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

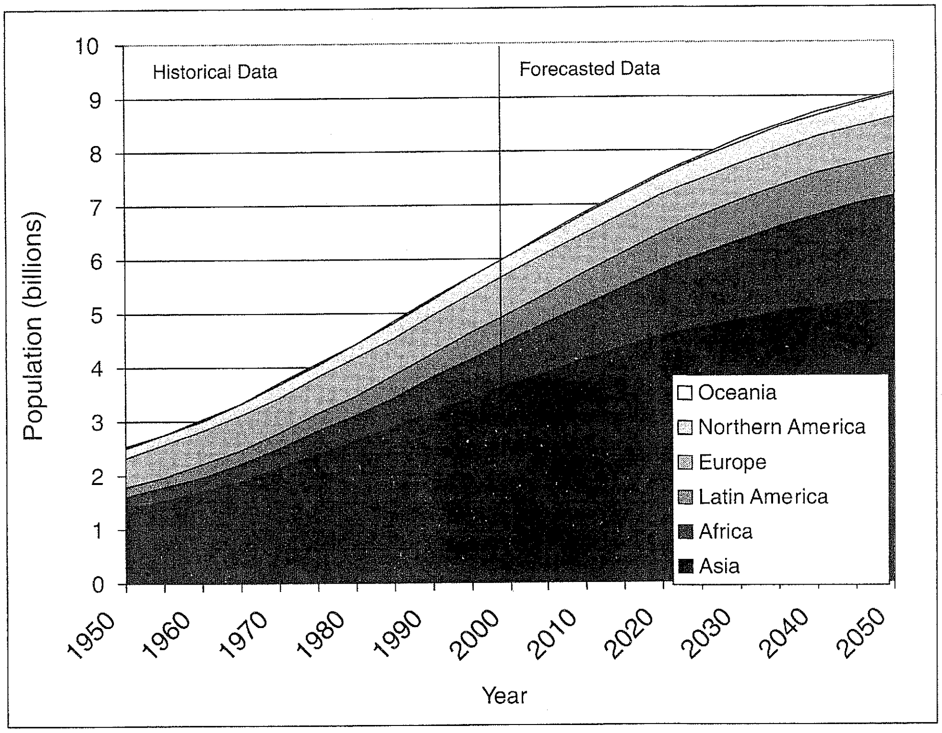


Figure 5.1 As you look at these historical data and the forecast to 2050, keep in mind that population forecasting is an inexact science. This graph shows the medium variant of the United Nations forecast, with a population of 9.1 billion in 2050. This medium variant is sandwiched between a high estimate 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.

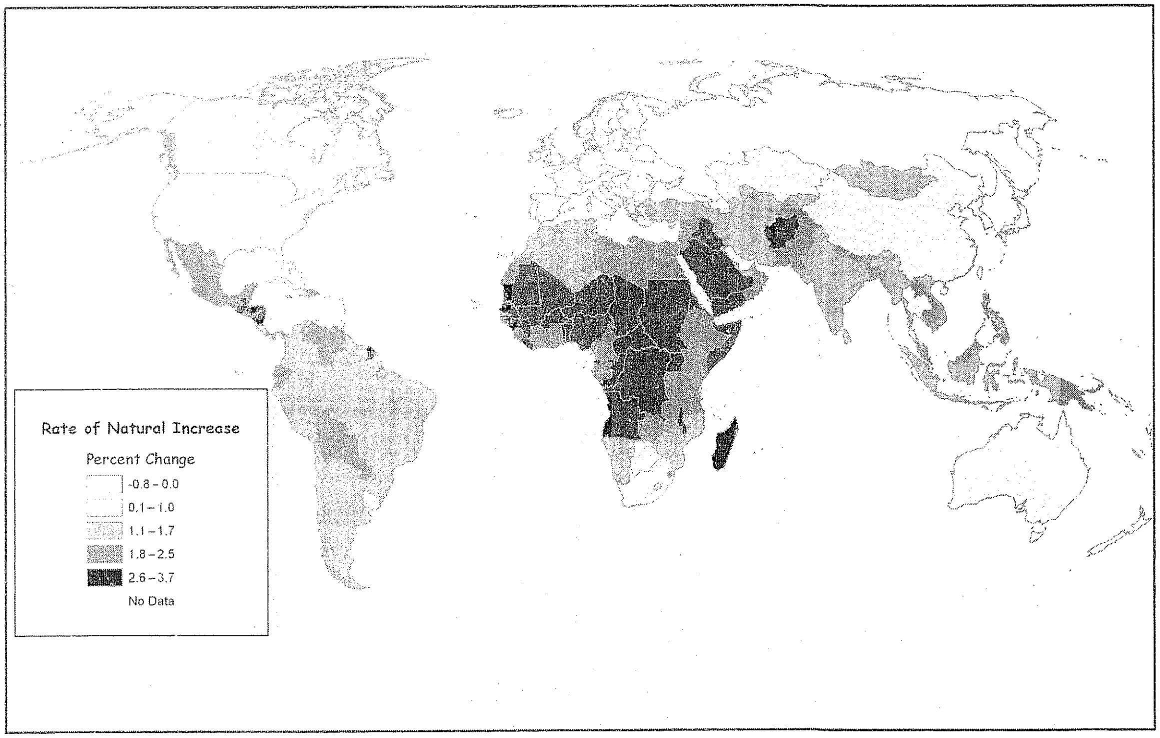


Figure 5.2 Annual rate of natural increase, 2004.
Source: Population Reference Bureau, *World Population Data Sheet 2004* (www.prb.org).

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

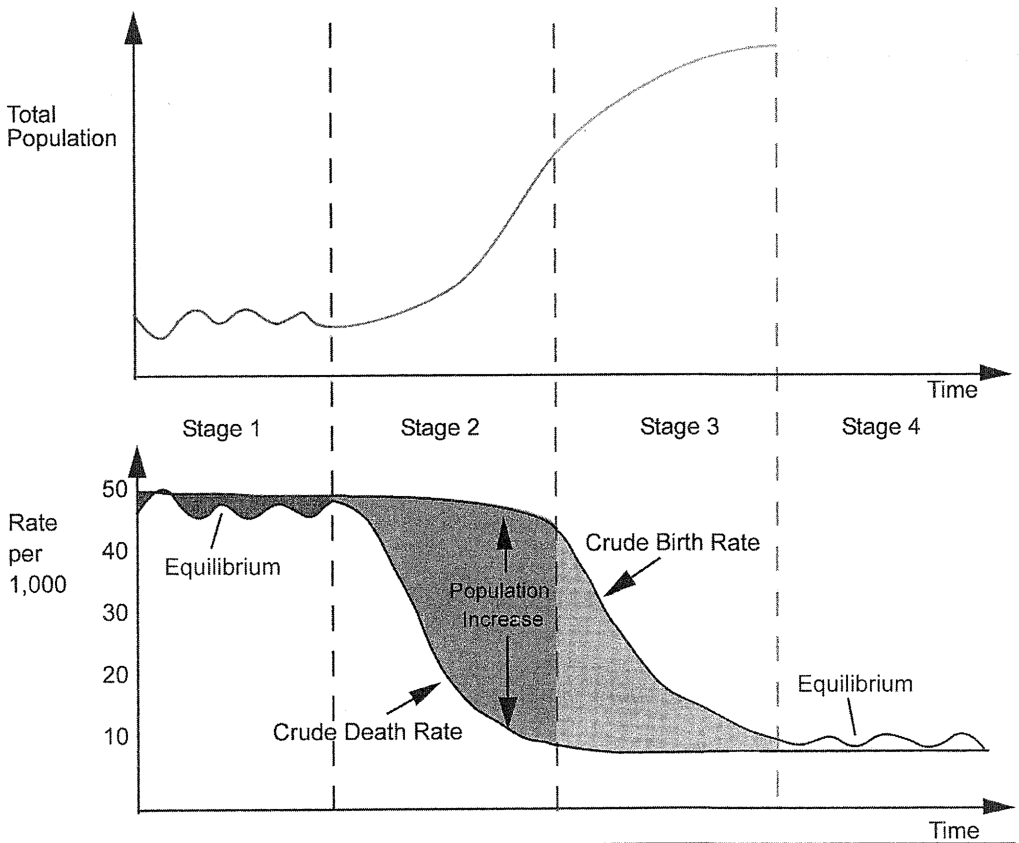


Figure 5.3 The demographic transition model.

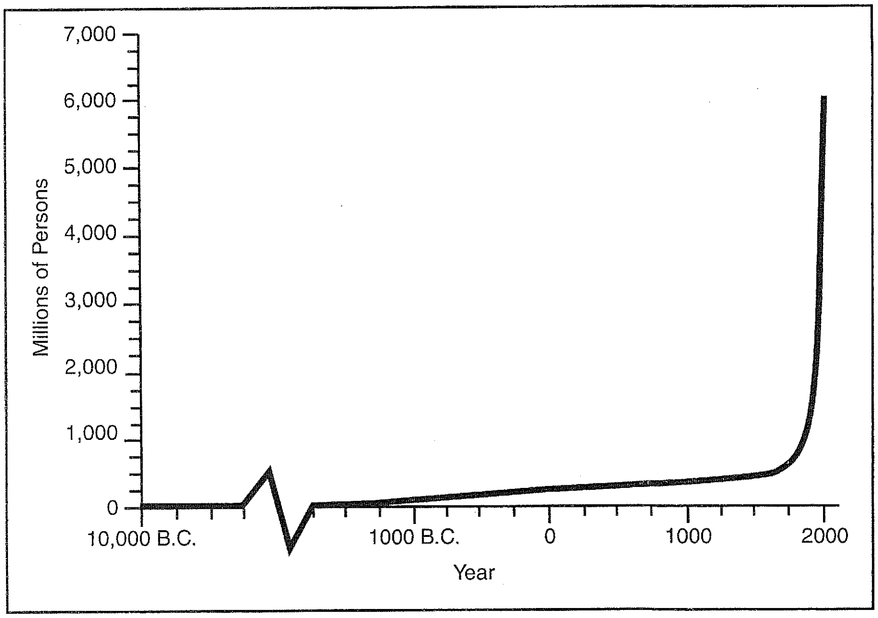


Figure 5.4 World population growth showing the rapid increase since the 1700s, which corresponds with the beginnings of the Industrial Revolution. Population growth before that time was very little. The zigzag you see shows a break in the data from 9250 B.C. until 1750 B.C. in order to extend the scale 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	2	47	21	2.6	20	80
Nigeria		43	18	2.5	47	70
Palestinian Territory		37	4	3.3	72	15
Brazil	3	20	6	1.3	83	6
Mexico		20	5	1.6	76	15
Philippines		26	5	2.1	63	35
South Africa		23	15	0.8	59	9
Sri Lanka		19	7	1.2	15	34
Australia	4	14	7	0.7	87	4
Canada		11	7	0.3	81	2
Cuba		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

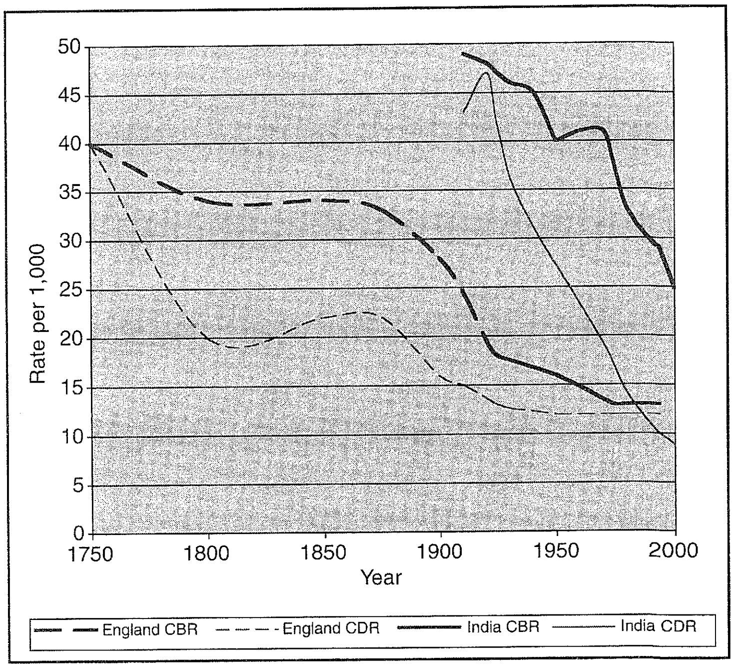
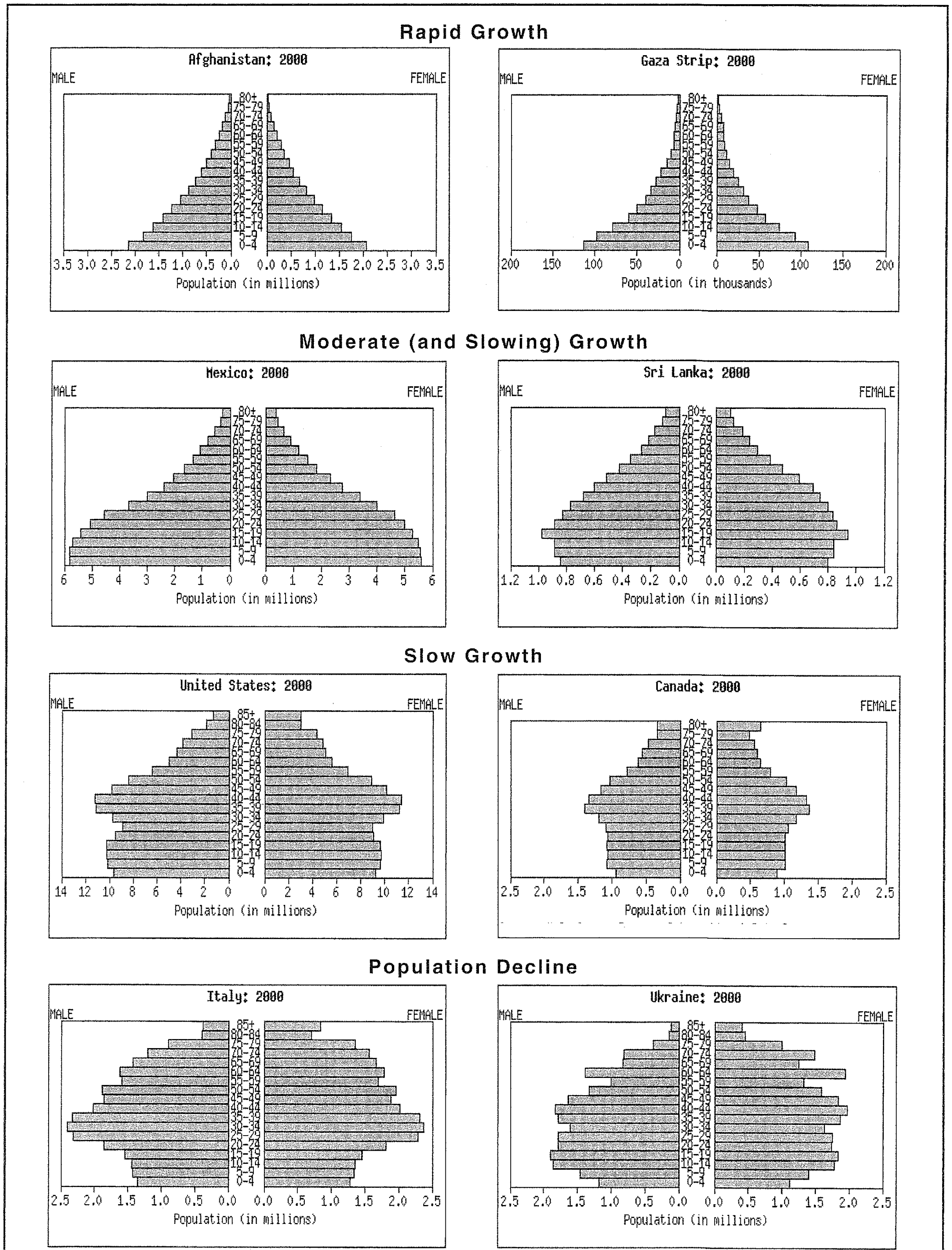


Figure 5.5 Contrasting demographic transitions of a more- and less-developed region: England and India. For both regions, the crude death rate (CDR) declined prior to the crude birth rate (CBR), but England started the demographic transistion much earlier and the changes occurred over a much longer time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



Source: U.S. Census Bureau, International Data Base.

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.

ONE BILLION AND COUNTING

GOAL

To learn how to interpret **population pyramids** and to apply that knowledge to understand population projections. You will simulate the effects of future fertility rate assumptions on the shape of pyramids and interactively examine the **hidden momentum** of population growth (i.e., why a long lag occurs between declining fertility and the end of population growth).

LEARNING OUTCOMES

After completing the chapter, you will be able to:

- Relate the shape of population pyramids to a country's birth, death, and growth rates.
- Differentiate population pyramids of countries with rapid, slow, and negative population growth.
- Understand the hidden momentum built into current population pyramids.
- Recognize the hypothetical nature of population projections.

SPECIAL MATERIALS NEEDED

- Computer with high-speed Internet access and a recent release of a Web browser. If using the student Companion Site with the printed book, click on *Tech Support* for system requirements and technical support. (If using the e-book in WileyPlus, click on *Help* for details about the system requirements.)

BACKGROUND

Sometime in 2000, India joined China in the One-Billion Club of demographic giants (Table 5.2). Because of its higher fertility, India is expected to surpass China within 30 years as the world's largest population. To understand India's current and future population prospects, it is important to know about its demographic history, the status of Indian women, efforts at family planning, connections with the rest of the world through international migration, and the environmental and societal effects of rapid population growth.

As with other developing nations, India's population growth before World War II was slow, owing to high death rates and low life expectancies (Figure 5.8). Epidemics of plague and cholera and famines kept the death rate high and population growth low. Fertility was high to compensate for the loss

TABLE 5.2 Ten Most Populous Countries, 2008

Rank	Country	Population in 2008 (millions)
1	China	1,325
2	India	1,149
3	United States	305
4	Indonesia	240
5	Brazil	195
6	Pakistan	173
7	Nigeria	148
8	Bangladesh	147
9	Russia	142
10	Japan	128

Source: 2008 World Population Data Sheet of the Population Reference Bureau.

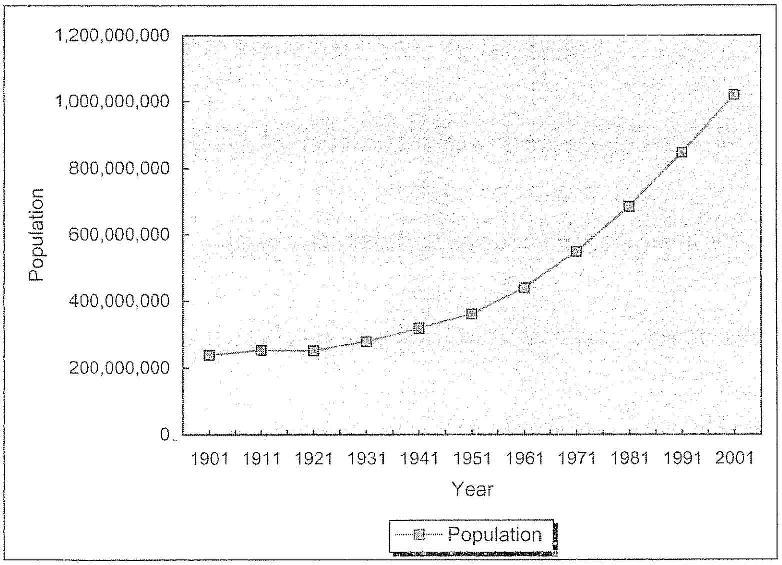


Figure 5.8 India's population, 1901 to 2000.
Source: www.censusindia.net.

▶ CASE STUDY (continued)

of children and to ensure that families would have enough sons to work the land and to take care of them in old age. India was in Stage 1 of the **demographic transition** with high fertility, high mortality, and slow population growth.

The beginnings of modernization after World War II improved health and diet. Life expectancy, which was only 32 years at the time of Indian independence in 1947, rose to 58 years in the 1980s and to 65 years today. The **infant mortality rate**, the number of babies who die before their first birthday (per 1,000 live births), fell from between 200 and 225 in 1947 to 90 during the 1980s and to 57 today. Initiated during the 1970s, the national government's program to provide free immunization to all children reduced the risk of contagious diseases such as tuberculosis, diphtheria, pertussis, tetanus, polio, and measles and was a major factor in reducing childhood death. Still, India's childhood immunization program misses a considerable percentage of children, especially in rural areas. Studies also show that children of illiterate mothers are less likely to be immunized than children of literate mothers, and girls are less likely to be immunized than boys.

As the demographic transition model predicts, the decline in birth rates in India lagged the decline of death rates (Figure 5.5). Norms of high fertility were, and still are, deeply ingrained in traditional Indian culture. Although India is the home of three of the world's 15 largest cities (Mumbai, Calcutta, and Delhi), 72 percent of the population lives in the rural countryside where incomes depend on agriculture, illiteracy is high, and the status of women is low (Figure 5.9). Despite rapid economic growth, there are still not enough jobs for the recent flood of young people entering the workforce, and a rigid class structure inhibits upward mobility. India is home to 40 percent of the world's poor, and among these lower classes, illiteracy, hopelessness, and dependence on traditional value systems keep birth rates high. India today falls squarely in the third stage of the demographic transition with high but falling birth rates, low death rates, and rapid population growth.

Although fertility in India is high by world standards, it has fallen rapidly since the early 1970s. The **total fertility rate**—the average number of children a woman would have under current age-specific fertility rates—provides the best indication of fertility change over time. From a six-child average in the 1960s, the TFR fell to 3.1 by 2005, the base year for the simulation in Activity 2 (Figure 5.9), and to 2.8 by 2008 (Figure 5.10). This decline is substantial and significant in the context of the country's rural roots and traditional culture, but fertility remains above the replacement standard of two children per woman that prevails in societies that have completed the demographic transition. Pivotal factors in fertility decline have been an increase in the average age at marriage for women, from 16 in 1961 to about 22 today, and higher rates of contraceptive use, from 13 percent in 1970 to 56 percent today.

One of the biggest barriers to further fertility decline is the low status of Indian women. Evidence from the rest of the world shows the strong link between women's status and fertility. Literate, working women define their worth beyond the number of children they produce for the family. In most Indian

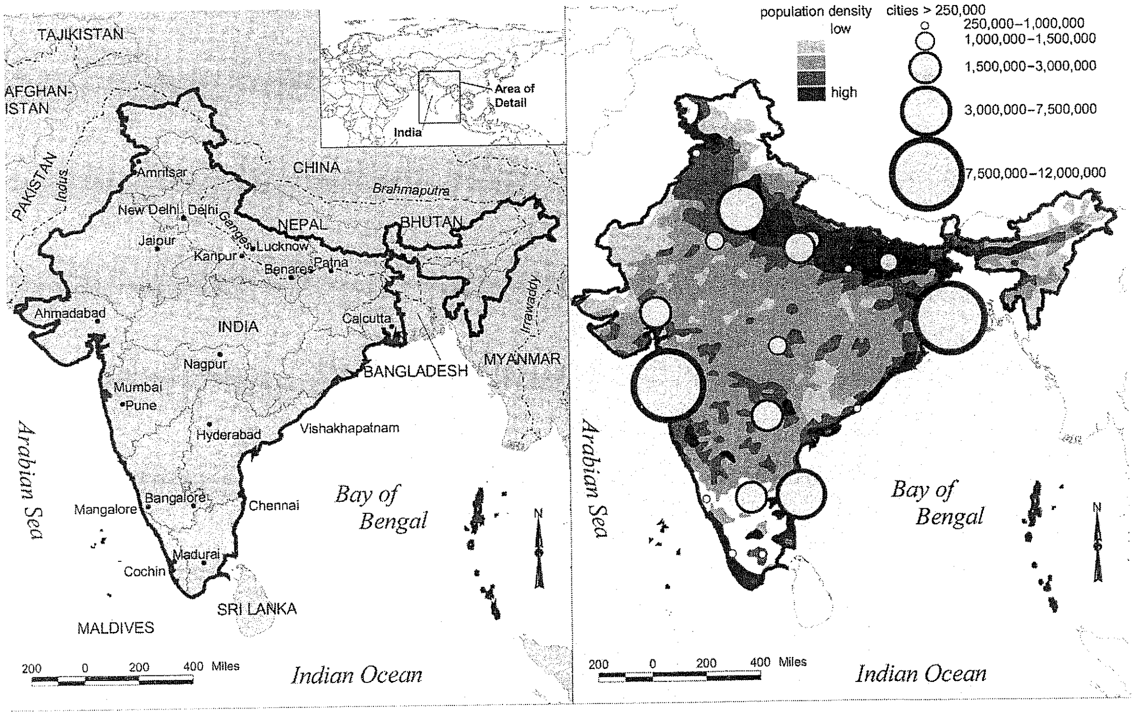


Figure 5.9a (left): India reference map, with major cities shown.
Figure 5.9b (right): India population density and major city population.

▶ CASE STUDY (continued)

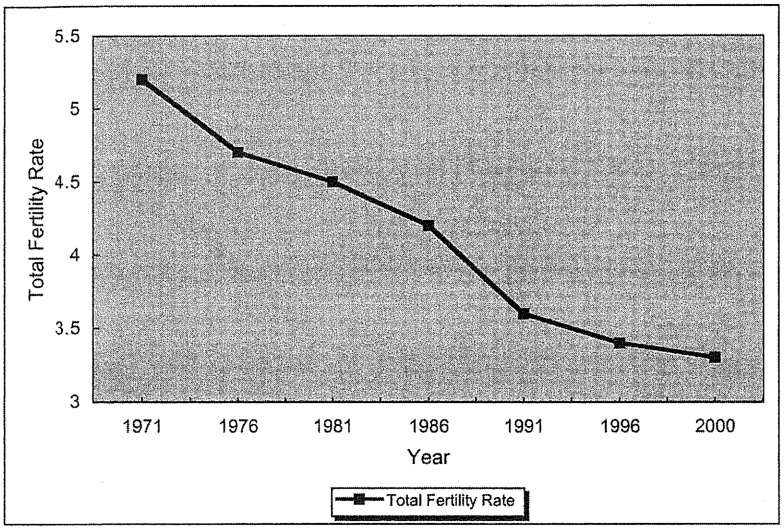


Figure 5.10 Total fertility rates in India, 1971 to 2000.
Source: Vital Rates for India 1971–1996, based on the Sample of Registration System (SRS). New Delhi: Registrar General of India, 1998.

families, males continue to make decisions about finances, work, social relationships, and selection of spouses. Marriage customs rely on arranged marriages, patrilineal inheritance systems, and wives who move in with their husband's family and then have little contact with their family of birth.

Related to the status and position of women in Indian society, a strong cultural preference for sons over daughters continues. This preference promotes neglect of female children, especially in poor families. Neglect can be extreme as in the case of outright infanticide among girl babies or more subtle as in failing to inoculate girls against childhood diseases or not sending them to school. Neglect of females leads to a deficit of women in the Indian population. Most populations contain more women than men because of higher across-the-board mortality among males. Because of the extremely low status of women, India's population has 5 percent more males than females.

Faced with high fertility and unprecedented population growth, India initiated a family-planning program during the 1950s. The program evolved from one focused on increasing the availability of family planning methods to a more all-encompassing view of family planning as integrated with efforts to improve overall health, reduce poverty, protect women's rights, and maintain the environment. Early efforts at family planning stressed methods over motivation and failed because Indian couples were not ready to accept family planning or were concerned about the risks of contraceptive use. In one ill-fated example, 800,000 to 900,000 Indian women were fitted with intrauterine devices (IUDs) in the mid-1960s. Real and perceived IUD-related health risks caused IUD use to plunge, and the method has never again gained widespread popular acceptance.

Frustrated by slow progress toward fertility reduction, many government officials rejected family planning as a means to slow population growth in the mid-1970s. At the 1974 World Population Conference in Bucharest, the Indian delegation articulated the now-familiar slogan that "development is the best contraceptive." In their minds, contraceptives are only a means to an end—a vehicle to help people achieve the family size they desire, however large that size may be. Without development and all that it includes—education, rising income, upward mobility, and urbanization—the view was that family planning would be unable to reduce fertility. This view has been moderated subsequently with growing evidence from India and elsewhere that family-planning programs can reduce fertility even without the obvious benefits of development. For instance, in neighboring Bangladesh, a small, mostly rural, country the size of Wisconsin with almost half as many people as the United States, TFR has fallen to 2.7 children per woman as a result of a strong government program of community-based family planning.

In the late 1970s, the Indian government established sterilization clinics around the country and offered financial and material incentives (e.g., money, bags of rice, radios) to those agreeing to the procedure (Figure 5.11). The national government gave local officials sterilization "targets" to achieve, and rumors of forced sterilizations soon swept India. As a result, the Indian people voted President Indira Gandhi out of office, and subsequent democratically elected governments have been careful not to cross the line to the kinds of punitive methods of fertility control practiced in nondemocratic China.

Today's program in India offers a wide range of contraceptives, including permanent sterilization and more reversible methods, such as oral contraceptives and IUDs, that appeal to a wide range of couples; administration is decentralized so programs can be sensitive to local area differences in language, religion, literacy, and economic development; and family planning is linked to women's reproductive health rather than viewed merely as a means of population control.

India has a vast **diaspora** across the world, with people who maintain close contact with families at home and are agents

▶ CASE STUDY (continued)

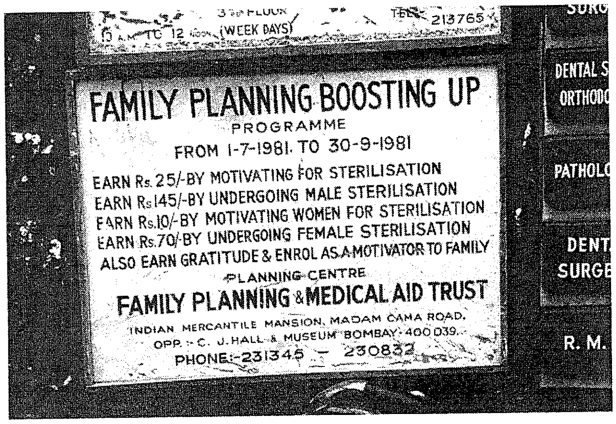


Figure 5.11 A sign outside a medical facility in Mumbai in 1978 entices passersby with money in payment for voluntary sterilization.

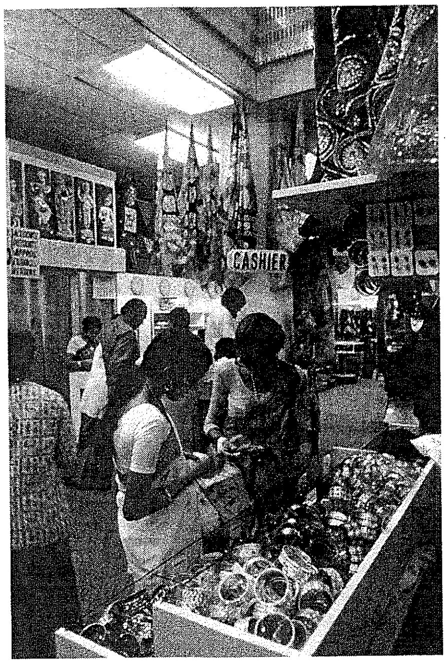


Figure 5.12 Women of Indian descent shopping at an Indian market in Durban, South Africa. Mohandas "Mahatma" Gandhi practiced law in South Africa from 1893 to 1914, where he was mistreated by whites for defending Asian immigrants. He developed the strategy of passive resistance there, which he used to lead India to independence from Britain in 1947.

of economic and social change. While India was a colony of Great Britain, many Indians emigrated to countries of the Commonwealth to provide plantation labor and to help build railroads. Large communities grew up in Guyana, Trinidad, Kenya, South Africa, and other British colonies and protectorates (Figure 5.12). More recently, Indians have moved to more-developed countries in search of high-wage jobs. This so-called brain drain draws off some of India's most ambitious and best educated people, but because emigrants send more than $3 billion to family at home, migration is a major source of income for the nation. There is considerable debate about whether remittances to family from Indians living abroad are spent on unproductive consumer goods (houses, cars, clothing, etc.) or used for education and to start businesses—investments that reap long-run returns for the Indian economy.

Major destinations for highly educated Indian migrants today are the United States, Great Britain, Canada, and Australia. Until 1990, the Persian Gulf also had drawn many Indian migrants, but they were forced to return home during the Persian Gulf crisis between Iraq and Kuwait. Slowing economies and the reluctance of Middle East governments to allow workers to bring their families or settle eventually reduced this historically and economically significant migration stream.

The social and environmental implications of rapid population growth in India are serious. The challenge of feeding more than 1 billion people puts extreme pressure on environmental resources. Supplies of fresh water are stretched to the limit, and soil exhaustion and erosion become major problems when farmland is overworked. In an effort to develop remaining arable land, farmers expand into marginal areas by cultivating low-lying, hurricane-prone islands in the Ganges delta, building terraces on steep mountainsides prone to landslides, and overgrazing arid lands. Thus far, increased use of fertilizers, pesticides, irrigation, and hybrid seeds (see discussion of the Green Revolution in Chapter 8) has enabled India to become more or less self-sufficient in food supply, but 20 percent of the population is undernourished, and many poor people cannot afford the food that is available.

India's growth is outstripping the country's ability to provide social services and education to its entire population. Tens of millions have left rural India for the major cities, which cannot accommodate the huge influx of migrants. Millions of people are estimated to live in makeshift housing in squatter settlements around Mumbai, Calcutta, and Delhi without adequate sanitation and water supply, electricity, schools, and medical care. All three cities are predicted to grow by more than 33 percent from 2000 to 2015, with Mumbai surpassing 26 million people and possibly becoming the world's largest city.

It is hardly all doom and gloom, however. In addition to being the world's largest democracy, India has the largest middle class in the world. Its universities are first rate, its railway system is extensive, and it is industrializing rapidly. From 1990 to 2005, India's economy grew at an average rate of 6 percent per year—faster than any country in the world except China. Knowledge-based industries, particularly software engineering, are leading India's economic expansion and attracting foreign investment (Figure 5.13). Yet the rapid population growth puts the brakes on the rate of development by siphoning off capital

▶ CASE STUDY (continued)

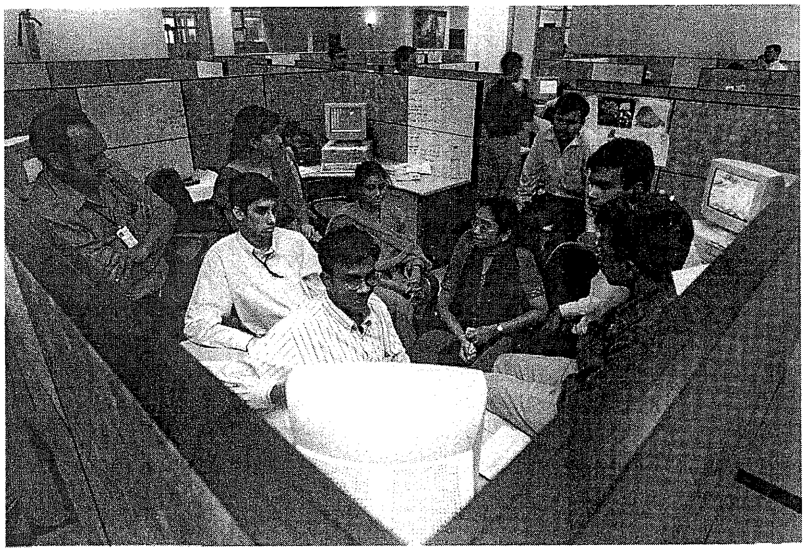


Figure 5.13 India is training ground for one of the world's largest technology work forces. Bangalore, home to the Indian Institute of Technology in South-Central India, is one of India's main high-tech centers.

surpluses that could have been invested in industrial infrastructure and technology but instead must be used for food, clothing, housing, health care, and education for the large cohort of children (Figure 5.14).

You will be asked in this exercise to put this background information to work in interpreting the shape of India's age-sex pyramid and in explaining the consequences of different future population scenarios. Due to the process of **demographic momentum** discussed earlier in this chapter, India is locked into future population growth by virtue of the high fertility in its recent past.

Figure 5.14 Children in Bangalore, India.

Name: ______________________ Instructor: ______________________

One Billion and Counting: The Hidden Momentum of Population Growth

ACTIVITY 1: MATCHING DEMOGRAPHIC DESCRIPTIONS WITH POPULATION PYRAMIDS

A. To start your activity, click on the *Student Companion Site* at www.wiley .com/college/kuby. (For students using WileyPlus, log on to your class Web site, select the *Assignment* tab, locate and click on this assignment, and follow all instuctions.)

B. Select this chapter from the drop-down list and then click on *Computerized Chapter Activities*.

C. Click on *Activity 1: Matching Demographic Descriptions with Population Pyramids*.

1.1. Match the verbal description of a country's demographic composition (at the top of the screen) with the correct population pyramid. Click on the pyramid to check your answer. To go to the next description, click on the *Next Description* arrow in the right margin. Write the correct answer and the country name here:

Description 1: "A country with rapid population growth" matches population pyramid __________ Country name ________________.

Description 2: "A country that shows the demographic effects of World War II" matches population pyramid _________ Country name _______________.

Description 3: "A country at close to ZPG (zero population growth)" matches population pyramid __________ Country name ________________.

Description 4: "A country that has undergone a recent shift from high to low fertility" matches population pyramid ________ Country name ____________.

Description 5: "A country with many temporary immigrant workers" matches population pyramid __________ Country name ________________.

Description 6: "A country with a declining population" matches population pyramid __________ Country name ________________.

D. When you have finished, close all browser windows.

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One Billion and Counting: The Hidden Momentum of Population Growth

ACTIVITY 2: DEMOGRAPHIC MOMENTUM

Activity 2 of this chapter will use the population pyramid for India. To demonstrate the hidden momentum of population, you will run several scenarios of population change. Underlying these scenarios are two assumptions that relate to (1) the final total fertility rate (TFR) and (2) the number of years until that rate is achieved. You will experiment with changing the final TFR and the length of time it takes to get there. Once these assumptions are set, you will scroll through the years and watch India's population pyramid and total population change. This simulation will enable you to see when, if ever, population growth stabilizes, and at what level.

India begins with a TFR of 3.1 and a population of 1.1 billion in 2005 (based on U.S. Census Bureau and Census India estimates). By changing the final TFR either upward or downward, you can determine in the long run the number of children Indian women will bear. By changing the number of years to achieve that rate, you determine how long it will take for India to move to the new TFR position. Although the graphs start in 2000, your TFR assumptions will be put into effect starting in 2005.

In addition to these two assumptions, the computer incorporates (1) age-specific mortality rates, (2) age-specific fertility rates, and (3) the sex ratio of newborn children. The simulation resembles a conveyor belt that moves each cohort ahead in 5-year increments. Every five years, deaths are "trimmed off" the bar graph according to the age-specific, gender-specific death rates that generally increase with age. As the conveyor belt moves women through their childbearing years, children are added to the bottom of the pyramid according to the TFR you have specified and the age-specific birth rates of women 10 through 49. These births are added at a sex ratio of 51.2 percent male and 48.8 percent female, the biological average. Fortunately, the computer will automatically perform all calculations rapidly, and you can visualize the changes over time based on your assumptions.

It is important to recognize that any population simulation or projection is hypothetical in nature. One must exercise caution in dealing with simulations. One of the dangers of projecting future population change is assuming that various demographic parameters will stay the same in the future. Fifty years ago, few demographers would have imagined European countries with fertility rates barely above 1.0 or that a disease called AIDS would kill tens of millions of people in Africa. Fifty years from now, future demographers might say that no one foresaw the dramatic increase in life expectancy that resulted from artificial organs, a cure for cancer, or the mapping of the human genome—changes that would render most of today's population projections too low. In our case, although we allow total fertility to change, we assume that age-specific death rates, life expectancy, and the ages at which women give birth will all remain the same. Although we acknowledge the hypothetical nature of future projections by asking you to perform multiple "what-if" simulations, keep in mind that other parameters besides TFR will also change.

A. To start your activity, click on the *Student Companion Site* at www.wiley.com/college/kuby. (For students using WileyPlus, log on to your class Web site, select the *Assignment* tab, locate and click on this assignment, and follow all instuctions.)

B. Select this chapter from the drop-down list and then click on *Computerized Chapter Activities*.

C. Click on *Activity 2: Demographic Momentum*.

D. On the left side of the screen you will see the 2000 population pyramid of India. Try moving the mouse over the bars of the pyramid to see the exact population in both absolute and percentage terms. This will be especially useful for certain scenarios in which there will not be room to display an entire bar because the cohort in question surpasses the maximum of 15 percent that can be displayed.

On the upper right is a graph of India's population growth since 1900, and on the lower right is a demographic transition graph. These will change as you run different simulations. Try moving the mouse over the dots on the graphs.

Below the pyramid, in the bottom two gray boxes, you will see the variables you can adjust in these simulations. *Final Total Fertility Rate* is set to 3.1, the 2005 level; the allowable range is 0–10. *Years to Achieve Final TFR* is set to 0; it refers to years beyond 2005, the base year. For the following scenarios, you will adjust these variables and see what effect they have.

Scenario 1: Base Case, No Change in Total Fertility Rate

E. Assume no changes in India's fertility rate. Leave the *Final Total Fertility Rate* at 3.1, the 2005 value for India. Leave *Years to Achieve Final TFR* at 0, meaning this level is reached immediately. Click *Animate* and watch as the pyramid and graph evolve. To review the animation and freeze it at any year, use the up and down arrows on the screen to change the *Currently Shown Year*.

2.1. What would India's population be in 2050? ____________________________.

2.2. The Population Reference Bureau reports the world's mid-2005 population as 6,396 million (or 6.396 billion). If India were to maintain its current fertility rate, how would its 2100 population compare to the current global population, in percentage terms?

India's population in 2100 would be roughly ________________________________ percent of the 2005 global total.

2.3. India's 2005 population was 1,103 million. Approximately when would that population double, assuming the current fertility rate? __________________________.

2.4. Describe the shape of the population pyramid in 2100. ____________________
____.

2.5. The gap between the crude birth rate (CBR) and the crude death rate (CDR) equals the rate of population change. Would this gap ever close if the TFR remains at 3.1? ______________________________.

2.6. What would the annual rate of change of population be in 2100, in percentage terms? Calculate it as (CBR – CDR)/10, which gives you the rate of change in percentage terms. You can find out the exact CBR and CDR by mousing over the CBR and CDR dots in the graph.________________________________.

Scenario 2: Instant Replacement Level

F. Next, assume that *overnight*, as of 2005, Indian women average 2.4 children. Use the up and down arrows to set the *Final Total Fertility Rate* to 2.4 and the *Years to Achieve Final TFR* to 0 (since we are assuming this level is reached immediately).

2.7. When would India's total population stop growing and more or less stabilize? ________________________________.

2.8. What would be the approximate population when it stops growing? ________________________________.

2.9. What would happen to the birth and death rates at the time when the population stops growing? ________________________________.

G. Change the *Currently Shown Year* to 2020. Compare the size of the newly born 0- to 19-year-old generation (i.e., the children) with the size of the 20- to 39-year-old generation (i.e., their parents). (As you add up the cohorts, you can round each one to the nearest million before adding them up.)

2.10. Would the children's generation "replace" the parents' generation in terms of *approximately* equal numbers of people (+/– 25 million)? ________________________________.

H. The comparison in Question 2.10 between parents and children does not, in the short term, control whether the population grows or not. For that you must compare births to deaths. Move the year shown back and forth between 2005 and 2025. Compare the size of the oldest four cohorts in 2005 (all of whom die between 2005 and 2025) to the youngest four cohorts in 2025 (all of whom were born between 2005 and 2025).

2.11. Would there be more births or elderly deaths between 2005 and 2025? ________________________________.

2.12. By the year 2100, which of the four types of pyramids in Figure 5.6 would India's population pyramid most resemble? ________________________________.

2.13. Assuming that achieving replacement-level fertility is desirable, is the assumption of 0 years to reach replacement fertility realistic, optimistic, or pessimistic? ________________________________. Why? ____.

Scenario 3: Forty Years until Replacement Fertility

I. Assume that a replacement-level TFR of 2.4 is India's ultimate goal but be more realistic about when that goal can be achieved. Leave the *Final Total Fertility Rate* at 2.4. Set the *Years to Achieve Final TFR* to 40, giving India until 2045 to achieve the replacement fertility rate.

2.14. How much larger would India's peak population be than in the previous scenario with no delay in achieving replacement fertility?

____________________________________.

2.15. How many people will there be when the population peaks?

____________________________________.

Scenario 4: Seventy-Five Years of Delay until Replacement Fertility

J. Now assume India will not achieve replacement fertility for 75 years. Leave the *Final Total Fertility Rate* at 2.4 but set the *Years to Achieve Final TFR* to 75.

2.16. Does India's total population completely stop growing before 2100?

____________________________________.

2.17. What is the approximate population in 2100? __________________________.

Scenario 5: High Fertility

K. According to the *2005 Population Data Sheet* the country in which women have the largest number of children is Niger, with a TFR of 7.5. Assume that India reaches the same TFR as Niger by 2015. Set the *Final Total Fertility Rate* to 7.5 and the *Years to Achieve Final TFR* to 10.

2.18. What would India's total population be in the year 2100?

____________________________________.

2.19. Under this high-fertility assumption, in which 5-year period would India's population surpass the world's current entire population of 6.396 billion?

____________________________________.

2.20. What would happen to the base of the pyramid over the first 25 years?

____________________________________.

Scenario 6: Low Fertility

L. In order to control population growth in China—a country with more than 1.3 billion people—the government enforced strict economic and social incentives for families to have only one child. Because not everybody complied with the policy, the 2000 TFR in China was 1.7 (rather than the sought-after TFR of 1.0). Assume the Indian government applied the same measures and this TFR was reached by 2015. Set the *Final Total Fertility Rate* to 1.7 and the *Years to Achieve Final TFR* to 10.

2.21. In what year would death rates surpass birth rates?

____________________________________.

2.22. What would happen to the total population at that time?

________________________________.

2.23. At what total population would it peak? ______________________________.

2.24. What would be the difference in population between the peak year and the final year, 2100? ________________________________.

2.25. What would be the annual rate of change of population in 2080, in percentage terms? Calculate it as (CBR – CDR)/10. ________________________________.

Scenario 7: One-Child Policy

M. Assume a one-child policy was adopted and there was perfect compliance instantly. Set the *Final Total Fertility Rate* to 1.0 and the *Years to Achieve Final TFR* to 0.

2.26. When would the population completely stop growing?

________________________________.

2.27. At what total population would it peak? ______________________________.

2.28. What would be the difference in population between the peak year and the final year, 2100? ________________________________.

2.29. How would you describe the shape of the age-sex distribution in 2100?

________________________________.

2.30. Why would the crude death rate get so high near the end of the twenty-first century? ____

________________________________.

N. When you have finished the activity, close all browser windows.

Name: ____________________ Instructor: ____________________

One Billion and Counting: The Hidden Momentum of Population Growth

ACTIVITY 3: INTERPRETING POPULATION CHANGE

3.1. Using the understanding you have gained by projecting India's population pyramids into this hypothetical future, give a carefully worded explanation of how it is possible for a population to continue growing for several generations after women begin averaging only two children each. It may be particularly helpful to review your answers for Scenario 2 in Activity 2.

DEFINITIONS OF KEY TERMS

Age-Specific Birth Rate The number of births to women in a certain age cohort divided by the number of women in that cohort.

Cohort All individuals in a certain age range.

Crude Birth Rate (CBR) Annual number of live births per 1,000 population.

Crude Death Rate (CDR) Annual number of deaths per 1,000 population.

Crude Rate of Natural Increase The difference between the crude birth rate and the crude death rate.

Demographic Momentum Continued population growth long after replacement-level fertility rates have been reached.

Demographic Transition Model A model of population change from an equilibrium with high birth and death rates through a high-growth transition period in which death rates decline sooner than birth rates, to a new equilibrium with low birth and death rates.

Diaspora Scattered settlements of a particular national group living abroad.

Equilibrium A state in which forces of change are in balance.

Hidden Momentum Same as demographic momentum.

Infant Mortality Rate Number of deaths of children under 1 year of age per 1,000 live births in a year.

Population Pyramid A graph showing the number of males and females in discrete age cohorts (age categories).

Replacement Fertility The fertility rate at which each female in a population produces on average one female baby who survives to the time when she herself can reproduce.

Total Fertility Rate The average number of children a woman would have during her reproductive years assuming the current fertility rates of women across all ages.

Zero Population Growth (ZPG) A state in which the crude birth rate minus the crude death rate equals zero. The number of deaths exactly offsets the number of births.

FURTHER READINGS

Bloom, David E., and David Canning. 2006. Booms, Busts, and Echoes. *Finance & Development* 43(3).
Cohen, Joel E. 2005. Human Population Grows up. *Scientific American* (August): 48–55.
Gavin, Michelle. 2007. Africa's Restless Youth. *Current History* (May):220–226.
Gelbard, Alene, Carl Haub, and Marym Kent. 1999. World Population Beyond Six Billion. *Population Bulletin* 54:1–40.
Haub, Carl, and O.P. Sharma. 2006. India's Population Reality: Reconciling Change and Tradition. *Population Bulletin* 61(3):1–20.
Hopper, Gordon R. 1999. Changing Food Production and Quality of Diet in India, 1947–98. *Population and Development Review* 25:443–477.
India on Fire. 2007. *The Economist* (Feb. 3):77–80.
Kent, Mary M., and Carl Haub. 2005. Global Demographic Divide. *Population Bulletin* 60(4):1–24.
Lee, Ronald, and Andrew Mason. 2006. What is the Demographic Dividend? *Finance & Development* 43(3).
Levine, Ruth. 2006. Educating Girls, Unlocking Development. *Current History* (March):127–131.
Malthus, Thomas R. 1952. An Essay on Population. *Everyman's Library, Vol. 1.* New York: Dutton.
McFalls Jr., Joseph A. 2007. Population: A Lively Introduction (5th ed.). *Population Bulletin* 62(1): 1–31.
McMichael, Anthony J. 2008. Population, Human Resources, Health, and the Environment. *Environment* 50(1):46.
Meadows, Dana H., Dennis L. Meadows, and Jorgen Randers. 2004. *Limits to Growth: The 30-year Update.* White River Jct., VT: Chelsea Green.
O'Neill, Brian, and Deborah Bulk. 2001. World Population Futures. *Population Bulletin* 56(3):1–40.
Pinstrup-Andersen, Per and Fuzhi Cheng. 2007. Still Hungry: One Eighth of the World's People Do Not Have Enough to Eat. *Scientific American* (September):96–103.
Population Reference Bureau. 2008. World Population Highlights: Key Findings From PRB's 2008 World Population Data Sheet. *Population Bulletin* 63(3):1–12.
Riley, Nancy E. 2004. China's Population: New Trends and Challenges. *Population Bulletin* 59(2):1–36.
Singer, Max. 1999. The Population Surprise. *Atlantic Monthly* (Aug.):22–25.
United Nations. 1998. *Long-Range World Population Projections: Two Centuries of Population Growth, 1950–2150.* New York: United Nations.
Walker, Martin. 2006. India's Path to Greatness. *The Wilson Quarterly* 30(3):22–30.
Wilson, Chris. 2006. The Century Ahead. *Daedalus* 135(1):5–8.
Zakaria, Fareed. 2006. India Rising. *Newsweek* (March 6, 2006):32–42.