Population

In 1973, marking the completion of his first term as president of the World Bank, Robert McNamara wrote *One Hundred Countries, Two Billion People,* which brings together his basic views on economic development. There is no ambiguity about McNamara's beliefs. He writes, "The greatest single obstacle to the economic and social advancement of the majority of the peoples in the underdeveloped world is rampant population growth."[1]

Before coming to the World Bank, McNamara was a professor at the Harvard Business School, president of the Ford Motor Company, and secretary of defense in the Kennedy and Johnson administrations. A man of incredible intellectual reach, McNamara understood much about the role of capital accumulation and technological change and their contributions to economic growth. But he maintained the view that rapid population growth was a threat that would have "catastrophic consequences" unless dealt with. "The underdeveloped world needs investment capital for a whole gamut of productive projects, but nothing would be more unwise than to allow these projects to fail because they are finally overwhelmed by a tidal wave of population."[2]

The "Two Billion People" in the title of McNamara's book refers to the early 1960s when the world's population was close to 3 billion, with 2 billion, or about two-thirds of the total, living in the developing nations. Since then the world has grown,

[1]Robert McNamara, *One Hundred Countries, Two Billion People* (New York: Praeger, 1973), p. 31.
[2]MacNamara, *One Hundred Countries,* p. 31.

reaching 7 billion in 2011. Over 5.8 billion of these people reside in low- and middle-income economies.

Despite this massive increase in numbers of people, the views of James Wolfensohn, World Bank president from 1995 to 2005, could not be more different from those of his predecessor. Wolfensohn's speeches and publications reveal only limited reference to population growth. Most often these references indicate how population growth exacerbates another problem, whether improving access to clean water or making a dent in the numbers suffering from absolute poverty. The same is true for Wolfensohn's successor, Robert Zoellick. After his first 100 days in office, Zoellick delivered a speech identifying six strategic themes to meet global challenges. Reducing population was not one of them; in fact, "population growth" is not mentioned even once.[3]

Was McNamara unnecessarily alarmist? Or did Wolfensohn and Zoellick make irreversible mistakes by not focusing on rising population numbers? Was the United Nations similarly wrong in not including reductions in population growth as one of the original millennium development goals (MDGs; introduced in Chapter 2)? We begin to address these questions by reviewing the world's population history and exploring the demographic transition that has characterized today's high-income nations and increasingly the low- and middle-income nations as well. We also consider population projections for the future before turning our attention to the complex relationship between population growth and economic development. This relationship is viewed both at an aggregate level and at the level of individual families making decisions about how many children to have. We conclude by reviewing the options nations face in pursuing policies to limit the size of their populations.

A BRIEF HISTORY OF WORLD POPULATION

Anthropologists debate when our first ancestors appeared. For our purposes, we do not have to go that far back in time. We might begin at the end of the last Ice Age, about 13,000 years ago, when humans on all continents were still living as hunter-gatherers, or 12,000 years ago with the first signs of agricultural settlements, or 7,000 years ago with the first indications of urbanization. For most of the thousands of years since then, population growth has been close to zero, with annual births roughly offsetting annual deaths. Opportunities for human survival slowly improved, and by 1 C.E. the world's population is estimated at about 230 million.[4] To gain some perspective on this number, today Indonesia by itself has a population that size.

[3]Robert Zoellick, "An Inclusive & Sustainable Globalization," speech to the National Press Club, Washington, DC, October 10, 2007.

[4]Angus Maddison, *The World Economy: Historical Statistics* (Paris: Development Centre of the Organisation for Economic Co-operation and Development, 2003).

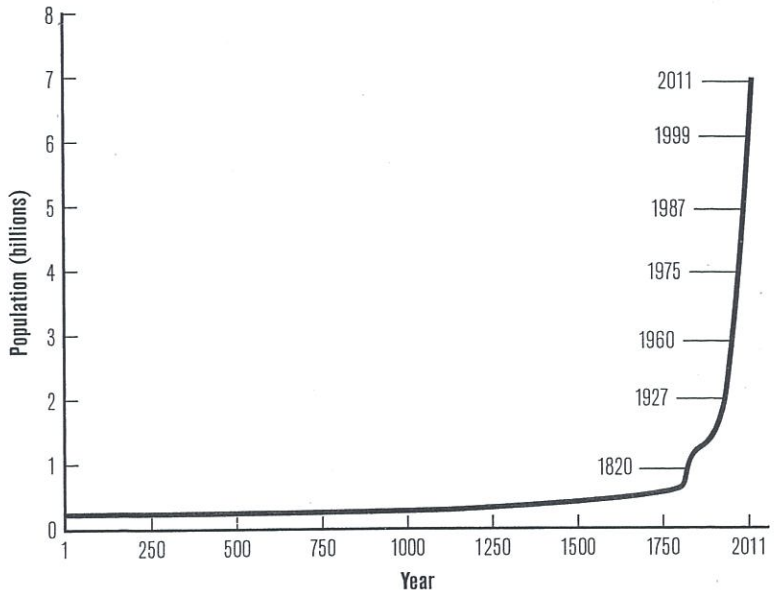


FIGURE 7-1 World Population Growth through History: Years Needed to Add 1 Billion More People

Source: Angus Maddison, "Statistics on World Population, GDP, and Per Capita GDP, 1–2008 AD," www.ggdc.net/MADDISON/Historical_Statistics/vertical-file_02-2010.xls.

Figure 7–1 charts world population from 1 C.E. through 2011. The figure makes it abundantly clear that population growth is a recent and unprecedented event in human history. From the beginning of human settlements, it took more than 10,000 years for the world's population to reach 1 billion in 1820. But the next billion were added in only about 110 years and, for the last four decades, the world added 1 billion people every 12 to 15 years. No wonder McNamara was so worried.

We have a broad understanding of how world population went from a period of relatively small and stable population numbers to the 7 billion (and still growing) that inhabit the planet today. The introduction of settled agriculture revolutionized the earth's capacity to sustain human life. During the years leading up to the Industrial Revolution of the late eighteenth and early nineteenth centuries, the food supply grew and became more reliable. The death rate fell, life expectancy increased, and population growth gradually accelerated. This growth, however, was set back at intervals by famines, plagues, and wars, any of which could wipe out as much as half of the population in a given area. As late as the fourteenth century, the black death (bubonic plague) killed one-third of the population of Europe. Despite these catastrophic events, by 1800, the world's population had grown to almost 1 billion, implying an annual growth rate of a mere 0.08 percent between 1 C.E. and 1800.

The Industrial Revolution, which marked the start of modern economic growth, further expanded the earth's **population-carrying capacity**. Innovations in agriculture matched innovations in industry, permitting labor to be transferred to industry while the productivity of the remaining agricultural laborers rose quickly enough to feed the growing urban population. Transcontinental railroads and fast, reliable ocean shipping further boosted world food output in the late nineteenth century, making it possible to grow more basic foodstuffs in the areas best suited for this activity and get supplies to food-deficit areas in record time in emergencies. Famines, especially in what are now the high-income nations, decreased in frequency and severity. Food prices fell. Meanwhile, modern medicine, sanitation, and pharmaceutical production began to develop. All these factors helped reduce the death rate and accelerate population growth. By 1945, the population of the world was slightly less than 2.5 billion, meaning that global population grew by 0.6 percent per year between 1800 and 1945.

After World War II, there were further dramatic improvements in food supply and disease control. Techniques introduced in the developed countries during the preceding era spread throughout the globe. The result was a veritable revolution in falling death rates and rising life expectancy in both the developed and the developing world. Plummeting death rates in many areas raised population growth rates to levels the world had never known before. Reference to a worldwide **population explosion**, unthinkable for most of human history, became commonplace in the 1960s and 1970s as the world's population grew to 3 and then 4 billion. World population passed 5 billion in 1987, 6 billion in 1999, and 7 billion early this decade; almost all this growth has occurred in the developing countries. Between 1945 and 2009, the growth in world population averaged a historically unprecedented rate of 1.6 percent per annum, twenty times faster than the estimated 0.08 percent between 1 C.E. and 1800.

THE DEMOGRAPHIC TRANSITION

The relationship between annual births and deaths determines population growth. Figure 7–2 depicts the basic stages in the **demographic transition** in a now-developed nation, Finland. Finland's experience is typical of what most high-income countries have experienced over the past several centuries. The top line in Panel a refers to the **crude birth rate**, the number of live births per year per 1,000 people. The lower line refers to the **crude death rate**, the number of deaths per year also per 1,000 people. The difference between these two rates, the excess of births over deaths, is the rate of **natural increase** in the population, which often is expressed as a percentage. For the world as a whole, the natural increase in the population equals the population growth rate; for an individual country, population growth is the difference between the rate of natural increase and net migration.

For hundreds of years before the eighteenth century, Finland was in the first stage of the classic demographic transition. High birth rates were matched by high death rates and the natural increase in population was close to zero. In some years,

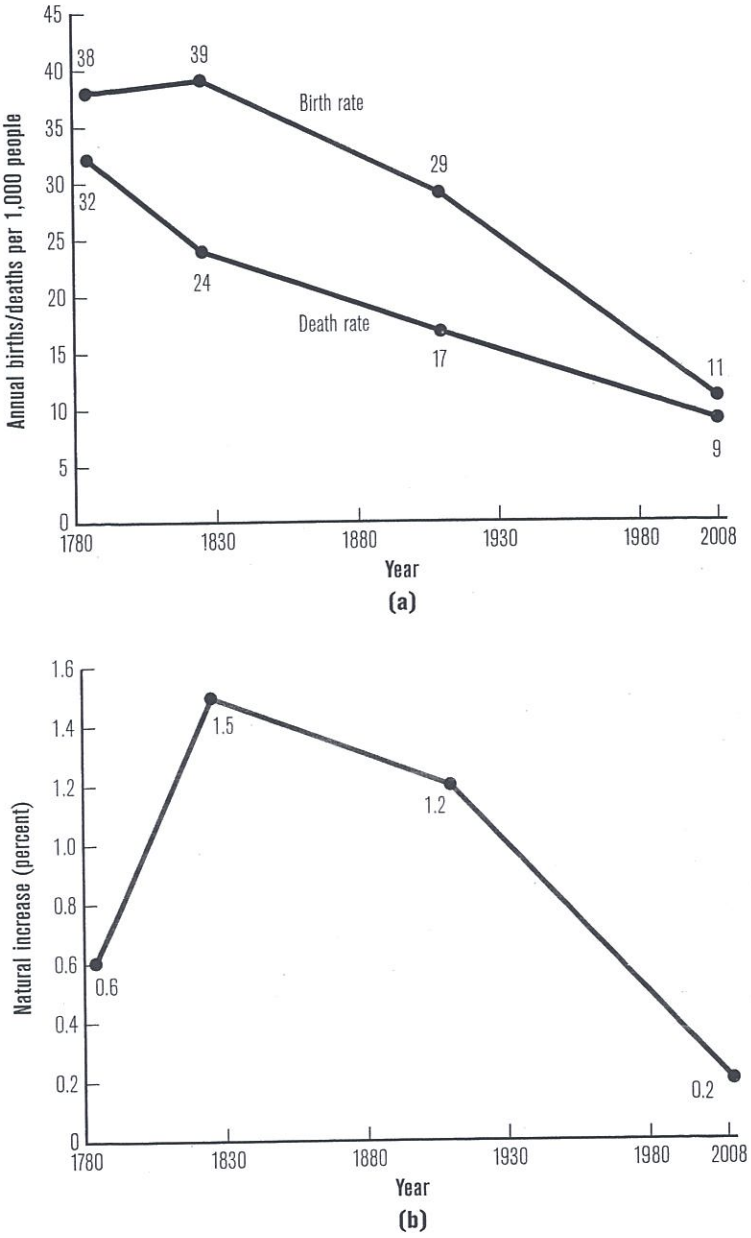


FIGURE 7-2 Demographic Transition for Finland (1785–2008)

Source: Arthur Haupt, Thomas Kane, and Carl Haub, *PRB's Population Handbook* 6th edition (Washington, DC: Population Reference Bureau, 2011).

births exceeded deaths; in other years, the opposite occurred. By 1785, before the start of industrialization and the first year for which data are available, Finland still had high birth and death rates, but the gap between the two resulted in a 0.6 percent rate of natural increase. If this rate had been maintained, it would have taken 117 years for Finland's population to double.

By the early 1800s, Finland was in the second stage of the demographic transition, characterized by death rates declining more quickly than birth rates. This was before the advent of modern medicine and public health interventions; so much of this decline can be attributed to improved nutrition as food supplies became more abundant and less variable. With no change in the birth rate and a fall in deaths, the rate of natural increase in the population reached 1.5 percent by 1830. At this rate, the population would double in just under 50 years. After 1830, death rates continued to fall but not as quickly. At the same time, birth rates started to drop as Finnish families decided to have fewer children. Note that they did so in the absence of modern forms of contraception. Finland was now in the third stage of the demographic transition, with birth rates falling more quickly than death rates. By 1915, Finland's natural increase in population had slowed to 1.2 percent.

By 2008, Finland reached the fourth stage of its demographic transition in which its population growth had fallen close to zero, this time with low birth and death rates. The nation had gone from relatively high birth and death rates producing a low rate of population growth before 1785, through a period of more rapid natural increase in the nineteenth and early twentieth centuries, back down to a very low rate of population growth characterized by both low birth and death rates. Today, Finland has a population of 5 million, growing at 0.2 percent per annum. Abstracting from changes due to migration, at this rate Finland's population would require 350 years to double in size. But Finland's population probably will never double again. As has happened elsewhere in Europe, birth rates may fall even further and the crude death rate will rise as the population ages. In coming decades, Finland may even experience negative population growth, just as Germany and Italy already are.

Based on the few observations available, Finland's rate of natural increase never exceeded 1.5 percent. Compare this to the experience of the developing countries where, as a group, the rate of natural increase reached 2.5 percent during the 1960s. Even today, Pakistan's population is growing by 2.1 percent, Jordan's by 3.2 percent, and Madagascar's by 2.9 percent. Why draw so much attention to a 1- or 1.5-percentage point difference in population growth rates? Because doubling time drops from around 50 years at a growth rate of 1.5 percent to only 28 years at 2.5 percent to 22 years at 3.2 percent. Seemingly small differences in growth rates provide societies with even less time to achieve a demographic transition before population levels increase by substantial amounts.

Clearly, there are major differences between the historical experience of today's industrialized nations and the contemporary demographic transition of the developing nations. Figure 7–3 portrays the movement of crude birth and death rate for the less-developed nations as a group from 1950 to 2005. Panel b charts the corresponding rate of natural increase over the same years. By 1950, the rate of natural increase in the developing nations was 2.1 percent, far larger than the rate ever experienced by today's industrialized countries. The higher rate was the result of somewhat higher birth rates than historically had been the case in today's high-income nations due,

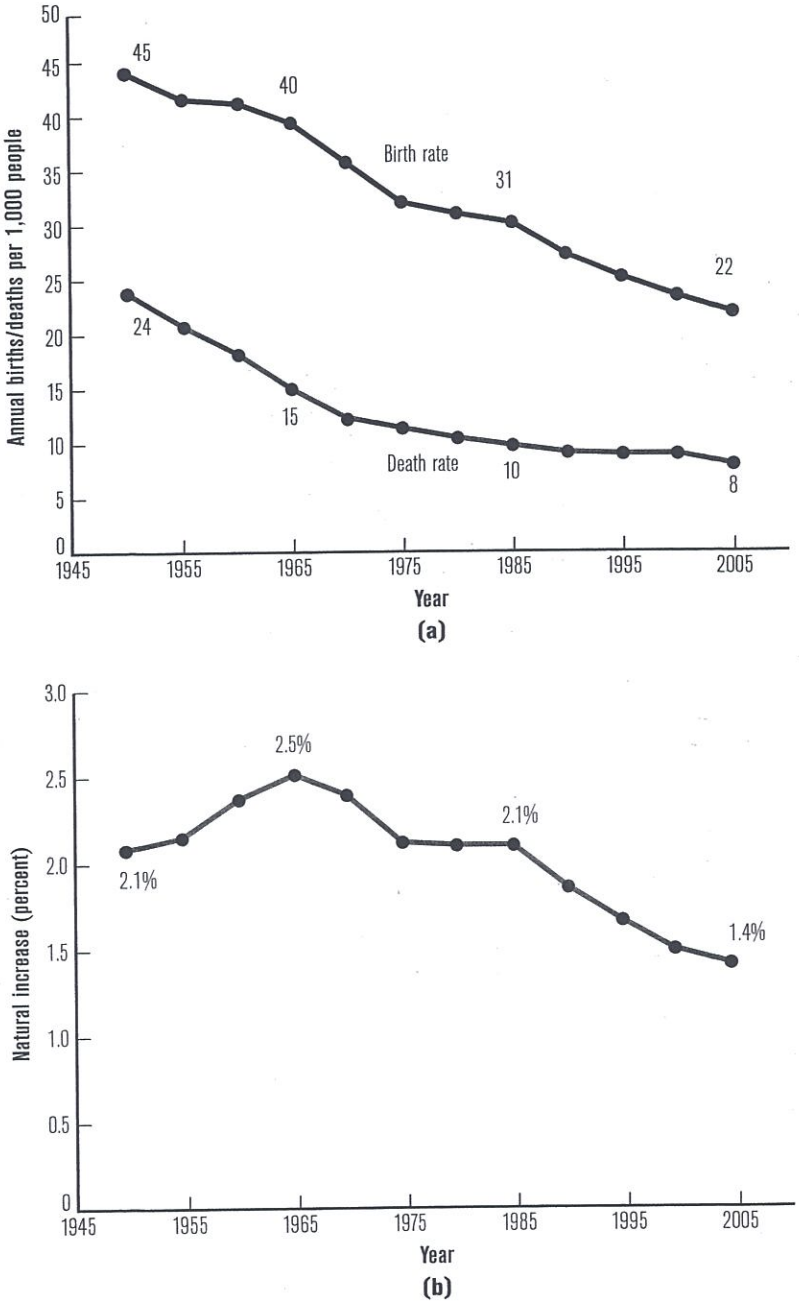


FIGURE 7-3 Demographic Transition for Less-Developed Regions (1950–2008)

Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2002 Revision* and *World Population Prospects: The 2008 Revision.*

in part, to earlier age at marriage. Of even greater significance, the decline in death rates in the developing nations began at much lower levels of per capita income and fell much faster than it had historically in the now-developed countries. The transfer of public health interventions and other medical advances, including vaccines and improvements in water and sanitation services, from the developed to the developing world contributed to this outcome.

Between 1950 and 1970, death rates in the developing world continued to drop faster than birth rates, and the natural increase in populations rose. It peaked at around 2.5 percent in the late 1960s, shortly before McNamara warned of the catastrophic consequences of rapid population growth. With little evidence of falling birth rates, it is not surprising that McNamara was so alarmist about population trends. But a demographic transition already was under way. Between 1950 and 2005, the crude birth rate fell from 45 to 22 per 1,000, and even though death rates also fell, from 24 to 8 per 1,000,[5] the natural increase of the developing nations slowed to 1.4 percent, still high by historical standards but with an unmistakable trend. In all regions of the world and in almost every nation, women started having fewer children and **total fertility rates (TFRs)** fell (Box 7–1). These trends help explain why the World Bank and other multilateral organizations appear less concerned about population growth today. The world population is still growing and will continue to do so for several more generations, but the *rate of growth* has slowed and population *explosion* no longer seems an appropriate metaphor.

THE DEMOGRAPHIC SITUATION TODAY

In 2009, world population exceeded 6.7 billion. Only 16 percent resided in the high-income countries, 84 percent lived in the low- and middle-income nations (Table 7–1). Almost 3 out of every 10 inhabitants of the planet lived in East Asia. China alone accounted for just under 20 percent of world population. South Asia, dominated by India's more than 1 billion inhabitants, represented another 23 percent of the world's people. Sub-Saharan Africa accounted for 12 percent of world population, but this share is expected to rise in the future. At 2.4 percent, sub-Saharan Africa had the most rapid rate of natural increase in population of any region.

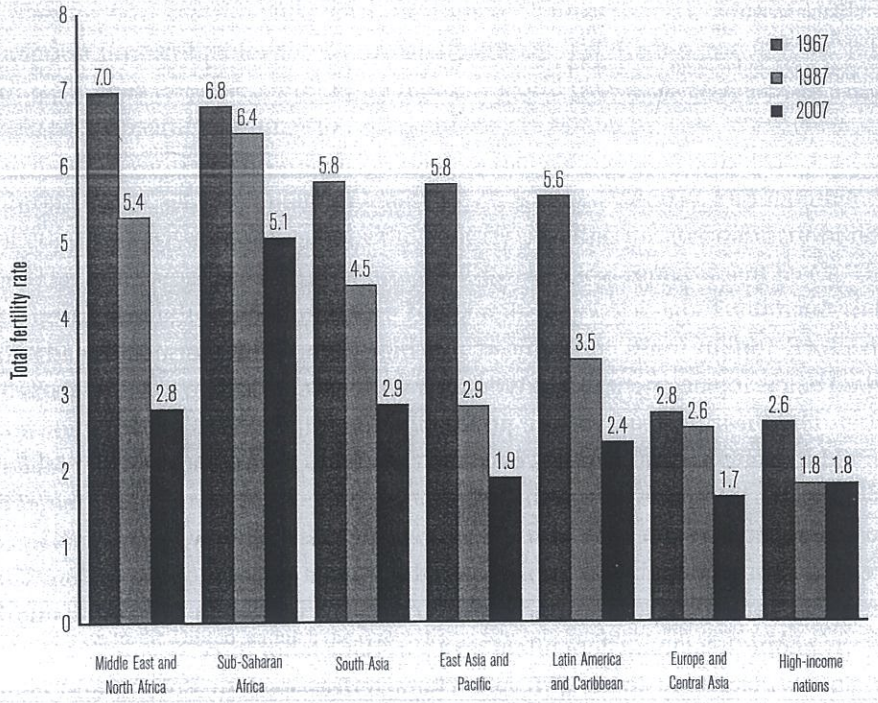
The situation in the high-income countries could not be more different from that in sub-Saharan Africa. With aging populations, crude death rates are likely to rise, and with declining fertility, crude birth rates will fall. Rates of natural increase already have slowed to 0.4 percent. Almost all *population growth* in the high-income countries is attributable to immigration, with openness to immigrants at a higher

[5]Careful inspection of Figures 7–2 and 7–3 reveals that the death rate in 2008 in Finland, at 9 per 1,000 people, is almost identical to the death rate in 2005 in the less-developed regions. This does not mean that life expectancy and the overall survival chances in the two places are the same. If one compares age-specific mortality rates, survival probabilities in Finland exceed those of the developing countries for every age group, especially for infants. But, in the aggregate, because Finland has a much older population than the developing world, the crude death rates, coincidentally, average to almost the same number.

BOX 7-1 TOTAL FERTILITY RATES

Another way to assess population trends is to examine fertility behavior. One of the most common measures of fertility is the total fertility rate (TFR). TFR sometimes is thought of as a measure of the average number of children a woman will bear, but this is not entirely correct. TFR is a *synthetic* measure. It sums the age-specific fertility rates of women in a given year, where age-specific fertility rates refer to the average number of children born to women of a specific age (usually, 15–19, 20–24, . . . , 40–44). In other words, TFR is the number of children the average woman would have in her lifetime if age-specific fertility rates remained constant. But these rates change over time as younger women delay having their children and as women have fewer children over all. TFR is a reliable indicator of the number of children women *currently* are having, and trends in TFR reveal a great deal about the world's demographic transition.

The figure below charts TFRs over the past 40 years for the World Bank's seven geographical regions. In 1967 in Africa, Asia, and Latin America, TFR was 5.5 children or more. Only the high-income economies and the nations of Europe and central Asia had reached low TFRs of fewer than 3 children. Over the next four decades, and at varying speeds, fertility rates fell in every region. In East and



South Asia and in Latin America and the Middle East, TFR fell by half or more. Sub-Saharan Africa's demographic transition took longer to begin, but even in this poorest part of the world, TFR, now at 5.1 children per woman, has fallen by more than one child since 1987. Most demographers expect the decline in Africa's TFR to follow that of other regions and the rate to continue to fall.

TABLE 7-1 Levels and Trends in the World Population, 2009

	TOTAL POPULATION		POPULATION GROWTH		
	NUMBER (MILLIONS)	PERCENT OF TOTAL	BIRTH RATE (PER 1,000)	DEATH RATE (PER 1,000)	NATURAL INCREASE (PERCENT)
World	6,775	100	20	8	1.2
Income category					
Low income	846	13	34	11	2.3
Middle income	4,813	71	19	8	1.1
High income	1,117	16	12	8	0.4
Region					
East Asia	1,944	29	14	7	0.7
South Asia	1,568	23	24	7	1.7
Sub-Saharan Africa	840	12	38	14	2.4
Latin America	572	8	18	6	1.2
Europe and Central Asia	404	6	15	11	0.4
Middle East and North Africa	331	5	24	6	1.8

Source: World Bank, "World Development Indicators Online," http://databank.worldbank.org.

level in Australia, Canada, New Zealand, and the United States than in Europe and Japan. Total fertility rates in many of the high-income economies already have dropped below replacement levels. Women must have at least two children each during their childbearing years for the population to replace itself. Allowing for infant and child mortality, demographers estimate that the replacement level of total fertility is around 2.1. In countries such as Germany, Italy, and Japan, where the TFR is below the replacement level and immigration rates also are low, policy makers are concerned about a population implosion rather than a population explosion. These societies can anticipate smaller populations overall as well as an increasing number of elderly people becoming dependent on a shrinking labor force.

Below replacement level, TFR also characterizes eastern Europe and central Asia, where the rate of natural increase is only 0.4 percent. East Asia's TFR has dipped

below replacement levels (1.9 in 2007). By contrast, neither Africa, Latin America, nor the Middle East has progressed as far along its demographic transitions, implying faster growth in population and an increasing share of the world's total.

THE DEMOGRAPHIC FUTURE

When extrapolated into the future, even modest population growth rates generate projected total populations that seem unthinkable. Continued growth at the world's 2010 rate of natural increase, 1.2 percent, would bring population to 11 billion by 2050 and 26 billion by 2100. This type of projection, beloved by some popular writers, is frightening to many. It is hard to imagine life in a world with three to four times as many people as there are today. How will this expanded population live? How will the globe's finite supplies of space and natural resources be affected?

While a significant increase in world population can be expected during your lifetime, it is unlikely to double. Linear extrapolations of current trends are badly misleading because after accelerating for more than two centuries, world population growth has been slowing down for the past four decades. This trend is likely to continue, but no one can be certain how quickly the transition to lower fertility levels will be or whether there will be any reversals in recent trends.

Every few years the United Nations produces forecasts of future population growth.[6] These projections offer a variety of scenarios based on a similar set of assumptions about declining mortality but using different assumptions about the amount and speed of fertility declines. Figure 7–4 combines estimates of the world population from 1820 to 2000 with the United Nations' low-, medium-, and high-population projections for the twenty-first century. The high scenario assumes the world TFR does not reach replacement levels, world population reaches 10.8 billion people by 2050, and continues to expand to over 15 billion by 2100. The medium scenario has the world reaching slightly less than replacement levels by 2050. Under the medium variant, world population rises to over 9 billion by 2050. Population growth then continues to slow throughout the century, leveling off at around 10 billion in 2100. The low scenario assumes a future TFR well below replacement levels. Under these assumptions world population hits a maximum of 8.1 billion shortly before 2050 and declines to 6 billion by the end of the century. The United Nations offers the three variants as alternative projections without assigning probabilities to which outcomes are more likely.

What all three scenarios share in common is the projection that world population will continue to grow over the next 50 years, in other words, over the adult lifetime of a university student today. The scenarios differ in the size of the projected

[6]In addition to the United Nations, the International Institute for Applied Systems Analysis in Austria, the U.S. Census Bureau, and the World Bank produce independent population projections. A useful introduction to how such projections are made appears in Brian O'Neill and Deborah Balk, "World Population Futures," *Population Bulletin* (Population Reference Bureau) 56, no. 3 (September 2001).

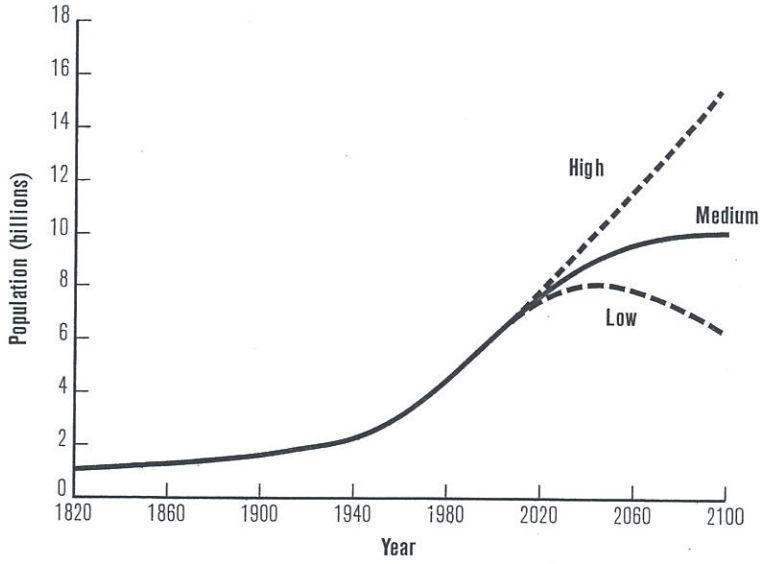


FIGURE 7-4 World Population Historical Trends and Projections

UN population projections for 2000–2100. The scenarios presented here represent different future levels of fertility.

Source: Angus Maddison, "Statistics on World Population, GDP, and Per Capita GDP, 1–2008 AD," www.ggdc.net/MADDISON/Historical_Statistics/vertical-file_02-2010.xls. U.N. Department of Economic and Social Affairs, Population Division, Population Estimates and Projection Section, *World Population Prospects, The 2010 Revision*, October 20, 2011, available at http://esa.un.org/unpd/wpp/index.htm; accessed February 2012.

growth within a broad range: from 1 to almost 4 billion. There are three basic reasons for this projected continued increase. The first two explain why the TFR may remain above replacement levels: (1) a desire for large families and (2) a failure to achieve the desired number of children (so-called unwanted children). The third reason is **population momentum**, a demographic concept requiring some explanation.

Populations that have been growing rapidly, as they have been especially in the developing world, have large numbers of people in, or about to enter, the most fertile age brackets. Even if all the world's couples today were to start having just enough children to replace themselves, the total population would continue to grow for many more decades before eventually leveling off. This is because today's children, who outnumber their parents, will become tomorrow's parents. Stated differently, past fertility decisions echo far into the future (Box 7–2). Population momentum alone could add several billion more people to the world's population in the twenty-first century.[7]

Another way of appreciating the demographic future is to focus on specific countries, especially those projected to be the world's most populous. Table 7–2 lists the

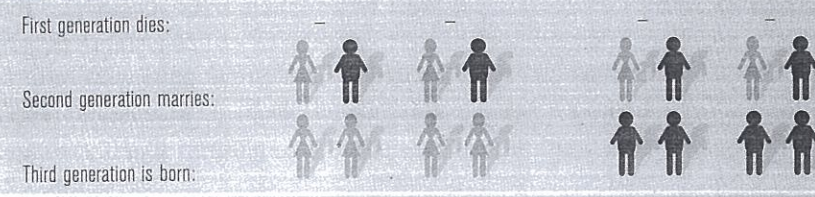
[7]John Bongaarts estimated that half of the projected increase in the world's population during the twenty-first century could be attributed to population momentum alone. John Bongaarts, "Population Policy Options in the Developing World," *Science* 263, no. 5148 (February 11, 1994).

BOX 7-2 POPULATION MOMENTUM

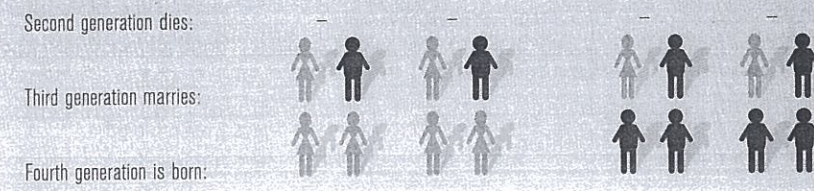
The impact of population momentum on future population levels can be illustrated by the following example of two families. The first generation of each family consists of one man and one woman. Each woman has four children over her reproductive life. This second generation includes four females and four males.

PERIOD ONE
Fertility above Replacement Level; Total Population, 12

PERIOD TWO
Fertility at Replacement Level; Total Population, 16



PERIOD THREE
Fertility at Replacement Level; Total Population, 16



In period two, the first generation dies and everyone in the second generation marries. Each woman in the four resulting couples has two children, producing a third generation of four males and four females. Even though the second generation reaches replacement levels of fertility, population momentum causes a 33 percent increase in total population, from 12 to 16, between period one and period two.

The process is repeated in period three. The second generation dies; the third generation marries and produces a fourth generation. If the third generation remains at replacement levels of fertility, the total population stabilizes. The size of the steady-state population in the final period is the result not only of the fertility decisions of the second and third generations, but of those of the first generation as well.

Population momentum also can work in reverse. If subsequent generations have lower than replacement fertility, the decline in total population could be rapid, reflecting the fertility decisions of both current and previous generations.

TABLE 7-2 Projections: The World's 10 Most Populous Nations in 2050*

	2050		2010		POPULATION INCREASE	
COUNTRY	POPULATION (MILLIONS)	RANK	POPULATION (MILLIONS)	RANK	MILLIONS	PERCENT
India	1,748	1	1,189	2	559	47
China	1,437	2	1,338	1	99	7
United States	423	3	310	3	113	36
Pakistan	335	4	185	6	150	81
Nigeria	326	5	158	8	168	106
Indonesia	309	6	235	4	74	31
Bangladesh	222	7	164	7	58	35
Brazil	215	8	193	5	22	11
Ethiopia	174	9	85	13	89	105
Congo	166	10	68	19	98	144
Total (share of world's population)	5,355 (0.56)		3,925 (0.57)		1,430 (0.55)†	

*Projections are based on the "United Nations" medium variant.

†The absolute increase in the population of the 10 most populous nations in 2050 divided by the change in total world population between 2010 and 2050.

Source: Population Reference Bureau, *2010 World Population Data Sheet*, www.prb.org/pdf10/10wpds_eng.pdf.

10 most populous nations in 2050 according to the United Nations' medium-variant projections. The table also lists the population of those countries in 2010. These 10 nations are projected to account for 5.4 billion people in 2050, over half of the projected world population at that time.

China, India, and the United States will continue to be the three most populated nations, although India will replace China in the top spot. Increases in China's population, which already is well below TFR replacement levels, will be due exclusively to population momentum; in the United States, immigration will be the primary factor for increasing numbers; and in India, both population momentum and fertility above replacement levels will contribute to a projected increase of over 550 million *more* inhabitants than the 1.1 billion who live in India today.

Just as striking are the expected population gains elsewhere in South Asia. Pakistan is projected to increase its population by 81 percent and Bangladesh by 35 percent. In sub-Saharan Africa, the Democratic Republic of the Congo, Ethiopia, and Nigeria all are projected to experience even greater percentage increases in their populations. Projections for the Congo and Ethiopia are so large as to catapult them into the top-10 category in 2050, replacing Japan and Russia, which were among the top 10 in 2010.

It must be remembered that all these estimates of population trends are only projections, which become less and less reliable the further out in time one goes, and much could happen to change these outcomes. The impact on future population size of infectious diseases, some unknown today, is difficult to predict. Civil strife and migration will play a role as well. But what these projections make clear is that we should expect significant increases in world population, almost exclusively in today's low- and middle-income nations, over the next 50 years. Given the current difficulties many of these nations face today, the challenge of achieving economic development for ever-larger numbers of people seems daunting.

THE CAUSES OF POPULATION GROWTH

Discussions of the world's population future often turn acrimonious. Questions of whether and whose populations are to be limited and by what means are sensitive. Before we can confront such issues intelligently, we must consider what is known about both the causes and the effects of rapid population growth. We must concern ourselves with the two-way relationship between the growth of population and economic development—that is, with how population growth affects economic development and how economic development affects population growth. We deal with the latter relationship first.

THOMAS MALTHUS, POPULATION PESSIMIST

The most famous and influential demographic theorist of all time was **Thomas Malthus** (1766–1834). Malthus believed that "the passion between the sexes" would cause population to expand as long and far as food supplies permitted. People generally would not limit procreation below the biological maximum. Should wages somehow rise above the subsistence level, workers would marry younger and have more children, more of whom would survive. But this situation could be only temporary. In time, the rise in population would create an increase in labor supply, which would press against fixed land resources. Eventually, through diminishing returns, food prices would rise and real wages would fall back to the subsistence level. If this process went too far, famines and rising deaths would result. Malthus did not think that the growth of the food supply could stay ahead of population growth in the long run. In a famous example, he argued that food supplies grow according to an arithmetic (additive) progression, whereas population follows an explosive geometric (multiplicative) progression.

In the grim Malthusian world, population growth is limited primarily by factors working through the death rate, what he called *positive checks.* In this deceptively mild phrase, Malthus included all the disasters that exterminate people in large numbers: epidemics, famines, and wars. These phenomena, he believed, generally constitute the operative limitation on population. Only in later editions of his famous *Essay on the Principle of Population* did he concede the possibility of a second, less drastic, category of limiting factors: "preventive checks" that work through the birth rate. Here, Malthus had in mind primarily measures of "restraint," such as a later age of marriage. Unlike latter-day Malthusians, he did not advocate birth control, which as a minister he considered immoral. Although he grudgingly admitted that humanity might voluntarily control its own numerical growth, Malthus invested little hope in the possibility.

The gloominess of the Malthusian theory is understandable when one considers that its author lived during the early years of the Industrial Revolution. In all prior history, population had tended to expand in response to economic gains. With unprecedented economic growth under way in the world he knew, what could Malthus expect except an acceleration of natural increase as death rates fell? That indeed was happening during his lifetime.

Malthus did not live to witness the next stage in the European demographic transition. The early decline in death rates was followed, with a lag, by a fall in fertility; beginning in the middle of the nineteenth century, wages began to increase dramatically in contrast to Malthus's prediction. Why did all this happen? Wages rose, despite accelerating population growth, because capital accumulation and technical change offset any tendency for the marginal product of labor to decline. Death rates fell through a combination of higher incomes (better nutrition and living conditions) and better preventive and curative health measures. The fall in the birth rate is

harder to understand. There are both biological and economic reasons to expect, as Malthus did, that fertility would rise, not fall, as income went up. Healthier, better-fed women have a greater biological capacity to conceive, carry a child full term, and give birth to a healthy infant. Also, people might marry earlier when times are good, and better-off families have the financial capacity to support more children. Why, then, do increases in income seem to lead to declines in fertility? An answer to this question must be sought in post-Malthusian demographic theory.

WHY BIRTH RATES DECLINE

Two kinds of demographic change affect the crude birth rate. The first is change in the population shares of different age groups. A rise in the share of people of reproductive age (roughly 15 to 45) increases the birth rate, as we saw earlier in the discussion of population momentum. Conversely, if the proportion of older people in the population goes up, as is happening in many industrial countries today, the birth rate drops. The second factor is fertility, the rate at which women have children.

Why, then, do people have as many children as they do? Is it because they are moved by Malthus's "passion between the sexes" and do not know how to prevent the resulting births? Or is it because they are tradition bound and custom ridden? Or is it rational in some economic and social settings to have large families? All three positions have some merit. The case for the first one, implicitly, is what those who recommend providing birth control as a response to rapid population growth probably have in mind. A Latin American doctor at an international conference put it bluntly. "People don't really want children," he said. "They want sex and don't know how to avoid the births that result." This viewpoint captures the element of spontaneity inevitably present in the reproductive process. Yet the evidence suggests that all societies consciously control human fertility. Rarely does the number of children that the average woman has over her childbearing years even approach her biological capacity to bear children. One exceptional case is that of the Hutterites, a communal sect that left Russia and settled in Canada and the northern Great Plains in the late 1800s. The group's religious beliefs and lifestyle encouraged maximum fertility. Hutterite women, on average, bore over 10 children, a fertility rate no contemporary low- or middle-income nation comes close to approaching. All societies practice some method of controlling their numbers whether by aborting pregnancies, disposing of unwanted infants, or inhibiting conception. (Recall our earlier discussion of fertility decline in nineteenth-century Finland.)

As for the second proposition, it has been said that many children are the social norm in traditional societies, that society looks askance at couples who have no or few children, that a man who lacks wealth at least can have children, and that a woman's principal socially recognized function in a traditional society is to bear and rear children. Such norms and attitudes are important, but they probably are not the

decisive factors in human fertility. Fertility is determined by a complex combination of forces. Social scientists in recent years have given increasing credence to elements of individual rationality in the process. Simply stated, they believe that most families in traditional societies have many children because it is in their interest to do so.

This brings us to the third explanation. Although some might regard it as a cold, inhumane way of looking at the matter, it is nevertheless true that children impose certain costs on their parents and confer certain benefits. In some low-income settings, especially in rural areas, children may supplement family earnings by working. On family farms and in other household enterprises, there usually is something that even a young child can do to increase production. In many poor societies, children work outside the home. In the longer run, children also provide a form of social security, which is important in societies that lack institutional programs to assist the elderly. In some cultures, it is considered especially important to have a son who survives to adulthood; if infant and child mortality is high, this can motivate couples to keep having children until two or three sons have been born, just to be safe. In addition to these economic benefits, which are probably more important in a low-income society than a more-affluent one, children also can yield psychic benefits (and costs!), as all parents know.

The economic costs of children can be divided into explicit and implicit costs. Children entail cash outlays for food, clothing, shelter, and often for education. Implicit costs arise when childcare by a member of the family, usually the mother, involves a loss of earning time. Some of the costs felt by parents parallel the costs of population growth experienced at the national level. For example, more children in a family may mean smaller inheritances of agricultural land, an example of a natural resource constraint operating at the family level. Similarly, it may be harder to send all the children in a larger family to school; this reflects the pressures on social investment felt when population growth is rapid.

Viewing childbearing as an economic decision has several important implications:

1. Fertility should be higher when children earn income or contribute to household enterprises than when they do not.
2. Reducing infant deaths should lower fertility because fewer births are needed to produce a given desired number of surviving children.
3. The introduction of an institutionalized social security system should lower fertility by reducing the need for parents to depend on their children for support in their old age.
4. Fertility should fall when there is an increase in opportunities for women to work in jobs that are relatively incompatible with childbearing, essentially work outside the home.
5. Fertility should be higher when income is higher because the explicit costs are more easily borne.

The first four predictions have received substantial support from empirical studies. The fifth, however, conflicts with observation. Fertility usually is negatively related to income. The negative relationship shows up both in time-series data (that is, fertility usually declines over time as income rises) and in cross-section data (fertility generally is higher in poor countries than in rich ones; also, in most societies, middle- and upper-income families have fewer children than poor families).

Several theorists have wrestled with the seeming anomaly that household demand for children falls as income rises; in other words, children are "inferior goods." Economist Gary Becker of the University of Chicago, a pioneer of *the new household economics*, analyzes children as a kind of consumer durable that yields benefits over time.[8] Couples maximize a joint (expected) utility function in which the "goods" they can "buy" are (1) number of living children, (2) child quality (a vector of characteristics including education and health), and (3) conventional goods and services. The constraints faced by parents in Becker's model are (1) their time and (2) the cost of purchased goods and services.

Becker explains the fall in fertility as income rises over time by saying that the cost of children tends to rise, especially because the opportunity cost of the parents' time, particularly the mother's, goes up. The familiar income and substitution effects that result from any price change are at work here. As a woman's market wage rises, her income also rises, leading to an increase in her demand for any normal good, presumably including the demand for more children. But as a woman's wage rises, the opportunity cost of her time also goes up, so the price of raising children rises. As a result, her demand for any activity that is intensive in the use of her time decreases, including child rearing. If the substitution effect is greater than the income effect, couples may decide to have fewer offspring. Becker also argues that given the rising cost of child *quantity,* many parents opt to invest in child *quality* and spend more time and money on a smaller number of children. Wanting "higher-quality" children as income rises also reverts the demand for children back to the demand for a "normal good."

Much of Becker's work on the family was directed at understanding declining fertility levels in the United States and other high-income economies. But the application of the new household economics to the circumstances of developing nations also offers keen insights. Replacing Malthus's assumption that people are driven solely by their passions, fertility now is seen as the outcome of a rational process. This does not mean that every child born, in rich and poor nations alike, is the result of a conscious cost–benefit calculation. Economics rarely can explain individual outcomes; its power is in explaining average tendencies. What the new household economics suggests is that rich and poor people alike weigh the consequences of their actions, and to understand behavior, we may gain more insights by assuming people act in what they perceive as their own best interests. Having large numbers of children then may be seen not as an irrational act but as the result of the difficult choices poor people face. For poor families, having many children may make economic sense.

[8]Gary Becker, *A Treatise on the Family* (Cambridge, MA: Harvard University Press, 1981).

The new household economics provides insights into the fertility decisions of families in the developing world and, in so doing, raises an apparent contradiction. If individual decisions about fertility are rational and in the perceived best interest of the family, why did McNamara, and many others, identify population growth as "the greatest single obstacle" to economic development? How could rational decisions at the household level result in so dire a society wide outcome?

POPULATION GROWTH AND ECONOMIC DEVELOPMENT

Even if population growth is not the greatest obstacle, has population growth been a major impediment to achieving economic development and is it still one today? To a casual observer who has spent time in Cairo or Calcutta, Manila or Mexico City, or in hundreds of other cities or villages in the developing world, the answer might seem obvious. Looking at the masses of poor people in these places, it would be hard not to conclude that the situation could be measurably improved if only there were fewer people. (A casual observer might draw the same conclusion in New York or Tokyo.)

But more than casual observation is needed to understand the complex relationship between population growth and economic development, especially if one is going to consider policy interventions to reduce population growth. First, we must be clear on the question we are asking. We cannot ask whether people who have been born would have been better off having never been born. This is a question economics cannot possibly answer. Our question can only be whether per capita income, life expectancy, educational attainment, or any other indicator of economic development would be higher if a nation's population had grown more slowly. Given the centrality of economic growth to the development process, much of our attention is on the relationship between population growth and economic growth.

Simon Kuznets, a Nobel Prize winner in economics and a pioneer in the use of data to examine trends in economic growth, reported on a lack of correlation between population growth and per capita output growth for 40 less-developed nations between the early 1950s and 1964.[9] Similar studies have been conducted since Kuznets's work, many of which also report a low correlation between the two growth rates over various time periods.[10] Starting in the 1980s, it was more common

[9]For the 40 less-developed countries in Kuznets's sample, the rank correlation between rates of population growth and growth in per capita GDP was 0.111. From Simon Kuznets, "Population and Economic Growth," *Proceedings of the American Philosophical Society* 3 (June 1967), as reported in United Nations, *The Determinants and Consequences of Population Trends,* Department of Social Affairs, Population Division, Population Studies No. 17 (New York: United Nations, 1973).

[10]Discussion of these studies can be found in Allen Kelley and Robert Schmidt, "Economic and Demographic Change: A Synthesis of Models, Findings and Perspectives," in Nancy Birdsall, Allen Kelley, and Steven Sinding, eds., *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World* (Oxford: Oxford University Press, 2001).

to find a negative correlation between them. In growth regressions, which include many possible determinants of economic growth, the significance of population growth varies depending on what other variables are included.

The lack of one pattern relating population growth to economic growth should not be misinterpreted. It does not mean that population has no systematic effect on economic growth; it simply means that the relationship is complex. We need to ask, How does population growth affect the determinants of economic growth? What direction of causality is there between population growth and economic growth? And how important are the individual components of population growth—fertility, mortality, and migration—to gross domestic product (GDP) growth (and vice-versa)?

We begin by challenging a *naïve view* of how population growth and economic growth are related. The growth rate in GDP per capita equals the growth rate of GDP minus the growth rate in population.[11] The naïve view then holds that, for any given rate of GDP growth, per capita growth would be faster the slower the growth in population. This conclusion is true, but its implicit assumption is false. Growth in output is not independent of growth in the population. The simplest reason is that children born today are the labor force of the future, and labor, along with land and capital, is one of the main factors of production for any economy. Stated differently, population growth affects both the level of GDP and how many people must share in that GDP. Once one recognizes these connections, the critical question becomes how population growth affects the core determinants of economic growth: the accumulation of factors of production and the productivity of those factors.

POPULATION AND ACCUMULATION

A pioneering model of population's effect on material welfare was written in 1958 by demographer Ansley Coale and economist Edgar Hoover.[12] Their work falls squarely into the camp of **population pessimists**, or anti-natalists, those who perceive population growth as harmful to economic development. Coale and Hoover argue that a reduction in the birth rate could raise per capita income in three important ways. First, lower fertility levels would slow future labor force growth. The amount of investment then needed to provide a constant amount of capital per worker for a growing number of workers (*capital widening*) would go down and permit more investment to be used to increase capital per worker (*capital deepening*).[13] Second, with lower

[11]The growth rate of any fraction, A/B, is equal to the growth of the numerator, A, minus the growth of the denominator, B. This is because the growth rate of any variable, X, can be found by taking the derivative of the log of the variable with respect to time: $d(\ln X)/dt = (dX/dt)/X = g(X)$, where g is the rate of growth. If $X = (A/B)$, then $\ln(A/B) = \ln A - \ln B$, and $d[\ln(A/B)]/dt = d(\ln A)/dt - d(\ln B)/dt$, or $g(A/B) = g(A) - g(B)$. In the case of GDP per capita, $g(\text{GDP/population}) = g(\text{GDP}) - g(\text{population})$.

[12]Ainsley Coale and Edgar Hoover, *Population Growth and Economic Development in Low-Income Countries: A Case Study of India's Prospects* (Princeton, NJ: Princeton University Press, 1958).

[13]The implications of capital widening and capital deepening for economic growth are developed more fully in the discussion of the Solow growth model in Chapter 4.

fertility and fewer children, public funds could be diverted away from education and health expenditures and toward physical capital, which Coale and Hoover assumed would be a more productive use of government spending. Third, slower population growth would lower the **dependency ratio**, the ratio of the non-working-age population (usually 0 to 14 years and 65 and over) to the working age population (Box 7–3). A lower dependency ratio, in turn, would reduce consumption and increase saving at any given level of income, permitting a higher rate of asset accumulation. Taken together, these three benefits from slower population growth could raise income levels at both the household and aggregate levels.

Coale and Hoover's conclusions, generally, have not always been supported by later research.[14] For a given amount of investment, a larger labor force results in less capital per worker, but the quantitative significance of this effect on output often appears small. Coale and Hoover's concern about the diversion of resources toward education also has not held up to later research. Demographic factors do not exert much of an independent effect on the share of GDP allocated to education and other social welfare programs. In addition, education and health increasingly are seen, not as consumption expenditures, but as investments in human capital that may have returns equal to or higher than the returns on investments in physical capital.

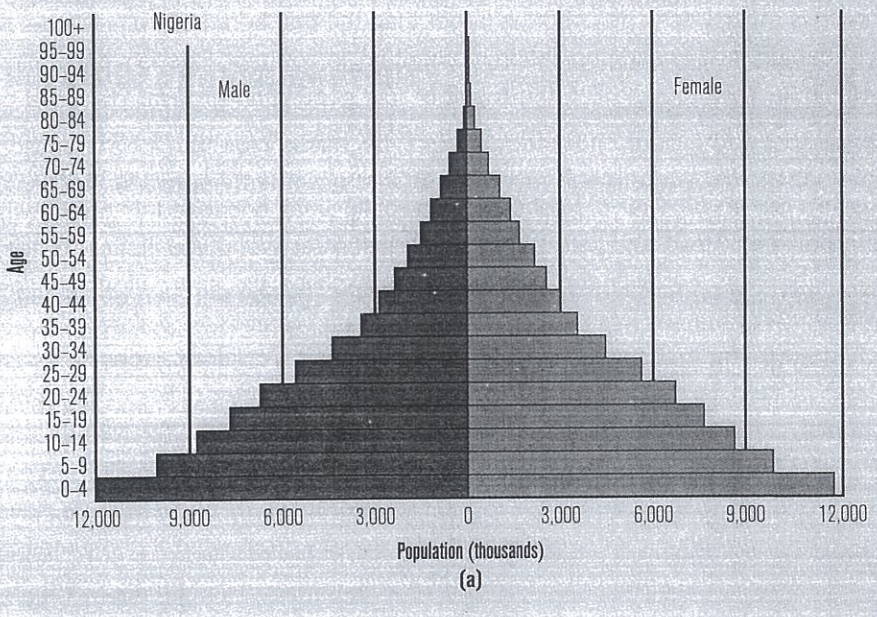
The third relationship highlighted by Coale and Hoover, among population growth, dependency ratios, and saving, has attracted a great deal of analysis. Some studies find little correlation. This may be because business and government savings are relatively independent of demographic change. Even household saving may be fairly insensitive to changes in population growth if most saving comes from wealthy families. Such households' saving behavior would be affected by neither their own fertility decisions nor those of the poor. On the other hand, there is cross-country evidence that, as the share rises of the population 15 years of age and younger, the aggregate saving rate falls.

This last insight is part of a more recent analysis often referred to as the **demographic dividend** or **bonus**. The dividend refers to the opportunity created when a nation with rapid population growth experiences a fall in fertility. As fertility falls, population growth falls too, but for a period of time the working age population (15- to 65-year-olds) grows *more rapidly* than the youth population (0 to 14). This is because the growth of the working age population depends on earlier and higher birth rates. The age pyramids in Box 7–3 experience a bulge in the number of young adults and a shrinking of the number of children. Not only are there now more potential workers per child, but more women join the labor force as fewer years are spent on childbearing. With relatively more workers, the productive potential of the economy expands. During this phase of the demographic transition, the society still has a relatively small older age cohort so the problem of the dependency of the elderly is not yet a concern. It will eventually become one, as it has in an increasing number of developed and developing nations today, making the demographic dividend a temporary opportunity.

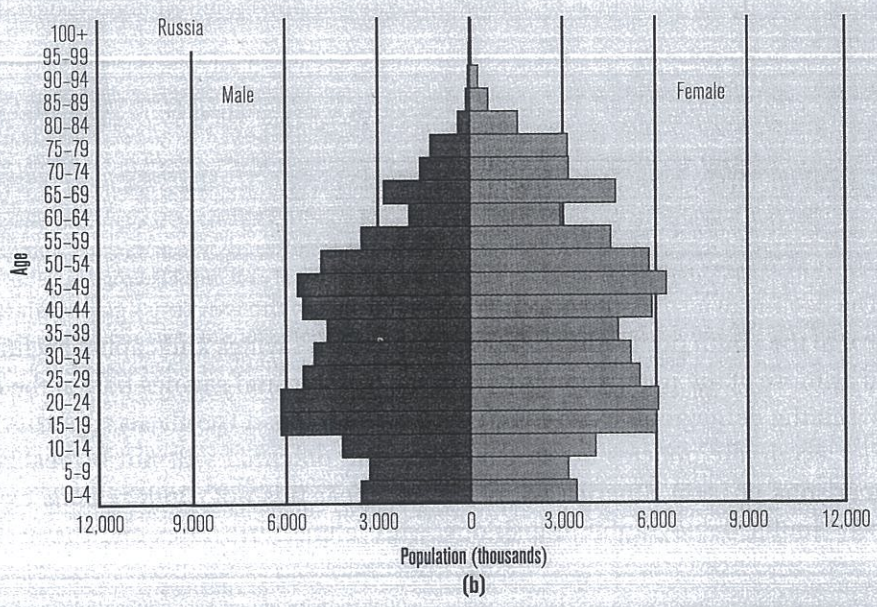
[14]Nancy Birdsall, "Economic Analysis of Rapid Population Growth," *World Bank Research Observer* 4, no. 1 (January 1989).

BOX 7-3 POPULATION GROWTH, AGE STRUCTURE, AND DEPENDENCY RATIOS

In 2009, Nigeria had a population of 153 million people compared to Russia with 142 million. Although similar in population size, the two nations are at very different points in their demographic transitions. Nigeria has a total fertility rate



(a)



(b)

of 5.7; Russia's is 1.5. Nigeria's population growth rate this past decade was +2.1 percent per year; Russia's was −0.35 percent. Only recently has Nigeria reached the stage of the demographic transition where birth rates have started to fall. Russia passed through this phase decades ago.

Differences in crude birth and death rates, in addition to their impact on population growth, have a large effect on a nation's age structure. Population pyramids (on previous page) illustrate these effects. Each bar of the pyramid refers to the number of males and females, respectively, in a given age cohort. Nigeria has the distinctive population pyramid of a nation in which population growth is rapid. Each age cohort is larger than the one born before it, the result of both high fertility and population momentum. In contrast, Russia's population pyramid is more rectangular, the result of low population growth. The base of Russia's pyramid is narrowing because fertility has fallen below replacement levels. (Differences among population cohorts also reflect historical events. Russia's 60- to 64-year-old cohort is especially small because this group was born between 1944 and 1948, during and just after World War II. Low fertility and high infant mortality during those years explains the shortfall in this age cohort today.)

Nigeria's youth dependency ratio, the number of children (ages 0 to 14 years) divided by the number of people of working ages (15 to 64 years), obviously will be higher than Russia's. The ratio equals 0.87 for Nigeria and only 0.21 for Russia. But Russia has a higher elderly (older than 64) dependency ratio of 0.14 than Nigeria's (0.03). Differences in age structure have important implications for every aspect of a society, from what it consumes to how it votes to the culture it creates. What implications differences in dependency ratios have for overall economic growth and development is considered in the text.

Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2008 Revision*, available at www.un.org/esa/population/publications/wpp2008/wpp2008_highlights.pdf.

The decline in fertility not only increases the size of the working age population relative to the youth population. It may also increase savings and capital accumulation as more of the population is now in the working and savings part of the life cycle. But the demographic dividend is not a sure thing; it is only an opportunity. If other economic policies are not in place, the potential will not be realized. Comparisons of Latin America with East Asia bear this out. Both regions experienced similar demographic transitions, with falling birth rates and increasing

working age cohorts. But the similarity ends there. East Asia boomed; Latin America did not.

Some researchers argue that East Asia's demographic transition contributed substantially to the region's rapid economic growth. Using cross-country growth regressions, they attribute one-third or more of the region's growth to the rapid increase in its working age population after the decline in fertility. Others think the effect on growth was far smaller, finding little empirical evidence at the household level to support the life-cycle hypothesis of saving central to the demographic dividend.[15] The relationship between population growth and saving remains unresolved.

POPULATION AND PRODUCTIVITY

In addition to its potential effects on the accumulation process, population growth also can influence the other important determinant of economic growth, the productivity of assets. Concern over these impacts dates back to Thomas Malthus. Malthus saw population growth leading to an inevitable decline in agricultural productivity and having devastating consequences for humanity. What Malthus did not envisage is the revolution in agricultural technology that would raise, not lower, the productivity of land. Malthus never would have believed that, in a world of 7 billion people, individuals, on average, would eat better than they did in his day, when world population was closer to 1 billion. Economic historian Robert Fogel cites evidence that, in the late eighteenth century, about the time Malthus wrote his famous essay, the average daily caloric consumption in France was 1,753 and in England in the neighborhood of 2,100. Contrary to Malthus's predictions, in the developing world today the average is much higher, exceeding 2,600 calories.[16]

[15]The significance of the demographic dividend is presented in David Bloom and Jeffrey Williamson, "Demographic Transitions and Economic Miracles in Emerging Asia," *World Bank Economic Review* 12, no. 3 (1998); David Bloom, David Canning, and Jaypee Sevilla, *The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change* (Santa Monica: Rand, 2003). A dissenting view is presented in Angus Deaton and Christina Paxson, "Growth, Demographic Structure and National Saving in Taiwan," *Population and Development Review* 26 (2000; Suppl.), 141–73.

[16]There is a group of countries that in recent years have consumed fewer than 1,750 calories per day, the level in France in the late eighteenth century. In 1999–2001, this group included Afghanistan, Burundi, the Congo, Eritrea, Somalia, and Tajikistan. Although all but Tajikistan had extraordinarily high TFRs of 6.0 or more at the time, what also distinguishes this group is that they were all failed states. It is likely that their malnutrition was caused less by overpopulation than by the disruption of agriculture due to massive political instability. Historical data on caloric intake are from Robert Fogel, "The Relevance of Malthus for the Study of Mortality Today: Long-Run Influences on Health, Mortality, Labor Force Participation, and Population Growth" (231–84), in Kerstin Lindahl-Kiessling and Hans Landberg, eds., *Population, Economic Development, and the Environment* (Oxford: Oxford University Press, 1994). More recent data are from United Nations Food and Agriculture Organization, *The State of Food Insecurity in the World* (Rome: FAO, 2003).

Despite these improvements, neo-Malthusian ideas still are popular. Concern over an imbalance between population and food supplies continues to be voiced, as is concern over how population pressures will affect the availability of fresh water and energy, the spread of infectious diseases, the degree of biodiversity and climate change, and the overall sustainability of the environment. Neo-Malthusians, like their intellectual predecessor, believe that there are limits to the carrying capacity of the planet and that science and technology cannot resolve fundamental problems of diminishing returns.[17]

Malthus's thinking placed him squarely in the camp of population pessimists. But some later economists, **population optimists**, would view population growth as having the potential to increase factor productivity. Several reasons for such a relationship have been proposed. First, a larger population, the result of more rapid population growth, can yield economies of scale in production and consumption. Roads are a good example. The return on an investment in a rural road is higher, up to a point, the more people there are to use the road. Other forms of infrastructure as well as public services in health and education exhibit similar scale effects. Second, there is some evidence that population pressures can induce technological change. Increasing population density in previously underpopulated regions can encourage more labor-intensive farming systems, increasing the return to land and, perhaps, to other inputs. Third, economist Julian Simon, perhaps the greatest population optimist of all, argued that a larger population contains more entrepreneurs and other creators, who can make major contributions to solving the problems of humanity. Simon called human ingenuity the "ultimate resource" that can overcome any depletion of other resources.[18]

Just as is true for the population pessimists, empirical support for the positions of the population optimists is spotty. Scale effects exist but often are realized at population densities that already have been achieved; a possible exception is some sparsely settled regions of Africa. Diseconomies of scale also exist and city sizes in parts of the world may be approaching those levels. Finally, there is no simple one-for-one correspondence between population pressures and technological change. Population is only one of many factors that affect the nature and quality of the institutional environment that conditions the introduction of new technologies and methods of pro-

[17]The neo-Malthusian perspective is presented in Lester Brown, Gary Gardner, and Brian Halweil, *Beyond Malthus: Nineteen Dimensions of the Population Challenge* (New York: Norton, 1999). The opposing view, that the planet is not overreaching its carrying capacity, is presented in Bjorn Lomborg, *The Skeptical Environmentalist: Measuring the Real State of the World* (Cambridge: Cambridge University Press, 2001).

[18]The seminal work on population pressures inducing changes in agricultural production is Ester Boserup, *The Conditions of Agricultural Growth* (Chicago: Aldine, 1965.) On human ingenuity, see Julian Simon, *The Ultimate Resource* (Princeton, NJ: Princeton University Press, 1981).

duction. Green revolution technologies, which can dramatically increase agricultural output for specific crops, such as rice and wheat, have been adopted in some densely populated areas but not in others. This suggests that population pressures alone have not been the deciding factor.

POPULATION AND MARKET FAILURES

In addition to the population pessimists and the population optimists who present such conflicting views, there is a third school of thought on population and development: the **population revisionists** (referred to by some as population neutralists). The revisionists situate themselves between the two extreme camps, arguing that there is no one size that fits all on population matters. Because of the varied influences of population growth on economic and social variables, growing populations may or may not be detrimental to economic development, depending on time, place, and circumstances.

The revisionists also bring together micro models of fertility behavior with macro assessments of the consequences of population growth. This merging of micro and macro is critical. According to the prevailing microeconomic model of fertility, individuals have control over their fertility decisions and behave rationally. In other words, couples, on average, make decisions on the number of children they want in their own best interest. If this insight is correct, how is it possible that actually tens of millions of rational individual decisions concerning the number of children to have could result in detrimental outcomes for nations or even for the planet as whole? The revisionist answer is a familiar one to economists: **market failures**, situations in which the costs or benefits of reproductive behavior by individuals (households) are not fully borne by them.

Revisionists agree with some neo-Malthusians that rapid population growth may hasten depletion of natural resources or harm the environment. But unlike the neo-Malthusians, revisionists argue the fundamental problem is not too many people, but the lack of well-defined property rights. As in the classic "Tragedy of the Commons," population growth can destroy a common resource—for example, common grazing lands or a fishery—because no one family takes into consideration the impact of its use on others. A larger family might help that family gain greater benefits from the common resource (at least in the short run) but, at the same time, help speed its destruction, to the detriment of all.[19] A similar argument can be made about many government services, whether in education, health, sanitation, or transport. Each family may be acting rationally, but if the population grows too quickly, government services may not expand quickly enough. The resulting congestion of government services may produce lower quality of life for all. The root cause of the problem is not

[19]Garret Hardin, "The Tragedy of the Commons," *Science* 162, no. 1 (1968), 243–48.

population growth but the inability of government to finance the increased demand for publicly provided goods and services. In both these examples, population growth may exacerbate an existing market failure.

Revisionists also call attention to a failure in the market for contraception. If there are poor, incomplete, or imperfect markets either for information on contraception or for the contraceptives themselves, women have more children than they want and population growth is higher. One study reports that in Haiti 40 percent of women 15 to 49 years old preferred to avoid a pregnancy but were not using contraception.[20] To the extent that this was the result of a lack of information about or access to birth control, there is a market failure for contraceptives. In such circumstances, fertility levels do not fully reflect individual preferences and are too high. The ultimate source of the market failure is less apparent. Is it due to lack of information, government restrictions on the sale of birth control devices, or something else? The price of birth control is far less than the price of raising a child. Free markets deliver Coca-Cola worldwide, why not contraceptives?[21]

In addition to drawing attention to market failures, population revisionists focus on the impact of fertility decisions on dimensions of human welfare other than growth in per capita income, such as income distribution. At a household level, high fertility may benefit parents, in terms of earnings from child labor and old age support. But these same advantages for parents may work to the disadvantage of children if they result in fewer resources available per child for human capital investments. Higher-birth-order children may be at a particular disadvantage. Looking across households, because higher fertility is inversely correlated with household income level, more rapid population growth may increase income inequality and worsen poverty outcomes.

Population revisionists have contributed to the otherwise polarized debate on population between the pessimists and optimists. The revisionists emphasize that rapid population growth is unlikely to be the primary impediment to economic development, focusing instead on how population growth can exacerbate the failings in other markets or particular government policies. Even these negative effects are likely to be mitigated over the long run as households adjust to changing circumstances. Despite their more nuanced approach, the population revisionists seem unable to identify the specific circumstances and country settings in which market failures are large and policies to limit births are warranted. Their perspectives, however, help frame the debate over appropriate population policies.

[20]Sara Maki, "Unmet Need for Family Planning Persists in Developing Countries" Population Reference Bureau (October 2007), www.prb.org/Articles/2007/UnmetNeed.aspx accessed March 2012.

[21]Adapted from William Easterly, *The Elusive Quest for Growth* (Cambridge: MIT Press, 2001), p. 89–90.

POPULATION POLICY

While economic analysis cannot provide a definitive answer as to where, or even whether, intervention is warranted to slow population growth, most governments in developing nations and most donors favor slower population growth. In pursuit of this objective, governments implement a variety of population policies. Economic reasoning can help evaluate the relative merits of specific policies when the stated goal is to lower population growth rates.

The growth of a population can be reduced either by lowering the birth rate or raising the death rate. In practice, the only acceptable policy solution is reducing the birth rate. No one would advocate increasing the death rate as a way to slow population growth, but nations and donors do not always follow a strictly anti-mortality approach. The initially slow donor response to the HIV/AIDS crisis in sub-Saharan Africa is a case in point.

If slowing the rate of population growth is the goal, then reducing the birth rate is the solution. This can be achieved by reducing the share of the population of reproductive age or the fertility rate. Raising the average age of women at childbearing slows down population momentum and, in time, leads to a reduction in the share of the population of reproductive age. Providing women with more education and better employment opportunities can achieve these results. These interventions will also reduce fertility levels. And reduction in fertility, whether by direct or indirect means, is the primary target of population policies.

Two controversies surround population policies aimed at reducing fertility. One is the debate over the significance of family planning efforts versus broad-based socioeconomic development. The other is the debate over the use of relatively authoritarian tactics, including elements of China's 1979 one child campaign, to achieve population goals. Before getting to either of these controversies, we can identify some noncontroversial elements of population policy.

Educating girls is one of the least controversial and most effective means of achieving a long-term decline in fertility. As predicted by the new household economics, women with more education have a higher opportunity cost of time and choose to have fewer children. This result has been born out empirically by numerous studies. (Figure 7–5 provides evidence from four nations.) Because educating girls is valuable in its own right, all schools of thought on population agree to support improvements in girls' education. Any subsequent impact on fertility is as much a consequence as a motivation for such policies. The same can be said for interventions that reduce infant and child mortality. Such interventions, usually involving prenatal care, better birthing practices, and health initiatives directed at the young, can significantly improve survival chances. These interventions need not be motivated by a desire to lower fertility, even though they have this effect.

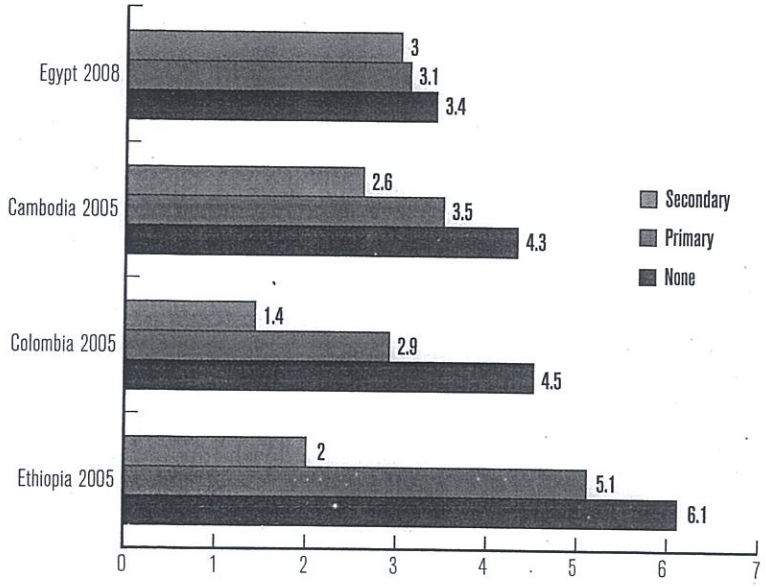


FIGURE 7-5 Total Fertility Rates by Mother's Education

Source: Demographic and Health Surveys, available at www.measuredhs.com.

All policies that promote economic development and lead to more education, better health, higher per capita incomes, and less poverty are associated with declining fertility, even if this is not their primary purpose. At the first United Nations World Population Conference, held in Bucharest in 1974, a popular slogan was, "Take care of the people and the population will take care of itself." Some development specialists go so far as to conclude that economic development is the best contraceptive. But others disagree and argue that more direct interventions to control fertility outcomes are needed.

FAMILY PLANNING

Family planning refers to a range of reproductive health information and services. It includes information on contraception and provision of contraceptives of various types, often highly subsidized or delivered at no cost to the user. Without government family planning services, couples could purchase contraceptives available at market prices or could control their fertility using traditional methods (abstinence, rhythm method, withdrawal). More modern forms of contraception (condoms; hormone therapies including birth control pills, patches, and injections; IUDs; male and female sterilization), however, are more reliable and associated with a greater probability of achieving desired fertility. One of the most important contributions of family planning services, whether provided publicly or through the market, is to help families reach their desired fertility levels. As levels of desired fertility fall, modern forms of contraception provide the means for achieving these goals.

Some population specialists also draw attention to the significant proportion of births in the developing world that are unwanted. Information on unwanted births is obtained from household survey data in which women report the number of births they have had as well as the number of children they would like to have. Using data from the 1970s and 1980s, demographer John Bongaarts estimated that approximately one out of every four children born in the developing world (excluding China) was unwanted.[22] Estimates for the past decade suggest much smaller numbers; for a sample of developing nations representing about two-thirds of the developing world excluding China, the total "not wanted" was only 8 percent, with another 9 percent "wanted later."[23] Reducing the number of unwanted births is another way of reducing population growth.

Whether family planning programs are effective at reducing unwanted births is a matter of some debate. This may sound surprising: Isn't the lack of contraception the reason women have births they do not want? Some further explanation is needed. When women reduce their desired level of fertility, contraception plays an important role in achieving these lower levels. Desired levels of fertility and contraceptive prevalence are well correlated, with causality most likely running from the former to the latter. When women desire small families, contraceptive prevalence is high. However, contraceptive use is less well correlated with reported differences between actual and desired fertility—that is, with the number of unwanted births. Using data from the 1970s and 1980s, development economist Lant Pritchett found that after controlling for desired fertility there was little correlation between contraceptive prevalence and excess births.[24] Women may have more births than they want but the availability of contraception may not explain why.

Family planning programs may influence individual preferences about how many children to have. This dimension of family planning efforts involves providing information, counseling, and various forms of "persuasion" concerning the number and spacing of children. Public campaigns to discourage high fertility are employed by many countries. In the 1980s, the slogan of India's national family planning program was *"Hum Do, Hamaray Do,"* which when translated means "Us Two, Our Two," or for two parents, two kids—a model family. The slogan was displayed widely on the sides of buses, billboards, and in TV advertisements and came with a logo, a silhouette of two parents holding the hands of two children, a boy in shorts and a pigtailed girl in skirts. The slogan on India's Ministry of Health and Family Welfare website recently flashed, "Control Population! Have fun with one!" In Indonesia, the *"Dua cukup"* program recommended "two is enough"; in the Philippines, public ads showed two happy children and advised, "If you love them, plan for them;" and in Zimbabwe, a family planning poster suggested,

[22]Bongaarts, "Population Policy Options," p. 771–76.

[23]Population Reference Bureau, *Family Planning Worldwide: 2008 Data Sheet,* www.prb.org/Publications/Datasheets/2008/familyplanningworldwide.aspx.

[24]Lant Pritchett, "Desired Fertility and the Impact of Population Policies," *Population and Development Review* 20, no. 1 (March 1994), 1–55.

"A small family brings a better life." These campaigns can affect social norms and the desire to have many children.

Family planning information also can be more personalized. One widely studied program of this type began in the late 1970s in the Matlab region of Bangladesh. It included fortnightly visits to each married woman in half the villages in the region. The visit was from a project employee, who discussed family planning needs and provided contraceptives. As a result of these visits, fertility rates fell dramatically by 1.6 births relative to the half of villages in the region that did not receive such visits. One evaluation of the program in Matlab considered its long-term consequences. After roughly 20 years, families who lived in the program villages not only had fewer children with greater spacing between them but were healthier and more prosperous than residents of similar villages that had not been served.[25] An important lesson of the Matlab experiment is that family planning can be effective at reducing fertility and providing other benefits, but it can entail substantial costs. Fortnightly field visits, free contraceptives, and administrative expenses per woman amounted to 10 percent of per capita income, sums that could not be sustained at a national level.[26]

Family planning programs need not be as expensive as in the Matlab program to be effective, but the general point remains. If the goal is to reduce fertility levels, is it better to devote scarce resources to expand family planning programs, or might it be more effective to devote these same resources to general improvements in socioeconomic status, which, in turn, could result in an equal or greater decline in fertility? In their evaluations of Indonesia's rapid decline in fertility rates, economists Paul Gertler and John Molyneaux determined that heavy subsidization of contraceptives, representing about half of the family planning program's expenditures, had a marginal impact on reducing fertility. Expansion of the distribution network into rural areas had a more significant effect. But most of the increased use of contraceptives was induced through economic development and the improved education and opportunities facing Indonesian women.[27]

Family planning may not play a large independent role in reducing fertility but this does not suggest that governments should abandon these programs or limit the availability of contraceptives. Modern forms of contraception enable families to better control their fertility. In this sense, family planning and development are complements, not substitutes. Family planning services also help people lead healthier and more satisfying lives. By being better able to time pregnancies, women can better space their children. Children born three to five years apart have higher rates of survival than children born within two years of one another. Avoiding unintended pregnancies can also reduce the need for abortions. In many low- and middle-income

[25]James Gribble and Maj-Lis Voss, "Family Planning and Economic Well-Being: New Evidence from Bangladesh," *Policy Brief* (Population Reference Bureau, May 2008).

[26]Pritchett, "Desired Fertility and the Impact of Population Policies," p. 37.

[27]Paul Gertler and John Molyneaux, "How Economic Development and Family Planning Programs Combined to Reduce Indonesian Fertility," *Demography* 31, no. 1 (February 1994), 33–63; John Molyneaux and Paul Gertler, "The Impact of Targeted Family Planning Programs in Indonesia," *Population and Development Review* 26 (2000; Suppl.), 61–85.

nations, abortions are illegal and take place under unsafe circumstances, contributing to maternal mortality. Increased use of contraceptives can help reduce the amount of premature deaths of both women and children in poor nations.

The 1994 Cairo International Conference on Population and Development endorsed the idea that family planning be replaced by a broader program of reproductive health. The World Health Organization defines the goals of this new approach as follows:

> Reproductive health implies that people are able to have a responsible, satisfying, and safe sex life and that they have the capability to reproduce and the freedom to decide if, when, and how often they do so. Implicit in this last condition are the right of men and women to have access to safe, affordable, and acceptable methods of fertility regulation of their choice, and the right of access to appropriate health care services that will enable women to go safely through pregnancy and childbirth and provide couples with the best chance of having a healthy infant.[28]

In the same spirit, the United Nations in 2007 added achieving universal access to reproductive health as a target to the MDG to Improve Maternal Health.[29]

AUTHORITARIAN APPROACHES

Some countries, concerned over the growth of their populations, have resorted to relatively authoritarian approaches to reduce their birth rates. In India, during the 1970s, the government added male sterilization to its list of promoted family planning methods. It did so because the government felt unable to control population growth by conventional means. Incentives were offered to men who agreed to be sterilized, and quotas were assigned to officials charged with carrying out the program. Problems arose when force allegedly was used against low-status individuals by officials anxious to fill their quotas. The sterilization campaign provoked an adverse political reaction because the methods of population control were regarded as excessively zealous and callous in their disregard of individual rights. Indira Gandhi's surprising defeat in India's 1977 general election was attributed in part to the population policy of her emergency government.

China's experience has been different. Chinese leaders have expressed concern about the size of the nation's population since the census of 1953 revealed a population of almost 600 million. Modest attempts to influence fertility outcomes followed, but not until 1971 was a more aggressive stance adopted. In that year the "planned births" campaign was initiated and established three reproductive norms, *wan, xi, shao* ("later, longer, fewer"): later marriage, longer spacing between births,

[28]Cited in World Bank, *Population and Development* (Washington, DC: World Bank, 1994), p. 81.

[29]Specific goals and strategies for improving reproductive health are presented in, World Bank, "The World Bank's Reproductive Health Action Plan, 2010–2015" (April 2010), http://siteresources.worldbank.org/INTPRH/Resources/376374-1261312056980/RHActionPlanFinalMay112010.pdf.

and fewer children. To implement these norms, birth targets were set for administrative units at all levels throughout China. The responsibility for achieving these targets was placed in the hands of officials heading units ranging from provinces of 2 to 90 million people down to production brigades of 250 to 800. The national government held information and motivation campaigns to persuade people to have fewer children, but it was left to local officials to fill out many details of the program and finance much of its cost. In China's villages, where much of the population lived, IUD insertions, abortions, and, later, sterilizations were offered. A wider range of contraceptives was provided in the cities. National spokespeople maintained that participation in the program was voluntary, but local officials with targets to fulfill often applied pressure. At the production brigade level, birth planning became intensely personal, as couples were required to seek approval to have a child in a particular year. (The application might be accepted or they might be asked to wait a year or two.)

The *wan xi shao* campaign began by discouraging couples from having more than two children; by the end of the 1970s, couples were encouraged to have only one. During the 1970s, total fertility rates in China plummeted from around six children per woman to less than three, a rate of fertility decline without precedent in world history. But, despite lowered fertility, population projections continued to cause concern, and in 1979, the **one child campaign** was promulgated. Couples, initially, were required to apply for official approval before conceiving the one allowed child. Those who complied could receive income supplements, extra maternity leave, and preferential treatment when applying for public housing. Couples bearing more than one child might be fined or lose access to education or other privileges. Early in the campaign, the government employed harsh methods to enforce its population goals. A system of incentives and penalties, plus other forms of social pressure, moved women to undergo sterilization after two births. China's one child approach has gone through various phases since its inception, with periods of stricter and looser interpretations. Since the late 1980s, rural couples in most provinces were allowed to have two children if their first was a daughter. Chinese couples still are obliged strictly to limit the number of children they have but elements of the earlier coercion to force such outcomes have waned.[30]

Several lessons can be learned from China's experience. First, the dramatic decline in fertility that took place in China is the result of more than the government's population policies. At the same time that these programs were implemented, economic reforms ushered in a period of rapid economic growth and urbanization, which decreased desired fertility. Even without the one child campaign, Chinese fer-

[30]For a survey of demographic trends and policies in the People's Republic of China, see Nancy Riley, "China's Population: New Trends and Challenges," Population Reference Bureau *Population Bulletin* 59, no. 2 (June 2004). The human face of China's policy is captured in the multimedia presentation by American Public Media, *Marketplace*, "China's One Child Policy" (June 2010), available at http://marketplace.publicradio.org/projects/project_display.php?proj_identifier=2010/06/21/china-one-child-policy; accessed February 2012.

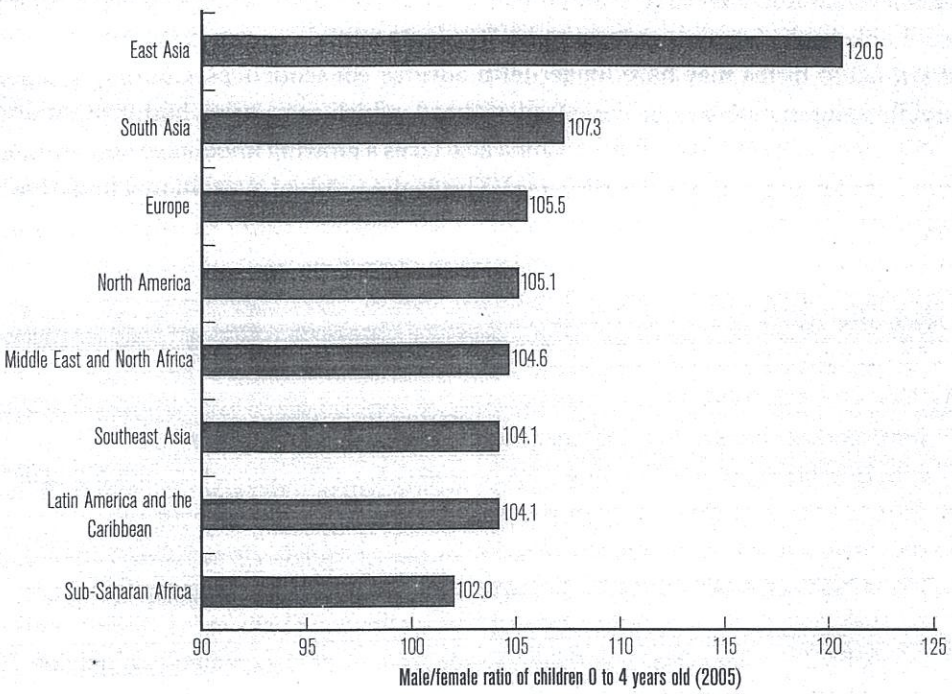
tility levels would have fallen but probably not as far. Today, many Chinese couples would likely choose on their own to have only one child or even none. Second, the sharp fall in births may have longer-term adverse consequences. China will face a rapidly aging population in the decades ahead, which may stress both private and public systems of old-age support. China also faces a growing imbalance between the number of males and females (Box 7-4). This is the result of a traditional preference

BOX 7-4 MISSING GIRLS, MISSING WOMEN

Most parents believe that the chances of having a daughter or a son are fifty–fifty. But this is not true. For most human populations, the expected ratio of boys to girls at birth is closer to 105:100. Scientists are not entirely sure why this is the case, but believe it compensates for biological weaknesses in males resulting in higher mortality rates for boy versus girl infants. Because more than biology determines survival, social scientists draw attention to sex ratios, at birth and throughout the life cycle, when they deviate from what is expected in a gender-neutral environment.

The chart on the next page compares the sex ratio of children 0 to 4 years old in various regions. Europe and North America have ratios close to 105:100. The lower ratios in some regions may be due to a tendency for populations of African descent to record male to female ratios at birth closer to 102:100 or to the higher rates of male infant and child mortality. The most striking result is the pattern in East Asia, where in 2005 there were close to 121 boys for every 100 girls. This is neither a recent outcome nor is it biologically driven. The shortage of girls 0 to 4 years old is the result of long-standing son preference in the region. In previous periods, the shortage of young females was the result of deliberate female infanticide and neglect. Today, sex-selective abortion is another mechanism causing male children to outnumber female children, one facilitated by the increasing availability of ultrasound and other prenatal screening devices.

Sex-selective abortions, abandonment of female infants, and differential neglect of girls, especially in medical care, are all means of realizing son preference. They have been common in many parts of East Asia but none more so than in China. Although son preference has a long history in China, the one-child campaign and the overall move to low fertility rates among Chinese households have contributed to these outcomes. In 1982, at the beginning of the one-child policy, the sex ratio of first births was 107; second births, 105; and all subsequent births, 110. The change by 2000 was dramatic. The sex ratio of first births in China was still 107, but for second births it rose to 152 and for any subsequent



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2008 Revision,* available at www.un.org/esa/population/publications/wpp2008/wpp2008_highlights.pdf.

births it was almost 160. Second and higher-order births represented only one-third of all births in 2000, but sex selection for these births resulted in the high and grossly imbalanced sex ratio for all Chinese births.

China is not alone in this extreme form of discrimination against females, which has been referred to as *gendercide.* Amartya Sen examined the issue of differential mortality of males versus females and found that survival chances vary across countries and over the life cycle. In India, the differential used to show up less at birth and more during childhood and the late teen years. Today, sex-selective abortions are on the rise in India. Sen and other researchers concluded in 1990 that more than *100 million women were missing* worldwide, 80 million from China and India combined, as a result of sex-selective abortions and the relative neglect of girls and women. Today the numbers may well be higher.

Sources: Nancy E. Riley, "China's Population: New Trends and Challenges," Population Reference Bureau, *Population Bulletin* 59, no. 2 (June 2004); Amartya Sen, "More Than 100 Million Women Are Missing," *New York Review of Books* (December 20, 1990); Stephan Klasen and Claudia Wink, "'Missing Women': Revisiting the Debate," *Feminist Economics* 9, nos. 2–3 (November 2003). The cover story of the March 6, 2010, issue of *The Economist* was on gendercide.

for sons combined with policies that limited the number of children a couple could have. This most severe form of discrimination against females has human rights implications and may result in a host of social problems for future generations of Chinese women and men.

Finally, nations that today are worried about the growth in their populations are unlikely to be able to follow the Chinese approach. Few states can exercise as much social control as Chinese governments have in the recent past. India's experience in the 1970s suggests that a democracy is unlikely to accept the authoritarian approaches employed in China. But, even if a nation could do so, should they? Amartya Sen argues that, if freedom is valued at all, depriving people of the freedom to regulate their own fertility, one of life's most personal decisions, must represent a significant social loss.[31] Such a loss can be justified only if the social cost of not intervening is high. As this chapter has shown, it is hard to make the case that individuals systematically make poor decisions when it comes to childbearing or that the negative externalities of these decisions are large. If this is true, what justification is there for coercion to regulate fertility? Noncoercive approaches, including broad-based socioeconomic improvements, can achieve similar ends and should be pursued instead.

POPULATION ISSUES FOR THE TWENTY-FIRST CENTURY

In retrospect, the fears of Robert McNamara and many others about a population explosion no longer seem warranted. Population growth has slowed dramatically, and the expectation is no longer that world population will increase indefinitely. By mid-century, the world's population is expected to peak, admittedly with billions more people then when McNamara first expressed his fears.

But the drop in population growth rates does not mean that demographic concerns are a thing of the past. The world economy, if the United Nation's medium term projection comes to pass, still must accommodate another 2 billion more people over the next 40 years, almost all of whom will be born in today's developing nations. A second major demographic development will be the change in the age distribution of the world's population. There will be fewer children and many more elderly; not only are the developed nations aging but so are many of the developing ones. According to United Nations' projections, those 65 and older made up 6.7 percent of Asia's population in 2010; in 2050 they will make up 17.3 percent. In China alone, in part due to the one child policy, the percentage of seniors is projected to rise from

[31]Amartya Sen, "Population: Delusion and Reality," *The New York Review of Books* 41, no. 15 (September 22, 1994).

8.2 to 23.3 percent of the population. In Latin America the change will be similar to that in Asia. Only in sub-Saharan Africa, where fertility rates remain high, will the share of the elderly remain in single digits.

How will the needs of the elderly be met? As households grow smaller in size, traditional systems of family support are likely to breakdown. Financing old-age pensions, a huge problem now in developed nations, will increasingly confront emerging economies. Chile's pension system is often cited as a model for dealing with old age security. It no longer relies on a traditional pay-as-you-go (PAYGO) system similar to Social Security in the United States, where workers pay taxes each year that finance the pensions of those who already are retired. Starting in 1981, Chile developed a national system of mandatory personal retirement accounts, similar to 401K plans in the United States. This system of prefunded retirement savings relieves some of the burden of publicly financed old-age support. But it is not a complete solution, as many Chilean workers are self-employed or work in the informal sector and do not participate. About half of Chilean women were not covered because they did not work outside of their homes. Low-income workers may not earn enough for their accounts to lift them above poverty after their working years. Recent reforms, which include more public funding of old-age security, address some of these limitations but continue to build on the personal retirement account system.[32]

A changing age structure will challenge some economies; others will continue to face high fertility and the burdens (and opportunities) of a young population. This will be the case for many nations in sub-Saharan Africa. If this region follows what has happened elsewhere, economic growth and development will reduce the demand for children and accelerate a demographic transition to lower birth and death rates, and a slower rate of population growth.

SUMMARY

- The twentieth century will be remembered for populating the planet. In 1900, the world population stood at about 1.5 billion. By 2000, there were over 6 billion people; 5 billion living in developing nations. In no prior century did the world population increase by even 1 billion. World population growth has slowed since the 1960s, and current projections do not envision that the twenty-first century will see increases as large as those of the last century.
- The driving force behind the population increases of the last 100 years is the demographic transition, especially in the developing world. Improvements

[32]Estelle James, Alejandra Cox Edwards, and Augusto Iglesias, "Chile's New Pension Reforms," Policy Report No. 326, National Center for Policy Analysis, Dallas, TX, March 2010.

in nutrition, medical knowledge, and public health led to a rapid decline in death rates. Birth rates took longer to fall, and in the interim, the rate of natural increase in the populations of low- and middle-income nations soared to unprecedented levels. Today, most regions of the world are experiencing a decline in fertility and are approaching replacement levels. Sub-Saharan Africa is the one exception, where total fertility remains high, but even in this region, some decline is evident.

- There is considerable debate over the consequences of population growth on economic development. This is because of the multitude of ways population growth affects the determinants of growth; population growth, for example, may inhibit capital deepening, but it also may encourage institutional and technological innovations that increase factor productivity.
- In trying to understand the impact of population growth on economic development it is important to reconcile micro behavior with macro outcomes. If individual couples are making rational choices over the number of children they have, then at a macro level, why might a problem arise? The answer is market failures—for example, if the social costs of raising children exceed the private costs. In practice, it has proven difficult to identify the precise circumstances in which this happens and how large the resulting costs are.
- The debate over whether population growth is an obstacle to economic development is reflected in the choice of population policies governments pursue. If household behavior is rational and market failures are small, then development may be the best contraceptive. With better education, especially for girls; better employment opportunities, especially for women; and improved healthcare, especially for the young; couples desire fewer children. Family planning programs also may influence social norms about family size and assist individuals in attaining desired fertility levels in a safe and reliable manner.
- Some governments, especially in China, decided that the macro consequences of population growth are so negative that authoritarian steps must be taken to limit fertility. Such approaches have proven effective at reducing fertility levels and rates of population growth. But their development benefits are less obvious. Coercive population policies entail high social costs and loss of individual freedom. It is difficult to justify these actions with such limited evidence that reduced fertility contributes to faster economic growth and development.
- Despite the slowing of world population growth, the twenty-first century will face demographic challenges of its own, including a rising share of the elderly. With fewer workers per nonworking senior, nations will need to craft fiscally sustainable systems of old age support.