POPULATION AGEING : ECONOMIC EFFECTS AND SOME POLICY IMPLICATIONS FOR FINANCING PUBLIC PENSIONS

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CONTENTS

The authors. administrator and consultant. respectively. in the Monetary and Fiscal Policy Division. wish to thank Isabelle Wanner for her extremely valuable and dedicated statistical assistance. They are also grateful for the very useful suggestions from Kenji Matsuyama and many colleagues in the Economics and Statistics Department and the Directorate for Manpower. Social Affairs and Education.

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 policy-makers concerned about the possible causes and consequences **of** such a demographic change and the appropriate policy responses.

Concern over slowing population growth and the consequent shifting of the age composition of the population is not new, of course. Interest this century can be traced to Keynes (1937), Hansen **(1939)** and Myrdal (1940), authors who were concerned about the possibly depressing effects of slower population growth on aggregate demand and output growth. The generally unanticipated post-war baby boom which occurred in most industrialised countries – testimony to the difficulty of making population projections – drew attention away from the subject. However, the sudden and large decline in fertility rates during the late **1960s** and early **1970s** and maintained into the current decade, has revived interest in the issue.

Demographic developments are expected to have widespread economic effects, through both size (slower population growth) and age distributional (population ageing) channels. Indeed, population ageing will be a pervasive force affecting the structures of industrialised economies in many ways, through its impacts on labour markets, the structure of demand, the national rate of saving and capital accumulation, etc. An obvious question that arises is whether population ageing will be favourable or not to economic well-being. Will ageing have a positive or negative impact on ***per*** *capita* income? This amounts to asking whether ageing will be favourable or harmful to technical progress?

Since ageing will increase the relative size of the dependent population, this demographic change also raises important distributional questions. How should tomorrow's national output be shared between the working and non-working populations? What institutional arrangements are best for distributing this output (i.e. by which mechanisms do the future retirees make their claim to future output)? Because of the important role now played by the public sector in effecting the transfer of real resources from workers to retired (e.g. via social insurance schemes),

population ageing promises to have a significant impact on government pension policies.

This paper has two main purposes. First, the paper considers the effects of demographic changes on the provision of public pensions. Following a general discussion, some simulations are presented which highlight the possible impact of ageing on the financing requirements in four countries – Germany, Japan, Sweden, and the United States – countries with somewhat different demographic prospects and social insurance schemes. Estimates are also made of the potential effects that selected policy responses could have on social insurance contribution rates.

A second objective is to review some of the principal ways in which demographic changes could affect the economies of OECD countries. As will be seen, in spite of the considerable literature which has emerged on the subject, relatively little certainty attaches to the likely economic consequences of ageing per se. This is due in part to the complexity of demographic-economic interactions as well as to the lack of "real world" experiments. Because ageing can be expected to have widespread general equilibrium effects during the transitional period, simulation analysis, such as presented in the next article in this volume, can provide considerable insight.

The remainder of the paper is organised as follows. Section I briefly discusses the demographic outlook in OECD countries over the next half century. Section II focuses on the implications of ageing for public finances, while Section III reviews some of the economic considerations associated with population ageing.

I. DEMOGRAPHIC DEVELOPMENTS IN OECD COUNTRIES

A. Slower population growth

Population growth rates have been falling in almost all OECD countries 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, which become negative for most from 2020 to 2050. These population projections were obtained as follows[2] :

- Fertility rates to 1995, most of which are below replacement[3] were provided by Member countries. After 1995, fertility rates are assumed to converge to replacement level by 2050.

Table 1. **Average annual population growth rates**[a]

Per cent

Country	1050 to 1960	1960 to 1970	1970 to 1980	1980 to 1990	1990 to 2000	2000 to 2010	2010 to 2020	2020 to 2030	2030 to 2040	2040 to 2050	Projected population in selected years relative to level in 1980		
											2010	2020	2050
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	1.12	1.13	1.12
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	−0.20	1.21	1.28	1.23
Norway	0.96	0.77	0.53	0.26	0.18	0.03	0.01	0.00	−0.1	−0.10	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	1.15	1.19	1.19

a) 1950-1960 to 1970-1980 actual rates; 1980-1990 to 2040-2050 projected rates.
b) Unweighted average.
Source : OECD (1988a).

- Mortality is 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, with the absolute population size of several countries being significantly smaller than in 1980. By 2050, the populations of Denmark and Germany would be roughly two-thirds their levels in 1980. The populations of Belgium, Italy, and Switzerland 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 Australia, Canada, Iceland, Ireland, New Zealand, the United States, and, especially, Turkey, larger.

B. Changing age distributions

These generally low growth rates for the total population would result in substantially different rates of growth among different age groups of the population, which in turn would alter their relative sizes. The proportion under age 15 would decline significantly, from an average of about 23 per cent to 17 per cent in 2030 (Table 2). 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 (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 aged 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 define an elderly dependency ratio as the number of ***potential*** non-working elderly persons 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 3, this ratio rises for all countries over the projection period. 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 Canada and Japan. In Turkey, the ratio rises sharply because the ratio of the elderly to 15-64 year olds is initially very low[4].

Table 2. **Per cent of the population by age group**

Country	Under 15			15 to 34			34 to 54			55 to 64			65 and over		
	1980	2010	2030	1980	2010	2030	1980	2010	2030	1980	2010	2030	1980	2010	2030
United States	22.5	19.3	18.5	35.3	27.0	24.9	21.3	28.5	25.4	9.6	12.6	11.5	11.3	12.6	19.6
Japan	23.6	18.5	16.8	30.7	23.2	25.1	28.1	26.3	23.9	8.6	14.5	14.2	9.1	17.6	20.1
Germany	18.2	13.3	14.6	29.5	21.7	20.0	27.2	31.6	24.5	9.6	13.3	15.1	15.5	20.2	25.9
France	22.3	17.5	17.1	31.6	25.6	23.0	23.2	27.9	25.1	9.0	13.0	12.9	14.0	16.0	21.9
United Kingdom	21.0	19.9	18.6	30.0	25.2	25.9	23.1	28.2	23.7	11.0	12.1	12.4	14.9	14.5	19.4
Italy	22.0	15.4	15.7	29.3	23.7	21.5	25.5	31.1	25.1	9.8	12.6	15.8	13.4	17.2	22.0
Canada	23.0	17.2	17.2	36.5	26.4	23.1	22.3	29.0	25.3	8.8	12.9	11.9	9.5	14.6	22.5
Australia	25.3	19.9	18.7	33.8	27.4	25.4	22.3	28.5	25.4	9.0	11.7	12.1	9.6	12.5	18.4
Austria	20.5	16.9	16.8	29.9	24.1	22.8	24.4	29.9	24.0	9.8	12.0	13.4	15.5	17.1	23.0
Belgium	20.0	16.2	16.3	31.1	25.2	22.7	24.2	29.7	25.9	10.3	13.1	13.4	14.4	15.7	21.7
Denmark	20.8	14.7	15.1	30.3	23.4	21.4	23.8	30.9	25.2	10.6	14.3	15.4	14.4	16.8	22.9
Finland	20.3	15.8	16.0	33.8	24.6	22.0	24.2	27.6	25.6	9.8	15.2	12.4	12.0	16.7	23.9
Greece	22.8	17.9	16.8	28.3	25.7	24.1	26.4	27.7	25.9	9.4	12.1	13.7	13.1	16.6	19.6
Iceland	27.5	18.7	18.0	34.6	29.2	23.5	20.0	29.5	27.3	7.9	11.3	12.9	9.9	11.3	18.2
Ireland	29.2	19.8	20.1	31.6	27.1	24.3	20.4	29.2	25.2	8.1	11.2	13.0	10.8	12.7	17.2
Luxembourg	18.8	16.0	16.8	31.3	24.4	23.0	26.8	28.5	25.2	9.6	13.0	12.2	13.5	18.2	22.7
New Zealand	24.6	18.0	16.5	33.9	25.3	23.2	22.4	28.2	26.2	8.8	13.3	12.2	10.3	15.2	21.9
Netherlands	22.3	16.4	16.0	34.0	23.9	22.3	22.9	30.8	24.4	9.3	14.0	14.3	11.5	15.0	23.2
Norway	22.2	17.3	16.8	30.4	25.2	23.4	21.2	29.4	25.1	11.4	13.1	13.9	14.8	15.1	20.9
Portugal	23.5	18.1	17.4	31.0	26.2	24.0	23.1	27.1	25.8	10.4	13.1	12.2	12.0	15.4	20.6
Spain	25.9	16.7	16.8	30.0	26.9	21.8	23.8	29.8	26.6	9.5	10.9	14.6	10.9	14.6	17.1
Sweden	19.6	17.0	16.6	28.6	24.3	23.4	23.7	27.7	24.8	11.8	13.6	13.3	16.3	17.5	21.8
Switzerland	16.9	14.4	14.6	30.5	21.6	21.2	27.4	24.6	23.9	10.5	15.0	11.8	14.6	24.4	28.5
Turkey	36.6	24.9	25.5	35.6	32.6	28.0	18.1	26.4	25.7	5.5	9.1	10.3	4.1	6.9	10.5
Averages															
Major seven	21.8	17.3	16.9	31.8	24.7	23.4	24.4	28.9	24.7	9.5	13.0	13.4	12.5	16.1	21.6
Small countries	23.4	17.6	17.4	31.7	25.7	23.3	23.2	28.6	25.4	9.5	12.7	13.0	12.2	15.4	20.7
Total OECD [a]	22.9	17.5	17.2	31.7	25.4	23.3	23.6	28.7	25.2	9.5	12.8	13.1	12.3	15.6	21.0

a) Unweighted average.
Source: OECD (1988a).

CHART 1

PROJECTED TRENDS IN THE PERCENTAGE OF THE POPULATION AGED 65 AND OVER

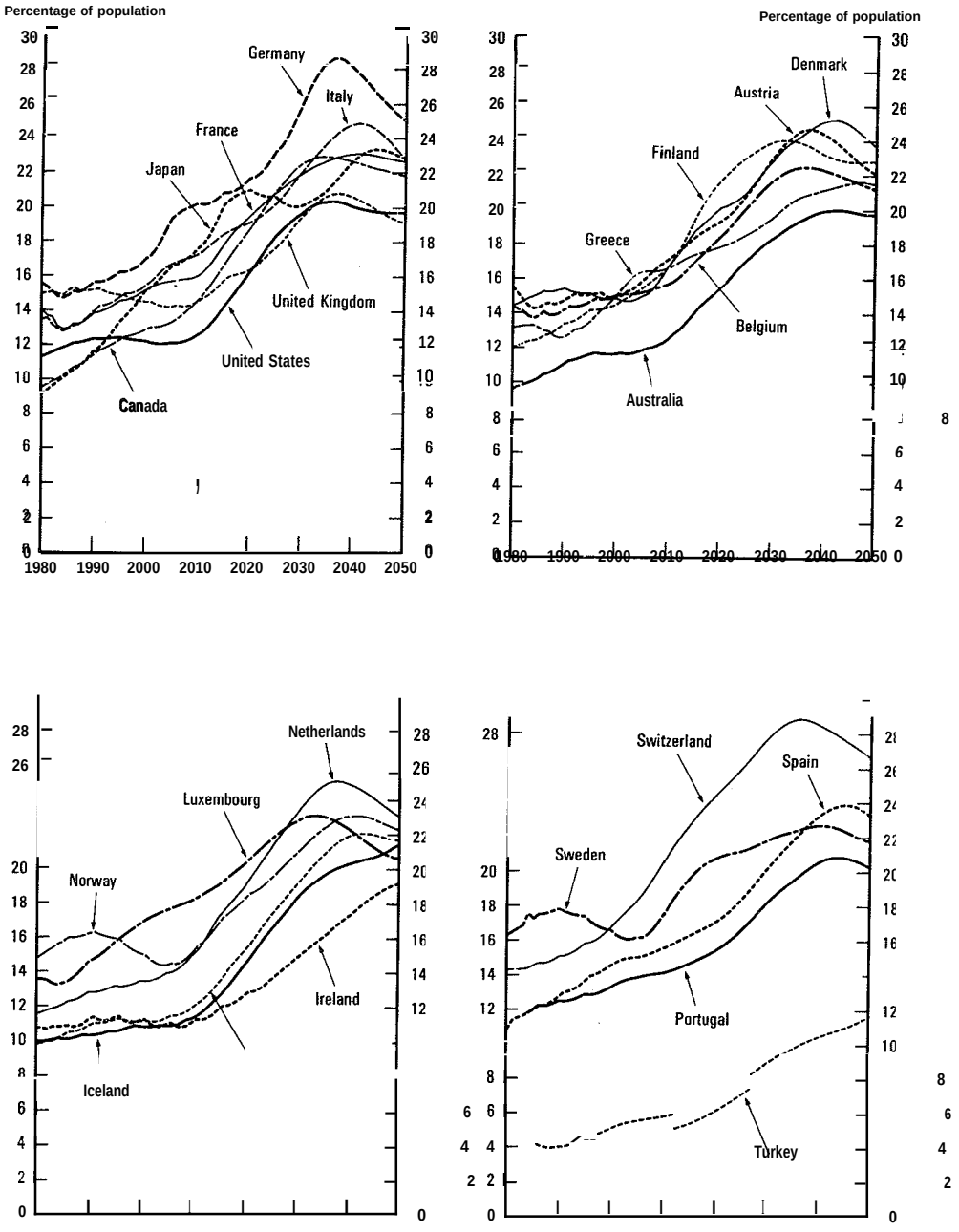

Table 3. Old age dependency ratios in OECD countries : population aged 65 and over as a percentage of population aged 15-64

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 seven	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).

These measures of course provide only a rough indication of the economic impact of population ageing, since they do not take account of the inactivity among 15-64 year olds, nor of the employment of those 65 years of age and older. 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 at higher ages imply that the elderly subgroup is itself ageing. For instance, in 1980, 18 per cent of the total OECD population 65 years and older were over 80 years of age; by 2050 the over-80 subgroup

is projected to account for nearly 31 per cent of the 65 year and older population. Alternatively, if 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[5]. To the extent that these much older persons are likely to be less productive than their younger counterparts, this element of ageing 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. 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 the levels assumed in these projections. Lastly, international migration, heavily influenced by political as well as economic forces, is also very difficult to predict. Considerable uncertainty therefore attaches to any demographic projection. Nevertheless, with the exception of the effect which greater or lesser migration might have on future age distributions, it seems reasonably inevitable that the OECD area as a whole will experience a rise in the old age dependency ratio over the medium term. For instance, even if the total fertility rate is assumed to rise to 2.5 in the long run instead of 2.1 as assumed in the projections, the share of the population 65 years of age and over in the total population in the OECD area as a whole would rise to 19.8 per cent in 2050 compared to 21.2. By 2030, the difference in the elderly share as between the higher and lower fertility assumptions is negligible[6].

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 or immigration from non-OECD countries. This lower growth will in turn be accompanied by widespread ageing of the population, a process that could be furthered by larger increases in life expectancy than are assumed here. 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 developing countries will experience a dramatic shift from "young" to "elderly" dependency, it is worth noting that the median age of the populations of these countries 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 add substantially to the imbalance 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.

II. THE DEMOGRAPHIC TRANSITION AND PUBLIC PENSION FINANCING

Population changes generally proceed at a slow pace, allowing social and economic structures to adjust gradually to the new environment. However, the sudden and steep rise and fall of fertility rates in most industrialised countries constitute in many ways "demographic shocks" whose future repercussions will occur particularly rapidly in some instances, making adaptation difficult. Such difficulties are likely to be especially acute in respect of public sector outlays targeted toward the elderly population. Indeed, because of the relatively heavy dependence of the elderly on publicly provided social expenditures, demographic developments in OECD countries can be expected to put increased pressure on public finances. 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 show that the share of social outlays could 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.

In every country included in these studies, the largest demographically induced increase in social expenditure is for public pensions. This to some degree merely reflects the more general notion that, as a consequence of recent and anticipated low fertility rates, economies will have to devote an increasing share of output to support a relatively larger elderly dependent population. However, given the expanded role of the state in providing retirement income, governments have a direct influence on the relative shares of the working and retired populations, shares which, as discussed below, are in any event not invariant to the demographic environment. On the assumption that governments will in general continue in the future to play an important role in providing old age income[7], changes are likely to be warranted in order to make the financing of public pensions more consistent with demographic developments. This section examines the effect of demographic changes on the distribution of output between workers and the retired, and illustrates quantitatively the impact which ageing may have on social security contribution rates required to provide future pensions. The motives for, and effects of, selected policy responses are also discussed.

A. Alternative financing schemes

There are fundamentally two ways of financing a public pension scheme : pay-as-you-go financing (PAYG) and advance (or full) funding. In a 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 offer 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, as Aaron **(1966)** has shown, the pay-as-you-go scheme can potentially provide a higher rate of return to each generation if the sum of the growth rates of the labour force and wages exceeds the market rate of interest.

A 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 from which pensions are to be paid; it merely transfers purchasing power from one group (workers) to another (retired). Second, 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[8]. Even in a stable demographic environment, the PAYG scheme may imply a constant stock of government unfunded liabilities because the present value of future pension obligations always exceeds the present value of future revenues from ***living*** generations[9]. Under the assumptions that individuals are forward-looking with perfect foresight and are not liquidity constrained, and that private intergenerational transfers do not exist, these unfunded liabilities of the government (which are "hidden" in the sense of being unaccounted for in government book-keeping) can have the same kind of crowding-out effects as the accumulation of government debt resulting from deficits as defined on a national accounts basis[10]. Third, 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, these could result in large aggregate welfare losses since the latter rise more than proportionately with increases in tax rates. Finally, 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[11].

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[12]. 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, contributions to fully funded schemes are less likely to be regarded as taxes, thereby avoiding the distortionary consequences of a PAYG scheme.

Advance funding also has some notable disadvantages. First, since benefits are paid from accumulated contributions to the fund and its 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[13]. 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. 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.

5. The effects of demographic shocks

Large demographic shocks, such as the substantial and rapid ageing of the population, can have a significant impact on the rates of return provided by either of these schemes in a closed economy, 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 their contribution rates must of necessity be increased to maintain the same ratio of retirement benefits to current wages. Under advance funding, these consequences fall primarily on future retirees since the depletion of the capital accumulated in earlier periods puts downward pressure on future asset prices for a while, depressing rates of return, thus lowering the future retirement benefits expected by current contributors. If future population growth rates are negative, the imbalance between the supply of and demand for assets will further reduce rates of return in a fully-funded system.

Most **OECD** countries have chosen to finance public pensions 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 discussed by Keyfitz (1985), who provides some illustrations of the sensitivity to demographic changes of rates of return on social security contributions under PAYG financing. 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, Table **4** shows that with fertility rates maintained at their 1979 level (column headed by 1.0) the rate of return

Table 4. Percentage rate of return on social securii pension contributions for successive birth cohorts, for five levels of fertility – United States population data, fixed pension

Birth cohort	Fraction of 1979 birth rates				
	0.5	0.75	1.0	1.25	1.5
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
2005-2015	– 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).

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 expect 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. Naturally, 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 since these 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. 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 partially or fully into higher benefits[14]. 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. But in this case the relative incomes of retirees and workers changes.

Another major issue raised by the interactions between demographics and PAYG schemes relates to intergenerational equity. To what extent should the burden induced by current period fertility decisions be shifted to future generations? 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, as suggested by Petersen (1988), by a "constitutional rule" which reflects society's equity norm. At a minimum, it would seem that governments 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 *net* rather than *gross* 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 will be substantial by virtue of their relative numbers, 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 pension. Moreover, in some countries (e.g. Germany), contributions made in support of current retirees provide legal entitlement to future benefits, and some governments will be unable to alter benefits except via a long-term phase-in[16].

C. The transition illustrated

To illustrate the implications of population ageing for public pension financing, estimates have been made of the contribution rates required for balancing projected outlays and revenues in Germany, Japan, Sweden, and the United States. 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, as suggested by the projections described in Section I. Second, the four countries provide contrasting social security situations. Germany and (until recently) the United States have operated primarily on a PAYG basis, while Japan and Sweden have accumulated large trust funds. Third, Japan and the United States have both recently made important changes to their programmes.

The starting point in quantifying the effects of demographic trends on public pension financing requirements is the calculation of realistic dependency ratios, namely ratios of potential beneficiaries to potential contributors. This is done by adjusting the demographic old-age dependency ratios for the effects of labour force participation and unemployment. Under the assumption that the elderly *either* participate in the 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:

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

where $s(s = M,F)$ and $a(a = L,L+1,\ldots, 100)$ 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 fifteen years of age.

These dependency ratios, along with purely demographic ones based on the projections discussed in Section I, are shown in Table 5. Projections from national sources are also shown for the United States and Japan[17]. The table highlights the importance of taking into account the effects of labour force participation and unemployment. The "adjusted" dependency ratios are noticeably higher for all countries, although less so for Sweden, reflecting in part the 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 differences are minor and the former are used to quantify the impact of policies aimed at altering the ratio of beneficiaries to contributors.

Using the basic social security budget constraint, the impact of ageing on financing requirements can be determined in a straightfonward manner. The budget identity of the pension system simply states that 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

Table 5. Demographic and "adjusted" dependency ratios

Year	United States			Japan			Germany		Sweden	
	Demo-graphic	Adjusted	Official[a]	Demo-graphic	Adjusted	Official[b]	Demo-graphic	Adjusted	Demo-graphic	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

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 :

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

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:

$$REV(t)\equiv\tau(t)y(t)N^c(t) \quad [b]$$

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:

$$F(t)\equiv\phi(t)y(t)N^c(t) \quad [c]$$

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

$$EXP(t)\equiv b(t)N^b(t) \quad [d]$$

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 over time is the product of wage inflation $(1+\pi)$, of the growth of real taxable wages $(1+g)$ and of the growth of the number of contributors $(1+n)$:

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

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 :

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

and,

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

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[18] :

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

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 rise if the level of the fund is to be increased, 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 value for ϕ and future 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 value for τ 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.

Equations [2] and [3] are used to estimate the impact of ageing on the financial balances of the old-age components of the social security systems in the United States, Japan, Germany and Sweden, incorporating to the extent possible several of the changes made in the recent reform of social security in the first two countries. In the United States, the 1983 legislation provided for 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. While there has been growing concern over the future financing of social security in Germany and, to a lesser extent, in Sweden, no major policy changes have yet been adopted in either country[19]. In Germany, 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, a degree of partial funding has been maintained, with rates still above PAYG levels and a sizeable trust fund accumulated over the past 25 years.

The projections of the funds' assets and surpluses for Japan, Germany and Sweden are obtained assuming that the average contribution rates are kept constant at the initial levels determined by using the latest available values of the funds' assets. For the United States, projections were obtained by setting the average contribution rates (gross of revenues from taxation of benefits) at the legislated levels over the projection period, with the starting level of the fund at its observed level in 1986 of 0.02 as a fraction of taxable income. Other policy and economic assumptions are explained in the Annex.

In Table **6** 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) contribution 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

Table **6. Estimated trust funds given legislated tax rates** [a]
As a per cent of taxable payroll

Year	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	*	*	*		*	*	*	

Year	2038	2013	1991	2018
Rate	16.9	15.4	13.5	20.2

a) An asterisk indicates the fund is depleted.
b) Incorporates phase-in of increase in retirement age.
c) Annual average for the preceding five-year period. Four year average for the first entry.
Source: Authors' estimates.

legislation will lead to a significant growth in the fund, continuing well into the next century, followed by a run-down[20]. 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. 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 shortfalls 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 contribution and benefit levels.

Table *6* also shows 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. Since deficit financing cannot be viewed as a viable alternative to meet shortfalls that could continue indefinitely, and because it is unlikely that governments will be prepared to finance pensions out of general revenue, other policy measures within the existing framework are more probable. Some of these are considered below.

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 that the trust fund per unit of taxable income is maintained at its current level throughout the projection period (with the exception of the United States, as explained below), and that the associated interest income contributes to paying future pensions[21].

Table 7. Projected social security contribution rates required for payment of public pensions

Per cent of taxable payroll

Year	United States (OASI)	Japan (EPI & NPS)	Germany (ARV & ANV)	Sweden (FP & ATP)	
				Unindexed Basbelopp	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 : Angesteliten Versicherung. FP : Folkpension. ATP : Allrnaenna tillaeggspensionen.
Source : Author's estimates.

The results of the projections are shown in Table 7. 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 methodology described above. As can be seen, contribution rates required to balance income and outlays would increase after 2010 in the other three countries, and substantially so 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 (see Annex), 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, 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 popu-

lation 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. 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 need to raise contribution rates or reduce benefits at undesirable times. 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. To avoid the tax-induced distortionary effects of such a policy, however, the linkage between contributions and future benefits should be made explicit. Indeed, as Auerbach and Kotlifoff (1987) have shown, benefit-tax linkages can significantly alter the efficiency effects of social insurance contributions.

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 both their own retirements and those of current retirees. Taking the perspective that demographic shocks are random events which are beyond at least the direct control of governments, this form of burden-sharing could be justified in terms of the general risk-sharing principle on which social insurance is based. Moreover, to the extent that the policy results in higher public saving not offset by reductions in private saving, it could contribute to a decline in real interest rates and an increase in the stock of capital.

This naturally raises important questions about the way in which an increase in public sector ***ex ante*** saving (i.e. the fund accumulation) can best be translated into higher ***ex*** post saving. In most countries (Sweden and Japan being notable exceptions), the excess of current revenue over current expenditure is invested solely in public debt instruments. If such surpluses induce greater public sector consumption, the build-up of a reserve does not lead to an increase in aggregate net saving and, hence, does little to augment the economy's capital stock. Moreover, since these loans are from one sector of government to another, the eventual retirement of the accumulated debt implies that, in the future, non-social security revenues must either be diverted from other uses or be increased (on unchanged pension provisions).

Difficulties could also arise where adoption of a long-term policy of explicit national saving for anticipated increases in pension claims is in conflict with short-run macroeconomic policies aimed at redressing external imbalances. 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 eliminating the imbalances rather than at maintaining the advance funding policy for pensions.

Table 8. **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	3.2	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	5.2	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	7.5	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	9.6	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	11.4	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	13.0	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	14.5	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	15.8	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	16.9	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	17.9	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	18.7	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	19.4	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	20.0	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	20.4	1.4	28.8	1.4	28.7	*	20.0	*	19.5
2055	*	16.9	0.6	16.6	*	21.5	1.3	20.8	0.6	29.6	0.6	29.4	*	19.6	*	19.6
2060	*	17.3	0.0	17.3	*	20.8	0.0	20.9	0.0	30.0	0.0	30.0	*	19.6	*	19.6

a) Legislated rates to 2038; authors' estimates thereafter.
b) Assumes "basbelopp" and ceiling are indexed *to* real wages (see text).
Source : Authors' estimates.

CHART 2

SIMULATED PAY-AS-YOU-GO AND "SMOOTHED" CONTRIBUTION RATES FOR PUBLIC PENSION FINANCING

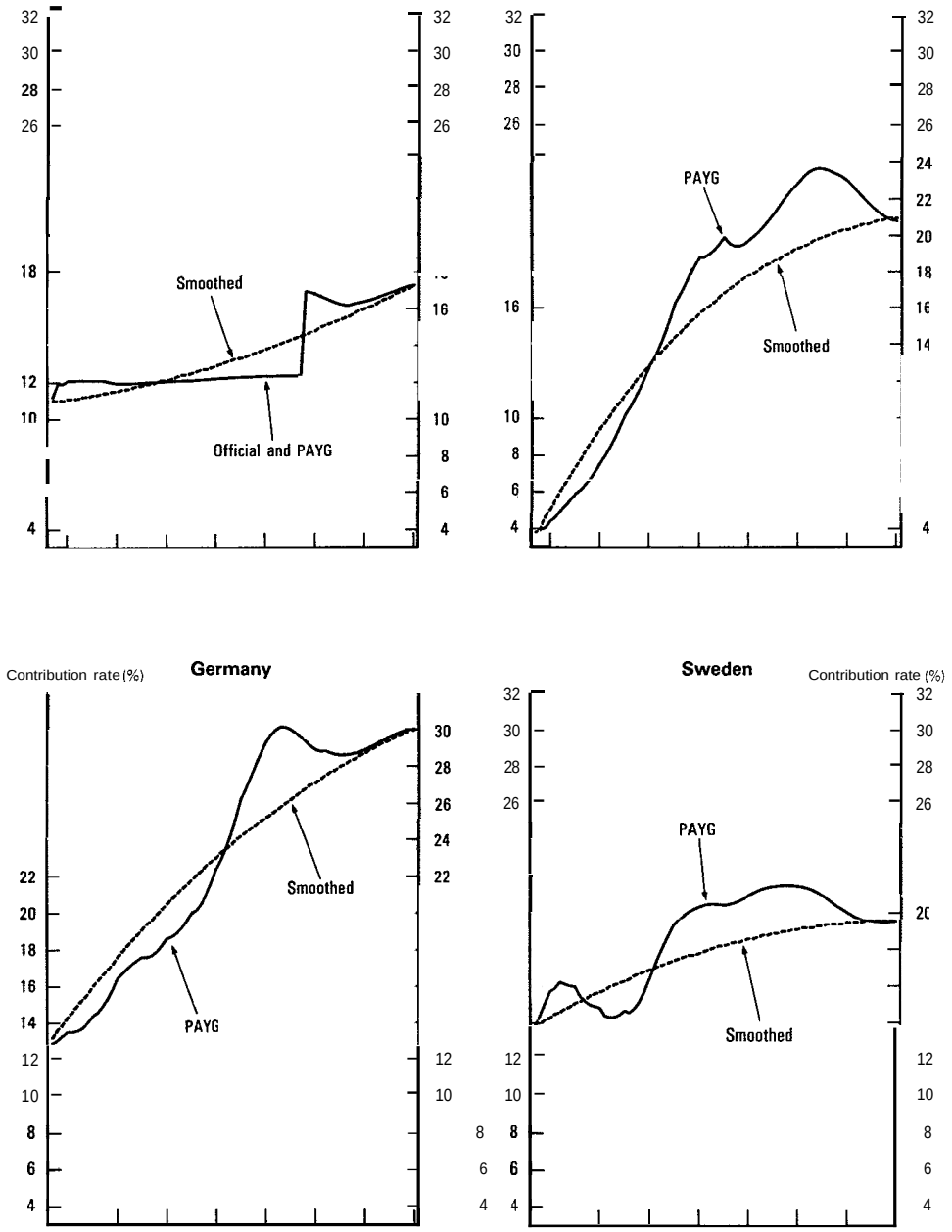

Table 8 and Chart 2 show simulated contribution rates implied by a partial funding policy aimed at smoothing through time the increases in rates required by the social security budget constraint during the demographic transition. The table shows PAYG rates as well as the "smoothed" rate paths resulting from two assumptions; first, 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[22], the exogenous paths of future pension outlays per beneficiary, and the rates of return on the trust fund; and, second, that by 2060 revenues are sufficient to pay for the level of pension outlays per beneficiary implied by the new age distribution of the population[23]. For the United States, Table 8 shows the legislated rates up to the year following which the trust fund is estimated to be depleted. It should be noted that this is a somewhat earlier date than estimated by the Social Security Administration. As can be seen, the pattern differs between countries. In the United States and Sweden, smoothing would permit lower rates in the early and later periods, with an intervening period of rates higher than PAYG requirements. In Germany and Japan, rates would increase in the early period above PAYG requirements, but rates could be significantly lower in the future.

While smoothing could have the advantage of minimising the rate of change in contribution rates which might be required, this approach would still not eliminate the 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 the tax-benefit linkage is not clear for individual contributors, social insurance contributions give rise to similar distortions as other taxes, so that the rate increases simulated above would reduce economic welfare. Instead, governments could consider raising the age at which benefits are paid, or changing benefit formulae 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, and so 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 contribution 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 increasgs, the first of which was chosen based on the year in which the dependency ratio begins to rise rapidly in each country, while the second is arbitrarily set 10 years later, are[24] :

- 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 9. 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 7) to between 19 and 20 per cent. In Germany, the projected tax rates by 2030 would be approximately 3.5 percentage points lower

Year	Japan (EPI & NPS)	Germany (ARV & ANV)	Sweden (FP & ATP)	
			Unindexed Basbelopp	indexed Basbelopp
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	−6.74	−11.64	−6.18	–
2040	−8.03	−8.15	−5.36	–
2050	−5.94	−10.74	−5.48	–
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 : Authors' estimates.

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 nearly 3 percentage points.

c) Reducing benefits

A third policy choice available to governments would be to reduce benefits to future retirees. Naturally, there are a variety of mechanisms by which this could be achieved, such as by reducing the degree of indexing pre-retirement earnings for both productivity growth and price increases, or by lengthening the qualifying period for receipt of full benefits. One approach, proposed by Musgrave (1981), and which has received increased consideration in some countries, particularly in Germany, is to relate pensions to *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

Table 10. Contribution rates with increase in retirement age and switch to net-wage replacement

Year	United States (OASI)	Japan (EPI and NPS)	Germany (ARV and ANV)
		Contribution rate	
1987	*	3.96	12.88
1990	*	4.56	13.42
2000	*	7.41	14.82
2010	*	10.83	15.73
2020	*	14.63	18.09
2030	15.95	15.20	22.63
2040	15.83	16.94	23.17
2050	15.52	17.62	22.59
		Difference from PAYG[a]	
1987	*	0.11	0.00
1990	*	0.10	–0.09
2000	*	–0.24	–1.61
2010	*	–2.10	–2.87
2020	*	–4.19	–4.30
2030	–0.96	–4.57	–6.60
2040	–0.94	–5.97	–5.72
2050	–0.86	–5.33	–6.29

taxes) and pensioners (whose benefits are lower than they otherwise would be if benefits were tied to gross wages). As indicated earlier, the estimated contribution rates assume that pension benefits are set in proportion to gross earnings, that is, including contributions. Hence, on unchanged policies, the full burden of increased dependency ratios is shifted onto future workers, and any restructuring that shifts the burden from workers to future pensioners represents a ***de facto*** "new" intergenerational contract. In the absence of such a policy change, the after-tax income of retirees will tend to rise relative to that of workers.

Table 10 shows the impact on contribution rates in the United States, Japan and Germany[25] of immediate adoption of a net wage replacement policy, together with a phased-in increase in the age of retirement. For Japan and Germany, it is assumed that the fund is kept constant per unit of taxable income. Estimates are not made for Sweden because benefits are already fixed in terms of net earnings[26]. As *is* evident, this policy can have a significant effect on contribution rates. By 2050, rates would be about 5 percentage points lower in Japan than on unchanged policies, and 6 percentage points lower in Germany. In the United States, setting pension benefits in relation to net wages would also reduce the long-run contribution rate required for balance. It is important to note, however, that even under these policies the increase in rates can only be dampened, reflecting the sheer weight of the transition to an older population.

E. Summary

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. The alternative simulations indicate the effects which some policy measures might have in limiting the increase in contribution rates. The analysis shows that while such options as reducing future benefits or increasing the age of retirement may be desirable, the transition to an older population will still increase the cost to each worker of supporting more elderly. This simply reflects the broader consequence of an ageing population, namely 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 still 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[27], or firms relocate where labour compensation costs are comparatively low, or activities are shifted underground. Of course, future contribution rate increases could be limited by broadening the contribution base to include ***all*** wage income in countries such as the United States where the contribution base is limited to wage income below a given ceiling. The contribution base could also be broadened to total value-added, although this might

have adverse effects on capital formation. The possibility of partly supporting social security systems through consumption based-taxes would be still another option.

It should be noted that the analysis has not taken into account the fact that public pensions are not the only source of retirement income for the elderly, and that occupational pensions and personal savings often play an important role in providing old-age support[28]. Governments may in fact choose to increase reliance on such sources of retirement income in the future. 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.

The analysis has also been partial in that no attention has been focused up to this point on some of the broader economic consequences of ageing. Some of these may be favourable to aggregate economic well-being and thus beneficial to both workers and retirees in the future. Others may aggravate the dependency burden beyond that implied solely by demographic developments. The final section reviews some of these aspects of ageing.

III. ECONOMIC DIMENSIONS OF AGEING

A. Labour market effects

One of the most obvious channels through which population ageing will affect industrialised economies is via significant alterations to 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. in particular, the consequences of labour force developments on "economic" dependency ratios depend on the interaction of ageing and two socioeconomic tendencies observed in many countries over the past several decades. These are the decreasing rates of labour force participation among male workers, particularly those in the final years of pre-retirement, and the increasing labour force participation of women of all pre-retirement ages.

Table **11** 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 have historically had comparatively high rates of participation, the decline has been non-negligible. In other countries it has been greater, although less so in Finland. **Also** noticeable in all countries except Japan has been the significant drop in labour force participation rates of men aged 55 to 64. These have declined from between **71** and **91** per cent

Table 11. **labour force participation rates by age and sex**

Country	Males				Females			
	15-24	25-54	55-64	65 and over	15-24	25-54	55-64	65 and over
Australia								
1970	76.5	97.2	85.1	22.1	59.7	43.4	23.3	3.7
1985	73.7	93.5	60.4	8.9	65.0	57.2	19.3	2.0
Canada								
1970	61.8	96.2	84.2	22.6	46.3	39.8	29.8	5.0
1985	70.1	93.8	70.2	12.3	64.6	68.2	33.8	4.2
Finland								
1970	58.0	93.4	71.1	19.0	51.5	70.2	46.3	4.4
1985	62.6	93.5	57.8	10.6	54.9	86.7	52.9	4.8
France								
1970	60.3	96.0	75.4	19.5	47.2	50.1	40.0	8.6
1985	49.0	95.9	50.1	5.3	40.3	68.9	31.0	2.2
Germany								
1970	75.4	97.1	80.1	17.2	65.0	47.3	28.5	6.1
1985	62.1	91.5	56.2	5.1	54.6	56.7	21.6	2.1
Italy								
1970	52.1	93.9	48.2	12.9	35.5	28.3	10.6	2.6
1985	48.1	92.1	38.2	8.9	40.7	43.8	10.5	2.1
Japan								
1970	57.7	97.3	86.6	49.4	53.4	55.1	44.4	17.9
1985	42.6	96.7	83.0	37.0	43.2	60.3	45.3	15.5
Netherlands								
1970	64.8	96.4	80.8	11.4	53.0	23.1	14.9	2.3
1985	50.5	91.7	46.9	3.4	49.1	44.3	12.3	0.6
Spain								
1970	70.6	96.5	84.2	25.9	47.7	25.1	22.0	7.7
1985	64.5	94.1	66.3	5.9	43.9	35.2	19.9	2.1
Sweden								
1970	67.0	94.8	85.4	28.9	59.4	64.2	44.5	8.7
1985	65.7	95.2	75.9	11.0	66.4	88.9	59.9	3.2
United Kingdom								
1970	80.8	97.9	91.2	20.1	60.6	53.1	39.2	6.4
1985	79.8	93.7	68.2	8.2	69.4	66.9	34.7	3.0
United States								
1970	71.8	94.8	80.7	25.1	50.7	49.7	42.2	9.0
1985	73.3	93.1	67.3	15.2	63.7	69.5	41.7	6.8

Source : Labour Force Statistics, OECD.

to a range (for the countries shown) of 50 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, a choice which in some countries has been reinforced by govern-

ment policies and private sector early retirement incentives. However, such inducements are likely to have accounted only partly for the fairly large declines in most countries.

Rates among men aged 24 to 54 were more stable, although they declined slightly in several countries, notably in Germany and the Netherlands. Finally, there is a clear trend to a decline in the participation rate of 15-24 year olds in most countries over the period, although the United States and Canada are exceptions here. Thus, there has been a general trend toward declining participation in the labour market among men, a tendency which aggravates the demographically-induced rise in the dependency rate. On the other hand, the labour force participation rates of women have been generally rising throughout the QECD area during the past several decades, which of course operates to offset, at least at the beginning, some of the rise in dependency. 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, and a large part of the increase in female participation is in part-time work; if labour force participation rates were adjusted to a full-time basis, the increase would obviously be smaller. Among women aged 55 to ***64,*** labour force participation rates have generally declined, with Sweden and Finland the main exceptions. As in the case of men, women 65 years and over have also substantially reduced their participation rates in all countries except Finland.

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. As noted in OECD (1988b), there has been a general decrease in the average age of retirement in many OECD countries, 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 ones as well, induce early retirement via strong disincentives to remain employed. These arise in many ways, such as through tying of pension benefits to complete withdrawal from the labour force, the high implicit marginal rates of taxation of earned income beyond certain ages, and explicit government efforts to motivate early retirement in the interest of increasing the employment opportunities of younger persons[29].

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 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 policy-makers 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 associated with job changes. Job retraining programmes could also become important elements in maintaining the dynamism of the labour market in an ageing population.

On the other hand, 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 to higher real wages, the latter due both to cohort size effects (OECB, 1986) and to capital-deepening investment (Auerbach and Kotlikoff, 1987). The extent to which the 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.

B. 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 if the rate of population growth were higher[30]? Since greater output enables both consumption and leisure 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 some uncertainty attached to both **of** these issues (Ermisch and Joshi, 1987).

In standard neoclassical models of optimal economic growth, reduced population growth is associated with capital-deepening and, other things being equal, an older population should on this count have higher per capita income than a younger one. 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, thereby, per capita income.

Whether or not slower population growth is beneficial or harmful to ***per capita*** income growth is generally uncertain. 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. Since the latter is typically taken as exogenous to population growth, a cessation of labour force growth would have no direct adverse effect on income growth[31]. The extent to which technological progress is independent of population and 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 by ageing. 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, as Kindelberger (1967) has suggested, if capital-deepening investments are riskier than capital-widening ones (i.e. more of the same is easier), total investment may be greatly discouraged by increased riskiness, particularly in conjunction with a lower rate of profitability[32].

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 level and growth rate 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 and, in principle, should not be adverse to its growth rate (Serow and Espenshade, 1978; Clark, Kreps, and Spengler, 1978; Richter, 1988). However, ambiguity arises as a result of the general failure of most analysts to consider the possibly important link between population growth and technological progress, or to take account of economic and social regulations or tax policies and other institutional arrangements.

C. 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 at least 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 age itself 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 demographic factors 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 services, while food, most services, and, particularly, medical care would increase. It is important to note, however, that since 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, so that a more slowly growing population leads to remarkably similar consumption patterns.

Changes in the age distribution of the population could also 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[33]. 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., Kotlikoff, **1988;** and Jenkins, **1988)** that the elderly do not dissave, at least not to the extent suggested by the pure life-cycle model.

Recent partial equilibrium simulation analyses by Heller **(1989)** of the potential effects of demographic changes on future private saving rates in the major seven OECD economies suggest that the increase in the share of elderly in these countries could reduce private savings by between **5** and **12** per cent of GNP for the group taken as a whole over the period **1980** to **2025.** The potentially largest declines over the period as a whole could occur in Canada, France, and the United States, The results also suggest that private saving rates could rise for a while in some countries, particularly in the United States and Canada. By the end of the simulation period **(2010-2025),** however, private savings rates would be declining in all countries. Similar results are obtained from general equilibrium simulation analyses such as in Auerbach and Kotlikoff **(1987)** and Auerbach ***et al.*** **(1989)** in another article in this volume. Given the fact that the demographic transitions among OECD countries are projected to occur at somewhat different paces and to different degrees, capital would flow from countries with excess saving (i.e. over domestic investment requirements) to those with high capital demands and, hence, countries' current account balances would be affected.

CONCLUSIONS

While the very low levels of fertility observed in a majority of OECD countries are unlikely to be sustained over the long term, birth rates are generally expected to return only gradually to replacement or near replacement levels. 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 policy-makers, in particular with respect to public pension financing.

Demographic-economic interactions are extremely complex, and there are many unanswered questions about 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 generally coincided with long-run improvements in standards 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 economic well-being. Nevertheless, some lessons arise from the analysis presented above :

a) 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, it would be preferable to adopt early changes to public retirement schemes so that they may be phased-in gradually. Increasing the age of initial receipt of full pension, as has been adopted in the United States and is under discussion in the other three countries studied in this paper, could substantially reduce the required tax increases in many countries. Also, benefit reductions, such as would result from a move toward making pensions a constant proportion of *net* rather than ***gross*** wages, would spread the impacts of changes in fertility more equitably between generations while also limiting contribution rate increases.

b) 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.

c) The period of transition to an older population, during which the age distribution will be changing considerably, is likely to be associated with demographically-induced changes in national saving rates. On the basis of a life-cycle model of consumption behaviour, and making the somewhat heroic assumption that all other things will be the same, it can be expected

that the private saving rate for most OECD countries will decline over the very long run.

d) Considering the effects of age distribution alone, an older population would most probably be a more productive one. Taking other factors into account such as lower labour force mobility, possibly slower technological progress, and higher transfer burdens, the effect of ageing on productivity can not be predicted with certainty.

NOTES

1. The suddenness and length of the decline in population growth rates in industrialised countries have attracted considerable attention recently (Steinmann, 1984, and Davis et *al.*, 1986).
2. Projections were also made under low and high fertility assumptions, and with longer life expectancy.
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. Bourgeois-Pichat (1987) has noted that completed cohort fertility rates have, in some countries, declined by more than the total fertility rate.
4. 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 (OECD, 1988a).
5. OECD (1988a), Table 8.
6. OECD (1988a), Table 4.
7. 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).
8. 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-cycle savers. 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 (Atkinson, 1987, and Munnell, 1987). However, the uncertainty of the empirical evidence attaches most, but not solely, to the United States. Feldstein's research (1974) 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 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, for Sweden; Shibuya, 1987, for Japan; and Brugiavini, 1987, for Italy).

9. The size and 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.

10. Using a method described in Hagemann and Nicoletti (1989), a portion of the unfunded public pension obligation in the United States, Japan, Germany, and Sweden is estimated as of 1985 to be, respectively, $ 7 billion (158 per cent of GNP), Yen 749 billion (217 per cent of GNP), DM 7 billion (355 per cent of GDP), and Kr 1.8 billion (183 per cent of GDP).

11. Actuarial fairness is not confined 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. In the initial stages of a new PAYG scheme, actuarial fairness is not achievable, however, as some beneficiaries inevitably receive more than they contribute (in present value terms).

12. 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.

13. 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, or not at all, due to the immaturity of the programme.

14. The degree to which productivity increases feed through to pensions, and with what lags, depends upon the way in which past earnings are indexed in determining initial pension benefits. For a discussion of this and an international comparison (OECD, 1988b).

15. 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 41 per cent of the voters in Germany, and between 33 and 38 per cent in the other major seven countries in 2010.

16. 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."

17. For the United States, the "official" projected dependency rates are taken from United States (1988), while for Japan they are obtained from Japan (1985).

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

19. For Germany, see Zur langfristigen *Entwicklung* der *gesetzlichen* Rentenversicherung (June 1987), while for Sweden, see ATP och dess finansiering *i* det rnedel-och *langsiktiga* perspektivet, 1987.

20. 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 authors' 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). Even though the methodology here takes account only of OASI benefits, the estimate of 16.8 in 2038 is quite similar in both analyses, in spite of the divergence of the dates of fund exhaustion.

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

22. These "smoothed" contribution rates are obtained by constrained minimisation of the government's objective function using a non-linear numerical optimisation programme known as GAMS/MINOS (Manne, 1986).

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

24. 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.

25. Since the initial simulations for the United States (i.e. in Tables 6 and **7)** incorporate the legislated rise in retirement age, the changes shown in Table 10 reflect the net impact of the switch to net wage replacement for this country. Given the accumulation of reserves which is anticipated, only the post fund-depletion rates are affected.

26. 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.

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

28. See Schmahl (1987), Palmer (1987), Japan **(1985)** and Andrews **(1985).**

29. See ***Reforming Public Pensions,*** OECD (1988b).

30. 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.

31. See, for instance, Coale and Hoover (1958), and Pitchford **(1974).**

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

33. 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.

Annex

POLICY AND ECONOMIC ASSUMPTIONS UNDERLYING SIMULATIONS OF FINANCING REQUIREMENT FOR PUBLIC PENSIONS

Policy assumptions include the fraction of outlays financed by general revenues (*S*) and the average replacement rate (β). The fraction financed by general revenues was assumed to be constant over the projection period at its latest available historical value in the case of the Japan (0.2) and Sweden (0.15), although in the latter case the subsidy is applied only to the Folkpension. 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. This fraction, currently comparatively lower than in other countries, is assumed to converge to the OECD average in the long run. 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, while 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. Thus, 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.

In the following four tables are shown the economic assumptions used in the simulations of contribution rates and social security trust funds reported in Section II.

Table A1. **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 (%)	(π)	← 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-π 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-π 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+π) 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	← 6.0 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 A2. **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 (%)	(π)	← 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 itn →													
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+π →													
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+π) →													
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 A1.

Table A3. Economic assumptions : Germany

Variable	Svmbol	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2060
Rateofwageinflation (%)	(π)	← historical →			1.7	1.6	1.6	1.5	1.4	4	← 1.3 thereafter →							
Average nominal rate of return on fund's assets (%)	(I)	4 historical ▶	4	← calculated as it x →														
Average real rate of return on fund's assets (%)	(i)	4 historical ▶	4	inter from 87-90 ▶	4	← 2.0 thereafter →												
Nominal interest rate (%)	(R)	← historical →	4	← calculated as r t x →														
Real interest rate (%)	(r)	← historical →	4	interpol. ▶	4	← 2.0 from 1990 to 2060 →												
Rate of nominal wage growth (%)	(G)	← historical →	4	← 4.0 from 1988 to 2060 →														
Rate of real wage growth (%)	(g)	← historical →	4	← calculated as G - n →														
Unemployment rate (%)	(u) [a]	4 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.

Table A4. 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 →					4	← 5.0 thereafter →								
Average nominal rate of return on fund's assets (%)	(I)	◀ historical ▶	←							calculated as itn →								
Average real rate or return or fund's assets (%)	(i)	4 historical ▶	← interpolated from 1987 to 1992 →							← 2.0 thereafter →								
Nominal interest rate (%)	(R)	← historical →	4	← calculated as r+π →														
Real interest rate (%)	(r)	← historical →	4	inter. from 1988 to 1992 ▶	4	← 2.0 thereafter →												
Rate of nominal wage growth (%)	(G)	4 hist. ▶	4	← calculated as (1+g) (1+π) →														
Rate of real wage growth (%)	(g)	4 hist. ▶	4	inter from 1986 to 1989 ▶	1.6	◀ inter. from 1991 to 1994 ▶		1.9	4	inter. from 1995-1999 ▶		1.7	4	see note b ▶				
Unemployment rate (%)	(u) [a]	[see note a]																

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

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