AGE EFFECTS IN WORK AND CONSUMPTION

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FOREWORD

Low fertility levels in many countries are creating aging populations whose demands for health care and income maintenance (social security) will increase to unprecedented levels, thereby calling forth policies that will promote increased family care and worklife flexibility. The Population Program at IIASA is examining current patterns of population aging and changing life-styles, projecting the needs for health and income support that such patterns are likely to generate during the next several decades, and considering alternative family and employment policies that might reduce the social costs of meeting these needs.

The program is seeking to develop a better understanding of how fertility and mortality combine to create aging populations, with high demands for health and income maintenance, and reduced family support systems that can provide that maintenance. The research will produce analyses of current demographic patterns, primarily in IIASA countries, together with an assessment of their probable future societal consequences and impacts on the aging. It will consider the position of the elderly within changing family structures, review national policies that promote an enlarged role for family care, and examine the costs and benefits of alternative systems for encouraging worklife flexibility by transferring income between different periods of life.

This paper considers age effects in production and in consumption. In it Nathan Keyfitz argues that whereas experience may be an asset to the individual and the economy under conditions of fixed technology, with rapid technical change it can be a handicap to both. He goes on to consider the redistribution of consumption, and to examine social security in the framework of intergenerational transfers. On this topic Keyfitz concludes that the current difficulties with the financing of social security in the United States and elsewhere arise largely out of the fact that the public was led to expect more benefit from social security than it was capable of providing. By exaggerating the promises of what it could provide and understating the true costs of these benefits, the sponsors of such systems contributed to the current crisis in financing.

Related publications are listed at the end of the paper.

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ABSTRACT

The consequences of the extensive changes in age distribution now occurring in developed countries are different according to whether one considers aspects of production or consumption. Too little attention has been given to the former, especially in relation to the pace of technical change. This paper opens up that subject. Under fixed technology, experience is an asset to the individual and to the economy; under rapid change, experience can be a handicap to both. It is also shown how fewer entrants into the labor force makes for higher starting wages but slower promotion to more responsible work.

Of the various consumption and redistribution aspects, social security is the most conspicuous. An earlier paper (Keyfitz, 1981) developed formulas for the implicit reserve of a social security scheme; here we carry these further in relation to social security wealth. The crisis in social security consists in the fact that schemes have been priced lower than sheer arithmetic shows to be their long-term cost. Because the public believed the costs to be lower than it now realizes they are, it bought a larger quantity than it really wanted. Yet it is reluctant to reduce the quantity -- by raising the retirement age or lcwering the replacement ratio -- because the scheme seems so fragile that any tampering with it could be the opening wedge to total dismantling. We locate social security in the framework of intergenerational transfers, whose problems arise as a direct consequence of birth fluctuations. Lines of argument converge to show that the solidarity of the generations is strengthened by at least partial funding of social security.

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Nathan Keyfitz

We know that one can read the population history of a country from its age distribution; the wars, epidemics, rise and fall of fertility of at least the last 70 years are plainly imprinted on the population pyramid. We know also that a fast growing population will take the form of a squat triangle, while a stationary population with modern low mortality will have almost equal numbers of people at ages up to 60 or so. However it is arranged, the care of the young is more difficult for the growing population by virtue of the high ratio of children to adults, and the care of the old is easier because the ratio of those of retired age is small in relation to those working. Low mortality is responsible for some of the large relative number of retired in contemporary populations, but a much more important factor is the low birth rate. These and similar statements have been disseminated widely in journals and the press of industrial countries during the past few years. Some of their consequences for social security financing in IIASA countries were taken up in an earlier working paper (Keyfitz, 1981) that treated the distinction between funded and pay-as-you-go schemes. That material is not repeated here.

The present paper reaches further in attempting to measure some of the effects quantitatively, and then goes on to point out other features of age distribution that have not yet appeared in the standard literature. More important, it makes a distinction between the age incidence of consumption, including its redistribution through social programs, on the one hand, and the effect of age distribution on production on the other hand. Some of what follows is far enough off the beaten path that at this stage it must be regarded as conjecture

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rather than assertion. We start with the production side, and consider in particular the relatively large number of entrants into the labor force 20 years after the baby boom in Europe and even more in America, and the subsequent decline of entrants.

PART I. THE INCIDENCE OF AGE ON PRODUCTION

Table 1 shows the age distribution of the United States in 1982 and projected to 1992. The peak age, 20-24, corresponding to births of 1957-62, is more than one third higher than 5-9, corresponding to births of 1972-77. The extraordinary compression of the pyramid at ages under 20 is typical of other developed countries in wake of the baby boom; most European countries show the effect in less accentuated form, while Japan shows it even more sharply.

The official projection to 1992 foresees a drop of 16 per cent in ages 15-24 over the decade, amounting to a fall in entrants into the labor force of about 1.8 per cent per year. For ages 15-29 taken as a whole the drop is 12 per cent. Table 2 gives single years of age and shows a drop over the decade of 2 1/2 per cent per year among the 18 and 19 year olds.

Great importance has been attributed to the aging of the labor force as the baby boom recedes, and some spectacular positive effects are foreseen. A publication of the Rand Corporation (Butz et al., 1982) said not only that their small numbers augur well for the currently entering cohorts, but that the prosperity that these attain will spread to the economy, and good times are ahead for all. This carries to an extreme the thesis of Richard Easterlin (1980), whereby a small cohort is advantaged, a large one suffers, that has been the most convincing explanation of the baby boom (its parents being the small cohorts of the 1930s) so far offered. Others draw optimistic conclusions from ageing on the grounds that more experience results in higher productivity, and they even measure the productivity increase with apparent exactitude by the

Table 1. Age distribution for 1982 and 1992, according to variant II of the USBC 1977 projection.

Age at last birthday	THOUSANDS 1982	1992	Average annual increase (%)
Total	226,341	247,426	0.89
0-4	17,263	19,296	1.11
5-9	15,415	19,487	2.34
10-14	17,642	17,974	0.19
15-19	19,414	16,075	-1.89
20-24	21,086	17,798	-1.70
25-29	19,775	19,017	-0.39
30-34	18,086	21,068	1.53
35-39	15,423	20,091	2.64
40-44	12,408	18,141	3.80
45-49	11,045	15,252	3.23
50-54	11,402	12,120	0.61
55-59	11,323	10,433	-0.82
60-64	10,276	10,122	-0.15
65-69	8,820	9,960	1.22
70-74	7,073	8,165	1.44
75-79	4,607	5,586	1.93
80-84	2,870	3,797	2.80
85+	2,414	3,043	2.32
Total 20-64	452,683	494,851	

rise in average pay with age.

It is striking, then, that the Japanese press has been filled with foreboding regarding the same phenomenon--aging of the population--that causes euphoria in the United States. Japan had very large numbers of entrants into the labor force ten years ago, and its birth rate declined even more sharply than those of western countries in the 1970s, so that its prospective entering cohorts will

Table 2. Single years of age for 1982, 1992, for the United Sates, showing absolute amount of increase and rate of increase in percent.

Age	THOUSANDS OF PERSONS 1982	1992	Increase	Average annual increase (%)
15	3593	3250	-343	-1.00
16	3661	3160	-501	-1.47
17	3888	3222	-666	-1.88
18	4087	3168	-919	-2.55
19	4185	3274	-911	-2.45
20	4326	3522	-804	-2.06
21	4277	3721	-556	-1.39
22	4146	3585	-561	-1.45
23	4100	3453	-647	-1.72
24	4237	3517	-720	-1.86
25	4167	3546	-621	-1.61
26	3961	3586	-375	-0.99
27	3962	3837	-125	-0.32
28	3893	4000	107	+0.27
29	3791	4048	257	+0.66

Source: USBC 1977 Projection.

be very small. Small numbers of entrants, an aging labor force, and increasing numbers past working age is a combination common to the United States, Western Europe and Japan; why the Japanese should worry about it while we base our hopes of prosperity on it needs examination.

Clearly small entering cohorts will encounter a strong demand for their labor, and their wages will be higher than if they were larger. It is said that they will be promoted more rapidly—by this author (Keyfitz, 1977) and others. We will see how that assertion is subject to some serious qualifications. But first we look into the argument frequently used that an aging labor force is good for the economy because older workers are more productive. If wages

are set at marginal productivity then that must be true.

The age gradient of wages

It must be even more true of Japan than of the United States, for in Japan the wages of employees rise more sharply with age than they do in Europe and America. Whereas men about age 52 in the United States (1970 data from the USBC, Current Population Reports, Series p-60 No 80, 1971, cited by Lee Rainwater, 1974, p. 161) were on the average paid less than 2.5 times men aged 22, in Japan the ratio seems to be between 3 and 4. Does this mean that men increase more rapidly in effectiveness with age in Japan than they do in the United States?

Few would assert that national differences lie in the gradient of productivity with age; most would say that the countries differ rather in the stability of employment in the firm, in the respect given to age, and in the conventions concerning pay raises. Whatever the causes of the steeper gradient of pay with age in Japan, there can be no doubt of the disruptive effect of ageing on patterns of employment and of profit. For the custom has been to replace employees as early as 55 with younger ones that do similar work at a fraction of the salary. If the younger ones are not to be had, so that the old high cost workers have to be retained, the effect on profits can be disastrous.

While the steeper gradient of pay with age may partly explain the different analyses of ageing in the two countries, yet the gradient even in western countries is probably higher than corresponds to productivity. There are conventions among us, especially in white collar work, whereby the employee's pay goes up year by year, without any very close consideration of whether he has become more productive. As the labor force shifts from manufacturing occupations (often paid by the piece, and therefore by definition with a gradient equal to that of productivity) to white collar work the weight of convention in

fixing remuneration in the economy increases. The assessment of productivity in most white collar tasks is difficult, and this difficulty encourages the play of convention in setting salaries higher for older people. The result is bound everywhere to make aging a disadvantage for the firm, though the degree of disadvantage will vary with the strength of the convention that people who have been in the firm longer ought to be paid more, and with the stability of employment.

This does not suspend the laws of economics. Young people choosing employers, and noting the low starting wages, will choose partly on the basis of which offers the better prospective lifetime wage Competition will force lifetime wages to some degree of correspondence with lifetime productivity. Sooner or later there will be adjustment to the aging labor force but the adjustment process could take more than a generation and be far too slow to avoid bankruptcies caused by soaring labor costs.

The main question of the first part of this paper is under what condition does the productivity of the individual increase with age and experience. We shall argue that the pace of technical change is fundamental to answering this question.

The value of experience under technical change

Under a fixed technology the experience of the worker is bound to cumulate, and there must be few occupations in which he does not get more and more skilled, up to some advanced age that corresponds to physical deterioration. Improved skill pays off not only for the worker but for the economy to which he contributes his services. The tool-and-die maker could be the prince of craftsmen because he could accumulate experience, perhaps up to the very day that he retired.

But if technical change is rapid then economic advance depends on something very different from the experience of the labor force in place; it depends on the speed with which those in place can either change themselves (even requiring that they forget their old skills as they learn new ones) or else be succeeded by a new generation of workers. With numerical control of machine tools existing workers have to learn very different skills, or else give over to younger people. The changeover to automatic composition in the world's newspapers, ultimately inevitable if only to eliminate typesetters' errors, would take place sooner if there were fewer skilled typesetters previously employed, and if each had not invested so many years in acquiring a specific skill. In an epoch of rapid change advance depends not on the cumulation of experience, but on its discarding and replacement.

With a given pace of technical advance and less than lifetime employment in the same firm competition would drive the age gradient of salary to some degree of conformity with the age gradient of productivity. Especially if the pace of technical advance has been slow, the employee of 52 may indeed be worth 2.5 times as much as the employee of 22. But what happens to this equilibrium if the technology speeds up? Then even with a fixed age distribution the pay gradient becomes inappropriate and a fortiori with a rising average age.

But what happens to this equilibrium if the technology speeds up? Then even with a fixed age distribution the pay gradient becomes inappropriate.

The bearing of this point on the advantage or disadvantage of an older labor force is clear enough. Unfortunately its application requires some knowledge, or at least surmise, on the prospects of technical change in the future, as well as on the skill requirements of new technology. Just as manufacturing productivity took a jump in the 1930s, and agricultural in the 1950s, so it looks as though office productivity is having its turn in the 1980s. With the

majority of the labor force now in white collar (essentially information processing) work the spread of computers will rapidly change the distribution of skills needed in the economy as a whole.

While generalization is difficult, one can say broadly that new techniques tend to require less specific skills, but more general competence and adaptability. Not the skill of the artisan cabinet maker who has worked over the same bench for half his life, skill that is entirely useless for activities other than cabinet making, but the kind of high school or college education by which the person could use a word processor this year, be a programmer next, manage a print shop the year after that. The tendency of our system of upbringing, including more schooling and delayed entrance into the labor force for youth, makes young people more adaptable than their elders, even at the start of their working life. That is one of the reasons why having fewer young people cannot be an advantage for the economy.

Substitutability among ages

Any assertion on the effect of changing age distribution depends on the facts regarding the substitutability of persons of various ages in production. If it were the case that age was entirely indifferent to the employer and entirely unrelated to productivity, then no alteration of age distribution would have any significance; the only demographics that would count would be the number of persons in the labor force and their occupational distribution. This condition rarely applies, but the opposite extreme, complete determination by age, appears equally unlikely. Though there are few circumstances under which, because of age alone, a person of 32 could not substitute for one of 33, or even of 40, yet we know that in most concerns responsibility increases with age and the office boy is younger than the president.

To measure substitutability among ages is crucial for further study of the effects on production of changing age distribution. We repeat that without some knowledge (or in the absence of knowledge some surmise or implicit assumption) of substitutability we do not know whether a given change in age distribution is an advantage or a disadvantage or indifferent. Knowledge of substitutability can be gained in a number of ways--by macroeconomics with the help of a production function whose parameters would tell the contribution of the various ages; by questioning employers on the desirability of workers of various ages in the several occupations; by observation of productivity of persons of different ages in activities where measurement is possible. The least one can say is that assertions on the effect of changing age distributions on production must be suspect if they do not take into account this element. Pending such investigation we shall assume in what follows that there is an age element in production; that some, but not complete, substitution is possible among workers of different ages. We go on to a little noticed paradox on the effect of changing cohorts on promotion. Strange as it may seem, the standard literature on the subject is concerned with slots and pay and promotion, but disregards that the purpose of each job is to get some work done.

Production and promotion

Suppose, in order to make the argument simple, that there is limited substitutability among ages, and that in 1992, 10 years from now, we will need the same proportion of 20-24 year olds as in 1982, which is to say we will need about 5 million more of them than the 18 million then available according to the official projection. That would mean more demand for the services of the 20-24 year olds, and so their wages will be high--in a wage sense they will be promoted young. But in a job sense the opposite would apply--they will be held back by the fewness of their numbers. If they do not work longer hours, they

will have to stay more years on the same job in order to make up for their fewness. (If they are willing to work longer hours then the problem disappears, but differentials by age in number of hours worked per week seems an unlikely solution.)

They could well regard themselves as blocked by large cohorts ahead of them, now ensconced in jobs of greater responsibility. The effect of these contradictory influences--advancement in pay but retardation in job responsibility has not been fairly considered.

The standard way of looking at the matter is at its best on the advantages accruing to the small cohort that is preceded and followed by large cohorts. A larger younger cohort will require teachers and supervisors, and so the small cohort will be pushed up by those following it, as happened in the 1960s to the fortunate small group born in the 1930s. Later in its career it will also be drawn upwards by the large cohort that is older as the latter approaches retirement; there will be plentiful good slots to be filled. This is aside from the simple play of supply and demand; insofar as jobs are age-specific the wages of a small group of applicants will be higher than if the applicants were more numerous.

The case is very different for a small cohort that is followed by other small cohorts. For then the first element--need for supervisors and teachers--does not enter. And the fact that there are few people and many jobs of entry level that need doing causes genuine difficulty to management. It will be a long time before these young people can be drawn into the senior jobs that will be vacated by the retirement of their elders, and in meantime they are needed longer at the bottom. Let us examine in more detail the arithmetic for prospective changes in the United States of the decade 1982-92.

There were 21,086 thousand persons aged 20-24 in 1982, and if this age group grows as the population total it would be up to 23,050 thousand by 1992.

If the proportion of jobs that need doing at the several ages does not change, the shortfall would be substantial: only 17,798 thousand people to do the work of 23,050 thousand. How can the shortage of more than 5 million be made up? Unless working hours are lengthened for this group then those who are too few can only make up for their fewness by staying more years before they are promoted to the work done by 25-29 people. After they have attained the age of 25 they will have to act as though they are still 24; as far as promotion to more responsible work is concerned they will just have to wait. We assume in this exposition that a person can do any job suited to a younger person, but cannot do those of older people.

The deficit in the numbers 20-24 can be made up by each working 5 times 23,050/17,798 or 6.48 years. They would stay in the 20-24 kinds of jobs for 6.48 years rather than the 5 years of 1982. The division point for the ages would not be 25 years but 28.08 years, taking account of a similar deficiency at ages 15-19. Though the deficiency at ages 15-19 will not have so large an effect insofar as most of these are not in the labor force anyhow. To be strict we ought to do the calculation not with the total population but only with that part of it that is participating in the labor force. Needless to say this calculation, developed in detail in Table 3, is for illustrative purposes only, and does not pretend to forecast the quantitative delay in promotion that will actually occur.

The columns of Table 3 correspond to the above account. Column 1) is the 1982 population of both sexes for the United States, column 2) that of 1992 as forecast by the Bureau of Labor Statistics (Fullerton 1982). Column 3) posits requrements at the several ages as the same proportion of the estimated 1992 total population that the ages were in 1982. The number of years that would have to be served in 1992 by each of those in the age group is given by column 4), and the cumulative of column 4) is shown as the age boundaries in column 5).

Table 3. Age intervals that would enable the 1992 population to fill the 1982 jobs, and corresponding delay in promotion, United States.

Age	Pop '82 (1)	Pop '92 (2)	Required '92 (3)	Width (4)	Bound 1 (5)	Bound 2 (6)	Mean bound (7)	Delay or displacement (8)
15	19,414	16,075	21,223	6.60	15.00	15.00	15.00	0.00
20	21,086	17,798	23,050	6.48	21.60	21.52	21.56	1.56
25	19,775	19,017	21,617	5.68	28.08	27.95	28.01	3.01
30	18,086	21,068	19,771	4.69	33.76	33.59	33.68	3.68
35	15,423	20,091	16,860	4.20	38.45	38.28	38.37	3.37
40	12,408	18,141	13,564	3.74	42.65	42.43	42.54	2.54
45	11,045	15,252	13,074	3.96	46.39	46.06	46.23	1.23
50	11,402	12,120	12,464	5.14	50.34	49.90	50.12	0.12

Interpolation is required for such calculations, and an alternative method of interpolation gives the somewhat different boundaries of column 6); column 7)

averages the two interpolations. Column 8) gives the cumulative displacement, which is to say the cumulative delay in promotion across the age boundary.

The table estimates a delay increasing up to age 30, and then diminishing virtually to zero by age 50, at which point the excess of people 30 to 49 has offset the shortage 15 to 29. The example serves to show how the position of the young cohort is very different when we take account of the work to be done, rather than merely of slots to be filled and pay to be drawn.

With the shortage of entry level applicants we can expect some changes in the definition of who is the right incumbent for many occupations. Suppose that there is a shortage of 5 million men in their 20s but an increase of 10 million women in their 30s and 40s, partly due to the continued movement of women with children into the labor force, partly to low fertility that means fewer women kept at home looking after children. One can hardly imagine a shortage in one age-sex group coexisting with a surplus in another without pressure for substitution. Similar forces in the decades after the war enabled women largely to take over from men the occupation of bank teller among others. Such changes would neutralize some of the effect illustrated in Table 3, the entrants being relieved of part of the consequences of their fewness. In exchange the women in their 30s would be taking over the entry jobs, i.e. jobs below what their age would have entitled to. The shortage of entrants at the youngest ages means that someone has to stay longer in the junior posts, i.e. to accept promotion to more senior work later than would otherwise be necessary.

More possibility of substitution softens the Easterlin effect by which the small cohort is better paid, and it also softens the somewhat opposite effect demonstrated in Table 3. This section has shown that any serious consideration of promotion as well as of the returns to labor at different ages must take account of substitutability and of the pace of technical change. Once the pace of

change becomes so rapid that it cannot be accommodated by the succession of generations then pressure on individuals to change occupations in mid-career becomes strong. Those who are not adaptable enough to change tend to be forced out. This is probably one of the causes of earlier retirement shown by the declining participation rates of older ages in Table 5--though we will find that its main cause is the social security system.

PART II AGE AND THE REDISTRIBUTION OF CONSUMPTION, WITH SPECIAL REFERENCE TO SOCIAL SECURITY

The two important units for study of age distribution: Family and nation

Any human aggregate has an age distribution, and one is often required to examine the consequences of changing age distribution in a province or city. But the two kinds of population for which age distribution is most revealing are the family and the nation. It is in the degree to which each is effectively an economic collectivity that age distribution is important for them. What makes the investigation of the relation between their distributions potentially useful is the fact that the larger unit is made up of an aggregate of the smaller, and changes in the smaller in specific ways have consequences for the larger.

The question for us will be then, how the superposition of families one on the other makes a certain age distribution for the nation. The question is analogous to that concerning the timing of births in the family and cohort and the period birth rate of the country, as studied by Ryder and others. Various propositions can be demonstrated mathematically; for instance that the period birth rate is lowered compared with the cohort birth rate by a fraction equal to the ratio of annual change in the mean age of childbearing to the cohort birth rate. If the age of childbearing is going up by one tenth of a year each year then

the period rate will be lower than the cohort rate by 10 per cent.

We need corresponding propositions for the effect of the change in family sizes and ages at of marriage and childbearing on the age distribution of the population. This would regard family formation as a cohort process, and the age distribution at any given time as the cross-section of what is taking place in a number of cohorts that exist simultaneously at different stages in their careers.

The family is so tightly knit an earning and spending unit that there is not even a way of ascertaining the effective incomes of its several members. In a one earner family the income can be imputed to the one who brings it into the family, but in the course of within-family distribution that person may receive only a small part of the benefits. That will apply if there are many children, and especially in that case the distribution is very different in the several stages of the family's life.

Immediately after the family is formed by a marriage there are likely to be two earners, and earnings pooled so that each spends approximately half of the earnings pool. When children come the number of earners might drop from two to one, and the number of consumers rise to three, four and five successively. Expenditures will not be equal among the members, but the earner is likely to have considerably less than half of the total. As the family grows up the costs of the members other than the head will increase, and perhaps reach a maximum when the head is in his forties, perhaps considerably before his income attains its maximum. Then the children leave home, perhaps the wife takes a job, and expenditure can rise considerably, just at a time when the need for expenditure is much less pressing. Finally, the time comes when the couple cannot earn anything by their own efforts, and if they are an independent unit they must live on the saving that they have accumulated--though

with family solidarity they are aided by the children who received the benefit of their earlier efforts.

The familiar story of the family cycle is worth telling here as part of our analysis of age distribution only because it shows how an important unit copes with changing age composition. The usefulness of exchanges among the several stages of the family cycle is clear. The aging but not yet old couple can set aside some of their income for their old age; they can also save before the children arrive to prepare for the time of heavy expenditure. It would be a further advantage to them to be able to borrow at the time of greatest expenditures, and pay back later when the children have left home.

The fact that before the welfare state came into existence the family were able to handle the radical change in age composition to which it is necessarily subject ought to inspire any consideration of how the nation is to handle its changes in age distribution. For though we speak of an aging process that will take place over the next half century or so in the United States and other countries, with a fall in the number of children, the amount of aging is trifling compared with what the individual family must undergo.

The nation has an easier time than the family. It does not have to save in order to handle the unevenness in the relation of income to expenditure, but can simply transfer among families. Thus the families that are at the height of their earnings and without children to support can contribute to the schooling of those that have children; those that are beyond the age where they can earn their own living can be supported by those who are working. Without anyone saving anything the expenditure curves for individuals can be smoothed out so that despite greatly varying numbers of claimants within the family and conventional salary differentials by age they can have a relatively uniform age-curve of individual expenditure. At least attempts along this line are written into the tax

laws of nearly all countries, as well as into their social welfare programs. In the freest of free market economies that exist today there is a large measure of this kind of mutual help, quite distinct from the mutual help of workers in producing the output of a factory. The mutual help in consumption is instituted either to smooth out the variations in the life course of the individual or to diminish the spread of incomes that a free market generates. It is the former that will be our main interest here as we try to learn something about the effects of age distributions. Cooperation in consumption being very different from cooperation in production we will need to have methods for its study correspondingly different; it is to these two separate aspects that the two parts of this working paper are respectively dedicated.

Quasi-interest on zero investment

Two features of the consumption-helping process are worth mention. In comparison with the individual family struggling along on its own, the collectivity can help its members without accumulating a fund. Its taxes collected for education are paid out in school construction and support as soon as received; its social security taxes are immediately spent on the old people of the moment. If the age distribution is stable it could even out the consumption of its citizens through their life course without anyone saving anything. Moreover if the age distribution is stable and the population increasing the community could seem to obtain interest on a fund that it has not saved! At least this applies to the provision for the old; what Samuelson (1958) calls the biological rate of interest is available; each generation can get more in old age pension than it contributed, simply because of the growth of population and income between the time when it contributed and when it drew. In a rapidly increasing population old age pensions are cheap, at the same time as education costs are high; insofar as children have to be schooled before they become earners

there are more of them in relation to the earners at any one time. The children, belonging to a later and therefore larger cohort, have their schooling cost paid by the smaller working cohort of the time, an effect that will be identified with negative interest.

We can provide an arithmetic example of what all this amounts to by supposing some rate of increase, taking it that the school children average 10 years of age, the working population 35 years, and the retired 70 years. Table 4 shows by how much the effective burden is modified by the sole fact of population growth. For instance at 3 per cent it is as though 142 per cent was added to the amount set aside for the old, and as though 59 per cent was deducted from the payments made for the care of the young.

Table 4. Effective quasi-interest paid or received on unfunded provision for schooling and for pensions. Percent advantage or loss per person working, compared with cost in a stationary population.

Assumed mean age of benefit or of work	Effective percent interest on unit with population growing at			
	0%	1%	2%	3%
Schooling:10	0	-26	-45	-59
Work:40	0	0	0	0
Pension:70	0	35	81	143

Thus under a rapid increase of population schooling of the young is a serious problem, while the care of the aged is surprisingly easy. When the rate of growth slows, ultimately as it must to zero, then the schools are partly empty on the one hand, and there is the crisis of social security that we know about. The entire structure based on growth-generated quasi-interest collapses.

Thus we have seen the contrast between the individual and the collectivity in respect of the capacity to shift the time when income is spent. The individual can defer the spending of income; he cannot advance it. He can save for the college education of his children out of income earned before the age of about 50, say; he cannot send them to college with the income that he will later earn about the age of 60.

A person would have considerably more flexibility if the law permitted an effective pledge of future income. One can borrow on bonds or other collateral, but that is simply converting past income. In order to pledge future income one would have to consent to some effective sanction for ensuring that the debt be collectible. Our laws protecting debtors are so effective and wide-reaching that they prevent the advancing of credit, for instance on future salary, beyond a very small scale at very high interest rates. The law would have to permit people to sell themselves into slavery before there could be any substantial spending in advance of earning.

Incidentally to protecting the debtor the law making impossible an effective pledge of repayment prevents some of the indebtedness that would otherwise occur, and thus may have the function--even though that is not its explicit purpose--of causing the community's saving to be greater than it would be without laws protecting debtors.

The LDCs and the decline of fertility

Table 4 has clear implications for the development process, showing as it does how population growth increases the burden of the young at the same time as it diminishes that of the old. This is a new way of expressing a very old proposition, one that goes back at least to Coale and Hoover (1958), in which it is shown that the accumulation of capital is hindered by the need to care for many children, and to provide the new labor force with existing tools before the

economy can be renovated--to express the matter much too briefly. We find that the notion of quasi-interest is useful insofar as it contrasts the effects of children and the aged. The comparison has attained a certain currency recently, partly through the discussions of the World Assembly on Ageing, held in Vienna this year.

It has always been known that following the decline of fertility there comes a negative element in development that parallels the positive effects on resources and the accumulation of capital. We cannot get the benefits of containing the pressure on resources and greater capital accumulation per worker without an increase in the aged relative to the number of workers. The advantages of the chain-letter game that is played out in an increasing population, by which ever more young people are available to support each old person are discussed below. These advantages apply indifferently whether individual parents are supported by their own children, or the community supports older people through social security. The cnain-letter game cannot be played forever, and the question is whether to stop it now, or at some later time when further difficulties associated with the larger population will have accumulated.

The World Assembly on Ageing meeting in Vienna in 1982 made much of the difficulty in the maintenance of the old that arises in the wake of control of fertility. The opponents of family planning would like to take advantage of their late discovery of old age. It might have been better if demographers, who were never in doubt about this point, had made more of it publicly in the debate on family planning, so that there would have been no reason for the public to discover it with surprise and disappointment. Some demographers have indeed laid stress on this, notably Coale (1980) in relation to China's dilemma in the adoption of the one-child family. These points are reviewed a recent UNFPA (1982) paper.

Yet ultimately, all agree, any advantage of growth is at best temporary; like a chain letter (though not as quickly) it has sooner or later to come to an end.

Social security wealth

By the mere enactment of the law establishing social insurance wealth was created amounting to trillions of dollars. There must be something wrong with the preceding statement; since the enactment did not produce even one dollar's worth of goods how could it make a gift of trillions to the nation? The answer is that it provided some individuals with claims on other individuals, and the aggregate of the claims constitutes wealth for the former.

There are at least four ways of reckoning this wealth for a cohort of given age.

1) We can take the simple value of what that cohort will get on the average by living as long as the prospective life table says and disregard their contributions on the grounds that they have to pay taxes anyhow. Thus for a cohort aged x the wealth that will ultimately be received is an expected T_{65}/l_x per person, or about 14 times the annual benefit, say $5000 in the United States, or $70,000 per person now working. Multiplying by the 100 million or so in the labor force gives $7 trillion in total. It is not clear whether we should also include those who have not yet started to work and so bring the total to $10 trillion.

2) We can consider only the present value of that amount, discounted at some suitable rate of interest. Since the amount is indexed we should discount by the real rate of interest, whatever that is going to be over the next 50 years or so. This is presumably the $2.4 trillion that was often mentioned in the literature of the 1970s (Feldstein 1974); in 1982 dollars it would be correspond-

ingly larger.

3) We can take the accumulated payments of all persons now contributing, as though each was buying an annuity to start at age 65. That is the amount he would have to his credit if the operation had been fully funded, which is to say if each cohort had been paying for itself. Our formula of the earlier paper (Keyfitz, 1981) shows that this is about 6 times the annual drawings (i.e. about six times the annual contributions since no reserve is being built up) or over $1 trillion.

4) We can take account of the taxes to be paid, and then we can only find that the wealth represented by social security is zero, in the same sense that the wealth represented by the national debt is zero, on the grounds in both cases that claims by one individual against others are neither assets nor liabilities for the community as a whole. Thus social security constitutes wealth in the sense that the national debt is wealth.

At the same time it must be pointed out to those who worry about the national debt of $1 trillion, that the total of claims that it represents is only about one seventh or one tenth that of social security calculated on the corresponding basis of 1) above. (Petersen, 1982)

The Chain Letter Principle

The advantage of a chain letter to those who initiate it and the disadvantage to those that follow after are well-known. If each recipient pays his dollar to the name at the top of the list and sends the letter on to four new people whose names he adds at the bottom, then provided the necessary discipline is maintained and enough new addressees are found, each participant will get the fourth power of four dollars back after four cycles of mail. If there are 10 persons on the list participants will obtain 10 billion dollars back, always provided

that enough new participants willing to maintain the discipline can be found. (It would need more than twice the present world population for the original sender to get his $10 billion, and the same number of people for the next sender). It is the same with social security on the pay-as-you-go basis, except that the cycle is not the time for a mailing, but the length of a generation. U.S. law forbids the use of the mails for the chain letter, but requires the chain letter principle for social security.

All this has been said before, but perhaps the analogy of the increasing population to a rate of interest has not been sufficiently stressed. If a letter takes a week in the mail, then the chain letter with four names provides a rate of interest of 300 per cent per week; one with 10 names of 900 per cent per week. Our Table 4 showed the (more modest) implicit returns on pension contributions.

It helps understanding to realize that the formula for cost under a funded scheme with rate of interest r is identical with the formula for a pay-as-you-go scheme with rate of increase r. The growth of population works just as does interest to increase the return that the individual participant receives. (For a proof see the earlier working paper, Keyfitz,1981)

As the scheme matures and the population increase slows people seem to be getting less and less for their money. If the benefits are to be maintained then the contributions have to be raised. That is what has been happening in all countries where the contributions have been specifically levied for this purpose. (Where the benefits are paid out of the general treasury the same phenomenon occurs but there is no costing system to reveal it.) Since the drop to stationarity is sooner or later inevitable if only because space and resources are finite, the quasi-interest obtained because of population increase is necessarily temporary.

A calculation that would demonstrate the chain letter more empirically than this paper has done would be to take individual contribution records and link them to benefit entitlements. Records for categories of individuals could perhaps be obtained simply from the regulations that existed from year to year during the history of the scheme. One could for each individual or for each category see what percent interest he or she effectively obtained. One very rough calculation shows that early participants averaged a generous 7 per cent or more in real terms; those who retired in the 1960s and the 1970s averaged about 3 per cent, and those retiring now are getting their contributions back without interest. It is in the nature of a chain letter that later participants, say in the 1990s, will balance this out with negative interest; such a balancing out must occur since the scheme as such does not produce anything, and stationarity is in the end inevitable. (Though the scheme does not produce anything its administrative costs are a creditable one percent or less of the amount handled and can be disregarded for our purposes.) If one person gets more than in the long run another must get less, and early participants are favored over later. The mechanisms of this process deserve both theoretical clarification and empirical study.

In such study one would have to distinguish between open and closed systems. The idea of the chain letter is that it is expected to be open, which is to say that ever increasing numbers of persons would continue to enter. All such arrangements that come to an end, in that the recruitment to the chain drops to zero, are plainly zero sum, which is to say that they have amounted only to an exchange, with the losses exactly equal to the gains. An intermediate condition is the chain does not end, but drops from increase to stationarity. From that moment the further entrants get their money back, and those who were in the scheme in the increasing phase have made their gains at no cost to anyone else.

The only sense in which their gain cost anyone anything is that all subsequent players now must be on the pay-as-you-go system rather than on the funded system. This is no disadvantage as long as exact stationarity is maintained in the population but moment that there start to be waves then we have the difficulties mentioned frequently in this paper.

The theory would then go on to see to what extent every such scheme is asymptotically closed. This is in the sense that as time goes along the gains must be a smaller and smaller part of the sum of transactions. The closure property is the equivalent of the well-known fact that an exponential, however small its (positive) parameter, cannot continue for an infinite time.

No one should be surprised that the moment when the rate of return has fallen to zero and threatens to become negative is the moment when the public and congress become alarmed, and successive Commissions are appointed.

But the maturing of the system need not occur once and for all. When a new group enters the labor force--for instance married women in the 1960s--that gives a new start, since the entrants provide contributions and they do not yet draw. That has to end when all the women who are going to enter the labor force have come in. Other groups previously omitted can be drawn in by legislation--farmers, self-employed, public servants who have resisted incorporation up to now. Each such group enables the existing contribution schedule to be continued for a little longer without any diminution of benefits.

However, this is not all, for the chain letter principle is sustained by another quite different agency. Rising wages have the same effect as population increase. Wages rising at 3 per cent per year will enable everyone to seem to be obtaining 3 per cent return on contributions. This applies whether the rise of 3 per cent is due to inflation, in which case the 3 per cent is a money return, or if the rise of 3 per cent is due to rising productivity, in which case

the participants get a real 3 per cent return on contributions.

The impact of social security on age of retirement

Beneficiaries under the retirement program of the US OASDHI (Old-Age, Survivors, Disability, and Health Insurance) rose from 13,918,000 in 1965 to 22,421,000 in 1979, and benefits paid out went from $12.5 billion to 67.1 billion.(Statistical Abstract, 1981, p. 324). This five-fold increase has as one of its causes the fall from 27.9 per cent of males 65 and over working in 1965 to 20.0 per cent in 1979. We will examine what fraction of labor force changes are accounted for by changed labor particpation rates.

Table 5 shows a drop in male participation rates at all ages for the United States and Japan; a more extensive calculation for the 13 countries of our Table 6 contains no group in any country in which the male participation rates are foreseen to increase over the decade. Females rates, on the other hand, are expected to increase, in greater degree at most ages than the male decrease. But what dominates Table 5 from the present viewpoint is the decline in participation rates at age 65 and over, for both sexes, typically around 1 per cent per year. (On the other hand population growth at old ages is great enough that the absolute number of workers continues to increase.)

Comparison of Japan and the United States in many of the respects with which we are here concerned is hardly to the advantage of the latter. Japan shows 89.6 per cent of adult males in the labor force, compared to the US 85.3; 46.0 of its males 65 and over were active compared with 22.9 per cent for the US. Japan has a higher percent of its population enrolled in secondary school (Statistical Abstract 1981, p.873); it spent somewhat less in proportion on education (5.7 per cent of GNP as against the US 6.3 per cent), but one suspects spent it more effectively in better-disciplined schools; had 2 per cent of its labor

force unemployed in 1980 compared with 7.1 per cent (p.682); and showed 930,000 days lost in industrial disputes in 1979 compared with over 15 million.

Table 5. Average annual increases in population, labor force, and participation rates, 1980-1990, for the United States and Japan.

	POPULATION		LABOR FORCE		PARTICIPATION RATES	
Age	Male	Female	Male	Female	Male	Female
UNITED STATES						
10-14	0.79	0.74	-0.47	-0.36	-1.25	-1.09
15-19	-1.56	-1.61	-2.92	-2.30	-1.36	-0.69
20-24	-1.68	-1.67	-1.89	-1.50	-0.21	0.17
25-44	2.41	2.26	2.39	2.90	-0.02	0.64
45-54	1.01	0.88	0.96	1.54	-0.04	0.66
55-64	-0.37	-0.34	-0.61	0.15	-0.24	0.49
65+	1.32	1.51	0.38	0.99	-0.95	-0.53
JAPAN						
10-14	1.32	1.35	-0.67	-0.32	-1.98	-1.66
15-19	2.06	2.07	1.21	1.21	-0.86	-0.86
20-24	1.10	1.03	0.90	1.41	-0.21	0.38
25-44	-0.33	-0.50	-0.34	0.21	-0.02	0.71
45-54	0.99	1.16	0.95	1.90	-0.04	0.74
55-64	4.48	2.68	4.20	3.18	-0.28	0.51
65+	1.97	2.82	0.79	1.93	-1.19	-0.89

Source: ILO forecast 1975-2000

On the variable of age of retirement the influence of social security is clear, though measuring the effect quantitatively is difficult. It is not unnatural that with each expansion of the benefits--including provision for dependents and indexing--further millions of people are drawn into retirement. Some of the underestimate of costs is due to this effect of social security on behavior. If at each new stage, in considering some new benefit, it was assumed that people

would continue working to the same age as before, and the new benefit caused many to advance their retirement plans, then some of the history of underestimate of costs becomes understandable. It is not easy to take account of such behavioral responses in actuarial calculations.

At least in retrospect we can ascertain how much of added cost and of diminished contribution is due to earlier retirement in exactly the same way that we have analysed mortality and fertility. One would take the cost (say for the retired) with retired fractions of 1960, and of 1980 and see how much the difference was. This would be added to the purely demographic differences obtained as described above. The same can be applied to the future, using the prospective retirement ratio presented by the ILO against the ratio fixed at the 1975 level.

The use of the word 'cause' is bound to give trouble in the present context. We may be able to say that so much of the increase of cost is due to mortality change insofar as we can demonstrate this with a direct numerical decomposition. We can likewise say that earlier retirement was responsible for some part of the increased cost. But when we come to a closer analysis we are in trouble; there is no way of saying how much of the earlier retirement is due to the social security scheme, on the one side, and how much is due to changed lifestyle, lower ambition, or other cultural change on the other side. That kind of decomposition is beyond any possible computing.

The crisis of social security in the 1980s is not due to aging

Yet despite much that has been written, the aging of the population is not the cause of present difficulties in social security. In fact the demographics have been relatively favorable for the last few years. The baby boom has been moving into employment, that is into contribution status, and the retirees are those who were born prior to 1920. While the birth rate had not by 1920

decended to its low point, yet the absolute number of births was only about 2 million in the United States, and even adding subsequent immigrants does not bring the number in retirement year by year to any very high figure.

The prospect for the next few years is mixed: entrants into the labor force will be fewer, but it will not be long before the new retirees are the births of the 1930s, and the scheme will be given a respite as far as this factor is concerned.

One way of thinking about the matter is to compare the population 15-19 with that 60-64. The former group are about to enter the labor force, and the latter are about to retire. In 1982 the former are estimated at 19.4 million for the United States, the latter at 10.3 million. Additonal to these prospective entrants into the labor force and retirement respectively are immigrants who can be assumed to enter mostly at working ages.

Counting those present in 1982, the net increase of the labor force from 1982 to 1987 is approximately 19 - 10 = 9 million, of the retired population about 10 million. These additions will raise the ratio of retired to workers during the next five years; taking ratios the working ages will increase by about 5 per cent, the retired ages about 50 per cent. Looking further down the line, in the following five years the entrants into the labor force will be about 2 million lower, the exits at retiring age about 1 million higher than in 1982-7, so the change from 1987 to 1992 will again be adverse. Similar calculations of increments to the labor force and aged population respectively over successive five-year periods show in each interval proportionately more going into the aged category.

Expressing the same matter in terms of the ratio of those over 65 to those 20-64, the demographic element in the social security burden, we find 0.11 in 1940, a deterioration to 0.17 in 1970, a trifling rise to 0.18 during the subsequent 10 years, then a slow upward movement, and only about 2020 a sharp rise within a few years to fully 0.27 (US Statistical Abstract, 1981). Note that the

impending bankruptcy of the social security fund during the 1980s is occurring at a time when the demographic burden is rising less rapidly than either before or after. If the pensions are grossly underpriced even in a time when the demographic factors are not unfavorable, indeed as the baby boom is entering working age, then a fortiori they are underpriced in relation to long-term costs. The reasons for the underpricing have to do with the political process, rather than with the demography. There will be time enough to blame the demography in the 21st century.

For the developed countries as a whole, according to the United Nations the net increase in the population aged 15-64 will be 59.0 million from 1980 to 1990, and in the population 65 and over 12.7 million In relation to the 1980 numbers of 742.3 and 127.7million that means that the proportional increase of the old is only slightly more than that of the working age population, and the working age population remains at 66 per cent of the whole. A small increase of those too old to work is offset by a slight decrease--at least according to this projection--of those too young to work.

In summary, the demographic factor is not the main cause of the present difficulties either in the United States or in the developed countries as a whole. Prior to late in the first quarter of the 21st century we have to seek other causes causes for the crisis of social security; after 2020 demographic causes will dominate. Let us look into the several demographic causes to see which are more and which are less important when demography becomes operative.

Decomposition of age changes

Partly to show the usefulness of the technique, we first break down the increase of the female labor force in the United States according to the increase in number of women of working age, and increase in participation rates. In Table 6 we note for the United States an overall ratio of labor force in

1990 to that in 1980 of 1.136, i.e. an increase of 13.6 per cent.

Table 6. Decomposition of female labor force ratio, 1990/1980 into component due to participation rates and component due to population, for 13 countries.

Country	Ratio 1990/1980	PARTICIPATION EFFECT		POPULATION EFFECT	
		Ratio	Percent	Ratio	Percent
AUSTRALIA	1.208	1.034	17.2	1.167	82.7
BRAZIL	1.504	1.125	27.0	1.337	72.9
CANADA	1.164	1.045	29.6	1.109	70.3
FRANCE	1.136	1.049	37.8	1.081	62.1
ITALY	1.100	1.054	55.8	1.043	44.1
JAPAN	1.133	1.052	39.1	1.080	60.8
MEXICO	1.576	1.122	23.3	1.402	76.6
NETHERLANDS	1.096	1.026	30.0	1.063	69.9
SPAIN	1.161	1.084	54.6	1.070	45.4
SWEDEN	1.109	1.050	46.7	1.057	53.2
UNITED KINGDOM	1.079	1.033	44.4	1.042	55.5
UNITED STATES	1.136	1.041	33.0	1.086	66.9
WEST GERMANY	1.057	1.032	62.7	1.018	37.2

Source: Calculation based on ILO forecast 1975-2000.

The pure population effect is a ratio of 1.086 if the 1980 participation rates are used for both dates, and a ratio of 1.090 if the 1990 rates are used. (The latter not shown in the table.) These numbers are close enough that one can average them, and say that the population effect is 1.088 or an increase 8.8 per cent. Similarly the participation effect is an increase of 4.3 per cent. If we take the fraction 4.3/(4.3 + 8.8) as due to participation change and 8.8/(4.3 + 8.8) as due

to population change we obtain the 33.3 percent and the 66.7 per cent shown. The aftermath of the baby boom is twice as influential in determining labor force numbers as increasing participation rates. In the United States the baby boom peak was higher than in other industrial countries, and the population factor correspondingly more important in explaining changes.

It is natural to think of the prolonging of life as responsible for the difficulty of supporting the old, and that it is lower mortality that raises the contributions required for a given level of social security. Elementary demography gives the appearance of confirming this. One observes that the expectation of life about 1930 was 60 years; about 1945 this had risen to 65 years; in 1960 it was 68 years; in 1990 it will surely be 75 years. Sole reference to these expected values suggests that the number of years over 65, once null, is now rising towards 10. Such a dramatic increase must surely decisively affect social security. Some such thinking seems to lie behind popular articles on the subject.

Further knowledge of demography shows such reasoning in terms of expected values at birth to be wholly wrong. The expectation life at birth has nothing to do with the matter insofar as it is affected by mortality in infancy and childhood. What counts is the fraction of workers who survive to draw benefits, and the mean length of time after retirement that such workers live. In life table terms these two factors are T65/(T20 - T65) and T65/165 respectively, which multiplied together make T65/(T20 - T65), where Tx is the number of persons over age x in the stationary population, say with radix 100,000. Thus the decisive ratio is those of retired age to those of working age in the stationary population.

Alternative projections

Another and more immediately empirical approach to this question is to decompose the change in the projected population into its elements. When we do so it turns out that the decline of fertility is ultimately a bigger element than mortality in any demographically caused increase in the burden of social security. It is not so much that there are more old people than there would have been with the mortality rates of a generation ago, but there are fewer people of working age to support them than there would have been if the fertility decline of the 1960s and 1970s had not occurred. We will estimate the strength of the two factors over the course of the next half-century.

The obvious method is to project the population with the lower mortality likely to evolve over the next generation, and also with mortality fixed at the level of 1975, say. The difference has to be due to mortality change as it would take place. Then we can do the same with the fertility expected to evolve as against the fertility fixed at the level of 1975. The difference will be due to fertility change. Call p(m0,f0) the population, say in 2030, resulting from 1975 mortality and fertility, and correspondingly for the other combinations. Then for the pure effect of mortality change we would have p(m1,f1)-p(m0,f1) at the 2030 fertility level, and p(m1,f0)-p(m0,f0) at the 1975 level of fertility. The average of these, which it is permissible to use if they are not very different, gives the net effect of mortality. Similarly p(m1,f1)-p(m1,f0) averaged with p(m0,f1)-p(m0,f0) gives the pure effect of fertility.

The technique can be applied equally to the pension cost in absolute terms, to the contributions in absolute terms, to the ratio of the former to the latter, to schooling cost, and to any other function of age. It can be applied decade by decade for the last 40 years, and to projections over the next 100 years.

Some simple models for long-term social security costs

We cannot discuss long-term costs of the social security scheme without some conception of how population and work are going to evolve during the coming years. To start with the very simplest hypothesis, suppose in the ultimate stationary condition for which we must prepare that each person starts work at age 20, retires at 65, and then lives on to 80. The person works for 45 years, and lives on pension for 15 years. If everyone is in this condition, and the population is stationary, with a fixed number feeding in each year--say 100,000--then for a pension equal to the (supposed uniform) salary the contribution each year will have to be exactly 25 per cent of salary. For with three persons working for each one retired, the contributions would be 3/4 of salary for the retired persons, and each of those working would retain 3/4 of salary, so the person would have a lifetime income of 3/4 of the nominal salary. It is as though three full salaries are earned for each 4 persons in the population, and they are divided equally among the four.

We can take account of mortality in the stationary condition by referring to a life table Tx column. For the United States 1979 table T20 - T65 was 4136 on a radix of 1000, and T65 was 1272. For 100 per cent replacement with everyone working to age 65 and then retiring the fraction of salary that would have to be taken in tax would be 1272/(1272 + 4136) which is 24 per cent. One way to think of this is to say that if each working person receives $1 then together they receive $4136, and this sum would have to be divided among 5408 persons, so each would receive 4136/5408 before as after retirement, or $0.76.

Such calculations can be improved by several feasible modifications:

1) Suppose that people are satisfied with 60 per cent of the uniform salary on retirement. After all a considerable part of the expenditures of working people are directly connected with their work; this includes many items of clothing, transport, restaurant meals, entertaining, and even some

housing insofar as housing accessible to the place of place of work is more expensive. Aside from this the retired person is not typically sending children to college and indeed is long past maximum financial responsibilities. We ought to consult budget studies to find how much the elements of

a) work-related cost and

b)diminution of responsibility

amount to in a typical family for the several countries; suppose for now that they are 40 per cent of expenditure during working life, so that the person's own costs are 60 per cent of salary; then this would be the right percentage to provide for in old age in order that the person may live as well as when working. There are some costs of being old, especially health costs,but we will assume that these are covered under some scheme such as medicare, that does not come into the present calculation.

In this situation the premium or contribution that the person would have to make while working would be 60 per cent of the 25 per cent of which we spoke earlier--i.e. the premium would be 15 per cent of salary. That is somewhat higher than the 13 per cent now contributed by employer and employee together in the United States; we will have to test how realistic it is in view of other qualifications. Replacement values for a number of countries are shown in Table 7.

2) How much difference would it make if people insisted on retiring at 60, or if they were satisfied to work until 70? Evidently a great deal. Retirement at 60 on 60 per cent of salary on our zero mortality to age 80 hypothesis would raise the tax from 15 per cent to 20 per cent; retirement at 70 would lower it to 10 per cent. It would take twice as large a bite out of the salaries of all those working to provide for retirement at 60 as at 70. Insofar as we have used a rectangular distribution rather than the actual downward sloping distribution

Table 7. Replacement rates of social security old-age pensions for workers with average wages in manufacturing, and for couples, selected countries, 1969-80.

Country	PENSION AS PERCENT OF EARNINGS IN YEAR BEFORE RETIREMENT			
	Single worker		Aged couple	
	1975	1980	1975	1980
Austria	63	68	63	68
Canada	33	34	47	49
Denmark	29	29	44	52
France	60	66	74	75
Federal Republic of Germany	51	49	51	49
Italy	61	69	61	69
Japan	37	54	39	61
Netherlands	43	44	61	63
Sweden	57	68	73	83
Switzerland	40	37	60	55
United Kingdom	31	31	47	47
United States	38	44	58	66

Source: Social Security Bulletin, Vol.45, No.11, November 1982.

this underestimates the difference that age of retirement makes. A calculation using the life table is one stage more realistic; T60/(T20 - T60) is much more than twice T70/(T20 - T70). For the United Kingdom 1977-79, for exaample, averaging the two sexes, we have 0.40 against 0.17; that is a tax of 40 per cent as against one of 24 per cent for 100 per cent replacement.

3) Our sense of equity would provide somewhat more for those with family responsibilities--in particular having a nonworking spouse who does not qualify for a pension on her own. Suppose that one third of the population are in this condition, and that they are entitled to a 50 per cent increase of pension on

that account. With the standard age 65 retirement the 15 per cent premium for 60 per cent replacement would go up by one sixth (1/3 x 1/2), to 17 1/2 per cent.

4) Since on our assumptions the contributions are paid out as soon as collected and the population is stationary there is no fund and hence no interest accumulation in the usual sense.

Suppose however that the economy is growing (say at 1 per cent per annum), that the growth is reflected in higher wages per worker, and hence in an increased take of the social security tax. The application of this breaks down according as the pension is paid as a fraction of current wages or as a fraction of the wages received by the pensioner while he was working. If the replacement is of 60 per cent (or any other fraction) of current wages, then in the stationary condition a quasi-interest of 1 per cent per annum is obtained. If 60 per cent of the wages received by the person while working are replaced, then the premium would be reduced by something like the difference between current wages and those received a generation back, so the effective replacement rate is considerably less than 60 per cent.

To repeat the earlier crude approximation of Table 4, if the rate of growth of real wages is 1 per cent per annum, and if the average age of pensioners is 70 and of workers is 40, then we can treat the 1 per cent growth like a rate of interest, and say it accumulates something like 35 per cent during 30 years, and this constitutes a kind of dividend to reduce the premium to 74 per cent (=100/1.35) of what it would otherwise be, and hence that the premium is reduced by about 26 per cent.

One has to be cautious about incorporating this assumption, in that forecasting how the real wage will move over a long period is even more speculative than forecasting population.

The next step in the direction of realism is to replace the uniform salary by a salary that varies with the age profile shown by the actual population. It is not obvious that it makes much difference whether one uses average salary or the profile--with the right kind of average, when interest does not enter it would make no difference at all. But even where interest does not enter we have the equivalent of interest in the form of increase of wages, and the age gradient of salary makes a difference to the effective average.

Test with more realistic model

The above simple models may be useful for an intuitive understanding of the relation of costs and benefits, and for explaining these to the public, but to see how the system would evolve under any given combination of contributions and benefits we need an actual projection. To go from 1975 to 2075 should suffice to indicate the long-term prospect.

For any supposed contribution level the calculation would show over each five-year time interval what the income of the scheme would be and what the expenditure. A printout would say just how much was being taken from reserve or how much added in each five year period. In principle the hundred years should end with a zero balance.

We can surmise what will happen before the calculation starts. During the 1980s and up to about 2020 the fund will keep rising, owing to the entry of the baby boom generation into the work force After about 2020 the fund will be drawn down owing to the retirement of the same baby boom. After about 2040 there will be some relief as the low births of the 1970s retire, though such relief depends on the great unknown of which will happen to births over the next 50 years starting now.

A similar calculation is possible for the past. It is instructive to consider

what might have resulted if one had applied such a method not to the population as it has actually evolved since 1935 but to the projection of population available in 1935 when the United States social security scheme was first legislated. At that time it was thought that births would continue to be low for the long term future, which is to say that the population would age much more rapidly than it in fact did. This should give a conservative statement of costs, which is to say that if anything the premiums required would have been overestimated. The calculation can be carried out with the population as it was projected not only in 1935 but also as projected at various times since.

To make the calculation realistic one would need to suppose some rate of interest to the fund during the time when it was positive, as well as some rate of interest for the borrowings when the fund was negative. One could go on to apply the rules concerning contributions in detail. More difficult would be the projecting of earnings and employment; one would have to make assumptions not only on the total wage bill but on the way it is distributed, since the formula sets a maximum for each worker.

Cycles in births and the relation between the generations

Questions of intergenerational equity do not arise in a population with fixed birth and death rates and hence steady increase. In such a population the age distribution is stable, and each generation has the same relation to its predecessors as its successors have to it. The required tax contributions to pay-as-you-go pensions are constant over time, and there can be no question of one cohort having a higher ratio of benefits to costs than another.

With birth rates that fluctuate the question of intergenerational equity assumes considerable importance. Since cycles seem to be inseparable from the use of birth control we can count on public attention to equity for the indefinite future. The most trouble will be given by cycles of two generations

in wave-length. It is cycles that change the ratio of the population over 65, say, to that 20 to 65 that are of concern; the effect will be strongest with a cycle of births of half-wavelength 25 to 30 years. Such a cycle gives first a high ratio of those drawing to those contributing, and hence a great burden on the latter; then this changes to a low ratio, and corresponding relief of the contributors, assuming that the pension per retired person is held constant over time, or else is uniformly rising. Those shorter or longer than two generations will give less trouble.

We know a little about the amplitude of cycles of births, having observed those in some countries for up to two centuries. Unfortunately we have only one baby boom to go on, but let us take it as providing an indication of the range that is likely in the future. From the fact that the high in births was 4.3 million in the United States in 1961, and the subsequent low in the early 1970s was about 3.1 million, we can say that on a mean of 3.7 million births the extreme variation would be 600,000 births up and down. In this case the cycle seems to be shorter than the 50 to 60 years suggested above as having the maximum effect on equity, but we will combine the amplitude of the actual baby boom with the wave length that would maximize the intergenerational effect.

To ascertain the relation between cycles in births and cycles in the ratio of pensioners to contributors, we suppose constant mortality, and work out an ordinary population projection with a sine wave of births having amplitude 1.2 million and wave-length 60 years. With these inputs we will take as the relevant part of the output the ratio of the population 65 and over to that 20 to 65. It is expected that the output would considerably amplify the input.

One needs a reserve to buffer such waves as are generated in this model--and in the reality. Our next question is how big such a reserve must be in order to permit a constant charge to individuals along with a constant amount

of pension. The amount of reserve may be calculated by trial and error. Start the iteration with a reserve of 10 per cent of the average annual expenditure; suppose a suitable rate of interest accumulation, say 5 per cent; suppose also that the process starts with a large number of persons drawing, the reserve having been built up during the preceding period when there were many contributors and few drawing. In these circumstances we would find the amount of the reserve at the bottom of the next cycle or two. If it turns out that the reserve is positive at the bottom, then 10 per cent is larger than necessary; if it is negative at the bottom, then 10 per cent is too small. One could iterate to the reserve that would just serve to buffer the amount of fluctuation in births.

Under this condition we still have a question of equity between the initial generation that provides the reserve and the later generations that benefit from it without contributing. It would be better to build up the reserve over the course of several cycles. With such long waves the rate of interest that can be supposed becomes important; we need to experiment with several rates, preferably being concerned with the real rate after inflation is allowed for, not the nominal rate.

If the scheme is permitted to borrow in the troughs then a smaller reserve will suffice; the condition being only that the average balance over the long term be zero. Now no initial reserve would be necessary; one would start accumulating or borrowing from a neutral point. Given the history of short-range politically influenced decision-making on social security one may question the prudence of allowing borrowing.

Elements in Intergenerational Equity

The fluctuations of pension costs or benefits raises the subject of intergenerational equity, but it is only part of that subject. It is well to list the various

components of equity and see how the pension component fits with them.

1) Persons currently working pay the pensions of those retired. Since this is the subject of the rest of the paper, we need not say more here. However, it should not be forgotten that there are other kinds of transfer that similar related to the aged population, and hence can cross generations in the same way as pensions. Health insurance, whether private or public, involves heavier payments and smaller utilization by those working than by those too old to work; insofar as the former are healthier than the latter and current premiums do not take full account of this some part of the premium must be considered in the intergenerational account. (Though again the matter is radically different for a funded and a pay-as-you-go health scheme.)

2) Persons currently working pay for the schooling of the next generation. This goes in the opposite direction to the pensions, and may be regarded as an offset. If the two were of the same amount, then equity would be preserved in the community as a whole, just as it is in the individual family; father pays for the schooling of his children, and in return expects them to keep him in his old age. We need more data on the relative costs of schooling and pensions; some guesses are made in the section below.

For a traditional community the relation is clearcut. Individuals are identified in the family; the same father who paid for upbringing is the one who claims for maintenance later. If there is any place for gratitude in the social system it is here, and if there is one virtue that parents take care to instill in their children it is a sense of gratitude and respect towards their elders. The most that can be said about the relation in a modern community is that the same (more or less undefined) cohort that paid for schooling now claims for pensions. The state or local government is the intermediary, and it would be too much to expect gratitude for schooling to be funnelled through the

government and then be transmitted to individual old people.

For any community 'schooling' is at most a part of the cost of the oncoming generation. What is meant that would fit into the present context is total upbringing cost to be compared with total cost for the care of the aged. Unfortunately for measurement both contain elements that cannot be estimated by any method known to statistics. Mother's love may have infinite value, or none at all, depending on the frame of reference used.

3) The large generation has an easier time covering the pensions of its parents, but on the other hand it has a harder time making a living, if we accept the reasoning of Easterlin (1980) and others who make the prosperity of a group depend on its being small. We have at least the possibility that the older generation did the younger damage by bearing so many of them, and giving them an easier time in paying for the pensions of their parents is but a small offset to this.

4) A crucial element in the exchange is the material investment by which the older generation gives the younger a standard of living higher than its own. One can imagine a selfish cohort that ran its capital into the ground, aiming to leave it at net value zero by the time it died. Such a cohort would have little claim on the one that followed it, and the one that followed would have no means to respond to a claim if made, since its income would be only what can be produced without initial capital. Of course we now know that material capital is not what counts most, but rather human capital, including the ability of individuals to work together, to organize themselves effectively, and to perform the technical tasks necessary. That throws us back to item 2) above, yet material capital is not to be wholly disregarded.

A cohort that educated its children well, and also gave them a generous stock of physical capital would have a large claim on them collectively, and

they would have both the means to look after their aging predecessors and the willingness to apply them to this end. Thus after a long argument we come back to the means of providing pensions that arises naturally under a competitive system--i.e. the purchase of actuarially calculated annuities. If such savings are invested in capital goods they produce income from which in due course pensions can be paid. We have argued for partial funding on the grounds it could even out the costs and benefits of successive generations under the population waves that seem to be part of life in a contracepting society; the quite different argument of intergenerational equity leads to the same conclusion.

Reciprocity between parents and children

We proceed to examine the commitments that are required for any kind of social security scheme to work. In the pay-as-you-go arrangement each generation has to acknowledge an obligation to support the preceding generation, with no possible quid pro quo. True it has been brought up and sent to school at the expense of the older generation, but at least in the past this has created an obligation on an individual rather than on a collective basis. The collective obligation to the old must inevitably seem weaker than ancient traditional obligations within the family, and yet as time goes along more comes to rest on this obligation, especially because of two factors: the greater length of life and the increased cost of medical care.

From a purely cost point of view medical care feeds on itself: better care enables people to live longer, and pushing into older ages means more days in hospital per year, as well as more expensive treatment while in hospital. Medical advance that enables individuals to live longer gives them more opportunity to use physicians and hospitals. Let no one think that funds invested in medical research will save money later by keeping people well; they do of course help

keep people well, but that is more than offset financially by people living into a time of life when health hazards are greater.

Some hypothetical data should give an ideal of the cash items entering into the balance between costs of the old and of the young. Schooling information is available for most countries. Putting the matter on a per child basis, it might cost $5000 per year to keep a child at school on the average, and length of schooling is typically 12 years in industrial countries, making a total of $60,000. At the other end of life an old person might live 18 years beyond age 65, and be in hospital 6 days per year at a cost of $300 per day, or $1800 per year, making a total of $32,400. Aside from this the cost of the pension might be $5000 per year for the 18 years, making $90,000 in all. Thus the cash outlay for the old is considerably greater than the cash outlay for the education of the young. How much one adds for the personal service of the parents to the young is arbitrary. At one extreme taking the mother's time at a market price of $10,000 per year for 10 years gives $100,000. At the other extreme taking the mother at zero, as though she has no market value while raising her children, leaves the cost of the child at the relatively moderate amount needed for food, clothing, etc. We tend to arrange matters so that the personal care factor, the part that does not go through the market, is much greater for the young than for the old.

Thus we come to the point where without taking account of the time of the parents the cost of the old is much greater than the cost of raising the young; taking full market price for the time of the parents makes the cost of children while they are dependent much greater than the cost of parents when they are old. In traditional society the exchange was taken for granted, and no one reckoned costs; in modern society more of the cost of the old than of the young goes through the market, and costs covered in cash are more visible than costs in unpaid family care.

Corresponding to this is the difference between the two kinds of expenditure, that one is undertaken individually by parents, the other collectively by the community. Couples can decide to have children or not, and this free and voluntary choice contributes to a sense of responsibility; no one decides whether to have parents, and in a voluntaristic culture the parents not having been chosen lessens the sense of responsibility of their children for them.

The number of children that a couple have will in no way influence their welfare when old if they are on a complete social security system. That the costs of the children are born by the couple, while the cost of the couple when old is not to any appreciable degree born by their own children is a clear disincentive to have children, and the low birth rates of industrial countries, all of which have collective provision for their aged, may in part be attributed to this asymmetry between the maintenance of the young and of the old.

One would like to be able to gather empirical information on the strength of the social security effect on the fertility of parents; perhaps one could use historical series or cross-sectional data or a combination, plus hypothetical questions addressed to a sample of the population. The introduction of social security has been suggested as a means of reducing fertility in the LDCs but the method, given the difficulties that it offers in the richest countries, seems hardly within reach of the poor. China is trying a modified form of this in making the income of those too old to work the responsibility of the local brigade or neighborhood, rather than of the family. Some success is reported; how far this revolutionary change can be carried remains to be seen.

Commitment beyond the family

A funded scheme lessens the amount of commitment required. It makes the balance between the generations reciprocal on the transactions involved in social security, without the need to bring in the education of the

young. For a funded scheme the individual buys a pension, say with monthly payments deducted from his wages. If the price system is stable, and the contract is adhered to, and the employer or insurance company invests the payments productively so that the interest payments reflect added social wealth in real terms, then it seems fair to say that the pensioner has paid for his own pension; more strictly that the cohort has paid for its pension, since we have to recognize that individual ages at death are a random variable.

The conditions specified can break down in a number of ways. Some employers make a commitment to their employees but do not set aside the funds for it; they disregard the first rule of accounting by which the costs of this year's production ought to be charged to this year. The firm could be out of business by the time its employees retire; it could be in business but taking losses. The pension contributions should not only build up a fund, but the fund should be held in some outside company, so as to spread the risk to the employee.

The need for commitment is not entirely eliminated by the pension contract. The annuity policy issued by an insurance company, or the mortgage contract, if that has been the instrument in which the savings have been invested, could be simply repudiated. The question would be then whether such repudiation is more or less likely than the repudiation by some generation of its obligation to the preceding generation under pay as you go. If the burden keeps climbing it would be easy for the legislature to curtail benefits immediately to relieve the current contributors. On the other hand agreement to a modification to start 20 or 30 years hence is an action by present payers to reduce their own return.

Downward adjustments to the benefits to take effect some decades after the legislation is passed is more equitable than immediate adjustment of both

contributions and benefits. Just as the cohort principle embodied in a funded scheme puts less strain on the relation between generations so any modification will place less strain on the commitment if both benefits and contributions are adjusted for a given cohort rather than at a given moment.

Up to now the legislature has been making benefits ever more generous. Presumably this accords with its perception of the wishes of the community as a whole, or at least of the majority of its constituents. But imagine the day when the constituents focus on costs, as they have up to now focussed on benefits. Nothing in law or morality prevents reversal of the trend, with curtailment of benefits in order to hold down taxes. Insofar as this takes place at a given moment rather than for a given cohort, it is again unfair and strains the sense of commitment; now it is the old whose resentment would be aroused.

That brings us to the question of how to ensure that such curtailment will not occur, or will be as moderate as possible if it is inevitable. My answer is the simple one: make the scheme funded at least in part. If full funding means the holding of six years of contributions in trust, (see the earlier working paper for the algebra) then start by building up one year's contributions in trust, i.e start by working towards one-sixth funding. Such a fund could be built up either by increasing taxes or buy curtailing benefits with existing taxes.

This is no proposal for mere manipulation of finances, but concerns the creation of a direct quid pro quo by the older generation in return for the support that it expects from the younger one. It corresponds to the man building a house for himself and another for his son while he is in his working years, on the understanding that when he is old he will live in the house he built for himself and the son will provide him with groceries. Every contribution that is made along this line will strengthen the solidarity of the generations and head off the kind of repudiation of social security that people fear. It may well be that the

investment of the old in their children is too small to ensure the maintenance of the old by the children as things now stand, and a funded scheme is a way of enabling people to help their children more--by contributing to the capital stock-- and so having a more even balance between the generations.

This argument for a funded scheme has been developed in the earlier paper, which also dealt with the the argument raised (for example by Bourgeois-Pichat, 1978) against it--that the total fund would be greater than the entire wealth of the nation. Aside from the incorrect assumptions in such comparisons of the reserve with the national stock of capital, and even if their numbers were right, no one is discussing funding the whole scheme at the level of people's wages while they are working. All that is under discussion is the funding of a part, and initially it would have to be a small part, of the provision for old age, in addition to what is done through private pension schemes.

Of course private schemes would indeed serve the same purpose, and they should be encouraged through income tax and other provisions. The U.S. government by indexing guarantees the pensions of its own employees against inflation; why should it not do the same for all employees? Some countries ineffect have started to just that.

Apparent fragility causes resistance to any change and resistance makes schemes more fragile

Because the waters have been muddied by successive authoritative statements that the social security scheme was financially sound, and it turned out again and again conspicuously on the edge of bankruptcy, many find it difficult to accept reassurances that if some modification is now made the scheme will indeed be sound. The attitude has been rather that the scheme is in danger of collapse, that people seriously doubt whether they will ever collect their own pension from it, and the best hope of maintaining the scheme is to resist any

modification whatever as long as possible. Any change, however slight, seems just the opening wedge that will lead to total dismantling. This attitude is understandable, but it is hardly conducive to the adaptability so badly needed. It could well have the unintended result of making the scheme so intolerably expensive that at some point a generation of workers simply gives up. The question is how to persuade the public to a healthier understanding of the relation of costs to benefits that would bring about acceptance of changes clearly needed if schemes are to be truly permanent.

A Problem in Social Choice

a) How Much Social Security?

A thesis of this paper is that the widely mentioned "Crisis of social security" consists in nothing but the fact that the public was led to expect more benefit from social security than it is capable of providing.

The political dynamics by which social security was sold to the Congress and the corresponding institutions in other countries involved its liberal sponsors in exaggerated promises of what it could provide, and understatements of what these benefits would cost. Even those making the technical calculations feared that realistic estimates of the long term costs would discourage supporters of the scheme. The result was to surprise and please the public that so much could be obtained for so little. People said "Now I will be relieved of the care of my aged parents; they will have their own income at the government's expense." No one seemed to note that setting up parents in a home of their own was going to cost more than having them live with their children, and that the same children--now collectively--were going to have to cover the increased cost.

When any commodity is underpriced people will buy too much of it. Think

of someone offered shoes at $20 a pair; seeing that as a bargain he buys half a dozen pairs on credit; when he gets the bill he finds that they cost $50 per pair. He is annoyed that the apparent low price caused him to buy more than he wanted, and he is reluctant to pay the bill. A crisis ensues that can only be resolved by a clarification of the price. Then at least in future purchases the customer will not buy more than is really wanted.

What corresponds to "buying too much" in the matter of social security? We can talk about the quantity of social insurance in terms of the fraction of salary replaced and the age at which the pension starts, as well as lesser matters such as whether the benefit is to be subject to income tax, and how much is to be allowed for dependents. It is highly desirable to find out how much the public wants--whether people would like to replace all of of their income at a cost of 25 per cent of their wages when they are working (the simplified example given above), or whether they would prefer to drop down to 50 per cent replacement at a cost of 12 1/2 per cent of their wages through working life. We have already spoken of finding out what the public wants when it is told what the long term price is; this seems never to have been seriously undertaken.

b) Time-Pattern of Social Security

But a further dimension of what the public wants is the way in which the benefit will be distributed through life. Do people really want the whole benefit after they have done all their life's paid work? Especially under modern low mortality and improved health a person's working life may be as long as 50 years. He may wish to change careers in the middle of this course; that would require retraining, which could well be charged to social security. For example the person would agree to a retirement age three years older (say) in exchange for drawing two years of social security at the age of 45. In the section of this

paper dealing with work we have argued that rapid technical change demands such retraining for many, so the right to choose the time of drawing would not along be a privilege for the individual, but a boon to the economy. To give such flexibility would cost the scheme nothing, and would greatly increase the sense on the part of the participant that he had some control over the process, instead of being merely its subject. Such retraining would be especially sought by women who had taken time out for raising children, and did not wish to go back to their previous job. It would be especially appropriate to a time when technology and jobs are changing rapidly, with many occupations becoming obsolete, and new ones requiring freshly trained incumbents. Once the pace of technical change becomes faster than the turnover of the generations some provision for recycling those already in the workforce is required. At one and the same time the installing of flexibility in the social security scheme would secure these multiple objectives. We insist that aside from a trifling amount of additional record-keeping this flexibility would be introduced at no cost.

To sum up, flexibility would

a) give the participant the sense that he could tailor the scheme to his needs and so increase his sense that social security is worth contributing to

b) give him a chance to have some leisure when he could make better use of it than in his old age for whatever his purposes may be

c) encourage the retraining that the community needs when technological progress is too fast to be accommodated by the succession of generations

d) be especially advantageous to women who came into the labor force at a level below their potential, then took time off to have children, and after that are reluctant to go back to their old job.

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