

DEMOGRAPHY

The Study of Human Population

Fourth Edition

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A black silhouette of a city skyline with various building shapes of different heights and widths, spanning the width of the page above the title.

Population Growth

This chapter starts on what may be familiar ground for some readers: a description of world population growth in the past and projection into its future. With the world's population tripling from 2 billion to 6 billion over the course of the 20th century, and then reaching 7.2 billion just 14 years later, there is no more obvious demographic trend than that of population growth. The defining demographic characteristic of recent times is the modern population explosion. The world population continues to grow today, but now its growth rate is beginning to slow. As many nations come through the other side of their demographic transitions, the main demographic preoccupation of the 21st century will eventually turn to the “graying” of the population (IIASA, 2012). A few countries have already started to confront this process. The aging global population of the near future is a direct outcome of the mortality and fertility transitions that accompanied the past century's population explosion.

Our description of population growth distinguishes between the **more-developed regions** (MDRs) and the **less-developed regions** (LDRs), since the MDRs and LDRs generally have different pasts and prospects. However, we hasten to note that there is great variation within these classifications, particularly as LDRs continue to develop rapidly and at uneven paces from one another. The chapter also distinguishes countries by their stage in the nearly universal fertility decline that has taken place over the past century. The chapter closes with analyses of the issues and challenges resulting from present and future growth in countries at different stages of development, fertility decline, and “graying.”

A History of Global Population Growth

Figure 3-1 on the following page is a familiar graph in demography. It charts the size of the human population of the world from our earliest guesses to the future. The

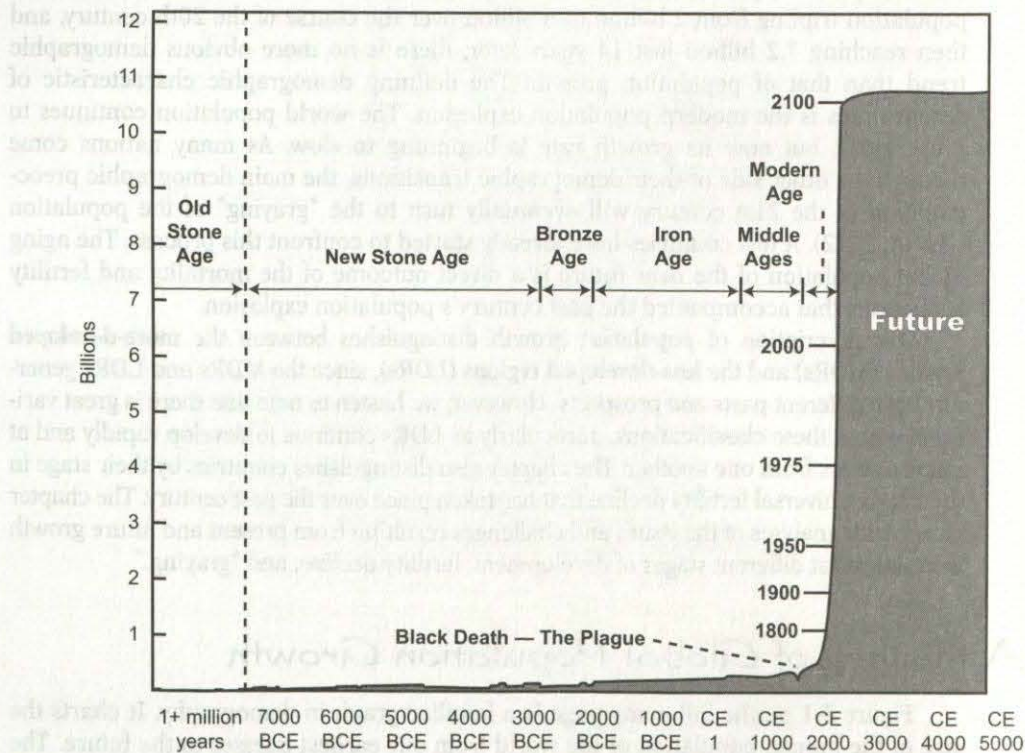
dates in this version of the graph range from between 1+ million years BCE to CE 5000. The time segment at the far left, the Old Stone Age, cannot be drawn to scale, since it would extend way off the page. From 7000 BCE, a regular time scale allows us to see the pattern of increase in population size, or population growth.

It took millions of years for the global population to reach a half billion people (about 1650), but by CE 2014 world population was over 7 billion. In just the past century 5 billion people have been added, tripling the world's population! Since the birth of a now twenty-year-old college student, the world's population has increased by nearly as many people as were alive in the world in 1900. The population is projected to continue growing into the future, albeit more slowly, leveling out at close to 10.9 billion people by the 22nd century (United Nations, 2013).

Clearly there was a dramatic change in the nature of population growth as the world reached modern times. To discuss the two very different patterns of population growth before and after about 1650, we will describe these two periods separately as the "premodern" and then the "modern" period.

Figure 3-1

World Population Growth through History



Source: Population Reference Bureau, © 2006. http://www.prb.org/presentations/gb-poptrends_all.ppt; and United Nations, *World Population Projections to 2100* (1998). Used with permission.

Premodern Growth, Before 1650

First, a warning is appropriate. To avoid distracting the reader with repeated cautions and qualifiers, we will write as though we really had a precise idea of how many people were alive in premodern times. In reality, our guesses are uncertain (see PRB, 2011 for estimates). This uncertainty is detailed in chapter 2, under "Demographic Estimation." Having said that, let us plunge boldly ahead.

In the premodern era, from about 300,000 BCE to roughly 1650, harsh living conditions resulted in extremely high mortality rates and slow growth (Collins, 1982). After thousands of years of hunting and gathering, the development of agriculture at the beginning of the New Stone Age (i.e., 8000 BCE) led to a more reliable food supply and more stable forms of social organization. Agricultural settlements in turn were followed by urban civilizations, first in Mesopotamia, then in Egypt, Crete, India, China, and Peru, wherein populations could flourish to a greater extent. With the emergence of agrarian societies, and despite continued high mortality, world population slowly increased, growing from an estimated 5 million to perhaps 200 to 300 million by CE 1.

During the early Common Era, growth was mainly held in check by infectious disease and periodic decimating epidemics that became more common as people gathered and settled in towns and cities (McKeown, 1983; McNeill, 1976). However, disease was not the only hardship of life during this slow growth period. Unfavorable climatic changes (Wrigley, 1969), periodic severe famines (Meuvret, 1965), and even lower birth rates from malnutrition (Watkins and Van de Walle, 1983) were among the myriad hardships limiting population growth. With few exceptions, this era was characterized by high birth rates and high but fluctuating death rates, resulting in slow, frequently interrupted population growth.

Modern Explosion, 1650 to the Present

Let us look more closely at the far-right segment of Figure 3-1, from 1650 to 2000. One thing to notice, of course, is the large and soaring number of people in the modern world in comparison with the premodern. The 2014 population of 7.2 billion is more than fourteen times as large as the 1650 population, the end of the premodern era. Another feature to notice, one that needs explaining, is the rapidly increasing slope of the line.

For almost all of the modern era, there are two reasons for this increasing upward slope. First is that any sustained positive *rate* of growth will result in the increasing upward slope of such a line. If people normally are behaving in such a way that they are more than replacing themselves every generation, then every generation will have more people behaving that way, producing even larger increments. By analogy, annual crude rates of population growth are like interest rates on a savings account; the rates operate not only on the original principal but also on the interest that is being reinvested continuously. The higher the growth (or interest) rate, the greater the degree of the line's concave arching that is caused by compounding alone. (Exercises 1 and 2 at the end of the chapter allow the reader to demonstrate this phenomenon.)

There is an important second reason for the upward curve of this particular line: The population **growth rate** did not simply stay stable and positive; the growth rate itself grew through almost all of this period. Table 3-1 shows that the annual rate of

Table 3-1 Annual Growth Rates of World Population and Implied Years to Double, 1650 to 2100

Period	Annual Growth Rate (percent)	Years to Double
1650–1750	0.4	175
1750–1800	0.4	175
1800–1850	0.5	140
1850–1900	0.5	140
1900–1950	0.8	88
1950–1955	1.8	39
1955–1960	1.9	37
1960–1965	2.0	35
1965–1970	1.9	37
1970–1975	1.9	37
1975–1980	1.7	41
1980–1985	1.7	41
1985–1990	1.7	41
1990–1995	1.7	41
1995–2000	1.3	53
2000–2005	1.2	58
2005–2010	1.2	60
Medium Fertility Projection		
2010–2015	1.1	61
2015–2020	1.0	67
2020–2025	0.9	75
2025–2030	0.8	84
2030–2035	0.7	94
2035–2040	0.7	105
2040–2045	0.6	118
2045–2050	0.5	135
2050–2055	0.4	156
2055–2060	0.4	179
2060–2065	0.3	205
2065–2070	0.3	235
2070–2075	0.3	272
2075–2080	0.2	315
2080–2085	0.2	359
2085–2090	0.2	408
2090–2095	0.1	485
2095–2100	0.1	630

Source: United Nations, *The Determinants and Consequences of Population Trends*, 1973, table 2-1; *World Population Prospects as Assessed in 1980*, 1981, table 1; *World Resources 1990–91*, 1990, table 16-1; *World Resources 1994–95*, 1994, table 16-1; *Revision of the World Population Estimates and Projections*, 1999; *World Urbanization Prospects*, 2004; *World Population Prospects: The 2004 Revision*, 2005; *World Population Prospects: The 2012 Revision*, 2013. Used with permission.

global population growth doubled in the three centuries between 1650 and World War II, and the postwar era witnessed an even more dramatic explosion of growth rates, peaking around 1960 to 1975.

Growth rates fell annually thereafter, and by 2005 had dropped substantially to 1.2% annually. At this writing, they are projected to continue dropping through the rest of the century and will even drop below 1650 levels by 2060. The recent drop in growth rates is due primarily to declining births in almost every country, but also, in part, to the suddenly rising number of deaths from HIV/AIDS throughout the world. The number of excess deaths due to HIV/AIDS in the forty-eight most seriously affected countries reached 9.4 million between 2005 and 2010, which is the highest recorded number of excess deaths since the discovery of the first HIV/AIDS cases in the early 1980s. Current projections show that the overall number of HIV/AIDS deaths may decline slightly in the next decade or so, but will then increase again slowly due to population growth (United Nations, 2012).

Table 3-1 also translates each of the annual growth rates into “years to double” at that rate. This is a device for dramatizing the implications of growth rates if extended over time. It is simple to make the conversion by using this formula:

$$\text{Years to double} = \frac{70}{\% \text{ annual growth rate}}$$

The reason why this formula works is explained mathematically in Box 3-1 on the next page. The implication of this formula is that at the current annual growth rate (we will use the UN’s estimate for 2010, 1.15%), the world’s population would double in the following 61 years to just under 14 billion by CE 2071; it would redouble to 28 billion in the next 61 years (by CE 2132), and so on.

Such populations are unimaginable! But this exercise helps drive home an important point: As the size of the world population gets larger, the impact of any positive growth rate gets greater. Since the base population on which any growth rate works is now large, even a moderate rate of growth means many people are being added.

However, our example of **doubling time** assumed growth at the present rate over more than a century. Is that realistic? The consensus would seem to be “no.” World mortality already is moderate or low overall, but continues to decline for most groups while rising for others (see chapter 5). World fertility is declining and will likely continue to do so even more rapidly than mortality, thus causing further erosion of the world rate of natural increase (or growth).

But a cautionary note is appropriate: Even if the world’s growth rate has peaked, the world’s population size certainly has not. If the world’s growth rate were cut by about half—say, to 0.7% per year—the population of the globe still would double in 100 years, then redouble, then redouble. . . . To clarify, although the world growth rate has slowed to almost half what it was in the 1960s, it is still positive, and the size of the world’s population has steadily increased—from 3 billion in 1960, 4 billion in 1974, 5 billion in 1987, 6 billion in 1999, and to 7.2 billion in 2014. Thus, what once took thousands and thousands of years—reaching the first billion people in the world—is now happening every twelve years or so.

Although actual population doubling and then redoubling is not necessarily inevitable, the general rapidity of population growth is why demographers are not content

Box
3-1

Why Does the "Doubling Time" Conversion Work?

Many readers simply will be willing to take our word for the legitimacy of the conversion of annual growth rates to "doubling time." This insert is for those who want a mathematical explanation.

Here are our variables. Let

- P_1 = the population at the beginning of an interval
- P_2 = the population at the end of the interval
- n = the number of years in the interval
- r = the annual population growth rate during the interval

Now, let us take the simplest case, where the interval is one year (where $n = 1$). In that case,

$$P_2 = P_1 + rP_1$$

That is, the population at the end of the interval is equal to the population at the beginning of the interval plus the growth in between, that growth being calculated by multiplying the annual growth rate by the beginning population. This equation can also be stated as

$$P_2 = P_1(1 + r)$$

If we let n extend beyond one year, then the general formula would be

$$P_2 = P_1(1 + r)^n$$

This equation also can be stated as

$$\frac{P_2}{P_1} = (1 + r)^n$$

Taking logarithms of both sides of the equation and solving for n , the equation would be as follows:

$$n = \frac{\log P_2 - \log P_1}{\log(1 + r)}$$

Now let us see how many years it would take for the population to double under the conditions of an annual growth rate of 1.0%. That is, let us solve the above equation for n assuming first that the population will double, or

$$P_2 = 2P_1$$

and, second, that the annual growth rate is 1%, or

$$r = .01$$

Solving the formula with these values would produce the equation

$$n = \frac{\log 2}{\log(1 + 0.01)} = \frac{0.30103}{0.00432} = 69.68$$

In sum, the number of years required for a population to double at a 1% annual growth rate is precisely 69.68 years, usually rounded to 70 years.

Incidentally, if we choose to use natural logarithms rather than common logarithms, then n would equal 69.32 rather than 69.68. Some texts will treat 69.3 (rounded to 69) as the number of years required for a population to double at a 1% annual rate of growth. The difference is trivial for our purposes. We will use 70 as our "magic number."

with observing that the rate is no longer increasing; rather, they are trying to estimate when and how that rate will become *zero*, when the modern global **population explosion** will come to its end. The slowing of population growth does not mean an end to population challenges and may lead to altogether new problems, as we will discuss later in the chapter.

The term "explosion" has a hysterical ring to it that annoys some demographers (e.g., Hartmann, 1995; Simon, 1986; Lam, 2011). Moreover, it may carry a negative connotation, implying a destructive and devastating event. But in attempting to describe the dramatic population growth shown in Figure 3-1, we think the term is visually apt.

Classifying Countries

The Development Dichotomy: MDRs and LDRs

Regions of the world did not march in lockstep from the 1600s to the present through those economic and demographic changes we call "modernization" or "development." Throughout, there have been the haves and the have-nots among nations. First there were the colonial powers and the colonies they exploited. Later there were the imperial powers and their empires.

Relatedly, there were those who started early in their agricultural, industrial, and demographic revolutions and then there were those who started later. One way that distinction is captured is by the familiar dichotomy between the countries of the more-developed regions (MDRs) and the less-developed regions (LDRs). In the past, economic development and demographic development have often gone hand in hand. (*Economic development is measured by efficiency of productive technology, while demographic development is measured by degree of control over death and birth.*) As a result, the distinction between MDRs and LDRs has reflected many demographic, as well as economic, developmental differences between regions. The United Nations version of the classification has been widely accepted by demographers: The **MDRs** are North America, Europe, Japan, Australia, and New Zealand; the **LDRs** are Africa, Asia (less Japan), Oceania (less Australia and New Zealand), Latin America, and the Caribbean.

Recently, however, the lack of synchronization between economic development and demographic development in some countries challenges such a simple typology. And, as a larger and larger proportion of the world's countries become more developed, there are many more countries that fall in between the MDR and LDR distinction than fall within it. To illustrate this, see Hans Rosling's TED Talk: Global Population, Box by Box, on this book's website at www.demographytextbook.com under the links section of the Chapter 3 tab. Moreover, the United Nations version of the development dichotomy has classified entire world regions, rather than nations, since adjacent countries have tended to share similar economic histories. But not all regions are homogeneous: Oceania, for instance, is demographically dominated by Australia and New Zealand but also contains Micronesia and Melanesia. East Asia includes Japan, which is clearly a developed nation. Latin America, though not labeled as a mixed region, includes temperate South America (Argentina, Chile, Uruguay), which stretches the label "less-developed."

A more complex and nuanced development category that is increasingly being adopted, including by the United Nations, is the **Human Development Index (HDI)**. This measure represents both social and economic development by combining a country's life expectancy, educational attainment, and national income level into a single statistic. Countries are then ranked according to whether they fall into the four following HDI tiers: very high, high, medium, and low. Generally, the continuum of the HDI falls in accordance with the LDR-MDR dichotomy, with MDRs scoring at the higher end of the scale and LDRs scoring at the lower end of the scale; however, there are a few notable exceptions. Argentina and South Korea, for example, despite being conventionally classified as LDRs, are ranked in the "very high" category of the HDI. We note this so that readers can keep in mind the generalizing nature of the classic LDR-MDR dichotomy that we rely upon for the sake of simplicity throughout this textbook.

Table 3-2 gives the current United Nations classifications for the basic LDR-MDR development dichotomy. The top rows present data for individual regions of the world. These six regions are ordered from the highest growth rate (Africa) to the lowest growth rate (Europe). In the bottom two rows of the table data is given for the more-developed and less-developed regions separately.

Table 3-2 also presents demographic rates that dramatize the contrast between classes of countries. Let us compare the MDRs and LDRs. Demographically, although there is a difference between the crude death rates (column 2), that difference is small compared with the difference between the crude birth rates (column 1). This reflects the fact that mortality has improved very quickly in LDRs while reductions in fertility are still a major transition in process. The fertility of the LDRs collectively is twice as high as that of the MDRs. The infant mortality rate (column 3), although strictly speaking a demographic measure, is often used as an index of overall well-being and of health care in nations; we see that the infant mortality rate of the LDRs is more than eight times as high as that of the MDRs. Column 4 contains the population's annual

growth rate and column 5 contains the years to double calculated from that growth rate. The growth rate in LDRs is 14 times greater than in MDRs. As a result, the population of the LDRs would double in only 50 years at their present rate of growth while the same doubling would require 700 years in MDRs. Not captured by these demographic statistics are the considerable differences in wealth and economic opportunity between MDRs and LDRs, nor the vulnerability of the poorest LDRs to collective and personal economic disaster, such as famine and war. Also not captured is the considerable variation among countries when considered apart from regional averages. For example, the infant mortality rate in LDRs like Cuba and Singapore is 4.6 and 2 respectively, a notably superior record to the U.S. infant mortality rate of 5.4. And there continue to be considerable differences in the health and well-being among those countries with a substantial degree of control over births and deaths. Thus, while we distinguish between LDRs and MDRs often in this textbook, the truth is that the line dividing the two typologies is often quite blurred and will only become more so in future years.

An interesting detail to note in Table 3-2 is Europe's rates. Europe is unique in that its crude death rate roughly equals its birth rate, reflecting swiftly declining fertility and an aging population structure. As a result, its population growth rate is currently zero, and if it remains at this level the European population will never double. The latest United Nations population projections indicate that Europe's future fertility rates will actually become low enough that the population will begin declining over the century (United Nations, 2013).

The regions described in Table 3-2, whether considered individually or combined into development categories, not only have different current demographic traits but also have had different demographic histories over the past two centuries. Starting in the late 1700s, one after another of the present MDRs began their **demographic transitions** from high to low death rates, and then from high to low birth rates. As regions experienced development, many countries moved gradually from *pre-transitional* to *transitional* categories. Early in this transition MDRs grew at more rapid rates than the LDRs, until about World War I. Starting with the Great Depression, and especially since World War II, the transition to lower birth rates began to slow MDR growth, while the regions with the most rapid growth since then have been the less-developed ones. The postwar rates of growth in the LDRs generally surpassed anything previously experienced by the present MDRs. This is because LDRs have benefitted from health advances far more rapidly than the pace at which health improvements occurred historically in the MDRs. The combination of rapidly increasing life expectancy, often within a single generation, and reproductive behavior that has not fully adjusted to these new conditions fueled this growth.

In the post-WWII period, most countries in the MDRs completed their fertility transitions and are now *late-transition* countries with low death, birth, and growth rates; some have even experienced negative growth rates. The MDR countries that continue to grow in population are the U.S. and Canada, and this is primarily from LDR immigration (PRB, 2008). Many countries in the LDRs have moved rapidly through similar demographic transitions, especially given where their growth rates were just a generation ago, while others are at various stages along the demographic transition. Uganda, for example, has seen a gradual decrease in its once-high mortality rate but its fertility rate still remains high. Guatemala's birth and death rates have been declining,

Table 3-2 Demographic Rates for Classes of Countries, 2014

	Crude Birth Rate (1)	Crude Death Rate (2)	Infant Mortality Rate ^b (3)	Natural Increase Rate(%) (4)	Years to Double (5)
Regions^a					
Africa	36	10	62	2.5	28
Asia (excl. China)	21	7	40	1.4	50
Latin America and Caribbean	18	6	18	1.2	58.3
Oceania	18	7	21	1.1	63.6
Northern America	12	8	5	0.4	175
Europe	11	11	6	0.0	
<i>Less-Developed Regions</i>	22	7	42	1.4	50
<i>More-Developed Regions</i>	11	10	5	0.1	700

^aOrdered by rate of natural increase.

^bInfant deaths per thousand births, 2013.

Source: Population Reference Bureau, 2014. 2014 World Population Data Sheet.

and India's birth rate is steadily approaching the replacement rate of 2.1 (Haub and Gribble, 2011).

As a general rule, the transition from higher to lower fertility almost always happens *after* the transition from high to lower mortality. This is largely because there are many long-standing and significant societal norms that value childbearing and large families. By contrast, few individuals value poor health and short lives. Therefore, when medical technology and preventative health knowledge become available, they are generally adopted. But the existence of birth control does not necessarily mean that people will use it. Pronatalist customs that have been in place for thousands of years, in part to offset high infant and child mortality, take considerable time to reverse. Economic advancement and changing gender roles are often precursors to changes in social norms around reducing family size. The time between when MDR populations started living longer and when they stopped having as many babies sometimes lasted a century, a much longer transitional population growth period than what we are seeing in many LDRs today.

Despite many variations in timing, today there is no country left in the world that has yet to begin its demographic transition. There are a few countries at the very beginning of the transition, just starting to increase their life expectancy (Haub and Gribble, 2011), but most are well into the fertility decline phase. In fact, 48% of the world's population now lives in low-fertility countries, where women have less than 2.1 children. While most of the low-fertility population is in MDRs, nineteen Asian countries, seventeen Latin American countries, and two African countries also fit into this category (United Nations, 2013). Only 9% of the world still fits into the high fertility category, where women have five or more children.

Demographers often study countries that are now in the later stages of transition both to understand the causes of the transition and as a historical precedent for what might happen to other countries as they are becoming more economically and demographically developed. This has been the underlying rationale for the study of the historic MDR demographic transitions.

The Prototypical Historical Demographic Transition

The time and place that provides the earliest model for the demographic transition was Western Europe between 1800 and the 1930s. This was the first world region to go through the sequence (Coale and Watkins, 1986). Economically, the Western European countries already had progressed in their agricultural revolutions before the 1800s. During the demographic transition period, they were going through that complex set of changes called the industrial revolution, with accompanying social changes such as urbanization, literacy, secularization, and growing consumerism.

Description

What happened to crude death and birth rates during the European transition, along with the economic changes, is shown schematically in Figure 3-2. In pre-transition populations (left side of figure), both death rates and birth rates were high. Pestilence and famine were major causes of death. The transition generally began with a

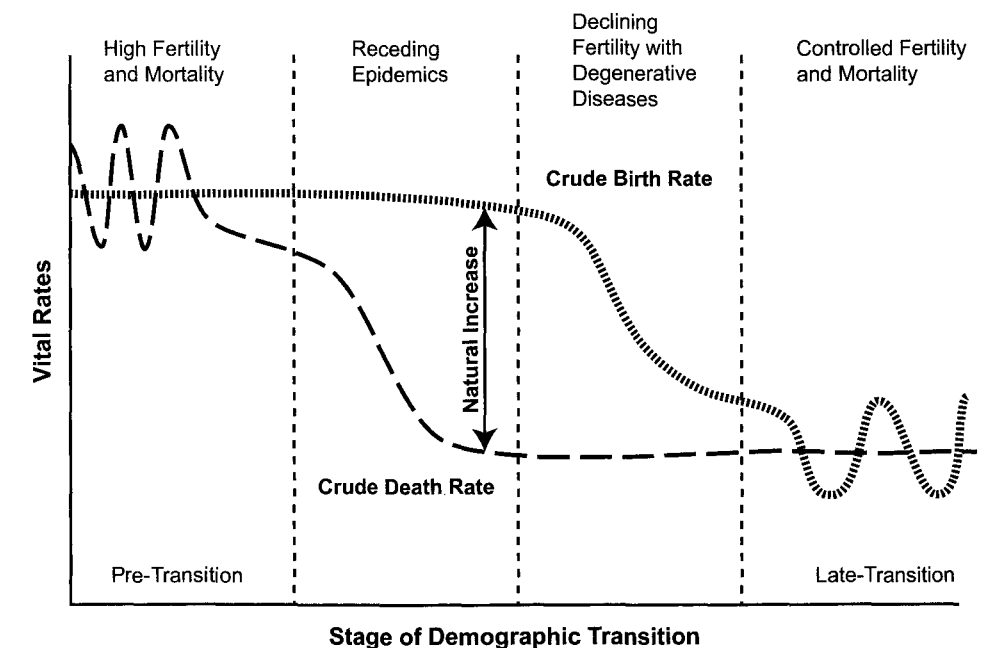
decline in epidemic mortality due to improved nutrition, sanitation, and so on. As death rates reached lower levels, remaining deaths were largely due to degenerative and human-made diseases; as death rates reached even lower levels, birth rates also fell. By the late-transition period (right side of figure), both birth and death rates were low. During the transitional phase, the model specifies that the death rate dropped before the birth rate, causing a period of very rapid natural increase—the classic population explosion. While death rates were more variable from year to year in the pre-transition phase, birth rates were more variable after the transition. The transition was not only from high to low rates, but also to *controlled* and more predictable mortality and fertility.

Not all Western European nations went through their demographic transitions simultaneously (Coale and Watkins, 1986). Sustained declines in death began as early as 1750 in countries as different as France and Sweden. Births generally declined much later in the transition, from 1827 (France) to 1922 (Ireland and European Russia). The gap between rapidly falling death rates and a delayed decline in birth rates led to rising population growth, with the period of greatest natural increase between 1870 and 1910 for most Western European countries.

Aside from the timing of the transition, there were many other deviations from the prototypical sequence given in Figure 3-2 within Western Europe. Pre-transition fertility was not steady, nor completely uncontrolled, as the stylized demographic transition model implies (Coale and Watkins, 1986, pp. 429–430). At times fertility fell simultaneously with mortality, or, much more rarely, even preceded it (Coale, 1975, p. 351). At

Figure 3-2

Simplified Diagram of the European Demographic Transition



the outset of the transition, fertility was rising, compounding the impact of mortality decline (Petersen, 1975, pp. 631–637). Figure 3-2 is not a theory of how mortality and fertility declines occurred or an exact model of any one country's experience. Rather, the simplified model of Figure 3-2 is a useful device for understanding the general pattern of demographic transition and why it often resulted in explosive population growth during periods before birth rates slowed down to match lowered death rates.

Mortality and fertility declines swept across Europe steadily and by 1930 few provinces of Europe remained untouched. With few exceptions, fertility declines lagged behind mortality declines, and natural increase generated population explosions within European countries.

Demographic Transition Theories

Let us suppose that the preceding description of the European demographic transition is true, generally. What does that tell us about the future of mortality and fertility in developing countries? It tells us that many LDRs will eventually achieve low, stable mortality and low, variable fertility. But there are some important questions we must ask. *When* in the modernization and mortality-decline process will fertility decline? What *aspects* of the modernization process are crucial for triggering such a fertility decline? Is it ethnocentric to predict that LDRs will follow the same model of demographic transition as the MDRs? Given the different times and circumstances, what can we expect for transitions that are just getting underway in some LDRs?

To address such questions, we have to go beyond observing that trends coincide in time and investigate the causes of mortality and fertility declines in order to develop an analytical theory. There have been several provocative and plausible attempts to formulate such a general theory of demographic, and especially fertility, transition as well as harsh criticisms of each.

Following Mason's seminal review of demographic transition theory (1997), we can identify six major transition theories. Classical demographic transition theory emphasizes fertility decline as following mortality decline and due to changes in social life accompanying industrialization and urbanization (Thompson, 1930; Notestein, 1945). Lesthaeghe (1983) adds to modernization the importance of a shift toward self-fulfillment of parents with rising affluence. Caldwell (1982) emphasized a shift in wealth flows, brought about by such changes as compulsory education and child labor laws, which made children an economic burden, not a net benefit, to the family. The neoclassical microeconomic approach (Becker, 1981) emphasizes both the rising cost of raising children and the desire for alternative uses of family resources (e.g., rising consumerism and alternative consumption goods). Easterlin and Crimmins (1985) expand this thinking to include the psychological or social costs of limiting fertility. The ideational theory (Cleland and Wilson, 1987) attributes declining fertility to the diffusion of contraceptive information and changing childbearing norms.

Most criticisms of these general demographic transition theories arise either from the simplicity with which transitions are characterized (Mason, 1997) or from exceedingly high expectations for prediction (Feeney, 1994). As Feeney notes, even the most satisfactory transition theory may not predict the beginning of fertility decline any better than we can predict earthquakes by knowing they are caused by the shifting of tectonic plates. Although transition theories are useful to understand changes in human

behavior, there is no evidence they can predict the precise timing of demographic changes in a given set of circumstances.

Mason (1997) summarizes what demographers have established about the demographic transition:

1. Mortality decline is usually a necessary, but not a sufficient, condition for fertility decline.
2. Fertility transitions occur in different circumstances when various *combinations* of conditions are sufficient to motivate or enable populations to adopt birth control.
3. A transition caused by circumstances in a given population may influence, or *diffuse* to, other regions of different circumstance.
4. Such influences may travel at different speeds depending on a variety of circumstances (e.g., state policy, information and transportation networks).
5. The number of children families can support varies across pre-transition populations.
6. If families exceed their ability to support children, parents will resort to some form of fertility control.
7. Fertility control after pregnancy or birth depends on available and acceptable forms of such control (e.g., abortion or infanticide).
8. When conditions limit such controls after pregnancy, prenatal controls such as contraception or birth spacing will be encouraged (especially if aided by state policy or programs).

This summary emphasizes the variability in circumstances of demographic transition and highlights the difficulty in identifying a single cause, or a comprehensive list of causes, for transitions. Mortality and fertility declines may have different causes in different countries or periods. Moreover, transitions are not likely to proceed in other countries exactly the same way they did in Western Europe.

There is also debate among demographers over whether a **second demographic transition** (SDT) is now emerging on the tail of the major first demographic transition just described. This is primarily characterized by a shift from traditional and universal marital households to a proliferation of different family forms and very low, unstable fertility levels (Lesthaeghe and Surkyn, 2002; Lesthaeghe and Willems, 1999; van de Kaa, 1987). In the late 20th century, new patterns of delayed marriage, nonmarital childbearing, and very low, unpredictable fertility became more common in Northern Europe, which then spread across Europe and into eastern Europe. Although it was initially argued that these patterns were idiosyncratic to Europe (Coleman, 2004), the new patterns are now proliferating in North America and appear to be under way in a number of Asian countries (Lesthaeghe, 2010).

What makes this second transition different from the first demographic transition stage? Whereas the latter transition ends with relatively stable, replacement-level fertility, the SDT describes unforeseen levels of variation in low fertility, including below-replacement fertility, which has been enabled by the revolution in modern contraceptive technology. Furthermore, the first demographic transition took place within a conservative cultural regime of traditional family and gender role norms. A defining

characterization of the SDT is the new flexibility in household structures that reflects societal secularization, individualism, and increasingly egalitarian gender roles. While the first demographic transition grew out of stabilizing economic forces that met much of modern society's basic material needs, the second seems to be a function of even greater prosperity and wealth, enabling higher order needs to be met such as self-actualization and freedom of expression. It remains to be seen how distinct the SDT will be from the first demographic transition, as it is only just now beginning to manifest itself in certain regions.

Therefore, throughout this text we largely focus on the first demographic transition, which we characterize as consisting of two distinct but interrelated transitions, one in mortality and one in fertility. We will emphasize the variety of factors that have historically influenced mortality and fertility declines, rather than focus on a single example. We will revisit these in context throughout the text. In studying both mortality and fertility, later chapters of this text take European history as a point of departure. LDRs are contrasted and compared with the historical transitions in Europe and the MDRs. This is the strategy we follow in chapter 5, where we deal with the *mortality transition*, and in chapter 7, where we discuss the *fertility transition* and spread of family planning in more detail. In chapter 8 we will examine changing trends in marriage and union patterns that appear to be an initial manifestation of the second demographic transition.

Differential Growth, 1950–2100

Let us return to the description of the modern world population explosion, dramatically illustrated in Figure 3-1. But now we will distinguish between the MDRs (which have largely completed their demographic transitions) and the LDRs (which are transitioning at many different stages).

Our coverage is divided into two time periods, from 1950 to 2010 and from 2010 to 2100. The first segment brings us up to the most recent U.S. census, and for this period we can depend on actual population counts or estimates from partial information. The second segment is largely in the future, and here we must depend on projection. The source for both sets of figures is the United Nations (United Nations, 2013).

Counts and Estimates, 1950 to 2010

MDRs differ from LDRs not only in their current growth rates but also in the trends of those rates over time. The top half of Table 3-3 gives the growth rates for more-developed regions, less-developed regions, and the world as a whole up to 2010.

In the MDRs the growth rate was fairly high in the 1950s and early 1960s—but has been declining steadily since. There has been a continuous gradual decline in mortality throughout the second half of the century. The consensus is that most of the 20th century mortality decline is attributable to public health practices and medical advances even more so than rising income. Fertility, on the other hand, has had wide swings, and so has the resulting natural increase. Most MDRs had postwar baby booms (sustained, in the case of the United States) that kept natural increase higher than normal for MDRs. Fertility since the 1960s has been declining even more rapidly than mortality, shrinking the rate of natural increase.

Even at the outset of the postwar era, LDR growth rates were more than 70% higher than those for the MDRs. The gap widened for most of this period as LDR rates soared. But it is now clear that a peak rate for the LDRs was reached in the mid-1960s and has gradually retreated since then. Throughout the postwar period, overall mortality was declining substantially. True to demographic transition theory, fertility did not decline as early as mortality and generally stayed at high levels through the mid-1960s. Then it started to decline, in one country after another, eroding the overall high rate of natural increase.

There still is considerable variety among LDRs in their current growth rates. Unexpected mortality, especially from the HIV/AIDS virus, has contributed to lower growth

Table 3-3 Population Growth Rates for More-Developed and Less-Developed Regions, 1950–2100

Period	More-Developed Regions	Less-Developed Regions	World
1950–1955	1.20	2.09	1.81
1955–1960	1.17	2.14	1.85
1960–1965	1.09	2.35	1.98
1965–1970	0.83	2.51	2.04
1970–1975	0.77	2.37	1.94
1975–1980	0.66	2.09	1.73
1980–1985	0.59	2.09	1.73
1985–1990	0.60	2.05	1.72
1990–1995	0.44	1.79	1.51
1995–2000	0.33	1.59	1.34
2000–2005	0.30	1.43	1.21
2005–2010	0.24	1.34	1.14
Medium Fertility Projection			
2010–2015	0.30	1.33	1.15
2015–2020	0.24	1.21	1.04
2020–2025	0.18	1.07	0.93
2025–2030	0.12	0.96	0.83
2030–2035	0.07	0.86	0.74
2035–2040	0.04	0.77	0.66
2040–2045	0.02	0.68	0.59
2045–2050	0.01	0.60	0.51
2050–2055	–0.01	0.52	0.45
2055–2060	–0.03	0.45	0.39
2060–2065	–0.04	0.39	0.34
2065–2070	–0.04	0.34	0.30
2070–2075	–0.03	0.30	0.26
2075–2080	–0.02	0.25	0.22
2080–2085	–0.02	0.22	0.19
2085–2090	–0.02	0.20	0.17
2090–2095	–0.03	0.17	0.14
2095–2100	–0.06	0.13	0.11

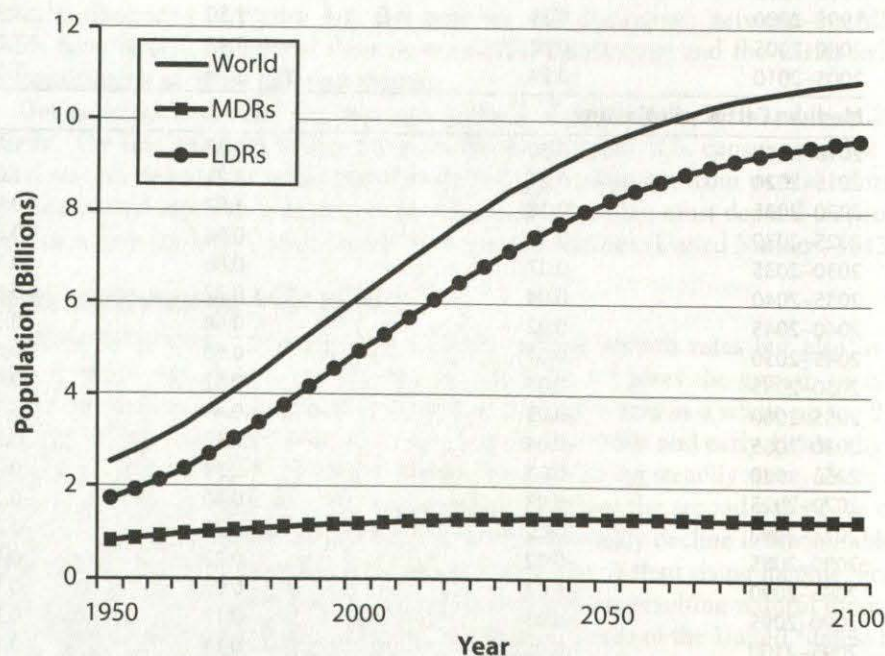
Source: United Nations, 2013. *World Population Prospects: The 2012 Revision*. Used with permission.

rates than expected in some LDR countries. More important, swift mortality declines that persisted before fertility declines followed resulted in a period of much higher natural increase for some countries than in historical European transitions. The greatest influence on variability in LDR growth rates is the timing of their fertility transitions.

What do these rates mean in terms of the size and distribution of world population? A larger and larger proportion of the world's population lives in LDRs. Accordingly, what happens in the LDRs increasingly determines what happens in the world as a whole. This point is illustrated vividly in Figure 3-3, where we see that as the size of LDR populations increased from 1950 to 2005, so did the size of the world's population.

Figure 3-4 diagrams the changing distribution of population by continental areas over three centuries. By the end of this century, North America, Latin America, and Europe will have a declining proportion of the world's population. In fact, Europe is expected to shrink in total population size by -14% (United Nations, 2013). Asia, too, will become a smaller proportion of the world's population from what it was, largely driven by China's demographic trends. Africa is the region that is expected to grow most rapidly, tripling in its global population proportion by the end of the century. Growth rates are and will be highest among a subset of 49 LDR countries that continue to have very high fertility. The United Nations projects that these countries will account for most of the growth shown in Figure 3-3.

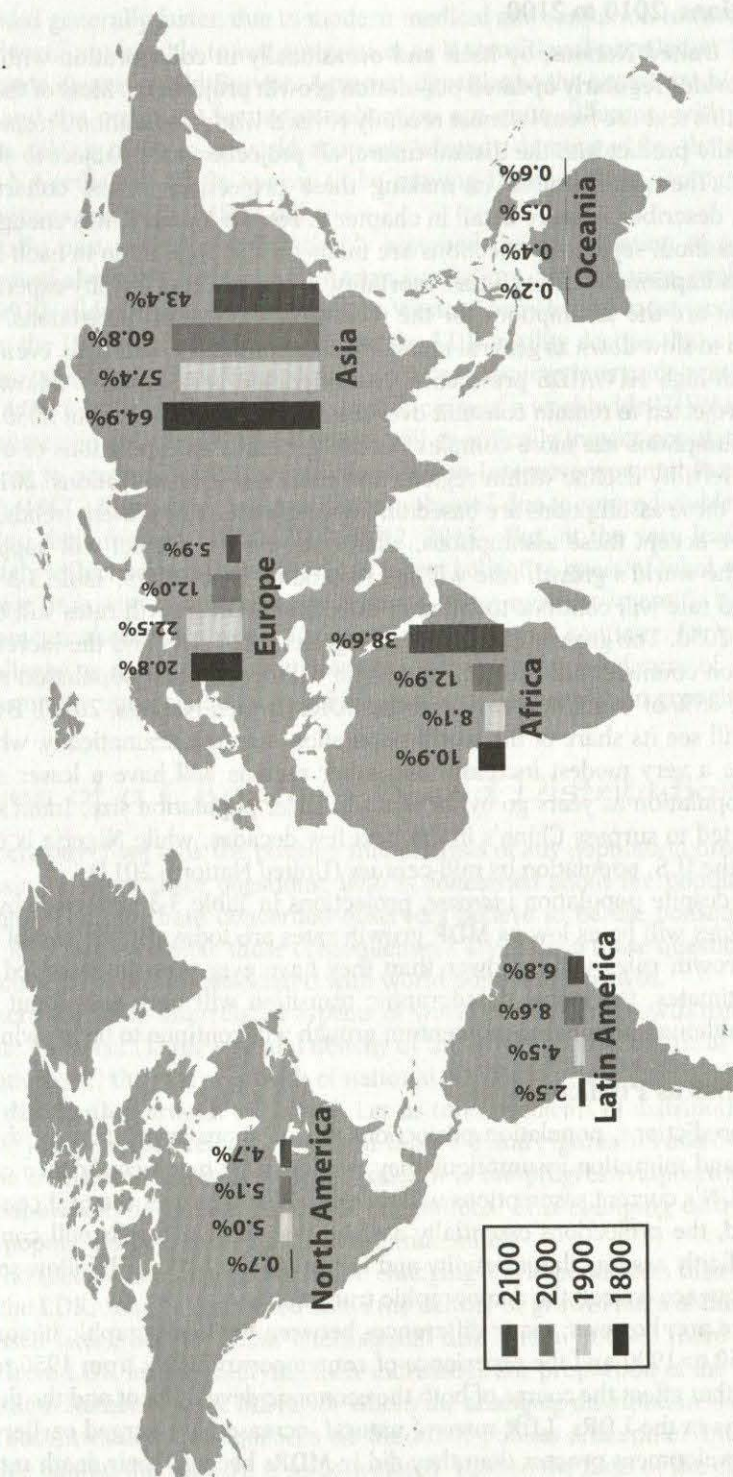
Figure 3-3
Population Growth of More-Developed and Less-Developed Regions, 1950–2100



Source: United Nations, 2013. *World Population Prospects: The 2012 Revision*. Used with permission.

Figure 3-4

World Population Distribution



Source: Data from Population Reference Bureau, *Human Population* (UN Population Division Briefing Packet, 2005); United Nations, 2011. *World Population Prospects: The 2010 Revision*.

Projections, 2010 to 2100

The United Nations, by itself and occasionally in collaboration with other agencies, provides regularly updated population growth projections. Most of the projections used in this text are from its most recently revised *World Population Prospects*. Because they boldly predict into the distant future, all projections are subject to such periodic revision. The method used in making these projections is the cohort-component method, described in more detail in chapter 4. For the moment, it is enough to say that in this method, separate projections are made for the population in each age category using assumptions about its future mortality, migration, and fertility experiences.

What are the assumptions for the recent United Nations projections? Mortality is assumed to slow down as general mortality risks continue to decrease, even in the countries with high HIV/AIDS prevalence. Net migration is assumed to follow past trends and is projected to remain constant over the next decades until about 2050. Finally, fertility assumptions are more complex but are generally extrapolations of observed patterns of fertility decline within regions and countries (United Nations, 2013, 2011). In essence, these assumptions are based on the continuation of present trends.

If we accept these assumptions, what does the UN project will happen, in summary? The world's growth rate will fall to around 1% by 2015. Table 3-3 tells us that the world rate will continue to fall after 2015 and MDR growth rates will become negative by 2050. The growth rates of some high-fertility LDRs and the increase of large-population countries like the U.S. and India will boost world population to 9.6 billion by 2050, 85% of which will reside in the LDRs (United Nations, 2013). By 2100, only Africa will see its share of the world population increase dramatically, while Oceania will have a very modest increase, and other regions will have a lesser share of the world population as years go by. In terms of sheer population size, India's population is projected to surpass China's in the next few decades, while Nigeria is estimated to surpass the U.S. population by mid-century (United Nations, 2013).

But despite population *increase*, projections in Table 3-3 show that by 2070 LDR *growth rates* will be as low as MDR growth rates are today. By the end of the century global growth rates will be lower than they have ever been in recorded history. By these estimates, the global demographic transition will have just about run its full course, although population momentum growth will continue to be in swing.

Projections as Predictions

As predictions, population projections are no more accurate than the mortality, fertility, and migration assumptions they employ. How much confidence can we have that the UN's current assumptions will turn out to be true over the next century? As we have said, the projections essentially assume that present trends will continue. They also implicitly assume that mortality and fertility in the LDRs will follow some version of the sequence we call the demographic transition.

There are, however, many differences between the demographic history of MDRs from 1850 to 1900 and the experience of contemporary LDRs from 1950 to 2010, differences that affect the course of both the economic development and the demographic transitions in the LDRs. LDR rates of natural increase have surged earlier in the economic development process than they did in MDRs because their death rates dropped

earlier and generally faster, due to modern medical and sanitation technologies. LDRs probably will not be able to use emigration as a transitional population "safety valve" to the same degree as did Europe. Agrarian densities at the outset are higher in many LDRs, and the prospects for industrialization are quite different, with current LDR attempts taking place in a world economy already dominated by the industrialized MDRs. Nevertheless, LDRs appear to be moving through their demographic transitions twice as fast as the MDRs did.

Finally, past projections that simply assumed the continuation of present trends have proved abysmally wrong as long-term predictions. For instance, projections made in the 1930s did not consider the postwar Western baby boom; most world projections made in the 1960s did not dare to assume the LDR fertility decline that even then must have been starting in some countries. Even recent assumptions understated the magnitude of LDR fertility declines and the dramatic rise of a worldwide HIV/AIDS epidemic. How future climate change, for example, will specifically impact population dynamics is difficult to predict; however, predictions by the Intergovernmental Panel on Climate Change (IPCC) forecast global population upheaval due to unpredictable weather patterns and their impacts (IPCC, 2007, 2012, 2013). But, at the very least, projections accurately reflect current information as a best collective guess of what will happen in the future. It is wise to view these projections not so much as scientific predictions but as statements about what would happen if current trends continue. Perhaps our greatest challenge as demographers is predicting the demographic future of countries that have begun the unprecedented transition into negative population growth.

Problems of a Changing World Distribution

In chapter 1 we took the position that analysis of any population problem involves addressing a set of three questions: *Who* is concerned about the population trend in question? *What* do these concerned observers believe to be the consequences of the trend? *Why* do they dislike those consequences? Try to keep those questions in mind as we discuss the problems associated with world population growth.

There are three interrelated aspects of world population growth trends that seem to excite concern: (1) the size and density of the world population, or of LDR national populations; (2) the rate of growth of national populations; and (3) the changing **population distribution** around the world. Let us treat problems of distribution first, since we have just described relevant trends in Table 3-3 and Figures 3-3 and 3-4. The feature of these trends that arouses the most concern is the progressive postwar tendency of LDR populations to outnumber MDR populations. This changing distribution of the world population is projected to continue indefinitely.

Who seems to be worried about the changing world population distribution? Leaders of the LDRs may be concerned about the density or growth rates of their populations (discussed later), but not about international distribution per se. There are few statements from LDR leaders decrying their increase in the proportion of the future world's population. Rather, it is the MDRs for whom the changing distribution is a problem.

What unwanted consequences do the MDR publics anticipate? Interestingly, the rationale behind the concern is seldom stated. Rather, the facts of the changing distri-

bution simply are presented and the unhappy consequences are assumed to be self-evident. The LDR publics, naturally, have their suspicions as to underlying motives behind the MDR concerns (Hartmann, 1995). Let us consider and analyze some of these possible MDR motives.

Can it be that MDRs fear a shifting population distribution will diminish their role in the global balance of power? The recognition that population is related to power lies behind some of the earliest demographic censuses, which tallied national populations available for industry and soldiering. If we define power as being able to influence others' behavior, then (other things being equal) population probably still contributes to national power. For instance, MDR nations treat mainland China with more care than they do Singapore, even though the latter is more developed. Given this, perhaps MDR publics are concerned that the changing world population distribution also means a changing world power distribution, to their disfavor.

Can it be that MDRs are worried about becoming an even smaller minority? Are Westerners concerned about the submerging of Western culture? Or do they worry about preserving their own socioeconomic privileges in the face of shifting population distributions? One clearly stated public concern in MDRs is a fear that immigration will rise as the share of population in LDRs continues to increase, eventually making many historically majority groups a minority in their "own" country. However, MDR immigration policies do not always match public concern over immigration since labor migration generally proves so economically useful for MDRs. We will treat this in detail in chapter 9.

It may also be that MDRs are concerned about being globally overwhelmed by the poverty or economic development of some LDRs. Do they see the rich countries as a shrinking, embattled enclave in a poorer world? Do they fear that their higher standard of living and past economic dominance will no longer be tolerated under the new population circumstances? Such concerns appear reasonable given the resource consumption and waste production in MDRs. Although MDRs comprise just a small percentage of the global population, their resource consumption and pollution generation are disproportionately large (Ewing et al., 2010). Per capita water consumption by MDR residents is thirty to fifty times that by LDR residents, while per capita carbon dioxide emissions are triple that of LDRs (The Royal Society, 2012; UNESCO, 2003). If LDRs tried to strictly emulate MDRs, at the very least resource constraints would require MDRs to reduce their privileged, and wasteful, use of world resources. This speculation about the basis of MDR concern over world *distribution* is not very flattering.

Speculations about the basis for MDR concern regarding LDR population *size* and *growth rates* are not so unflattering. They could range from simple humanitarian desire to improve lives in LDRs, to a desire to cut down on the costs of international foreign aid, to a desire to reduce LDR-to-MDR migration pressures.

Whatever the basis for the concern, the reasoning behind defining overpopulation and rapid growth as LDR problems is not as simple as it may seem. In an attempt to inject order into this discussion, let us separate our treatment of population size problems from that of population growth problems.

Problems of Population Size

Carrying Capacity, Population Density, and the Ecological Footprint

The popular notion of overpopulation is vague. It suggests that the population of an area is too large. The closest demographic specification of that fear is population density, or the size of a population within a given area. Indeed, one notion of overpopulation is the idea that a population is too densely settled.

Chapter 1 defines density as the relationship between a population's size and the space it inhabits. Thus defined, density can be measured by this ratio:

$$\frac{\text{population size}}{\text{space (e.g., land area)}}$$

This is sometimes called the population per area.

But a concept that better captures the impact of population on its resources is known as the **carrying capacity**. For our purposes it is sufficient to define carrying capacity as the maximum population size within a given area that can sustain itself indefinitely without damaging its existing resources, given its technology and consumption patterns. Since at least 1679, there have been many estimates of the earth's carrying capacity for human populations, ranging in size from below to well above the current world population (Cohen, 1995). One recent calculation estimates that the global carrying capacity has already been overshot by 30% (Rees, 2010). We can crudely generalize the ratio as follows:

$$\frac{\text{population size}}{\text{resources}}$$

The resources depend on both technology and consumption behavior. In the case of an agricultural economy, it may be primarily land, but the concept is meant to include all natural resources considered essential for human well-being and production (e.g., water, fresh air, a nonpolluted environment, and energy sources). It also includes the other nonlabor determinants of productive capacity (e.g., investment capital, education, and health services). The total area of land needed to sustain many populations often reaches far beyond its immediate geographic borders to include other lands and resources. This is particularly true for the MDRs. Thus, a closely related concept to carrying capacity is the **ecological footprint**, which specifies how environmentally sustainable a given population is (Rees and Wackernagel, 1992). Originally called the "appropriated carrying capacity," but renamed to the more policy-friendly "ecological footprint" (EF), the EF calculates the per-capita amount of consumption relative to the environment's ability to regenerate needed resources. Specifically, it is a natural resource accounting tool that measures how quickly resources are being regenerated and waste is being absorbed in a given time period. These are generally divided into types of renewable resource usage, including cropland, grazing land, timber, fishing, and land development. The EF also includes a measure for carbon, the by-product of burning fossil fuels, which is defined as the amount of forest land required to absorb the amount of carbon emissions (for more details see Ewing et al., 2010).

As a general rule, higher income countries consume many more resources than lower income countries when measured on a per-person basis. For example, lower

income countries like Bolivia have 16.3 hectares of excess biocapacity, whereas high-income countries like Qatar record 8 hectares of ecological deficit due to extensive use of renewable resources. A significant portion of the ecological footprint can be attributed to carbon emissions, especially for high-income countries. Not all high-income countries produce the same carbon footprint. To list a few, the United Arab Emirates produced 8.1 hectares and the United States produced 5.5 hectares per capita worth of carbon emissions in the early 21st century, whereas Norway only produced 1.4 hectares (Ewing et al., 2010).

The relationship between population and its consumption impact on world resources has been recognized by the United Nations. Among its current Millennium Development Goals is ensuring environmental sustainability and reducing biodiversity loss at the same time that it advocates for ameliorating global poverty. Thus, economic development should be directly linked to the environment, ensuring that current development needs do not compromise the potential for future generations to meet their needs as well.

From Malthus to Marx to the Neo-Malthusians

Historically, the judgment of overpopulation necessarily focused on scarcity: too large a numerator (population) and too small a denominator (resources). Overpopulation can be eased either by decreasing the numerator or by increasing the denominator. Labeling a high ratio as overpopulation amounts to blaming the large numerator rather than the small denominator. Such a judgment often is made not only where the density is high but also where the denominator is difficult to expand given current technology and consumption behavior. The classic instance is an agricultural economy with no unused arable land to plow and not enough to go around among the potential farmers. In England at the end of the 18th century, for example, changes in agricultural technology came slowly, requiring the importation of grain for sustenance (and exportation of emigrants). The tendency to blame the population size for shortages in the means for subsistence owes much to the theories of Thomas Malthus, which were formulated at just this time in English history.

Thomas Malthus's first and second essays on the principles of population (published in 1798 and 1803) were landmarks in the development of population theory. He was not the first to include demographic variables in economic and social analysis; in fact, his essays were partially in refutation of competitive theories by Godwin, Condorcet, and others. But the role of population size and growth was so prominent in Malthus's theory, and he spent so many years and later editions of his essays (seven in all) trying to test, polish, and defend his theory, that it could not be ignored.

Box 3-2 provides a summary of Malthus's central thoughts on the subject of overpopulation. Malthus's theory, as summarized, was simplistic and demonstrably wrong in many ways. Population does not increase geometrically. Nor does subsistence on resources increase arithmetically. These erroneous simplifications by Malthus do not, however, alter the force of his central argument that, without checks, a population will tend to outgrow its available resources (i.e., the numerator will increase more rapidly than the denominator).

Two important critics of Malthus, Karl Marx and Friedrich Engels, were both teenagers in Germany when Malthus died in England in 1834. Malthusian theory was

Box 3-2

Thomas Malthus's Principle of Population

According to Malthus, populations tend to grow more rapidly than do the means for their subsistence; that is, unless checked in some way, populations tend to grow in a geometric progression (1, 2, 4, 8, etc.). On the other hand, there is no such tendency for the means of subsistence to expand by geometric progression; rather, they expand by arithmetic progression (1, 2, 3, 4, etc.). Moreover, where resources are finite and limited, such as arable land in an already densely populated country, then a principle of diminishing returns will apply: The best land will be plowed first and each successive acre plowed will be of poorer land. By "means for subsistence," Malthus meant—ultimately—food supply, so this agricultural example is apt.

Population is kept within the limits of the means for subsistence mainly by **positive checks**, those operating through the death rates. When the means for subsistence are not adequate to take care of a population at a given size, the death rate will go up until the population has shrunk to a supportable level.

By the same token, whenever a surplus might appear in the means for subsistence, this will tend temporarily to lower the death rate (and raise the rate of natural increase) until the population has grown to the limits of the new means for subsistence. This is the "Malthusian dilemma."

Hypothetically, the way out of the dilemma is through the application of "preventive checks" on population growth, operating through the birth rate. These fall into two categories: "moral restraint" and "vice." They are quite distinct in terms of how they correspond to the improvement of humanity (says the Reverend Malthus). Humanity differs from animals, at least potentially, in terms of its ability to foresee the consequences of its actions and to guide its current behavior accordingly.

"Moral restraint," as advocated by Malthus, consists of not marrying until one can support the resulting children and of remaining sexually chaste outside of such marriage. Clearly this appeals to the best in human nature, as Malthus saw it. Moreover, if marriage and sexual companionship must be earned, then people will work harder to win this prize, thereby increasing aggregate means of subsistence.

"Vice," according to Malthus, includes promiscuity, homosexuality, adultery, and birth control (including abortion). Undoubtedly Malthus did not foresee the degree to which the technology of contraception would develop over the next century and a half, nor the growing social acceptability of his other forms of "vice." His stated objection was on moral grounds. Engaging in any of these vices represented an indulgence in sexual appetites without an acceptance of the responsibility for the consequences of such indulgence. It was a rejection of individual responsibility, and Malthus saw acceptance of such responsibility as—in the long run—humanity's only hope for emerging from the dilemma. This pessimism seemed to soften over his seven consecutive editions of the essays.

Such a brief summary is clearly only a simplification of Malthus's life's work. What you have here is undiluted Malthusian thought, as it is preserved in demographic theoretical tradition.

Sources: William Petersen's summary (1975); his volume titled, simply, *Malthus* (1979; see reviews by Dupâquier, 1980, and Keyfitz, 1980); and a volume of essays, *Malthus Past and Present*, edited by Dupâquier (1983).

dominant both in their native country and in England, to which they each moved. What little Marx and Engels said about demography was in rejection of Malthus (Meek, 1954). Within the socialist theory that Marx and Engels were developing, the effect of population size on subsistence and wealth depended on the kind of social organization a society had. What were considered population problems by Malthus were actually results of an unwise and unjust social organization of production and distribution. Humanity is not universally trapped in the Malthusian dilemma. Marx and Engels believed we can escape the supposed negative consequences of population density by reordering society, specifically by socialist control over the means of production and distribution. Some classical Marxist scholars might go further and point out that the labor theory of value leads to the conclusion that “people are wealth,” generally, and that population growth is never a root source of poverty. Some conservative “capitalist” economists have reached the same basic conclusion (e.g., Simon, 1986). The contributions of Malthus’s critics, including Marx and Engels, were to remind us that population size is only half of the density, or carrying capacity, equation.

The tension between fears of overpopulation and the alternative of blaming current social organization of production and distribution has been echoed in all subsequent discussions of population growth and development. In recent decades a *neo-Malthusian* perspective has used part of Malthus’s theory as a justification for worldwide family-planning programs. *Neo-Marxian* perspectives, and economic development theory, have meanwhile promoted development policies such as improved agricultural technology, opportunities and access to credit for marginalized social groups, and efficient social distribution systems within LDRs. Not surprisingly, these two perspectives are complementary, reflecting the numerator (i.e., population size) and the denominator (i.e., means of subsistence) in our general formula for population density. Both clearly have a role in concerns over population growth. Malthus’s contribution was to bring attention to the importance of population growth in this equation.

We can assume that Malthus would applaud the recognition that many countries have given to the importance of population growth. China, for example, came to recognize its huge population and rapid growth as a cause of continued underdevelopment and took measures in the form of fertility regulation to counteract it (however, evidence shows that fertility decline began in China prior to regulation). Though few countries have taken an approach as extreme and controversial as China’s, officials in many countries have respect for the possible negative consequences of entirely unchecked population growth.

Malthus would not, however, applaud the family-planning policies that countries have implemented to address concerns with population growth. These policies are examples of neo-Malthusianism, which openly advocates the use of **preventive checks** to escape the Malthusian dilemma. That includes, prominently, birth control, which Malthus called “vice.” A product of the Victorian era, Malthus instead advocated “moral restraint” through abstinence and delayed marriage. In spite of this difference, neo-Malthusians and the modern family-planning movement are directly descended from Malthus and rely on a general notion of his “principle of population” as pointing to the need for family-planning programs.

Global Overpopulation and the Environment

In the mid-20th century, those alarmed over rapid population growth were writing books and founding population study centers. There was much discussion of how the 20th-century population explosion would inevitably lead to food shortages, depleted resources, and growing poverty. But despite the doubling of the global population in a very short period, global food production during that time outpaced population growth, resources became cheaper, not more expensive, and global poverty actually decreased (Lam, 2011). This is not to suggest that the overpopulation voices of the period were off base, as their warnings are arguably what led to agricultural innovations and proactive attempts to prevent growing poverty. And there is little question that the environmental repercussions of rapid population growth and the consumption patterns of wealthier countries are harsh and potentially catastrophic. However, in terms of food production and economic growth, it is an important lesson in how prediction-making is highly dependent on an unchanging context.

When talking about long time spans and speaking on a global level, it is easy to envision finite limits of arable land, water, clean air, any given natural resource, and ultimately living space itself. Thus, those most sensitive to the problem of potential overpopulation are those most conscious of such limits, such as environmentalists, human ecologists, and international development organizations (Catafaro and Crist, 2012; Ehrlich and Ehrlich, 2012; Robertson, 2012; United Nations Secretary-General’s High-level Panel on Global Sustainability, 2012). Rather than focusing on overpopulation in terms of too many people in one place, measures such as the ecological footprint make clear that overconsumption and lack of sustainability among even a small population can have devastating effects on the global environment.

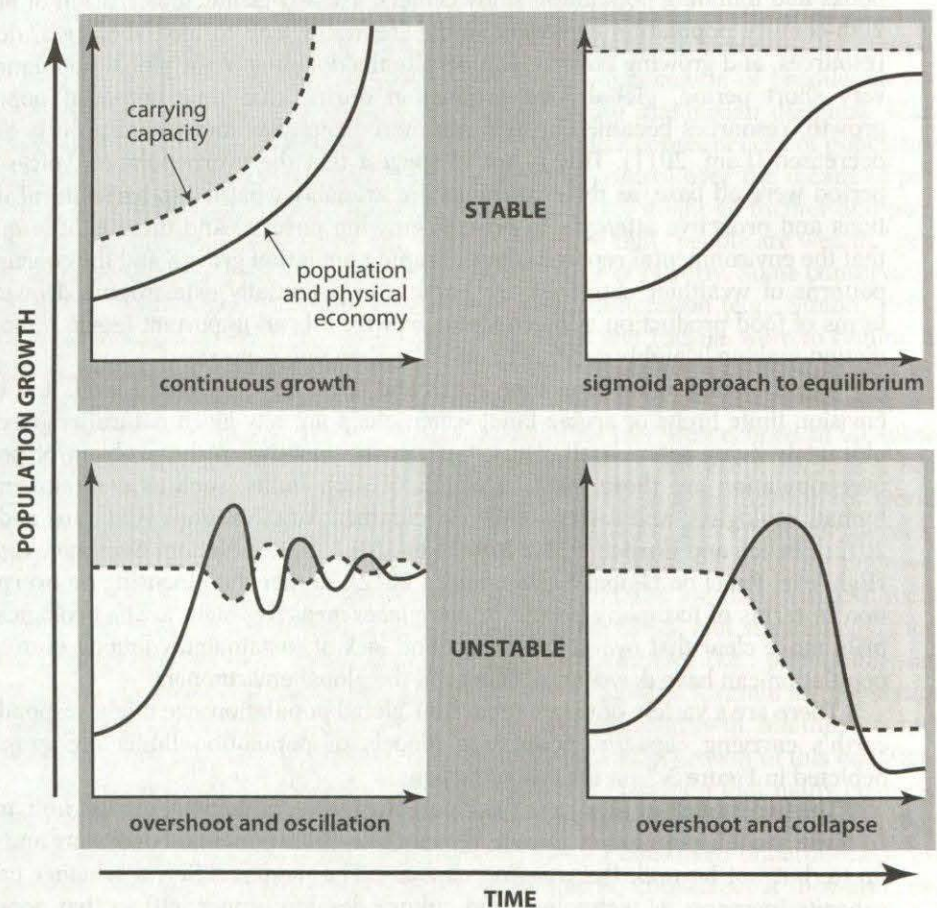
There are a variety of views about how global population size might respond to the earth’s carrying capacity. Four such models of population limits are graphically depicted in Figure 3-5 on the following page.

The two models at the top of this figure are stable, or *adaptive equilibrium*, models. In these models population growth responds to environmental conditions and grows up to, but not beyond, the carrying capacity. The models differ in whether carrying capacity increases as technology and culture develop (upper left) so that population can also continue to grow, or whether the carrying capacity is really an overall fixed limit that population size will approach as it grows (upper right). The central feature of both models is that population growth responds to limited carrying capacity before reaching limits to growth.

The two basic models at the bottom of this figure are unstable, or *overshoot*, models. In both of these cases population growth is not aware of, or at least not responsive to, limits to growth until it has exceeded the carrying capacity. Based on current population and consumption trends, some estimate that the earth’s sustainable carrying capacity has already been overshoot, but that the population has not yet been affected because it has not yet depleted its remaining stores of nonrenewable energy sources (Ewing et al., 2010).

These two models differ in how population growth responds once the carrying capacity of the population is exceeded. The first possibility (lower left) is that population drops off (i.e., negative growth) once it exceeds carrying capacity, perhaps with

Figure 3-5
Global Population Size and Carrying Capacity: Four Models



Source: Reprinted and adapted from *Limits to Growth: The 30-Year Update*, copyright © 2004 by Meadows, Meadows, and Randers. With permission from Chelsea Green Publishing Co.

some damage to the environment, and oscillates above or below carrying capacity until, perhaps, an eventual equilibrium is reached. This model is often characterized as a population learning its carrying capacity by trial and error. It is also the model that is closest to what Malthus might have envisioned.

The second possibility (lower right) is the bleakest of all. In this model, once the population exceeds its carrying capacity there is catastrophic damage to the environment. Once this happens, both the carrying capacity and the population collapse in ruin or extinction. It is not farfetched to imagine increasing world conflict over limited natural resources prior to a collapse. This model is, of course, only the most pessimistic possibility. In a bit more optimistic view, those who believe that there are fixed lim-

its to growth often point out that, with exceptions, humanity would not likely reach limits simultaneously all over the world. Depending on both population and technology, some regions would encounter limits earlier than others. Already, some countries are facing severe water shortages (World Water Assessment Programme, 2012). If other regions with excess resources were willing to share them unselfishly, limits to growth, or possible overshoot, might be postponed and eventually avoided altogether. Can we have faith in such interregional altruism, and on the massive scale required as additional “overpopulated” regions are added, including ever larger proportions of the world’s population? Even if it were only a problem of redistribution of resources, it is a massive and difficult one to resolve.

Other demographic-environmental concerns have more immediate global implications. Carbon emissions and resulting climate change is a major example. While population growth and energy consumption have by now been well documented as causes of climate change (IPCC 2007, 2013; Pachauri and Jiang, 2008; National Research Council, 2008), research is needed on the extent to which demographic characteristics of populations—such as age structure, household size, and urbanization—may predict differing energy consumption patterns (Jiang and Hardee, 2011). The “feedback” effects of future climate change are even more difficult to predict. The United Nations’ Intergovernmental Panel on Climate Change (IPCC) estimates that immediate effects will be felt differentially across the globe (IPCC, 2007, 2012, 2013). Regions located near the equator are likely to experience worsening conditions, whereas regions in higher latitudes may experience some short-term agricultural benefits. Unfortunately, those countries who will bear the immediate brunt of global warming are LDRs, which not only produce the lowest amounts of greenhouse gases in the first place, but also have fewer resources to protect themselves from related agricultural and economic instability. Longer term, however, the accelerating impacts of climate change will likely be felt globally. The IPCC predicts increasing frequency of extreme weather events, unpredictable weather patterns, rising sea levels, and water shortages. Potential consequences, such as impaired agricultural productivity and food shortages, altered infectious disease prevalence, and environment-related mass migrations would impact global sociopolitical stability, and we could certainly expect them to also influence classic demographic trends, such as migration, mortality, and perhaps even fertility.

One of the greatest challenges to resolving population-related environmental degradation is the phenomenon known as the **tragedy of the commons**, which describes how individual interests are often at odds with the collective best interest. A classic example is fisheries. Fish are a global resource and, in the absence of international regulation, each nation will seek to expand its yield, because if it does not, another nation will. However, the end result will be overfishing and fishery depletion, which is ultimately in no nation’s interest. The same is true of climate change, where each nation has an economic stake in energy consumption and little short-term disincentive to check their global greenhouse gas emissions.

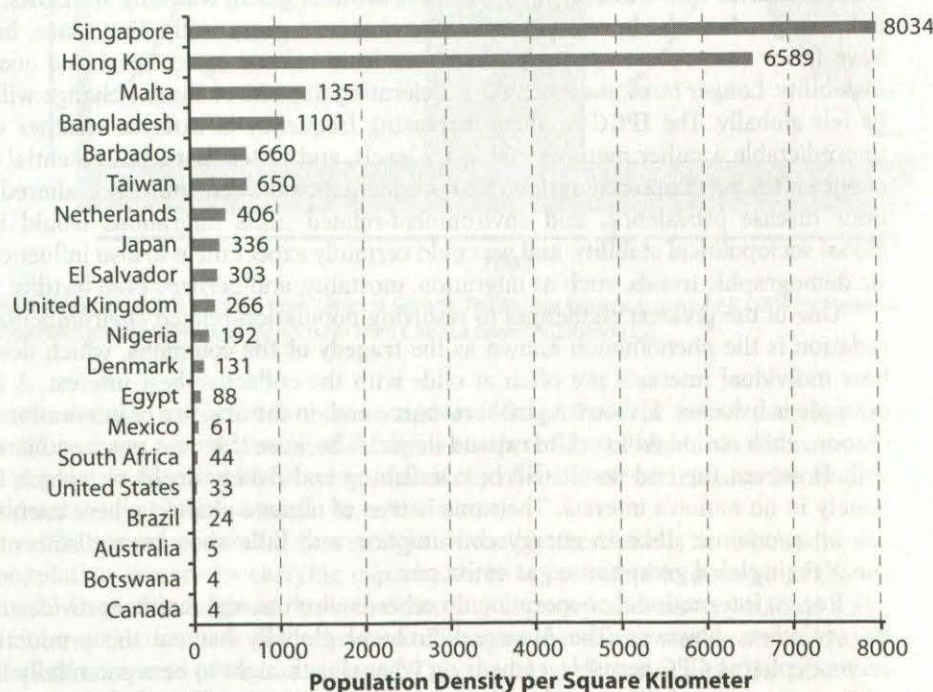
Recent international cooperation on other environmental matters provides reason for optimism, however. The Montreal Protocol globally banned the production of ozone-depleting CFC aerosols, remedying what was thought to be a potentially intrac-table environmental disaster (Sarma and Andersen, 2011). Although the causes of climate change are more complex and the political and economic stakes of reducing

reliance on nonrenewable fuels are much higher, there are nascent signs of emerging international cooperation. The Kyoto Protocol is the first international attempt to limit global carbon emissions through a system of reduction goals, caps, and emissions trading. Because the United Nations is unable to enforce participation, however, some of the most significant carbon-emitting countries, like the United States, have opted out. As climate change becomes a more visible risk, the hope is that all nations can be persuaded to participate before the repercussions of climate change are too severe. Evolving technologies, such as the development of renewable energy sources, including wind, solar, bioenergy, hydropower, biothermal, and ocean energy, also have the potential to reduce global reliance on fossil fuels (IPCC, 2011).

National Overpopulation

Countries vary greatly in their population densities, as Figure 3-6 dramatizes. The bars in the graph measure the population-per-area ratios of twenty countries, from MDRs and LDRs, which were selected for their widely varying densities. Australia, Canada, Brazil, and the United States, **frontier regions/nations**, appear at the sparsely populated extreme. Singapore and Hong Kong are at the other extreme, far outstripping even the Netherlands and Japan.

Figure 3-6
Population Density in Twenty Selected Countries, 2014



Source: Data from Population Reference Bureau, 2014. 2014 World Population Data Sheet.

Are the more densely settled of these countries “overpopulated”? The debate over this issue is often in terms of economics and health. For example, if country X had fewer people and a lower density, would that increase the wealth of the country and living standards of its citizens? Would lower density improve the available housing for the population? Would lower density improve health or lower death rates? Any number of such questions may be raised.

A large, densely settled population is deemed to both help and hurt the pursuit of national and personal wealth. On the benefit side, a large population, settled together in space, increases the possibility for division of labor and specialization of producing units; it also makes possible large enterprises that produce economies of scale. On the cost side, a large, densely settled population may limit the productivity per worker by limiting the resources per worker. The balance between these pros and cons depends on the basis of the economy. In countries based on industry, the problem of undersupplying workers with the means for production may be less pressing because those means (capital, equipment, skills, and energy) are expanded and relocated more flexibly. In countries with extractive economies, on the other hand, the resources that make workers productive are less expandable and more easily outstripped in a given location. The classic example of a nonexpandable resource is agricultural land, but one also could include mineral wealth, forests, and fossil fuels.

Aside from its effect on economic productivity, population density has complex effects on living standards and health. Local densities, such as those associated with urbanization, have their advantages as well as their disadvantages, as we will explore in chapter 10. And density has been historically related to mortality and health (chapters 5 and 6).

With all of these dimensions of overpopulation, the problem on a national level is either confined to, or more acute in, the densely settled LDRs. In some of these countries, the benefits of size and density can be outweighed by the detriments. Bangladesh is still commonly cited as the classic case of an overpopulated country, a country in the Malthusian dilemma. It is a small country with a proportionally large population size and, until recently, its economy was almost entirely agricultural. Living standards were marginal, public services were underdeveloped, and it has experienced a number of cyclones, military conflicts, and famines that have aggravated public health concerns. But in recent decades it has made extraordinary development gains that contradict its reputation as a country overburdened by population problems. Thanks largely to the government’s investment in women’s education and public health, fertility has fallen to almost replacement levels and life expectancy has increased dramatically (*The Economist*, 2012).

The Netherlands and Japan, on the other hand, although fairly heavily settled, have seldom ever been referred to as “overpopulated” because their economies are not basically extractive. Even more dramatic cases of heavily populated but not “overpopulated” countries would be Singapore and Hong Kong, because of their commercial-industrial economies. Again, there are some negative costs of density in these countries, but they are limited compared to those in many LDR urban centers where infrastructure has not always been able to keep up with growth. There also are some LDRs that, though they have extractive economies, are not yet so densely populated that they would be considered as having an “overpopulation” problem; Bolivia is one such example.



Careers in Demography

Wendy Baldwin

President, Population Reference Bureau
Program Director, Population Council, 2006–2012
Executive Vice President for Research, University of Kentucky, 2003–2006
Deputy Director, NIH and NICHD, 1994–2002

How did you decide that being a demographer was the career path for you?

In my sophomore year in college I took a course on population and knew immediately that it combined my interest in social issues with quantitative methods. I was hooked!

What kind of education and training did you pursue to get to where you are in your career?

As part of my BA program I was able to do a five-week self-directed activity. I chose to do all the research I could on how family planning became an issue in the U.S., how it evolved, what the challenges were, and so forth. I augmented that with visiting and talking with the local family-planning program.

I felt strongly that if women could not control that fundamental aspect of their lives, they would be unable to control others, such as investing in education and professional lives. That said, I worked for a year and then went to graduate school to build more skills. My experiences while doing dissertation research in Bogotá, Colombia, reinforced my view of the key importance of understanding how women and couples made decisions about family and how they were able to implement them.

After graduate school I went to the NIH on a two-year appointment—and stayed for 30 years. I was able to develop a research program on adolescent sexual and fertility behavior, advance our understanding of AIDS risk behaviors, and much more. It was a great experience. Now, I have been able to extend those interests in my work at the Population Council and most recently at the Population Reference Bureau.

Describe your work/research as a demographer. What do you consider your most important accomplishments?

My work has been largely in research administration—which sounds dull, but is anything but! It has placed me at the interface of academic research advances and the process of getting those advances known and understood by policy makers. There is a great need for demographic information in many sectors and there is a need for those who can help translate information for those audiences.

As president of the Population Reference Bureau (PRB) in Washington, DC, we get data to decision makers to inform, empower, and advance population issues in the United States and around the world—actions that are critical to the support of strong, effective policies and programs to advance reproductive health and the well-being of populations.

In my past work at NIH, I helped to craft the policies on sharing data and on the inclusion of women and minorities in research, both key issues for how research is done to the benefit of all. At the Population Council, I worked toward helping adolescents make the transition to healthy, productive adulthood.

The kinds of problems we deal with take a long time to address but we have seen success. There may be long-standing traditions of child marriage, for example, but families and communities can learn ways to redefine those traditions that also protect young girls from marriage. The younger the girl, the greater the age gap between her and her

spouse, the less voice she is likely to have in the decision to marry, the end of schooling, and the beginning of very early childbearing. So, when we see communities that begin to value their daughters more, provide alternatives for them, support their schooling, and open up new opportunities for them . . . well, that looks like success to me!

I believe that whether or not girls are valued is an issue that everyone can relate to. Too often problems in developing countries seem so far away and it isn't clear what can be done to make the lives of girls better. I have seen programs that have a transformative effect on girls; I've talked with fathers who were so appreciative of the help in finding a better life for their daughters. There is a fundamental satisfaction that comes from such work and this is an important way to spread a vision of the compassion of people for others.

What do you see as the field's most important contribution as well as its greatest challenge?

The field of demography faces several challenges. While there are massive amounts of data available, they are not necessarily easily available. We should always be looking for ways to ensure that data are truly available and accessible to "end users," not just demographers! Also, demography deals with fundamentally personal topics—sex, fertility, marriage, and death. We must forge strong alliances with many disciplines so that we can obtain the most valid information in a way that protects the sensibilities and rights of respondents.

It is again important to remember that there are many costs and benefits of density. To have a particular problem that is aggravated by population density does not necessarily make a clear case for overpopulation. If that were so, then only the areas inhabited by hermits would not be overpopulated. As a result, demographers have gotten out of the habit of thinking in simple terms of overpopulation and underpopulation. This is more a layman's definition of the problem. It is difficult to arrive at a defensible all-purpose "optimum" population figure for any given area. Instead, most demographers focus on the specific effects of population growth rates.

An alternative definition of overpopulation is the ecological footprint measure. That is, how environmentally sustainable is a population, regardless of its density? Does the population consume more resources than it renews? By this measurement, then, Figure 3-6 would look quite different, with countries like the United Arab Emirates and Belgium topping the most "overpopulated" countries in the world (Ewing et al., 2010).

Problems of Growth Rates

Too-Rapid Growth

Who defines rapid growth as a problem for the less-developed countries? Such a belief is widespread in the Western press, which is given to statements like this: "And to cap off the economic problems of impoverished (insert name of LDR country), it is burdened with a population growth rate of more than 2% per year. Thus, every advance in its economy is gobbled up by its burgeoning masses." Many demographers, developmental economists, and population policy planners share the belief that rapid popula-

tion growth may limit or constrain economic development. Poverty in LDRs may be both worsened and made more difficult to redress by rapid population growth.

An alternative, optimistic point of view, championed by Julian Simon (2006, 1986, 1981, 1977; see also Lal, 2006), argues that evidence shows that human ingenuity is “the ultimate resource”; the more people we have thinking about how to solve problems of production, the greater will be the improvement of technology and economic development. This view is not always met with much sympathy among the demographic establishment (see reviews by Anderton, 1988; Cutright, 1982; Timmer et al., 1982; Coleman and Rowthorn, 2011). A similar sentiment has also been associated with conservative think tanks that seek to deny the seriousness of related environmental concerns (Jacques et al., 2008).

But, despite a recent history of debate over the effects of population growth on economic development, many scholars now agree that rapid population growth is not the *primary* obstacle to economic development. Other factors, such as institutional contexts, labor markets, and social policies are as important as the effects of population growth on economic development (Coleman and Rowthorn, 2011; Das Gupta et al., 2011; Kelley and Schmidt, 2005; Weil and Wilde, 2009; National Research Council, 1986). For example, while rapid postwar economic growth in East Asia was accompanied by drastic decline in population size, shifting from an average of six or more children per woman to two or less in a couple of decades, scholars believe that fertility decline was not the only condition for this economic growth (Mason, 2003). Economists and demographers also pay attention to other facets of economic development, such as resource dilution and diversion, social expenditure, welfare state policies, and so forth, and they differentiate between short- and long-term effects of population growth on economic development (Headey and Hodge, 2009).

Many LDR governments—presumably advised by their own economists (and often under pressure from the West)—have come to view rapid population growth as one of many potential obstacles to economic development. The number of LDR governments concerned that their growth rates were too high increased significantly throughout the latter half of the 20th century. During this time, LDR growth rates decreased significantly, on average from 2.4% in 1971–1975 to 1.4% in 2005–2010 (United Nations, 2010). Today about half the governments of developing nations think that their population growth rate is too high and believe that managing population growth must be a part of LDR strategies for economic development (United Nations, 2010).

Given the relationship between population growth and development, it is reasonable to ask how, theoretically, rapid population growth rates might result in slower economic development in the LDRs. Traditional arguments fall into two categories, one dealing with youth dependency and the other with the productivity of the workforce (Birdsall, 1977; Boserup, 1981; Coale and Hoover, 1958; Crenshaw et al., 1997; Lee, 1983, 1986; McNicoll, 1998).

Strictly speaking, the **youth dependency** problem results from high fertility rather than high growth rates. Rapid growth rates in the modern world are caused by high birth rates coupled with much lower death rates, as shown in the demographic transition in Figure 3-2. The number of new babies added to the population every year is progressively larger. It is true, as Marx pointed out, that each of these babies comes equipped with only one mouth but two hands. But, mouths become operative immediately (ask any parent) while the hands become productive only after a long immaturity.

Society has to treat these babies as consumers immediately and as producers only later in their lives. First, society has to bear the costs of their mothers’ pre- and postnatal care, the babies’ own infant care, and so on through their years of education and job training. It is only much later that children start to pay back the societal investment. In short, high-fertility populations tend to have large proportions of people at young, dependent ages (see chapter 4 on age and sex structure).

Importantly, if fertility decreases, LDR economies may profit from a temporary economic boost as these young dependents become adults, enter the productive labor force, and are replaced by smaller numbers of dependents in coming generations (Gribble and Bremner, 2012; Crenshaw et al., 1997). This has been referred to as the **demographic dividend**. Theoretically, curtailing rapid population growth, then, may both reduce the immediate burdens of youth dependency and also provide a transition generation with unusually low burdens of youth dependency. Both outcomes would, hypothetically, increase the capital and labor resources available for investment in economic development.

The second explanation of how rapid growth rates inhibit development focuses on the capacity of the economy to improve worker productivity. Theoretically, productivity per worker is related to how many workers share the means for production, the capital. This can be expressed as a version of the general density ratio encountered earlier:

$$\frac{\text{workforce}}{\text{capital}}$$

(Economists sometimes use the inverse of this ratio, capital available per worker, or the *capital-labor* ratio.) Economic development results from expanding capital by providing better tools, better training, improving the transportation infrastructure, and so forth. But some argue that the more rapidly the population—and thus the workforce (in the numerator)—grows, the more rapidly the capital (in the denominator) has to grow in order to decrease the ratio between the two. This is less of a problem where capital is easily expandable, but the economic consensus seems to be that, by their very nature, technologically underdeveloped economies do not expand their capital flexibly; they are more extractive economies, relying on agriculture, mining, forestry, and fishing. Indeed, most LDRs already suffer from high rates of unemployment and underemployment, unable to keep their existing workforces supplied with the capital for production (United Nations, 2009). Controlling rapid population growth theoretically gives LDRs a greater amount of capital per worker, or *capital intensification*, which should allow for greater economic development.

In simple form, the arguments of youth dependency and worker productivity seem convincing. Unfortunately, reality is much more complex and hard evidence supporting these theories is lacking (McNicoll, 1998; Crenshaw et al., 1997). Indeed, some demographers have argued that the realities of population growth and various aspects of economic development are so complex as to defy any formal analysis (e.g., Rodgers, 1989). Even ardent supporters of these theories acknowledge that there is, as yet, little quantitative cross-national evidence for them. Yet, the lack of evidence is also, in large part, due to a lack of detailed longitudinal data and the result of seeking a single model that would apply across all LDR countries. Careful historical observation of individual countries does lend some support for these theories (McNicoll, 1998). Demographers

have shown an increasing appreciation for how complex these relationships can be, even if “complexity does not imply inconsequence” (McNicoll, 1998, p. 4).

Beyond these reactions, some scholars are skeptical about Western economic development theory generally as it applies to contemporary modernizing LDRs. Those theories were formulated domestically in countries whose economic development occurred in quite a different era, one ripe for industrialization and imperial exploits. In contrast, contemporary LDRs are trying to scratch out a foothold in a world whose economic institutions are already shaped by the West. In particular, capital-intensive industrial production is dominated (and outsourced) by the MDRs. Therefore, world economic development in the future could take quite a different form than what occurred during Western modernization. It might involve an unprecedented pattern of economic development for the LDRs, one with more emphasis on labor-intensive production and the development of human capital (Sadik, 1991). Policies promoting women’s economic development and providing agricultural education are examples of such human capital investments (Kristof and WuDunn, 2010; World Bank, 2006).

Too-Slow Growth

As Table 3-3 shows, the population growth rates of MDRs are low relative to the LDRs, and getting lower. Between 2005 and 2010, the rates were 0.86% for North America and 0.11% for Europe as a whole (United Nations, 2011). Eastern Europe even had a negative growth rate (-.17%), making a platform of population growth stimulus a major factor in Russia’s 2011 presidential election (Parfitt, 2011). As one might expect, the current definition of population growth problems is quite different in the MDRs than in the LDRs. The problem, where one is acknowledged, is “stagnation.” In 2009, 47% of governments believed their population growth rates were too low (United Nations, 2010). Thus, compared with LDRs, the MDRs have the opposite concern about population growth.

As Espenshade (1978, p. 645) points out, the MDRs have not always been very calm about slow population growth:

When the Great Depression had plunged the Western world into a protracted period of sluggish economic growth and high unemployment, it was fashionable among academic economists in the United States and Western Europe to attribute these conditions partly if not wholly to the unprecedented low rates of population growth. This view, popularly known as the “stagnation thesis,” held that population growth stimulated business investment in factories and machines; and by contributing to business optimism, in which investment misallocations were likely to be regarded less seriously than if population were to slow to nil.

The reaction to the current slow growth is calmer, informed by the Depression experience. The MDRs lived through the period of slow population growth in the 1930s without apparent damage. And, although critics of the prevailing views on population growth might take heart in such an explanation for the Great Depression, hindsight blames many other factors in addition to slow population growth. Economic growth of MDRs has not appeared to suffer inordinately from slowing population growth (Coleman and Rowthorn, 2011), particularly as long as the influx of immigrants from LDRs is able to fill MDR labor force gaps.

To the degree that slow growth is seen as a source of social and economic problems, the short-term path of its negative effect is largely through the transitioning age composition of the population. Contemporary slow growth is achieved by low birth rates, which generate a population whose average age is older. There is some evidence that recent financial crises in Japan, the Asian Tigers,¹ and the United States stem from the transition from a large young adult population (ages fifteen to twenty-four) to a smaller one (Macunovich 2012, 2007). This age group tends to consume significant amounts in terms of new households formed and educational investments. Failure to forecast the contraction of this young adult population may lead to unexpected inventory build-up and production cutbacks. Furthermore, an aging population can create its own problems through the disproportionate dependence of the elderly on the working-age population. This can undermine the stability of various country-level policies, such as social security and healthcare systems, among others, which we revisit at the end of chapter 4.

In the long term, however, if population growth rates continue to slow and eventually become negative, as they are projected to do in some countries, a more grave concern is population decline. Just as the doubling-time equation demonstrates how quickly a growing population can expand, populations with negative growth can halve and then halve again just as suddenly. For example, if current fertility rates in Europe were to continue, the European population is just past its peak and will have 199 million fewer people by the year 2100 (United Nations, 2013).

Historic concern with **underpopulation** has often been fueled by an “us versus them” mentality, where MDRs feared being eclipsed culturally and politically by quickly growing LDR populations (Teitelbaum and Winter, 1985). But it has become clear in recent years that population decline no longer falls only in the domain of MDR concerns. Underpopulation has the potential to become a global issue, albeit occurring much sooner for some countries than others. Most of the world’s population resides in countries that have undergone or are undergoing fertility transition, and evidence from MDR fertility transitions suggests that very low fertility levels are an inevitable outcome. A world with high fertility may eventually become a historical footnote (Morgan, 2003; Bongaarts and Bulatao, 2000; United Nations, 2003).

Just as the dialogue on overpopulation has sometimes been accused of having a sensationalist overtone, the same is true of the dialogue on underpopulation. Titles of popular books like *What to Expect When No One’s Expecting*, *How Civilizations Die*, and *Shock of Gray* are in direct contrast to classic overpopulation standards of earlier decades, such as the well-known *The Population Bomb*. Hyperbole often factors prominently in such missives, with the word “plummeting” taking the place of the word “explosion.” While *The Population Bomb* compared growth rates to a “cancer” with the potential to expand at the “speed of light” (Ehrlich, 1968, p. 152), underpopulation characterizations are equally bleak. For example, in *What to Expect When No One’s Expecting: America’s Coming Demographic Disaster*, the author writes, “Throughout recorded human history, declining populations have *always* followed or been followed by Very Bad Things. Disease. War. Economic stagnation or collapse” (Last, 2013, p. 7). These issues, as it turns out, also make great fodder for fiction novels with grim demographic themes (see Box 3-3).

¹ Named *Asian Tigers* for their rapid economic transition during the 1960s–1990s, these include Singapore, Taiwan, South Korea, and Hong Kong.

Box
3-3

Demography in Fiction

Because beneath the field's dry statistical surface, there teems an irresistible Pandora's Box of paranoia, nationalism, rivalrous ambition, misanthropy, and apocalyptic dread, demography is sure to tempt fiction-writing dabblers to prize open the lid.

—Lionel Shriver, award-winning novelist and journalist

Once loosely associated with eugenics in the early 20th century, the field of demography began self-consciously differentiating itself from the movement by the 1930s. Nonetheless, demographers are still sometimes nefariously associated with eugenicists of the past who promoted the reproduction of some groups and discouraged the reproduction of others. Thus, in the popular imagination, novels with demographic themes tend to gravitate toward the post-apocalyptic and the dystopian. The following works of fiction are just a sampling of many that explore basic demographic questions of humanity and morality.

Reproductive Genetic Engineering Themes

Brave New World (1931). A classic by British author Aldous Huxley, this book was among the first to imagine a future of state-regulated fertility using reproductive technology. In the year 2540, natural reproduction no longer exists. Instead, children are genetically engineered to fit a particular social caste, "decanted," and then raised in "conditioning centres."

The First Century after Beatrice (1994). Novelist Amin Maalouf picks up on the theme of sex selection and carries it out to its disturbing conclusion. A medicine is developed that results only in boy births. Industrialized countries deliberately market the pill to less developed countries in the hopes of drastically cutting their fertility rates, which ultimately leads to a doomed all-male world.

Never Let Me Go (2005). Kazuo Ishiguro writes an emotionally devastating book exploring the use of cloned humans as organ donors. Life expectancy for "originals" is extended well beyond the age of 100 by harvesting organs from one's clone, who is fated to die by early adulthood.

Overpopulation Themes

Make Room! Make Room! (1966). Harry Harrison's novel takes place in 1999 in the midst of environmental catastrophe and dwindling resources due to global overpopulation (the population had reached 7 billion people, slightly less than today's population size!). The better known movie version, *Soylent Green* (1973), introduces the sinister twist of secretly terminating the elderly and making them into a food source for the starving population.

Game Control (1994). Lionel Shriver features a whole cast of real-life demographers. The main protagonist is a villain who advocates for ignoring high infant mortality in the developing world in order to avoid overpopulation. He develops a virus designed to kill 2 billion humans in the name of sustainability.

Inferno (2013). Dan Brown's latest novel is about an overpopulation "cure," a purposefully-released virus that induces sterilization in a third of the global population. One of the characters is the head of the World Health Organization (WHO), who becomes infected with the virus. The larger premise is that this virus is the only way to prevent an overpopulation crash and allow the human race to evolve into the next stage of "transhumanism."

Underpopulation Themes

Earth Abides (1949). In George R. Stewart's novel a plague causes the collapse of North American society, and with too small of a population, society cannot sustain itself. This book allegedly inspired Stephen King's 1978 post-plague apocalypse *The Stand*.

The Children of Men (1992). Also made into a 2006 film, P. D. James paints a world where mass infertility has beset the population, giving a heartbreaking description of the final generations of people facing their extinction. "Omegas" are the last generation of humans to be born and are treated by the rest of society as celebrities, while pets are coddled and treated like infants.

Aging Themes

Diary of the War of the Pig (1969). In this harrowing depiction of the future, Adolfo Bioy Casares describes a rapidly aging population where the elderly are scorned and persecuted. Society, governed by youth, has decided that the elderly do not contribute to society and should be systematically exterminated.

Death with Interruptions (2005). Immortality is finally achieved in José Saramago's disturbing novel. The development is only fleetingly celebrated because it becomes clear that the environment cannot sustain an undying population. Furthermore, the healthcare system cannot provide for the terminally frail elderly population that is permanently suspended in the act of dying.

Sources: Brown, Dan. 2013. *Inferno*. Bantam Books; Domingo, A. 2008. "Demodystopias: Prospects of Demographic Hell." *Population and Development Review* 34: 725–745; Kuijsten, Anton C. 1999. "Demografiction." In Anton Kuijsten, Hans de Gans, and Henk de Feijter (eds.), *The Joy of Demography . . . and Other Disciplines: Essays in Honour of Dirk van de Kaa*. Amsterdam: Thela Thesis, pp. 83–102; Shriver, Lionel. 2003. "Population in Literature." *Population and Development Review* 29(2): 153–162; Ramsden, Edmund. 2009. "Confronting the Stigma of Eugenics: Genetics, Demography and the Problems of Population." *Social Studies of Science* 39: 853–884.

But sometimes a tendency toward hyperbole provides a needed catalyst in bringing about social change. The overpopulation movement of the 1960s and 1970s inspired a vast body of writings and research in the Malthusian tradition, which quickly gained widespread currency among the mainstream public. This, in turn, has inspired governments and nonprofit organizations around the world to make family planning a top funding priority, arguably paving the way for the newest concern over falling fertility rates.

What is a measured response to these population debates? Although the transition to population decline is a potential future problem, the immediate ramifications of rapid population growth is a pressing issue that many countries must face in the present. Of the two extremes, a future of global population decline is arguably more desirable than one of unchecked population growth like that experienced over the past fifty years. In his address to the Population Association of America, Philip Morgan summed it up this way:

In my view, low fertility is not a twenty-first-century crisis—not yet, anyway. It is a genuine problem, but the kind of problem we want to have. That is, it is the result of solving a bigger, more threatening social problem: the crisis of continued population growth. Low fertility is also a problem that can be addressed through public policy and institutional adjustments. Finally, low fertility is a problem that befalls developed countries that, by and large, have the resources to respond. (2003, p. 600)

SUMMARY

After millennia of slow growth, the world’s population took off at an unprecedented rate starting in the 1600s and peaking in the late 1960s. Population consumption patterns—more so than population growth—may challenge the carrying capacity of the planet, even though fertility has begun to decline worldwide. Concerns about population overconsumption patterns include carbon emissions leading to climate change, the exhaustion of fisheries and freshwater resources, and so forth. The modern population explosion has not been equally intense worldwide. It started in what are now the more-developed countries. They have experienced, with their modernization, a sequence of declines in death and birth rates described as the demographic transition. A few of these countries even now have below-replacement fertility. Many MDRs today are experiencing significant changes in union and householding patterns, what has been called the “second demographic transition.”

After World War II the less-developed countries replaced the more-developed as those with quickly growing populations. Although most LDR countries have now begun to move into the demographic transition, the ramifications of rapid population growth will continue through the 21st century and growth will decline only slowly.

The recent explosive growth of many LDRs has theoretical consequences that are sometimes defined as potential problems. The fact that much of this growth is concentrated in LDRs means that the distribution of world population is changing. MDRs are becoming an ever smaller minority of the world’s peoples, a fact that may strain the past privileged position and political dominance of MDRs. Some MDRs and LDRs are densely settled, and are increasingly so. Population density may place strains on resources, living standards, and a population’s health, especially in less-developed countries. The rapid natural increase (with accompanying high birth rates) in many LDRs means that economically dependent segments of the population are large relative to the economically mature, or productive, segments. In addition, rapid population growth makes it difficult for governments to supply growing workforces with capital, or the means for production. These economic concerns are largely based on the historical experience of Western economies.

There is still much debate as to the causes of and solutions for these problems and even as to whether they really are “problems” for contemporary LDRs and MDRs. There is an acknowledged relationship between rapid population growth and challenges to economic development; however, it is increasingly recognized that population growth rates are not the primary barriers to economic development in LDRs. The relationships between population growth and development are complex, depending on other characteristics of the specific population involved and requiring demographic policies suited to the unique challenges and resources of contemporary LDRs. Among MDRs and a few LDRs, challenges related to rapidly aging populations are a final legacy as the demographic transition plays itself out.

Among some demographers, there is growing concern about eventual population decline once fertility transitions have run their course around the world. This possibility is far enough in the future, however, that it is difficult to give it too much credence yet, especially when so many countries are just now dealing with the repercussions of rapid population growth. In any case, the causes and consequences of underpopulation are generally preferable to those of overpopulation.

EXERCISES

1. Table E3-1 shows what would happen to the total population of Japan if it started at 127,587,800 at the midyear of 2012 and decreased by −0.2% (i.e., 2 per thousand or .002) every year until midyear through 2017. Copy the same procedure and apply it to Bangladesh, filling in the blanks in the table. Assume an annual growth rate for Bangladesh of 1.6% (i.e., 16 per thousand). Figures are provided for the year 2012 to get you started. Round off the increment figure to the nearest thousand before adding it to the population as of the beginning of the succeeding year.

Table E3-1 Projected Population at Constant Growth Rates

Midyear	Japan		Bangladesh	
	Midyear Population	Increment During Year	Midyear Population	Increment During Year
2012	127,587,800	−255,175.6	152,875	2,446
2013	127,333	−255		
2014	127,078	−254		
2015	126,824	−254		
2016	126,570	−253		
2017	126,317	−253		

Note: After Japan 2012, all figures in thousands.

2. Plot the projected population of Bangladesh for every year from 2012 to 2017 in Figure E3-1 on the following page. Connect the dots with a freehand line.
3. The implications of a constant growth rate can be expressed dramatically in terms of the years to double at that rate. The formula is:

years to double = $\frac{70}{\% \text{ annual growth rate}}$

Suppose that the annual growth rates for the United States and Mexico in 2012 were 0.9% and 1.1%, respectively. How many years would it take for the populations to double? Round to one decimal place.

U.S. doubling time _____ (years)

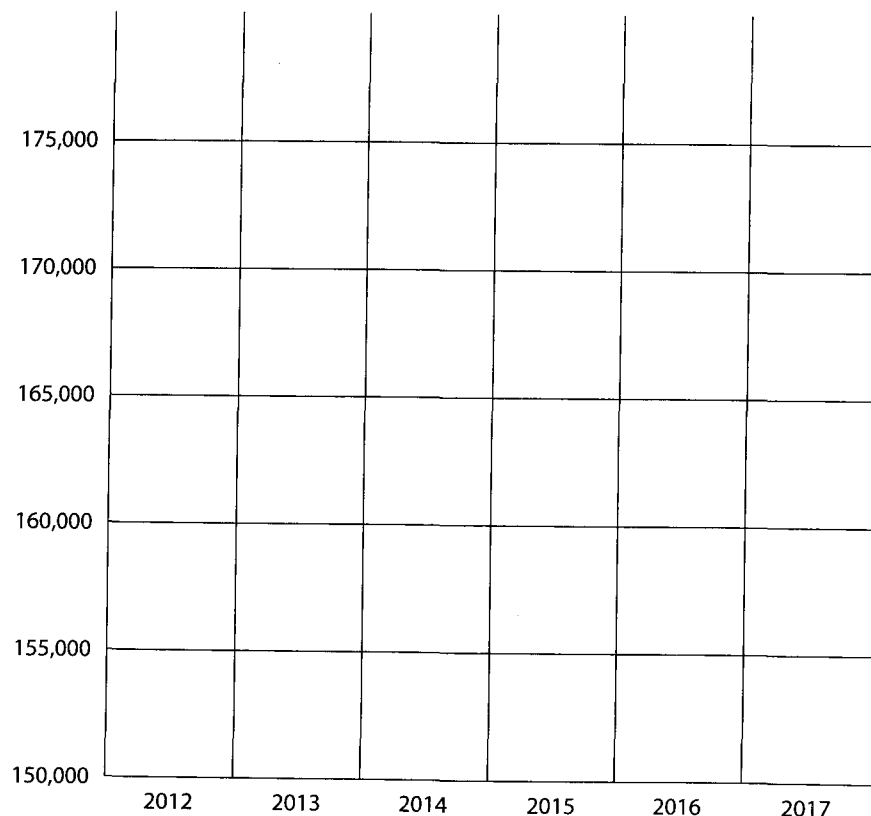
Mexico doubling time _____ (years)

4. Go to the textbook website at www.demographytextbook.com to the exercises section under the Chapter 3 tab to view Exercise 4, which shows carbon emissions over time. On the right hand select tool, select China, United States, United Kingdom, Brazil, and Botswana. Click play to see the cumulative CO₂ emissions from 1800–2011. Describe the trends you see.

Now change the Y-axis measurement on the left hand side from cumulative emissions to emissions per person by changing the Y-axis to “CO₂ emissions (tonnes per person).” Click play. Describe the trends you see compared to the previous example.

Figure E3-1

Graph of Projected Population of Bangladesh, 2012–2017



Note: All figures are in thousands.

PROPOSITIONS FOR DEBATE

1. Thomas Malthus's principle of population is wrong.
2. World population is more likely to overshoot carrying capacity than stabilize below it, but it will not be too late to avoid a population collapse.
3. Those who view overpopulation and rapid population growth as problems lack sufficient faith in human ingenuity and technological development.
4. The motivation of MDR leaders in viewing LDR rapid growth as a source of problems is basically selfish, concerned only with the privileges and power of the MDRs.
5. It is not rapid population growth in the LDRs that is slowing development; rather, it is domination of the world economy by the MDRs.
6. Explore your ecological footprint here:
<http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/>

REFERENCES AND SUGGESTED READINGS

- Anderton, Douglas L. 1988. "Review of 'Theory of Population and Economic Growth,' by Julian L. Simon." *Contemporary Sociology* 17(4).
- Becker, Gary S. 1981. *A Treatise of the Family*. Cambridge, MA: Harvard University Press.
- Birdsall, Nancy. 1977. "Analytical Approaches to the Relationship of Population Growth and Development." *Population and Development Review* 3(1–2).
- Bongaarts, J., and R. A. Bulatao, eds. 2000. *Beyond Six Billion: Forecasting the World's Population*. Washington, DC: National Academy Press.
- Boserup, Ester. 1981. *Population and Technological Change: A Study of Long-term Trends*. Chicago: University of Chicago Press; and Oxford, England: Basil Blackwell.
- Caldwell, John C. 1982. *Theory of Fertility Decline*. London: Academic Press.
- Catafaro, Philip, and Eileen Crist. 2012. *Life on the Brink: Environmentalists Confront Overpopulation*. Athens: University of Georgia Press.
- Cleland, J., and C. Wilson. 1987. "Demand Theories of the Fertility Transition: An Iconoclastic View." *Population Studies* 41(1).
- Coale, Ansley J. 1975. "The Demographic Transition." In *United Nations: The Population Debate*, Vol. 1, pp. 347–355. Population Studies, No. 57. New York: United Nations.
- Coale, Ansley J., and Edgar M. Hoover. 1958. *Population Growth and Economic Development in Low-income Countries*. Princeton: Princeton University Press.
- Coale, Ansley J., and Susan Cotts Watkins, eds. 1986. *The Decline of Fertility in Europe*. Princeton: Princeton University Press.
- Cohen, Joel E. 1995. *How Many People Can the Earth Support?* New York: W. W. Norton.
- Coleman, David. 2004. "Why We Don't Have to Believe without Doubting in the 'Second Demographic Transition'—Some Agnostic Comments." *Vienna Yearbook of Population Research*, Vol. 2, pp. 11–24.
- Coleman, David, and Robert Rowthorn. 2011. "Who's Afraid of Population Decline? A Critical Examination of Its Consequences." *Population and Development Review* 37: 217–248.
- Collins, Lynn. 1982. "World Population." In John A. Ross, ed., *International Encyclopedia of Population*. New York: The Free Press.
- Crenshaw, Edward M., Ansari Z. Ameen, and Matthew Christenson. 1997. "Population Dynamics and Economic Development: Age-Specific Population Growth Rates and Economic Growth in Developing Countries, 1965 to 1990." *American Sociological Review* 62(6).
- Cutright, Phillips. 1982. "The Best of All Possible Worlds." A Review of "The Ultimate Resource" by Julian L. Simon. *Contemporary Sociology* 11(6).
- Das Gupta, Monica, John Bongaarts, and John Cleland. 2011. *Population, Poverty, and Sustainable Development: A Review of the Evidence*. Policy Research Working Paper 5719. Washington, DC: The World Bank.
- Dupâquier, Jacques. 1980. "Malthus Reconsidered." A Review of "Malthus" by William Petersen. *Contemporary Sociology* 9(4).
- Dupâquier, Jacques, ed. 1983. *Malthus Past and Present*. New York: Academic Press.
- Easterlin, Richard A., and Eileen M. Crimmins. 1985. *The Fertility Revolution: A Supply-Demand Analysis*. Chicago: University of Chicago Press.
- The Economist*. 2012. *The Path Through the Fields* (November 3).
- Ehrlich, Paul. 1968. *The Population Bomb*. New York: Ballantine.
- Ehrlich, Paul, and Anne H. Ehrlich. 2012. "Solving the Human Predicament." *International Journal of Environmental Studies* 69(4): 557–565.
- Espenshade, Thomas J. 1978. "Zero Population Growth and the Economics of Developed Nations." *Population and Development Review* 4(4).
- Ewing, Brad, David Moore, Steven Goldfinger, Anna Oursler, Anders Reed, and Mathis Wackernagel. 2010. *The Ecological Footprint Atlas 2010*. Oakland, CA: Global Footprint Network.

- Feeney, Griffith M. 1994. "Fertility Decline in East Asia." *Science* 226(2).
- Gribble, James N., and Jason Bremner. 2012. "Achieving a Demographic Dividend." *Population Bulletin* 67(2).
- Hartmann, Betsy. 1995. *Reproductive Rights and Wrongs: The Global Politics of Population Control*. Boston: South End Press.
- Haub, Carl, and James Gribble. 2011. "World at 7 Billion." *Population Bulletin* 66(2). Washington, DC: Population Reference Bureau.
- Headey, Derek D., and Andrew Hodge. 2009. "The Effect of Population Growth on Economic Growth: A Meta-Regression Analysis of the Macroeconomic Literature." *Population Development Review* 35(2): 221–248.
- IIASA (International Institute for Applied Systems Analysis). 2012. *Population Forecasting and Aging* (November 5). Retrieved February 19, 2013. <http://www.iiasa.ac.at/web/home/research/researchPrograms/WorldPopulation/Research/Population-Forecasting-and-Aging.en.html>
- IPCC (Intergovernmental Panel on Climate Change). 2007. *Climate Change 2007: Impacts, Adaptation, and Vulnerability*. Cambridge, UK: Cambridge University Press.
- . 2011. *Mitigation, Climate Change: IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*. Cambridge, UK: Cambridge University Press.
- . 2012. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. Special Report of the Intergovernmental Panel on Climate Change, edited by Christopher B. Field, Vincente Barros, Thomas F. Stocker, Qin Dahe, David Jon Dokken, Kristie L. Ebi, Michael D. Mastrandrea, Katharine J. Mach, Gian-Kasper Plattner, Simon K. Allen, Melinda Tignor, and Pauline M. Midgley. Cambridge: Cambridge University Press.
- . 2013. *Climate Change 2013: The Physical Science Basis*. IPCC Working Group I Contribution to Fifth Assessment Report, edited by Thomas F. Stocker, Qin Dahe, Gian-Kasper Plattner, Melinda Tignor, Simon K. Allen, J. Boschung et al. Switzerland: IPCC.
- Jacques, Peter J., Riley E. Dunlap, and Mark Freeman. 2008. "The Organisation of Denial: Conservative Think Tanks and Environmental Scepticism." *Environmental Politics* 17(3): 349–385.
- Jiang, Leiwen, and Karen Hardee. 2011. "How Do Recent Population Trends Matter to Climate Change?" *Population Research and Policy Review* 30(2): 287–312.
- Kelley, Allen C., and Robert M. Schmidt. 2005. "Evolution of Recent Economic-Demographic Modeling: A Synthesis." *Population Economics* 18: 275–300.
- Keyfitz, Nathan. 1980. "Petersen on Malthus." A Review of "Malthus" by William Petersen. *Contemporary Sociology* 9(4).
- Kristof, Nicholas D., and Sheryl WuDunn. 2010. *Half the Sky: Turning Oppression into Opportunity for Women Worldwide*. New York: Vintage Books.
- Lal, Deepak. 2006. "India: Population Change and Its Consequences." *Population and Development Review* 32(1): 145–182.
- Lam, David. 2011. "How the World Survived the Population Bomb: Lessons From 50 Years of Extraordinary Demographic History." *Demography* 48(4): 1231–1261.
- Last, Jonathan V. 2013. *What to Expect When No One's Expecting: America's Coming Demographic Disaster*. New York: Encounter Books.
- Lee, Ronald. 1983. "Economic Consequences of Population Size, Structure, and Growth." *Newsletter of the International Union for the Scientific Study of Population* 17.
- . 1986. "Malthus and Boserup: A Dynamic Synthesis." In David Coleman and Roger Schofield, eds., *The State of Population Theory: Forward From Malthus*. Oxford: Basil Blackwell.
- Lesthaeghe, R. 1983. "A Century of Demographic and Cultural Change in Western Europe: An Exploration of Underlying Dimensions." *Population and Development Review* 6(4).
- . 2010. "The Unfolding Story of the Second Demographic Transition." *Population and Development Review* 36(2): 211–251.
- Lesthaeghe, R., and J. R. Surkyn. 2002. "New Forms of Household Formation in Central and Eastern Europe: Are They Related to Newly Emerging Value Orientations?" *UNECE Economic Survey of Europe*, Chapter 6, pp. 197–216. Geneva: United Nations Commission for Europe.
- Lesthaeghe, R., and P. Willems. 1999. "Is Low Fertility a Temporary Phenomenon in the European Union?" *Population and Development Review* 25(2): 211–228.
- Macunovich, Diane J. 2007. "Effects of Changing Age Structure and Intergenerational Transfers on Patterns of Consumption and Saving." In Anne Hélène Gauthier, C. Y. Cyrus Chu, and Shripad Tuljapurkar, eds., *Allocating Public and Private Resources Across Generations*. Dordrecht, The Netherlands: Springer.
- . 2012. "The Role of Demographics in Precipitating Economic Downturns." *Journal of Population Economics* 25(3): 783–807.
- Mason, Andrew. 2003. "Population Change and Economic Development: What Have We Learned from the East Asia Experience?" *Applied Population and Policy* 1(1): 3–14.
- Mason, Karen Oppenheim. 1997. "Explaining Fertility Transitions." Presidential Address to the Population Association of America, *Demography* 34(4).
- McKeown, Thomas. 1983. "Food, Infection and Population." In Robert I. Roberg and Theodore K. Rabb, eds., *Hunger and History: The Impact of Changing Food Production and Consumption Patterns on Society*. Cambridge: Cambridge University Press.
- McNeill, William H. 1976. *Plagues and Peoples*. Oxford: Blackwell.
- McNicol, Geoffrey. 1998. "Population and Poverty: The Poverty Issues, Parts I & II." Presented at the Workshop on Population, Poverty and Environment held at FAO, Rome, October.
- Meek, Ronald L., ed. 1954. *Marx and Engels on Malthus: Selections from the Writings of Marx and Engels Dealing with the Theories of Thomas Robert Malthus*. New York: International Publishers.
- Meuvret, Jean. 1965. "Demographic Crisis in France from the Sixteenth to the Eighteenth Century." In David V. Glass and David E. C. Eversley, eds., *Population in History*. London: Arnold.
- Morgan, S. Philip. 2003. "Is Low Fertility a 21st-Century Demographic Crisis?" *Demography* 40(4).
- National Research Council, Working Group on Population Growth and Economic Development, Committee on Population. 1986. *Population Growth and Economic Development: Policy Questions*. Washington, DC: National Academy Press.
- National Research Council, Board on Atmospheric Sciences and Climate. 2008. *Understanding and Responding to Climate Change: Highlights of National Academies Reports*. Washington, DC: National Academy Press.
- Notestein, Frank W. 1945. "Population—The Long View." In Theodore W. Schultz, ed., *Food for the World*. Chicago: University of Chicago Press.
- Pachauri, Shonali, and Leiwen Jiang. 2008. "The Household Energy Transition in India and China." *Energy Policy* 36(11): 4022–4035.
- Parfitt, Tom. 2011. "Vladimir Putin Pledges to Spend £32bn on Increasing Russian Life Expectancy." *The Guardian* (April 21). Retrieved March 7, 2013. <http://www.guardian.co.uk/world/2011/apr/21/vladimir-putin-increasing-russian-life-expectancy?INTCMP=SRCH>
- Petersen, William. 1975. *Population*. 3rd ed. New York: Macmillan.
- . 1979. *Malthus*. Cambridge, MA: Harvard University Press.
- . 1980. "Further Comments on Malthus and 'Malthus.'" *Contemporary Sociology* 9(4).
- PRB (Population Reference Bureau). 2008. *World Population Highlights: Key Findings from PRB's 2008 World Population Data Sheet*. Retrieved February 19, 2013. <http://www.prb.org/Publications/PopulationBulletins/2008/worldpopulationhighlights2008.aspx>
- . 2011. *How Many People Have Ever Lived on Earth?* Retrieved June 6, 2013. <http://www.prb.org/Articles/2002/HowManyPeopleHaveEverLivedonEarth.aspx>
- . 2014. *2014 World Population Data Sheet*. Retrieved September 2014. http://www.prb.org/pdf14/2014-world-population-data-sheet_eng.pdf

- Rees, William. 2010. "The Human Nature of Unsustainability." In Richard Heinberg and Daniel Leach, eds., *The Post Carbon Reader: Managing the 21st Century Sustainability Crisis*. Healdsburg, CA: Watershed Media.
- Rees, W. E., and M. Wackernagel. 1992. *Ecological Footprints and Appropriated Carrying Capacity: Measuring the Natural Capital Requirements of the Human Economy*. University of British Columbia, School of Community and Regional Planning.
- Robertson, Thomas. 2012. *The Malthusian Moment: Global Population Growth and the Birth of American Environmentalism*. New Brunswick, NJ: Rutgers University Press.
- Rodgers, Gerry, ed. 1989. *Population Growth and Poverty in Rural South Asia*. New Delhi: Sage.
- The Royal Society. 2012. *People and the Planet: The Royal Society Science Policy Centre Report 01/12*. London: The Royal Society, Science Policy.
- Sadik, Nafis, ed. 1991. *Population Policies and Programmes: Lessons Learned from Two Decades of Experience*. United Nations Population Fund. New York: New York University Press.
- Sarma, K. Madhava, and Stephen O. Andersen. 2011. "Science and Diplomacy: Montreal Protocol on Substances that Deplete the Ozone Layer." In Paul Arthur Berkman, Michael A. Lang, David W. H. Walton, and Oran R. Young, eds., *Science Diplomacy: Antarctica, Science, and the Governance of International Spaces*, pp. 123–132. Washington, DC: Smithsonian Institution Scholarly Press.
- Simon, Julian L. 1977. *The Economics of Population*. Princeton: Princeton University Press.
- . 1981. *The Ultimate Resource*. Princeton: Princeton University Press.
- . 1986. *Theory of Population and Economic Growth*. Oxford: Basil Blackwell.
- . 2006. *Hoodwinking the Nation*. Piscataway, NJ: Transaction Publishers.
- Teitelbaum, M. S., and J. M. Winter. 1985. *The Fear of Population Decline*. Orlando: Academic Press.
- Thompson, W. S. 1930. *Population Problems*. New York: McGraw-Hill.
- Timmer, C. Peter, Ismael Sirageldin, John F. Kantner, and Samuel H. Preston. 1982. "Review Symposium of Julian L. Simon, 'The Ultimate Resource.'" *Population and Development Review* 8(1).
- UNESCO. 2003. "Political Inertia Exacerbates Water Crisis, Says World Water Development Report: First UN System-Wide Evaluation of Global Water Resources." Press Release, March 5. Paris: United Nations Educational, Scientific and Cultural Organization.
- United Nations. 1973. *The Determinants and Consequences of Population Trends*. Vol. 1. ST/SOA/SER.A/50. New York: United Nations.
- . 1981. *World Population Prospects as Assessed in 1980*. Population Studies Series, no. 78: ST/ESA/SER.A/78. New York: United Nations.
- . 1990. *World Resources 1990–91*. A Report by the World Resources Institute. Oxford: Oxford University Press.
- . 1994. *World Resources 1994–95*. A Report by the World Resources Institute. Oxford: Oxford University Press.
- . 1999. *Revision of the World Population Estimates and Projections*, 1998 briefing packet. New York: United Nations.
- . 2003. *World Population Prospects: The 2002 Revision*. Department of Economic and Social Affairs, Population Division. New York: United Nations.
- . 2004. *World Urbanization Prospects: The 2003 Revision*. Department of Economic and Social Affairs, Population Division. New York: United Nations.
- . 2005. *World Population Prospects: The 2004 Revision*. Department of Economic and Social Affairs, Population Division. New York: United Nations.
- . 2009. *Rethinking Poverty: Report on the World Social Situation 2010*. ST/ESA/324. Department of Economic and Social Affairs. New York: United Nations.
- . 2010. *World Population Policies 2009*. ST/ESA/SER.A/293. Department of Economic and Social Affairs, Population Division. New York: United Nations.
- . 2011. *Assumptions Underlying the 2010 Revision*. Retrieved February 27, 2013. http://esa.un.org/wpp/Documentation/pdf/WPP2010_ASSUMPTIONS_AND_VARIANTS.pdf.
- . 2012. *World Mortality Report 2011*. ST/ESA/SER.A/324. Department of Economic and Social Affairs, Population Division. New York: United Nations.
- . 2013. *World Population Prospects, The 2012 Revision*. Department of Economic and Social Affairs, Population Division. New York: United Nations.
- United Nations Secretary-General's High-level Panel on Global Sustainability. 2012. *Resilient People, Resilient Planet: A Future Worth Choosing*. New York: United Nations.
- Van De Kaa, D. J. 1987. "Europe's Second Demographic Transition." *Population Bulletin* 42(1): 1–59.
- Watkins, Susan Cotts, and Etienne Van de Walle. 1983. "Nutrition, Mortality, and Population Size: Malthus's Court of Last Resort." In Robert I. Roberg and Theodore K. Rabb, eds., *Hunger and History: The Impact of Changing Food Production and Consumption Patterns on Society*. Cambridge: Cambridge University Press.
- Weil, David N., and Joshua Wilde. 2009. "How Relevant Is Malthus for Economic Development Today?" *American Economic Review* 99(2): 255–260.
- World Bank. 2006. *Gender Equality as Smart Economics: A World Bank Group Gender Action Plan, Fiscal Years 2007–10*. Washington, DC: World Bank.
- World Water Assessment Programme. 2012. *The United Nations World Water Development Report 4: Managing Water under Uncertainty and Risk*. Paris: UNESCO.
- Wrigley, E. A. 1969. *Population and History*. New York: McGraw-Hill.