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Ageing Populations: Economic Effects and Implications for Public Finance

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ECONOMIC EFFECTS AND IMPLICATIONS FOR PUBLIC FINANCE

by

Robert P. Hagemann and Giuseppe Nicoletti

Monetary and Fiscal Policy Division

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Recent swings in fertility rates, combined with anticipated increases in life expectancy, are expected to result in a significant increase in the number and proportion of elderly persons in the first half of the next century. This "ageing" of OECD populations is expected to have widespread impacts, affecting labour markets, the composition and level of consumption and output, national rates of saving and the rate of capital accumulation, etc. A widely recognized effect of ageing will be the pressures it will place on public sector finances as the share of future output transferred to a large dependent population rises. This paper discusses some of the potential economic impacts of ageing. It also presents an analysis of its impacts on public pension financing requirements, with particular emphasis on selected OECD countries -- Germany, Japan, Sweden and the United States. It is shown that, where desirable, future increases in retirement age and benefit reductions could help reduce pressures on public finances. Accumulating a trust fund could also ease the transition to an older population.

* * * * *

Les évolutions récentes des taux de natalité, s'ajoutant aux hausses anticipées de l'espérance de vie, auront pour effet de faire croître fortement le nombre et la proportion des personnes âgées dans la première moitié du siècle prochain. On s'attend à ce que ce "vieillissement" de la population ait de multiples effets économiques, affectant les marchés du travail, la structure et le niveau de la consommation et de la production, les taux d'épargne nationaux et les rythmes d'accumulation du capital, etc. On s'accorde à reconnaître qu'il en résultera une pression sur les finances publiques, au fur et à mesure qu'une part croissante de la production devra être transférée à une population dépendante plus nombreuse. Cette étude traite de certaines des incidences économiques potentielles du vieillissement de la population. Elle tente également de cerner l'impact de ce phénomène sur les charges de financement des retraites publiques, notamment en ce qui concerne quatre pays de l'OCDE -- l'Allemagne, le Japon, la Suède et les Etats-Unis. Il en ressort que, là où cela apparaitrait approprié, des relèvements de l'âge de la retraite et des réductions de prestations pourraient à l'avenir contribuer à atténuer les contraintes pesant sur les finances publiques. La constitution d'un fonds de réserve serait peut-être aussi de nature à faciliter la transition vers la nouvelle situation démographique.

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by

Robert P. Hagemann and Giuseppe Nicoletti*

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I. INTRODUCTION

The low birth rates experienced by most OECD countries during the past decades have reduced their population growth rates and will drastically alter their age compositions in the first half of the next century, and sooner in some cases. Sustained low rates of fertility will naturally result in smaller numbers of young dependents, while the large cohorts born in the period 1950 to 1970 will swell the elderly age groups. This "ageing from the bottom" has increasingly attracted the attention of policymakers concerned about the causes and consequences of this demographic change as well as the appropriate policy responses.

There are several broad reasons for interest in population developments. First, there is concern about the possible effects of slower population growth in and of itself. Will a slower rate of population growth be beneficial or harmful to the economy, that is, with respect to such variables as capital accumulation and productivity, per capita income and consumption, and the external balance? In essence, will aggregate welfare be improved or worsened by slower population growth? Second, changes in the age distribution of the populations of OECD countries will have a multitude of social and economic effects, ranging from altering the dynamics of the labour market to raising the share of national income transferred to elderly dependents. Third, extremely low fertility rates and possible declines in population have in some countries at times invoked concerns about the "national identity" (United Kingdom, 1949).

Recently, the OECD Social Affairs, Manpower and Education (SME) Directorate has considered in some detail the social implications of ageing (OECD 1988a), quantifying the possible effects of changes in age distributions on social outlays in twelve Member countries. The present study extends this work by focusing more specifically on the likely effects of ageing on public finances, and its potential economic consequences.

It is of course far beyond the scope of this paper to consider in depth all economic dimensions of population ageing, particularly since far less is known about its implications than would be desirable. This reflects the complexity of the interactions between demographics (which, in addition to fertility and mortality trends includes such features as the household and sex compositions of various subgroups of the population) and the socioeconomic structure of a country. How ageing eventually affects national well-being will depend on how easily each economy responds to demographically-induced changes in key economic variables, and on the willingness and ability of governments to implement policies which are more appropriate for very different age distributions than currently exist. Slower population growth has both positive and negative economic and social implications, affecting different cohorts to varying degrees. It is important that government policy not neglect the welfare of transitional generations. This is especially important since demographic shocks can have subsequent repercussions of very long duration. Institutions established during periods of more rapid population growth may have to be adapted to cope successfully with a transition to a steady state of low population growth.

The objective of this paper is to consider the potential implications of the demographic transition toward a new steady state in which the elderly and the young represent, respectively, larger and smaller shares of the population. In particular, the paper presents:

1. A broad review of the demographic developments in the OECD area, based on the most recent population projections prepared by SME;

2. An overview of the potential economic implications of ageing;

3. An analysis of the implications of ageing for the financing of public pensions, with particular emphasis on selected OECD economies (the United States, Japan, Germany, and Sweden);

These are treated in turn in the subsequent sections.

II. DEMOGRAPHIC DEVELOPMENTS IN OECD COUNTRIES

A. Reduced population growth rates

The decline in population growth rates has been virtually universal throughout the OECD during the past fifteen years or so (1). After averaging slightly over 1 per cent per year during the period 1950 to 1970, population growth declined to an average annual rate of 0.8 per cent during the 1970s, and is expected to fall further to 0.5 per cent for the current decade. As can be seen in Table 1, projections into the next century show a gradual approach to very low rates of growth, becoming negative for most from 2020 to 2050. These projections are based on the following assumptions (2):

-- Fertility rates to 1995 are those provided by Member countries as most likely to prevail by that time, most of which are below replacement (3); thereafter they are assumed to converge to replacement level by 2050.

-- Mortality is (conservatively) assumed to continue to improve slightly, with life expectancy at birth rising on average by 2 years for both men and women between 1983 and 2030, and remaining constant thereafter.

-- Net international migration is expected to continue at recent rates, these in some cases being zero.

On the basis of these assumptions, 20 Member countries would have declining populations by the middle of the next century (Table 1), with the absolute population size of several countries being significantly smaller than in 1980. The populations of Germany and Denmark would be roughly two-thirds their levels in 1980. Italy, Belgium, and Switzerland's populations would be between 15 and 20 per cent smaller, while Austria, Finland, Greece, the Netherlands, and Sweden would have populations roughly 10 per cent smaller than in 1980. The populations of the remaining countries would be either about the same size or, as in the cases of the United States, Canada, Australia, Iceland, Ireland, New Zealand and, especially, Turkey, larger.

These generally low rates of growth would result in substantially different rates of growth among the age groups of the population, which in turn would alter their relative sizes. With reduced fertility, the younger age groups would grow more slowly, eventually declining for a while. Conversely, older age groups will increase substantially in absolute terms as the baby boom cohorts of the mid-1940s to 1970 period move through the life cycle. As can be seen from Table 2, the population aged 14 years and under would decline substantially in most OECD countries between 1990 and 2030. In only four countries (United States, Canada, Australia and Turkey) does the number of young increase during a portion of the projection period.

The relative sizes of the subgroups of the working age population (15 to 64 years of age) would also change substantially. By the year 2010, the absolute number of potential young workers (those aged 15 to 34) would decline relative to 1980 in 20 OECD countries, and by the year 2030 only two countries, Australia and Turkey, are expected to have a larger pool of 15 to 34 year olds. Conversely, those in the age groups 35-54 and 55-64 would be substantially larger by 2030, with a few exceptions. While the subgroup aged 35-54 will remain larger than in 1980 for part of the period, by 2030 the absolute level would have declined in Japan, Germany, Italy, Austria, Belgium, Denmark, Luxemburg and Sweden. In the United States, Canada, Australia, Iceland, Ireland, New Zealand and, especially, Turkey, the 35 to 54 year olds would grow significantly in numbers throughout this period. The number of older potential workers, those aged 55 to 64, would grow for a while in most countries, and stabilise thereafter. As shown in Table 2, only in Germany and Denmark would the absolute number of 55 to 64 year olds decline during the projection period.

The age group which would grow the most throughout the period is that composed of those 65 years and older. With the exception of the United Kingdom and Austria, where their numbers decline slightly to the year 2000 and 2010, respectively, after which they would begin to increase, the population aged 65 and older is projected to grow steadily to 2030 and beyond.

B. Changing age distributions

The differential growth rates among sub-groups of the populations of OECD countries naturally imply significant changes in their age distributions. (see Table 3). The proportion under age 15 would decline significantly, from an average of about 23 per cent to 17 per cent in 2030. Along with the tilt toward an older labour force implied by the more rapid growth in the 35 to 64 year age groups, the share of the population aged 65 and older would rise in all countries, and quite rapidly in most from 2010 onward (Table 3 and Chart 1). Japan stands out as a country in which the proportion of elderly, smaller in 1980 than in most other OECD economies, would increase very rapidly throughout the projection period. Germany and Switzerland are notable as countries whose populations age 65 and over would attain the highest levels among OECD economies by the end of the projection period.

The economic significance of such shifts is found in their implications for the dependency ratio, defined as the ratio of non-working to employed persons. As a first approximation, one can consider an elderly dependency ratio defined simply as the number of potential non-working elderly to potential workers. Using the admittedly very arbitrary distinction that

persons aged 65 and over are totally inactive while those 15 to 64 are completely and equally productive, the ratio of the former to the latter yields one estimate of the impact of population ageing on the old-age dependency burden. As can be seen in Table 4, this ratio rises for all countries over the projection period.

At the same time as the number of elderly increases, the share of young dependents in the populations of OECD countries is expected to decline throughout most of the projection period, given the fertility assumptions indicated above. Thus, some of the resources that would otherwise be transferred to the young could be devoted to the old. However, the anticipated decline in the youth dependency ratio is smaller than the increase expected in the elderly ratio. This can be seen in Table 5. Even taking account of the decline in the youth dependency ratio, the total dependency ratio (the sum of the populations under age 15 and over 64 divided by the population aged 15 to 64) rises during the projection period -- that is, the number of potential workers to potential dependents falls.

To the extent that the resource requirements of elderly dependents may in some instances be greater than those of the young, and that many of the expenditures on the young are in the nature of investments rather than consumption, the increases in the elderly dependency ratios ratios shown in Table 4 may be of more concern. Whereas in most countries the ratio was about 1 to 5 in 1980, by 2030 it will almost double. The increase is even more substantial in some countries, such as in Japan and Canada. In Turkey, the ratio rises sharply because the ratio of the elderly to 15-64 year olds is initially very low.

These measures of dependency provide only a rough indication of the economic pressures of population ageing, since they do not take account of the non-employment among 15 to 64 year olds and the employment activities of those 65 years of age and older (4). More refined projections of economic dependency ratios are presented below for four countries where the impact of ageing is analysed in greater depth.

While the demographic changes discussed above derive in large part from recent reductions in fertility rates, some of the "ageing" is due to increases in longevity. Improvements in life expectancy, particularly, result in greater population "ageing" within the subgroup of elderly itself. As shown in Table 6, for the OECD as a whole, whereas 18 per cent of the population 65 years and older was over 80 years of age in 1980, by 2050 it is projected to account for nearly 31 per cent. If, alternatively, the very old are defined as those 70 and over, they may account for 74 per cent of the 65 year and over group by 2050, compared with 64 per cent in 1980. To the extent that these much older persons are likely to be less productive than their younger counterparts, this component will increase the dependency burden substantially over the next several decades.

C. Sensitivity to assumptions

Population projections, especially those extending to the long run, are subject to considerable uncertainty. And the more distant are such projections, the more likely they will be wrong. Fertility is particularly volatile, and mortality, while more stable over the medium term, can also be

difficult to project in light of the impossibility of anticipating significant medical breakthroughs. Moreover, since changes in life-style and health care at early ages may affect longevity in uncertain ways, life expectancy may differ significantly from levels assumed in the projections. Lastly, international migration, heavily influenced by political as well as economic forces, is also very difficult to predict.

It is therefore useful to consider the demographic implications of alternative assumptions about fertility and mortality. Among the many combinations of assumptions about fertility, mortality and migration which can be invoked, the most illustrative alternatives to the medium assumptions used above are, alternatively, higher fertility and greater life expectancy.

With higher fertility rates (5) (Table 7), while the old age dependency ratio rises by about 3 per cent less by 2050 than in the case of the lower fertility assumption, it nevertheless rises sharply. Moreover, the total dependency ratio rises slightly compared with the baseline projections, reflecting the significant increase in the proportion of children in the population. Retaining instead the fertility rates of the medium scenario, but allowing life expectancy at birth to improve by more than 2 years (Table 8), the old-age dependency ratios increase by significantly more than before.

In sum, the populations of all OECD countries are likely to grow significantly more slowly in the future unless there are large increases in fertility, net international migration, or life expectancy. This lower growth will in turn be accompanied by widespread ageing of the population. Moreover, the expectation is that this demographic transition will be experienced throughout the industrialised world. In fact, the general increase in the average age of the population is a development anticipated more or less world-wide, basically reflecting the fall in fertility rates. While it can hardly be said that the less developed countries (LDC) of the world will experience a dramatic shift from "young" to "elderly" dependency, it is worth noting that the median age of the populations of the LDCs was projected in 1980 to rise from 21.1 in 1950 to 28.3 in 2025, an increase of the same magnitude as anticipated for the more developed regions (United Nations, 1984). Nevertheless, the projected differential rates of population growth between these two regions would result in a significant shift in the distribution of the world's population. Whereas in 1980 the more developed regions accounted for 26 per cent of world population, by 2025 its share could fall to 17 per cent.

III. ECONOMIC DIMENSIONS OF AGEING

Projected demographic changes such as described in the previous section will undoubtedly have significant social and economic influences. While intense interest in the likely consequences of low population growth and population ageing can be traced in modern times to Keynes (1937), Hansen (1939) and Myrdal (1940), the post-war "baby boom" in many industrial economies drew attention away from the subject (6). However, the sudden and large decline in fertility rates during the late 1960s and early 1970s revived interest in the issue (7).

A. Steady-states versus the transition to low population growth

The age structure of the developed countries can be viewed as being between two alternative steady states, one characterised by moderate to high population growth (the immediate post-war period), and a second by low to zero growth (8). Constant low and high rates of population growth will lead to demographic steady states with fixed age distributions;the more rapidly growing population will have a higher proportion of young, while the other has more old. However, the large swings in fertility experienced by most countries will result in a demographic transition during which the age structure will change very rapidly before approaching its new steady-state. This transition itself has economic implications. For instance, the age structure of the workforce will change substantially in a relatively short period, and it is reasonable to suggest that the degree of economic dislocations which may result will vary depending upon the speed of this transition and countries' adaptability. Also important is the impact that such a transition will have on the financing of public pensions, an issue addressed in the next section. In this section, the principle focus is on the economic aspects of an older population per se, as opposed to the transitional phase often referred to as an ageing population.

B. Effects on labour markets

The decline of fertility rates in OECD countries will affect significantly the size and structure of the working age population. In fact, the effect of population ageing on economic growth and, ultimately, on welfare, operates to a great extent through its consequences for the labour market. Labour force developments are all the more important in the context of ageing in that labour supply is increasingly believed to be affected by social insurance policies. Inasmuch as many countries may be faced with the necessity of rapidly and sharply increasing social security contribution rates in future years, both labour supply and demand could be significantly affected. While evidence is mixed as to the quantitative effects of social security contributions on labour supply and demand, this ambiguity may reflect the fact that rates have generally been low relative to possible future levels. As rates rise in the future, the effects of social security contributions may become more evident.

The consequences of labour force developments for the "economic" dependency ratios depend on the interaction of ageing and three socioeconomic tendencies observed in many countries over the past several decades (9): a) decreasing rates of labour force participation among male workers, particularly those in the final years of pre-retirement; b) increasing labour market activities of women of all pre-retirement ages; and c) low and declining rates of activity among men and women aged 65 years and over.

Table 9 shows historical labour force participation rates of males and females in a sample of OECD countries. The most significant development has been the very large decline in the participation rates of elderly workers (particularly male) in all countries. Even in Japan, where men 65 years and older historically have had comparatively high rates of participation, the decline has been about a third. In other countries it has been greater (although less so in Finland), rates averaging roughly two thirds their levels in the 1960s. Also noticeable in all countries except Japan has been the

significant drop in the labour market activities of men aged 55 to 64. These have declined from between 80 and 90 per cent in the early 1960s to a range (for the countries shown) of 58 per cent in Germany to 76 per cent in Sweden. Clearly, some of this decrease, which occurred largely during the last decade, is associated with withdrawal from the labour force induced by relatively high unemployment, sometimes reinforced by government policies. However, such effects only partly account for the fairly large declines in most countries. Particularly notable is the decline in the United States in the first half of the 1980s (from 71 per cent to 67 per cent), which occurred during a period of relatively rapid economic growth by post-war standards. Rates among men aged 24 to 54 were more stable, although they declined somewhat in Germany, from 96 per cent in 1965 to 91 per cent in 1985. Finally, a notable trend is the decline in the participation rates of 15-24 year olds in most countries over the period, with the exception of the United States and Canada, where it rose throughout. Also worth noting is the lower participation rates of the young in Japan than in most other countries. This reflects to a great degree higher educational attainment rather than lack of employment opportunities.

As is evidenced in Table 9, the labour market activity rates of women have been generally rising throughout the OECD area during the past several decades, especially in the 25-54 year age group. However, only in Sweden and Finland does the labour force participation rate of women in this age group approximate that of men of the same age. Among women aged 55 to 64, labour force participation rates have generally declined, although in Sweden these exceed those of men of the same age in several countries. As in the case of men, however, elderly women have also substantially reduced their participation rates in all countries except Finland (10).

Partly reflected in the falling rates of labour market activity among older men and women are the increasing proportions of workers taking advantage of early retirement. There has been a general decrease in the average age of retirement in many OECD countries (Table 10), a development which mirrors the trends in the labour force participation rates shown above. The available evidence suggests that public pension programmes and, in many instances, private as well, induce early retirement via strong disincentives to remain employed. These arise in many ways, such as through the tying of pension benefits to complete withdrawal from the labour force, the implicit high marginal rate of taxation of earned income, and explicit government efforts, often made in the interest of increasing the employment opportunities of younger persons, to motivate early retirement (11).

It seems reasonable to suggest that inasmuch as participation in the labour market among older workers is at least partly, and in some instances predominantly, influenced by rules and regulations governing the retirement decision (in both private and public pension programmes), governments will have to reconsider the appropriateness of certain policies in the light of the demographic developments described above. Policies that tend to increase the labour force participation rates of old workers, such as a gradual increase in the legal retirement age, could help reduce the impact of ageing on the "economic" dependency ratios.

An older work force resulting from the ageing of the population raises a number of questions about the mobility and flexibility of labour markets which, in turn, may influence the dynamism of the economy. Keyfitz (1973) has

underlined the concern that as older workers become a larger proportion of the work force, vertical mobility will be slowed as the opportunities for promotion decline. This could in turn lead to considerable social tensions, as younger workers compete more and more aggressively for fewer and fewer promotions.

Geographic and job mobility is also likely to be adversely affected by an ageing work force. As such mobility tends to decline with age, the adaptability of the labour force to significant changes in market structure may be reduced. Particularly in light of the growing emphasis being placed by policymakers on structural reforms, attention will increasingly have to be turned toward factors which operate to further reduce mobility beyond the effect of age, such as risks of loss of pension rights (i.e. pension portability) associated with job changes. Job retraining programmes could also become important elements in maintaining the dynamism of the labour market.

Reduced population growth could clearly have some positive effects on labour markets. An older and more experienced work force may raise overall labour productivity. For instance, MacGregor (1988) found that the passage of the baby-boom cohorts into high productivity years could raise Canadian labour productivity by 0.2 to 0.3 percentage points over the period to 2001. An older work force which has a higher level of labour productivity in a static sense does not assure that overall labour productivity growth would be maintained in a dynamic setting, however. This would depend importantly on the ability of the older labour force to adapt to new production techniques and procedures. Decreased growth in labour supply could also lead to lower unemployment in countries where it is now high, and/or, due both to cohort size effects [OECD(1986)] and to capital-deepening investment, to higher real wages [see Auerbach et al. (1988)]. The extent to which such potential employment gains can be achieved will depend upon whether or not workers already employed exploit the reduced labour supply growth and extract even higher real wage gains than warranted for full employment. Where labour markets respond flexibly to the slower growth in population, supply-induced labour market pressures should ease and employment prospects improve.

C. Effects on capital formation, productivity and income

The most fundamental question surrounding ageing is whether economic welfare will be improved by a more slowly growing or, equivalently, an older population. Will the average individual have more or less of combined lifetime consumption and leisure than he or she would have if the rate of population growth were higher (12)? Since greater output enables both to increase, a critical question is whether ageing can be expected to have a positive or negative effect on per capita income. This, in turn, depends on the effects of slower population growth on capital accumulation and productivity. There is considerable uncertainty attached to both of these issues (Ermisch and Joshi, 1987).

Standard neoclassical models of optimal economic growth associate capital-deepening with reduced population growth (Pitchford, 1974), and, other things being equal, an older population should therefore have higher per capita income than a younger one. In a slowly growing population, the source of this improvement in per capita income is the capital-deepening

associated with a lessened capital-widening requirement (Coale and Hoover, 1958). Since less of the addition to the capital stock needs to be allocated to new workers to maintain a constant capital-labour ratio, the amount of capital per worker can more easily be raised in a more slowly growing population, ceteris paribus. The greater (and possibly more productive) capital stock per worker, other things being equal, raises productivity and per capita income.

It is well-known (see, for instance, Branson, 1972) that the steady-state rate of growth of income per capita depends on the rates of population growth and technological progress. The latter is typically taken as exogenous to population growth and, therefore, a cessation of labour force growth would have no adverse effect on income growth. The extent to which technological progress is independent of population (and, hence, labour force) growth remains an open question, however. If, as Kuznets (1960) and Simon (1977, 1986) argue, a positive relationship exists between the rate of population growth and the rate of technological progress, the latter may be slowed (13). Moreover, the depressing effects of rising capital-output ratios (associated with capital-deepening) on the rate of profitability may substantially reduce the incentives to invest, thereby slowing economic growth (Keynes, 1937; and Ermisch, 1982). Third, if, as Kindelberger (1967) has suggested, capital-deepening investments are riskier than capital-widening ones (i.e. more of the same is easier), total investment may be sufficiently discouraged by increased riskiness, particularly in conjunction with a lower rate of profitability (14).

A review of the existing literature suggests that there is much uncertainty regarding the effects of low rates of population growth and, hence, ageing, on the rate of growth of per capita income. Theoretical and empirical studies generally conclude that, other things being equal, the slowing of population growth should lead to higher per capita income (Serow and Espenshade, 1978; Clark, Kreps, and Spengler, 1978; Richter, 1988). However, as noted by Serow (1982), this conclusion is not very robust. This is because of the general failure i) to consider the possibly important link between population growth and technological progress, and ii) to take full (or even partial) account of the importance of institutional arrangements (e.g. economic and social regulations or tax policies).

D. Effects on private consumption and saving

One of the most important questions surrounding the ageing of populations is its implications for private consumption and saving, and, hence, for national saving, investment and interest rates. While per capita private consumption ultimately depends on the effect of ageing on income, about which there is some uncertainty, ageing may also have an independent impact on both the level and structure of consumption.

Changes in the age distribution can be expected to alter the relative importances of different commodities in the structure of private consumption, since age is an important determinant of preferences. Empirical analysis generally reveals statistically significant effects of demographic factors on the composition of consumption (Eilenstine and Cunningham, 1972; Parks and Barten, 1973; Resek and Siegel, 1974; Ketkar and Cho, 1982; Musgrove, 1982; Barnes and Gillingham, 1984; and Guger and Wueger, 1988). Naturally, the

extent to which age distributional effects can be detected depends in part on the degree of disaggregation of consumption. In general, however, the categories of private consumption that would tend to decline the most in relative importance in an ageing society are education, transportation, recreation and durables, including housing, while food, services (in general) and medical care would increase, the latter markedly. Importantly, as most analysts assume that population ageing would be associated with both unchanged relative prices and rising per capita income, the age-distributional effects tend to be offset by the indirect effects and, thus, a more slowly growing population leads to remarkably similar consumption patterns.

Changes in the age distribution of the population could affect a country's rate of private consumption or, equivalently, of private saving. This effect would arise if, as suggested by the "life-cycle hypothesis" (Modigliani and Brumberg, 1954; Modigliani, 1986), an individual's marginal propensity to consume increases with age. In its most simple form, the life-cycle hypothesis of consumption supposes that individuals maximise lifetime utility from an intertemporal stream of consumption. Because earnings are realised unevenly over the life cycle, saving occurs in pre-retirement years so as to finance consumption in retirement. At any point during its life-cycle, a household's consumption is determined by the relationship between its net wealth (i.e. past accumulation), current and expected income, expected length of life, and anticipated duration of retirement (15). If population ageing alters the age-distribution of income, this too could alter the aggregate rate of consumption and saving, although there is growing evidence [e.g. Ando (1986), Kotlikoff (1988), and Jenkins (1988)] that the elderly do not dissave, at least not to the extent suggested by the pure life-cycle model.

In a recent empirical analysis of the potential effects of demographic changes on future private saving rates in the major seven OECD economies, Heller and Sidgwick (1987) obtain results using different approaches that suggest that the increase in the share of elderly in these countries could reduce private savings by between 5 and 15 per cent of GNP for the group taken as a whole over the period 1985 to 2025, depending upon methodology. The largest declines are projected for Japan, where savings are simulated to fall by 14 per cent of GNP. The results also suggest that private saving rates could rise for a while in some countries, particularly in the United States and, later, in Canada. By the end of the simulation period (2010-2025), however, private savings rates would be declining in all countries.

Private saving is of course influenced by many factors, one of which could be the provision of public pensions financed on a pay-as-you-go-basis (PAYG). Given the prospective increase in the level of these transfers due to ageing, this channel of influence is particularly important. Feldstein (1974) was one of the first to suggest that the introduction of a PAYG pension system could reduce the rate of private saving in an economy composed of life-cycler savers. As explained in more detail below (Section IV), the PAYG system operates by providing pension benefits to current retirees financed by contributions of current workers. Where the system is structured (intentionally or not) in such a way that some generations receive benefits in excess of lifetime contributions, as is certainly the case during the phase-in of a new PAYG system (16), private consumption is raised via the wealth effects associated with the intergenerational transfer.

At the same time, however, the introduction of a mandatory public pension programme may increase the average length of retirement. In order to finance this longer period of retirement, an increase in saving during working years is necessitated. Moreover, as stressed by Barro (1974), if individuals have bequest motives, such as may be the case where generations are linked by the concern for one another's welfare (the "dynastic model"), public transfers from young to old may simply be offset by private ones. If public transfers exceed levels that would otherwise be desired by the private sector, private savings rates may increase in anticipation of the future tax burden from the public programme. Because of the offsetting nature of these effects, empirical analysis is required to determine the net impact of social security on private saving.

In spite of a large and growing body of empirical research into this critical question, the evidence concerning the effects of PAYG financing on private saving remains ambiguous (Munnell, 1987 and Atkinson, 1987). However, the uncertainty of the empirical evidence attaches most, but not solely, to the research focusing on the United States. Feldstein's (1974) research concludes that social security in the United States has reduced substantially the private saving rate, while studies by Barro (1978), Darby (1979), and Leimer and Lesnoy (1982) raise doubt about such an effect. Evidence from empirical analysis based on international cross-sectional data is also mixed (Barro and MacDonald, 1978; Feldstein, 1977; Kopits and Gotur, 1980; Koskela and Virèn, 1983; and Modigliani and Sterling, 1983). For several countries, however, there is some evidence of a depressing effect of social security on saving. Bentzel and Berg (1983) and Berg (1983) find that the introduction of the public pension system in Sweden had a significant depressing effect on private saving, reducing it by about 4 per cent over the period 1953-79. Similarly, Shibuya (1987) finds that the public pension system in Japan may have reduced private saving by roughly 4 per cent during the period 1965-83. Lastly, Brugiavini (1987) estimated that the pay-as-you-go system is likely to have reduced saving in Italy.

Beyond the inconclusiveness of the empirical evidence, so critical to the resolution of the theoretical ambiguity of the effects of social security on saving, there is the question of the very feasibility of "testing" the hypothesis of the existence of such effects. As Leimer and Lesnoy (1982) found, the rejection of the null hypothesis of no social security effect on saving is extremely sensitive to sample period, the choice of discount rate and, especially, the structure of expectation-formation. Furthermore, Auerbach and Kotlikoff (1983) have shown that even using a hypothetical pure life-cycle model of saving yields results which are sufficiently sensitive to sample period as to make econometric evidence weak at best.

It is also important to note that if, as the projections suggest, since the ratio of workers to retirees declines in the future, increasing the per capita stock of capital becomes critical for reducing the future burden of a higher dependency ratio. Thus, irrespective of whether or not social security as currently structured in the different countries has reduced saving below the level it would otherwise have reached, attention must focus on assuring an adequate flow of savings to promote growth in the capital stocks of all countries during the demographic transition. This may, of course, increase international capital flows from countries with stronger saving flows to those with high investment requirements and, hence, affect countries'

current account balances [see Auerbach et al. (1988)], as these transitions will not occur at exactly the same time and with precisely the same intensity in all countries. The possible consequences of these imbalances have to be weighed against the future costs of providing pensions out of a smaller resource base.

IV. AGEING AND PUBLIC SECTOR OUTLAYS

From the above discussion, it is clear that there is a great deal of uncertainty surrounding the economic implications of population ageing, although they are likely to prove to be important in a number of respects. One of the least ambiguous consequences of ageing, however, is the potentially large increase in the role of the government in transferring resources from the working age to the elderly population, at least given the expansion of the government transfer programmes during the recent decades in most countries. Because of the relatively high reliance of the elderly on publicly provided social expenditures, demographic developments in OECD countries can be expected to put increased pressure on public finances. The purpose of this section is to consider the quantitative implications of ageing on social expenditure in general and public pensions in particular.

A. Social expenditures

Publicly provided social expenditures, which include different categories from one country to another, are very sensitive to the age distribution of the population, and can be expected to be substantially affected by the changing age distributions in OECD countries. Younger populations are heavier consumers of education, while older ones absorb large quantities of medical services. The extent to which population ageing will result simply in a reshuffling of an existing share of national output devoted to social programmes, or will augment the total share, depends in the first instance on the relative importance of each public expenditure category to the different beneficiary groups.

Recent analyses by the OECD (1988a) and the International Monetary Fund (Heller et al., 1986) considered the implications of population ageing for the level and structure of social expenditures, broadly defined to include public outlays on education, family assistance, health care, unemployment insurance, and pensions. These studies conclude that the share of social outlays will rise significantly as a consequence of demographic changes even taking into account the reductions in education and family assistance spending that should result from smaller young cohorts. For a sample of twelve countries, the OECD projections (see Table 11) show education and family benefits declining in nine countries between 1980 and 2030 (the exceptions being Australia, Canada, and the United States), while health expenditures are projected to increase everywhere except Denmark and Germany (in the latter country, these first rise before declining as a result of decreasing population). The combination of rising health and pension outlays is projected to increase total social expenditures significantly in most countries (17).

For some countries, concern must be focused on the containment of medical costs if the quality and quantity of health care provided to an

increasingly older population is to be maintained. For instance, in the United States, the health care price deflator increased by 359 per cent between 1960 and 1986, compared to 262 per cent for all prices. If such relative price changes were to continue, and policy aims at the same time to maintain the level of medical care provided, public sector health care costs could consume a substantially larger proportion of national output than suggested by these estimates.

B. The demographic transition and public pension financing

As evidenced in Table 11, in every country included in the OECD study the largest demographically-induced increase in social expenditure are public pensions. As a consequence of recent and anticipated low fertility rates, OECD economies will have to devote an increasing share of output to support a relatively larger elderly dependent population. Given the expanded role of the government, public sector finances are expected to be heavily affected. Notwithstanding the increased importance which governments may choose to give private retirement planning, the role of the state in providing pensions is likely to continue (18). Hence, governments will inevitably have to face the difficult task of making the financing of public pensions more consistent with demographic developments.

a) Alternative financing schemes

There are fundamentally two ways of financing a public pension scheme: pay-as-you-go financing and advance (or full) funding. As mentioned earlier, in the PAYG scheme, retirement benefits are financed by contemporaneous taxes, and the pension system is in balance in the sense that such revenues by definition always equal benefits in each time period. The taxes are almost universally payroll taxes, so that labour income as opposed to capital income is used to finance social insurance. In a stable demographic environment, and on the assumption that it does not affect economic behaviour (i.e. neither reduces private saving nor alters labour supply), a PAYG system can present several advantages. First, it enables immediate payment of benefits, thus permitting a rapid initiation of transfers to current retirees. Second, PAYG financing can eliminate pensioners' inflation risks by linking future benefits to future nominal wages. Third, the pay-as-you-go scheme can potentially provide a higher rate of return to each generation provided that the sum of the growth rates of population (or labour force to be exact) and wages exceeds the market rate of interest (19).

The PAYG system can have distinct disadvantages, however. First, as a direct transfer, the PAYG financing scheme does not in-and-of-itself raise the resource base against which pensions are to be paid. Second, as noted in the previous section, while raising the lifetime income levels of initial recipients, the introduction of current-period financing of public pensions could potentially discourage saving, thereby lowering the stock of capital relative to what it otherwise would have been. Even in a stable demographic environment, the PAYG scheme will imply a constant stock of government unfunded liabilities to the extent that the present value of future pension obligations always exceeds the present value of future revenues from living generations (20). Thus, under certain assumptions (21), such unfunded liabilities of the government (which are "hidden" in the sense of being unaccounted for in government book-keeping) can have similar crowding-out

effects as the accumulation of government debt resulting from deficits defined on a national accounts basis. Second, if contributions are perceived by workers as taxes rather than saving, these can have distortionary effects (for example reducing labour supply). And where large increases in contribution rates are induced by demographic shocks, which will be the case in many countries during the next several decades, these could result in large aggregate welfare losses since the latter rise more than proportionately with increases in contribution rates (22). Third, contribution rate increases, by raising the cost of labour, can be potentially adverse to a country's international competitiveness.

Alternatively, the government can choose to advance fund public pensions. In this case, the premiums of the insured group (i.e. the future pensioners) are set so that the present value of all contributions (past and future) paid by the group equals the present value of the future liability engendered by the group. In other words, the pension plan is "fully funded," and each group's benefits originate from the stream of payments and interest revenues earned by the accumulated pension fund. If the programme is actuarially fair, the real rate of return to individual cohorts is equal to the market real interest rate, and there is no net wealth redistribution between generations (23).

Advance funding has two distinct advantages over PAYG financing. First, on the assumption that it does not lead to increased government consumption, funding can, by raising aggregate saving, increase the capital stock and future levels of output (24). This enables higher levels of consumption for both future workers and retirees. Second, since the retirement benefits of each cohort are financed out of its own saving and interest earnings, advance funding avoids the distortionary consequences of the PAYG scheme.

Advance funding also has some notable disadvantages. First, since benefits are paid from contributions and interest earnings, it takes many years for full benefits to be payable. This obviously makes such a scheme less politically attractive than a programme which enables the immediate distribution of pensions out of current contributions (25). Second, if ex ante domestic investment is less than the increase in national saving that could potentially result from the accumulation of a large trust fund, a country's exchange rate and current account balance could be significantly affected, other things being equal. Third, the presence of a large trust fund may itself induce higher levels of government consumption or the distribution of higher benefits to current recipients of government transfers (26). Fourth, to the extent that a large fund increases national savings, this could depress overall rates of return domestically. Lastly, the management of a large fund could be problematic, particularly if subject to political influence.

b) The effects of demographic shocks

Large demographic shocks, such as the substantial and rapid ageing of the population, can have significant impacts on the rates of return under either of these schemes, although the distribution of these effects across generations differs greatly. With PAYG financing, the consequences of a large decline in fertility are primarily adverse to future workers since, for

unchanged relative (to current wages) retirement benefits, their contribution rates must of necessity be increased. Under advance funding, these consequences fall primarily on future retirees since the substantial eventual depletion of the capital accumulated in earlier periods would put significant downward pressure on future asset prices for a while, depressing rates of return and, thus, lowering the future retirement benefits expected by current contributors. Where future population growth rates may even be negative, the potential imbalance between the supply of and demand for assets could further reduce rates of return in a fully-funded system.

Most OECD countries have chosen to finance public pensions generally on a PAYG basis. It is therefore useful to consider the impacts which demographic swings can have on rates of return to cohorts of different sizes. This is clearly illustrated by Keyfitz (1985), who provides some illustrations of the sensitivity of rates of return on social security contributions under PAYG financing to demographic changes. Using historical and projected population data for the United States, he shows that a sharp decline in fertility can have a very profound effect on the internal rates of return that different generations may expect from social security. For instance, as can be seen in Table 12, with fertility rates maintained at their 1979 level (column headed by 1.0), the rate of return to generations born in the years 2000-2005 will be negative. If the birth rate declined to only 75 per cent of its level in the late 1970s, the generations born this decade can already anticipate a negative rate of return on social security contributions. If adjustments are made for labour force participation (i.e. the fact that not everyone is active), returns are somewhat lower, as they also are with a declining age of retirement. In terms of demographic influences on the relative rates of return to different cohorts, Keyfitz also shows that the only change which would prevent the systematic depression of returns to negative levels would be a rise in fertility. The effect of immigration depends greatly on the age distribution of immigrants.

What emerges from these simulations is a relatively clear picture of the inter-cohort effects of fertility decisions on PAYG financing. The cohort with high fertility facilitates intergenerational transfers to the elderly by diluting the costs (which are spread over a large contribution base). On the other hand, the low birth rate generation raises the per-contributor burden to future generations.

As mentioned above, the rate of return to PAYG social security also depends on the growth of real wages. In principle, an increase in real wages, if sufficiently large, can more than offset a decline in the rate of population growth. Again, there is some uncertainty that the higher productivity increases required to compensate for slower population growth could actually be achieved. This is particularly the case since higher productivity growth depends on many factors, not the least of which is the growth in the stock of capital (physical and human) and technological progress, both of which may be affected by demographic developments. However, where public pensions are a more or less constant percentage of current wages (which tends to be the case in most countries), productivity increases feed through into higher benefits. Thus, a rise in productivity would be insufficient in many countries to reduce significantly, if at all, the future burden of public pensions. Only if productivity gains are not passed through to initial pension benefits can increased output per worker ease the burden of PAYG financing.

Using simulated benefit and contribution rates required for current-period financing in four OECD countries (see subsection C below), the ratio of expected lifetime benefits to lifetime contributions (i.e. a benefit-cost ratio) has been estimated separately for typical fully-insured men and women of different cohorts. A ratio greater than 1.0 would signify a positive intergenerational transfer, since the present value of anticipated benefits are greater than the present value of contributions. Conversely, a ratio less than 1.0 would suggest a negative transfer.

These estimates are shown in Table 13. The first thing to notice from the table is that in all countries the implicit rates of return are greater for women than for men (27). This reflects the fact that in all countries women's life expectancy exceeds that of men. As a result, there is intragenerational redistribution from male to female workers (in addition to that implicit in the survivor's benefit provisions of many social security programmes). The second noticeable feature in these estimates is the corroboration of the patterns suggested in the simulations by Keyfitz, namely that the returns to more recently born cohorts are likely to be much lower than those to older cohorts, although this is not as apparent as it would be if the calculations for the already retired generations had been made. Only in Japan (for all but the 1970 cohort) do the estimated benefits exceed contributions. In the other countries, the simulations point toward potentially negative returns to all the male cohorts born after 1945. The slight U-shape of ratios for the United States is explained by the fact that contribution rates are scheduled to decline for a while near the turn of the century, so that younger cohorts benefit more for a longer period than older ones.

The above discussion thus suggests that the interplay of a large decline in fertility and pay-as-you-go financing raises important issues for governments. At a minimum, to the extent that workers fail to recognise the contribution-benefit relationship in social security contributions (in other words, so long as they treat contributions as taxes rather than saving), some potentially large welfare losses can be anticipated where rates are raised to meet commitments to retirees.

Another major issue raised by the demographics-PAYG interactions relates to intergenerational equity. To what extent should the burden induced by current period fertility decisions be shifted to future generations? As suggested, the degree of burden-sharing may be determined by in-period decisions -- that is, at the time in which the increases in dependency ratios are occurring -- or by a "constitutional rule" which reflects society's equity norm (28). At a minimum, it would seem that government should aim at limiting the welfare losses to transitional generations. This could be achieved in any number of ways, either explicitly via an arbitrary reduction in future income replacement rates, or implicitly, such as by replacing a proportion of <u>net</u> rather than <u>gross</u> earnings. Alternatively, the government can accumulate a fund which enables it to smooth contribution rate increases over successive cohorts. However, inasmuch as the political power of future pensioners, by virtue of their relative numbers, will be substantial, it is reasonable to hypothesise that postponement of policy changes increases the likelihood that future workers will be made to bear the burden of tomorrow's pensions (29). Moreover, in some countries (e.g. Germany), contributions made in support of current retirees provide legal entitlement to future benefits, and therefore

governments may be unable to alter benefits except via a long-term phase-in (30).

C. The outlook in four OECD countries

In this subsection, the implications of ageing for the financing of the pension components of social security are considered by focusing on the four countries mentioned earlier -- the United States, Japan, Germany and Sweden. There are several reasons for the choice of these countries:

-- First, population ageing, while occurring in all four countries, is doing so at a different rate and from different starting points. Japan and Germany will have significant increases in old-age dependency ratios, although Japan's transition is starting from a lower ratio which rises comparatively rapidly. The United States will only experience considerable ageing after 2010, while Sweden, with an already comparatively old population, will experience an intermediate decline in dependency, following which it is expected to increase as in other countries. Moreover, population ageing, while occurring in each of the three major economies, will take place at a different pace and with different intensity. This asynchronization of the transition has often been suggested as a partial explanation for their trade imbalances.

-- Second, the four countries provide contrasting social security situations. The United States, until recently, and Germany have operated on a primarily PAYG basis, while Japan and particularly Sweden have accumulated funds.

-- Third, Japan and the United States have both recently made important changes to their programmes.

The assessment is made using a common methodology which captures the essential features of each country's public pension scheme. While national projections are available for some countries, a common framework enables meaningful cross-country comparisons and, moreover, makes possible a quantitative assessment of alternative policy options where actions appear to be desirable.

The common methodology used in the simulations, for which a more detailed description is shown in the Annex, is derived from the social security budget constraint where the sum of revenues from social security contributions and interest income of the accumulated trust fund must equal, in each period, the sum of benefits paid (less any general government subsidy) and the growth of the trust fund in the same period. In other words, the total income of the social security system can be used either to pay current period benefits or increase the trust fund. As shown in the Annex, the budget constraint can be used to solve for the contribution rate, defined in terms of taxable earnings, required for balance, given the average replacement rate (per capita pension benefit divided by average taxable earnings), the dependency ratio, and the growth in the trust fund (31). The contribution rate in each period required for balance is: i) positively related to the old-age dependency ratio, the average replacement rate, and the growth in the size of the trust fund per unit of the current period income base (i.e. the

same base on which contributions and benefits are determined), and ii) inversely related to the differential between the real rate of return earned by the trust fund and the growth of the tax base. Alternatively, for given (i.e. current and future legislated) contribution rates, the pattern of cash flow deficits implied by demographic and pension developments can be ascertained.

The starting point in quantifying the effects of demographic trends on social security financing requirements is the determination of more realistic dependency ratios, namely the ratio of potential beneficiaries to potential contributors. Estimates have been made for each of the countries, after adjusting population projections for age of retirement, as well as age-specific labour force and unemployment rates (see Annex for details). These dependency ratios, along with purely demographic ones based on the projections discussed in Section II, are shown in Table 14. Projections from national sources are also shown for the United States and Japan, for which these are available.

The table makes clear the importance of taking into account the effects of labour force activity and unemployment. The "adjusted" dependency ratios are noticeably higher for all countries, although less so for Sweden, reflecting in part the already high labour force participation of women. While there are some divergences between the authors' estimates of the dependency ratios and those of national authorities, the approximations are sufficiently close that the former may be used in quantifying the impact of policies aimed at altering the ratio of beneficiaries to contributors.

The budget identity and the dependency ratios in Table 14 are used to estimate the impact of ageing on the financial balances of the old-age components of the social security systems in the four countries, given existing policies with respect to: i) contribution rates, ii) average replacement rates, iii) general revenue subsidies, and iv) legal retirement age. Hence, the estimates incorporate several of the changes made in the recent reform of social security in the United States and Japan, and the principal features of the programmes in Germany and Sweden.

In the United States, the 1983 legislation provided for, among other things, interim social security contribution rates in excess of PAYG requirements, a phased-in (between 2000 and 2027) increase in the age at which full benefits are receivable, and the taxation of a portion of benefits of recipients with total incomes in excess of $25,000. (The legislation also provided for a reduction in early retirement benefits, as well as the elimination of the limitation on earnings after receipt of benefits, but these changes are not taken into account here. For Japan, where past surpluses have led to the build-up of a sizeable trust fund, the analysis accounts for the recent decision to lengthen the qualifying period from 30 to 40 years, an action which reduces the prospective increase in the average replacement rate implied by the maturation of the programmes. In Germany, while there has been considerable debate recently over the future financing of social security (32), no major policy changes have yet been adopted. Thus, social security pensions are still financed on a pay-as-you-go basis, with a contingency fund maintained at a level sufficient to finance only one month of current expenditures.

In Sweden, the starting point includes a sizeable trust fund built up over the past 25 years. Recently, some concern has arisen that the current indexing mechanisms will gradually lead to an erosion of the programme's original insurance objectives (33). Pensions replace pre-retirement income only up to a ceiling which is equal to 7.5 basic pension units (the "basbelopp"), while no ceiling is applied to taxable earnings, providing a degree of progression in the benefit formula. The estimates take into account that, as the incomes of more workers approach and then exceed the ceiling (which is indexed only for inflation), the average replacement rate will decline, easing the increased financing burden due to ageing but also reducing coverage (34). Subsequent estimates are also presented, by way of illustration, in which the ceiling is indexed to real growth.

In Table 15 are shown the estimated trust fund levels (in per unit of taxable income) and the associated cash flow deficits given current and planned (in the case of the United States) contributions rates in each country. While the projections for the United States differ (due to differences in methodology) from those of the Social Security Administration (United States, 1988), which anticipates exhaustion of the trust fund at a later date (2051), they do correspond in predicting that the recent legislation will lead to a significant growth in the fund, continuing well into the next century, followed by a run-down (35). Thus, the recent actions taken in the United States appear to have done much to restore solvency to the old-age income component of social security over the medium-term on the given economic and demographic assumptions (see Annex). For Japan and Sweden, the large initial funds could permit contribution rates to remain at current levels, but only at the cost of very substantial declines in the funds after 2010. With contribution rates maintained at current levels, deficits begin to appear in the early part of the next century in Japan, with the fund exhausted in the period 2015-2020. In Sweden, revenue short-falls at current levels of contribution rates are estimated to lead to a depletion of the fund at roughly the same time as in Japan. Lastly, in Germany, large shortfalls appear very soon -- beginning in the early 1990s. The very small starting level of the fund, set by law to equal roughly one month's benefits, leads to its very rapid depletion at current contributions and benefit levels.

Also shown in Table 15 are the contribution rates that would be required in the year following exhaustion of the reserve. This is useful in highlighting the long-run nature of the move toward a demographic environment in which there is a permanently higher ratio of elderly dependents. Thus, while the simulations suggest that rates can be contained for some time in Japan, Sweden, and (since the recent social security reform) the United States, the need for adjustment inevitably arises, although the precise year in which the adjustment must be made is sensitive to which projection one considers. Deficit financing cannot be viewed as a viable alternative to meet shortfalls that could continue indefinitely. Deficits in social security could be financed by general revenues, but such a policy would represent a fundamental change of approach in most countries. It therefore seems worthwhile to first consider options which are available within the current generally prevalent framework, namely benefit reductions and/or partial funding (36). In the following subsection, a number of simulations are presented which suggest the possible impact which several different policy actions could have on the financing of old-age income in these countries.

Before presenting the results of simulations of alternative policy responses, it is perhaps useful to consider the scope of the financing burden using an alternative perspective (37). If the view is taken that the difference between the present value of the future pension benefits of current living generations (of working age) and the future contributions of the same generations represents a debt of the public sector (which could of course be negative, in which case it is an asset), by comparing this debt to the current size of the trust fund, an estimate can be made of the amount by which these pension obligations are funded or not. To the extent that such commitments are unfunded, an estimate is obtained of the maximum amount by which the pensions are under-capitalized, given certain restrictive assumptions (38) or, correspondingly, of the size of the trust fund that would be required for the programme to be fully-funded.

In Table 16 are shown illustrative estimates by the Secretariat of the unfunded obligations associated with the pension programmes for each of the four countries. These estimates include only men and women with own pension rights; the calculations take into account neither the benefits of dependent spouses or survivors nor disability payments. As would be expected, the estimates are very large, both in absolute terms and relative to GNP. The estimate for the United States is similar to the one obtained by Auerbach and Kotlikoff (1987). While it is neither realistic nor necessarily desirable to suggest that countries could or should fill this hypothetical gap, the estimates nevertheless highlight the potential scope of the financing dilemma.

D. Alternative policy options

a) Accumulating a fund

Historically, and of course within the framework of the PAYG financing scheme adopted in these countries, contribution rates have been set roughly in line with current and near-term anticipated revenue requirements. Thus, one option for governments is simply to allow contribution rates to evolve in line with the increasing dependency ratio and, in the case of Japan and Sweden, with the changes in average replacement rates implied by the maturation of the public pension schemes and the characteristics of the benefit formulae. (Average replacement rates are kept constant in the United States and Germany.) To see the effects that demographic developments could have on contribution rates, use is made of the budget identity discussed above to simulate PAYG rates in each country on the assumptions (admittedly arbitrary) that the trust fund per unit of taxable income is maintained at its current level throughout the projection period, and that the associated interest income contributes to paying future pensions (39).

The results of the projections are shown in Table 17. For the United States, the rates up to 2030 are those projected by the Social Security Administration, while the authors' estimates are shown for later years given the earlier depletion of the trust fund obtained using the current methodology. As can be seen, contribution rates required to balance income and outlays would increase after 2010 in the other three countries, substantially in Japan and Germany. Rates would increase quite rapidly in Japan, where the speed of population ageing combines with the maturation of the programme to raise financing requirements considerably. In Germany, while the rate of increase in the required contribution rates is less significant

than in Japan, the levels that would be required are quite high, reaching an estimated 29 per cent by 2030. The rise in Sweden would be comparatively smaller as a slight decline in the dependency ratio is expected between 2000 and 2015. If the standard pension unit is left unindexed for real growth, future required contribution rates would rise through 2020, but decline thereafter. If, however, the "basbelopp" is adjusted in line with the growth of real wages, rates would continue to rise beyond 2020 for another decade and would not decline before the middle of the century.

Thus, governments would be faced with the need to make in-period adjustments, decisions which could well be required at undesirable phases of the business cycle. The government's ability to adopt macroeconomic policies consistent with the conjuncture could be significantly constrained by the rigidities imposed by potentially coincident cyclical downturns and higher financing requirements induced by population ageing. Moreover, the bulk of the adjustment would fall on workers later in the period when rates would peak.

For at least two sets of reasons, one based on arguments of intergenerational equity and the other on efficiency, it may be desirable for the government to adopt a policy of building up a fund to partly pay for future pensions of current workers -- that is, by accumulating a trust fund equal to several years' pension outlays. Setting contribution rates in excess of PAYG requirements would allow accumulation of a capital reserve which could be used as a buffer against demographic and economic shocks, limiting or avoiding the necessity of raising contribution rates or reducing benefits at undesirable times (40). While retaining the basic PAYG system, this partial funding would also shift explicitly to current workers part of the future financing burden induced by currently lower fertility (41). Taking the perspective that demographic shocks are random events, and are beyond at least the direct control of governments, this form of burden sharing could be motivated in terms of the general risk-sharing basis on which social insurance is justified. Moreover, to the extent that the policy results in higher public saving not offset by reductions in private saving, it could contribute to an increase in the stock of capital and a decline in interest rates (42).

Table 18 and Chart 2 show simulated contribution rates implied by a partial funding policy aimed at smoothing through time the increases in rates required by the social security budget constraint during the demographic transition. The table shows PAYG rates as well as the "smoothed" rate paths resulting from the assumptions i) that the government's objective is to minimise the distortions implied by the required increases in contribution rates, given the sequence of budget constraints of the pension programme (43), the exogenous paths of future per capita pension outlays, and the rates of return on the trust fund, and ii) that by 2060 revenues are sufficient to pay for the level of per capita pension outlays implied by the new age distribution of the population (which is assumed to be stable thereafter) (44). In Chart 2 are shown the PAYG rates (assuming a constant fund) and the "smoothed" rates under the latter restriction. (Associated trust funds are shown in Chart 3.) For the United States are shown the legislated rates up to the year following which the trust fund is estimated by the Secretariat to be depleted, bearing in mind that this is a somewhat earlier date than obtained by the Social Security Administration. As can be seen, the pattern differs by country. In the United States and Sweden, smoothing would permit lower rates in the early and later periods, with an

intervening period of higher than PAYG requirements. In Germany and Japan, rates would increase in the early period above PAYG requirements but rates could be lower in the future, particularly during a portion of the period.

While smoothing could have the advantage of minimising the substantial changes in contribution rates which might be required over a very short period, this approach by itself would not alleviate growing concern over the potentially adverse consequences of higher tax rates, at least under the assumption of unchanged non-social security revenue requirements. So long as social insurance contributions give rise to similar distortions as other taxes, which is likely to be the case wherever the tax-benefit linkage is not clear for individual contributors, or not fully recognised, such rate increases as simulated above would combine with other taxes to substantially increase distortions, reducing economic welfare. Instead, governments could consider raising the age at which benefits become available, or changing benefit formulas applicable to future retirees.

b) Raising the retirement age

One of the most often discussed proposals for limiting future contribution rate increases is to raise the age at which public pensions become available. An important justification for increasing the legal age of retirement is that this would raise the ratio of working life to life expectancy, making it more consistent with improvements in longevity. As noted earlier, this is one of the policy changes adopted in the recent reform in the United States. Therefore, the simulations in this section apply only to Japan, Germany, and Sweden. Raising the age of retirement would operate in two ways to limit the rise in future contribution rates. First, later qualification for full benefits would obviously retard pension expenditure increases. Second, raising the legal retirement age would tend to increase labour force participation rates of the elderly, thereby increasing the contribution base.

In order to assess the impact that an increased retirement age could have on simulated tax rates, the dependency ratios in Japan, Germany and Sweden were modified by supposing that the average age of retirement is increased by two years, implemented (arbitrarily) in two stages over a ten-year period. The "effective" dates of these increases are (45):

-- Japan: from 65 to 66 in 2000, and to 67 in 2010;

-- Germany: from 61 to 62 in 2000, and to 63 in 2010;

-- Sweden: from 65 to 66 in 2015, and to 67 in 2030;

The impact of this policy on both the old-age dependency ratios and the required contribution rates is shown in Table 19. (The assumption of a constant fund per unit of taxable wages is retained in these simulations). In all countries the policy would have a significant impact on the dependency burden. In Japan, the effect would be relatively strong, reducing contribution rates in 2040 and 2050 from roughly 23 per cent of taxable payroll (Table 17) to between 19 and 20 per cent. In Germany, the projected tax rates by 2030 could be approximately 3.7 percentage points lower than if the age of retirement is left unchanged. Since Germany has a much lower

retirement age than the other countries, there would be scope for realising substantially larger gains through progressively increasing the legal retirement age. In Sweden, raising the age of retirement would also have a large impact, lowering the required rate increase by as much as 2.8 percentage points.

These simulations suggest that raising the legal retirement age can have a substantial effect on future contribution rates, in spite of the fact that the latter would still rise greatly due to the large increase in future dependency ratios. For such beneficial effects to be obtained, however, increased flexibility in both the public and private retirement choices are desirable. Naturally, general improvements in employment opportunities for elderly workers are also a necessary precondition for improved elderly labour force activity.

c) Reducing benefits

As indicated earlier, the estimated contribution rates assume that pension benefits are set in proportion to gross earnings, that is, including contributions. As a consequence, the full burden of increased dependency ratios is shifted onto future workers. Any policy which shifts the burden from workers to future pensioners represents a de facto "new" intergenerational contract. Naturally, there are a variety of mechanisms by which benefits can be lowered, such as by reducing the extent of indexing pre-retirement earnings for both productivity and inflation, or by lengthening the qualifying period for receipt of full benefits (46). One approach which has received increased consideration in some countries, particularly in Germany, is the proposal that pensions be determined as a share of net rather than gross wages, where the former exclude pension contributions. In this manner, demographically-induced increases in contributions are shared by workers (whose net wages decline due to higher taxes) and pensioners (whose benefits are lower than they otherwise would be if benefits were tied to gross wages). In the absence of such a modification of benefit formulas, the after-tax income of retirees will tend to rise relative to workers.

In Table 20 is shown the impact of this policy on contribution rates in Japan and Germany (assumed to be implemented immediately and retaining the assumption of a constant fund per unit of taxable income. Estimates are not made for Sweden because the policy cannot be easily implemented in this framework, since contributions are paid only by employers (i.e. benefits are already fixed in terms of net earnings) (47). Nor are they made for the United States in light of the interim measures already taken. As is evident, this policy can have as significant an effect on contribution rates as raising the age of retirement. By 2050, rates could be about 3 percentage points lower in Japan than otherwise, and 4 percentage points lower in Germany. As in the case of increased age of retirement, the increase in rates can only be dampened, reflecting the sheer weight of the transition to an older population.

E. A brief assessment

The principal objective of the above analysis has been to provide a quantitative assessment of the impact which population ageing could have on financing requirements for public pensions. Also, the alternative simulations

are suggestive of the effects which some policy measures might have in limiting the increase in contribution rates. The results confirm that while such options as reducing future benefits in parallel with raising contribution rates or increasing the age of retirement are perhaps desirable, the transition to an older population will still increase the per worker cost of supporting more elderly. This simply reflects the broader consequence of ageing, that the output of a relatively smaller workforce will in the future have to support a relatively larger dependent population. Because old-age pensions are financed by taxes on payrolls, labour as opposed to capital will bear the burden of maintaining public pensions. An ironic consequence of this could be a yet greater burden on future workers if rate increases result in an erosion of the contribution base. This could arise if workers migrate to countries with lower tax rates (48), or firms relocate where labour compensation costs are comparatively lower, or activities are shifted underground. To the extent that some countries may choose to limit the labour distortions associated with contribution rate increases while at the same time maintaining the PAYG structure, this could be achieved by broadening the contribution base to include all wage income (where the contribution base is limited to wage income below a given ceiling, as, for instance, in the United States), or possibly by broadening the base to total value-added, although this might be adverse to capital formation (49). The possibility of partly supporting social security systems through consumption based-taxes would be still another option.

This highlights the admittedly partial perspective presented in this section. Indeed, the analysis has not taken into account that public pensions are not the only source of retirement income of the elderly, and that occupational pensions and personal savings often play a major role in providing old-age support. This is true not only for the four countries considered here (50), but for others as well. Governments may in fact choose to increase reliance on such sources of retirement income in the future (51). As desirable as this may be, the financing dilemma posed by public pension schemes will remain until actions are taken to alter the mix of retirement income sources.

Lastly, the analysis is partial in that no indirect consequences of the demographic transition and financing arrangements (for example on private saving and capital formation) have been taken into account. Broadening the focus to consider the general equilibrium effects of long run demographic and fiscal policy changes modifies somewhat the conclusions one might reach from the analysis conducted here (52).

V. CONCLUSIONS

While the very low levels of fertility observed in a majority of OECD countries are unlikely to be sustained over the long term, births rates are generally expected to return only to near replacement level over time. The associated low rates of population growth will then lead to age structures in which the elderly represent a permanently larger share of the population. In the meantime, however, the back-to-back demographic shocks of the baby boom and bust will lead to a transitional period during which the ratio of elderly dependents to workers will be higher than in the long run. These developments have potentially important implications for policymakers, in particular with respect to public pension financing and possible economic effects of ageing.

Demographic-economic interactions are extremely complex, and as such many questions remain regarding the impact which ageing will have on economic well-being. The secular decline in population growth rates, and the consequent shift towards an older population, have been coincident with long-run improvements in the standard of living in industrialised countries. Thus, the "long" view suggests that slower population growth is at least partially associated with strong economic growth, measured in per capita terms. However, widespread sustained zero population growth and, especially, below-replacement fertility, are unprecedented in modern economies, and much uncertainty attaches to the effects which these might have on income. Nevertheless, some lessons arise from the analysis presented above:

i) On the basis of most existing evidence, income per person is likely to continue to increase even under low or zero population growth, so long as the rate of technical progress is not adversely affected.

ii) The transition period, during which the age distribution will be changing considerably, will likely be associated with demographically induced changes in national saving rates. On the basis of a life-cycle model of consumption behaviour, and making a somewhat heroic assumption that all other things will be the same, it can be expected that the private saving rate for a large proportion of the OECD area will decline over the very long run.

iii) On an age distributional effect alone, the older population with greater work experience would most probably be a more productive one. Taking other factors into account (e.g. lower geographical and job mobility, possibly slower adaptability to technicological progress, higher transfer burdens motivating early retirement, etc.), the effect of ageing on productivity is less certain.

iv) The transition to an older population poses significant problems for the financing of public pensions, and, given the long-run nature of the individual retirement decision, future changes to public retirement schemes should be adopted early so that they may be phased-in gradually.

NOTES

1. The decline in population growth rates has attracted considerable attention recently. For instance, see Steinmann (1984) and Davis et al. (1986).

2. Projections under low and high fertility assumptions, as well as longer life expectancy, were also prepared.

3. Below replacement fertility refers generally to less than 2.1 births per adult woman of child-bearing age. An alternative measure, "completed cohort fertility", refers to the number of births per adult woman of the same cohort during the length of the cohort's reproductive life. Some analysts (Bourgeois-Pichat, 1986) have noted that completed cohort fertility rates have, in some countries, declined by more than the total fertility rate.

4. Even if all persons 65 years and over were inactive in terms of market activity, many would still be productive on a voluntary basis, providing for instance community services.

5. In the higher fertility projections, it is assumed that total fertility rates converge to 2.5 by 2050 (versus 2.1 in the medium scenario).

6. In fact, the attention of economists interested in the economic consequences of population growth turned their attention instead towards the potential impact which slower population growth could have on the economies of developing countries, where very high fertility rates were raising questions about their potentially adverse effects on economic growth.

7. See, for instance, Clark, Kreps and Spengler (1978), Serow and Espenshade (1978), and Richter (1988) as useful surveys. The United Nations Economic Commission of Europe is currently preparing a bibliography of research in this field, with in excess of 400 entries to date.

8. It is useful to abstract from the economic implications of negative population growth, as this is unsustainable in the long run. Moreover, it can be shown that a sustained rate of below replacement fertility, while affecting the total size of the population comparatively little in the early years, gathers momentum in later years and the population begins to disappear quite rapidly. In such circumstances, it is safe to presume that an intrinsic sense of national self-preservation would operate to return fertility to replacement levels.

9. Abstraction is made here of the possible contribution which international migration could have on the labour force.

10. Much of the increase in female participation has been in part-time jobs. Thus, if the labour force participation rates were adjusted to take account of this, the increases would generally be smaller.

11. See Reforming Public Pensions, OECD, 1988b.

12. As noted earlier, an older population requires a greater per worker transfer of output to the elderly dependents in the population, which unambiguously lowers workers' consumption-leisure possibilities for unchanged relative incomes of workers and non-workers.

13. This could arise if, for instance, technological progress depends on the absolute number of "knowledge producers." Kuznets (1960) suggests that there is a positive relationship between the number of inventors and the size of the population.

14. To the extent that more attractive investment opportunities may be found in foreign markets, capital may be accumulated abroad rather than domestically.

15. While much is known, theoretically and empirically, about the determinants of saving, there is considerable uncertainty about the relative importances of the different factors. See Sturm (1983) for a survey of this literature.

16. For instance, Rosen (1985) reports that the first recipient of social security in the United States received about $22,000 in benefits on lifetime contributions of $22.

17. Interestingly, the increases are greatest in the case of the United States because public health expenditures are predominantly targeted to the elderly, making their sensitivity to population ageing particularly acute. The simulated increase may even be somewhat understated, as the projections are based on equal per capita outlays for all elderly aged 65 and over, thus not taking account of the greater requirements of the very old.

18. There are a number of justifications for public pensions (Kotlikoff, 1987). The increased role of the state is, in many respects, a natural and necessary concomitant to the structural transformation of an economy from rural and agricultural to the urban-industrial stage (Lensgsfeld, 1987). As the family's role in providing old-age income security declined with increased job mobility, the assumption by the state of the responsibility for intergenerational transfers performed a catalytic function in facilitating economic development. The complete portability of a public pension is a distinct advantage, one which may become more important in an economy composed of an older, somewhat less mobile, labour force. An additional advantage of a mandatory public scheme is that it can improve economic welfare to the extent that some individuals may under-anticipate old-age resource requirements (the paternalist argument). Also, private markets, because of problems of adverse selection, may fail to provide an efficient means of insuring against the uncertainties of life expectancy (Atkinson, 1987).

19. See, for instance, Aaron (1966).

20. Of course, the size (and the very existence) of these liabilities depends on the definition of the "group" of agents on which pension

obligations and contribution revenues are based. In a "closed" group, the liabilities can be substantial since they are based only on living cohorts of working age or older. In an "open" group, living cohorts below working age, as well as unborn generations, are included, and the liabilities are non-existent if the PAYG scheme is balanced in each period.

21. These include that a) individuals are forward-looking with perfect foresight, b) individuals are not liquidity constrained, and c) private intergenerational transfers do not exist.

22. See, for instance, Atkinson (1986), Chapter 18.

23. Actuarial fairness is not specific to full-funding. A mature PAYG system can also be actuarially fair if the present value of expected benefits to any individual cohort is equal to the present value of lifetime contributions.

24. Government consumption may be increased relative to what it might otherwise be if the excess of current-period revenues (i.e. contributions) over outlays (current period pensions) is not used to raise the government's financial balance, such as by public sector investments or retiring existing public debt.

25. Contrary to popular belief, however, it is not essential that beneficiaries have built-up an entitlement via life-long contributions, since the government can always conduct an interim two-track programme providing general revenue financed benefits to retirees that have contributed too little, if at all, due to the immaturity of the programme.

26. In the United States, for instance, past accumulations of surpluses facilitated the expansion of coverage (e.g. to survivors and dependent spouses) and increases in benefits.

27. These are similar to some of the estimates for Sweden reported by Stahlberg (1988), and for the United States by Boskin and Puffert (1987).

28. See Petersen (1988).

29. This political power may indeed be great. If one defines age 50 (somewhat arbitrarily) as the age at which an individual would vote in "solidarity" with current recipients of public pensions, and the total potential voting population as those over age 19, the former group would represent slightly over 50 per cent of the voters in Germany, and between 47 and 49 per cent in the other major seven countries in 2010.

30. For instance, Hauser (1982) reports that in the case of Germany "... previously accumulated claims to the statutory schemes arising from employee contributions enjoy a form of property right status based on the guarantee to property as postulated by the German Constitution."

31. This obviously requires an initial estimate of the trust fund balance, along with assumptions about a number of economic variables. See Annex for details.

32. See, for instance, Zur langfristigen Entwicklung der gesetzlichen Rentenvbersicherung (June 1987).

33. See ATP och dess finansiering i det medel-och langsiktiga perspektivet, 1987.

34. As the average replacement rate falls with price indexation of the pension ceiling, however, supplementary pensions would operate to limit the decline in pension income for many workers. Currently, public sector employees are assumed a total replacement rate of 65 per cent, the excess over the ATP benefit being financed by other government revenues than social insurance contributions. In the case of private sector workers, both blue and white collar employees depend on negotiated occupational supplementary pensions to limit the decline in the total replacement rate when the ATP ceiling is only adjusted by price increases.

35. Because the methodology used here does not incorporate all the changes enacted in the recent reform, it is not surprising that there is a divergence between the Secretariat's estimate of the year of depletion of the trust fund and that of the Social Security Administration. It is nevertheless useful to note that the latter estimates that a contribution rate of slightly over 16 per cent would be required by 2035 if OASDI were operated on a purely PAYG basis (United States, 1987). Since the present analysis excludes disability payments, the estimate of 16.9 in 2038 is likely to be upwardly biased. Nevertheless, the two analyses are consistent in showing the need for adjustment, since the demographic conditions in 2038 are projected to be very similar to those in 2051.

36. Raising the legal retirement age can be viewed as conceptually similar to reducing benefits.

37. See Kotlikoff (1984).

38. These include: a) no liquidity constraints; b) no bequest motives; c) perfect foresight and absence of myopia; d) no general equilibrium effects.

39. The simulations are similar to those of Halter and Hemming (1987), although the authors' methodology allows for the effect of a trust fund build-up on contribution rates.

40. This would be distinct from a move to a fully funded system in which future generations would pay for their own pensions, while transitional generations would finance not only their own retirements but those of current retirees as well. An immediate switch to full funding would result in transitional generations paying for not only their own pensions but those of all retirees retaining a claim on the PAYG-financed retirement benefits.

41. With the exception of Sweden, social security cash flow surpluses (i.e. the excess of current revenue over current expenditure) are invested solely in public debt instruments. To the extent that such surpluses induce greater public sector consumption than in their absence, the build-up of a reserve does not lead to an increase in aggregate saving and, hence, does little to augment the economy's capital stock. Moreover, since these loans are from one sector of government to another, there eventually comes a time when either non-social security revenues must be diverted from other uses to repay the debt, or be increased (on unchanged pension provisions).

42. This points to the conflicts which may arise between, on the one hand, adopting a policy of explicit national saving for anticipated increases in pension claims and, on the other hand, shaping macroeconomic policy to redress short-term external imbalances among trading partners. Other things being equal, increased domestic saving in excess of desired investment will lead to an increase in net capital outflows, a lower exchange rate of the currency and a current account surplus. This, in turn, can result in policy adjustments aimed more at redressing the imbalances than maintaining the advance funding policy for pensions.

43. These "smoothed" contribution rates are obtained by constrained minimisation of the government's objective function using a non-linear numerical optimisation programme (See Annex).

44. In this demographic environment, the elderly represent a permanently larger share of the population.

45. Labour force participation rates are increased (equally arbitrarily) in the years immediately before retirement to take account of the labour supply effects of this policy.

46. See Reforming Public Pensions, OECD, 1988b.

47. In effect, the replacement rate is calculated here in terms of the average pension benefit divided by average "covered" earnings, where the latter include the employee contributions. In the case of Sweden, however, the observed income base is net of social security contributions, which are paid fully by employers. Without information on the incidence of social security contributions, it was not possible to "gross" up the earnings of the average worker in Sweden.

48. This could be of particular importance in a fully integrated Europe where labour mobility is essentially unrestricted but public pension schemes are widely different.

49. Palmer and Palme (1987) and Mannel (1987).

50. See Schmähl (1987), Palmer (1987), Japan (1985) and Andrews (1985).

51. This was recently recommended at the Ministerial meeting of the Manpower and Social Affairs Committee of the OECD.

52. See Auerbach and Kotlikoff (1987) and Auerbach et al. (1988).

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Table 1

AVERAGE ANNUAL POPULATION GROWTH RATES (%) (a)
1950-2050

	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000	2000-2010	2010-2020	2020-2030	2030-2040	2040-2050	Ratio of projected population to 1980 level: 2010/1980	2030/1980	2050/1980
Canada	2.66	1.77	1.22	1.01	0.85	0.65	0.60	0.43	0.28	0.28	1.27	1.40	1.46
France	0.88	1.06	0.57	0.37	0.22	0.14	0.00	-0.09	-0.22	-0.25	1.09	1.07	1.01
Germany	0.66	1.29	0.15	-0.10	-0.22	-0.55	-0.69	-0.78	-0.72	-0.79	0.92	0.79	0.67
Italy	0.78	0.55	0.59	0.01	-0.10	-0.20	-0.40	-0.43	-0.54	-0.59	0.97	0.89	0.79
Japan	1.11	1.14	1.13	0.48	0.37	0.12	-0.23	-0.31	-0.18	-0.24	1.11	1.05	0.99
United Kingdom	0.39	0.60	0.07	0.08	0.12	0.08	0.13	0.04	-0.16	-0.16	1.03	1.04	0.99
United States	1.73	1.27	1.06	0.88	0.66	0.53	0.48	0.29	0.19	0.35	1.23	1.33	1.36
Average of above (b)	1.17	1.10	0.68	0.39	0.27	0.11	-0.02	-0.12	-0.19	0.20			
Australia	2.31	1.98	1.63	1.34	1.07	0.85	0.74	0.71	0.53	0.47	1.38	1.58	1.72
Austria	0.16	0.53	0.11	0.02	0.08	-0.01	-0.02	-0.20	-0.31	-0.36	1.01	0.98	0.90
Belgium	0.58	0.53	0.20	-0.01	-0.08	-0.07	-0.12	-0.24	-0.36	-0.39	0.98	0.93	0.84
Denmark	0.70	0.73	0.39	-0.14	-0.27	-0.44	-0.57	-0.58	-0.63	-0.65	0.92	0.82	0.71
Finland	1.04	0.35	0.37	0.34	0.03	-0.04	-0.22	-0.42	-0.49	-0.42	1.04	0.97	0.87
Greece	0.97	0.55	0.93	0.22	0.15	0.16	-0.08	-0.17	-0.28	-0.36	1.06	1.02	0.95
Iceland	2.02	1.55	1.08	1.04	0.63	0.38	0.24	0.18	0.07	-0.17	1.23	1.27	1.24
Ireland	-0.47	0.41	1.43	0.90	0.56	0.44	0.29	0.30	0.19	-0.43	1.18	1.25	1.25
Luxembourg	0.59	0.77	0.72	0.37	0.17	0.02	-0.04	-0.12	-0.19	-0.14	1.05	1.03	0.98
Netherlands	1.25	1.30	0.82	0.45	0.26	-0.04	-0.18	-0.22	-0.48	-0.50	1.07	1.02	0.91
New Zealand	2.17	1.74	1.10	0.91	0.75	0.48	0.39	0.19	-0.08	-0.2	1.21	1.28	1.23
Norway	0.96	0.77	0.53	0.26	0.18	0.03	0.01	0.00	-0.10	-0.1	1.05	1.05	1.00
Portugal	0.73	-0.07	0.42	0.74	0.27	0.07	-0.05	-0.18	-0.37	-0.49	1.12	1.08	0.97
Spain	0.84	1.12	0.99	0.59	0.34	0.12	-0.04	-0.01	-0.15	-0.31	1.10	1.09	1.02
Sweden	0.65	0.73	0.33	0.02	-0.04	-0.11	0.00	-0.14	-0.22	-0.10	0.99	0.97	0.92
Switzerland	1.38	1.40	0.22	0.26	0.08	-0.06	-0.26	-0.47	-0.63	-0.62	1.04	0.96	0.83
Turkey	2.92	2.53	2.27	2.65	1.77	1.36	1.13	1.15	0.86	0.43	1.68	2.10	2.36
OECD average (b)	1.13	1.03	0.76	0.53	0.33	0.16	0.05	-0.04	-0.17	-0.25			

a) 1950-1960 to 1970-1980 actual rates; 1980-1990 to 2040-2050 projected rates.
b) Unweighted average.

Source: OECD (1988a).

Table 2

RELATIVE SIZE OF POPULATION AGE GROUPS
(1980=100)

Country	Under 15			15 to 34			35 to 54			55 to 64			65 & Over		
	1990	2010	2030	1990	2010	2030	1990	2010	2030	1990	2010	2030	1990	2010	2030
United States	106.1	105.5	109.0	99.0	94.3	93.7	130.7	165.0	158.0	98.2	163.0	158.9	119.9	137.5	230.3
Japan	83.5	87.1	74.9	97.2	83.7	85.7	111.9	103.6	89.0	143.9	187.4	173.8	135.2	215.0	232.5
Germany	81.5	66.8	63.0	101.0	67.4	53.3	101.0	106.3	70.8	119.5	126.9	123.9	99.5	119.2	131.2
France	95.1	85.1	82.3	99.1	87.9	78.1	114.7	130.8	116.3	123.0	158.2	154.1	103.6	124.4	168.5
United Kingdom	91.9	97.4	91.9	101.5	86.3	89.7	110.1	125.6	106.8	93.9	113.0	117.0	102.3	99.7	134.9
Italy	79.4	68.2	63.7	106.5	78.9	65.5	101.8	118.7	88.0	118.9	124.7	143.6	103.8	124.8	146.1
Canada	99.0	95.2	104.5	97.1	91.8	88.7	128.8	164.9	159.1	112.0	185.9	189.5	130.9	194.0	330.5
Australia	100.0	108.4	117.1	110.0	111.7	118.8	131.0	176.5	180.6	108.1	178.1	212.9	131.1	179.8	302.4
Austria	87.7	83.4	80.6	105.0	81.4	75.1	107.2	124.2	96.8	105.9	124.0	135.0	95.8	112.0	146.6
Belgium	91.7	78.9	75.6	96.4	79.1	67.7	106.3	119.9	99.5	110.7	123.8	120.4	98.4	106.5	140.3
Denmark	79.2	64.9	59.4	98.2	71.2	57.6	117.0	119.9	86.7	91.9	124.2	118.7	106.1	107.4	129.9
Finland	98.2	80.7	76.4	87.2	75.5	63.2	124.2	118.5	102.6	108.3	161.5	123.2	116.1	144.5	193.8
Greece	91.4	83.1	75.5	105.8	95.8	87.1	99.3	110.9	100.6	138.5	135.8	149.1	98.8	133.8	152.6
Iceland	101.1	83.7	83.3	108.4	103.7	86.5	127.4	181.2	173.7	113.4	174.9	207.5	115.7	140.5	234.2
Ireland	96.1	82.3	82.0	110.5	114.8	100.1	122.6	171.3	181.5	93.8	139.3	183.1	112.1	122.8	172.4
Luxembourg	95.8	89.4	92.2	96.0	81.8	75.6	105.2	112.1	97.0	126.9	143.0	130.7	111.5	141.4	173.1
New Zealand	89.3	88.1	81.7	107.6	94.4	90.9	125.5	176.6	157.4	103.6	165.2	209.5	119.4	148.5	250.4
Netherlands	85.4	78.5	73.1	99.2	75.0	66.9	124.7	143.8	108.9	107.2	161.5	157.3	116.3	139.1	205.6
Norway	86.6	81.7	79.3	103.1	86.8	80.3	123.2	145.2	123.7	82.3	120.4	127.0	112.7	107.5	147.9
Portugal	89.1	82.0	72.3	115.4	98.4	88.1	109.2	138.3	118.0	121.7	129.0	158.1	134.6	155.9	194.1
Spain	86.2	71.3	70.8	113.0	99.2	79.2	102.3	138.5	121.7	121.1	126.9	167.4	123.9	158.2	202.6
Sweden	88.7	85.8	82.7	97.0	84.3	79.7	115.8	115.5	101.7	86.0	114.4	109.9	110.2	106.3	130.4
Switzerland	91.0	81.0	74.0	98.3	74.1	64.9	112.9	113.4	85.6	111.9	146.3	129.5	109.5	149.0	186.3
Turkey	112.7	120.0	141.1	132.2	171.8	178.3	123.5	231.4	301.1	175.8	266.3	480.8	102.3	199.5	383.7
Averages															
Major 7	90.9	86.5	84.2	100.2	84.3	79.2	114.2	130.7	112.6	115.6	151.3	151.5	113.6	144.9	196.3
Small countries	92.4	84.9	83.3	104.9	94.1	85.9	116.3	143.4	131.6	112.2	149.1	171.8	112.6	138.4	196.8
Total OECD (a)	91.9	85.4	83.6	103.5	91.2	83.9	115.7	139.7	126.0	113.2	149.7	165.9	112.9	140.3	196.7

(a) Unweighted average

Source: OECD (1988a)

TABLE 3

FRACTION OF THE POPULATION BY AGE GROUP

Country	Under 15			15 to 34			35 to 54			55 to 64			65 & Over		
	1980	2010	2030	1980	2010	2030	1980	2010	2030	1980	2010	2030	1980	2010	2030
United States	0.23	0.19	0.19	0.35	0.27	0.25	0.21	0.29	0.25	0.10	0.13	0.11	0.11	0.13	0.20
Japan	0.24	0.18	0.17	0.31	0.23	0.25	0.28	0.26	0.24	0.09	0.14	0.14	0.09	0.18	0.20
Germany	0.18	0.13	0.15	0.29	0.22	0.20	0.27	0.32	0.25	0.10	0.13	0.15	0.16	0.20	0.26
France	0.22	0.17	0.17	0.32	0.26	0.23	0.23	0.28	0.25	0.09	0.13	0.13	0.14	0.16	0.22
United Kingdom	0.21	0.20	0.19	0.30	0.25	0.26	0.23	0.28	0.24	0.11	0.12	0.12	0.15	0.15	0.19
Italy	0.22	0.15	0.16	0.29	0.24	0.21	0.25	0.31	0.25	0.10	0.13	0.16	0.13	0.17	0.22
Canada	0.23	0.17	0.17	0.36	0.26	0.23	0.22	0.29	0.25	0.09	0.13	0.12	0.10	0.15	0.22
Australia	0.25	0.20	0.19	0.34	0.27	0.25	0.22	0.29	0.25	0.09	0.12	0.12	0.10	0.13	0.18
Austria	0.21	0.17	0.17	0.30	0.24	0.23	0.24	0.30	0.24	0.10	0.12	0.13	0.15	0.17	0.23
Belgium	0.20	0.16	0.16	0.31	0.25	0.23	0.24	0.30	0.26	0.10	0.13	0.13	0.14	0.16	0.22
Denmark	0.21	0.15	0.15	0.30	0.23	0.21	0.24	0.31	0.25	0.11	0.14	0.15	0.14	0.17	0.23
Finland	0.20	0.16	0.16	0.34	0.25	0.22	0.24	0.28	0.26	0.10	0.15	0.12	0.12	0.17	0.24
Greece	0.23	0.18	0.17	0.28	0.26	0.24	0.26	0.28	0.26	0.09	0.12	0.14	0.13	0.17	0.20
Iceland	0.28	0.19	0.18	0.35	0.29	0.24	0.20	0.29	0.27	0.08	0.11	0.13	0.10	0.11	0.18
Ireland	0.29	0.20	0.20	0.32	0.27	0.24	0.20	0.29	0.25	0.08	0.11	0.13	0.11	0.13	0.17
Luxembourg	0.19	0.16	0.17	0.31	0.24	0.23	0.27	0.28	0.25	0.10	0.13	0.12	0.14	0.18	0.23
New Zealand	0.25	0.18	0.17	0.34	0.25	0.23	0.22	0.28	0.26	0.09	0.13	0.12	0.10	0.15	0.22
Netherlands	0.22	0.16	0.16	0.34	0.24	0.22	0.23	0.31	0.24	0.09	0.14	0.14	0.12	0.15	0.23
Norway	0.22	0.17	0.17	0.30	0.25	0.23	0.21	0.29	0.25	0.11	0.13	0.14	0.15	0.15	0.21
Portugal	0.24	0.18	0.17	0.31	0.26	0.24	0.23	0.27	0.26	0.10	0.13	0.12	0.12	0.15	0.21
Spain	0.26	0.17	0.17	0.30	0.27	0.22	0.24	0.30	0.27	0.10	0.11	0.15	0.11	0.15	0.17
Sweden	0.20	0.17	0.17	0.29	0.24	0.23	0.24	0.28	0.25	0.12	0.14	0.13	0.16	0.17	0.22
Switzerland	0.17	0.14	0.15	0.31	0.22	0.21	0.27	0.25	0.24	0.11	0.15	0.12	0.15	0.24	0.29
Turkey	0.37	0.25	0.26	0.36	0.33	0.28	0.18	0.26	0.26	0.06	0.09	0.10	0.04	0.07	0.10
Averages															
Major 7	0.22	0.17	0.17	0.32	0.25	0.23	0.24	0.29	0.25	0.09	0.13	0.13	0.13	0.16	0.22
Small countries	0.23	0.18	0.17	0.32	0.26	0.23	0.23	0.29	0.25	0.10	0.13	0.13	0.12	0.15	0.21
Total OECD (a)	0.23	0.17	0.17	0.32	0.25	0.23	0.24	0.29	0.25	0.09	0.13	0.13	0.12	0.16	0.21

(a) Unweighted average

Source: OECD (1988a)

TABLE 4

OLD AGE DEPENDENCY RATIOS IN OECD COUNTRIES:
POPULATION 65 & OVER/POPULATION 15-64

Country	1980	1990	2000	2010	2020	2030	2040	2050
United States	17.1%	18.7%	18.3%	18.5%	25.0%	31.7%	32.4%	31.8%
Japan	13.4%	16.6%	22.4%	27.5%	33.7%	31.8%	37.5%	37.6%
Germany	23.4%	22.5%	25.1%	30.3%	33.2%	43.4%	48.8%	42.3%
France	21.9%	21.0%	23.1%	24.0%	30.5%	35.9%	38.7%	37.8%
United Kingdom	23.3%	23.1%	22.3%	22.1%	25.6%	31.3%	33.1%	30.4%
Italy	20.8%	20.3%	22.9%	25.6%	28.7%	35.3%	42.1%	37.8%
Canada	14.1%	16.8%	19.0%	21.3%	29.0%	37.2%	37.8%	36.4%
Australia	14.8%	16.6%	17.4%	18.6%	23.7%	29.2%	32.4%	32.0%
Austria	24.2%	21.9%	22.4%	26.0%	30.2%	38.3%	41.3%	36.5%
Belgium	21.9%	21.1%	22.4%	23.1%	28.2%	35.0%	36.5%	34.5%
Denmark	22.3%	22.7%	21.4%	24.4%	30.5%	36.9%	42.7%	39.8%
Finland	17.7%	19.8%	21.3%	24.7%	34.6%	39.9%	38.6%	38.1%
Greece	20.5%	18.8%	22.7%	25.4%	27.5%	30.8%	34.1%	34.8%
Iceland	15.8%	15.9%	16.0%	16.2%	21.1%	28.6%	33.1%	35.5%
Ireland	18.0%	17.1%	16.4%	18.7%	22.7%	27.5%	31.1%	31.1%
Luxembourg	20.0%	21.4%	25.6%	27.6%	32.0%	37.6%	36.8%	33.5%
New Zealand	15.8%	16.5%	17.4%	22.8%	29.8%	35.5%	35.2%	35.2%
Netherlands	17.4%	18.5%	19.7%	21.8%	28.9%	38.0%	42.0%	38.1%
Norway	23.4%	24.9%	22.7%	22.4%	27.9%	33.5%	38.4%	36.8%
Portugal	18.6%	20.3%	21.3%	23.2%	28.5%	33.2%	32.4%	32.4%
Spain	17.2%	19.3%	22.2%	23.0%	25.3%	32.1%	39.2%	39.0%
Sweden	25.4%	27.4%	25.1%	26.6%	33.0%	35.5%	37.6%	35.8%
Switzerland	21.2%	25.0%	31.7%	40.0%	48.1%	50.1%	46.0%	46.0%
Turkey	7.0%	8.1%	8.6%	10.1%	13.6%	16.4%	17.6%	17.6%
Averages								
Major 7	19.1%	19.9%	21.9%	24.2%	29.4%	35.2%	38.6%	36.3%
Small countries	18.9%	19.7%	20.9%	23.2%	28.6%	34.0%	36.2%	35.1%
Total OECD (a)	19.0%	19.8%	21.2%	23.5%	28.8%	34.4%	36.9%	35.4%

(a) Unweighted average

Source: OECD (1988a)

Table 5

TOTAL DEPENDENCY RATIOS IN OECD COUNTRIES:
POPULATION UNDER AGE 15 AND 65 AND OVER
DIVIDED BY
POPULATION AGED 15 TO 64

Country	1980	1990	2000	2010	2020	2030	2040	2050
United States	51.1%	51.8%	49.9%	46.7%	54.2%	61.7%	61.9%	61.4%
Japan	48.4%	43.3%	48.4%	56.4%	60.7%	58.5%	65.4%	65.0%
Germany	50.8%	44.0%	48.0%	50.2%	53.5%	67.8%	74.3%	69.1%
France	56.8%	51.7%	52.8%	50.3%	56.8%	64.0%	67.6%	66.9%
United Kingdom	56.1%	52.3%	53.9%	52.5%	56.5%	61.2%	60.8%	59.0%
Italy	54.9%	45.7%	48.8%	48.5%	50.3%	60.5%	69.9%	65.9%
Canada	48.1%	47.6%	47.8%	46.6%	55.2%	65.7%	67.2%	66.8%
Australia	53.5%	49.7%	49.6%	47.9%	52.7%	58.9%	62.0%	61.8%
Austria	56.2%	48.4%	50.9%	51.6%	56.1%	66.2%	69.5%	65.3%
Belgium	52.4%	48.4%	49.3%	46.9%	52.5%	61.3%	63.7%	62.7%
Denmark	54.5%	47.2%	44.3%	45.8%	51.5%	61.3%	69.8%	68.1%
Finland	47.7%	48.3%	46.8%	48.2%	59.7%	66.6%	66.4%	67.0%
Greece	56.1%	49.0%	51.3%	52.9%	53.9%	57.2%	60.8%	61.7%
Iceland	59.8%	54.6%	48.0%	42.9%	46.9%	56.8%	63.1%	65.6%
Ireland	66.8%	52.6%	47,5%	48.1%	53.3%	59.7%	62.1%	62.1%
Luxembourg	47.8%	47.0%	52.7%	51.8%	57.9%	65.5%	64.5%	62.5%
New Zealand	53.6%	48.0%	46.0%	49.7%	56.8%	62.4%	62.3%	62.3%
Netherlands	51.1%	44.9%	46.3%	45.7%	52.8%	64.2%	68.4%	65.3%
Norway	58.5%	53.5%	50.7%	47.9%	53.0%	60.4%	66.4%	65.3%
Portugal	55.1%	52.9%	50.9%	50.4%	56.5%	61.3%	59.7%	59.7%
Spain	58.1%	51.3%	52.2%	47.7%	48.3%	58.8%	68.4%	67.9%
Sweden	56.0%	54.0%	51.6%	52.5%	58.7%	62.5%	65.4%	64.1%
Switzerland	46.0%	49.5%	54.6%	63.6%	73.5%	75.7%	72.8%	72.8%
Turkey	68.7%	59.0%	49.7%	46.7%	53.3%	56.2%	50.8%	50.8%
Averages								
Major 7	52.3%	48.1%	49.9%	50.2%	55.3%	62.8%	66.7%	64.9%
Small countries	55.4%	50.5%	49.6%	49.4%	55.1%	62.1%	64.5%	63.8%
Total OECD (a)	54.5%	49.8%	49.7%	49.6%	55.2%	62.3%	65.1%	64.1%

(a) Unweighted average

Source: OECD (1988a)

Table 6

AGE DISTRIBUTION OF POPULATION
AGED 65 YEARS AND OLDER

Year	65–69	70–79	80 and over
1980	32.7	45.6	18.2
2000	30.8	47.5	21.8
2010	32.1	44.5	23.5
2020	31.7	46.5	21.9
2030	30.8	45.6	23.6
2040	26.7	47.1	26.2
2050	26.0	43.4	30.7

Source: OECD (1988a)

Table 7

EFFECTS ON DEPENDENCY RATIOS
OF HIGHER FERTILITY

	Total	Old Age
Baseline Projection		
1990	50.2	19.5
2000	50.1	20.8
2010	49.4	22.2
2020	54.0	27.5
2030	61.9	33.2
2040	66.2	36.5
2050	65.1	35.0
	Total	Old Age
Higher Fertility		
1990	50.2	19.4
2000	50.0	20.8
2010	49.9	22.9
2020	56.5	27.6
2030	66.4	32.9
2040	70.7	35.0
2050	69.2	32.2

Source: OECD (1988a)

Table 8

EFFECT OF HIGHER LIFE EXPECTANCY
ON POPULATION 65 YEARS AND OVER
(PER CENT OF POPULATION)

	1980	2000	2020	2040	2050
United States					
Baseline mortality (a)	11	12	16	20	20
Low mortality (b)	11	12	17	25	29
Japan					
Baseline mortality	9	15	21	23	23
Low mortality	9	15	23	29	33
Germany					
Baseline mortality	16	17	22	28	25
Low mortality	16	17	24	34	36
France					
Baseline mortality	14	15	19	23	23
Low mortality	14	15	21	30	34
United Kingdom					
Baseline mortality	77	14	16	21	19
Low mortality	15	15	19	26	29
Italy					
Baseline mortality	13	15	19	25	23
Low mortality	13	15	21	29	31
Canada					
Baseline mortality	10	13	19	23	22
Low mortality	10	13	20	29	33

Notes: (a) In general, life expectancy at birth is assumed to increase by two years between 1983 and 2030, remaining constant thereafter.
(b) Assumes an increase of life expectancy of ten years at age 60 between 2000 and 2030.

Table 9

LABOUR FORCE PARTICIPATION RATES BY AGE: SELECTED PERIODS AND COUNTRIES

	Males				Females			
	15-24 years	25-54 years	55-64 years	65 years+	15-24 years	25-54 years	55-64 years	65+ years
Australia								
1965 (b)	78.9	97.3	85.8	23.3	60.8	37.3	21.0	4.4
1970	76.5	97.2	85.1	22.1	59.7	43.4	23.3	3.7
1975	74.7	95.9	78.8	16.7	61.2	49.6	23.7	3.9
1980	76.4	94.5	68.8	11.1	65.1	53.3	22.0	2.9
1985	73.7	93.5	60.4	8.9	65.0	57.2	19.3	2.0
Canada								
1965	57.2	97.1	86.4	26.3	39.0	33.9	27.0	6.0
1970	61.8	96.2	84.2	22.6	46.3	39.8	29.8	5.0
1975	68.8	94.8	79.4	18.5	56.8	50.5	30.8	5.0
1980	71.8	94.8	76.2	14.8	62.6	60.1	33.6	4.4
1985	70.1	93.8	70.2	12.3	64.6	68.2	33.8	4.2
Finland								
1965	65.8	94.8	81.5	18.0	54.7	67.9	54.9	3.8
1970	58.0	93.4	71.1	19.0	51.5	70.2	46.3	4.4
1975	51.3	91.6	62.1	10.3	48.9	78.0	44.4	2.8
1980	57.1	93.3	57.3	17.0	52.0	83.0	43.0	6.0
1985	62.6	93.5	57.8	10.6	54.9	86.7	52.9	4.8
France								
1965	65.3	96.1	76.0	28.3	49.8	42.8	36.9	11.5
1970	60.3	96.8	75.4	19.5	47.2	50.1	40.0	8.6
1975	55.6	96.4	68.9	13.9	45.6	57.3	35.9	5.8
1980	52.5	96.4	68.5	7.5	43.2	63.0	39.7	3.3
1985	49.0	95.9	50.1	5.3	40.3	68.9	31.0	2.2
Germany								
1965	78.1	96.6	84.6	24.0	69.3	46.1	30.2	7.8
1970	75.4	97.1	80.1	17.2	65.0	47.3	28.5	6.1
1975	66.4	95.1	68.1	10.8	58.6	51.6	24.8	4.5
1980	62.2	93.6	65.5	7.0	53.4	53.6	27.2	3.1
1985	62.1	91.5	56.2	5.1	54.6	56.7	21.6	2.1
Italy	(c)	(d)	(e)		(c)	(d)	(e)	
1965	60.9	94.7	54.8	18.4	39.3	28.8	14.3	4.7
1970	52.1	93.9	48.2	12.9	35.5	28.3	10.6	2.6
1975	44.8	94.0	42.4	10.4	31.6	31.3	8.5	2.1
1980	47.3	91.7	38.6	8.4	4.04	44.1	10.2	2.1
1985 (f)	48.1	92.1	38.2	8.9	40.7	43.8	10.5	2.1

Table 9 (cont.)

	Males				Females			
	15-24 years	25-54 years	55-64 years	65 years+	15-24 years	25-54 years	55-64 years	65+ years
Japan								
1965	59.0	96.7	86.7	56.3	51.8	56.0	45.3	21.6
1970	57.7	97.3	86.6	49.4	53.4	55.1	44.4	17.9
1975	50.2	97.4	86.0	44.4	45.6	52.3	43.7	15.3
1980	42.9	97.0	85.4	41.0	43.9	56.7	45.3	15.5
1985	42.6	96.7	83.0	37.0	43.2	60.3	45.3	15.5
Netherlands								
1965	..	..	..	..	..	..	..	..
1970 (g)	64.8	96.4	80.8	11.4	53.0	23.1	14.9	2.3
1975	54.7	94.2	72.2	8.0	48.7	28.5	14.2	1.8
1980	49.4	93.1	63.2	4.8	47.3	36.7	14.4	0.9
1985	50.5	91.7	46.9	3.4	49.1	44.3	12.3	0.6
Spain	(j)				(j)			
1965	..	..	..	..	..	..	..	..
1970 (h)	70.6	96.5	84.2	25.9	47.7	25.1	22.0	7.7
1975	71.9	96.5	79.8	18.8	52.1	27.9	23.0	6.3
1980	69.8	95.4	76.2	12.3	48.3	30.9	21.4	3.8
1985	64.5	94.1	66.3	5.9	43.9	35.2	19.9	2.1
Sweden	(j)							
1965	71.7	96.2	88.3	37.7	60.5	56.0	39.2	11.6
1970	67.0	94.8	85.4	28.9	59.4	64.2	44.5	8.7
1975	72.4	95.2	82.0	19.9	66.2	74.3	49.6	6.1
1980	71.5	95.4	78.7	14.2	70.1	82.9	55.3	3.7
1985	65.7	95.2	75.9	11.0	66.4	88.9	59.9	3.2
United Kingdom	(j)				(j)			
1965	77.4	98.4	92.7	23.7	61.0	48.1	35.6	6.5
1970	80.8	97.9	91.2	20.1	60.6	53.1	39.2	6.4
1975	75.4	95.8	87.6	15.6	62.0	61.0	40.1	4.9
1980	80.1	95.4	81.6	10.3	71.4	63.4	39.1	3.6
1985	79.8	93.7	68.2	8.2	69.4	66.9	34.7	3.0
United States	(j)				(j)			
1965	70.9	95.7	82.9	26.6	43.6	45.1	40.3	9.4
1970	71.8	94.8	80.7	25.7	50.7	49.7	42.2	9.0
1975	73.2	93.8	74.6	20.7	57.1	55.0	40.7	7.8
1980	74.5	93.4	71.2	18.3	61.7	63.8	41.0	7.6
1985	73.3	93.1	67.3	15.2	63.7	69.5	41.7	6.8

Notes: a) The participation rate for a given age group is defined as the ratio between the total civilian labour force for the age group divided by the population for the age group.
b) 1966; c) 14-24; d) 25-59; e) 60-64; f) 1985; g) 1971; h) 1972; j) 16-24.

Source: OECD (1988a).

Table 10

AVERAGE RETIREMENT AGE IN OLD-AGE SCHEMES IN OECD COUNTRIES

		1960	1970	1975	1980	1983-84
Austria						
Employees (ASVG)	males	64.6	62.6	62.9	61.6	61.3
	females	61.0	60.1	60.4	58.7	58.6
Self-employed (FSVG+BSVG)	males	--	--	63.8	62.0	61.5
	females	--	--	61.0	59.0	58.9
Belgium						
Employees	males	--	--	--	63.2	63.3
	females	--	--	--	60.1	60.7
Canada						
Canadian pension plan	males	--	66.7	66.2	65.2	65.1
	females	--	66.7	66.0	65.2	65.1
Finland						
Employees (occupational, old age)	males	--	66.0	65.5	65.1	65.1
	females	--	65.5	65.3	65.0	64.9
Employees (unemployment pensions)	males	*	*	62.2	57.9	58.1
	females	*	*	61.6	58.3	58.6
Germany						
Blue-collar workers	males	65.2	65.2	64.0	62.5	61.9
	females	64.0	63.2	63.2	63.2	60.9
white-collar workers	males	65.2	65.1	64.2	61.9	62.0
	females	62.8	63.0	62.7	61.7	60.8
France						
Employees (general scheme)	droit directs	--	--	63.6	63.4	62.4
	droits dérivés	--	--	65.2	64.9	64.7

Table 10 (cont.)

		1960	1970	1975	1980	1983-84
Japan						
Employees (EPI)	males	--	--	--	62.3	62.3
	females	--	--	--	60.5	60.6
Self-employed (NPS)	males	--	--	--	62.8	62.4
	females	--	--	--	62.3	61.1
Luxembourg						
Employees	males	63.4	63.3	63.9	62.5	60.6
	females	66.0	64.9	70.4	64.3	63.0
Portugal						
Employees (general scheme)	males	--	--	69.1	66.5	66.0
	females	--	--	70.5	64.6	63.8
Spain						
Employees (general scheme)	total	--	--	64.8	64.4	63.9
United Kingdom						
Category A Retirement pensions	males	--	--	65.6	65.4	65.4
	females	--	--	61.0	60.3	60.4
United States						
Employees (OASDI)	males	66.8	64.4	64.0	63.9	63.6
	females	65.2	63.9	63.7	63.5	63.3

Notes: -- not available; * programme not in existence.

Source: OECD (1988b).

Table 11

GROWTH OF PUBLIC SOCIAL EXPENDITURE IMPLIED BY PROJECTED DEMOGRAPHIC CHANGE (a) 1980-2040 (1980 = 100)

	Education	Family benefits	Health	Pensions	Total social expenditure(b)
Australia	128	126	240	288	207
Belgium	71	74	99	134	102
Canada	103	110	218	304	187
Denmark	58	61	95	124	88
France	80	83	119	172	128
Germany	53	60	90	126	97
Italy	62	64	108	134	107
Japan	79	77	146	229	140
Netherlands	70	69	137	160	121
Sweden	83	84	117	123	109
United Kingdom	85	86	121	130	110
United States	102	114	178	215	165

Notes: a) Cumulative growth rates assuming constant real per capita expenditure by age within each progamme;
b) Including education, health, pensions, family benefits, unemployment compensation and, in the case of Australia and the Netherlands, other cash benefits and welfare services.

Source: OECD (1988a).

Table 12

PERCENTAGE RATE OF RETURN ON SOCIAL SECURITY PENSION CONTRIBUTIONS FOR SUCCESSIVE BIRTH COHORTS, FOR FIVE LEVELS OF FERTILITY -- UNITED STATES POPULATION DATA, FIXED PENSION

Birth cohort	Fraction of 1979 birth rates				
	0.50	0.75	1.00	1.25	1.50
1960-1965	0.89	0.98	1.05	1.12	1.17
1970-1975	0.32	0.59	0.80	0.97	1.12
1980-1985	-0.55	0.05	0.49	0.84	1.12
1990-1995	-1.41	-0.51	0.16	0.67	1.09
2000-2005	-1.84	-0.87	-0.12	0.50	1.01
2010-2015	-1.98	-1.04	-0.23	0.46	1.06
2020-2025	-1.93	-1.04	-0.22	0.52	1.16
2030-2035	-1.74	-0.99	-0.21	0.50	1.13
2040-2045	-1.54	-0.94	-0.21	0.49	1.13
2050-2055	-1.37	-0.89	-0.21	0.49	1.13

Source: Keyfitz (1985)

Table 13

SECRETARIAT ESTIMATES OF BENEFIT-COST RATIOS
FOR SELECTED COHORTS

	United States		Japan		Germany		Sweden (a)	
Year of Birth	Men	Women	Men	Women	Men	Women	Men	Women
1970	0.63	0.88	0.96	1.21	0.76	1.02	0.76	1.02
1965	0.62	0.89	1.10	1.42	0.83	1.14	0.76	1.04
1960	0.61	0.87	1.26	1.62	0.85	1.18	0.74	1.00
1955	0.60	0.86	1.46	1.89	0.84	1.17	0.75	1.03
1950	0.60	0.86	1.73	2.24	0.85	1.18	0.79	1.07
1945	0.61	0.88	2.04	2.66	0.86	1.19	0.84	1.14

(a) Assumes "basbelopp" is indexed to real wages (see text).

Table 14

DEMOGRAPHIC AND "ADJUSTED" DEPENDENCY RATIOS

	United States			Japan			Germany		Sweden	
Year	Demographic	Adjusted	Official	Demographic	Adjusted	Official	Demographic	Adjusted	Demographic	Adjusted
1987	19.94	27.47	26.50	16.80	20.81	19.63	32.00	43.10	29.63	32.93
1990	20.48	27.61	26.90	18.56	22.00	24.35	33.43	44.73	29.81	33.18
2000	19.95	26.20	27.20	25.48	30.46	30.99	41.45	52.81	27.31	29.84
2010	21.02	28.10	29.00	32.95	40.12	39.89	45.01	59.39	30.30	32.68
2020	28.17	38.04	37.30	37.09	46.29	42.36	53.36	70.04	36.42	40.08
2030	35.14	47.21	45.10	35.65	44.53	42.77	69.90	91.14	39.76	43.74
2040	35.52	47.90	47.20	41.47	51.09	45.12	67.39	90.07	42.09	46.54
2050	35.49	47.96	48.10	38.35	48.75	42.46	68.12	90.08	40.81	45.32

Table 15

ESTIMATED TRUST FUNDS
GIVEN LEGISLATED TAX RATES (a)
(AS A PER CENT OF TAXABLE PAYROLL)

	United States (b)		Japan		Germany		Sweden	
	Fund level	Change in fund (c)	Fund level	Change in fund (c)	Fund level	Change in fund (c)	Fund level	Change in fund (c)
1987	2.37	-	52.46	-	1.45	-	72.94	-
1990	5.20	0.77	59.15	2.30	0.16	-0.33	68.61	-1.13
1995	11.38	1.24	65.15	1.20	*	*	56.87	-2.35
2000	18.31	1.38	63.80	-0.27	*	*	49.89	-1.40
2005	27.28	1.79	50.71	-2.62	*	*	45.65	-0.85
2010	38.78	2.30	23.00	-5.54	*	*	36.55	-1.82
2015	46.59	1.56	*	*	*	*	12.98	-4.72
2020	51.02	0.89	*	*	*	*	*	*
2025	45.69	-1.07	*	*	*	*	*	*
2030	30.80	-2.98	*	*	*	*	*	*
2035	9.74	-4.21	*	*	*	*	*	*
2040	*	*						
	Contribution rate in year after fund depletion							
Year	2038		2013		1991		2018	
Rate	16.94		15.39		13.48		20.23	

(a) An asterisk indicates the fund is depleted.
(b) Incorporates phase-in of increase in retirement age.
(c) Annual average for the preceding 5 year period. Four year average for the first entry.

Source: Secretariat

Table 16

SECRETARIAT ESTIMATES OF UNFUNDED
PUBLIC PENSION OBLIGATIONS (a)

	Level (billions of currency)	Per cent of GNP/GDP
United States	$ 7,074	158
Japan	Yen 749 131	217
Germany	DM 7,154	355
Sweden		
Unindexed "basbelopp"	Kr 1,843	183
Indexed "basbelopp"	Kr 2,299	228

(a) Includes only men and women with own pension rights, and excludes benefits of dependent spouses, survivors and disability payments.

Table 17

SECRETARIAT PROJECTIONS OF SOCIAL SECURITY
CONTRIBUTION RATES REQUIRED
FOR PAYMENT OF PUBLIC PENSIONS

				Sweden	
Year	United States (OASI)	Japan (EPI & NPS)	Germany (ARV & ANV)	Unindexed Basbelopp (FP & ATP)	Indexed Basbelopp
1987	11.2	3.85	12.88	13.89	13.89
1990	12.1	4.46	13.50	15.75	15.75
2000	11.9	7.65	16.43	14.84	14.84
2010	12.0	12.93	18.60	16.34	16.34
2020	12.2	18.82	22.39	20.37	20.37
2030	12.3	19.77	29.23	19.94	20.98
2040	16.8	22.91	28.89	16.75	21.45
2050	16.4	22.95	28.88	12.74	20.05

OASI: Old Age and Survivors' Insurance
EPI: Employee Pension Insurance
NPS: National Pension Scheme
ARV: Arbeiter Versicherung
ANV: Angestellten Versicherung
FP: Folkpension
ATP: Allmaenna tillaeggspensionen

Table 18

SECRETARIAT ESTIMATES OF "SMOOTHED" CONTRIBUTION
RATES AND ASSOCIATED TRUST FUNDS FOR
PAYMENT OF PUBLIC PENSIONS
(AS A PER CENT OF TAXABLE PAYROLL)

Year	United States				Japan				Germany				Sweden (b)			
	Current legislation		Smoothed		PAYG		Smoothed		PAYG		Smoothed		PAYG (constant fund)		Smoothed	
	Trust Fund	Contribution Rate (a)	Trust Fund	Contribution Rate	Trust Fund	Contribution Rate	Trust Fund	Contribution Rate	Trust Fund	Contribution Rate	Trust Fund	Contribution Rate	Trust Fund	Contribution Rate	Trust Fund	Contribution Rate
1987	2.4	11.2	2.1	11.1	47.2	3.9	47.4	3.5	1.8	12.9	1.8	12.9	72.94	13.9	73.2	13.9
1990	5.2	12.1	2.1	11.1	59.2	4.5	50.1	5.5	3.7	13.5	3.7	14.3	68.61	15.8	70.4	14.3
1995	11.4	12.1	3.8	11.3	65.2	5.9	58.7	7.8	10.9	14.4	10.9	16.0	56.87	16.0	62.6	15.1
2000	18.3	11.9	7.9	11.5	63.7	7.7	71.0	9.9	18.5	16.4	18.5	17.6	49.89	14.8	60.6	15.7
2005	27.3	12.0	15.8	11.8	55.1	10.3	82.5	11.7	24.9	17.6	24.9	19.1	45.65	14.7	62.8	16.3
2010	38.8	12.0	27.1	12.1	33.8	12.9	90.4	13.3	34.6	18.6	34.6	20.5	36.55	16.3	63.4	16.9
2015	46.6	12.1	36.0	12.5	3.1	16.2	91.2	14.8	45.4	20.0	45.4	21.8	12.98	19.3	54.8	17.4
2020	51.0	12.2	42.9	12.9	*	18.8	82.3	16.1	54.7	22.4	54.7	23.0	*	20.4	40.0	17.8
2025	45.7	12.3	41.9	13.3	*	19.9	71.1	17.2	54.8	26.2	54.8	24.2	*	20.5	26.7	18.2
2030	30.8	12.3	33.5	13.8	*	19.8	63.7	18.2	41.3	29.2	41.3	25.2	*	21.0	16.8	18.6
2035	9.74	12.3	21.4	14.3	*	21.2	55.3	19.0	20.9	30.0	20.9	26.2	*	21.4	9.0	18.9
2040	*	16.8	10.5	14.8	*	22.9	41.2	19.7	8.1	28.9	8.1	27.1	*	21.5	3.6	19.1
2045	*	16.2	4.4	15.4	*	23.6	23.4	20.3	2.8	28.6	2.8	28.0	*	21.0	0.7	19.3
2050	*	16.4	1.9	16.0	*	23.0	8.7	20.7	1.4	28.8	1.4	28.7	*	20.0	*	19.5
2055	*	16.9	0.6	16.6	*	21.5	1.3	21.1	0.6	29.6	0.6	29.4	*	19.6	*	19.6
2060	*	17.3	0.0	17.3	*	20.8	0.0	21.3	0.0	30.0	0.0	30.0	*	19.6	*	19.6

(a) Legislated rates to 2038; Secretariat estimates thereafter.
(b) Assumes "basbelopp" and ceiling are indexed to real wages (see text).

Table 19

IMPACT OF TWO-YEAR INCREASE IN RETIREMENT AGE
ON DEPENDENCY RATIOS AND CONTRIBUTION RATES
(DIFFERENCE FROM PAYG RATES)

			Sweden	
Year	Japan (EPI & NPS)	Germany (ARV & ANV)	Unindexed Basbelopp (FP & ATP)	Indexed Basbelopp
		Adjusted Dependency Ratios		
1987	0.00	0.00	0.00	-
1990	0.00	0.00	0.00	-
2000	-2.78	-4.14	0.00	-
2010	-6.70	-7.45	0.00	-
2020	-6.49	-9.89	-2.74	-
2030	-6.47	-11.64	-6.18	-
2040	-8.03	-8.15	-5.36	
2050	-5.94	-10.74	-5.48	
		Contribution Rates		
1987	0.00	0.00	0.00	0.00
1990	0.00	0.00	0.00	0.00
2000	-0.15	-1.27	0.00	0.00
2010	-1.55	-2.33	0.00	0.00
2020	-2.72	-3.14	-1.38	-1.38
2030	-2.90	-3.74	-1.98	-2.13
2040	-3.72	-2.61	-2.14	-2.76
2050	-2.86	-3.44	-1.55	-2.43

Source: Secretariat

Table 20

IMPACT ON CONTRIBUTION RATES
OF SWITCH TO NET-WAGE REPLACEMENT
(DIFFERENCE FROM PAYG RATES)

Year	Japan (EPI & NPS)	Germany (ARV & ANV)
1987	0.11	0.00
1990	0.10	-0.08
2000	-0.11	-0.57
2010	-0.85	-1.01
2020	-2.14	-1.95
2030	-2.42	-4.12
2040	-3.33	-3.99
2050	-3.32	-4.00

Source: Secretariat

CHART I

TRENDS IN PROPORTION AGE 65 AND OVER

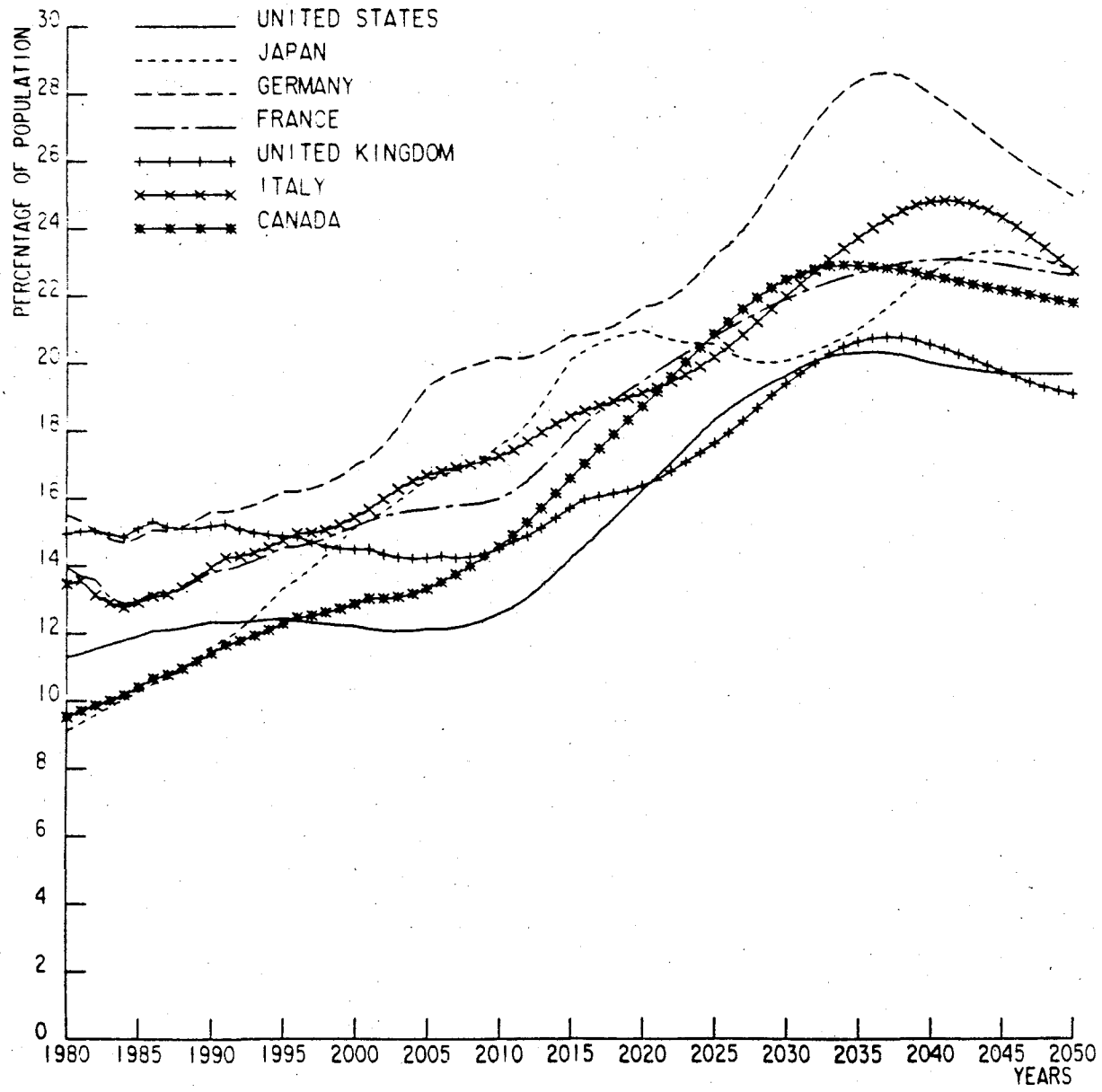


CHART I (CONTINUED)

TRENDS IN PROPORTION AGE 65 AND OVER

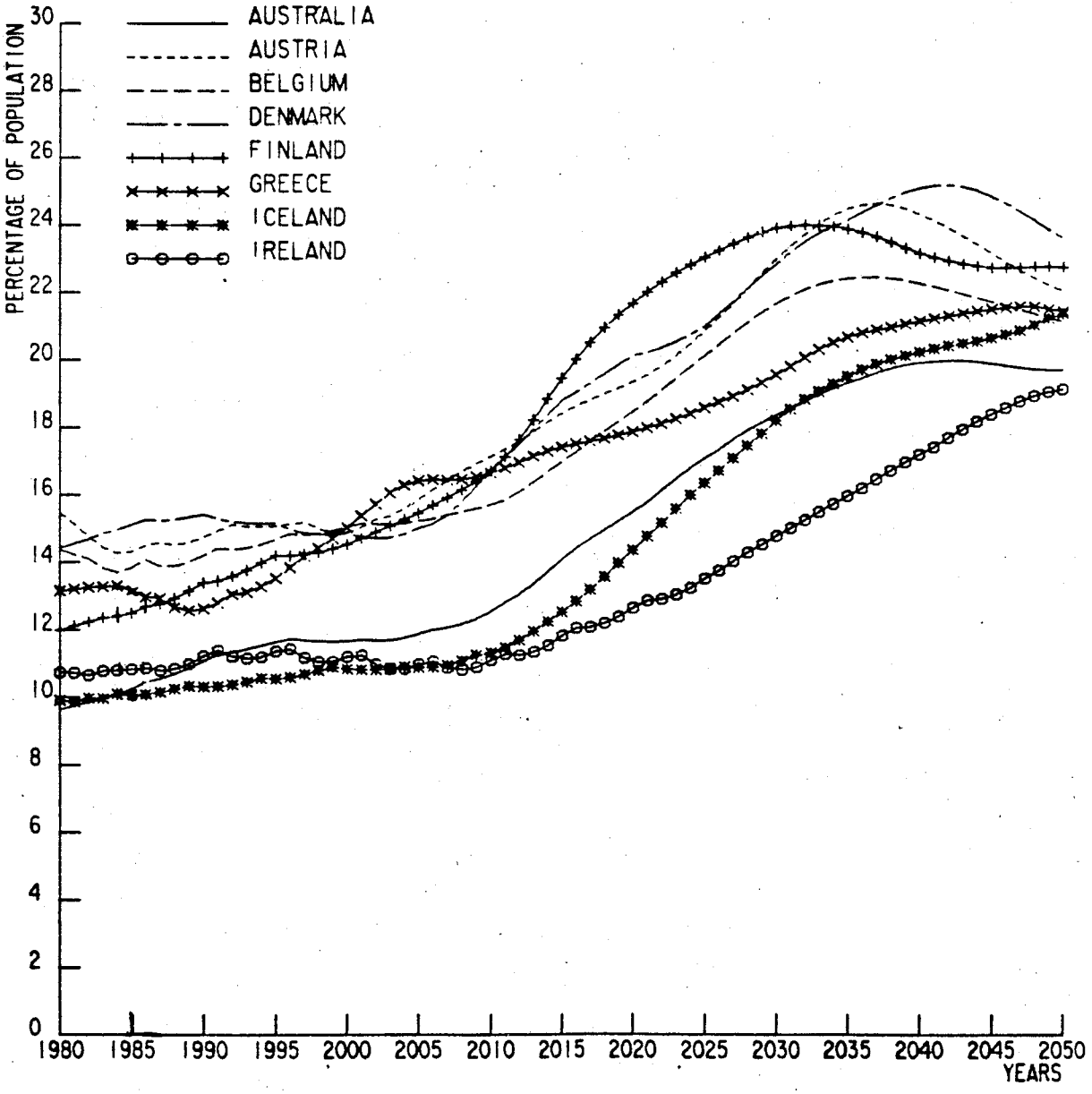


CHART I (CONTINUED)

TRENDS IN PROPORTION AGE 65 AND OVER

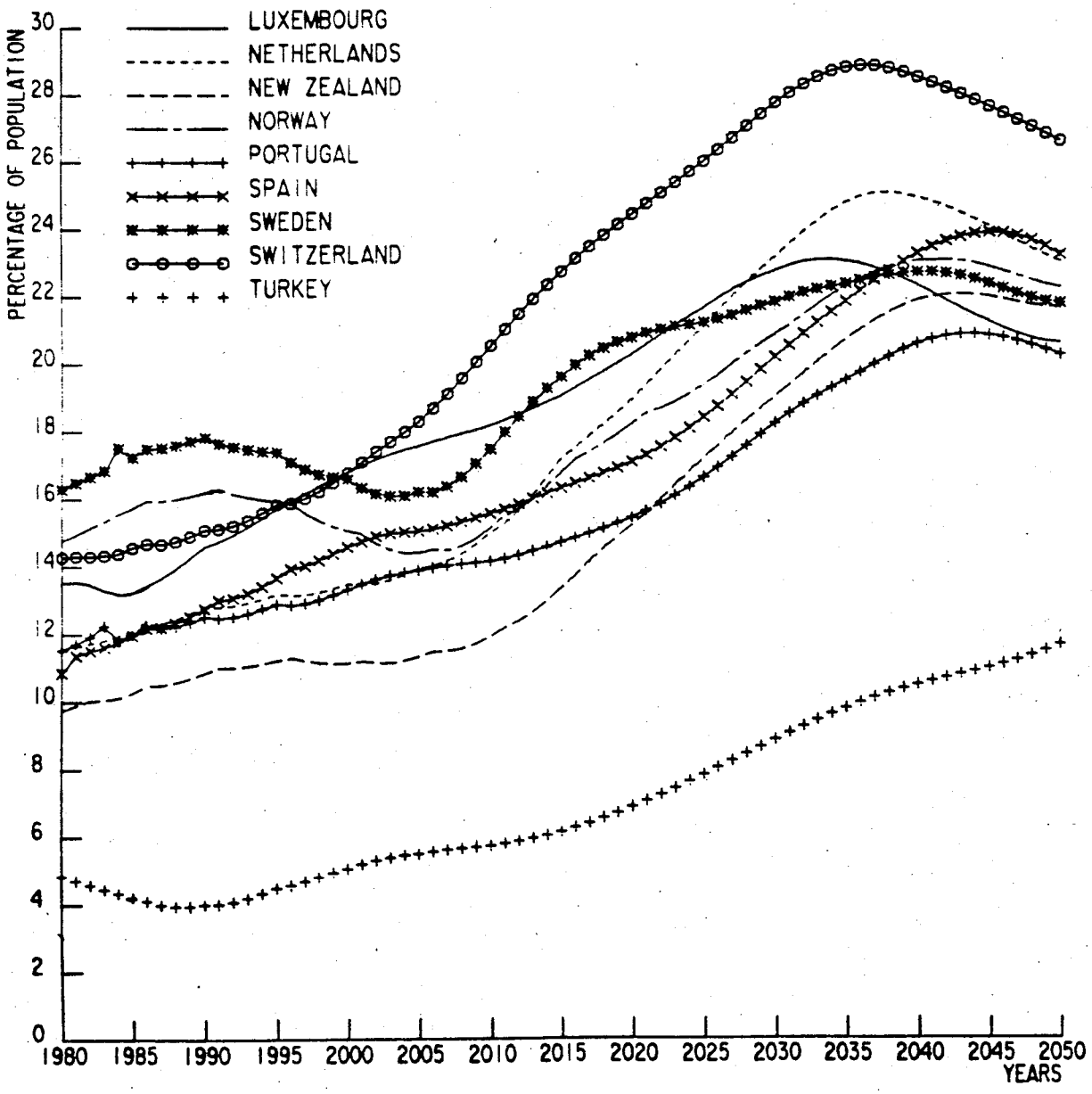
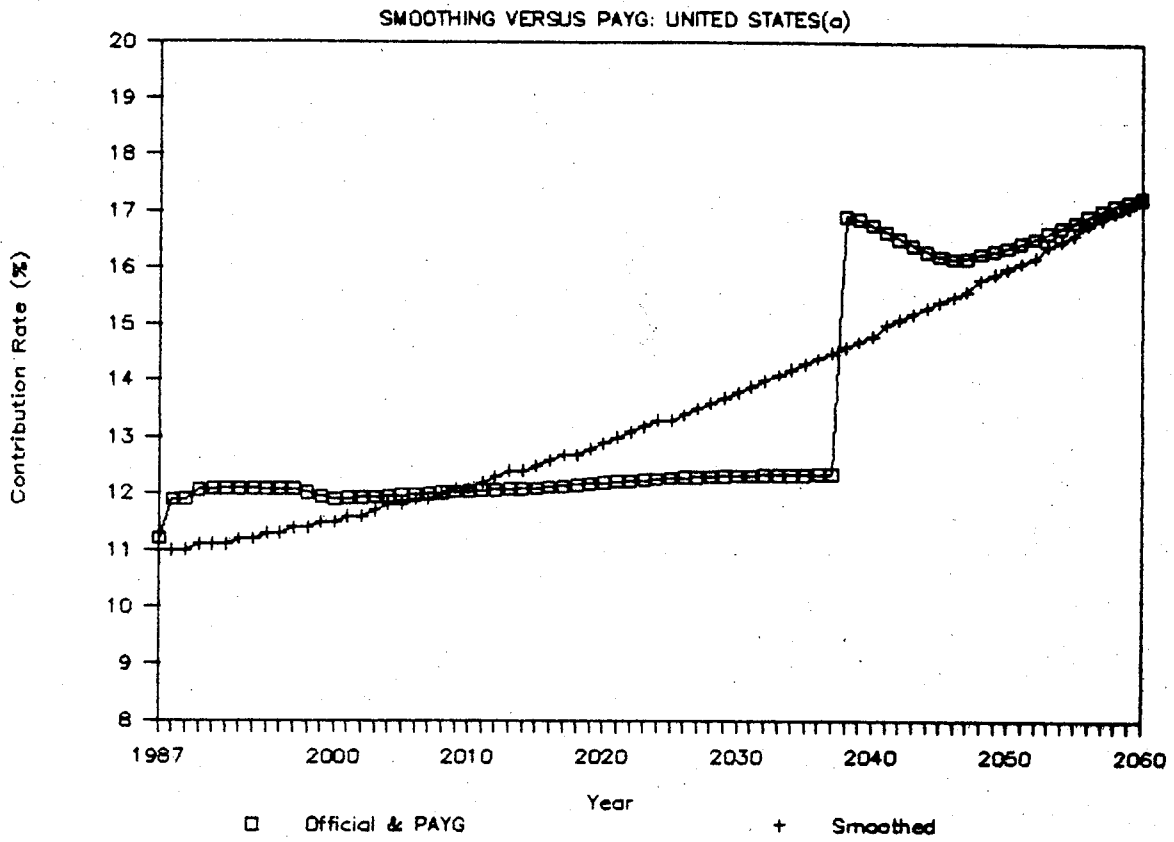


CHART 2



(a) Legislated contribution rates to 2037, and estimated rates thereafter.

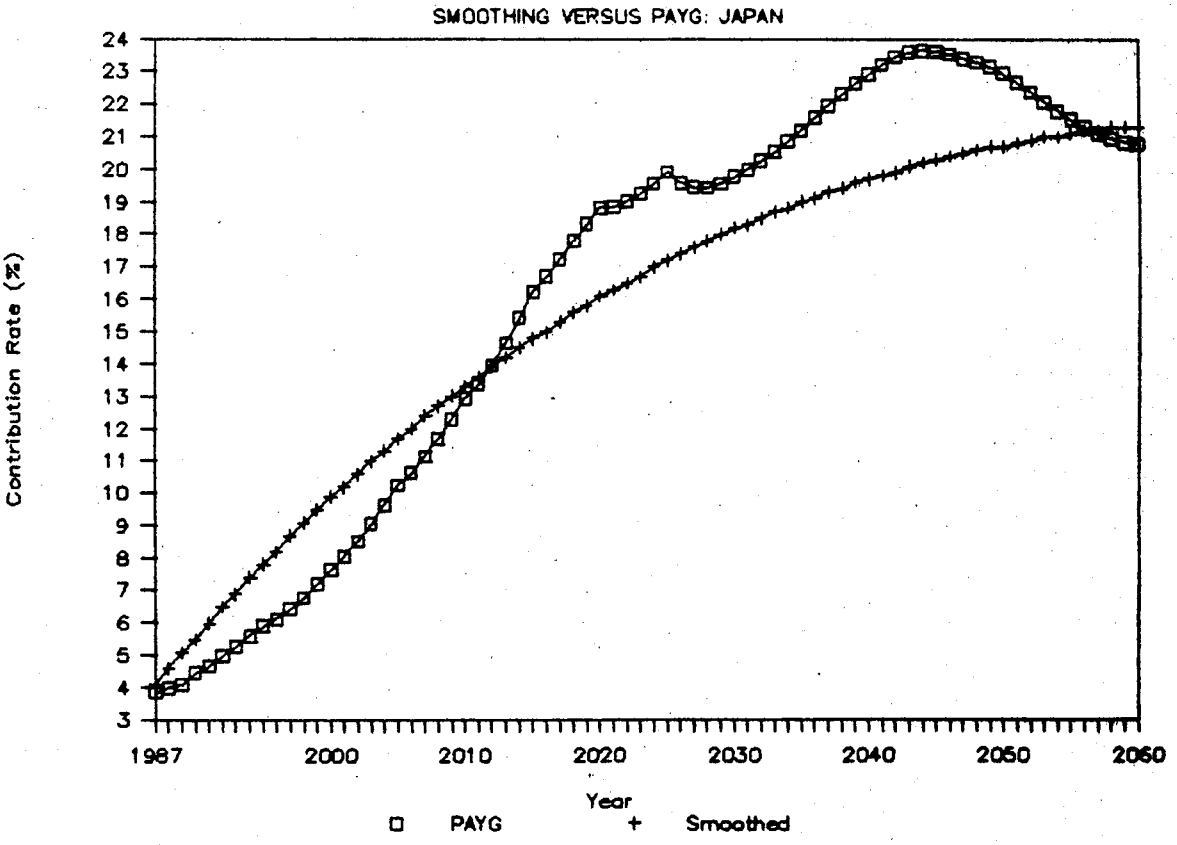
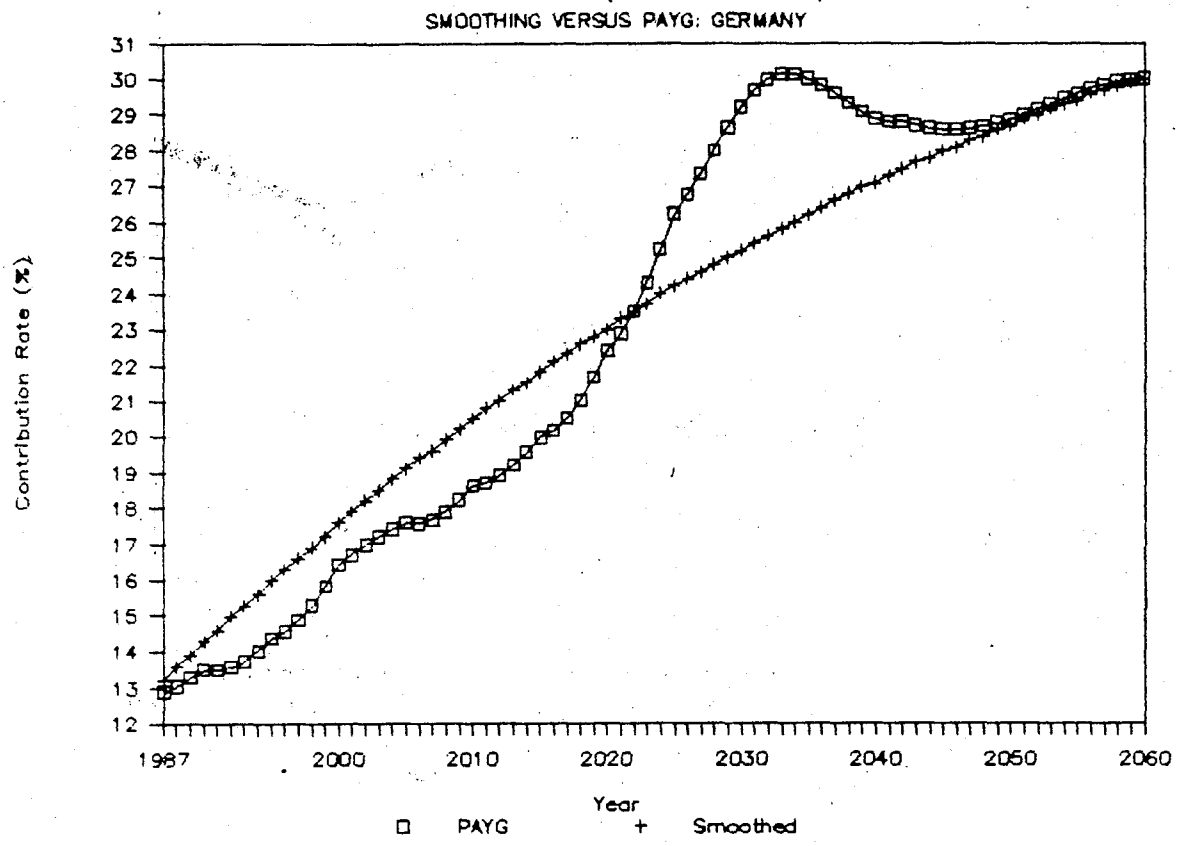


CHART 2 (continued)



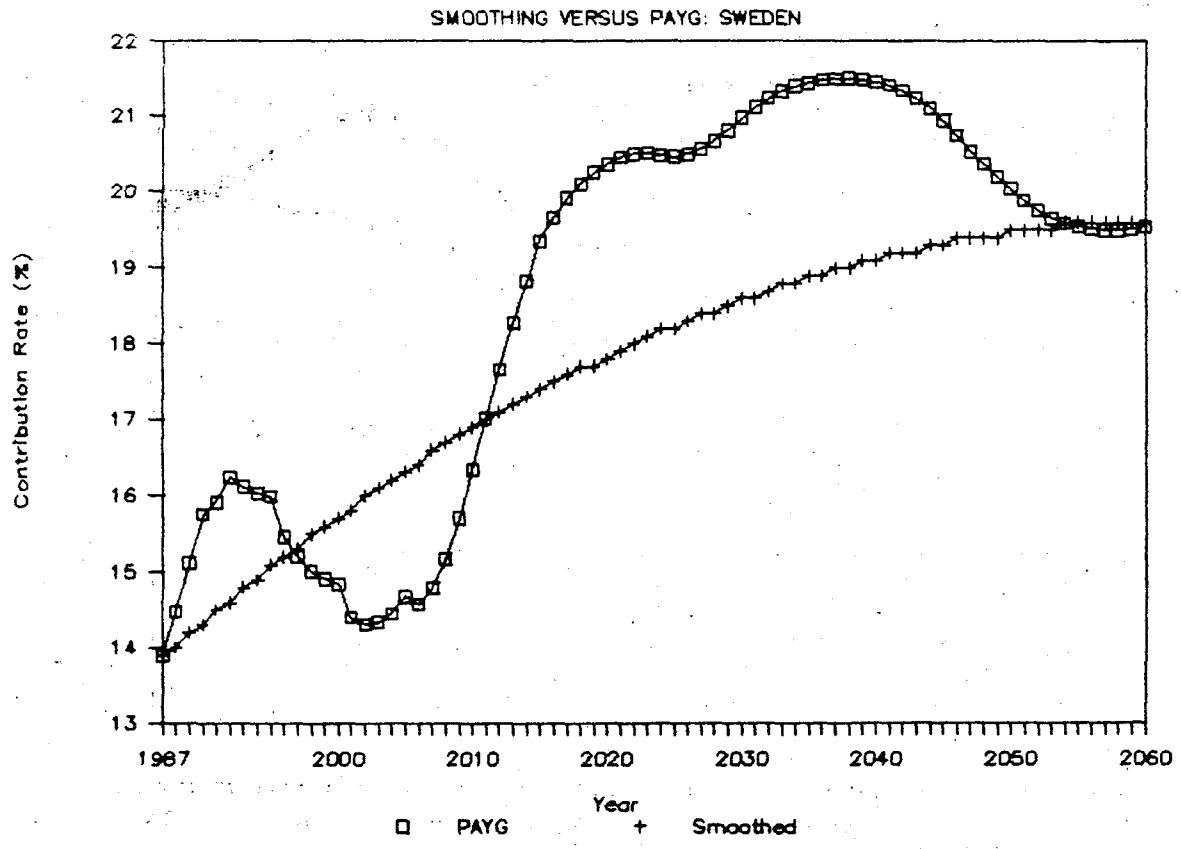
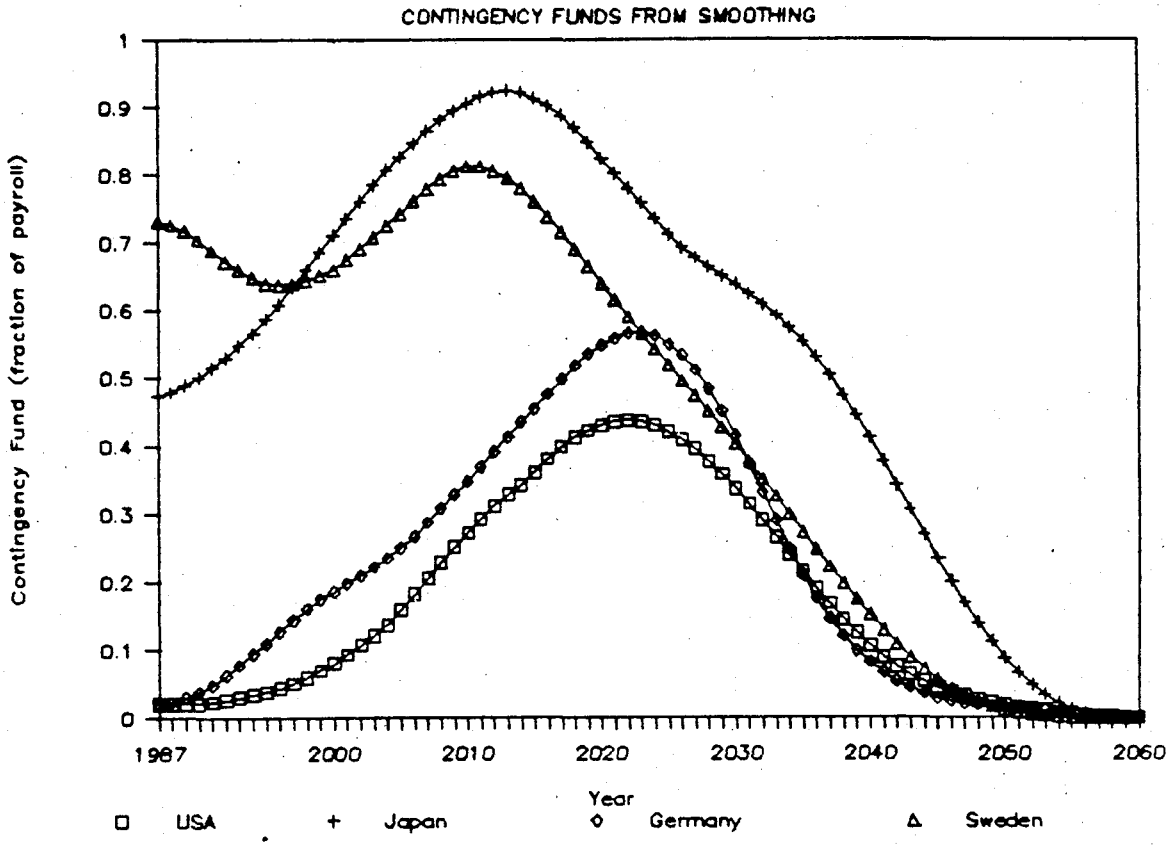


CHART 3


CONTINGENCY FUNDS FROM SMOOTHING
Contingency Fund (fraction of payroll)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1987
2000
2010
2020
2030
2040
2050
2060
Year
□ USA
+ Japan
◇ Germany
△ Sweden

ANNEX

METHODOLOGY UNDERLYING THE SIMULATIONS PRESENTED IN SECTION IV

This annex describes the methodology for the analysis in Section IV of the main paper. This refers in particular to:

a) the projections of contribution rates and flow deficits of the old-age pension schemes;

b) the estimates of the benefit-cost ratios;

c) the estimates of the unfunded pension obligations.

All computations refer only to the old-age components of the following national social insurance schemes in the four countries analysed:

-- the old-age and survivors insurance (OASI) scheme in the **United States**;

-- the National Pension (NPS) and Employee Insurance (EPI) schemes in **Japan**;

-- the Blue-Collar (ARV) and White-collar (ANV) insurance schemes in **Germany**;

-- the basic (FP) and supplementary (ATP) schemes in **Sweden**.

Computations are based on a consistent set of a) economic assumptions concerning future labour force participation rates, unemployment rates, rates of growth in real wages and inflation, and real rates of interest; and b) population projections or, alternatively, cohort-specific survival probabilities. Economic assumptions, which are drawn from both national and OECD sources, are shown in Tables A1.1-A1.4. Population projections are those of Social and Manpower Affairs Directorate (OECD, 1988), while survival probabilities were obtained from national sources.

A. Projections of contribution rates and flow deficits

The starting point for these projections is the adjustment of the demographic old-age dependency ratios for the effects of labour force participation and unemployment. Under the assumption that elderly either participate in labour force or get benefits from the retirement scheme, "economic" dependency ratios (DEP) approximating the actual ratios of beneficiaries (N^B) to contributors (N^C) in the old-age pension schemes can be defined as follows in each period t:

$$(a) \qquad DEP(t) = \frac{\sum_{s=M,F} \sum_{a=R^s}^{100} N^{s,a}(t)\,[1-p^{s,a}(t)]}{\sum_{s=M,F} \sum_{a=L}^{R^s-1} N^{s,a}(t)\,p^{s,a}(t)\,[1-u^{s,a}(t)]} \approx \frac{N^B(t)}{N^C(t)}$$

where s(s=M,F) and a (a=L,L+1,..., 100) are indexes of sex and age, respectively; $N^{s,a}(t)$ is total population of sex s and age a at time t; $p^{s,a}(t)$ and $u^{s,a}(t)$ are, respectively the labour force participation and unemployment rates of the members of $N^{s,a}(t)$; L is the age of entry in the labour force; and R^s is the sex-specific average retirement age. In the computations R^s varies across countries while L is arbitrarily set at 15 years of age. The derived dependency ratios are shown in Table 14 of the main text.

Projections of trust fund balances and contribution rates are based on the budget identity of the pension fund whereby revenues from contributions (REV) and interest on the fund's assets are equal in each period to the sum of pension outlays (EXP) and the fund's surplus. Letting I be the nominal average rate of return on the fund's assets (F), and S be the fraction of pension outlays financed by general revenue (i.e. a general government subsidy), the identity can be expressed as follows:

(1) $REV(t)+I(t)F(t-1) = EXP(t)[1-S(t)]+F(t)-F(t-1)$

Since the variable of interest is the average contribution rate, (i.e. the revenue per unit of taxable wages of contributors), it is convenient to express (1) in units of taxable income. This can be done as follows. In each period, revenues from contributions can be decomposed into the product of the average contribution rate τ, average taxable income y, and the number of contributors N^c.

(b) $REV(t) \equiv \tau(t)y(t)N^c(t)$.

Similarly, the fund's assets can be expressed as the product of the fund per unit of taxable income ϕ, average taxable income y, and the number of contributors N^c:

(c) $F(t) \equiv \phi(t)y(t)N^c(t)$.

Finally, pension outlays can be expressed as the product of the average pension benefit b and the number of beneficiaries N^B:

(d) $EXP(t) \equiv b(t)N^b(t)$

Since aggregate taxable income can be expressed as the product of the average taxable income y and the number of contributors N^c, its growth factor over time is the product of the factor of wage inflation $(1+\pi)$, of the growth factor of real taxable wages $(1+g)$ and of the growth factor of the number of contributors $(1+n)$:

(e) $$\frac{y(t)\,N^c(t)}{y(t-1)N^c(t-1)} = [1+\pi(t)][1+g(t)][1+n(t)]$$

Defining the average replacement rate β as the ratio of the average pension benefit b to the average taxable income y and using definitions (a)-(e) above, the budget identity (Equation 1) can be divided by aggregate taxable income in period t to obtain, after rearrangement of the terms of the identity, the following expressions for the average contribution rate τ and the surplus of the pension fund ϕ, respectively, per unit of taxable income:

$$(2) \quad \tau(t) \equiv \Phi(t)-\Phi(t-1)+\frac{g(t)+n(t)-i(t)}{1+g(t)+n(t)}\ \Phi(t-1)+\beta(t)[1-S(t)]DEP(t)$$

and,

$$(3) \quad \Phi(t)-\Phi(t-1) \equiv \tau(t)-\beta(t)[1-S(t)]DEP(t)-\frac{g(t)+n(t)-i(t)}{1+g(t)+n(t)}\Phi(t-1),$$

where i, the average real rate of return on the fund's assets, is defined as the nominal rate of return I deflated by the wage inflation π (1):

$$i(t) \equiv \frac{1+I(t)}{1+\pi(t)} \ -1$$

Equation (2) shows that the average contribution rate is directly related to: i) the growth in the fund per unit of taxable income; ii) the average replacement rate; and iii) the economic dependency ratio, and inversely related to: i) the difference between the average real rate of return on the fund's assets and the rate of growth of real taxable income; and ii) the fraction of outlays subsidised by general revenues. Independently of the level of pension outlays, contribution rates have to increase if the authorities plan to increase the level of the fund, and can be lowered if subsidisation is increased. The effect of interest revenues is to lower (increase) contribution rates if the real rate of return is higher (lower) than the real rate of growth of the taxable base; if these rates are equal, the contribution of interest revenues is nil independently of the size of the fund. This suggests that in the long run, where the two rates are expected to be approximately equal, the level of the contribution rates depends exclusively on the level of outlays per unit of taxable income (i.e. on the average replacement rate and on the economic dependency ratio).

Equation (3) defines the surplus of the pension fund per unit of taxable income as the sum of the basic surplus (i.e. the difference between the average contribution rate and pension outlays per unit of taxable income net of government subsidies) and net real interest revenues. The latter contribute positively to the growth in the fund only if the average real rate of return on the funds' assets exceeds the growth in the real taxable income. Therefore, in the long run, the behaviour over time of the fund per unit of taxable income depends mainly on the size and the magnitude of the basic surplus.

Given an initial condition on Φ and the future time paths of τ, β, DEP, S, g, n, and i, equation (3) simulates dynamically the future time path of the funds' assets per unit of taxable income. Alternatively, given an initial condition on Φ and the future time paths of Φ, β, DEP, S, g, n and i, equation (2) yields static projections of the future contribution rates required to balance the budget of the pension fund over the projection period. The projections of the funds' assets and surpluses for Japan, Germany and Sweden in Table 15 of the main text were obtained assuming that the average contribution rates are kept constant at the initial levels simulated using the latest available historical values of the funds' assets (see Table A2). For the United States, projections were obtained by setting the average contribution rates (gross of revenues from taxation of benefits) at the following legislated levels over the projection period, with the starting level of the fund at its observed level in 1986 (as a fraction of taxable income) of 0.02:

Legislated levels of τ for the United States*

1986	11.3
1987	11.4
1990	12.3
2000	12.2
2010	12.4
2020	12.7
2030	13.0
2040	13.1
2050	13.1

* Includes revenues from taxation of benefits.

The projections of the average contribution rates in Table 17 of the text were obtained assuming that the funds' assets per unit of taxable income are kept constant at their initial levels over the projection period. Assumptions on g and i are shown in Tables A1.1-A1.4, while the time path of n reflects the growth rate of the Secretariat's estimate of N^c over time.

Other policy assumptions used in the simulations in Section IV of the main text concern the fraction of outlays financed by general revenues (S) and the average replacement rate (β). The first variable was assumed to be constant over the projection period at its latest available historical value in the case of the United States, Japan and Sweden (the values for these countries were, respectively, 0.0, 0.2 and 0.15) (2). In the case of Germany, central government subsidisation was assumed to decline from 0.18 of outlays in 1986 to 0.114 after 2030. The average replacement rates for the United States and Germany were assumed to be constant over the projection period at their latest available historical values (0.41 and 0.36, respectively). For Japan and Sweden, programme maturation and other specific characteristics of the pension schemes suggested that replacement rates would change over the projection period. For Japan, projected average replacement rates were computed separately for EPI and NPS, taking into account changes in the average benefits due to the increase in the average length of the contribution period associated with the maturation of the schemes. A single average replacement rate was then obtained by a linear combination of the two programme-specific rates with weights equal to the fraction of taxable wage income over total income of employees and self-employed (3). For Sweden, in order to account for the maturation of the ATP programme, projected average replacement rates were computed separately for ATP and FP, and a single rate was obtained by adding the FP rate to the ATP rate weighted by the fraction of beneficiaries receiving both ATP and FP benefits (this weight converges to unity by 2015). The average replacement rate in the FP programme declines over time since average benefits are indexed only to inflation. The average replacement rate in the ATP programme could evolve along either of two alternative paths, depending upon the kind of indexation chosen by the authorities. If, as in the current legislation, the basic pension unit, or "basbelopp", is indexed only for inflation, the income ceiling for the

computation of benefits (which is set at 7.5 times the "basbelopp") is also indexed only for inflation and, as soon as the average income of contributors exceeds the ceiling, the average replacement rate in ATP also begins to fall. If the "basbelopp" were indexed for real wage growth as well, the average replacement rate in ATP would remain constant after programme maturation. The projected time paths of the average replacement rates resulting from these assumptions are summarised in Table A3.

Projections in Tables 15, 17, 19 and 20 of the main text are purely mechanical, derived solely from the budget identity of the pension fund. The latter can only yield estimates of the funds given contribution rates or, alternatively, estimates of the contribution rates given the fund. Adding a "behavioural" component for the government to the budget identity (Equation 3) allows simultaneous estimation of both the projected contribution rates and the associated trust funds. If it is assumed that the basic structure (i.e. PAYG) of pension financing is retained, and that:

a) the government's objective is to choose paths of the contribution rates and trust funds which minimise the welfare losses due to taxation while at the same time respecting the budget constraint (Equation 3);

b) the government plans to do so by avoiding sudden "jumps" in the level of the contribution rates (i.e. by smoothing over time the necessary increases in rates);

c) the level of contribution rates in the final projection period must be sustainable [i.e. must respect the budget identity (Equation 3)] assuming that the new demographic (and economic) steady-states have been reached.

then an "optimal" path of contribution rates and trust fund balances can be determined using the following non-linear optimisation problem:

$$\min_{\tau} \sum_{t=t_0+2}^{T} [\tau(t) - \tau(t-1)]^2$$

subject to a) equation (3) from t_0 to T

b) $\Phi_{t0} = \Phi(t_0)$
$\tau_{t0+1} = \tau(t_{0+1})$

c) $$\tau(T) = \beta(T)[1-S(T)]DEP(T)+\frac{g(T)+n(T)-i(T)}{1+g(T)+n(T)}\Phi(T)$$

In other words, the authorities seek to minimise the sum of the quadratic first differences of the contribution rates over time. Since the welfare losses from taxation are proportional to the square of the tax rate, the objective function above adds to the sum of the squared tax rates an autoregressive component (i.e. the cross-products of the current and past contribution rates) in order to prevent the optimal solution from requiring

"jumps" in the level of the contribution rate from one period to the other. The minimisation problem is subject to three sets of constraints. The first is a feasibility condition requiring that the budget constraint be satisfied in each period. The second states initial (historical) conditions for the fund's assets per unit of taxable income and for the average contribution rate. The third is a terminal condition stating that in the new steady-state (assumed to be reached at the end of the projection period) contribution rates and interest revenues must be sufficiently high to ensure the continued payment of the pension outlays per unit of taxable income. The problem was solved using GAMS/MINOS, a software designed for non-linear dynamic optimisation models (4). The resulting paths for the average contribution rates are shown in Table 18 and Charts 2 and 3 of the main text.

B. Estimates of benefit-cost ratios

Public pension cost-benefit ratios are defined as the ratio of the present value of lifetime contributions paid to the present value of the lifetime benefits received by an individual of a specific cohort. The Secretariat estimates of these ratios are hypothetical, entailing the construction of lifetime earnings, benefit and contribution profiles for selective representative individuals differentiated by age and sex (5). Benefit-cost ratios (as of 1985) were computed for representative male and female individuals born between 1945 and 1970 and fully-insured by the national old-age insurance programmes described in the earlier section. Hence, these ratios must be interpreted as applying to only a subgroup of the current working age generations (6).

The building blocks of the age and sex-specific present values of contributions and benefits are the historical and projected average replacement rates (β), average contribution rates (τ) and average earnings (y) from the period of entry in the labour force of the oldest cohort in 1985 (i.e. the year 1962 given the assumption that the entry age is 17) to the period in which no members of the youngest cohort in 1985 are still alive (which is assumed to be 2060 when the cohort is 90 years old). Given a series of historical and projected nominal interest rates (R), these variables are used to construct the series of present value benefits (B) and contributions (T). Choosing 1985 as the reference year and assuming (for illustrative purposes only) a constant rate of interest, the typical elements of these series can be expressed as follows:

$$B(t) = \beta(t)y(t)\ (1+R)^{1985-t}$$

$$T(t) = \tau(t)y(t)\ (1+R)^{1985-t}$$

where t runs from 1960 to 2060.

In order to obtain the stream of discounted benefits and contributions expected by each representative individual upon entry in the labour force, B and T must be weighted by the probability that the representative male or female individual of the cohort aged a in 1985 was or will be alive in period t. For simplicity, sex-specific survival probabilities are assumed to be the same for all cohorts and are derived from the latest available life-table for each country (7). Labelling the probability of an individual of sex s of surviving to age k as $\sigma^{s,k}$, the sum of the weighted (by σ)

discounted benefits and contributions over the life span of each individual of sex s aged a in 1985 yields the following age and sex-specific present values of benefits (BEN) and contributions (TAX):

$$BEN^{s,a} = \sum_{k=R^s}^{90} B(1985-a+k)\sigma^{s,k}$$

$$TAX^{s,a} = \sum_{k=17}^{R^{s-1}} T(1985-a+k)\sigma^{s,k}$$

C. Estimates of unfunded pension obligations

Unfunded pension obligations are defined as the difference between the present value of the future stream of pension outlays implied by commitments of the old-age pension fund towards an arbitrary group of fully-insured individuals and the present value of the future contributions expected to be paid by this group. While this concept is reasonably well-defined, it is clear that the quantitative estimates of the unfunded pension obligations depend heavily on the definition of the group of insured. Two extreme cases can be considered. When the group of insured includes all individuals either in the labour force or retired as well as the future (born and unborn) cohorts that will contribute to the programme (the "open group" case), respect of the budget identity (2) in each period implies that unfunded pension obligations do not exist, since pension obligations will always have a source of financing through contribution rate increases, benefit reductions, increased government subsidies, or a combination of those. Conversely, when the group of insured includes only currently living cohorts (the "closed group" case) the very nature of PAYG financing implies that a positive stock of unfunded pension obligations exists in each period since part of the future pension outlays must necessarily be financed by cohorts that do not yet belong to the workforce. The difference between this stock and the initial assets of the fund measures the gap between the PAYG (or even partially funded) system and one that would be fully-funded. The stock of unfunded obligations itself can be considered as public debt not accounted for in general government accounting and has, under certain conditions, the same crowding-out effects as official government debt (8).

The Secretariat estimates of the unfunded pension obligations are based on a closed group approach, with the group defined as including all individuals aged 17 to 90 years in 1985. In addition, due to data limitations, the estimates are based on the following restrictions:

a) Only old-age pension obligations and contributions of male and female individuals entitled to own pensions are considered.

b) In each period, all employed male and female individuals are assumed to contribute to the system (and do not get benefits from the pension fund).

c) In each period, female retirees entitled to full pensions are approximated by the number of women of retirement age or more multiplied by the average labour force participation rate of the same group of woman at ages 40 to 60.

d) Average benefits and contributions of fully-insured individuals are assumed to be the same for the two sexes.

e) Early retirement provisions are ignored.

As a result of a) above, the computations exclude benefits of individuals receiving dependent-spouse, survivor or disability payments. Assumption b) approximates the fully-insured population with the employed individuals, while c) approximates the number of non-dependent women entitled to full pensions from 1985 to 2060 using the average labour force participation rates of the women aged 40 to 60 from 1960 to 2025. The other assumptions are self-explanatory.

These estimates, even abstracting from their dependence on underlying assumptions, are subject to bias. On the one hand, insofar as the analysis is restricted to old-age pensions only, the estimates of the unfunded obligations are understated. On the other hand, since the populations of both contributors and beneficiaries could be overstated by these simplications, the final overall bias implied by assumptions a)-e) is ambiguous.

Labelling the proportion of women entitled to full pension benefits in each period t (t=1985,... 2060) by w, the number of beneficiaries (N^B) in each period can be redefined as follows:

$$N^B(t) = \sum_{a=R^M}^{95} N^{M,a}(t)[1-p^{M,a}(t)] + w(t)\sum_{a=R^F}^{95} N^{F,a}(t)[1-p^{F,a}(t)]$$

Using this and the other previously defined variables, the 1985 present value of the government's current and future pension obligations (EXP) and revenue claims (REV) is simply the sum of the stream of discounted pension outlays and contribution revenues over the projection period:

$$EXP = \sum_{t=1985}^{2060} B(t)N^B(t)$$

$$REV = \sum_{t=1985}^{2060} T(t)N^c(t)$$

The stock of unfunded pension obligations (DEBT) is then derived as the difference of these two magnitudes:

$$DEBT = EXP-REV$$

It is intuitive and can be shown formally that the unfunded pension obligation (per unit of taxable income) increases with the dependency ratio (DEP) and the average replacement rate (β), and decreases with the rate of growth in the number of contributors (n)(9). The Secretariat estimates of the unfunded pension obligations are shown in Table 16 of the main text.

NOTES

1. The derivation of Equations (2) and (3) ignores the second-order terms given by the pairwise cross-products of π, g and n.

2. The value for Sweden was applied only to outlays for the basic pension (FP).

3. This fraction, currently much lower in Japan than in other big OECD countries, was assumed to converge at average OECD levels in the long run.

4. GAMS/MINOS, Alan S. Manne, Department of Operations Research, Stanford University, March 1986.

5. An alternative approach is based on individual histories and requires longitudinal data on insured persons. Examples of the hypothetical approach are Aaron (1977), Brittain (1972) and Kruse and Stahleberg (1977).

6. The computation of the ratios for representative individuals aged more than 40 years in 1985 would have required data for the 1930 to 1960 period, which was not readily available for Sweden, Germany and Japan. In addition some of the programmes considered in the simulations were only established in the early sixties.

7. This assumes that the estimates of the cost-benefit ratios are not affected by changes in life expectancies over time. The only effects taken into account are those of different life expectancies between sexes.

8. See Auerbach and Kotlikoff (1987) for arguments in favour of this interpretation.

9. The comparative statics of the unfunded pension obligations of a PAYG system can be found in Kotlikoff (1979).

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Table A1.1

Economic assumptions: United States

Variable	Symbol	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2060
Rate of wage inflation (%)	(ж)	‹—historical—›			3.9	4.5	4.3	4.2	4.0	‹—— constant from 1992 to 2060 ——›								
Average nominal rate of return on fund's assets (%)	(I)	‹historical›		8.4	8.4	9.1	8.9	8.6	7.8	7.4	6.9	6.6	6.4	6.2	6.1	6.05	‹6.0 thereafter›	
Average real rate of return on fund's assets	(i)	‹historical›		‹—— calculated as I-ж from 1987 to 2060 ——›														
Nominal interest rate	(R)	‹—historical—›		‹—— interpolation from 1988 to 2000 ——›													‹6.0 thereafter›	
Real interest rate	(r)	‹—historical—›		‹—— calculated as R-ж from 1988 to 2060 ——›														
Rate of real wage growth (%)	(g)	‹historical›		-0.6	0.90	1.1	1.1	1.3	1.7	‹—— interpolation from 1992 to 2000 ——›							‹1.4 thereafter›	
Rate of nominal wage growth	(G)	‹historical›		‹—— calculated as (1+g) (1+ж) from 1987 to 2060 ——›														
Unemployment rate (%)	(u)(a)	‹hist›	7.00	7.10	7.10	6.90	6.60	6.20	6.00	5.90	5.90	5.80	5.80	5.85	5.90	5.95	‹6.00 thereafter›	

a) Age-specific unemployment rates were projected by multiplying the projected total unemployment rate by the average ratio (over the last decade) of the age-specific unemployment rates to the total unemployment rate.

Table A1.2

Economic assumptions: Japan

Variable	Symbol	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2060
Rate of wage inflation (%)	(R)	‹—historical—›			1.5	1.5	1.5	1.5	1.5	‹——interpolation from 1993 to 1999——›							‹2.5 thereafter›	
Average nominal rate of return on fund's assets (%)	(I)	‹historical›	‹——calculated as i+R——›															
Average real rate of return on fund's assets (%)	(i)	‹historical›	‹——interpolation from 1987 to 2000——›														‹3.5 thereafter›	
Nominal interest rate	(R)	‹—historical—›	‹——calculated as r+R——›															
Real interest rate	(r)	‹—historical—›	‹——interpolation from 1988 to 2000——›														‹3.5 thereafter›	
Rate of nominal wage growth	(G)	‹hist›	‹——calculated as (1+g)(1+R)——›															
Rate of real wage growth (%)	(g)	‹hist›	‹interpol.›		3.2	3.2	3.2	3.2	3.2	‹——interpolation from 1992 to 2000——›							‹2.5 thereafter›	
Unemployment rate (%)	(u)(a)	‹hist›	2.77	2.97	3.00	3.25	3.28	3.36	3.42	3.45	‹——interpolation from 1993 to 2060——›							3.0

a) See Table 1.1

Table A1.3

Economic assumptions: Germany

Variable	Symbol	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2060
Rate of wage inflation (%)	(R)	‹—historical—›			1.7	1.6	1.6	1.5	1.4	‹—— 1.3 thereafter ——›								
Average nominal rate of return on fund's assets (%)	(I)	‹historical›	‹—— calculated as i+R ——›															
Average real rate of return on fund's assets	(i)	‹historical›	‹inter. from 87-90›	‹—— 2.0 theafter ——›														
Nominal interest rate	(R)	‹—historical—›	‹—— calculated as r+R ——›															
Real interest rate	(r)	‹—historical—›	‹interpol.›	‹—— 2.0 from 1990 to 2060 ——›														
Rate of nominal wage growth	(G)	‹—historical—›	‹—— 4.0 from 1988 to 2060 ——›															
Rate of real wage growth (%)	(g)	‹—historical—›	‹—— calculated as G-R ——›															
Unemployment rate (%)	(u)(a)	‹hist› 7.95	7.92	8.15	8.47	8.23	7.77	7.29	6.80	‹——— interpolation from 1993 to 2060 ———›								6.0

a) See Note (a) of Table A1.1.

Table A1.4

Economic assumptions: Sweden

Variable	Symbol	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2060
Rate of wage inflation (%)	(π)	‹—historical—›			‹—inter. from 1988-1992—›				‹— 5.0 thereafter —›									
Average nominal rate of return on fund's assets (%)	(I)	‹historical›	‹— calculated as i+π —›															
Average real rate of return or fund's assets	(i)	‹historical›	‹interpolated from 1987 to 1992›		‹— 2.0 thereafter —›													
Nominal interest rate	(R)	‹—historical—›			‹— calculated as r+π —›													
Real interest rate	(r)	‹—historical—›			‹inter. from 1988 to 1992›				‹— 2.0 thereafter —›									
Rate of nominal wage growth	(G)	‹hist›	‹— calculated as (1+g)(1+π) —›															
Rate of real wage growth (%)	(g)	‹hist›	‹inter. from 1986 to 1989›		1.6		‹inter. from 1991 to 1994›		1.9			‹inter from 1995-1999›				1.7		‹see note b›
Unemployment rate (%)	(u)(a)	[see note a]																

a) See note (a) in Table A1.1

b) Interpolated to 2004. The values for the subsequent years are: 2005-2010: 2.0; 2010-2015: 1.9; 2015-2020: 2.0; 2020-2025: 2.2; 2025-2030: 2.3; 2030 thereafter: 2.5.

Table A2

Initial level of Trust Funds and Contribution Rates (a)

	Japan		Germany		Sweden	
	Initial level of ϕ (ratio to taxable income)	Initial level of τ (percentage)	Initial level of ϕ (ratio to taxable income)	Initial level of τ (percentage)	Initial level of ϕ (ratio to taxable income)	Initial level of τ (percentage)
1985	0.47	-	0.014	-	0.73	-
1986	-	3.6	-	12.8	-	13.7

a) See text of Annex for United States.

Table A3

Replacement Rates for Japan and Sweden (a)

	Japan			Sweden					
				Non-indexed basbelop			Indexed basbelop		
	Average repl. rate in NPS	Average repl. rate in EPI	Average repl. rate	Average repl. rate in FP	Average repl. rate in ATP	Average repl. rate	Average repl. rate in FP	Average repl. rate in ATP	Average repl. rate
1986	0.13	0.52	0.28	0.29	0.38	0.54	0.29	0.38	0.54
1990	0.14	0.51	0.29	0.28	0.38	0.54	0.28	0.38	0.54
2000	0.15	0.49	0.34	0.23	0.38	0.54	0.23	0.38	0.54
2010	0.18	0.54	0.43	0.19	0.38	0.54	0.19	0.38	0.54
2020	0.21	0.61	0.52	0.16	0.38	0.53	0.16	0.38	0.53
2030	0.23	0.64	0.58	0.12	0.35	0.48	0.12	0.38	0.50
2040	0.23	0.64	0.58	0.10	0.28	0.37	0.10	0.38	0.47
2050	0.23	0.64	0.60	0.08	0.22	0.29	0.08	0.38	0.45

a) See text of Annex for United States and Germany

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