ABOUT THE AUTHOR

Jeffrey D. Sachs is Director of the Earth Institute and Quetelet Professor of Sustainable Development at Columbia University, and the global bestselling author of *The End of Poverty*. He is internationally renowned for his work as an economic adviser to governments around the world and is a special adviser to United Nations Secretary-General Ban Ki-moon on the Millennium Development Goals. He was the BBC's Reith Lecturer for 2007 and presented some of the ideas in this book to a worldwide radio audience during those lectures.

Common Wealth

ECONOMICS FOR A CROWDED PLANET

Jeffrey D. Sachs

PENGUIN BOOKS

Chapter 7

Global Population Dynamics

THOUGH THE WORLD'S POPULATION GROWTH RATE has declined, any complacency about global population growth would be misplaced. The global population continues to increase by large numbers and in the regions least able to ensure the health, stability, and prosperity of the population. Nonetheless, most mainstream economics now gives a pretty big yawn about the issue. Here is how *The Economist* magazine, the world's authoritative economics weekly, recently dismissed concerns about population growth:

> There doesn't seem to be much danger of a Malthusian catastrophe. Mankind appropriates about a quarter of what is known as the net primary production of the Earth (this is the plant tissue created by photosynthesis)—a lot, but hardly near the point of exhaustion. . . . Raw materials have become more abundant, not scarcer. Certainly, the impact that people have on the climate is a problem; but the solution lies in consuming less fossil fuel, not in manipulating population levels.

Yet we need to worry about population growth and take global public actions to address it. Here's what I shall argue:

- The world's population growth remains far too rapid.
- Resource scarcity is very real, especially regarding the impact of rising populations on the Earth's ecosystems and biodiversity.
- The rapid growth of populations in the poorest countries hinders economic development, condemns children in poor countries to continued poverty, and threatens global political stability.

Public policies can play an important and salutary role in assisting poor households in achieving a voluntary reduction of fertility rates. Fortunately, if today's high-fertility countries, especially in Africa, can follow the successful lessons of countries that have reduced population growth in the recent past, and if they are helped with increased assistance in that effort by international agencies, these countries can achieve a rapid and voluntary reduction in fertility, much to the benefit of economic development, the next generation, and global security. The world should embrace a set of policies to help stabilize the global population, through voluntary choices, at a population of roughly eight billion people, rather than the current trajectory, which is likely to take us to nine billion or more by 2050. This may seem like a modest difference, but the consequences would be large, especially since the population control would come mainly in the world's poorest places.

THE DEBATE OVER POPULATION

Economists tend to be divided into three camps: population optimists, who say that today's population growth is good for development or is at least neutral; population pessimists, who say that population growth has already gone too far to avoid disaster; and those (including myself) who believe in the importance of spurring the demographic transition to lower fertility rates in the poorest countries.

Population optimists maintain that there are no real bounds to the Earth's population because technology can and will keep ahead of the curve. One variant of this optimism is associated with the ideas of economists Simon Kuznets and Michael Kremer, who have each argued that a larger global population will tend to bring about the very technological advances that are needed to sustain that larger population. From their viewpoint, an important part of economic advance comes from the scientific and technological discoveries of geniuses in society. These extraordinary individuals represent a small but relatively constant proportion of the population. Therefore, a world of one billion people will tend to be populated by ten times the number of geniuses of a world of one hundred million people. Kuznets, Kremer, and other economists argue that the overall rate of economic progress depends not on the number of geniuses per million population, which is fixed, but on the total number of geniuses at any time, since each good idea that a genius brings forward can be adopted by the entire population. As we've noted earlier, ideas are nonrival in that the use of the idea by one person does not diminish the ability of others to use the idea as well. Therefore, a population of one billion people will generate a lot more brilliant ideas, and technological advance, than a population of one hundred million. If this is true, a larger population will experience faster growth than a smaller population. The very takeoff of modern economic growth, for example, might have been triggered by the fact that the world's population had gradually crept up to the one-billion mark by 1830, finally enough to trigger a worldwide technological revolution.

Population pessimists believe that humanity has lived not only on ideas but also on the rampant and ongoing depletion of natural resources, especially ecosystem services such as freshwater, habitat, and harvesting of plants and animals. They assert that we have still not proved that we can use technology to overcome natural resource limits, only that we can mine depleting resources fast enough to stave off collapse temporarily. To these pessimists, the current optimism is like the man falling from the thirtieth floor of a building who reports "so far so good" when he passes the tenth floor. In this interpretation, the test is not the first two hundred years of economic growth but the possibility of smooth landing this century.

The advocates of demographic transition, such as myself, remain cautiously optimistic. This group in the middle of the debate acknowledges that good ideas and man-made capital can substitute, though imperfectly, for ecological resources in fixed supply. High-yield seeds and improved irrigation, for example, can raise food production per hectare and thereby support a larger population on a fixed amount of arable land. Nonetheless, rising populations still weigh heavily on a fixed or depleting natural resource base, especially ecosystem services. Economic development, therefore, hovers between ecological constraints on the negative side and the benefits of technology and man-made capital on the positive side. The net outcome depends on the rate of technological advancement versus population growth and on the ability of man-made capital (for example, irrigation) to substitute for natural processes.

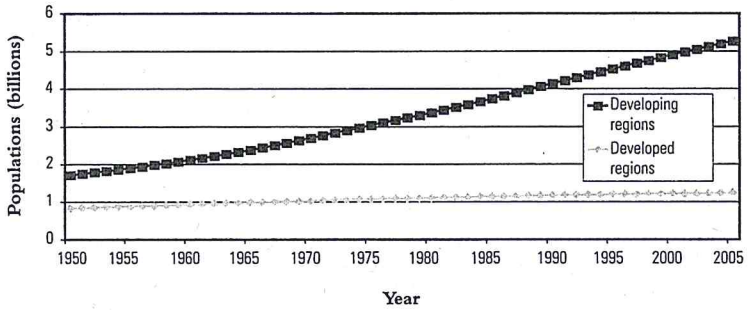
Advocates of speeding the demographic transition emphasize the need for public efforts to speed the voluntary reduction of fertility rates as rapidly as possible to achieve the stabilization of the world's population as well as the

population of each major region of the world. Rather than depend only on technological advances to save the day, the world, they believe, should relieve the direct pressures of population growth through direct population policies.

THE TOTAL FERTILITY RATE (TFR) AND POPULATION GROWTH

For two and a half centuries, the world has been living through an explosion of the human population supported by remarkable technological advances in food production and disease control. During the first phase of the post-1750 population surge, the greatest increases occurred in today's high-income economies. These were, after all, the societies that first mastered the technological advances in food production and industrialization that could reduce mortality rates and support a booming population with increased food supplies. Those technological advances gradually spread to the rest of the world. As a result, the burst of population growth also transferred from the high-income world to the developing world. In recent decades, the growth of the developing-world population has dramatically outpaced that of the high-income countries, both in proportionate terms and even more widely in absolute terms (Figure 7.1). The rich world added roughly 400 million people between 1950 and 2005, a gain of some 50 percent. The developing world

Figure 7.1: Human Population in the Developed and Developing Countries from 1950 to 2005



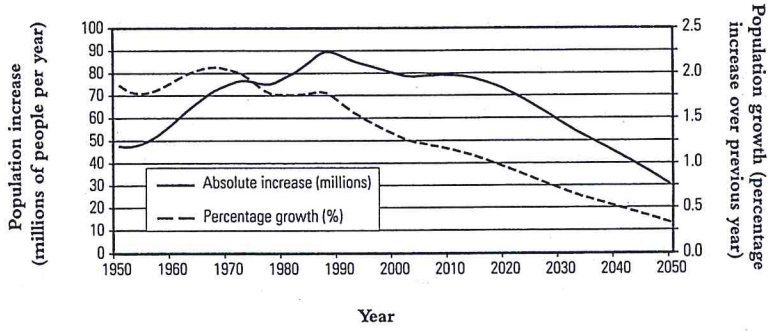
Source: Data from UN Population Division (2007)

added 3.5 billion people, a gain of 200 percent. In 1950, the developed world (United States, Canada, Europe, Japan, Australia, and New Zealand) was roughly one third of the world's population, and by 2005, it had fallen to roughly one sixth of the world's population.

Our societies and cultures are still adjusting to the happy surprise of falling child mortality and rising life expectancy. The decline of fertility lagged behind the decline of mortality, and a massive bulge of population ensued. Those population increases for a time were compatible in most countries with ecological limits, but as the world's population has continued to increase, the threats to human well-being from rising populations have also multiplied. In many developing countries, the rate of population increase has been so rapid and unprecedented that rising populations have destabilized the countries' politics and economics.

In recent decades, the population growth rate (the population increase as a percentage of the world's population) has slowed in most countries. While the world's population grew at around 2 percent in the 1960s, it is growing at around 1.2 percent today. Despite the slowdown, the absolute growth of the world's population—and hence the pressures on the Earth's carrying capacity—remains very high. With growth around 2 percent per year of the world's population of 3.3 billion in 1965, the annual population increase was around 70 million, which is actually slightly less than 1.2 percent of today's population of 6.6 billion, or roughly 78 million per year! Figure 7.2 illlustrates how the proportionate growth rate of population (measured on the right-hand

Figure 7.2: Population Growth from 1950 to 2050



Source: Data from UN Population Division (2007)

axis) has slowed significantly while the *absolute increase* of population per year remains high. The slowdown in the growth rate will likely continue, but the absolute increases in population will likely remain 70 to 75 million per year through 2020.

The slowdown in the growth rate of the world population reflects a decline in the total fertility rate, which measures the average number of children per woman during her reproductive years. Women in most parts of the world are choosing to have fewer children than in the recent past, contributing to the decline in the population growth rate. The most important reason for the fall in the TFR has been the decline in children's mortality. As newborns survive to adulthood with much greater frequency, it makes sense for households to reduce the number of births. Other forces have helped: female empowerment, female participation in the labor force, modern improvements in contraceptive technology, and the introduction and diffusion of family planning programs designed to encourage and help households to have fewer children. Yet, just as with the poverty trap, certain parts of the world, notably the poorest, are stuck in a demographic trap of high fertility.

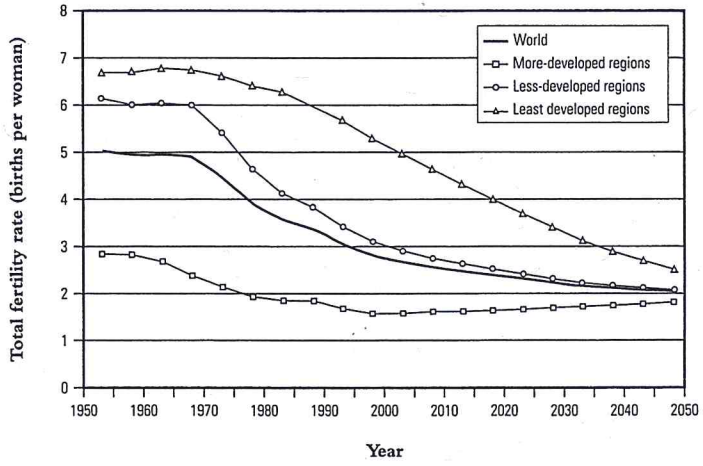
The future trends in global population are startlingly sensitive to the TFR. Slight changes, up or down, from a given trend can mean differences of billions in population. Here's an illustration why: suppose that each woman in a particular society has five children, and one of them dies in childhood while the rest grow to adulthood. In that case, each woman will have four surviving children, and two, on average, will be girls. Therefore, each mother will be raising two girls who will survive to adulthood. We can say that each mother is "replaced" by two daughters in the next generation. This means that the population will tend to double each generation, or roughly every twenty-five years. The number of surviving daughters per mother is known as the net reproduction rate (NRR). When the NRR equals 1, the size of the population will tend to stabilize from one generation to the next. When the NRR is greater than 1, the population will grow. In the example just given, the NRR equals 2.

When the TFR is around 2, and almost all children survive, each woman will raise, on average, one daughter to adulthood. The population will be steady if this fertility rate is maintained over time. Specifically, suppose that the TFR is 2.1 and that 50 out of every 1,000 daughters (5 percent) die in childbirth. Each mother averages 1.05 daughters (half of 2.1), of whom 0.05 die. The NRR is therefore 1. We then say that fertility is at the "replacement

rate," since each mother is replacing herself with one daughter in the next generation. For this reason, a TFR of 2.1 is conventionally taken to be the replacement rate, though in truth the precise level depends on the child mortality rate. The fertility rate therefore turns out to be the most crucial variable for determining the overall rate of population growth. When the TFR exceeds 5, as in much of Africa today, the population roughly doubles each generation. When the fertility rate falls to 2 or below, the population tends to stabilize or even begins to decline.

Figure 7.3 shows the TFR profile today and what is projected to be most likely in the future for various regions of the world. The projections are made by the UN Population Division, the keeper of the "official" global population forecasts. The "more-developed regions," or rich countries, have a TFR of 1.6, below replacement, while the least developed countries (and especially African countries) have a TFR of around 4.6. With roughly 0.8 of children dying before adulthood, the net reproduction rate in those countries is roughly 1.88 (equal to 3.84 surviving children, divided equally between girls and boys), meaning a doubling of population approximately every thirty years. The projection is that all regions of the world will gradually converge at the replace-

Figure 7.3: Total Fertility Trajectories of the World and Major Development Groups from 1950 to 2050 (medium variant)



Source: United Nations Population Division (2007)

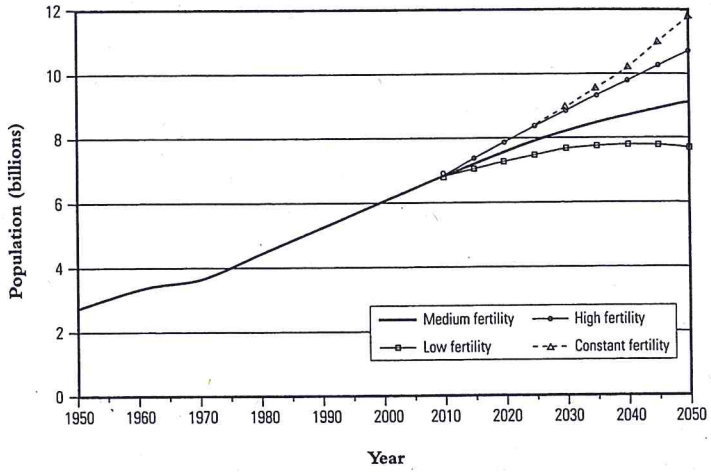
ment rate. The TFR of the more developed regions is forecast to rise very gradually from its current low level, reaching 1.8 as of 2050. The TFR of the less developed regions is assumed to decline to 2.05 by 2050, just about the replacement rate. And the TFR of the least developed countries is forecast to decline to 2.5 by 2050, much lower than today but still above the replacement rate.

THE WORLD'S POPULATION IN 2050

The world's population prospects as of 2050 will be determined mainly by the evolution of TFR in the poor countries. If the fertility rates remain constant, not declining from today's high rates, the global population will soar to nearly unimaginable levels and will almost surely trigger Malthus's "positive checks" (war, disease, famine). If the fertility rates come down according to the medium forecasts or low variant, then the global population can actually stabilize within a half century or so. The UN Population Division puts forward four variants of future TFR and population. The medium forecast is deemed to be the most likely, and it is flanked by a low-fertility variant and a high-fertility variant as well as a fourth variant that assumes an unchanged TFR in the future. The low variant assumes a TFR roughly one-half child lower than in the medium forecast, and the high variant assumes a TFR roughly one-half child higher. In all of these variants except the fourth, the TFR of the poor countries is assumed to decline gradually over time from high levels today toward the replacement rate by midcentury.

The global population trends associated with these alternative TFR assumptions are shown in Figure 7.4. In the medium (most likely) forecast, the world's population is carried to 9.1 billion in 2050, which is pretty much the peak of the world's population. When this forecast is extended beyond 2050, the global population rises a tiny bit more and then declines gently to 9.1 billion, after which it stabilizes according to the long-term TFR assumptions used in the scenario. In the high-fertility variant, in which the TFR is just one-half child higher, the slight difference in fertility rates is enough to carry the world's population to 10.6 billion instead of 9.1 billion! In the low-fertility variant, in which the TFR of the developing world comes down more quickly to the replacement rate, the world's population reaches "only" 7.8 billion. If the TFR remains unchanged between now and 2050, the population will rise

Figure 7.4: Population of the World from 1950 to 2050, According to Different Projection Variants



Source: United Nations Population Division (2007)

to a startling 11.7 billion. Crucially, in the medium variant the population stabilizes by around 2070 at 9.2 billion; in the low variant, the population stabilizes by around 2035 at roughly 7.8 billion.

The stunning fact is that all of the world's population increase will come in today's developing countries (though many of these countries will become developed countries based on successful economic development). Today's high-income countries will have little overall change in population, remaining at about 1.2 billion. The developing world will experience a rise from 5.2 billion to 7.8 billion in the medium forecast, equal to the world's projected rise in population. And of that 2.6 billion rise, a stunning 1 billion will be in Africa and 1.3 billion in Asia. Not only will the world's population increase, but the shift in composition will reshape the world as well. From today's share of the global population of around 12 percent, Africa's share will rise to a remarkable 20 percent by midcentury and to around 24 percent by 2070 in the medium forecast. India will overtake China as the world's most populous nation.

These projections need some digesting. Not only will the world's population continue to soar by another 2.6 billion or more in the medium and high

forecasts of fertility, but it will soar in precisely those parts of the world that are struggling the most today with extreme poverty, disease, famine, and violence. Both cause and effect are at play. Poverty contributes to high fertility rates, while high fertility rates prolong poverty. The poorest countries in the world are stuck in a demographic trap as much as a poverty trap. Fortunately, there are solutions—good ones—for achieving a rapid and voluntary reduction of the fertility rate in these countries if we pay attention and coordinate our global efforts.

POPULATION MOMENTUM

In all cases, there will be a substantial increase in the global population before we are through with population increases. In fact, even if the TFR falls magically and instantly to the replacement rate in all countries, the world will still experience an overall population increase of more than one billion people! This is the consequence of population momentum. It works as follows: Suppose, to illustrate, that a country with a TFR of 5, a child mortality rate of two hundred per one thousand, and therefore a net reproductive rate of 2, has been doubling in population each generation. Currently there are two million older people, four million childbearing adults, and eight million children. The total population is fourteen million. Now suppose that the TFR immediately falls to the replacement rate, and the NRR immediately falls to 1. When today's children become parents, they will just replace themselves. In the coming generation, there will be four million elderly (the same as today's four million who are of childbearing age), eight million childbearing adults (the same as today's eight million children), and eight million children (born to the new adult population). The next generation's population will therefore be twenty million, up from fourteen million, despite a TFR that has been at the replacement rate during the entire generation! In the generation after that, the population will grow one more time. There will then be eight million elderly, eight million childbearing adults, and eight million children, or twenty-four million in all. From that point on, the population momentum is over, and the population will thereafter remain stable at twenty-four million. Population momentum by itself has therefore carried the original population from twelve million to twenty-four million, a doubling, even after the TFR fell to the replacement rate. The reason, simply, is that the original population had

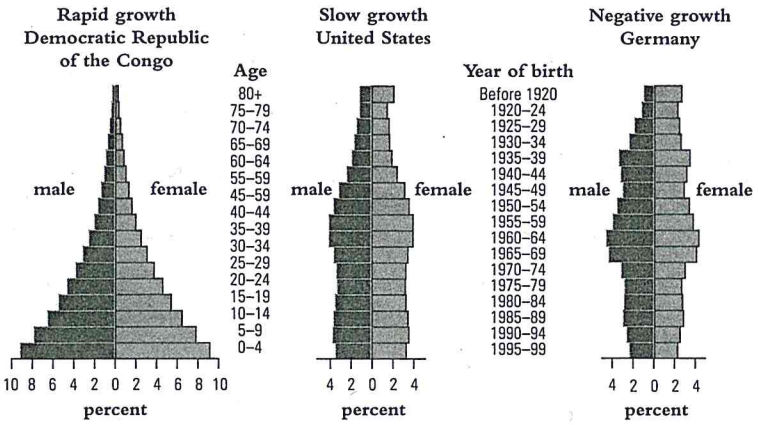
a massive youth bulge, which grew up to become childbearing adults and then the elderly.

This is our situation in the world today. We are at 6.6 billion people. If somehow, miraculously, the TFR were to fall today to the replacement rate, the world's population would still grow by approximately another one billion (depending on the precise assumptions made). We would end up with a planet of 7.5 billion. That's true even with the so-called baby bust in the more developed regions. In the coming decades, the momentum of population growth in the developing countries, with their very young population, will simply overwhelm any tendency to population decline in the high-income countries. This is why, in essence, we need to be working much harder to reduce the fertility rates in those regions, for their benefit and for the world's.

FERTILITY AND AGE STRUCTURE

The TFR largely determines not only the population growth rate but also the age structure of the population. When the TFR is high, say 5 or more, there will be a bulging number of youths relative to the number of adults. When the TFR is close to 2, the number of adults and childen will be similar (at least in the long term, after the population momentum has worked itself out). The population age structure is summarized by the so-called age-population pyramid, which shows the number of males and females in the population for each age cohort, usually designated in five-year intervals. The age-population pyramid for three types of countries is shown in Figure 7.5. On the horizontal axis is the number of males and females in each five-year age cohort as a percentage of the total population. On the vertical axis is the age category. In the Democratic Republic of the Congo (DRC), the TFR is around 6.7 and around one fifth of the children die in childhood. Each mother raises around four surviving children and, therefore, an average of slightly more than two daughters. The age-population pyramid has a broad base (children roughly twice as numerous as their parents) and a narrow peak (few people living to old age). In the United States, where the fertility rate is 2 and fewer than ten children per one thousand die before their fifth birthday, the age-population profile is more like a rectangle than a pyramid. The numbers of parents and children are similar. In Germany, where the TFR is only 1.4, below the replacement rate, there are fewer children than parents! The age-population

Figure 7.5: Three Patterns of Population Age Structure in 2000



Source: United Nations Population Division (1999)

profile resembles an inverted pyramid for the population born after 1959. This is characteristic of a population whose numbers will gradually decline in the future.

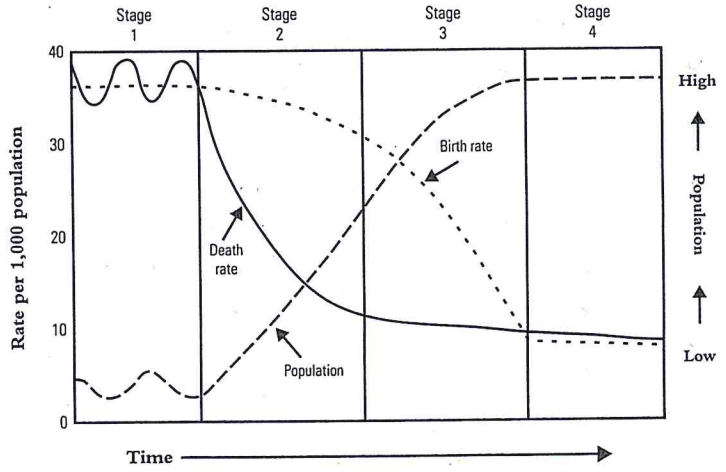
An age-population pyramid like that of the DRC has huge implications for national stability and global security, as we will see in the next chapter. Regions with bulging youth populations are less stable than those with older populations. There are too many young people for every adult. In particular, there are too many potential young male fighters, aged fifteen to thirty, for every more mature social elder and potential peacemaker. Young men, especially impoverished young men without reliable employment, are fodder for the nightmarish dreams of political manipulators. This is not to blame the poorest countries for their plight, or to fear them. It is to suggest to them, and to us, that reducing the TFR from very high levels is part of their own security and ours.

SPEEDING THE DEMOGRAPHIC TRANSITION

The world is not locked in a demographic straitjacket but is instead in a transition, albeit one that is stretched out over many decades and with large differences across regions. The core idea is known as the demographic transition, illustrated in Figure 7.6. A society begins with very high mortality rates (especially of young children) and very high fertility rates. The population is roughly stable because the high fertility rates are offset by high mortality rates. As an example, suppose that the TFR is 5, but three of five children never reach adulthood. Then the net reproduction rate would be 1, despite the high fertility. In the figure, note that the high fertility and mortality rates are shown not by the TFR and deaths per one thousand births, but by what demographers call the crude birth and death rates, measured as births and deaths per one thousand of total population.

According to the theory of the demographic transition, the child mortality rate declines ahead of the total fertility rate. For example, the spread of immunizations, improved food production, safer water supply, and availability of antimalarial medicines and antibiotics cuts the mortality rate from three out of five children to one out of five children (still extraordinarily high from the perspective of modern public health). This is illustrated in the figure by the fall in the crude death rate from forty per one thousand down to ten per one thousand. Only later, with a lag, does the total fertility rate come down commensurately. In the interim, labeled as Stage 2, the crude birth rate exceeds

Figure 7.6: Demographic Transition Model



Source: Haggett (1975)

the crude death rate by as much as thirty per one thousand, at the maximum gap. At that point, the population will be growing rapidly, indeed at 3 percent per annum. A population growth rate of 3 percent per annum leads to a doubling of the population in twenty-three years. Roughly speaking, a 3 percent annual growth rate corresponds with a net reproductive rate of around 2.

Let's take the case of Kenya during 2005–10 as an illustration. The under-five mortality rate has declined to 1 in 10 children (104 per 1,000 for the period 2005–10 in the UN Population Division projections). This corresponds to a crude death rate of 12 per 1,000. The total fertility rate remains high at 5, which translates to a crude birth rate of 39 per 1,000. The difference between the two, 39 minus 12, results in a net annual population increase of 27 per 1,000, or an annual growth rate of 2.7 percent per year. The net reproduction rate with a TFR of 5 and an under-five mortality rate of 104 per 1,000 is just a sliver under 2 (1.96).

The upshot of demographic transition theory is that the total fertility rate declines with a lag, leading to a massive onetime bulge of population as the society transitions from high fertility and high mortality to low fertility and low mortality. At both the start and the end of the transition, the overall population growth is low, but during the transition, the population soars. The world has been in that transition, claims the theory, for the past two hundred years. In fifty years' time, or earlier with good policies, the world will complete the transition and enter an era of population stability. Note that in Stage 4 of the transition, the birth rate dips below the death rate. This would be the case if the TFR remains below the replacement level. That is possible. In that case, the world's population would begin to decline after nearly three centuries of bulge. There is nothing in the laws of demographics that would prevent a gradual and voluntary decline in overall world population. A long-term decline of the European population has, perhaps, commenced.

One key question, which drives the policy judgments of the next chapter, is why the decline in fertility lags behind the decline in mortality, and what can and should be done about it. There are three kinds of answers, all contributing to a realistic picture. First, fertility choices are built into the culture. The age of marriage, the social expectations of the number of children a family should have, the beginning of the childbearing age, the use of contraception, the birth spacing, and the like, are cultural as well as economic choices. Societal norms and expectations play a role in determining the choices. Even when the fundamental determinants of fertility choice change—for example,

a steep drop in child mortality—the resulting change in actual fertility practices might take a generation or more.

Second, there can be a recognition lag, during which the parents are unsure that child mortality rates have really declined. The parents maintain high fertility rates just to be sure. Once the reduced mortality is firmly believed in, the fertility decline picks up speed. Third, and perhaps most important, there is nothing automatic about the transition of fertility following a decline of child mortality. Fertility choices represent the active decisions of households (including differing views and interests of fathers and mothers). The continuation of high fertility rates in the face of falling mortality rates might reflect a rational calculation by the parents, given the socioeconomic conditions of the household. When families live by subsistence farming and children provide labor and old-age security, and when the mother and daughters have few alternative means of livelihood, high fertility rates may be accepted as the preferred option for women, or at least the decision imposed on them by their husbands and the community. Moreover, contraception may be prohibitively costly for a family living at subsistence. Health care and family planning advice may be nowhere to be found.

Consider one more illustration. Suppose that children are the main old-age security for their parents, especially in the countryside. To ensure that old-age security, the household would like to ensure a surviving son with a very high probability, which we'll put at 97 percent for purposes of illustration. The household then chooses the number of children needed to ensure at least a 97 percent chance of a surviving son. If the probability of each child dying is one in five (20 percent), then having one son only won't be enough to ensure a 97 percent survival rate. The chance of a single son surviving is only 80 percent, not high enough for the parents' security. Having two sons is still not enough. The chance that both would die would be 20 percent multiplied by 20 percent, or 4 percent (if their survival probabilities are independent of each other). The chance of at least one surviving son would therefore be only 96 percent (equal to 100 percent minus 4 percent).

Having 3 sons would do it. The chance that all 3 would die before adulthood would be 20 percent times 20 percent times 20 percent, or 0.8 percent. There would be a 99.2 percent chance that at least *1* of the sons would survive. For families to have 3 sons, they would need, on average, to have 6 births, half girls and half boys. A child mortality rate of 20 percent (200 deaths per 1,000 births) would therefore induce a TFR of 6 in this illustration. The population