POPULATION AND EMPLOYMENT
IN CHINA

Nathan Keyfitz

February 1982
WP-82-14

THE AUTHOR

Nathan Keyfitz, Professor of Sociology at Harvard University, is a member of
the U.S. National Academy of Sciences and the author of a number of books on
mathematical demography, among them *Introduction to the Mathematics of Population* and *Applied Mathematical Demography*.

FOREWORD

One-fourth of the world's population lives in China. The future of global population growth, therefore, is inextricably linked with that of the People's Republic. Yet our knowledge and understanding of that nation's demography is remarkably inadequate.

Nathan Keyfitz spent January 1 - 22, 1982 in the People's Republic of China as part of a distinguished scholar exchange program. He had a nearly unrestricted opportunity to visit factories, hospitals, and other institutions and to meet peasants in Hebei and Sichuan Provinces. On the basis of tape recordings of interviews with village officials and with villagers on questions of production as well as on population control, he has written this report. It outlines in crisp detail how China's population factor is embedded in a number of social, political, and economic issues.

Andrei Rogers
Chairman
Human Settlements
and Services Area

ACKNOWLEDGMENTS

ABSTRACT

China's effectiveness in population control can be credited to the direct line of command through party and administrative cadres that extends from the leadership in Beijing down to the production team in a distant rural commune. The reason that the administrative machine has devoted so much attention to population control is twofold: the perceived limits of the natural environment, as indicated by slowness of growth of food supplies, and the difficulty of arranging productive employment for the large cohorts of the 1960s. The employment problem is intensified by mechanization in the countryside, and applies especially to the increasing numbers of middle-school graduates. Raising the capital that would employ the new entrants into the labor force productively involves undesired commitments for repayment if money is borrowed abroad and risks political tension if the exactions from the rural population go beyond a certain point. Among other potential sources of division is the ambition of the young generation to get ahead with work and careers, and their fear that too many of the limited number of places are being held by the old. The one-child family now being promoted would avoid repeating about the turn of the century the pressures to find jobs now being experienced. On the other hand it would make for a very awkward age distribution as the births of the 1960s appear as claimants for old age secruity about 2040.

CONTENTS

POPULATION AND EMPLOYMENT IN CHINA

Drastic changes have taken place in China during the 6 years since the death of Mao and the removal from power of the "gang-of-four." While equality is still important, such inequality as results from higher education and the needs of advanced technology is increasingly accepted. Sending young people to the fields for several years is no longer seen as an answer to any problem, and those who were compelled to work as farm hands during the cultural revolution, necessarily at the cost of their education, blame their lack of subsequent progress on that gap in their studies. The notion that Communism can cope with any population however large has been dropped, and now one hears rather that resources of food, water,and capital are limited and that people added to the population by the high births of the 1960s will not easily be able to produce their subsistence. We will see how the population question is embedded in a number of social, political, and economic issues.

"SELF-RELIANCE"

The rapid growth of population during the 1960s and early 1970s seems to underly not only the sharp measures of population control but also the policy of "self-reliance" that is the current watchword. Detailed central planning for the productive employment of a labor force of 600 million, growing by a net increase of as much as 20 million in a single year, has effectively been abandoned. Some central planning will continue, but it will make no pretense of covering every enterprise. This delegation of planning downward, to provinces, communes, and smaller regions, is justified above all by the need to make jobs, jobs that will raise the standard of living. It is conceded that the central planning of the USSR indeed maintains full employment, but the production of needed goods in China requires more thought and planning than the central government considers itself capable of.

Now that the delirium of the cultural revolution is past, Chinese leaders and their public understand the close relation between population and economic advance in a country whose population has probably passed the billion mark and whose area is equal to that of the United States. Unlike the United States, 90 per cent of China is mountain or desert, not good for agriculture or much of anything else. The relation of population to progress shows up as an ecological upset with intermittent famine in the Sahel, as premature urbanization in Latin America. In China this relation shows itself especially clearly as an employment problem, now that the high births of the early 1960s are appearing as young people needing jobs. Committed to full employment of the young people leaving school each year, the central government can only fulfill this responsibility by giving relative freedom to local groups, to provinces, municipalities, communes, and so on down to the production team--a part of a village containing perhaps 50 families.

The self-reliance policy is applied at all levels: between China and foreign countries (restraint in incurring indebtedness to American and European banks); between the different levels of government, with each level distancing itself from claims against it by lower levels; between individuals, who are given a certain freedom of action and urged to be responsible for themselves as far as they can. This displacement of responsibility downward may well be the only policy that fits the size of the population, and the fact that every smallest resource must be cultivated if people are not to starve. It is hard to visualize the collection of night soil bureaucratized and made part of a central plan.

If devolution of responsibility is the right policy for agriculture, for cottage industry making flour and other food products, brick-making, house construction, and clothing; it is less certain that it is right for heavy industry. In the present phase where the authorities emphasize light industry and where per

capita income is on the order of $450 per year, self-reliance fits well. The question is what happens at a later stage, when automobiles take the place of bicycles, and trucks displace handcarts. Small-scale manufacture of heavy equipment can be wasteful of capital, materials, and labor.

Population growth and the resultant employment problem is only part of what has moved the state to pass power downward. The other part is the need for income of governments at all levels. Insofar as individual salaries are set by law it is not necessary to tax individuals. Redistribution is accomplished by suitably fixing wages and prices. The levies that provide the funds for any level of government are assessed on the productive unit. Hence what every government wants under its auspices is productive units. Any new enterprise that makes a profit will to that degree help the financial balance of the government that sponsored it and contribute funds to aid further new enterprise.

My interviews in communes and production brigades show that those concerned have in mind two kinds of bookkeeping for each political unit--a financial balance in which there are enough taxable profits to maintain the administrative, police, health, educational, and other services with which the unit is charged, and a population balance in which the labor employed is equal to the labor available.

The labor available is increasing rapidly as those born in the 1960s mature, and at the same time the need for labor in the fields is gradually being reduced by mechanization. Ploughs that one walks behind, like our roto-tillers, are coming into use. Trucks are increasingly available for transport, in place of the shoulder-yoke. It is true that some of the vehicles look home-made, and they would not win prizes for reliability, but they still cut the manpower used in transport by a large factor. Cultivation has always been intensive, but now seed-varieties that can benefit from fertilizer, along with supplies of synthetic fertil-

izer, are further increasing the crop. Thus food output, while not as great as desired,* is by and large able to keep up with natural increase; but the prospect is that it will not require a proportional increase of labor.

INITIATIVE FOR CREATING PRODUCTIVE EMPLOYMENT

As things stand there is little tendency to put people to work just for the sake of keeping them busy. China resembles our private enterprise system, at least in that if workers cannot produce saleable objects there is no source from which the money to pay them can be taken. I heard no expression of the illusion that putting people on the payroll and printing the money to pay them will accomplish anything worthwhile.

If a comrade wants to start a brick plant in the village, he will have to persuade some authority--perhaps the Brigade Committee--to advance the cost of the kiln. He may secure working capital from the local bank. He can then go ahead and hire labor, build the kiln, and sell the product to his neighbors or to distant customers that his salesmen turn up. Because the regime is not yet aware of the advantages of intermediaries there is a lack of wholesalers and shippers; whether present trends towards devolution will go so far as to accept private trade is yet to be seen.

The brick plant is owned by the Committee or other authority under which it was established and the material compensation of the entrepreneur is limited to his salary, but he has much other compensation. As a manager he becomes an important man in the community; he gives jobs to his friends and relatives; he can sell the product at a discount to his neighbors. These are powerful incentives.

---

*One official statement had it that 10 percent of the population is underfed (A. Doak Barnett, China's Economy in Global Perspective, Washington, D.C. 1981. The Brookings Institution, p.305)

Of course there are constraints of a kind that do not limit the American entrepreneur. The business is a public one, and has to meet standards of propriety. An employee cannot simply be dismissed. If a mistake has been made in hiring, and the person is incapable of doing the job, then the manager will have to find a job for him that he can do. If the employee is unwilling to work, then he must be spoken to. The Chinese express an almost infinite faith that any kind of delinquency may be handled by showing the person the error of his ways, and they have enormous patience in dealing with delinquents. Correction rather than punishment is always the object; Americans often talk this way, but the Chinese believe it. Workers are essentially good, capable, and industrious, and it is the task of the manager to bring out this goodness.

Though job security is precious the present labor surplus has forced many young people into what is called provisional employment, often far below their qualifications. A middle-school graduate may operate a sewing machine in a clothing factory, until something in the administrative service opens up. The expansion of the educational system above all has made the employment problem especially acute for middle-school graduates--not yet a crisis but capable of becoming one. Expansion of the central bureaucracy has gone further than anyone thinks desirable, and so the facile creation of white collar adminstrative jobs is hardly the answer.

AXES OF POTENTIAL CONFLICT

Built into a system that is designed for harmony are a number of axes of potential cleavage. The cultural revolution attacked particularly the advantages of the better educated and urban dwellers. Mao Zedong preferred barely controlled chaos to a stable system in which a class of office holders would establish themselves forever. Given that 80 percent of China still gains its living in the countryside the potential for some later movement with aims similar to the

cultural revolution cannot be dismissed. For the moment this danger is diminished by the increased prices offered in the state food collection centers, and by the free markets to which peasants can bring produce for sale on their personal account. A limit is set by taxes on such individual incomes, but nonetheless many a peasant lives better than some senior bureaucrats. A television set in a rural home is still exceptional, though I did see some, based on the sale of produce on nearby free city markets.

For the moment the distant peasants are disadvantaged, since the lack of middlemen means that they cannot have access to city markets. On the average rural incomes are a small fraction of city incomes. Yet as long as the variation in income among neighbors is held down there is less ground for discontent. The authorities hope to be able to tackle the differentials among regions in due course.

The division between young and old is a more immediate trouble, and the regime has recently required the resignation of certain senior officials, a measure that symbolizes its sympathy for the young who see their promotion as blocked.

Beyond all this, of course, is the people versus their leaders if present policies do not produce an increasing supply of goods.

In the context of the limitations of nature and the various potential sources of conflict, birth control emerges naturally. If births are reduced to half of what they were at the peak, I heard it said, then 15 or 20 years from now there will be half as many job-seekers, less resort to submarginal land, less tendency to overcrowd the cities or pressure to make jobs in the bureaucracy. These are not exactly the arguments that one reads in the professional western demographic literature, but they correspond to the immediate visual impression that masses of people make on the Chinese.

THE FOUR MODERNIZATIONS

The acquisition of modern technology from the west (in contrast to the Maoist tenet that the masses can improvise everything needed) has become a major instrument of economic progress. In agriculture, industry, science, and the military, the aim is to import whatever knowledge is necessary--both by sending Chinese students abroad and by having foreigners come to China. The policy is associated with Deng Xiaopeng, and no one can be sure how it will be modified when he passes off the scene. Even at the present time financial constraints have caused cancellation of some ambitious plans to import whole factories, and the policy now is to construct factories with domestic resources, buying abroad only indispensable machinery that cannot be made in China.

The modernization program has tempered self-reliance by some borrowing from foreign governments, banks, and suppliers. One agreement with France in 1978 provides for $6.8 billion in long-term credits over 10 years. Another with a consortium of seven British banks in the same year provides for a loan of $1.2 billion. In 1979 Japan agreed to lend $2 billion, and the same amount was provided by the Export-Import Bank of the United States. As far as possible China's transactions take the form of barter; thus Japan is to develop oil resources in Bohai Bay and will take part of the oil that results. Fear of indebtedness has roots in Chinese history of the past century as well as in observation of contemporary borrowing countries.

Mao's view that China's masses could accomplish every task by their sheer numbers did not lead to emphasis on birth control. It is especially in the context of the four modernizations that family planning fits as a necessary part. On the one hand the introduction of machinery seems wrong and will be resented by the people displaced if they are so numerous that employment cannot be found for all of them. On the other hand the existence of a large, and especially of a grow-

ing population, will require schools and many other facilities, whose provision
will reduce the resources available for capital investment in new fields.

POPULATION AND ITS PROSPECTIVE GROWTH

Pending the Census to be taken in June of 1982 all statements of China's
population and its rate of growth have to be provisional. If we start with the
official figure provided by the State Statistical Bureau and subtract Taiwan, we
obtain 980 million for mid-1979*, so it is nearly sure that the mainland has
passed the billion mark by now.

Various estimates are available for the future, those by John S. Aird of the
United States Bureau of the Census being especially well-regarded. Aird's low
estimate, which seems the preferred one, shows 1,255 million for the year 2000.
That implies an average of something like a 12 million annual increase between
now and the end of the century, the difference between about 18 million births
and 6 million deaths. These are close to the present numbers of births and
deaths, and assuming they will be the average for the rest of the century implies
moderate continued success of the birth control campaign but not the radically
reduced fertility being discussed in some circles and the subject of our discus-
sion below.

MOMENTUM

Momentum in demography refers to the tendency of a population to keep
increasing after its high birth rates have fallen sharply. A history of rapid
increase results in a young age distribution, which includes many children who
will shortly come into childbearing. If fertile married couples average about
2.3 children, the population will just replace itself and sooner or later will
become stationary, which is to say that births will be equal to deaths. But

*A. Doak Barnett, China's Economy in Global Perspective, Washington, D.C., 1981, p.313.

during a transitional period of about 50 years after the fall of births to bare replacement, the increase of population continues. The ultimate stationary population can be as much as 60 percent greater than the population at the time the fall to replacement occurred.

If the population of China is projected forward with a declining death rate, and births falling immediately (1980) to replacement then the population by the year 2000 would be 1,222 million. Let us compare this with the medium estimate made by various authorities for the year 2000

World Bank	1,209 million
United Nations	1,209 million
US Bureau of the Census	1,329 million
Community and Family Study Center	1,155 million

The fact that three of these figures are below our 1,222 million tells us that those who made the calculation believed that the birth rate would drop well below replacement for at least part of the time to the year 2000. This is an example of the use of knowing the future population that is implied by the drop to replacement immediately, by 1985, etc.; such numbers may be thought of as a scale that enables us to see what assumptions are implicit in various projections that are available to the public.

The same momentum calculated by fixing birth rates at replacement from 1980 onward, which produced 1,222 million for the year 2000, would continue to operate in the 21st century, so that by 2075 the population of China would have passed the 1 1/2 billion mark.

The Chinese authorities are more than aware of momentum*, and a good

*Song Jian, Yu Jingyuan, and Li Guangyuan, Theory on Prospect of Population Evolution Processes, Scientia Sinica, Vol. XXIV No.2, March 1981, pp. 431-444; Liu Zheng, Population Planning and Population Theory, in China's Population: Problems and Prospects. Beijing: The New World Press, 1981; Ansley J. Coale, Population Trends, Population Policy, and Population Studies in China, Population and Development Review, Vol.7, No.1, (March 1981), pp. 85:97.

deal of writing in Chinese and English is concerned with the problem of how to avoid the increase that would occur even if birth rates dropped to replacement immediately. Such a drop is not purely abstract, since the replacement level of births is about 16 million, not much below what is given officially as the actual number.

This literature seeks to find what will happen if China avoids the increase due to momentum by averaging considerably less than two children per couple for at least a decade or two. Such a hypothesis would be idle for most developing countries, but China seems confident of attaining any birth control target, however ambitious.

IMMEDIATE BIRTH STATIONARITY AND THE ULTIMATE POPULATION

In fact China has had remarkable success in explaining birth control to its masses, using communication methods developed before 1949 for the quite other purpose of defeating the Kuomintang and the Japanese. In innumerable meetings of small discussion groups the cadres of the party effectively pass the word down the line to the ultimate agent that must implement any new program--the couple of childbearing age. By means of this unique system of communication the authorities have put across to couples the importance of restraint in childbearing, and in the course of a decade are reversing attitudes that have developed over millenia.

Added to the effects of skilled communication is the assurance that people will have a pension in their old age and so can be unconcerned about their lack of children. The one-family ideal is also supported by some immediate material incentives—money rewards to the parents who promise to have only one child, and corresponding exactions from those who break their promise and go as far as a third child. In some places, says Barnett* one-child families are promised a

*Barnett, 1981, p.311

subsidy of 5 yuan a month for fourteen years, or fourteen years of free health services, and free education from nursery school through secondary school, plus higher pensions and other benefits. If the parents are not sterilized and they have another child, they must pay back all the subsidies or benefits previously received. If they have a third child, economic penalties are imposed--both father and mother may have 10 percent of their wages deducted. Such local measures have not yet been codified into a national law, and localities each have their own rules but the only parts of China formally excused from the limit on childbearing are the minority areas, those occupied by non- Han peoples.

The shift from private property to collective ownership, plus confidence in the provision of old age and other security, is part of what makes birth control acceptable. If there is no farm to pass on to the young, then it matters less that one has no son to take over. Child raising becomes less attractive when family property is no more, and everyone works on the commune's or other collectively owned lands. The individual identifies with the corporate non-kin group, and that group ensures his welfare and security.

TOO FAST A DROP IN BIRTHS?

The success already attained in the program has given grounds for concern that the drop may be too sudden, in that it will produce an awkward age distribution after the first quarter of the 21rst century*. The dependency burden will be light for the first decades of a successful program, for there will be few children and not yet many old people, but when those of the 1960s baby boom reach retirement age there will be too few workers to support them. It matters not for this purpose whether the individual couple are supported by their own children, or the children collectively pay the pensions for the aged people of the

*Ansley J. Coale, Population Trends, Population Policy, and Population Studies in China, Population and Development Review, Vol.7, No. 1, March 1981, pp.85-97.

production brigade or other collectivity; after a period of drastic control of childbearing the ratio of pensioned to working will be large enough that the burden on the community will be felt keenly.

The models that have been presented to show this effect of aging, some by Chinese scholars and some by foreigners, are authoritative, but they are not simple and self-contained. It would be hard for the untrained reader to verify their arithmetic, and so fully to see the machinery by which they work. One would like a simple enough model that the untrained reader can follow perfectly what is happening. Since the matter is one for public discussion far beyond the ranks of demographers, simplicity is valuable, and we ought even to risk some over-simplification.

Our starting point is not crude but is an exact statement of the total population that corresponds to a fixed and given number of births when the life table is known and constant. If the annual number of births is B, and the expectation of life is e, the resulting stationary population is Be. There is no qualification whatever on this formula, which can be proven by showing that the expectation of life is the sum of the probabilities of surviving to the several ages, and the sum of the probabilities of surviving to the several ages is also the total of the stationary population per birth. Our argument starts from this proposition that with all rates fixed P=Be, where P is population, B is births per year, and e is the expectation of life in years.

IMMEDIATE BIRTH STATIONARITY

We will take as the fixed annual number of future births in China for this purpose 15,000,000. Ansley Coale* has pieced together birth numbers appearing in the Chinese scholarly literature, and he finds a peak of 29.0 million births in

*Coale 1981, p. 41.

1963 and as many as 27.3 million as recently as 1970. Since 1970 the drop has been dramatic, to 16.2 million in 1977. We note that the United Nations numbers* are higher than these, and it is difficult for outsiders to judge the situation when the authorities themselves do not profess to know it with accuracy. Nonetheless the figure of 15 million births per year starting in the near future does not seem out of line.

The assumption of immediate birth stationarity then permits a very simple kind of projection to show what will happen to age distribution. Twenty years after the attainment of such stationarity, the age distribution of those under 20 years of age will be that of the life table, while at each age above 20 the survivors of a large earlier cohort will appear. Of the 29 million births of 1963, for example, we can expect over 25 million to be surviving by the end of the century.

Thus cohorts of well over 20 million births will have to be supported sooner or later by cohorts of just 15 million births.This will come about 60 years after the peak of births, say about the year 2030, when the working population will all be survivors of the low stationary level, while the retired population will all be of the higher level preceding.

Applying the formula above enables us to say that the ultimate stationary population will be 15 x 70 = 1,050 million. The exactitude of this depends on the assumed 15 million births and on the value we have taken for the expectation of life, i.e. 70 years. Chinese demographers say that the expectation of life at birth is already over 68 years, averaging the two sexes, while the United Nations* gives 67.3 for 1975-80. In the preceding 25 years the expectation of life increased steadily, and in all by more than 21 years--an achievement that must surely be unique. In view of this remarkable rise seventy years expectation could well be

*As calculated from crude rates given in World Population Prospects as Assessed in 1980, (published 1981) p.48.
*United Nations, 1981.World Population Prospects as Assessed in 1980, p.90

on the low side for the average of the next generation or two, but we take it as a convenient round number.

We can see roughly the family size that the trajectory implies by comparing numbers in two successive generations. If all childbearing were to take place at a single age, say 26, then by noting the ratio of current births to the population aged 26 we would know the number of births per person, and multiplying by two would give the number per couple. Thus if there are 20 million survivors of a cohort at the age of reproduction, and we suppose 15 million births, this implies $2 \times 15/20 = 1.5$ births per couple. For the number per married fertile couple we would need to add 10 to 15 percent to this. With constant births the trajectory of births that would be allowed to each couple on the average would be inversely proportional to the number of births a generation earlier. This means that for the first 25 or 30 years the number of births per couple would be decidedly less than 2, but after that time couples could average 2 children, or 2.3 to allow for nonmarriage, sterility, and mortality.

A SIMPLE POPULATION PROJECTION

Our tables show this more precisely, in that they allow for the dispersion of ages of childbearing as well as for mortality at the several ages. In order to see the implications of immediate stationarity in the births, we calculate the trajectories of a number of quantities, including the ratio of population over age 65 to that from 25 to 65; the ratio of children under 15 to the working population; the mean age of the population; crude birth rate and crude death rate; the crude rate of natural increase. the net reproduction and the average number of births per couple. (See the appendix by Peer Just for details of the calculation.) Tables 1 and 2 show aspects of age distribution; Table 3 crude rates and family sizes, all for 15 million births per year starting in 1980.

Table 1. Population of China in five-year age groups, 1980-2060, supposing 15 million births per year from 1980 (in millions).

Ages	1980	2000	2020	2040	2060
0- 4	90.9	73.5	73.5	73.5	73.5
5- 9	118.1	71.8	71.8	71.8	71.8
10-14	114.6	71.6	71.6	71.6	71.6
15-19	103.3	71.3	71.3	71.3	71.3
20-24	98.1	87.7	70.9	70.9	70.9
25-29	87.5	115.8	70.4	70.4	70.4
30-34	64.8	111.7	69.7	69.7	69.7
35-39	52.6	100.0	69.0	69.0	69.0
40-44	49.2	94.2	84.2	68.1	68.1
45-49	44.3	83.0	109.8	66.8	66.8
50-54	39.4	60.3	104.0	64.9	64.9
55-59	34.3	47.5	90.3	62.3	62.3
60-64	28.7	42.3	80.9	72.3	58.5
65-69	22.8	35.0	65.7	86.9	52.8
70-74	16.9	27.1	41.5	71.4	44.6
75-79	10.7	18.5	25.7	48.8	33.7
80-84	5.4	10.4	15.3	29.2	26.1
85-	2.0	5.7	8.7	16.3	21.6
Total	983	1127	1194	1155	1067

Table 2. Percentage distribution 1980-2060 with 15 million births per year
from 1980.

Year	0-14	15-64	65+
1980	32.90	61.22	5.87
1990	21.96	70.74	7.29
2000	19.24	72.19	8.57
2010	18.51	71.68	9.81
2020	18.16	68.71	13.13
2030	18.23	64.13	17.64
2040	18.77	59.36	21.87
2050	19.62	60.80	19.57
2060	20.51	62.93	15.94

Table 3. Crude birth and death rates, gross and net reproduction rates,
and children per fertile couple, with 15 million births per year
from 1980.

Year	Crude rate/1000 population			g.r.r.	n.r.r.	Children per fertile couple
	Birth	Death	Natural increase			
1980	18.87	6.24	12.63	1.134	1.061	2.3
1990	14.09	7.42	6.68	.737	.690	1.5
2000	13.31	8.59	4.72	.751	.703	1.5
2010	12.81	9.94	2.87	.933	.874	1.9
2020	12.56	11.76	0.80	1.054	.987	2.2
2030	12.61	14.39	-1.77	1.068	1.000	2.2
2040	12.99	17.36	-4.37	1.068	1.000	2.2
2050	13.58	18.01	-4.43	1.068	1.000	2.2
2060	14.05	16.40	-2.35	1.068	1.000	2.2
2070	14.23	14.23	0	1.068	1.000	2.2

In Table 1 the hump for ages 5-19 of 1980 is shown as moving down the table, appearing at ages 25-39 in the year 2000, 45-59 in 2020, and so on, not disappearing finally until 2060 (Figure 1). Table 2 shows how there is an immediate benefit in the form of far fewer children under 15, that more than offsets the initial small rise in the old as far as total dependency is concerned. The labor force will increase rapidly for some time, since the new entrants into it are the births of 1960 onward while those leaving are the survivors of the much fewer births of the 1920s.At the same time as this makes possible more economic activity than ever before it has its corresponding problem of organizing employment so as to use all the new hands and minds. The smaller number of school children will be an advantage, especially insofar as the educational system has not expanded to the point where the whole of each cohort is in school; if the whole of the larger preceding cohort was already provided with school buildings and teachers, then there would be organizational problems in putting some of the teachers and buildings to alternative use.

In summary the present proportion of old persons to those of the labor force is only 5.87 percent, and the ultimate, which will simply be that of the life table on our assumption of stationarity, will be considerably higher. But in between the present and the ultimate the ratio of old people to labor force will first decline (as the baby boom of the 1960s enters working ages) and after 40 years will rise as that same baby boom comes up for retirement. The peak of the proportion old will occur in the 2020s, and that will be a time when the People's Republic will face some genuine dilemmas.

COSTS OF YOUNG VERSUS COST OF OLD

With 15 million births per year the population increases to a maximum of 1,194 million by 2020, and then declines close to its ultimate with 1,067 by 2060. (Table 1 and Figure 2). The fraction over age 65 starts out with the present low of
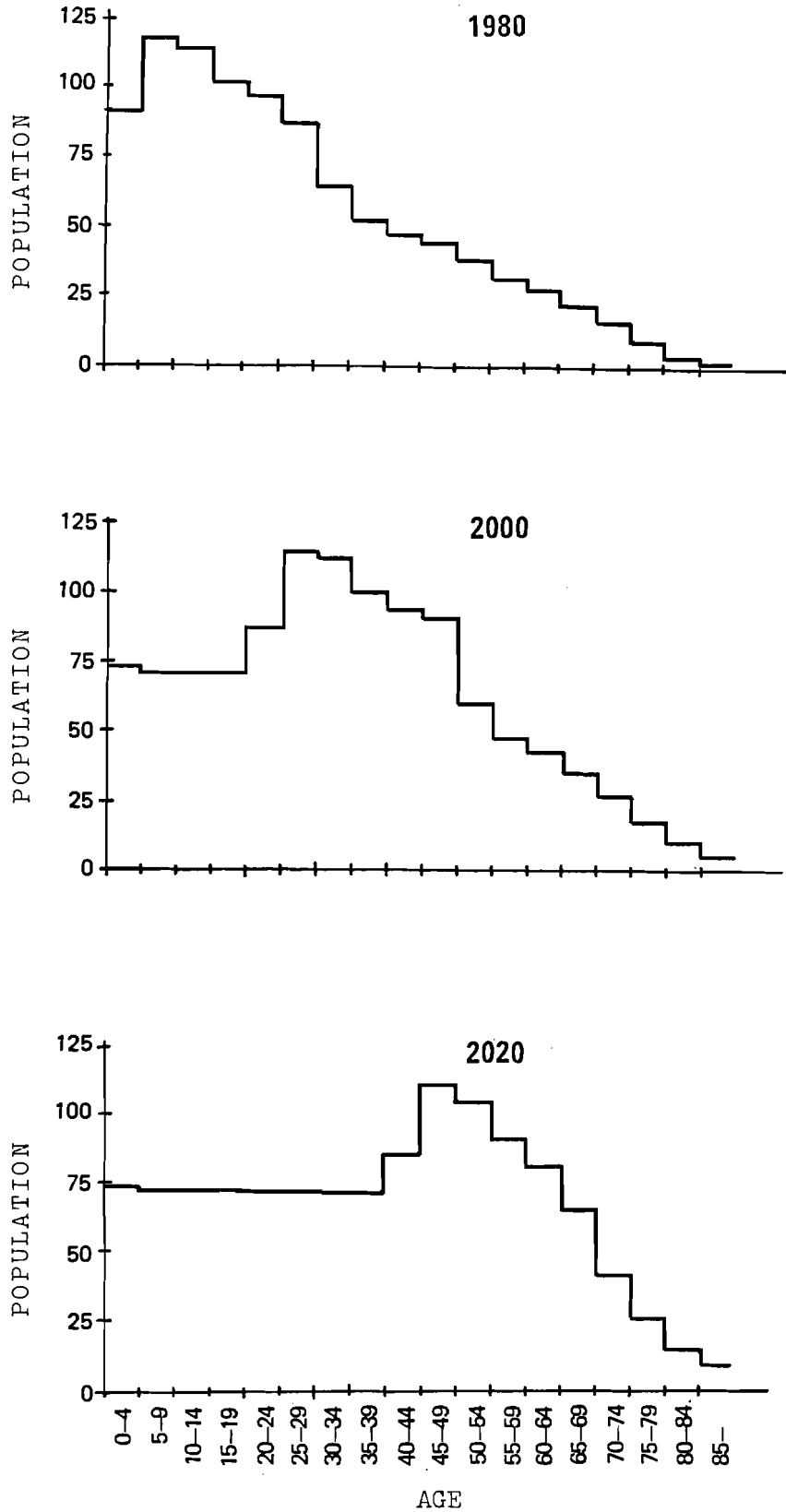
Figure 1. Population of China in five-year age groups,
1980 - 2060, supposing 15 million births per
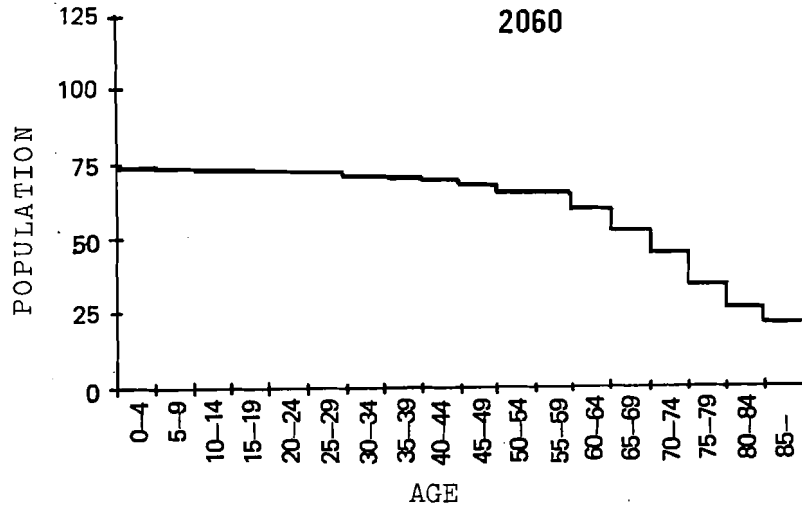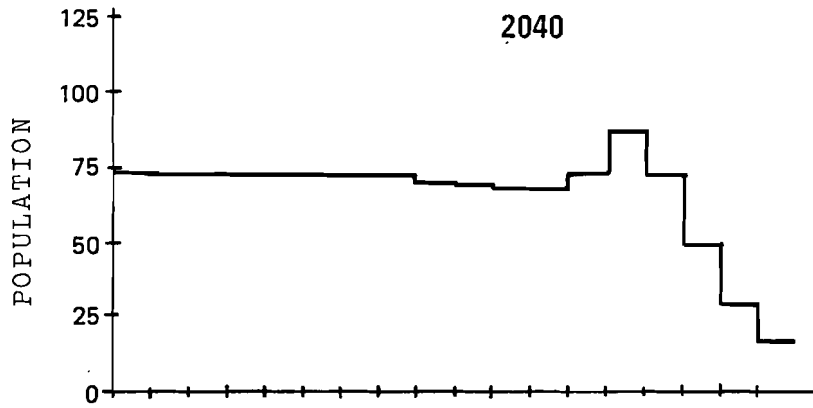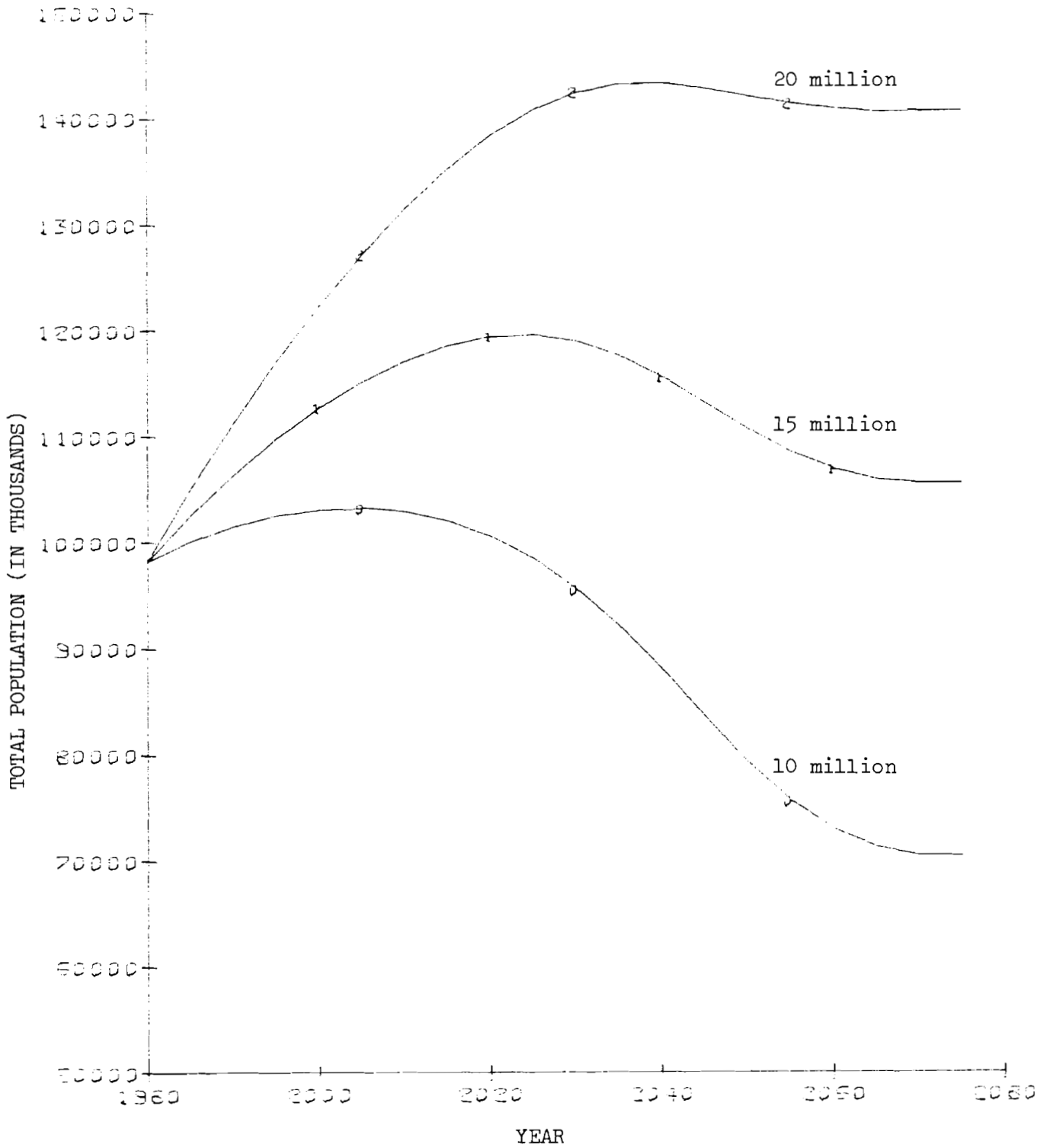year from 1980 (in millions).

Figure 1 continued.

Figure 2. Total population corresponding to annual births of 10, 15, and
20 million.

5.87 percent, rises to a peak of 21.87 in the year 2040, then by 2060 has declined to 15.94, close to its ultimate corresponding to a stationary population with 70 years life expectation of 15.69 percent. (Table 2)

How awkward is the high point of 21.87? We note first that it is somewhat above what the United States will face about the same time on the official forecast of the US Bureau of the Census. The ratio of those of the old age group to those of the labor force ages will be .37 for China at its worst against about .30 for the United States, Japan, and other industrial countries. To what extent can the large number of old be offset by the small number of children? We might well take all the dependents, those below as well as those above working ages, into account in such calculations. The young require nourishment, clothing and education, while the old require medical services and other kinds of attention. Perhaps the old should have a higher weighting than the young. What we know is that with the 15 million births per year the proportion of working ages varies much less than either the proportion old or young. It starts at 61.22 in 1980, rises to a peak of 72.19 by 2000, then declines to a low of 59.36 by 2040, and after that rises gently to its ultimate 63.55. At its low point it is only very slightly below the 1980 value (Table 2).

ALTERNATIVE NUMBERS OF BIRTHS

With 10 million births per year the fluctuations are enormously greater. The fraction over age 65 reaches 28.95 by 2045, when the ratio of retired ages to working ages is 53 percent. We discuss later how this would present a disagreeable choice: either work to older ages and so block the careers of the young, or stop work at the customary age and place a heavy financial burden on the young.

The contrast is sharp between what is right from the viewpoint of age distribution, and what is right from the viewpoint of the ecology. From supplies and

potential supplies, Song Jian* works out the population that can be sustained in comfort, and in each of three separate calculations comes to the conclusion that the maximum to the conclusion that the maximum population that will allow China to prosper is 700 million*. For example, in regard to food, he considers the present area of cultivated land, pasture land, and surface water, and noting the speed of agricultural development abroad, he estimates the increase of 150 percent in total food production a century from now. If the population is to have 85 grams of protein per day, and if animal protein is to make up 70 to 80 percent of this, then the population should not be more than 680 million. The same applies to fresh water resources, and also to capital.

A total population of 700 million with an expectation of life of 70 years requires only 10 million births per year in the stationary condition, according to the formula P=Be above. Let us then look into some of the consequences of stationary births at various levels.

At the present time the deaths number about 6 million per year, so any number of births from 10 to 20 million would increase the population at the start (Figure 2 and Table 4). To hold the population constant--to say that there could only be one birth for each death that occurred--would require not even 10 million, but only 6 million births per year. One can see what this would mean for age distribution in later years by extrapolating below the 10 million line.

The present population 65 and over is shown in Figure 3. Figure 4 shows that by the year 2040, with births of only 10 million per year each 2 workers would have to support one retired person.

With any less than 20 million births per year, the rate of natural increase would decline to below zero, and then would recover up to stationarity. With 10

---

*Song Jian, Population Development—Goals and Plans, in China's Population: Problems and Prospects, by Liu Zheng, Song Jian and others. Beijing: New World Press, 1981, pp. 25-31.

Table 4. Total population and proportion of working age, with 10, 15, and 20 million births per year.

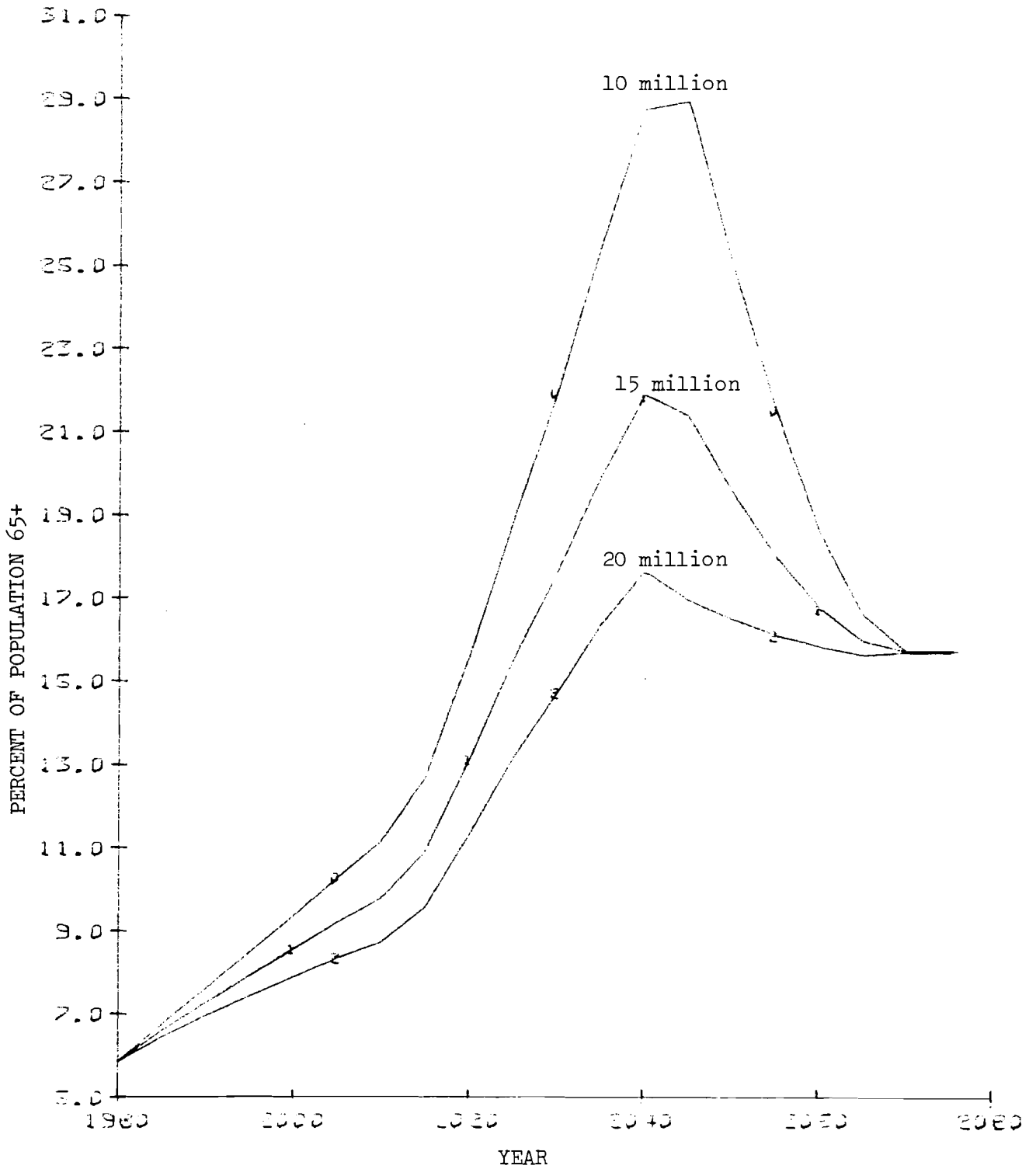| Year	Population (millions)			Percent age 15-64		
	10	15	20	10	15	20
1980	983	983	983	61.22	61.22	61.22
1990	1016	1064	1113	74.11	70.74	67.66
2000	1031	1127	1223	76.61	72.19	68.46
2010	1028	1171	1314	74.77	71.68	69.27
2020	1005	1194	1383	70.01	68.71	67.77
2030	955	1189	1423	62.90	64.13	64.96
2040	878	1155	1432	54.78	59.36	62.16
2050	791	1105	1419	56.62	60.80	63.14
2060	728	1067	1407	61.56	62.93	63.65

Figure 3. The percent of the population 65 and over corresponding to annual births of 10, 15, and 20 million.
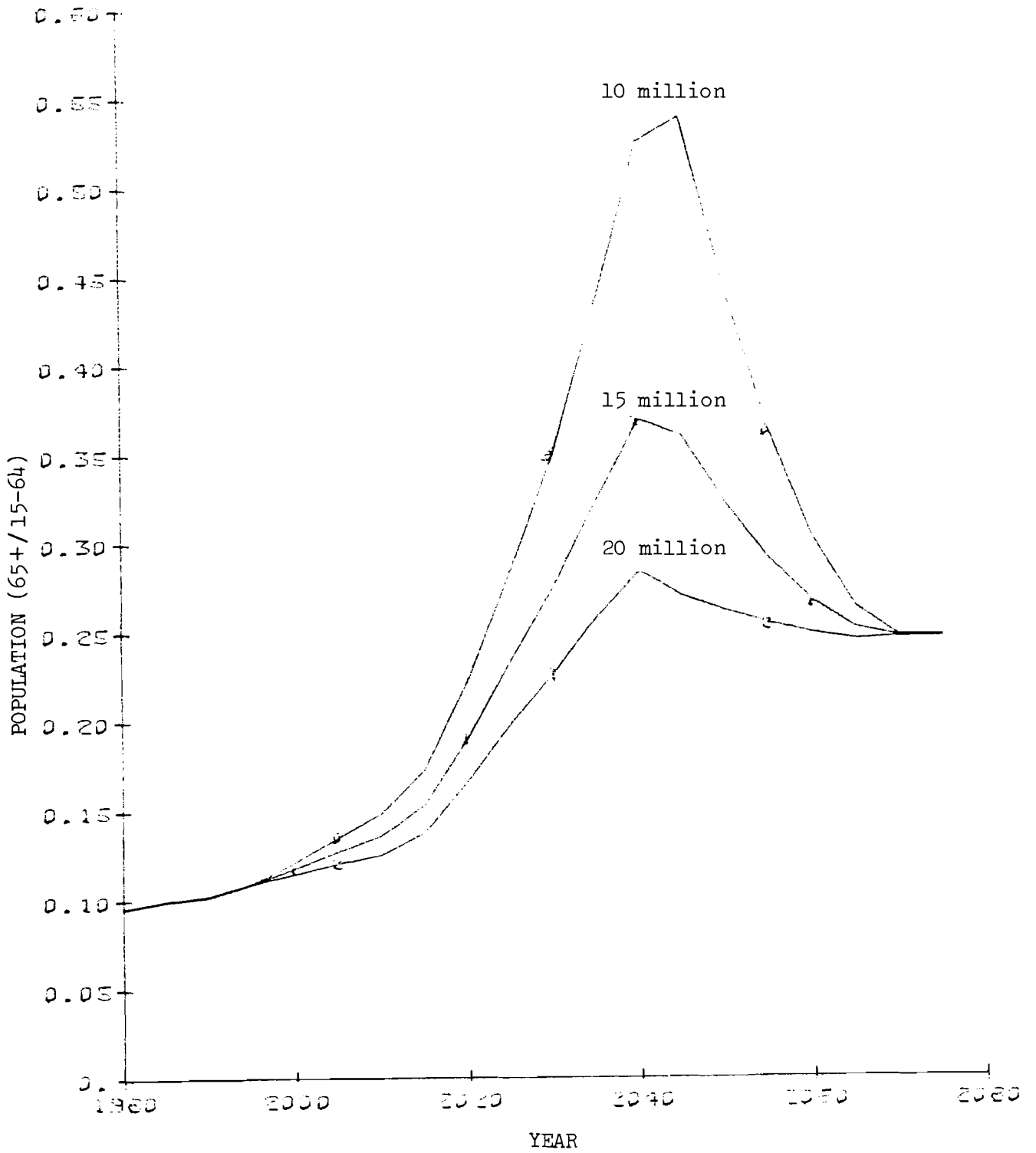
Figure 4. The ratio of the population 65 and over to that of 15-64 corresponding to annual births of 10, 15, and 20 million.

million births the decline would go below one percent per year by the 2040s; with 20 million the drop below zero would be negligible (Figure 5).

We can locate on Figure 5 the plans of China's leaders, especially the much repeated statement that the rate of increase is to go down to 0.5 percent by 1985, and to zero by 2000. Apparently the first statement implies births about half way between 10 and 15 million while the second implies births below 10 million. Our method is useful for inferring the implicit assumptions in elliptical official statements.

The three trajectories can be evaluated by the reproduction rates they imply, which is to say the number of girls that would be expected to be born to a girl child on the age specific rates of a given year. In all cases the gross reproduction rate falls below 1, which is to say that even without allowance for mortality couples could not have as many as two children--in the 10 million case they would not be allowed to have as many as 1 during the 1990s. But the picture becomes sharper when we take the net reproduction rate, which allows something for mortality. Figure 6 shows this. Again with 20 million births the departures from unity--which is to say the departures of mean family size from about 2--are not very great; with 15 million something like 1.5 children is implied and with 10 million less than one child. In all cases the minimum would occur in the 1990s. One would expect that to be the time, since with constant births the minimum birth rate to people of childbearing age would occur when these latter are the most numerous..

Without knowing more about marriage rates and sterility we cannot say more precisely what the family size of fertile married couples would be. If something like 10 percent are unmarried or sterile then the averages for the fertile married would be 2, 1.6, and 1 child for the three cases, respectively. This last situation therefore corresponds to the one child family spoken of by Liu Zheng
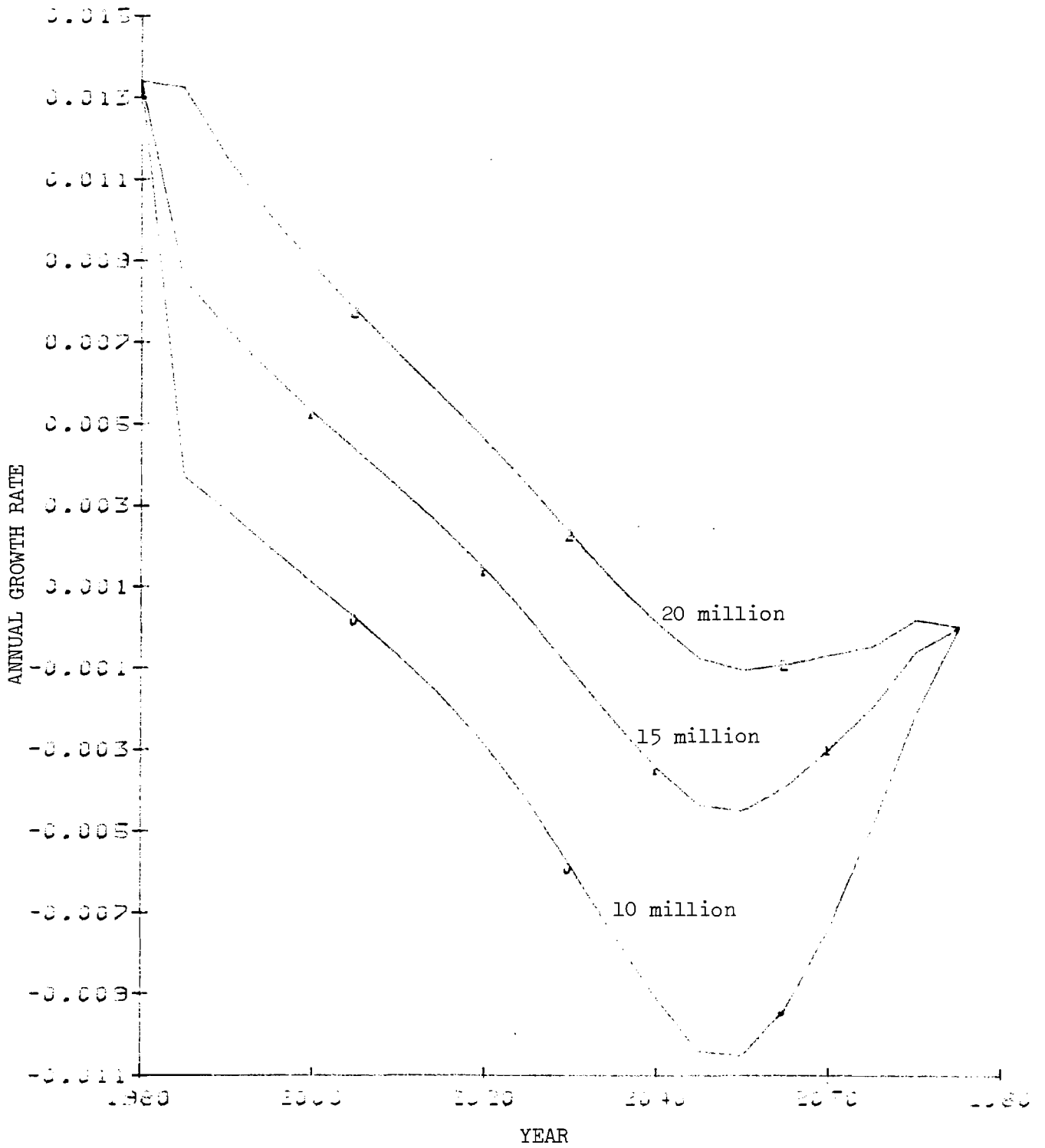
Figure 5. Annual growth rates corresponding to annual births of 10, 15, and
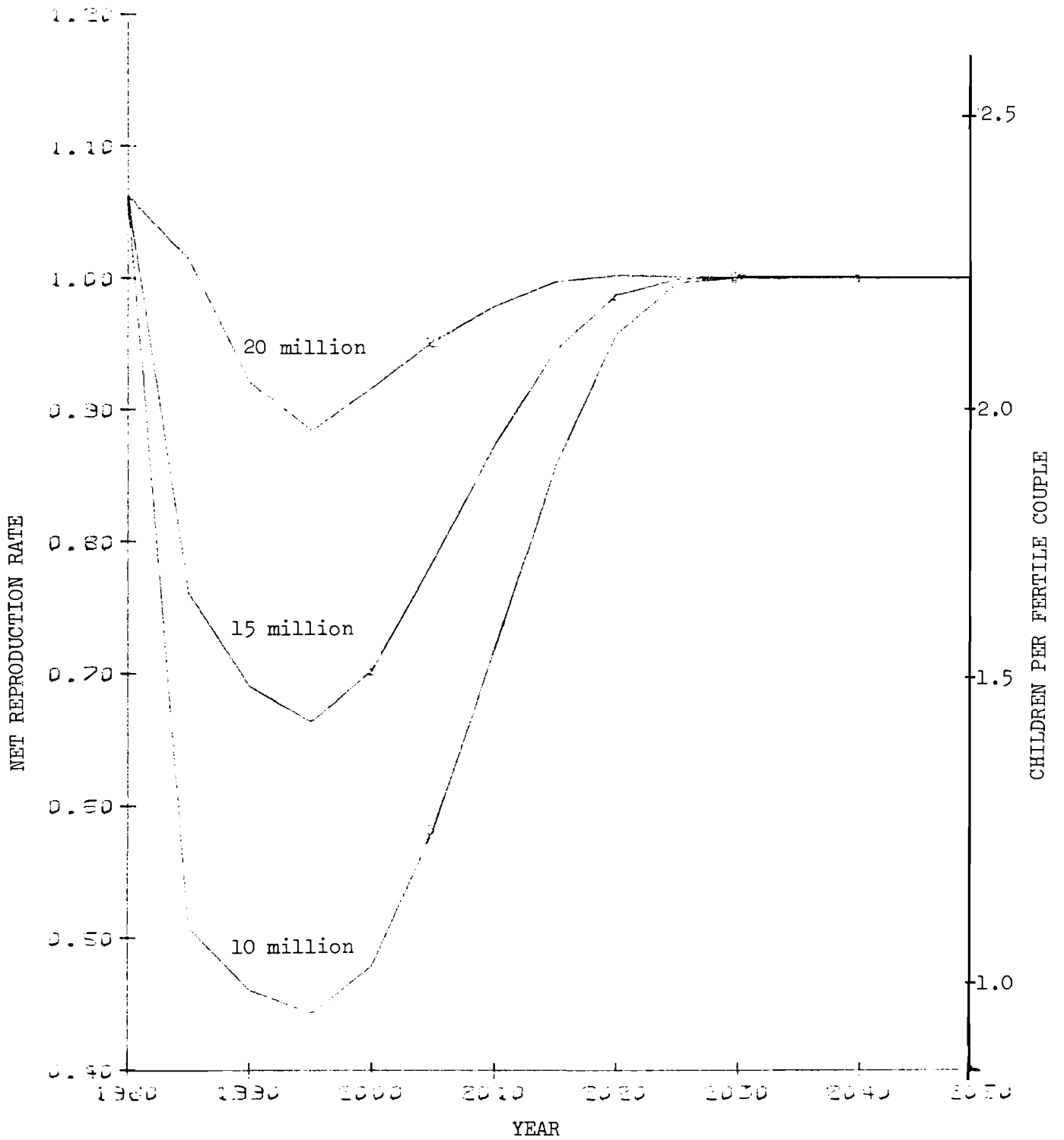20 million.

Figure 6. Net reproduction rate and children per couple corresponding to annual births of 10, 15, and 20 million.

that would produce an ultimate population (on his calculation as well as ours) of 700 million but would require one child families for a considerable part of the time between now and the end of the century--i.e. until the large generations of parents had moved beyond childbearing ages.

This corresponds to the statement of Chen Muhua in 1979 that she expected that by 1985 no one will have a third child, and that by then a large number will have only one*.

THE DILEMMA: WORK OR RETIREMENT FOR THE OLD?

One solution for an aging population is to extend people's working lives. With the better health that is already manifest and will surely be further improved in the next 40 years, older people will be increasingly able to continue their gainful work. One can imagine those in their sixties being as capable physically as people now are in their fifties. And since increasing parts of the work will be mental rather than physical as development proceeds, the old will retain an even higher proportion of their capacity than they would have when most labor was in the fields. Given these circumstances it would be easy to specify ages such that the ratio of old people to those working remains absolutely constant, whatever happens to age distribution. The age of retirement would be made to vary from 60 to 70 over the course of decades, being legislated in each decade so as to hold the proportion in the labor force more or less constant.

This way of coping with the concentration of population in the older ages, however, is not likely to please everyone. The old may not think it fair that they have to keep working until 70, say, when their parents had been able to retire at 60; they would point out that with a more productive society they should be able

*Controlling Population Growth in a Planned Way, Beijing Review, no.46 November 16, 1979, p.19, as quoted by A. Doak Barnett, China's Economy in Global Perspective, Washington, D.C.:1981, The Brookings Institution, p. 314

to retire sooner rather than later. But the main objections could well come from the young who would see the old blocking the path to promotion. Some of this is already starting to be articulated by the huge cohorts of the 1960s, that originated in numerous births and had a higher survivorship than any previous generation. When this large generation in turn comes near the end of their careers their successors will feel even more strongly that their way was blocked by old people hanging on to employment. They will be better educated than any previous generation, and hence feel themselves entitled to get ahead. In addition to all this one can fear for the pace of technical change if the same individuals stay in the same jobs for too long. Reforms and improvements in work organization everywhere depend on the replacement of senior staff; the retirement of the boss is the easiest point at which to introduce up-to-date methods.

To put the matter in the crudest form: the old have to be provided for, and if their number increases in relation to the labor force, the choice is between allowing them to retain the jobs, or putting them out of their jobs and supporting them on taxes. Whether to support the old by jobs or by taxes is a decision that will have to be made by some later generation. And this is without even raising the question whether there is some Keynesian or other mechanism operative, that would limit the total volume of employment. If there is such a limit then the continuation of the old in their jobs not only slow would slow the promotion of those young who are working, but also would prevent the accession to jobs of new entrants into the labor force.

Concern about this is diluted by the thought that it is about half a century distant. As productivity rises society will be able to afford much more leisure to everyone than is now possible. The working week will be shorter than its present 48 hours, and this will make working less onerous. There could still be a conflict between the generations on how the increased leisure should be divided--

whether as a shorter working week or a smaller number of working years--but high productivity will soften the conflict.

THE TRAJECTORY

The main thing to be said in favor of defining a trajectory in terms of a fixed number of births is that it is simple. We could instead have supposed a certain curve of fall in the crude birth rate, in the number of children per couple, or in the age-specific birth rate. But these do not exhaust the range of possibilities. If we think of a nation that is genuinely in a position to plan its future population, that recognizes it must ultimately be stationary, and that wants to find the trajectory that will lead to stationarity in the least painful way, what ought it to do? It need not plan the trajectory in terms of number of births or any other other quantity.

It could rather aim at a smooth movement of some entity like the net reproduction rate. Perhaps it could set the condition that the ratio of the over 65 to the 15-64 never goes below .4. One could say, for China, as Professor Song Jian does, that the ultimate sustainable population at a suitable level of welfare is 700 million, and then ask how one gets to that with whatever suitable constraint one wishes to place. The constraint might be the condition that at no point will the fraction of the population beyond working age exceed a certain number. Willekens and Rogers* develop an expression for migration that aims at a certain target defined in terms of age. It provides the vector of movers in each time period that would result in a given population with given distribution by age after t years. In application to births their intervention vector would have only one element--the number at the youngest age group. The full formula with all ages operating would be useful for finding what number of inmigrants

---

*Frans Willekens and Andrei Rogers, Normative Modelling in Demo-Economics, IIASA Research Report 77-23, December 1977, p.9

into a given city--say Beijing--would result in a population distributed in a certain desired way after 30 years, say.

A sophisticated treatment of the time path when births are under the control of policy makers is given by Arthur and McNicoll*. They tie population and the economy, and find optimal accumulation paths for both simultaneously. They recognize that people move through a succession of life-stages described by demographic age schedules, and that changes in the growth rate influence the population's age structure. Unfortunately for its immediate use the Arthur-McNicoll formulation requires considerable data on the economy that is not at present available.

We have found that the use of a fixed number of births gives a result not very different from those published by other writers. It enables us to see what set of rates are implied by statements of the Chinese authorities. Thus the drop to a rate of increase of .5 percent by 1985, and stationarity by the year 2000 implies a number of births per year intermediate between 10 and 15 million.

CHINA'S POPULATION OVER TIME

The volume and density of China's population, along with the richness of its civilization has been a theme of European literature since at least the eighteenth century, indeed going back to the voyages of Marco Polo. For many decades it has been said that every fourth child born in the world is Chinese. It is still true that nearly every fourth person in the world is Chinese (the proportion is between 22 and 23 percent), but if the Chinese births are 17 million and world births are 120 million, then only every seventh baby born is Chinese.

There could well be more information on the population of China through historic times than on that of any other country. Chinese literature abounds in

*Brian Arthur and Geoffrey McNicoll, Optimal Time Paths with Age-Dependence: A Theory of Population Policy, Review of Economic Studies, Vol. XLIV (1), February, 1977.

records of all kinds, and population counts go back to the time of the warring states prior to 220 B.C. Though incomplete and inaccurate by modern standards, this information is better than the guesses on which we have to depend for other parts of the world. Many of the figures have been collected together, analyzed and interpreted by Ho Ping-ti*. Durand* mentions 21 enumerations between A.D.2 and 1194 of which at least the total is available. Dwight Perkins* collects together records for recent centuries. Colin McEvedy and Richard Jones* summarize the results for some 3000 years.

The collapse of the Shang hegemony about 1000 B.C. and the start of the period of warring states occurred when China had a population of about 6 million, but early in the days of the Han Empire (206 B.C. to 220 A.D.) the figure of 50 million is said to have been reached. Here it remained until the Sung about 1000 A.D. when the introduction of new and fastgrowing rice varieties, especially in the Yangtze valley to the south, permitted a sharp rise. In due course the Mongol invaders were expelled and replaced by the Ming emperors, and in the later Ming days growth was steady, so that by the time of the Manchu conquest there were 150 million people in China proper. Again in the 18th century, especially due to the introduction of corn, peanuts, and other crops from the Americas, according to Ho Ping-ti, there was again a spurt that carried population to 300 million. The population of China was usually quoted at 400 million up to the middle of the 20th century, but a count released in 1953 gave 583 million. Outside demographers were suprised at the jump of some 100 million, but they have come to accept it.

*Ho, Ping-ti. 1959. Studies in the Population of China, 1368-1953. Cambridge, Mass.: Harvard
*John D. Durand, Population Studies, Vol. 13, No. 3, 1960
*Dwight Perkins, Agricultural Development in China 1568-1968, 1969
*Colin McEvedy and Richard Jones, Atlas of World Population History, Penguin 1978, pp.166-175

UNCERTAINTY OF STATISTICAL INFORMATION

To discuss the future in terms of rates given to several decimal places seems inappropriate when we have so little knowledge of the present population or vital rates. Much of the information available outside of China comes from newspaper articles, often by anonymous authors. Yet most demographers are inclined to accept the rapid decline of the birth rate during the 1970s as a fact, with reservations only on the rate of decline. According to Liu Zheng, quoted by Lucian Bianco* the birth rate was 38 per thousand population in 1970, and by 1978 it had declined to 18.3. The latter figure is widely agreed upon, but 1970 is given by Ansley Coale* as 33.4 per thousand, and Tian Xueyuan* as 33.6. Bianco spent a good deal of time trying to uncover figures at the local level, and he finds clear evidence, at least in Sichuan province that the fall in fertility has indeed taken place, though it may not be as steep as said. I can confirm from my questioning of several dozen families that the one and two child family does actually exist, though I would not want to . go from my observations to a provincial or national average. Like Bianco I found the information for Chengdu convincing, and in other places rather less so.

In a later article Coale* shows that births from 1958 to 1963 were under-recorded, especially in 1961, and that in general registrations are delayed until the time comes to apply for a ration card for the child.

What makes one so concerned is the casualness with which numbers are given by the authorities. Sometimes they will say that there has been a decline of so and so many thousands in the births, without saying anything about the

*Lucian Bianco, Planification des naissances en Chine. Quelle confiance accorder aux donnees locales? Population 36e year, January 1981, No.1, pp.123-146,

*Ansley J. Coale Population Trends, Population Policy, and Population Studies in China, Population and Development Review,7, No. 1 (March 1981), pp. 85-97

*Tian Xueyuan, China's Population, Ed. Liu Zheng and Song Jian, Peking, New World Press, 1981, p. 36

Ansley J. Coale, A Further Note on Chinese Population Statistics, Population and Development Review, Volume 7, Number 3, September 1981, pp. 512-518

initial or the final numbers. Yet with Bianco and Coale I do not believe that the authorities are trying to hide anything, but rather that there are few people trained in the collection and presentation of statistical data in China, and those few are frustrated by the lack of solid information coming up the line from local areas. The sense that accuracy is important does not permeate the system.

Roland Pressat* has looked into Chinese data and policies in regard to population. He shows a drop from 27.4 births per thousand population in 1970 to 16.0 in 1977, from official sources, but is troubled by the rise to 17.4 million for 1978 mentioned by Vice-President Chen Muha.

Let us now turn back to the cluster of population related issues, in particular to urbanization and resources, and see how they help to understand the firmness of the authorities in the matter of birth control. The enormous amounts of time and effort that have been expended in bringing about the degree of control that we see are explained by the social and economic context in which Chinese development is taking place.

URBANIZATION AND ITS CONTROL

Every developing country has trouble controlling the sizes of its cities, especially its largest cities. The flow of mobile job-seekers in the early phases of development exceeds the number of jobs. Ultimately, development means urbanization, but premature urbanization involves heavy costs.

The cities of China are indeed large, but not in proportion to its total population or to its stage of development. The fraction of population urban is said to be about 20 percent, less than many countries whose development is behind that of China. That still means some 200 million urban population, with individual

---

*Roland Pressat, La baisse de la natalite en Chine, Population 3, 1979, pp. 705-6; Mesures anti-natalistes en Chine, Population 4-5, 1979, pp. 908-9; Reapparition des statistiques chinoises, Population 1, 1980, pp. 226-31; Evolution des naissances en Chine, Population 4-5, 1980, pp. 968-72.

cities (Chungqing, Shanghai) big enough and burning enough coal to have serious pollution problems.

Urbanization in China is controlled by making many of the necessities of life dependent on having a job. With the job come ration cards, a dwelling, coupons that permit the purchase of a bicycle and other equipment, medical care, and various kinds of training. A person without a job, even if he has some savings, even though he may have friends in Beijing or Chungqing, cannot long survive in those cities. Anyone who tried to sleep in the street would be picked up very quickly. I cannot imagine a spontaneous squatter colony. The instruments of control are such that the number of inhabitants of the cities is very close to the number who have jobs and their immediate families.

One way of holding down the size of cities is by reducing the incentive to leave the countryside. In most developing countries urbanization is the direct result of rural incomes that are much lower than city incomes. In China also rural incomes are on the whole much lower; Barnett* says that the average peasant's income (as of 1979, 84 yuan per year) was only 12 percent of the wage of an urban worker. The discrepancy is of course greatest between the urban worker and the peasant in a remote part of the country. But recent policies have done much to raise rural incomes. Aside from some freeing of markets, the state purchase prices for agricultural goods was raised considerably in 1979. For the whole period from 1952 to 1977 the state's purchase price for farm products increased by 68.8 percent, while the sale prices of chemical fertilizers, pesticides, and farm machinery dropped 48 percent*.

The degree of control over city growth now maintained does not relieve the authorities of concern about the future. Even in good years some imports of

---

*A.Doak Barnett, China's Economy in Global Perspective, Brookings, 1981, p.342
*Barnett 1981, p.341

wheat are necessary (partly offset by exports of rice) largely to fill gaps in city stocks; in bad years the imports can take up a large part of funds planned for purchase of capital goods. If the grain crop in a good year (say 1978) is 305 million tons then a drop of 5 percent would require imports of 15 million tons to maintain the previous level of diet, and this would cost upwards of $4 billion, depending on how bad crops were elsewhere in the world. That total export income from everything in 1978 was only $10 billion shows how a perfectly possible food deficit would cut into industrialization. The matter is not hypothetical. In 1979 grain imports minus rice exports amounted to just under 10 million tons* and so accounted for something like one third of the total export income.

Any increase in population, especially in city population, adds just that element of uncertainty to the development process. Could it be covered by increased land taxes in the countryside? At present some 50 million tons are what the Chinese call commodity grain, a part of which is collected by the land tax in kind, which runs about 5 percent of output. To increase this task would risk resuscitating the conflict that authorities and public alike hope is a thing of the past.

Employment for the children of city people is a problem that the cultural revolution solved by simply ordering them out to do farm work in Inner Mongolia and other distant places. Such a solution is out of the question now for two reasons: present agricultural manpower is sufficient; to order young people into the countryside now would be another way of creating antagonism. Thus population control would have among other advantages the lightening of the incipient problem of cities outgrowing their need for industrial manpower.

While surplus population in the countryside is less of a burden than surplus population in the cities, the countryside also has its problems. Mechanization

*Barnett, 1981, p.352

of the work in the fields was pursued vigorously for a while; now it is emphasized less. Nonetheless output per person employed in agriculture is increasing, and good new lands are hard to find. Agriculture's share of the gross domestic product has declined* from 47 percent in 1952 to 26 percent in 1970, and industry has grown from 17 percent in 1952 to 42 percent in 1970. Every effort is being made to stimulate small industry in the countryside to take up the labor released from farming, but finding even the relatively small capital to buy homemade looking equipment presents difficulties at the lower levels of government.

PRESSURES ON THE FOOD SUPPLY

China's food production has been just ahead of its population growth, so the average consumption has been more or less constant during the history of the People's Republic. What has greatly improved is distribution. A firm ration system prevents people from using their higher incomes to buy more food--in some less developed countries as much as 80 percent of increases in income are spent on food, but not in China. Regarded ecologically, what has been effectively prevented is increased meat consumption by some while others are still hungry; what grain there is will be fed to people rather than to cows and pigs. People are urged to spend their increased income on manufactured goods rather than on food.

Yet the latent demand for food is strong, and the authorities have called for an improvement in the national diet*. Whether the new policies--especially greater incentives to farmers--will increase output enough to keep up with the increasing demand is not clear; it is possible that the provision of some meat will only increase appetites for more meat. Once again, it is impossible to think

*Barnett, 1981, p.158
*Barnett, 1981, p. 343

about this problem, given the intensity of China's use of arable land, without see-
ing it as tied to population and its increase.

Chairman Mao's vision was the integration of industry with agriculture and a
reduction of differences between manual and mental labors[*]. Presumably the
mechanization of the work in the fields will release labor for local industries--
there is no intention of having it flow to the cities. Part of the labor released
goes into local production of the mechanical equipment, some of which takes
place in very small workshops. Other manpower can go into livestock, fishing,
and manufacturing of light consumer goods. Displacing labor in the fields will
only make the country poorer if the displaced labor is not put to productive
work somewhere else.

Decentralized manufacture is not without its problems. Most agricultural
machinery is low in quality and difficult to maintain and repair. Since the
machines are produced in thousands of small workshops, parts are rarely inter-
changeable, and keeping a stock of repair parts locally is a nightmare. The
responsibility for each part lies not with the concern that assembled and sold
the tractor, but with the maker of the part, so recourse in case of failure is
difficult. Beijing initiated a campaign in 1979 to achieve "standardization, seriali-
zation, and versatility."[*]

ENERGY AND ITS LIMITS

China's energy potential is considerable, but its development is not going to
be easy. Coal has been the main source for a long time, and it is possible that
China has one fifth of all the recoverable coal in the earth's crust, but its mines
are old and badly need reequipping[*]. The growth of output has slowed in recent

[*]Leo A. Orleans, Agricultural Mechanisation, in Leo A. Orleans, Ed. Science in Contemporary
China, Stanford University Press, 1980, pp. 373-380
[*]Orleans, 1980 p.379
[*]Barnett, 1981, p.418.

years. In some places factories are close enough together to make the air black; burning the coal more cleanly will require much investment. China has large reserves of natural gas, and production has expanded in recent years, especially in Sichuan. But heavy investments in pipelines, or else in liquefaction plants, will be needed if use of this resource is to become widespread. Oil production expanded greatly in the North and the Northeast as new fields were discovered. The Taching field went into operation in 1960 and by 1976 produced 43 million tons*. In the period from 1950 through 1976 oil production as a whole increased at an average rate of 26 percent per year. But like that of coal, the increase of oil has slowed in the last two or three years. Negotiations are proceeding for exploiting both inland and offshore oil. Reserves have been estimated* and the conclusion seems to be that ultimately recoverable oil reserves are somewhere between 40 and 100 billion barrels. At present rates of use, that would be enough for 100 years, but the rate will increase. The time that these reserves will last for a prosperous China is very much dependent on whether it has 700 million or 1.4 billion people.

The limits to population and welfare set by energy are not as tight as those set by food, but the exploitation of energy resources is going to require a great deal of capital. To accumulate the necessary capital for these and other purposes a slower rate of population growth, even negative growth, will help. So the need for capital can be added to the limits of food supplies and the difficulties of employing the young generation as reasons for the insistence on population control.

---

*Barnett 1981, p.434
*By the CIA as well as the US Geological Survey

SCIENCE GIVES HOPE

China's resources are not plentiful in relation to her one billion population, and she has a severe problem of finding the capital to develop resources without mortgaging herself to foreigners on the one hand, or imposing unacceptable sacrifices on her own population on the other.

In contrast to the view held for a decade up to 1976, a main hope now is that science can amplify those resources. China is the third producer of coal, not far behind the United States and the USSR, but needs to produce much more and to burn it with less pollution. China's total energy consumption at 600 kg. of coal equivalent per head is well ahead of that of India (250 kg.) but behind Brazil (750 kg.) and far behind Mexico (1300 kg.)*. The eight-year plan 1978-85 puts energy second, after agriculture, in the priorities for modernization.

China's scarcest resource is technical manpower, and she is determined to economize this by using whatever scientific techniques and results she can import from the West. In pollution control, made urgent by the extensive use of coal and the prospect of more use, the instrumentation for determining trace intoxicants, laser scanning to measure particulate concentration, analysis of flue gases from steel-smelting furnaces, are matters in which western technology is being assimilated*. She is also using western techniques for improving the traditional methods of composting organic materials.

In medicine one sees Western and Chinese techniques in use in the same hospital. Beijing's Hospital of Traditional Chinese Medicine uses computers for diagnosis. One has the impression that many of the traditional cures are effective, and some sorting out is badly required. What is plainly needed are more clinical trials to evaluate the numerous herbs and drugs, and some of this

*Vaclav Smil, Energy, in Leo A. Orleans, Ed., Science in Contemporary China. Stanford University Press, 1980 p. 407.
*Baruch Boxer, Environmental Science, in Orleans 1980, p. 472.

is being undertaken by Western trained Chinese doctors, responding to Chairman Mao's injunction to combine Western and traditional medicine. Combined methods are being used in the study and treatment of hepatitis, for which an effective vaccine is still to be found.

In one respect at least Chinese medicine is different from, and demographically more effective than ours. Where our medical scientists are especially drawn to rare diseases, where the scientific payoff is greatest, the Chinese researcher is under the injunction* of Huang Jiasi, president of the Chinese Academy of Medical Sciences: "The problems of prevention and treatment of diseases most frequently seen [must] always top the list of medical services and medical research." The extraordinary fall in the Chinese death rate can well be attributed to this policy, along with the use of paramedical personnel--barefoot doctors, as they are still called, though all that I met wore shoes. There is a limit to what people with three months training can do, but they have been successful in screening for certain kinds of cancer. For a long time the emphasis was that prescribed by Chairman Mao, who attacked what he called the "Ministry of Urban Gentleman's Health" and doctors who had read too many books, and who "work divorced from the masses ... at the so-called pinnacle of science." Medical school curricula were reduced, to produce physicians in three rather than in five or six years. There may have been something to be said for this policy in its time, but it has since been quietly set aside.

Talented individuals continued to do research in all but the darkest periods of the gang-of-four. In 1966 Science acclaimed the synthesis of insulin in China as a major achievement*. At the end of a period in which the infectious diseases came to be largely controlled, the authorities began again to give priority to

*Myron Wegman, Biomedical Research: Clinical and Public Health Aspects, in Orleans, 1980 p. 269.
*H.M. Temin, Basic Biomedical Research, in Orleans, 1980, p.256.

basic biology. Genetic engineering was singled out for priority treatment in the 1978 National Plan for the Development of Science.

The combination of western science and instrumentation, traditional approaches and the Maoist appeal to the masses is to be found in the study of earthquakes. China is particularly subject to earthquakes, and it has records extending back some 3000 years* which permit mapping the country to show the susceptible areas. Tectonic and regional stress analysis, ground tilt or deformation, and the periodicity shown by historic records are used in making forecasts one or more years ahead. In addition to 250 regional stations and 5000 observation points equipped with modern instruments, there are 100,000 people at the commune level who use homemade instruments, observe water level in wells, and report any unusual behavior in wild and domestic animals. Chao* quotes a report showing nine successful forecasts of earthquakes, in five of which the authorities were sure enough of the forecast to order evacuation.

With the pressure of population on the land one would expect that plant breeding would have special importance in China, and this is indeed so. There are many institutes in the country, as well as university departments. Haploid breeding, in which the chromosome number of haploid plantlets is doubled, either spontaneously or artificially, a way of obtaining pure strains immediately rather after several years of selfing, has been pioneered in China, especially for wheat*. The participation of the peasant masses, for instance in such wide crosses as rice with bamboo, has been less successful here than it has been in earthquake observation*. The use of bacterial insect diseases in the control of insects is widespread. Insects are also controlled by extensive deployment of "blacklight" traps, often as many as one per hectare over wide areas. Under the

*Edward C.T.Chao, Earth Sciences, in Orleans, 1980, p. 202.
*Orleans, 1980, p. 202.
*Jack R. Harlan, Plant Breeding and Genetics, in Orleans 1980, p.301.
*Harlan, in Orleans, 1980, p.305.

trap is a tub with water and some rice, so the insects falling in the tub make a gruel for spreading on the fields as fertilizer. The Chinese contribution was to show that combining different kinds of light catches more insects than any one kind alone*.

Operations research and systems analysis are given strong emphasis in China, perhaps more than they receive in the West*. The practical character of Chinese OR is shown by one of the early problems it solved: with two fields some distance apart on a road, one bigger than the other, what is the right location for a common threshing floor? The answer is at the larger field; at any intermediate point there would be more ton-kilometers of grain to transport. The solution can be extended to more than two fields. Other practical problems tackled range from the shape of gear teeth to orthogonal experimental designs*. Computers are taken seriously; the Beijing Institute of Computer Technology employs about 1000 people, of whom about half belong to the manufacturing division*.

The intense interest in science at all levels from the Central Committee down to many peasants is a hopeful sign. Of course it would be too much to hope that the level of knowledge corresponds to the level of interest, and many of the "scientists" are remarkably innocent not only of the literature in their professed field, but also of the scientific approach in general.

During the Cultural Revolution, when science was treated very badly and economic progress was extremely slow, no attention was given to population--it was said that everyone would be looked after. Now that science is encouraged and is going ahead, so that the prospect of looking after more people better is excellent, one hears insistence that population be controlled, down to a number

*Saunders MacLane, Pure and Applied Mathematics, in Orleans, 1980 p. 59.
*MacLane, in Orleans, 1980, p.81.
*MacLane, in Orleans, 1980, p.67.

less than lives in China today.

A NEW DYNASTY MAKES A FRESH START

The Chinese revolution of 1949 was a peasant revolution. In some aspects it repeats the cycle of Chinese history. As Gustafson* says

> At the beginning of each dynasty the small independent peasant proprietors, who were the backbone of Chinese society, formed the majority of the peasantry. As the dynasty endured, the peasant free-holders accumulated debt, incurred mainly through excessive taxation, and more and more of them became tenants. This made the continuous absorption of land by the powerful landowners possible. But to the same extent the income of the government declined. Hence the amount of taxation demanded from the small peasant proprietors grew larger while the government became less and less able to pay its employees. Corruption increased sharply.

He goes on to quote Wu Ta-k'un*: "Peasant rebellions followed, and usually resulted in a new dynasty." The new dynasty was founded by insurgent generals or by successful rebellious peasant leaders. But since the system of taxation and land tenure remained unaltered the whole process began over again. It is this cycle that the liberation of 1949 seems to have broken by its drastic altera-tion of land tenure and by intensive industrialization.

We have seen how the enormous population now present constitutes a threat to industrialization, and how the realization of this has led to effective measures of birth control. The enormously effective birth control requires facing up to two dilemmas. One is the pressure on the land if population increases,

*Bo Gustafson, Economic Politics and Political Economy in China, Post-Industrial Society, Bo Gustafsson, Ed., London: Croom Helm, p.172
*Wu Ta-k'un, An Interpretation of Chinese Economic History, Past and Present, No.1, Febru-ary 1952.

versus a grossly unfavorable age distribution in the 21st century if births are sharply controlled. The other arises in sharpest form if the control is tight--say at a level of 10 million births per year: should the old people be kept in the labor force, and so stand in the way of the promotion of the young, or should they be retired and constitute a tax burden on the young?

The process of development, including the control of population that is so integral a part of it, is associated with continuance of the high morale and morality now in evidence. No one has noticed any appreciable amount of corruption. Even tipping is outlawed. Any trace of venality is ruthlessly hunted down. The attitudes of restraint extend to many other aspects of life. Sex outside of marriage is illegal as well as immoral, and is as little suggested in books and pictures as it was in England and New England when they were at corresponding phases of development. A regulated economy requires austerity and incorruptibility in the regulators. So far China's rulers have themselves practiced the austerity they impose on others. No one can tell whether this superhuman abstinence will continue as the revolution fades into the past.

APPENDIX: PROCEDURE USED IN PROJECTIONS

Peer Just

The procedure used for this forecast is very simple and the reader can easily verify it number by number if he wishes. The following information will help him to do this. To begin, the population of the base year 1980 had to be calculated. Since the population by age was available only for 1975, assumptions about mortality and fertility between 1975 and 1980 had to be made. Using age-specific death rates from Coale-Demeny model schedules, which correspond to an expectation of life of 70 years, a life table was then calculated (Table A1). The survivors to 1980 were calculated from this life table; the population under age 5 for 1980 was obtained using estimates of birth of 18.5 million per year and the L(o) of the life table.

For the estimation of the births between 1975 and 1980 crude birth rates from recent publications were taken (Lin Zheng, Song Jian, and others 1980).[*] In order to calculate age-specific fertility rates a typical fertility schedule with a gross reproduction rate of unity was chosen from

---

[*]Lin Zheng, Song Jian and others; China's Population: Problems and Prospects, Beijing, China; New World Press, 1980.

Table A1. Single-region life table for a mortality level of 70.26: China.

age	p(x)	q(x)	l(x)	d(x)	ll(x)	m(x)	s(x)	t(x)	e(x)
0	0.958960	0.041040	100000.	4104.	4.897399	0.008380	0.977242	70.2647	70.2647
5	0.996307	0.003693	95896.	354.	4.785945	0.000740	0.996705	65.3673	68.1648
10	0.997104	0.002896	95542.	277.	4.770175	0.000580	0.996209	60.5814	63.4082
15	0.995311	0.004689	95265.	447.	4.752090	0.000940	0.994344	55.8112	58.5851
20	0.993372	0.006628	94818.	628.	4.725212	0.001330	0.992704	51.0591	53.8494
25	0.992032	0.007968	94190.	751.	4.690737	0.001600	0.991291	46.3339	49.1920
30	0.990545	0.009455	93439.	883.	4.649888	0.001900	0.989363	41.6432	44.5670
35	0.988170	0.011830	92556.	1095.	4.600428	0.002380	0.986234	36.9933	39.9685
40	0.984275	0.015725	91461.	1438.	4.537099	0.003170	0.980966	32.3929	35.4171
45	0.977604	0.022396	90023.	2016.	4.450738	0.004530	0.972483	27.8558	30.9430
50	0.967245	0.032755	88007.	2883.	4.328268	0.006660	0.959623	23.4050	26.5946
55	0.951743	0.048257	85124.	4108.	4.153506	0.009890	0.938667	19.0768	22.4105
60	0.924928	0.075072	81016.	6082.	3.898759	0.015600	0.903111	14.9232	18.4201
65	0.879523	0.120477	74934.	9028.	3.521011	0.025640	0.844446	11.0245	14.7122
70	0.804566	0.195434	65906.	12880.	2.973305	0.043320	0.754894	7.5035	11.3851
75	0.693158	0.306842	53026.	16271.	2.244531	0.072490	0.627871	4.5302	8.5433
80	0.533684	0.466316	36755.	17140.	1.409276	0.121620	0.621856	2.2856	6.2185
85	0.	1.000000	19616.	19616.	0.876366	0.223830	0.	0.8764	4.4677

LEGEND

p(x) : probability of survival from age x to age x + 5

q(x) : probability that an individual of age x dies before reaching age x + 5

l(x) : number surviving at exact age x, of 100,000 born

d(x) : number dying between ages x and x + 5, of 100,000 born

ll(x): number of years lived between ages x and x + 5 per unit born

m(x) : age-specific death rate

s(x) : survivorship proportion—proportion of people x to x + 4 years old that
       will survive to be x + 5 to x + 9 years old, 5 years later

t(x) : number of years expected to be lived beyond age x by a newborn baby

e(x) : expectation of life at age x—number of years expected to be lived be-
       yond age x by a person of age x

Coale and Trussell's model tables. The procedure of deriving age-specific

fertility rates from the average crude birth rates (CBR), the age composi-

tion of the population $[c(x)]$, and the schedule $[F_\mu(x)]$ is given by

$$F(x) = F_\mu(x) \cdot [CBR / \sum_x c(x) \cdot F_\mu(x)]$$

The calculation of the number of births is now straightforward. The

same formula was applied to recalculate the fertility rates in each step

of projection from 1980 on. From the constant number of births and the

changing age composition of the population, age-specific fertility rates

were derived. These rates and the life table were used to calculate the

net reproduction rate. For the projection of the population from 1980 on

a constant number of births, independent from the age distribution of the

population, was assumed. Three alternative scenarios of 10, 15, and 20 mil-

lion births per year were considered. The population was then projected

forward by

$$
\begin{bmatrix}
0 & \cdots & 0 & \cdots & 0 \\
S_o & \cdots & 0 & \cdots & 0 \\
\vdots & \ddots & & & \vdots \\
0 & & S_i & & 0 \\
\vdots & & & \ddots & \vdots \\
0 & \cdots & 0 & \cdots & S_{n-1}
\end{bmatrix}
\cdot
\begin{bmatrix}
K_o^t \\
\vdots \\
\vdots \\
\vdots \\
K_n^t
\end{bmatrix}
+
\begin{bmatrix}
B \\
0 \\
\vdots \\
\vdots \\
0
\end{bmatrix}
\cdot L(o) =
\begin{bmatrix}
K_o^{t+1} \\
\vdots \\
\vdots \\
\vdots \\
K_n^{t+1}
\end{bmatrix}
$$

where S_i denotes the survivorship proportions from age group i at time t

to age group i + 1 at time t + 1. K_o^t is the population in the first age

group at time t and B represents the constant number of births in each year.

The L(o) gives the number of people in the first age group of the life

table population.