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HOW SECURE IS SOCIAL SECURITY?

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July 1981
WP-81-101

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FOREWORD

Sharply reduced rates of population and industrial growth have been projected for many of the developed nations in the 1980s. In economies that rely primarily on market mechanisms to redirect capital and labor from surplus to deficit areas, the problems of adjustment may be slow and socially costly. In the more centralized economies, increasing difficulties in determining investment allocations and inducing sectoral redistributions of a nearly constant or diminishing labor force may arise.

The socioeconomic problems that flow from such changes in labor demands and supplies form the contextual background of the Manpower Analysis Task, which is striving to develop methods for analyzing and projecting the impacts of international, national, and regional population dynamics on labor supply, demand, and productivity in the more-developed nations. One subtask is examining the growing problem of rising social security costs in industrialized countries. In this paper, Nathan Keyfitz observes that the problem of rising costs is likely to remain a tense issue for another half century, until by 2035 the demographic contributor to these costs will have reached a maximum and will start to decline, as the baby boom cohorts begin to die off. Keyfitz concludes his essay with a call for learning from the lessons of European experiences. Work on this topic is being directed toward that goal in the Human Settlements and Services Area.

Publications in the Manpower Analysis Task series are listed at the end of this paper.

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ACKNOWLEDGMENTS

I am grateful for suggestions to Andrei Rogers, Zenas Sykes, Luis Castro, and others at IIASA and Johns Hopkins.

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HOW SECURE IS SOCIAL SECURITY?

INTRODUCTION

Social security presents a continuing and ever more difficult problem. When the U.S. scheme was patched by the Legislature in 1977 the Commissioner declared that the system would be in good health financially for the next 50 years. Four years later the fund is nearing bankruptcy again. Other countries are doing only slightly better; a current newspaper headline calls Europe's social programs an endangered species. What makes it a problem is the steady increases of cost that is everywhere experienced, contrary to the population expectations under which social security has been initiated and expanded. The U.S. scheme was more optimistic than most; it started with a contribution of 1 percent of wages by employees and another 1 percent by employers, and the public was pleased and surprised that provision for old age could be made so cheaply. Other countries were more realistic at the outset but still face sharply rising costs.

Yet every industrial country has a scheme, and none thinks of abandoning it. All are concerned with costs, yet each of their publics prefer to depend on its children collectively rather than individually, and it wants the state to be the intermediary, taking up and disbursing the necessary funds.

The Reagan administration is probing budgets to cut costs, but it has been wary of cutting pensions, the largest item of social expenditure which accounts for one quarter of the total Federal budget. Like the United States, European countries have come to the point where taxes are seen as a hindrance to investment, as well as a disincentive to work. Sweden proposed to reduce income taxes to a maximum of 50 percent from the present 80 percent; the Netherlands plans to cut public spending by 10 percent each year for the next 5 years; West Germany, with a cap on present spending is being pressed by elements in the rural Social Democratic Party to shift money from defense to social areas. All these and other governments are looking hard for savings but so far they are leaving old age security severely alone.

Pensions are an example of how quickly a human need can be created and firmly rooted. We are only now celebrating the centennial of the first social security scheme, that was installed by Bismark in imperial Germany in 1881. The United States scheme started to operate only 40 years ago. Prior to those dates people who could no longer work simply expected to be looked after by their children.

In one sense old age security is the same thing as being looked after by one's children. The generation that works provides the support for the generation that is retired, and mostly the former are the children of the latter. Unlike old age security administered by the state, the traditional way of looking after the old is individual, household by household, while the modern way is collective. It was once taken for granted that old people would be part of the household of their children. Now both generations want the freedom and privacy that comes of living apart and of having their maintenance provided in cash rather than in kind. It has taken only a few decades for this desire to harden into an absolute necessity, so that the most determined budget cutter has not dared to whittle away any part of the level of payment so far attained.

In fact the payment becomes steadily greater. This is partly because of the dynamics of politics in a democratic society and the increase in length of life. During the one decade of the 1970s

American male expectation at age 65 has increased by more than one year; female by more than 1 1/2 years. That means that over the period in which they will draw, and quite aside from any changes in the legislation, Americans, male and female alike, increase their total lifetime benefits by about 8 percent on the average. This plus the rising cost of Medicare, plus food stamps and other help that is the equivalent of cash, all resistant to budget cuts that are elsewhere merciless, is evidence of the degree to which the collective care of the old, through government, has become fixed in public expectations.

This hardening of expectations that generate rising costs is now opposed by a growing resistance to taxes. Two such strong forces in opposition to one another insure continuing tension. Social security is not an issue that will be replaced on the public agenda by something else in a year or two just because people get tired of hearing about it. Boring or not, social security will be with us as an increasingly tense issue for another 55 years. We will be climbing the *rentenberg*, as Germans call it, the pension mountain. By 2035 the demographic component of costs will have reached a maximum and start to decline, as the baby boom cohorts begin to die off. One cannot guarantee that things will be better after 2035, but at least the demographic factor will start to work for rather than against us.

The following discussion takes the perspectives of the several disciplines involved. A brief legislative history suggests some of the political forces; relevant demographic facts are outlined; the translation of these into costs is sketched with the help of actuarial mathematics; the relation of social security to economic progress is indicated; the final theme is social security and the financial relations between the generations.

MANY DISCIPLINES INVOLVED

Each of the disciplines that bear on the questions of this paper poses its own questions, makes its own assumptions, and offers its own (very partial) answers. Actuarial science considers the funded scheme for a cohort (or equivalently, expected values for individuals) and works out premiums on different

methods of payment, as well as revenues for individuals and for populations. For it, each cohort is separate from each other; all funds gather interest at a market rate which they are too small to affect. Actuaries mostly developed their science in the service of individual companies, and the rate-setting of any company can safely accept prevailing interest rates, without any need to fear that its operations will affect that rate.

Economists, on the other hand, are aware, at least since the advent of macroeconomics, that major decisions do affect prices including the price of money. If people save more, the rate of interest will fall. Depending on investment opportunities, more saving may or may not increase employment. New savings that no one wants to borrow for investment could, following Keynes, throw people out of work; insofar as these savings reduce consumption from its previous level, demand will fall short of the supply of goods.

That people may want to distribute consumption over their lives in a fashion more or less independent of the distribution of earnings was observed by Irving Fisher half a century back and subsequently developed by Franco Modigliani and many others. In particular people will want to save for their old age and sometimes to make bequests to their children, incomes of well-off professionals are more unequally distributed over life than those of the poor, and the wealthy have more (though far from unlimited) opportunity to redistribute by borrowing.

The question of old age security is not dealt with extensively in the literature of sociology, but one can sketch out the perspective that the discipline would use. In societies where the family is a tightly integrated unit the aged would not typically be the concern of any group beyond the family. In the exceptional instances of those who do not marry or are sterile and who have no collateral relatives the local community might come into the picture; failing that, homes for the aged might be established under the auspices of the church, usually on a local basis.

In modern times the decline of solidarity in the family as well as in the church and the rising strength of the State has

shifted the responsibilities to this last. It is not in a position to look after individuals by informally providing services in kind, and old people's homes run by the State would too much resemble jails or homes for the feeble minded, so the State assistance is provided in cash. That this help is so firmly insisted on by the modern electorate testifies to the relative incapacity of the alternative institutions—family and church.

The question then comes to be whether the solidarity of the State will suffice to carry the burden. Those who have supported the previous generation have some doubts about their own old age security. Without that solidarity the logical policy for the present generation of those working is to forget the aged as Samuelson suggests: "In terms of immediate self-interest the existing productive workers should perhaps unilaterally repudiate the money on which the aged hope to live in retirement." (Samuelson 1958)

Notice that this way of seeing the problem in terms of solidarity does not lead to any "solution." The sociologist seeks to know how things work, and hesitates to make immediate policy recommendations.

LEGISLATIVE HISTORY

In the 1935 Congress the original social security arrangement was voted by the Democratic majority; Republicans were opposed, and they carried their opposition to the people in the 1936 election. This was the last serious opposition that social security legislation has had to face from either party; it has been nonpartisan from 1940 onwards. It is worth recalling that what Republicans opposed in 1935 was a conservatively planned scheme in which payroll taxes collected from 1937 onwards would build up a substantial trust fund; they have since gone along with the succession of changes that have departed ever further from conservative financing.

In 1939 the start of benefit payments was advanced from 1942 to 1940, and survivors and dependents were blanketed in with no additional premiums. At the same time as it advanced the increased benefits, Congress postponed a scheduled increase in the tax. That postponement was repeated until 1950 when the tax was

raised to a modest 1.5 percent for each of employer and employee. But in 1950 Congress increased benefits again, to take immediate effect. It also provided for raising the tax further, but not to start until 1954. Edward Tufte (1978) counts 13 benefit increases from 1950 to 1976, with proportionately more in election years. These included counting as fully insured any contributors who paid on as little as \$50 earnings in each of 40 quarters, and, from 1972 onwards, benefits automatically increased by the price rise of the previous year.

While Congress increased benefits periodically, each time to take effect immediately, it raised taxes that would pay for them later if at all; one suspects that this process is likely to continue as a matter of political dynamics. One foresees frequent near-bankruptcies of the fund and last-minute rescues by congressional action. In all this population changes are intertwined with changing social conditions and with political pressures.

There is a case for protecting sound programs from the arbitrariness of annual appropriations. After all, the constitution of Congress might change, and Democrats especially wanted to make it harder for Republicans to tamper with social security, Medicare, and other similar legislation. The formula in several cases, including social security, tied payments to the Consumer Price Index. Often Congress was persuaded to pass the legislation, including the entitlement clause, by gross underestimates of what the cost would be. When more realistic estimates of costs became available it turned out to be very difficult to change the formula.

Such inflexibility is not confined to U.S. legislation, as Max Horlick (1979:97) points out. Women's equality, for example, ought to include retirement at the same ages as men—or even later, if one counts from the end of life backward to give the sexes the same expected time to draw. But many countries have traditionally provided for women to draw from age 60, five years before men. That means that on the average women are on pension 9 years longer than men—an excess of about 75 percent. Yet, reports Horlick, alteration seems politically impossible.

DEMOGRAPHIC ANALYSIS

Any analysis of what will happen to social security in the future must start with estimates of future population. The outcome is moderately sensitive to the assumptions for births after about 20 years and for deaths from the beginning.

We begin with a forecast that simply supposes that the population will replace itself and that mortality will be subject to slow improvement. Thus our female expectation of life at age zero rises to 77.7 years by 2075 and male to 72.4, figures that are little above those already attained.

A proxy for the burden of social security is the number of persons 65 and over per 100 persons 1-64. Our calculation shows a climb, slow at first but rapid after about the year 2010, and a levelling off about 2030. An excerpt from a more detailed table is given as Table 1 below. If we had been more generous in respect of mortality we would have shown a climb of the ratio to a higher plateau. Thus the U.S. Bureau of the Census finds an even steeper rise in the 21st century (Statistical Abstract 1980).

Table 1. Estimate of persons 15-64 and 65 and over, United States, 1980-2060.

Year	15-64	65+	Ratio 100X 65+/15-64
1980	146,212	23,281	15.9
2000	169,734	28,296	16.7
2020	180,233	39,311	21.8
2040	181,853	45,623	25.1
2060	181,281	48,524	26.8

Source: Author's calculation.

Partly because of the initial restrictions on the disbursement of benefit, that 2 percent of payrolls did at first serve the purpose, and even sufficed to build up a trust fund of some dimensions. Aside from the restrictions on benefits, demography was kind to the scheme in its first years. The ratio of the number of persons 65 and over to those 18 to 24 was 0.11 in 1940; each 100 men and women of working age had only 11 people of retired age to support. Of course what counts is not people of working and retired ages but people with jobs and contributing versus people drawing; that we will come to later.

To illustrate such matters a Lexis diagram, drawn in the age-time plane, will be found useful. It represents each individual of a population as a diagonal line, corresponding to the fact that every year a person grows one year older. A figure that sketches the evolution of the American population into the 21st century shows how the baby boom of the 1950s comes into the labor force about now, and how it works its way through and enters the pensionable group by the first quarter of the new century. We should be surprised that the fund is having difficulties now when the ratio of old to working people is increasing slowly if at all; the real difficulties are still three or four decades ahead of us.

On the surface it appears that the troubles of social security are mainly caused by improved mortality at older ages. To show what has happened to mortality, it could be argued, we need to look at advances in the expectation of life. That expectation at age zero could have been as low as 45 years in 1880; it has risen to about 60 years by 1930; now in 1980 it is nearing 75 years. The improvement is about 30 years during the century, about 15 years since 1930. As the expectation goes beyond 65 the burden of old age insurance increases rapidly.

Such reasoning in terms of expected lifetime is almost entirely erroneous. The expectation of life at age zero is much influenced by the drop in infant mortality, as well as by the virtual disappearance of many infectious diseases of later childhood and young adulthood, of which tuberculosis is a prime example. A study of the survivorship curve is what is wanted, rather

than of the expectation of life; the probabilities of living have risen most *prior* to the age of retirement. Evidently the tendency since the beginning of the mortality record has been for a larger and larger fraction of people to live into adulthood, while extension of the span of life has been slight. The effect of mortality change as such has been mostly to increase the working population by reducing mortality at younger ages. We can examine the ratio of 65 and over to 20 to 65 in successive life tables to demonstrate this.

What has raised the ratio of those 65 and over to those 20 to 65 from 0.11 in 1940 to 0.18 today and will increase it by about 50 percent subsequently, is fertility change. In an important sense one can say that the high and increasing cost of social security is caused not as much by the increase in the older population as by the relative lack of increase in the population of working age. The declining birth rate has far more than offset improving mortality as far as those under 65 are concerned. If the mortality and fertility rates of 1957 (when the baby boom was at its peak) had continued, population would be increasing at about 2 percent per year, and the ratio of those over 65 to those 20 to 64 would have been much lower than we now find. Table 2 shows this ratio for various rates of increase with the present mortality rate, along with an approximation by a declining exponential. Such exercises in comparative statics are useful if one wishes to separate out the pure effect of natural increase from the influence of mortality. Permuting the input parameters in a projection is a more detailed way of following up the same subject (Keyfitz 1977:168).

Countries vary greatly in the degree to which the ratio of persons at retired ages to those at working ages changes over time. In both Germany's and in Austria, France, and the United Kingdom, the increase is small; in Japan it is very large, going from 11 percent to 24 percent in 50 years. This means that the cost per worker of provision for old age in Japan will rise by 140 percent for demographic reasons alone. Rises nearly as substantial are shown for Canada, Poland, the Netherlands, and Finland.

Table 2. Ratio of population 65 and over to that 20 to 64 at last birthday for various rates r of increase, given U.S. mortality of 1978.

r	Stable Ratio (65+)/(20-64)	Approximation by $.239 e^{-32.4r}$
0.00	0.239	.239
0.01	0.172	.173
0.02	0.122	.125
0.03	0.088	.091
0.04	0.059	.066

The rise is partly attributable to the present age distribution and low birth rates, partly to the assumed drop of the birth rate to bare replacement and subsequently of the population to stationarity. We can be sure that stationarity is already nearly with us in industrialized countries and will extend to the world as a whole. The rapid increase of population that made possible the low costs of social security we have had in the past is transitory. Once we see that the stationary rather than the increasing population is the normal condition, then it becomes clear that we have been playing a chain-letter game, and like all such games that depend on ever more participants, this one had to come to an end sooner or later.

Despite considerable variation among countries some clear overall tendencies appear for 17 industrial countries that have been tabulated by Luis Castro. With the falling rates projections the unweighted mean ratio of retired to working age population for these countries goes from 18.5 percent in 1973 to 26.3 in 2025, the larger part of the increase occurring in the 21st century, corresponding to the baby boom's arrival at retirement age.

The numbers translate directly into dollars, yen, deutsche-marks, etc. If retirement was at age 65 for all, and contributions were from age 15 to 64 (too long a period for most countries,

and shortening it would increase cost), and if the retirement income was to be equal to the (supposedly uniform for the present argument) wage, then in 1975 for Japan 11.5 percent of current wages would suffice for social security taxes; in the year 2000 20.1 percent would be necessary, in the year 2025, 27.3 percent. Plainly no social security scheme will replace 100 percent of wage income; if it is to replace half of income, then these numbers are to be divided by two. Even so half of 27.3 is 13.6 percent, which is large enough. We should be able to find survey data in the several countries giving attitudes of the young generations to ever rising social security taxes.

We have studied demographic effects in social security by the ratio of the old population to that of working age, i.e., the ratio of those 65 and over to those 20 to 64. No one assumes that the latter are all working or the former all retired, but nonetheless we use these as indexes of the two subpopulations.

We can do much better by recognizing more age groups, and using past and projected labor force participation rates. Experiments are possible to find what is the effect on social security costs and contributions of changed participation, different mortality, different fertility. If differentiated rates of any of these exist for rural and urban that can be taken into account as well. All this is possible on the base of the data and programs now available for many countries of Europe and America.

When populations are increasing rapidly the ratio of the retired to the working population depends much more on long-term fertility rates than on mortality. In the ratio $B = R/L$, where R are the retired, L the labor force, B the burden, the denominator is more easily influenced than the numerator. But when stationarity is approached this is less true; greater longevity then has a major effect. Very simple experiments will disclose this effect.

Pending such experiments some illustrative numbers may be useful. In a population increasing at 3 percent per year the ratio B might be .07; with a drop to stationarity that ratio can easily rise to .25. To obtain the same $B = .25$ by an increase of expectation at age 65 alone in a population growing at 3 percent

per year would require that expectation to multiply by 3 or more, i.e., an expectation at age 65 of about 40 years! The moderate improvements, say 1 year per decade in $e_{65} = 65$, are for a long time going to be a much smaller factor in rising social security costs than the falling birth rate, acting on the size of the labor force. We need more precise information on this effect in terms of the mortality and fertility schedules of several countries.

We also need more knowledge of the effect of retirement. The age of retirement has been dropping, partly encouraged in this by the provision of more generous social security improvements add not only their own costs to the budget but also the additional cost arising from the earlier retirements that result from these improvements. For Swedish men we have (Artle 1980:10) the participation rates

Age	Rate
63	66.3
64	62.7
65	19.3
66	15.7

which makes clear the effect of the age 65 social security benefit. Any doubt on this is resolved by the great drop in participation that occurred when the pension age was lowered from 67 to 65 in 1976. Experiments on various participation schedules for the future will show how influential is this variable in relation to mortality and fertility.

There is clearly a limit to the degree in which older people will be supported, and one suspects that a rise in the pension age will be more and more discussed. The improvement of mortality can be thought of as a gift to older people. In 1940 e_{65} was 12 years in the U.S.; in 1980 it is about 16 years. Thus in 1940 the person of pensionable age could expect to live to 77; in 1980 he could expect to live to 81. Should we not count backwards from these ages and say that social security is just as generous in

1980 as in 1940 if it provides 12 years of benefit on the average? On that condition the pension age would go with expectation and would be $81-12 = 69$ in 1980. Or perhaps a compromise could be provided, by which half of the increased expectation would be taken out in work, half in social security-funded leisure.

Again national materials can tell us the financial implications of these options.

TWO WAYS OF PROVIDING FOR OLD AGE

Enough for the demographic preliminaries and the legislation. We need now some theory of the two ways in which social security can in principle be provided. These are illustrated by the two principal perspectives of the Lexis diagram on which contributions and benefits may be portrayed.

1. Each cohort looks after itself. The method obtains the advantage of interest to reduce cost; the working people who save through the scheme obtain a share in the economy aside from their jobs; that one cohort is large and another is small is in principle indifferent (though we shall have to qualify this last assertion). The method cannot easily protect against inflation; it requires some stable repository of value. The unit is the group of people on each diagonal strip of the Lexis diagram.
2. Each time period looks after itself. Interest does not come into the matter; no fund is built up; changes in cohort sizes make for awkward changes in cost; cost becomes great with the approach of a stationary population and stationary economy. Transfers are along horizontal lines in the diagram. This pay-as-you-go method is inflation proof since the contributions of each moment are paid out very soon after collection to the old people of the moment. Just after a baby boom the method is cheap, since the contributors increase sooner than beneficiaries. In the same way a chain letter provides rewards to rapid increase. In a chain letter the successive "generations" are separated only by days or weeks rather than by many years. That rapid growth solves many

problems is evident, but it is equally evident that there are limits to the length of time over which we can take advantage of this kind of solution.

To study the demographics of social security we need expressions for the premium on funded and unfunded schemes, as well as the reserve that is required on the funded scheme. These will be worked out, relying where need be on stable population theory. In this approximation we will think of the ages 20 to 64 and 65 and over as working and retired, respectively. No assumption is made that all those under 65 are working, nor that all those 65 and over are retired; we take these ages only to obtain the demographic effect. Later study will apply labor force participation rates age by age and permit examination of the nondemographic elements.

For the unfunded scheme, in which the presently working support those who are presently retired, for each unit of benefit to every old person the total benefit will be $\int_{\beta}^w e^{-ra} \ell(a) da$, and $\int_{\alpha}^{\beta} e^{-ra} \ell(a) da$ working people contribute, so the cost to each will be

$$p_r = \frac{\int_{\beta}^w e^{-ra} \ell(a) da}{\int_{\alpha}^{\beta} e^{-ra} \ell(a) da} \quad (1)$$

where $\ell(a)$ is the probability of surviving from birth to age a , α is the age of starting work, β is the age of retirement, w is the highest age to which anyone lives, and r is the ratio of increase.

It is not immediately obvious that this is a decreasing function of r , but we can prove that at the same time as we find a convenient approximation. Differentiating by the theory of implicit functions gives without approximation

$$\frac{d \log p_r}{dr} = - (m_r - m_w)$$

where m_r is the mean age of the retired and m_w the mean age of the working population. By integrating back as though m_r and m_w were constant, we have

$$p_r = p_0 e^{(m_w - m_r)r}$$

p_0 being the premium in the life table or stationary population. This also is exact. Since the mean age of those working is necessarily younger than the mean age of the retired, the decline of p_r with age is proved. How fast this decline occurs as population growth rises is seen in Table 2 above, for a population in which $e_0 = 70$, $m_w = 38$, $m_r = 70$, $\alpha = 20$, $\beta = 65$, and $p_0 = .239$. For a population increasing at 2 percent per year, the cost is just half of what it is for a stationary population.

For a funded annuity the cost may be obtained by discounting back to age zero the expected benefit for an individual, i.e., $\int_{\beta}^w e^{-ia} \ell(a) da$, and equating this to the payments the person will be expected to make while he is working age, $p_i \int_{\alpha}^{\beta} e^{-ia} \ell(a) da$, where the symbols are those used in the derivation of (1) and i is the rate of interest. The premium that comes out of this equation is

$$p_i = \frac{\int_{\beta}^w e^{-ia} \ell(a) da}{\int_{\alpha}^{\beta} e^{-ia} \ell(a) da} \tag{2}$$

Expression (2) is identical with (1) except that it contains the rate of interest i in the same place where (1) contains the rate of increase r . Thus Table 2 also serves to show how p_i goes down with increase of the rate of interest. With 3 percent interest, often taken as the long term rate for the economy, it costs only a little more than one third as much to provide for one's old age as if no interest is paid. The point is important, since evidently for a stationary population and economy pay-as-you-go is equivalent to saving for one's old age without interest.

When only a few individuals make provision for their old age through funded schemes, their savings do not greatly affect the financial markets through which they go. But when a funded scheme applies to an entire population one cannot suppose that its reserves will simply disappear into the larger saving and investment process. Let us see how large the reserve will be, again on the stable model.

For each individual currently in the contributing age group the fund will receive p_i each year. Per individual in the contributing group it will pay out p_r each year. Thus it will accumulate as reserve the difference $p_i - p_r$. If the rate of population growth is greater than the rate of interest this will be positive, but in the more likely circumstances that the rate of interest is greater it will be negative. When this latter is the case the fund relieves contributors of part of the cost of their pensions.

The amount can be substantial. Thus consulting Table 1 again, we see that if the rate of interest is 3 percent and the growth of the population is 1 percent, then pay-as-you-go will cost 24 cents for each dollar of pension and the funded scheme will cost only 9 cents.

But our original and important question is how large the fund has to be. If the size of the fund is f per person of working age then annual interest drawn on it, fi , less provision for the increment of population, fr , must be equal to the difference $p_r - p_i$. This gives for the fund per person of working age

$$f = \frac{p_r - p_i}{i} \tag{3}$$

For those who find this argument restrictive an alternative statement is available. Per person in the working population the amount that would be paid out each year would be p_r as shown in (1). Per person in the working population the amount collected each year would be p_i , the premium as shown in (2). Thus in respect of each person in the working population, after the scheme has been in existence long enough and the condition of stability is satisfied, we would have an addition to the reserve of $p_i - p_r$.

If this annual amount has been collected continuously for a long time from each person working, i.e., from when the population was of negligible size, and if it has been accumulating interest at rate i , then we can readily find the total now in the reserve, all per person now working. Consider a time t years back. The number of people in the working population per person working now would have been e^{-rt} , and accumulation of interest would increase each dollar collected to e^{it} dollars. All we need do is add over t the difference $(p_i - p_r) e^{-rt} e^{it}$ to find

$$(p_i - p_r) \int_0^{\infty} e^{-(r-i)t} dt = \frac{p_i - p_r}{r - i} \quad (4)$$

This quantity must be positive, since if $r > i$ then $p_r < p_i$ and vice versa.

In the application that will be important in the future the population will be stationary, and let us say that the real rate of interest will be 3 percent. Then again from Table 2 we have

$$f = \frac{.239 - .088}{.03 - 0} = 5.0$$

which is to say that the reserve is 5 times the individual annual pension. For $i = .04$ we obtain in the same way

$$\frac{.239 - .059}{.04 - 0} = 4.5$$

To generalize the result to pensions that are not equal to the salary, but some fraction thereof, say 60 percent, we simply take 60 percent of the salary as the unit for all of the calculations above. In short we disregard the part of the salary beyond 60 percent. That is why we can say that the reserve equals $\frac{p_i - p_r}{r - i}$ times the annual pension, without necessary relation to salary.

If $i = r$ the expression looks indeterminate, but can be shown to equal $p_i (m_r - m_w)$, where m_r is again the mean age of those retired, m_w the mean age of those working. In symbols, the desired limit is

$$\lim_{i \rightarrow r} \frac{p_i - p_r}{r - i} = - \frac{d p_r}{d r}$$

If $i \neq r$, as Pavel Kitsul points out to me, the expression for the reserve is still nearly equal to the derivative of either of the terms in the numerator, taken about a point midway between i and r , and with sign reversed. The reserve can be written in terms of first and third derivatives at the mid-point of the p -function:

$$\frac{p_r - p_i}{i - r} = - p' \left(\frac{r + i}{2} \right) - \left(\frac{r - i}{24} \right)^2 p''' \left(\frac{r + i}{2} \right)$$

we check this with $r = .02$, $i = .04$ to obtain

$$\frac{p_{.02} - p_{.04}}{.04 - .02} = \frac{.12218 - .05949}{.04 - .02} = 3.135$$

The true reserve at the value .03 as shown in Table 3 for $r = .02$, $i = .04$ is 3.32, and the third derivative covers the small difference.

The quantity (4) is shown by Table 3 to be between about 3 and 8 for a low-mortality population. Note that values in Table 3 change little along diagonals from lower left to upper right. In short the reserve $\frac{p_i - p_r}{r - i}$ is very nearly a function of the sum of r and i , with values approximately as shown below

$r + i$	$\frac{p_i - p_r}{r - i}$
0.00	8.2
0.01	7.1
0.02	6.1
0.03	5.3
0.04	4.6

Table 3. Reserve as multiple of annual pension, for various rates of insurance and of interest, using (4) based on the stable rate of increase, and the Coale and Demeny West Male Life Table with $e_0 = 71.19$.

i	r				
	0.00	0.01	0.02	0.03	0.04
0.00	8.2	7.09	6.18	5.41	4.76
0.01	7.09	6.10	5.28	4.57	3.98
0.02	6.18	5.28	4.50	3.86	3.32
0.03	5.41	4.57	3.86	3.30	2.79
0.04	4.76	3.98	3.32	2.79	2.30

Thus we find that the greater the population increase the less the reserve needed; the effect of increase and interest is the same, just as it was in the determination of the premium.

The amount by which the number 3 to 7 is to be multiplied is not the wage, but the part of the wage that comes into the scheme. In the United States the collections and disbursements are now about the \$160 billion mark, so if the whole scheme was funded the reserve would be about one trillion dollars. Complete funding could be discussed at the initiation of the scheme but is hardly conceivable now.

The objection has been raised that it is impracticable to have any considerable fraction of such a large fund in the hands of the government. How could it choose impartially among the concerns in which it might invest? Would it single out declining sectors of the economy for rescue rather than stimulating the more dynamic ones?

Does not government ownership of the shares of private concerns constitute socialism? And would the total amount of shares and bonds, indeed total wealth, be adequate to the size of fund that would accumulate (Bourgeois-Pichat, 1978)?

Most such doubts and fears are shown to be groundless by the Swedish experience. It has had an earnings-related pension program, a second tier on top of the flat amount that everyone

was entitled to, since 1959. By 1978 it had accumulated 131.5 billion kronor (some \$30 billions), over 1/3 of annual GNP. That fund is now the major source of capital formation in Sweden and must have at least part of the credit for Sweden's passing the United States in income per head.

To prevent any group from having too large an influence on investment, the fund's assets are administered by four different boards. One of these, the Fourth Fund Board, invests in shares of private companies. In some years the returns were equal to the rate of inflation, in other years somewhat below. Promissory notes of local authorities and individuals for house building and other projects, have taken up much of all four funds (McArdle 1979:67).

As far as capital markets are concerned, it does not make much difference whether the government runs a budget surplus of 1 percent of the national income, or individuals saving 1 percent of the national income. Either way the same amount is available for investment. The government's budget surplus would be used to pay off the national debt, and the individuals whose bonds were called for repayment would seek a new investment of the funds. But though the economic effects of the two kinds of saving—governmental and private—are similar, they are seen very differently by the citizen. The money that he sets aside is his own nest egg; the money he pays in taxes is gone. It is vain to tell him that the effect on the economy is the same; he looks with a kinder eye on an accumulation in his own name, even one made under compulsion, even though the ultimate effect on his welfare may be the same.

DIFFERENT BOOKKEEPING IN FREE ENTERPRISE AND SOCIALIST SOCIETIES

The changing ratio of people of retired age (say, 65 and over) to those of working age is bound to affect all countries. That ratio has gone from about 10 percent to 18 percent in the United States between 1940 and 1980, and it will rise almost to 30 percent by 2025. In Brazil it is as low as 5 percent but will rise as the birth rate falls. The USSR is going through an evolution similar to that of the United States, and Sweden shows the change even more strikingly.

While the ultimate effect of this is everywhere the same—fewer workers to support each retired person—it shows itself in different ways, depending on such things as the state bookkeeping system. In the United States the successive threatened bankruptcies of the Social Security Trust Fund is the aspect the public and legislators are all too familiar with. Each time the fund is revived by a rise in the tax accompanied by optimistic pronouncements about subsequent solvency. Very soon Congress will have to act again, or old people will not receive their checks.

Other countries have no specific tax but simply take payments out of the national budget. This means that the demographically engendered crisis does not show itself so sharply and indeed can be covered over a considerable time at the cost of other items in the budget. In a socialist state where the budget covers all of the nation's productive activities, this capacity to cover up the immediate effect is especially great. Yet somehow the issue must be met, and the increasing cost consciousness in all countries constitutes pressure to make the costs explicit.

If one goes to the extreme of an economy in which the product is divided equally among the entire population, then if we abstract from other changes, a larger number of non-workers will mean a falling standard of living. A society facing this would want to even things out and might well accept more savings ahead of time so as to increase its capital stock and prevent the fall. Typically a society would have many opportunities for investment of savings, and the return on investment would help support the old. With even 3 percent return each dollar or ruble of saving would provide 2 dollars or rubles 23 years later.

Different countries have different ways of keeping the accounts, and bookkeeping has much effect on the way the problem is perceived. With a funded scheme the future old people *as a cohort* set aside money resources equivalent to physical capital. The society is then doing what an individual does when he builds a house durable enough to live in through his old age. Some such physical saving everyone does—one has clothes, perhaps an automobile, often a house or some equity in one.

Yet because we all require non-durable goods as well, physical saving is no complete solution for the individual. Samuelson shows that perishable goods require some kind of social solution. If working life is in two or more periods one can bribe younger workers to support one. If it is only one period, even that is not possible, and only a fiat of the community can ensure the consumption of the old.

Yet this solution, embodied in the social security legislation of most advanced countries, plants the seeds of intergenerational discord. We need to compare with populations that grew quickly with high mortality. In one instance the young might have been supported by their parents for 15 years and the parents later required support for 10 years. But in other cases the young might be supported for 20 years and the old (at higher cost per person-year) also for 20 years, a very different ratio. We need to look into the basis of the social decision on the length of time the old are entitled to be looked after. Moreover the care of the young is decentralized into families; the collectivization of the care of the old makes it seem a heavier burden.

We thus meet the problem of time in its acutest forms when we consider the several intergenerational transfers. If goods have no keeping qualities, then one is driven to a social solution; each time period must balance its books; the old can only live off current work. If goods keep one escapes from this dilemma, but not all of the goods needed for subsistence keep, and in particular food does not keep. A social solution is again necessary, but now it can be arranged *via* capital goods that keep and reproduce so that the books can be balanced *both* in each period and for each cohort.

LIMITS ON THE INDEPENDENCE OF COHORTS

Since a main argument for the funded scheme is that each cohort is independent of the others, we need to look more closely into the degree to which this can be so. It would be possible if the working population produced the actual physical goods on which they would live in their old age, if they could make the clothing, build the houses, bake the bread, that they would use

when they were past 65. Insofar as they cannot do that, they will have to depend on those currently in the labor force. This dependency is inevitable for bread, avoidable for houses.

Failing such saving in kind are we merely discussing financial provision when we argue the differences between funded and pay-as-you-go? Whatever the financial aspects, it is said that goods consumed in 1980 are produced by the labor force of 1980, and this transfer of goods is the only way that the old people of 1980 can be supported.

Yet still keeping the discussion close to real goods, that must be qualified. A man during his working years can build a house that is more durable than he currently needs and that will last him into his old age. But in an exchange economy he does not need to build the very house in which he will live; he can perform services for those who build while he is of working age, or he can otherwise come into the purchase and control of a house. Nor need the facility be a house or other object that directly serves for his personal use; he can save the money and invest it in a company that builds a steel mill, and so at second remove be said to build a steel mill to produce steel in his old age that will be sold to buy him groceries.

Thus seemingly unanswerable cases can be constructed to support two opposing contentions: that on a funded scheme each cohort independently provides for its own old age and that whether the scheme is funded or not each cohort when old must depend on the goods produced by the cohort that is then of working age. The first case is built by thinking of the saving and investment of money or of physical saving of durable consumer goods like houses. The second case is made by thinking of perishable goods like bread, that have to be produced from day to day, and excluding the possibility of saving.

The extent to which the cohorts can be independent of one another is limited: if the society collapsed there would be nothing for anyone, including the old. If the society does not collapse but suffers wild inflation, the possession of pensions resulting from saving, however fully funded, will do no good.

It is important to draw a distinction between this discussion and a similar discussion that was heard during the war. It was said that a war has to be fought in real terms, that there is no way of putting the burden on a future generation. Borrowing seems to do this, but that is an illusion, for borrowing is no more than a financial rearrangement; the tanks and planes have to be made while the war is going on, and they might just as well be paid by taxes then as by taxes later. Borrowing merely redistributes claims subsequent to the war. Fighting a war differs in many ways from supporting people in their old age, but most importantly in that once it occurs a war cannot be prepared for in advance. Old age is different in being perfectly predictable, and it is ridiculous to say that an individual or a cohort cannot save up for it. The general principle is that one cannot draw on future production for today's needs, but one can certainly draw on past production if one has had the necessary foresight.

I have given examples in physical terms by which individuals and cohorts can provide for their old age, but that may not be adequate for a complex money economy. If for instance individuals save but no one wants to invest, the Keynesian problem, then notwithstanding any number of physical examples, the society as such cannot provide in advance for its old age. Again, if the society is based entirely on money accounting, and money is not a stable repository of value, as in periods of inflation, then again any transaction across time is frustrated, including saving for old age.

A full fund would be about the order of magnitude of the national debt, now approaching a trillion dollars. If the U.S. scheme had been funded from the start, and the fund invested as the national debt was successively increased, then the interest now paid on the debt would be available for social security. That interest now amounts to about \$80 billion, so it would cover almost half the cost of current pensions.

This would be no paper difference from the present arrangement. We now tax ourselves (\$80.4 billion in fiscal 1981) to pay the interest on the debt, and we separately tax workers to pay the pensions of \$163 billion in 1981. We would of course

still need taxes to cover the interest payments on the debt; since these are half of the social security burden, they could be applied to relieve the wage earner of the entire half of the social security tax that he now pays.

It is true that people and institutions would have to adjust if government bonds and treasury notes were not available. Insurance companies and others whose investments are now determined by law would have to be released from some at least of present restrictions. They would be pushed out into financial markets that would channel their funds into productive use. Social security funds directly provide about half of the total net investment in the Swedish economy; we would achieve the same result indirectly.

The view that there is no difference between pay-as-you-go and funding is expressed with most energy and enthusiasm by Nicholas A. Barr (1979). Spending by the retired has to be matched by non-spending by the workforce. Suppose that the workforce do not want to spend less; suppose that they simply repudiate the bonds or other assets that the old have put their savings into. For Barr that possibility is to be taken as seriously as the refusal to pay social security taxes in the next generation.

Barr very correctly says that "the choice of pay-as-you-go or funding is completely irrelevant unless the method of finance is the *cause* of an increase in national output." (Barr 1979:50) But under very general conditions savings do cause an increase in output. Unless capital has entirely ceased to be productive, more output follows from more saving, and the claim to that extra output would be in the hands of those whose non-spending has been responsible for it. To argue otherwise is to be original in a contrived and convoluted way.

THE LIFE CYCLE MODEL

The life cycle model has rightly been placed at the center of economic thought on personal saving. It explains in terms of individual (strictly household) rational behavior the accumulation of savings in the economy as a whole. The idea has roots in Irving Fisher and was used in the study of social security by

Martin Feldstein (1974). Its point is that the young worker anticipates the day when his earnings will decline, and he saves accordingly. In one form the person takes it that his earnings will end at a fixed age of retirement, while Martin Feldstein's extended life cycle model does not fix the age of retirement in advance but allows it to be determined in the course of fitting the model.

From the start constraints were recognized that prevented people from freely redistributing their incomes over time. The income curve has indeed a peak at an age older than the peak of family responsibilities; people cease to have any income at all beyond a certain age and yet they have to keep on living; if the person can defer consumption he has by then accumulated resources that can be used directly or as collateral for loans. But having the spending precede the income offers problems: college students typically are unable to guarantee repayment and so cannot easily borrow on commercial money markets.

These constraints are thoroughly recognized in the economic literature. What is much less recognized, and throws a shadow of doubt on the applicability of the entire theory, arises on the asset or saving side, rather than on the consumption side. The individual may know exactly what his entire pattern of future earnings will be and exactly what pattern of consumption he wants, and the latter may be sufficiently posterior to the former in time so that no borrowing is necessary, but he has no stable repository of value for his savings. At one time money served as a repository of value, but the future value of money is now highly uncertain. We know how well land, stocks, stamps, paintings, antiques have retained their value in the past. But for the future no one knows, not even the most astute. A set of options and choices for redistribution of consumption through time has been removed.

Without a store of value there is simply no point in talking about the life cycle of desired consumption in terms of the life cycle of earnings. And this applies equally to individuals and to groups of individuals, including cohorts.

Thus among many other unpleasant consequences, inflation and the erratic changes in relative prices with which it is associated effectively destroys the usefulness of any attempt to explain savings in terms of the life cycle pattern of consumption. The consumer may be as rational as one can ask for on the planned distribution of his expenditures, but without a stable repository of value he is impotent to implement that distribution.

SOCIAL SECURITY AND SOCIAL COHESION

When social security was initiated in the 1930s it seemed to require only a 1 percent tax on the wage earner and 1 percent of payroll from the employer. As such it was a trifling part of the Federal budget. The public was in favor, indeed almost entranced by the discovery that the problem of old age could be solved at so little cost. The initial administration proposal was indeed opposed by Republicans in Congress, and it became a partisan issue in the 1936 presidential election, but after that it disappeared from politics; both parties agreed to the scheme as a whole and to its many successive extensions. No longer would it be necessary for old people to be dependent on their children individually; now they could be looked after collectively. Whereas they had been a burden to their children they would be only a small cash outlay for the community as a whole.

Of course those who made the social security calculations know that the shift from individual support of parents to collective support could not possibly lighten the financial burden, whatever its other advantages. It is more expensive to support people in cash and independence than in kind within the family. Now they could have separate dwellings and be independent of their children, where previously they had typically lived in the homes of their children. Actuaries knew that someone would have to pay the added rent.

Note that social security is indeed different from depending on one's children in various incidental ways. The support by children offered by social security is equal for old people who have many children and for those who have few; it is in cash rather than in kind. Yet the same intergenerational transfer is

involved, with the main difference that social security removes the incentive for individual couples to have children.

From a sheerly rational perception of self interest, as Samuelson (1958) pointed out over 20 years ago, the right thing for any generation to do is to repudiate the implicit "debt" to its elders. As he says, process of inflation does this in respect of personal savings tied to nominal dollars. A generation faced with a particularly sharp rise in tax could even argue that it was not in any way breaking its word, since the promises to pay pensions had never been given by it but by a generation long past, if it has been given by anyone. It might admit that it received its upbringing and education from its parents but deny the existence of any contract for a quid pro quo. It might argue that the ratio of old age costs to upbringing costs has risen so greatly (especially medical expenses) that if there ever was a contract its terms have so changed that no one can be held to it.

Social security can be regarded as a way of countering the diminished cohesion within the family of a modern industrial society. When firm bonds exist among the several generations within a family, governments are hardly expected to take funds from individual workers and hand them over to the aged parents of those workers. The intermediacy of government only comes to be offered and welcomed as the family loses its centrality. When the family was society's main unit, working people would no sooner see their helpless parents go into an institution for the aged than they would send their children out to be looked after in an orphanage. No matter how it is described, the advent of social security marks a stage in the loosening of family bonds.

Yet social security itself requires bonds, though of another kind. It is necessary that individuals replace their loyalty to parents within the family by loyalty to the state, if they are to continue to pay taxes.

Is it possible that the same social and psychological causes that make for families with few children, make also for households in which there are no old people? The young adult wants to be free of children, free of parents, even (to judge from divorce

rates) free of spouse. In this situation resort is to government. Will the bonds here, as reflected in willingness to pay taxes, be able to stand the increased load?

Echoing Samuelson, Shubik states that

If a man were individualistic, utilitarian and primarily self concerned, then without an extra economic structure to provide the connections there is no guarantee that the generations would hold together in a stable way. (Shubik 1981:3)

One way in which the generations can be glued together is by pieces of paper. Suppose that in order to take a job a man or woman needed a piece of paper, and it was only possible to secure that paper from someone who was now old and unable or unwilling to work. Then the old person could give or lend the paper to a young one on the condition that he be maintained. Once the old person died the paper would pass definitively to the young, and he would repeat the process, exchanging it for his maintenance when he became old (Shubik 1981).

A curious arrangement? Not at all. It is exactly what is done in agricultural societies with private ownership of land. The piece of paper is the deed to the family property; the deed is passed on through successive generations, always with the condition that the old people who give it over have the right to be supported as long as they live (Arthur 1981).

Social security has come to be built into our expectations within the last few decades, and it shows how quickly an item can move from not existing at all, to being a luxury, to being an absolute necessity. A generation or two ago people were expected to prepare for their old age individually; they might prepare by saving or by having children, or both. If they did neither or if their children were too poor to look after them, then they had to resort to other relatives; failing that they suffered the punishment of being looked after by charity, private or public. The incentive to save and to have children was strong.

Many things have changed since that time, only 50 years ago. The birth rate is down, so families have fewer children. Those children they do have want to lead their own lives; they typically

leave home long before marriage, and having lost the habit of living with their parents do not often welcome those same parents back into their home 20 years later. It is true that sometimes parents are inexpensive baby sitters. In Eastern Europe old people have the very important use of queuing in stores for luxuries, and even for necessities. Yet everywhere dignity is lost for old people who have no other option than to return and live with their children. Even the faithful single daughter whose mother is living with her, probably the circumstance in which the parent is best-off, appreciates the extra income provided by the mother's social security check, and the check increases the mother's options and dignity.

Thus the constituency for social security goes far beyond the old people who are drawing. It includes their children, perhaps other relatives, indeed virtually the entire electorate. The young want their parents to be independent, and only loosely do they indentify the parent's social security check with the tax they are paying.

We are rich in data on attitudes of people of working age, and especially rich on their attitudes towards children. We know much less about attitudes towards parents. Parents are sacred objects, on whom an especially large gap between stated attitudes on one side and behavior on the other is to be expected. Yet although people state attitudes different from those exhibited in behavior, skilled questioning could tell us much about inter-generational links, both those that are direct and those mediated by the state.

CONCLUSION

Whether the reader finds the subject of social security fascinating or tiresome, he is going to hear a good deal of it in the course of the next 50 years. After about 2030 the ratio of people of retired age will stabilize as a ratio of the working population, and at least demographic causes will not further exacerbate the problem. Until then demographic tendencies, acting along with the political dynamics and with economic considerations related to saving in the national economy, will keep the matter in the forefront.

As a measure of the present weight of social security in our economy, the 1982 budget submitted by the Carter administration, which has not been changed much in this respect by Reagan, allowed \$187 billion for social security, over 25 percent of the total. Total military expenditures were to be less than 25 percent, and these two headings constitute half of the federal budget. The average social security tax per employed member of the labor force is \$1800.

The worker is going to find his contribution rising from this level decade after decade, his payment always the pension of others, never for himself, and always for a fund in danger of default. Much as he may object to this, in his other capacity of son or daughter of an aged parent, he will be glad of the financial provision for old age.

The President's Commission on Pension Policy (1980) has many suggestions for bringing income and outgo into line. It took up a suggestion of Victor Fuchs that the retirement age be increased two months each calendar year. The Commission did not recommend that this start now, but in the year 2000, so that it would bring the normal age up to 68 by the year 2018. To start now would be an injustice to those approaching retirement, says the Commission. Going to universal coverage would provide some initial advantage to the scheme, which is to say the tax base would be enlarged more than the payments for a number of years. Benefits could be made subject to income tax. Most important, some part of the scheme would consist in personal savings. These would be mandated, not left to individual discretion, but the person could be free to put the savings into government or private funds.

Of course a funded scheme in any increment would add to the burden over more than a generation before the interest on the fund could lower the net cost. For this reason funding would have to be introduced slowly, replacing a small part at a time of the present pay-as-you go.

Horlick and Skolnick (1978) provide a valuable account of the European experience with mandated private schemes that are funded and are taken as supplementary to existing social security.

They deal with four countries: Switzerland and the Netherlands, where mandated private schemes have been accepted in principle, though the details are yet to be worked out; Great Britain, where employers can come into a second-tier government scheme or contract out and adopt a private scheme; Sweden, where the private pension layer is already operative, but not quite mandatory.

The concept of social security originated in Europe; we could well heed some of the lessons of European experiences.

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