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WP 94-10
September 1994



Working Paper

Department of Agricultural, Resource, and Managerial Economics
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POPULATION: PAST GROWTH AND FUTURE CONTROL

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POPULATION: PAST GROWTH AND FUTURE CONTROL

by Thomas T. Poleman*

It is no coincidence that the American Declaration of Independence and Adam Smith's *The Wealth of Nations*, two of history's most liberating documents, were both published in 1776. The latter part of the 18th century was a time of great dynamism and change. The Industrial Revolution was sweeping Great Britain and the Continent, and political unrest was beginning. It was also a time of great intellectual ferment, as philosophers sought to explain and justify what was happening. Their works were much read and discussed, and the social condition to which it would all lead was much debated.

Robert Malthus' father, a friend of Jean-Jacques Rousseau and David Hume, was fond of such discussions and optimistic about mankind's future, and it has been suggested that the son's famous essay was in part an exercise in filial rebellion (Durant 1975:400). Published anonymously in 1798, the full title of the first edition was *An Essay on the Principle of Population, as It Affects the Future Improvement of Society, with Remarks on the Speculations of Mr. Godwin, M. Condorcet, and Other Writers* (Malthus 1798). William Godwin, now forgotten, was the most influential English philosopher of the day; a utopian anarchist, he looked forward to a future age of perfect equality and happiness. The Marquis de Condorcet's *Prospectus* advanced similar hopes for mankind's march to perfectibility (Durant 1967:894-97; Keynes 1933:116).

Not so, said Malthus: the dream of infinite social happiness would always be frustrated because population growth would everywhere tend to outpace expansion of the means of sustenance. After apologizing to the two authors whose optimism he challenged, he wrote (1798:11-16):

I think I may fairly make two postulata.

First, That food is necessary to the existence of man.

Second, That the passion between the sexes is necessary, and will remain nearly in its present state . . .

Assuming then, my postulata as granted, I say, that the power of population is indefinitely greater than the power in the earth to produce subsistence for man.

Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio. A slight acquaintance with numbers will shew the immensity of the first power as compared with the second.

By that law of our nature which makes food necessary to the life of man, the effects of these two unequal powers must be kept equal.

This implies a strong and constantly operating check on population from the difficulty of subsistence The race of plants, and the race of animals shrink under this great restrictive law. And the race of man cannot, by any efforts of reason, escape from it. Among plants and animals its effects are waste of seed, sickness, and premature death. Among mankind, misery and vice. The former, misery, is an absolutely necessary consequence of it. Vice is a highly probable consequence

This natural inequality of the two powers of population, and of production in the earth form[s] the great difficulty that to me appears insurmountable in the way to perfectibility in society.

The misery and vice to which Malthus referred were an outgrowth of the possible means of restraining population growth. These he classified under two groupings: positive checks, which had the effect of increasing

* Professor of International Food Economics, Cornell University. The figures were drawn by Lillian Thomas, to whom credit is also due for the paper's layout. The paper is the first chapter of a projected book on *The World's Food*.

the death rate, including such scourges as war, pestilence, and famine; and preventive checks, which operated to limit the birth rate. Among these were promiscuity, abortion, and other known methods of birth control, which fell under the category of vice. If a society wished to avoid the extreme agony of the positive checks, it had no recourse but to fall back on the lesser misery of the preventive checks.

In later editions of the *Essay*--there were a total of six--Malthus grappled with the question of how populations controlled their size and the argument expanded and became less tidy. But it was his original perception of the inevitability of a population outstripping its food supply that captured the world's attention and had so profound an immediate impact. Not only were the utopians thrown into disarray; on a more practical level, Parliamentary conservatives--reasoning that workingmen would respond to increased wages by marrying earlier, having more children, and thus restoring their original poverty--seized on Malthus to justify their opposition to liberalization of the Poor Laws, and subsequently to repeal of the Corn Laws.

But over the longer term his theories have stood up less well. It has been remarked that whereas Malthus' ideas were of great theoretical importance--in biology Darwin and Wallace were independently led to the principle of natural selection by his writings--they have not to date demonstrated the empirical validity he claimed for them. The experience of the past 200 years would seem to refute the basic Malthusian perceptions: population growth has proved amenable to control by means less unpleasant than misery and vice, and agriculture almost everywhere has thus far been able to expand output at a rate more rapid than the increase in population.

Malthus reasoned from a very scanty statistical base and limited historical perspective, and it is therefore not surprising that his expectations have not come to pass. When he spoke of four thousand years of "passion between the sexes" (1798:13) it is evident that he shared the foreshortened view of the earth's antiquity then prevalent; one presumes the good Reverend--Malthus had taken Holy Orders before turning to economics--was content to accept Bishop Ussher's dating of the Creation at 4004 BC. Regarding population, not until 1790 and the first American census was a political rationale established for regular decennial counts, and the systematic registry of births and deaths in Great Britain was not begun until 1837, three years after Malthus' death. For most parts of the world in 1798 one really had no idea whether populations were growing, contracting, or stagnating. The proposition that populations had the capacity to increase geometrically drew its sole empirical support from the belief that the population of the United States had doubled during the final quarter of the 18th century (1798:20).

No less tenuous was the evidence regarding the supply of food. The thesis that sustenance had the capability of increasing arithmetically derived from Malthus' speculation that England's food output "by great exertion" might be increased every 25 years by no more than what it produced in the base period (1798:22). Actual guidelines were utterly lacking. Any information bearing on production which might be gleaned from tax records was local, and though fluctuations in price bore witness to scarcity or bounty, this was equally parochial; only after the construction of canals, and then railroads, did truly national markets emerge in Europe. The first census of agriculture dates from ____ and not until the 1914-1918 war did the food balance sheet, the accounting technique used to estimate total supplies, come into use.

With such limited evidence to draw on, Malthus could hardly be expected to have foreseen the enormous agricultural advances which were to come. During the 19th century vast acreages were introduced to cultivation in the United States and Canada, and in much of South America, Australia, Africa, and Asia. The Punjab, the Indian subcontinent's great granary, was made arable by improved irrigation facilities, and the surplus rice-producing areas in Burma, Siam, and Indochina began to be more fully exploited.

Immediately succeeding this period of expansion in the geographical sense came a second agricultural breakthrough, the precursor of today's Green Revolution. Beginning about 1900 and concentrated in the industrialized countries, it involved the adoption of improved plant varieties and increased use of fertilizer, pesticides, mechanization, and other technical advances.

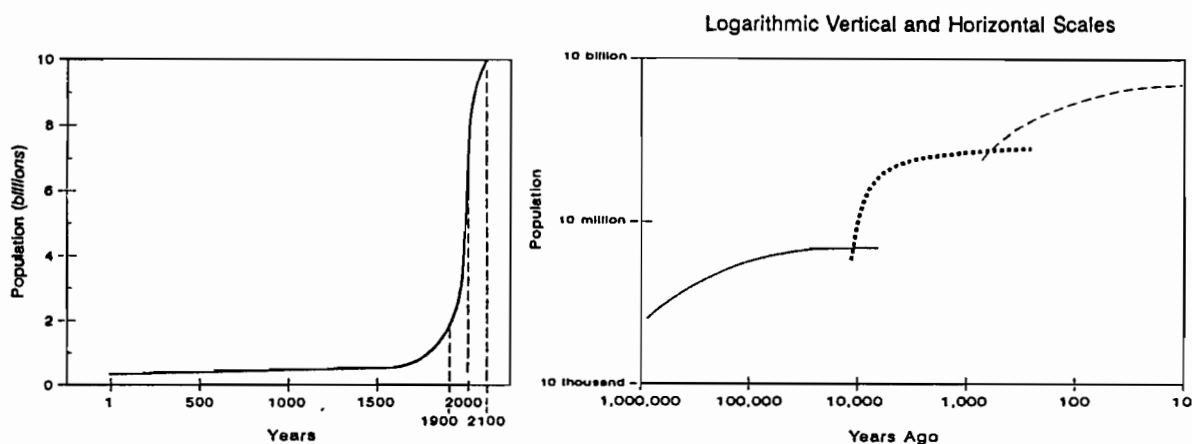
By the 1930s Malthus and his gloomy prognostications had largely been forgotten outside of the classroom. In the advanced countries concern was not so much with overpopulation as with underpopulation. European governments in particular pursued vigorous programs of population encouragement in order to enhance their political and military power. These included subsidies for larger families and during the early years of the Soviet Union and Nazi Germany, the awarding of medals to especially prolific mothers.

On the agricultural side, superabundance, not shortage, was the key problem. Coincident with the Great Depression, trade barriers rose increasingly between the industrialized countries, virtually all of whom were burdened with agricultural produce which could not be marketed at prices "equitable" to the farmer.

The Second World War was a major historical watershed. It not only brought on the rise of the United States and relegation of the European states to secondary status; it also laid the foundation for the emergence of the Third World, the great band of tropical countries in Africa, Latin America and Asia, plus the subtropical giants--China and India. Emergence of these countries has taken a number of forms: political independence, a growing voice on the world stage, and, most dramatically, an unprecedented increase in their population. It is this population "explosion" and concern whether the food supply can expand apace that triggered the current resurgence of Malthusian thinking.

An Overview of World Population Growth

The left-hand chart of Figure 1.1 is a familiar illustration. It shows that the world's population remained essentially stable from biblical times to about 1650, when it stood at perhaps .5 billion. It reached 1 billion by 1800 and by 1950 stood at 2.5 billion, two-thirds of whom lived in Third world countries. By 1990 the total had risen to 5.3 billion and the Third World's share to three-quarters. Predictions for 2100 put the total at between 10 and 12 billion, almost 90 percent of whom are expected to live in what are now the less-developed countries.



Adapted from Deevey, E. S. 1960. "The Human Population." *Scientific American*. September:198.

Figure 1.1. Two Views of World Population Growth

The chart is valid in that it drives home the magnitude of the current upsurge in population, but misleads in several important respects. The current upturn in population growth is not unique, and growth (and contraction) prior to 1750 took place not gradually but in bursts.

This is of fundamental importance and is perhaps most readily understood when visualized in terms of the right-hand chart of Figure 1.1, a deceptively simple graphing first conceived by E. S. Deevey (1960:198). This

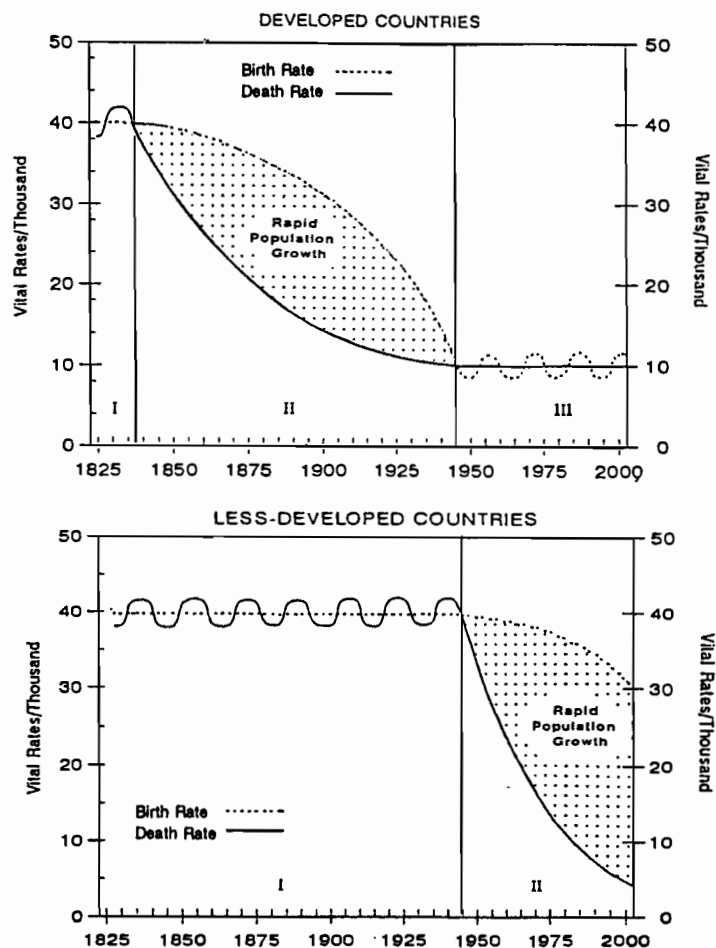
chart, which is plotted on logarithmic scales to make both time and numbers more manageable, strikes at the heart of Malthusian dogma. The present upsurge in numbers is not the first but the third in a sequence of bursts that have been associated with major breakthroughs in humanity's ability to cope with its environment. The first occurred several million years ago--Deevey plotted it at 1 million, although today he would no doubt move it back--and attended man's emergence from the primate line into a maker of tools able to hunt and gather over a range of conditions. The second marked his domestication of plants and animals some 10,000 years ago and the beginnings of agriculture, the "Neolithic Revolution."

These breakthroughs, of course, did not take place simultaneously around the world, but were staggered in their impact. Just as the industrial and scientific revolution occurred first in Europe, food gatherers and hunters first became agriculturists in the Fertile Crescent and Southeast Asia. Still the effect in a particular locality was rapid and profound. For example (Oliver and Fage 1968:26),

Twenty thousand people would probably be an extreme estimate of the population of hunter-gatherers the Egyptian section of the Nile valley could have supported at the end of palaeolithic times. The population of the Old Kingdom two thousand years later has been variously estimated at from three to six millions.

That such epochal technological breakthroughs would be accompanied by rapid population rises seems obvious. What is less obvious is the nature of the forces that ultimately acted to force a leveling off. Malthus' food supply, together with such other essentials as space, water, and air, clearly set an upper limit, but one wonders how frequently an operative one. The long-term population equilibria of the past would seem to have been at levels below those associated with marginal starvation. Thus, "a Paleolithic man who stuck to business should have found enough food on two square kilometers, instead of [the] 20 or 200" believed to have been available per capita, respectively, in the Upper and Lower Paleolithic ages (Deevey 1960: 198). And it is not weather but changed political circumstances that are most clearly linked to the great swings in China's population over the last two millennia (United Nations 1973:18).

The third and current population burst--associated with the industrial and scientific revolution and the spread of modern economic development--is commonly explained by demographers in terms of the demographic transition, first noted by Thompson in 1929 (1929:968-969) and illustrated in Figure 1.2. Prior to the transition (Phase I),



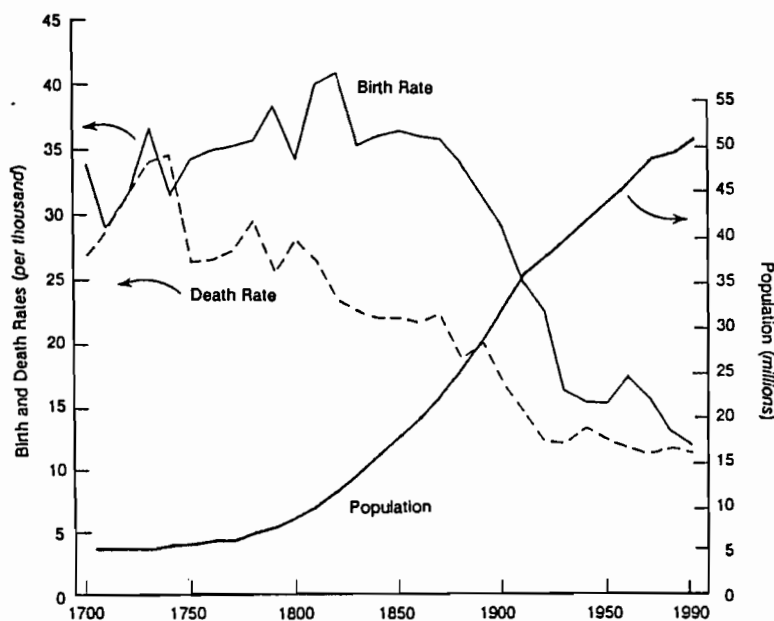
Rates and years are intended to be suggestive.

Figure 1.2. The Demographic Transition Schematized

the stability or near stability in the population of a traditional society reflects high birth and death rates offsetting each other. Then as the economy begins to develop, living levels rise, and public health conditions improve, life expectancy increases and the death rate drops. Births, however, remain at their old level (or rise briefly) and for a period the population soars (Phase II). Then the birth rate in its turn falls, and the population again approaches stability, but at a much higher level (Phase III).

Most of the industrialized nations have passed through this transition and have reached, if not stability, a condition approaching it. Most of today's developing countries, by contrast, did not enter the stage of declining death rates until about 1950. These countries are therefore still in the interval of maximum population growth and the ultimate size of their population will depend on the speed with which birth rates fall.

The demographic transition ranks among the "most sweeping and best documented" trends in recent history, its operation having been demonstrated in literally hundreds of investigations (Stolnitz 1964:20). The



Adapted from Weeks, J. R. 1992. Population: An Introduction to Concepts and Issues. Belmont: Wadsworth Publishing Co.:145.

Figure 1.3. The Demographic Transition in England, 1700-1990

Asia's Pacific Rim (Figure 1.4). In Singapore only 15 years was needed for it to fall from 40 per thousand to less than 20. The decline in Hong Kong has been equally dramatic, as has been the drop in China. Even *prior* to promulgation of China's one-child-per-family target in the late 1970s the rate had dropped within a decade to little over 20 per thousand.

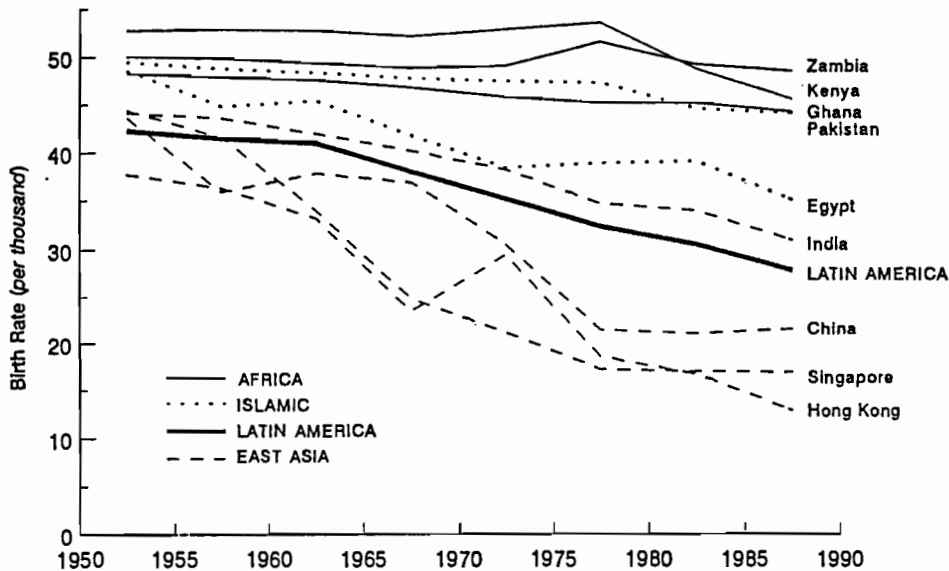
Less spectacular, but nonetheless steady has been the decline in Latin America. By the late 1980s the birth rate had fallen below 30 per thousand for the region as a whole, whereas it was half again as much 25 years earlier. The only true laggards are Sub-Saharan Africa and the Islamic countries of Western Asia and North Africa. In most of the Moslem countries the decline in births has been modest at best, while it is not an exaggeration to say that it has hardly begun to fall in the heart of Africa.

experience of England, one of the better documented European countries, is shown in Figure 1.3. There the transition required almost two centuries to run its course. The death rate began to drop during the latter half of the 18th century, coincident with the early stages of the Industrial Revolution and associated improvements in sanitation. A sustained drop in the birth rate did not set in until almost a hundred years later, and the two rates did not approach equality until almost 1950. During the 200 years of transition, England's population rose eight-fold--from 5 million to over 40 million. Similar "explosions" took place in the other industrializing countries of Europe and North America.

Enough time has passed for it to be evident that the transition need not be such a lengthy process in today's developing countries. Birth rates are dropping with unprecedented rapidity in the economically dynamic countries of

Hastening the Demographic Transition

The determinants of the speed with which the birth rate drops have been the subject of much research and speculation. Immediately following World War II, when the demographic transition had run its course in the industrialized countries, it was widely believed that fertility could quickly be reduced in the world's poorer regions if only women could be given access to modern contraceptive techniques (Davis 1967:730-731). That proved to be a simplistic and erroneous view, but one of remarkable durability. Even today it is frequently advanced and argued about (Robey *et al.* 1993).



Data from United Nations. 1993. *World Population Prospects: The 1992 Revision*. New York: Department for Economic and Social Information and Policy Analysis.

Figure 1.4. Birth Rate Declines in Selected Countries and Regions, 1950-55 to 1985-90

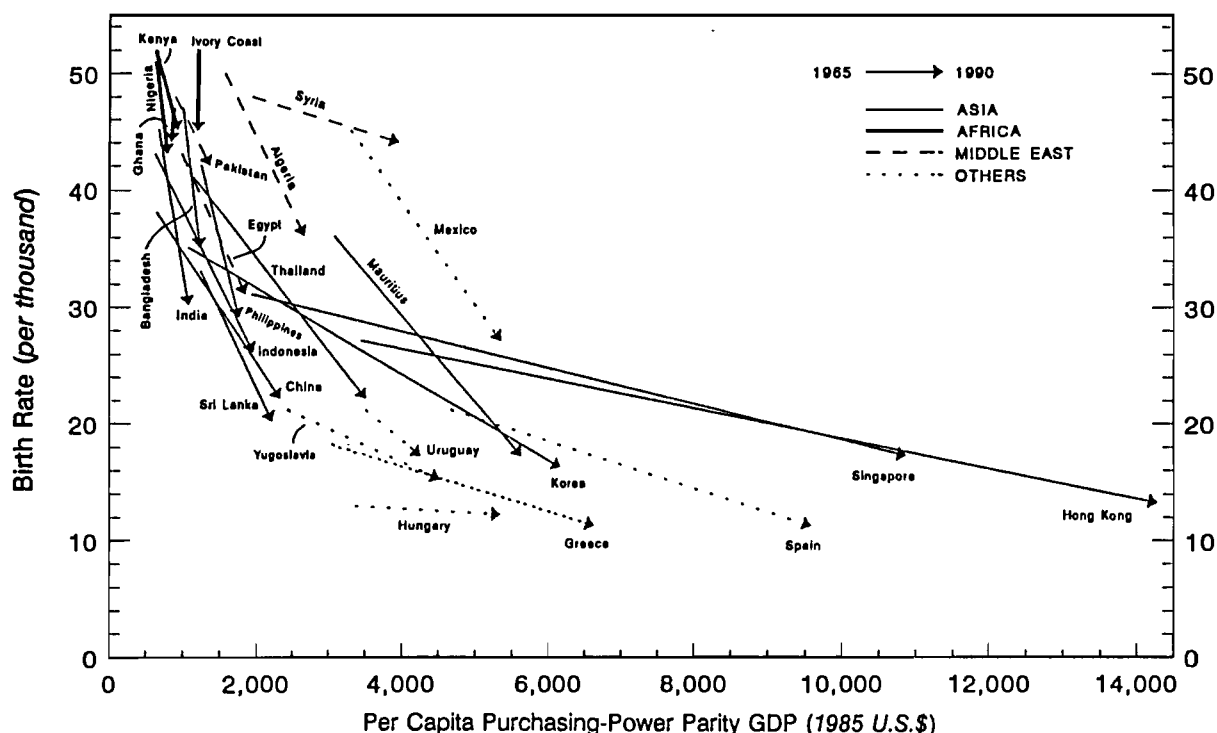
and clothe, they can be put to work at an early age; scaring birds away from fields of ripening grain is an age-old task for children, as is assuring that the family carabao does not wander too far from home or into the vegetable garden. As adults they become their parents' old-age insurance. With urbanization this changes. Children become expensive to educate and maintain, and the state or employer assumes responsibility for retirement income. The status of women and the educational opportunities afforded them are also modified by development. Education widens their access to roles outside the home and almost everywhere is the factor most strongly linked to reduced fertility (Pritchett 1994).

Operation of these development-induced preconditions to effective family planning would lead one to expect to find a strong correlation between declining fertility and the growth in a country's per capita income. Indeed such a correlation exists, but, as Figure 1.5 shows, it is not nearly as strong as might be expected. Anomalies abound and it is these which help make demographic forecasting the perilous exercise it is.

Who, for instance, could have foreseen the diverging demographic paths followed by Britain and France during the 19th century? Both ended the century with populations of about 50 million, but while for France this was double the 25 million of 1800, for Britain, which entered the century with a bit more than 10 million, it represented almost a five-fold increase. The divergence is most commonly explained in terms of urbanization and relationships to the land. Enclosure of the agricultural commons in the late 18th century virtually destroyed the British peasantry, and they had no alternative but to seek new opportunities either in town or the colonies overseas. Landholdings remained intact because of primogeniture, whereby the eldest son inherited. In France the Revolution eliminated the aristocracy and caused land to be divided fairly equitably among the peasants.

A more effective approach involves influencing the various factors which underlie a family's decision to have fewer children. A decline in the rate of child mortality is clearly one of these; as this falls couples soon realize that they need no longer plan on several live births to feel reasonably assured that one child will reach maturity. Additionally, the normal course of economic development is linked to a decline in the attractiveness of large families. In a traditional rural society children are economic assets. Cheap to feed

Inheritance was equal to all children, so it quickly became apparent that large families would produce poverty, especially since urbanization lagged and few French considered going overseas. That these factors rather than cultural considerations triggered the rapid drop in the birth rate in France is attested to by the fact that those



Data from World Bank. 1992. *World Development Report 1992*. New York: Oxford Univ. Press:270-271. Penn World Table (Mark 5.5). 1993. Annex to Summers, Robert and A. Heston. 1991. "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988." *Quarterly Journal of Economics*. May.

Figure 1.5. Relationship Between Birth Rate and Per Capita GDP, 1965 and 1990

French who migrated to Quebec, where land was plentiful and labor scarce, continued to have very large families (Kleinman 1980:180-183).

Another, more recent, example of the secondary importance economic status can play in reducing fertility comes from India. Kerala, situated along the Malabar Coast near the country's southern tip, has one of the lowest per capita income figures of any state in India, but also the lowest birth rate: 19.8 per thousand in 1989, compared with 30.5 for the country as a whole (Premi 1991:23-34). The explanation is to be found in Kerala's unique make-up. It is neither urban nor rural, but largely suburban, with an extensive network of roads and a high degree of social and economic mobility. It enjoys the highest literacy rate in the country and accessible health services. Women are relatively well educated and active in the community. Infant mortality is the lowest in the country. The Catholic church has been a presence in Kerala for 500 years and the electorate regularly returns a Marxist government. Alas, Kerala is not India (Mahadevan and Sumangala 1987).

Recognition that nonmonetary factors can play a role in expediting the demographic transition has led to active government involvement in a number of countries. Noteworthy among these is Singapore. When Singapore became independent in 1963 it was as a state within the newly formed country of Malaysia, an agglomeration of former British dependencies. Within two years it was ejected; because three-quarters of Singapore's population was Chinese, Malay politicians feared the Chinese might come to dominate the country politically as well as economically. Confronted with the prospect of supporting a population of almost 2 million, double that of 20 years previously, on an island only 210 square miles (544 square km) in size, the government

of Prime Minister Lee Kuan Yew launched a "stop-at-two" campaign. Abortions were legalized, tax relief and other benefits were cut for families with more than two children, and--perhaps most important in a rapidly changing economy where almost all new housing is controlled by government--large families were dropped to the bottom of the waiting list for accommodation (Wookey 1977).

It worked. By 1975 the birth rate had been cut to 17.8 per thousand, less than half the level recorded in 1960 (United Nations various years). In fact it worked too well. The group which experienced the most rapid decline in fertility was made up of university-trained Chinese women, whom the government was counting on to raise a new generation of skilled workers and technocrats, and subsequent efforts to persuade them to reproduce more abundantly have bordered on the comical. Lee Kuan Yew openly embraced eugenics. A government agency was established to bring suitable young graduates together, even to the point of sponsoring "love boat" evening cruises to nowhere. Working mothers who had performed above certain levels in tests given all students were permitted to deduct from their taxes a percentage of their income per child, the more children the higher the percentage. Poorer achievers were offered incentives to be sterilized (Kulkarni 1984).

One would be tempted to argue that such programs could be successfully implemented only in a small, tightly controlled city-state. But the Chinese experience indicates they are possible within a much larger country. Between the 1960s and late 1970s China underwent the most rapid fertility decline yet experienced by a developing country: from over 40 per thousand to about 20. The total fertility rate--the number of children an average woman will bear during her lifetime; 2.1 is the replacement rate--fell from over 6 to less than 3 (Sherris 1985:J-746).

These declines took place prior to the impressive economic gains triggered in 1978 by Deng Xiaoping's liberalization of the market. They also predated improvements in most social indicators. Literacy and educational levels remained low, and the bulk of the population continued to reside in the countryside. Health conditions had, however, much improved. Between 1960 and 1982 the infant mortality rate dropped from 165 to 67 per thousand live births, and life expectancy increased from 41 to 67 years (Sherris 1985:J-747).

A second cause of the birth rate drop appears to have been the "later, longer, fewer" campaign initiated in 1971. This urged later marriages (not before age 28 for men, 25 for women), longer intervals between births (at least three years), and fewer children (no more than two or three). Contraceptive and abortion services were made widely available through the primary health care program. By the time the one-child target was introduced in 1979 the battle to cut the birth rate had largely been won (Sherris 1985:J-747). The achievements of this later effort have been mixed and controversial. In urban areas where social pressure and the program's incentives--priority in schooling, housing, and employment to families with only one child--can operate, it has met with some success. In rural areas, where the appeal of larger families remains strong, results are less positive. There are also disquieting reports of widespread female infanticide and the use of ultrasound scans to determine the sex of fetuses, followed by abortion of girls. The sex ratio in China of newborns in 1992 was reportedly 118.5 boys for every 100 girls (Morgan 1988; Kristof 1993).

If the results of governmental efforts to reduce the birth rate can be mixed, they are usually positive; but on occasion they can be counterproductive. The classic example of misguided intervention took place in India during the "Emergency" declared by Prime Minister Indira Gandhi in 1976. The fertility decline in India has so far been moderate, perhaps because infant mortality remains high. The official family planning program dates from 1952 and over the years has given emphasis to the techniques of contraception, including sterilization. The Emergency was Mrs. Gandhi's response to an economic crisis caused by lagging food production and rising petroleum prices. Civil liberties were suspended, the press censored, and many arrested. Family planning in the form of sterilization was made a key element of the government's revitalization program at the behest of the Prime Minister's impetuous son, Sanjay.

Coercion inevitably played a role in attempts by state and local officials to meet the sterilization targets imposed by the central government. To achieve the 8 million sterilizations reportedly performed, quotas were divided among organizations and passed down the line. Customers for subsidized food at some "fair price" shops were given to understand that their needs could be met only if they showed proof of sterilization; not a few ticketless travelers found themselves unable to proceed (on the roofs of passenger trains) until they agreed to undergo a vasectomy; and many workers were given the choice of sterilization and continued employment or no job at all. Resentment against such ploys played a part in Mrs. Gandhi's rejection by the voters the following

year and the Janata Party government which succeeded her put an end to the experiment (Gwatkin 1970; Visaria and Visaria 1981:35-40).

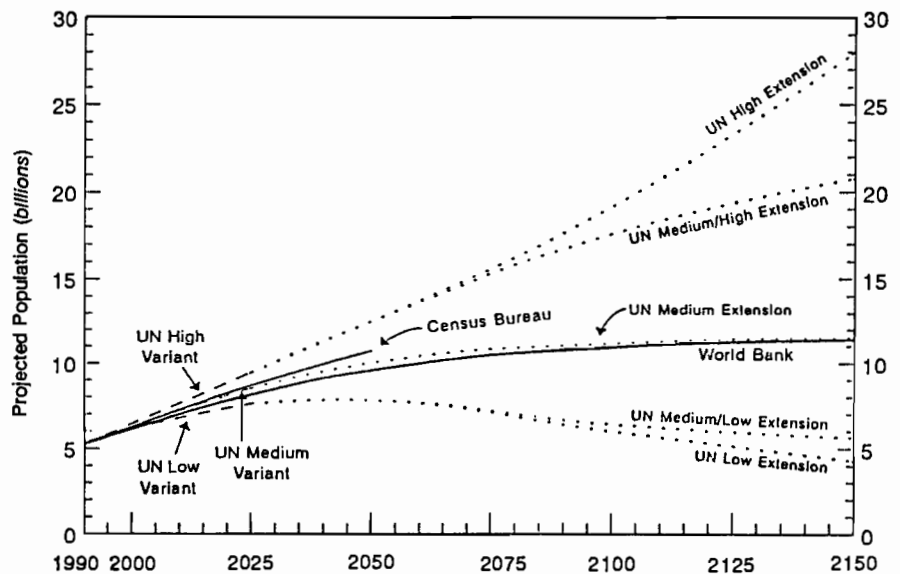
Future Population Growth

Because the course of demographic change is subject to so many influences, forecasting future growth involves more than simply extrapolating past trends in births and deaths. What is the level of infant mortality, of literacy, of education? Does the government have an effective family planning policy? What is the status of women? Along with these must be weighed the prospects for economic change, urbanization, and migration. The last mentioned is especially difficult to foresee and its impact on future population growth can be great. In 1989 the Bureau of the Census projected a population of 300 million for the United States in 2050. Four years later, in 1992, the figure was raised to 383 million. Changes in anticipated immigration, much of it illegal, accounted for most of the increase (Harper 1992).

In the circumstances about all the forecaster can do is to project a range, note the assumptions underlying the several variants, and caution the user that small differences in assumptions can produce mighty differences in results, especially if one has the temerity to project more than a few decades beyond the base period. As the authors of the United Nations' long-range projection prepared in 1992 put it (1992:34):

Perhaps the major conclusion . . . is that there is a wide range of uncertainty regarding the future size of the world population. The medium/high and medium/low extensions, which differ by only 10 percent in assumed ultimate fertility levels (a total fertility rate of 2.17 compared to 1.96), result in projected populations in the year 2150 of 5.6 billion and 20.8 billion, respectively. At the level of the individual couple . . . it is probably just as reasonable to assume that the average [family size] might be 1.96 or 2.17 children.

Figure 1.6 illustrates this problem graphically. Plotted are the long-term global projections of three of the principal agencies which engage in this activity: the Population Division of the United Nations Secretariat, the World Bank, and the U.S. Bureau of the Census. The World Bank and the Census Bureau publish only their middle projection, or medium-fertility variant, the one employing the set of assumptions considered "most likely." For the United Nations, the low-, medium-, and high-fertility variants are shown through 2025; thereafter five series are plotted. The medium extension continues the medium variant of the original projection. The medium/low and low fertility extensions carry forward the low variant; the medium/high and high extensions the high variant.



Census Bureau medium fertility variant from: Urban, Francis and Ray Nightingale. 1993. *World Population by Country and Region, 1950-90 and Projections to 2050*. Washington: U.S. Department of Agriculture, Economic Research Service, p.42.

World Bank projection from: Bos, Eduard et al. 1994. *World Population Projections, 1994-95 Edition*. Baltimore: Johns Hopkins for the World Bank, pp. 60-61. United Nations projections from: United Nations. 1991. *World Population Prospects, 1990*. New York: Department of International Economic and Social Affairs, pp. 226-227; and: United Nations. 1992. *Long-range World Population Projections: Two Centuries of Population Growth, 1950-2150*. New York: Department of International Economic and Social Affairs, p. 28.

Figure 1.6. Selected World Population Projections, 1990-2150

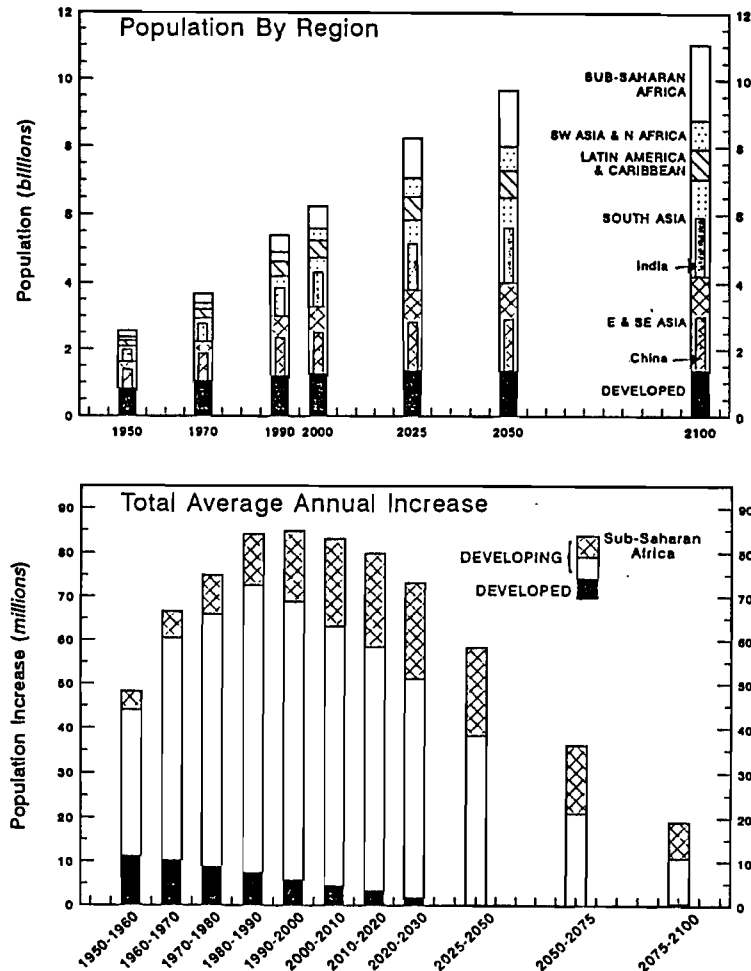
Several things are immediately apparent. The medium variants of all three projections are quite similar through 2025, and track one another closely as the figures are pushed into the far term. One presumes that,

when confronted with the unknown, demographers, being human, take comfort in each other's company. In fact, though, as the various United Nations extensions show, the projections begin to take on lives of their own after 30 or 40 years. By then a majority of a population will have been added since a projection's starting point and assumptions about their behavior will be largely conjecture. Further, the inputs to cohort-component projections become ever more arbitrary; not only is the level of fertility guesswork, so is the number of women of childbearing age. Only the foolhardy would deny the possibility of any of the wildly differing forecasts for 2150 coming to pass. There could by then be as few as 4.3 billion people on earth or as many as 28 billion.

For the more immediate future, of course, the problems are less severe, and it is possible to draw a number of conclusions about expected population growth with some certitude. These are illustrated in the two panels of Figure 1.7, derived from Census Bureau data and the medium-fertility variant projected by the World Bank. The first, not surprisingly, is the extent to which future increases in numbers will be concentrated in the developing countries. The demographic transition has long since been completed in the industrialized world, and in not a few European countries populations are declining. Birth rates continue to fluctuate, however, and it is quite possible that something akin to the "baby boom" of the years immediately following the Second World War will from time to time be repeated. But the impact of such boomlets on global numbers will pale in comparison to what happens in the poorer countries.

In these countries, declining fertility notwithstanding, the annual increase in population will remain in the neighborhood of 75-80 million until about 2020-2025. This reflects the momentum created by an abnormally large share of the population being in their reproductive years. Once this bulge has worked its way through the age structure, absolute increases are expected to fall. By 2050, when global numbers are projected to total between 9 and 11 billion, growth will be nominal; the medium variants look to only a billion or so more people being added during the last half of the century. The greatest challenges presented by future population growth will thus arise during the next 50 years.

A final conclusion concerns the role Sub-Saharan Africa will play in the course of future population growth, a role which adds a particularly powerful caveat to projections for the years beyond 2025. The demographic transition is still in its early stages in most African countries: death rates began to fall in the 1950s, but the parallel decline in fertility has barely begun. Infant mortality remains the highest in the world; by 1990 it had fallen below 100 per thousand in only a minority of countries. The outlook therefore is for population growth to continue in Africa well after it has been contained elsewhere. The medium-variant projections suggest



Data from Urban, Francis and Ray Nightingale. 1993. *World Population by Country and Region and Projections to 2050*. Washington: U.S. Department of Agriculture, Economic Research Service; and Bos, Eduard et al. 1994. *World Population Projections, 1994-95 Edition*. Baltimore: Johns Hopkins for the World Bank.

Figure 1.7. World Population: 1950-Projected 2100, By Region, and Average Annual Increase in Numbers

that after 2025 between a third and a half of global population growth will be concentrated in Sub-Saharan Africa.

Whether this will in fact come to pass is very much an open question. Africa is a demographer's nightmare. Actual population sizes and vital rates are not known with any certainty. It is known, for example, that Nigeria is Africa's most populous country, but by how much is almost anybody's guess. Censuses in Nigeria have been politicized, with Christians and animists in the south vying with the Muslim north for political representation and a "proper" share of petroleum revenues. Conducting an accurate count has been almost impossible, and the censuses taken in 1962, 1963, and 1973 were rejected by one party or another as fraudulent. The November 1991 census, however, is thought to have been reasonably reliable. Prior to it demographers seemed to agree that Nigeria had \pm 120 million inhabitants. The census found 88.5 million (Miller 1992:A24).

Adding to the uncertain demographic outlook for Africa is the AIDS epidemic raging in the eastern and southern parts of the continent. Because AIDS is heterosexually transmitted in Africa and most Africans lack access to preventative measures or medical facilities, some observers fear that its impact on population growth will become increasingly pronounced. Indeed, one expert, while acknowledging the "bewildering array of possible outcomes," goes so far as to predict that by 2010 in such badly afflicted countries as Uganda population trends may switch from their present high rate of growth to an actual decrease in numbers (Anderson *et al.* 1991:588; Perlez 1992:A8).

Regional Prospects

If population growth follows the path delineated by the medium-variant projections and stabilizes between 10 and 12 billion toward the end of the 21st century, between 85 and 90 percent of the world's population will reside in what are now the developing countries. Today's developed countries will grow hardly at all and their contribution will fall from about a quarter to little over 10 percent of the global total (Table 1.1).

Asia will continue to be the most populous continent, with about double its present population, and East/Southeast Asia and South Asia will each harbor about a quarter of mankind, between 2.5 and 3 billion. China and India will remain the most populous countries. The populations of both are expected to level out in the neighborhood of 1.6-1.8 billion, with India possibly succeeding to the title of most populous country.

In both Latin America and the Islamic belt of countries of North Africa and the Middle East populations are projected to stabilize somewhat below the billion mark. For Latin America this would represent a doubling of the figure for 1990, but more than a threefold increase for the Muslim countries. The rate of growth for the latter area is projected to be second only to that of Sub-Saharan Africa, considerably above what might be expected from the region's income per capita. The literature is surprisingly silent on the reasons for this, but tenants of the Muslim faith doubtless play a role, particularly regarding women's place in society.

The great unknown, to repeat, is Sub-Saharan Africa. If the medium-variant projections come to pass, the region's population will not stabilize until it reaches about 2.3 billion, four and a half times its 1990 level.

If such numbers give weight to the pessimism of modern-day Malthusians, they tell only part of the story. The demand for agricultural products reflects not just the number of mouths that must be fed, but also the type of diet they will be able to afford. Rising incomes and dietary change are likely to pose an equal if not greater challenge to agriculture in the future than population growth.

Table 1.1. World Population: Actual 1950 and 1990 and World Bank Medium-Variant Projections to 2100, by Region

(millions)

	1950	1990	2000	2025	2050	2100
WORLD - TOTAL	2,555 (100)	5,266 (100)	6,114 (100)	8,121 (100)	9,578 (100)	10,958 (100)
Developed - Total	832 (32)	1,214 (23)	1,273 (21)	1,364 (17)	1,367 (14)	1,378 (12)
Developing - Total	1,723 (67)	4,051 (77)	4,842 (79)	6,762 (83)	8,219 (86)	9,589 (88)
East & Southeast Asia	787 (31)	1,788 (34)	2,009 (33)	2,430 (30)	2,644 (28)	2,824 (26)
South Asia	472 (18)	1,186 (22)	1,444 (24)	2,038 (25)	2,484 (26)	2,847 (26)
SW Asia & North Africa	112 (4)	273 (5)	347 (6)	546 (7)	708 (7)	859 (7)
Sub-Saharan Africa	183 (7)	487 (9)	647 (11)	1,170 (14)	1,671 (17)	2,257 (21)
Latin America	166 (6)	435 (8)	512 (8)	686 (8)	804 (8)	883 (8)

Data from Urban, Francis and Ray Nightingale. 1993. *World Population by Country and Region and Projections to 2050*. Washington: U.S. Department of Agriculture, Economic Research Service; and Bos, Eduard *et al.* 1994. *World Population Projections, 1994-95 Edition*. Baltimore: Johns Hopkins for the World Bank. "Developed" countries are made up of Europe, the former USSR, United States, Canada, Australia, New Zealand, and Japan. Figures in parentheses are percentages of total.

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