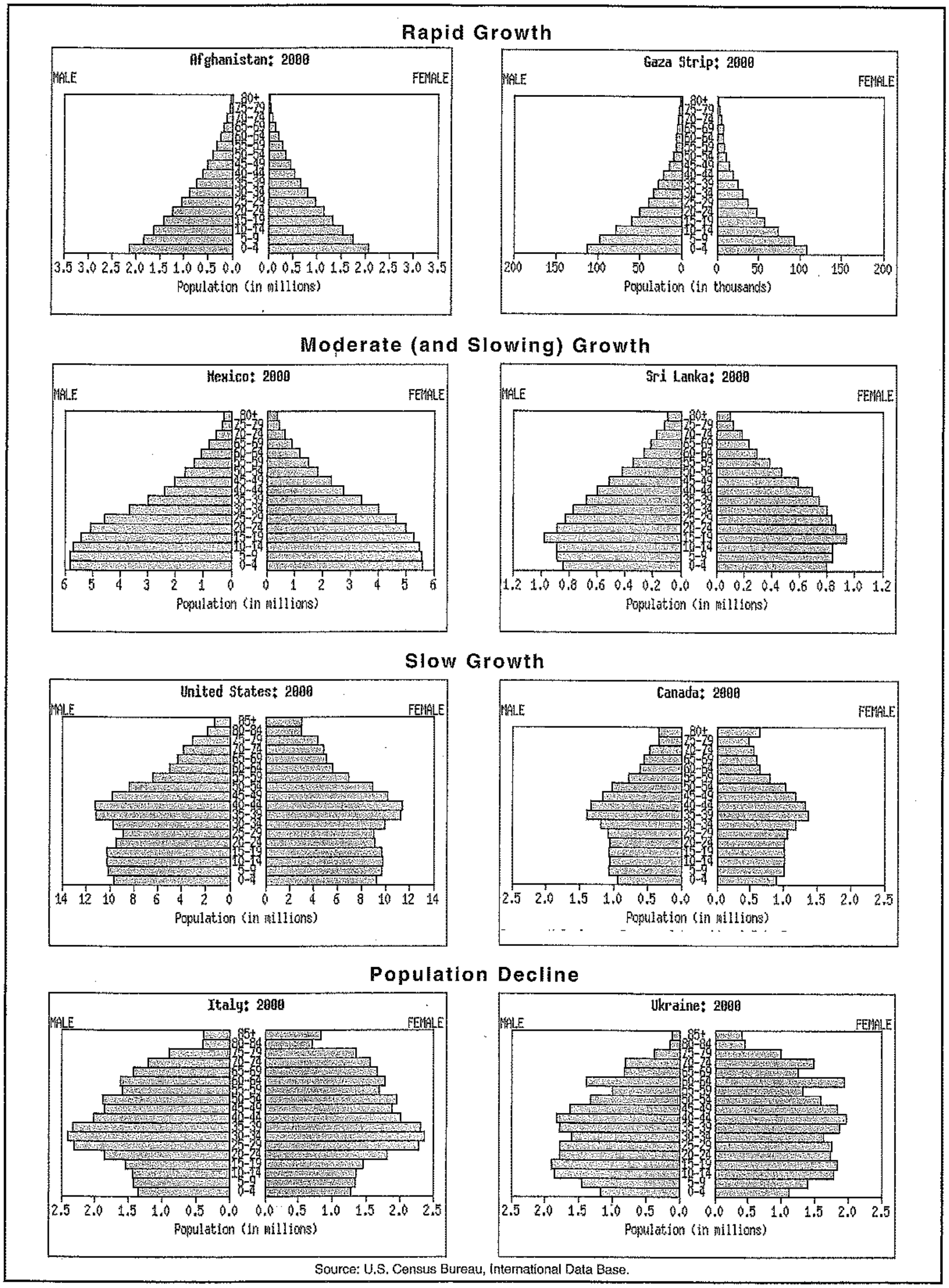

Figure 5.6 Examples of different countries' population pyramids.

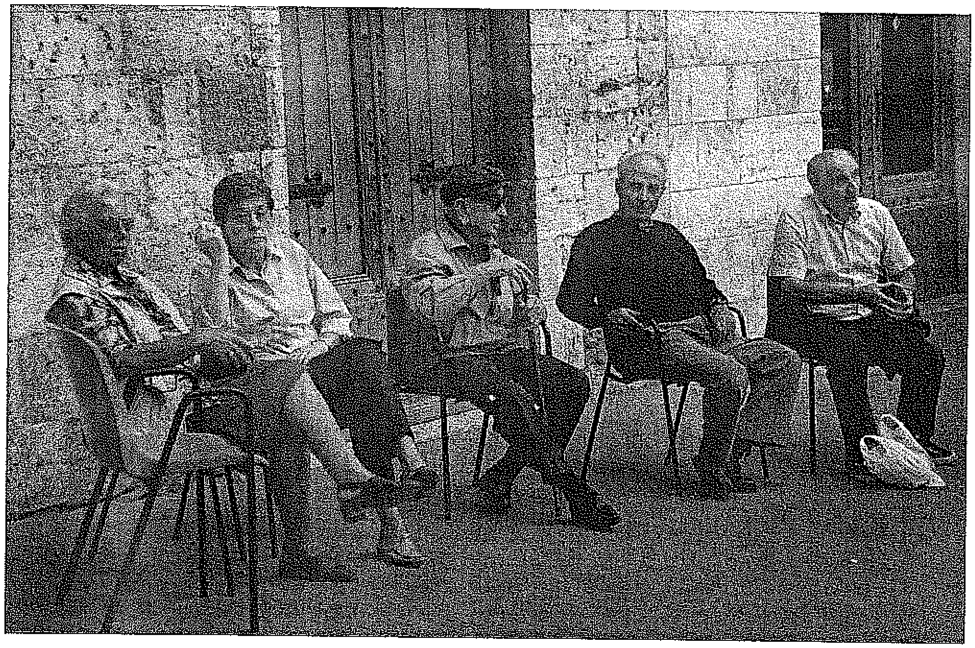

Figure 5.7 Elderly populations in a few countries, such as Italy, are now 20 percent of the total population and rising fast. How will these societies meet their growing needs for food, housing, transportation, and medical care?

creating a pyramid-shaped diagram. Today, however, the population pyramids for many countries are no longer shaped like pyramids.

The shape of a population pyramid is determined by the history of fertility (birth) and mortality (death) circumstances of a population. Countries with high birth and low death rates characteristic of stages 2 and 3 of the demographic transition model have age-sex structures with steeply sloping concave sides, large bases, and tiny tops (e.g., Afghanistan and Gaza Strip in Figure 5.6). In stage 4 of the demographic transition model, under conditions of low birth and death rates, age-sex structures do not look like pyramids at all. They resemble beehives with relatively straight sides sloping inward at the top (e.g., United States and Canada in Figure 5.6). Women usually outnumber men, especially in older age categories, because of the longer life expectancies for females than males. The typical life expectancy of women in North America is 81 years compared to 76 years for men. In Western Europe, 18 percent of the population is 65 and over, compared with just 3 percent in Africa and 7 percent in Asia. Already, wealthier countries with aging populations, such as Italy, are developing upside-down or tornado-like pyramids (Figure 5.6) and are starting to face the relatively new societal problem of a shrinking labor force having to provide for the needs of a burgeoning elderly population (Figure 5.7)

Of particular interest in an age-sex structure is the relationship between the generation that is currently bearing children, the so-called reproducing generation between the ages of 20 and 40, and their children at the base of the structure. In less-developed countries with triangular age-sex structures, the reproducing generation gives birth to a generation of children that is much larger than itself, often by a factor of 2 or even 3. This is symptomatic of high fertility and rapid growth.

Now contrast this situation with a beehive-shaped structure characteristic of more-developed countries. The reproducing generation is giving birth to a new generation that is about the same size as itself. These roughly equal-sized cohorts indicate that fertility is at or near the level needed for each generation merely to replace itself. The fact that older people eventually die leads to a tapering off at the top of the beehive.

The shapes of age-sex structures are strongly affected by **age-specific birth rates**. An age-specific birth rate is a precise indicator of the number of births occurring in each age cohort. More specifically, it is the number of births to women in a certain age cohort, say 25 to 29 years of age, divided by the number of women in that age cohort. Age-specific birth rates can be computed for all age categories in which women bear children, typically between 15 and 49 years. An age-specific birth rate tells us the likelihood that a woman of a certain age will bear a child in any given year.

If we add the current age-specific birth rates for all years from 15 to 49, we have a measure called the *total fertility rate*. Another way to think about the total fertility rate is that it is the number of children that an average woman would bear as she passes through her reproductive years. The **total fertility rate (TFR)**, often called the *average family size*, is a cross-sectional look at current fertility conditions. TFR ranges from a high of 7.1 children per woman in Niger and Guinea Bissau to a low of 1.1 in Taiwan. The TFR for the entire human race is 2.6 children per woman, which masks the differences between the more-developed countries (1.6) and the less-developed world (2.8, or 3.2 excluding China). China is a special case, with a one-child policy designed to dramatically slow (and eventually reverse) growth in its massive population of 1.3 billion people. The policy uses a variety of financial, medical, educational, and housing penalties and incentives; laws setting a minimum marriage age; and "birth planning" programs to convince people to have only one child. Originally designed in 1979 to cap the population at 1.2 billion by 2000, it has succeeded in lowering TFR only to 1.6, because of exceptions granted to farmers and ethnic minorities. Nevertheless, without the highly controversial one-child policy, China would have hundreds of millions more people today.

When the total fertility rate is about 2.0, the average woman and her spouse or partner are having just enough children to replace themselves. The population is said to be near replacement fertility. In developed societies such as North America or Europe, a total fertility rate of slightly more than 2.0 is needed to achieve **replacement fertility** because a small number of females will die before they reach an age at which they will reproduce. In high-mortality countries, a larger surplus of births is needed to account for the fact that many females born today will not live to an age when they will bear children. In such countries, a total fertility rate of 2.5 or 2.6 translates into replacement fertility.

The growth trajectory of a country is not determined by fertility conditions alone. The difference between the crude birth rate and the crude death rate determines the level of growth. When the number of births is equal to the number of deaths, the CBR minus the CDR equals 0, and the country is said to be at **zero population growth (ZPG)**. ZPG refers to the *current* relationship between births and deaths.

One of the more perplexing concepts for students to understand is how a population can have a total fertility rate at or below the replacement level and continue to expand through natural increase. Yet this is exactly what is happening in China, France, Thailand, Ireland, South Korea, and some other countries, including Canada, with a TFR of 1.6 children per woman and a natural increase rate of 0.3 percent per year. **Demographic momentum** (or hidden momentum) is what population geographers call this tendency for a population to continue to grow long after replacement fertility has been achieved. This phenomenon originates with young, triangular age structures similar to those found in less-developed countries today. When the base of the age-sex structure is wide, many people are at or will soon be in age groups that will bear children, that is, typically between ages 20 and 40. Very few people are at the top of the pyramid in age groups where the likelihood of death is high. Thus, even if the population were to achieve replacement fertility today, the sheer number of people in or near the base results in large numbers of births. The small number of old people at the top results in a small number of deaths. Remember that growth is the numerical difference between births and deaths, not between births and parents. ZPG is almost impossible to achieve in pyramids with large bases. It takes many years for the large base to work itself upward into older age groups where deaths typically occur. In Activity 2 of this chapter, you will see several scenarios that illustrate the hidden momentum of population growth.

Students interested in the population structure of Canada can view animations of population pyramids through time for the entire country or its provinces at www.statcan.gc.ca/kits-trousses/animat/edu06a_0000-eng.htm. This site demonstrates demographic momentum, as well as examples for rapid, moderate, slow, and declining growth.

The hidden momentum issue is the subject of this chapter. You will be asked to simulate demographic conditions in India based on how long it takes India to lower its total fertility rate from 3.2 in 2000 to approximately 2.4, the level that would lead to a stable population in the long run. Understanding this process will enable you to interpret the geographic distribution of current and future population growth.