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On the Stability of Pay-As-You-Go Pension Systems in an Ageing Population – The Case of Japan

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Kenichi Hirose

Social Protection Sector

INTERNATIONAL LABOUR OFFICE GENEVA

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Contents

List of tables and figures

Introduction

Pay-as-you-go (PAYG) pension systems[1] are the most prevalent form of financing old-age support in industrialised nations. These systems are characterised by a sequence of income transfers from the current active generation to the current retired generation.

The aim of this paper is to examine the stability of PAYG pension schemes in the context of the anticipated ageing of population structure. We have chosen the Employees' Pension Insurance (EPI) in Japan for our case study because Japan is expected to experience the most rapid population ageing in OECD countries and therefore the effects of demographic changes would appear in the most stark form. In particular, we shall focus on issues of long-term financial sustainability and intergenerational equity. These two issues are closely related as the PAYG financing inevitably entails intergenerational income redistribution.

The remainder of this paper is organised as follows. Chapter 1 sets out the basic analytical framework for evaluating PAYG pension schemes in general. Chapter 2 analyses the long-term financial status of the EPI and looks into intergenerational equity. Chapter 3 concludes with the discussion on policies implied by our analysis. For background information, Appendix A summarises the results of the actuarial valuation carried out by the Japanese Government actuaries in 1999; and, Appendix B presents the updated projection results which take into account the population projection revised in 2002. A Statistical Annex supplements with detailed data.

Throughout the paper, amounts are shown in the Japanese Yen (JPY); recent exchange rates are as follows:

Exchange rates:	JPY 100 = US$ 0.828 = € 0.830	(as of 01.07.2002).

1 Economic assessment of PAYG pensions

1.1 Performance indicators of a pension scheme

Let us consider a defined-benefit pay-as-you-go pension scheme. The financial operations of the fund are described by the following accounting identities:

$$R(t) = C(t) + G(t) + I(t), \tag{1}$$

$$C(t) = \pi(t) \cdot S(t), \tag{2}$$

$$\Delta F(t) = F(t) - F(t-1) = R(t) - E(t), \tag{3}$$

where,
$R(t)$: the total revenue to the fund in year t,
$C(t)$: the total contributions collected during the year t,
$\pi(t)$: the contribution rate in year t,
$S(t)$: the aggregate contributory salaries in year t,
$G(t)$: the state subsidy received in year t,
$I(t)$: the investment income in year t,
$E(t)$: the total expenditure of the scheme in year t,
$F(t)$: the reserve of the fund at the end of year t.

[1] By this term I shall mean "not fully funded schemes". Therefore, it also includes partially funded schemes which retain certain amounts of reserves.

For the description of the long-term transition of the fund's status, we define three performance indicators.

Firstly, the *PAYG cost rate* in year t is defined as $c(t) = E(t) / S(t)$. This is conceived as the contribution rate needed for payment of expenditure in the current year if costs were to be financed solely from the current contributory earnings. The PAYG cost rate is further expressed as a product of two factors: $c(t) = d(t) \cdot \theta(t)$. Here, $d(t)$ is the demographic dependency ratio, defined by the number of pensioners as a percentage of the covered population; and, $\theta(t)$ is the average replacement ratio, defined by the average pension as a percentage of the average contributory earnings.

Secondly, the *funding ratio* in year t is defined as $k(t) = F(t) / E(t)$, which represents the relative level of the reserve as a multiple of annual expenditure. It represents how many years the fund would be able to pay the current level of expenditure by liquidating the reserve (assuming that the reserve were fully liquidable).

Thirdly, the *balance ratio* in year t is defined as $b(t) = [E(t) - C(t) - G(t)] / I(t)$. To clarify the meaning of this indicator, we first note the liquidity of major income available to the fund. While contributions and the state subsidy are equivalent to cash, the liquidity of the investment income generally depends on the types of assets in investment. Further, the reserve can be used to cover the expenditure. Usually, special arrangements are necessary to liquidate the assets in investment. In the case of Japan, most reserves of the EPI are currently placed in the Fiscal Investment and Loan Programme managed by the Trust Fund Bureau in the Treasury. A liquid interest income is guaranteed by the Government. However, as the reserves are almost exclusively invested in long-term projects, the liquidation of principal is considered to be difficult to operate.

The balance ratio characterizes the status of the fund's balance in the following manner. Suppose a newly implemented pension scheme whose expenditure is initially small but gradually increases at a rate faster than the contributions and eventually exceeds them. In Stage I, where there is sufficient cash inflow to cover the expenditure (i.e. the sum of the contributions and the state subsidy exceeds the expenditure), the balance ratio is less than 0. In Stage II, where cash income is no longer sufficient to cover the expenditure but the balance is positive if the investment income is taken into account, the balance ratio takes values between 0 and 1. In this case the value of balance ratio represents the percentage of investment income that needs to be liquidated in order to finance the amount of expenditure in excess of the total cash income. Finally, in Stage III, the total revenue is less than the expenditure and the deficit in the balance should be met by the liquidation of the reserve. In this case, the balance ratio is greater than 1. The following table summarises the relation between the cash flow and reserve in terms of the balance ratio.

Table 1. Balance ratio and the relation between the cash flow and reserve

	Balance ratio	Cash flow	Reserve
Stage I	$b(t) < 0$	positive	increase
	$b(t) = 0$	zero	increase
Stage II	$0 < b(t) < 1$	negative	increase
	$b(t) = 1$	negative	stationary
Stage III	$b(t) > 1$	negative	decrease

Alternatively, the relation between the cash flow and reserve of a pension fund can be described by using the phase diagram[2]. If we denote by r the annual average rate of return on the investment of the reserve (for simplicity, r is assumed to be constant over time), then the investment income is written as

[2] This approach was suggested by Miller and Zhang (1999).

(4) $$I(t) = r \cdot F(t) + r/2 \cdot D(t),$$

where $D(t) = C(t) + G(t) – E(t)$ is the cash inflow to the fund.

Substituting (4) into (3), we obtain the following difference equation describing the evolution of the reserve:

(5) $$\Delta F(t) = (1 + r/2) \cdot D(t) + r \cdot F(t).$$

Then, each point in the upper half domain in the *D-F* plane represents a financial position of the fund[3]. The curve drawn in Figure 1 represents the development path of the pension scheme in the above example. As illustrated in Figure 1, the whole upper plane can be divided into three regions according to the value of the balance ratio. In the above terminology, Stage I corresponds to the north-east quadrant in which both *F* and *D* are positive. Stage II corresponds to the area between the vertical axis and the downward sloping line $L : F = – (1 + r/2)/r \cdot D$. Here, *L* represents a critical line on which the marginal increase in the reserve is zero. Stage III corresponds to the region left to the line *L*.

1.2 Methods of evaluating the financial viability of PAYG pensions

To examine the viability of a defined-benefit pension scheme from the point of view of the financial manager, two conditions should be taken into account. One is the liquidity requirement for the benefit payment. The other is the long-term solvency on a discounted present value basis.

The liquidity constraint means that at each period of time the scheme has to ensure the cash income and liquid asset adequate to cover the next payment due. Projections of the fund operation based on the estimated expenditure and tax base are generally used in order to ascertain this condition.

The liquidity constraint can usually be expressed in terms of the performance indicators. For the purpose of financial planning, we are interested in knowing the minimum contribution rate that attains predetermined target values of performance indicators in a given target year. By solving equation (5) with the given boundary conditions, we obtain the following formulae.

First, the level contribution rate under which the funding ratio attains k_0 in year *T* is given by

(6) $$\pi_1(k_0, T) = \frac{k_0 \dfrac{E_T}{(1+r)^T} + \left(1 + \dfrac{r}{2}\right) \cdot \displaystyle\sum_{j=1}^{T} \frac{E_j - G_j}{(1+r)^j} - F_0}{\left(1 + \dfrac{r}{2}\right) \cdot \displaystyle\sum_{j=1}^{T} \frac{S_j}{(1+r)^j}}.$$

Second, the level contribution rate under which the balance ratio attains b_0 in year *T* is given by

(7) $$\pi_2(b_0, T) = \frac{\left(1 + \dfrac{b_0 r}{2}\right) \dfrac{E_T}{(1+r)^T} + \dfrac{b_0 r}{1+r} \cdot \left[\left(1 + \dfrac{r}{2}\right) \cdot \displaystyle\sum_{j=1}^{T-1} \frac{E_j - G_j}{(1+r)^j} - F_0\right]}{\left(1 + \dfrac{b_0 r}{2}\right) \dfrac{S_T}{(1+r)^T} + \dfrac{b_0 r}{1+r} \cdot \left(1 + \dfrac{r}{2}\right) \cdot \displaystyle\sum_{j=1}^{T-1} \frac{S_j}{(1+r)^j}}.$$

[3] Note that we consider only the case of positive reserves.

Figure 1. Phase diagram for the relation between the cash-inflow and reserve

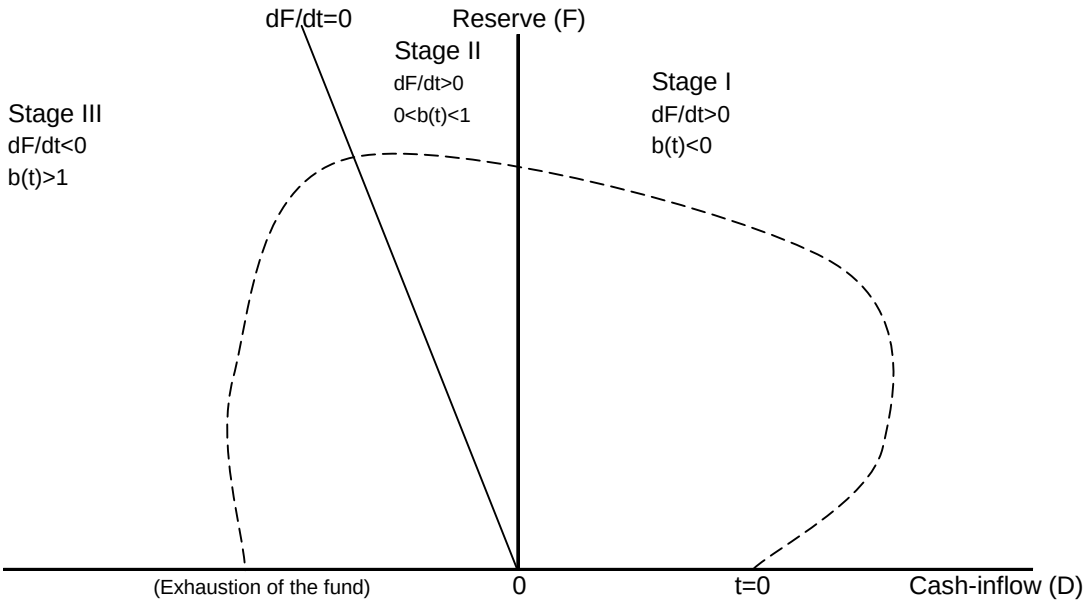
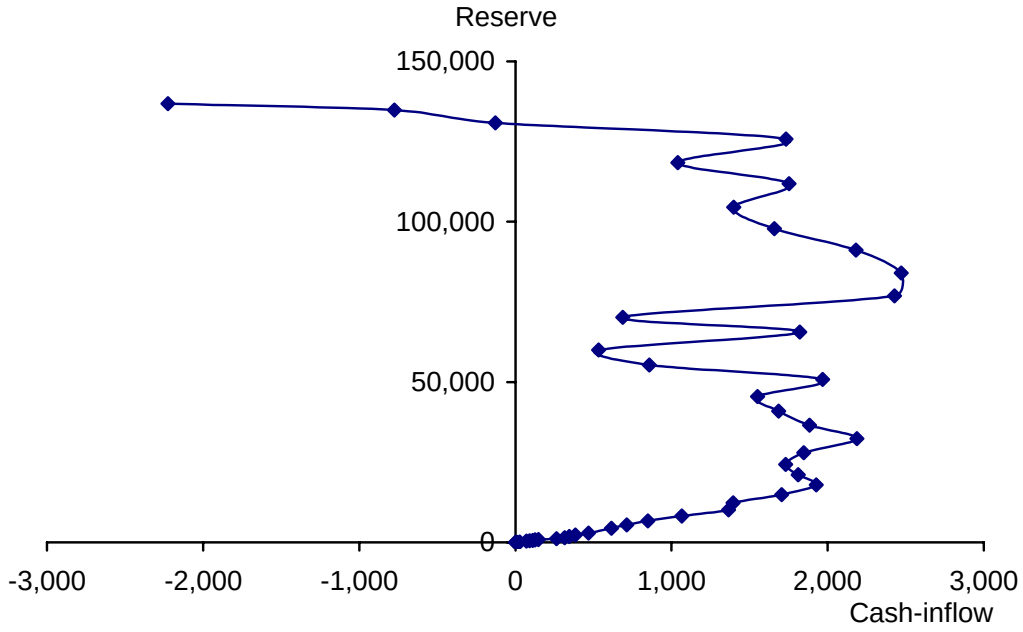


Figure 2. Phase diagram for the EPI fund, 1942-2000



These results give useful information in the determination of the future contribution rates[4].

On the other hand, to test the long-term solvency of a pension fund, a suitable methodological tool is the actuarial balance sheet, which looks as follows:

Table 2. Format of an actuarial balance sheet

Assets		Liabilities	
- Reserves (a-1):	F_0	- Benefits (b):	$\sum_{t=1}^{\infty} E(t)\cdot(1+r)^{-t}$
- Contributions (a-2):	$\sum_{t=1}^{\infty} C(t)\cdot(1+r)^{-t}$		
		- Actuarial balance:	(a-1)+(a-2)–(b)

The actuarial balance sheet compares the sum of the reserves at hands (item a-1) and the expected present value of future contributions (item a-2) against the expected present value of future benefit expenditure (item b). If a negative actuarial balance is detected, it is called the *unfunded pension liability* or the *implicit pension debt*.

It should be noted that there are several methods of evaluating liabilities in respect of the coverage of periods[5]. In our analysis, two methods are used. One is the *accrued-to-date liability* – alternatively called the "scheme termination" liability – which assumes that the scheme pays only *pro rata* pensions corresponding to the past contribution credits. (In the actuarial balance sheet, this liability is compared with the reserves since the future contributions are not considered.) The other is the *open fund liability* – alternatively, the "going-concern" liability – which takes into account not only past service liabilities but also the benefits corresponding to future contribution credits by the currently active workers and the new entrants to the scheme.

In the above approach, the problem of pension financing is viewed as that of a representative social planner (the financial manager) with an infinite time horizon. Although this approximation is sensible in the aggregate level, it is not sufficient when we look into intergenerational redistribution effects of PAYG pension schemes. The generational accounting is the generally used approach for this type of analysis. Whilst the actuarial balance sheet captures the scheme's net surplus or debt in the aggregate, the generational accounting breaks it down into the net pension transfer of each generation. The sum of the generational accounts over all generations, including future new entrants, is thus equivalent to the actuarial balance on the open fund basis.

1.3 Economic effects of population ageing under PAYG pensions

As is apparent from Table 3 below, population ageing is a common trend in industrialised countries[6]. This is generally ascribed to both an increase in life expectancy and a decline in fertility rates. In particular, there is a rapid and substantial rise in the ageing of the Japanese population. Amongst the six countries in the table, Japan had the youngest population in 1970 but is expected to have the oldest by 2010.

[4] For detail, see Hirose (1999). For example, the actuarial level premium is given by $\pi_1(0, \infty)$; and, the minimum contribution rate that avoids the decrease in the reserve is given by $sup\{\pi_2(1, T)\ ;\ T \geq 0\}$.

[5] For the discussion of methodology in detail, reference should be made to Holzmann et al. (2000).

[6] Figures S.1.(a)-(f) in Statistical Annex display the age distribution of the population (the so-called "population pyramid") from 1950 to 2050 for the above six countries.

Table 3. Comparison of the percentage of population aged 65 years and over for selected OECD countries, 1950-2050

(In percent)

	1950	1970	1990	2010*)	2030*)	2050*)
Japan	4.9	7.1	12.1	22.5	29.6	35.7
Germany	9.7	13.7	15.0	20.2	27.7	31.0
Sweden	10.3	13.7	17.8	19.8	27.0	30.4
United Kingdom	10.7	12.9	15.7	17.0	24.3	27.3
France	11.4	12.9	14.0	16.6	23.8	26.7
United States	8.3	9.8	12.4	12.9	20.2	21.1

Source: For Japan, National Institute of Population and Social Security Research (2002).
For other countries, United Nations (2001).
Note *): Estimates.

One of the weaknesses of the PAYG scheme is its sensitivity to demographic changes. Therefore, a concern may arise that the growing costs of social security caused by the population ageing would impede the accumulation of capital and thus reduce the growth of output of the economy.

We begin by investigating the relation between the tax and social security burden and the economic growth rate based on the econometric study by Furukawa et al. (2000). In this study the following 1-factor error-components model was applied to the panel data of 13 OECD countries for the period 1960-1996[7]:

(8) $$y_{it} = \beta \cdot x_{it} + \alpha_i + v_{it}, \quad i : \text{country}, \ t : \text{year}.$$

Here y_{it} denotes the growth of real per capita GDP and x_{it}, the ratio of tax and social security contributions to GDP[8]. The unobservable error terms consist of an individual heterogeneity α_i and a standard Gauss-Markov error v_{it}. The coefficient β has been estimated by the fixed effect estimator and compared with the OLS estimator using the pooled data. Note that the fixed effect estimator is a consistent estimator of β whereas the OLS estimator is generally inconsistent and biased.

From the regression results summarised in Table 4, we can observe a significant negative correlation between the tax and social security burden and the growth rate. In the fixed effect analysis, a better fit of regression and a more negative coefficient are obtained as compared with the pooled data analysis. (The implication of the individual heterogeneity will be discussed in section 3.2 later.) For every percentage increase in the tax and social security contributions in GDP, the growth rate decreases by 0.302 percentage-points. In addition, the results indicate that the tax and social security burden also exhibits negative correlations with capital stock and savings. If the budget deficit is added to the tax and social security contributions, the absolute values of these negative coefficients become smaller. These evidences are in conformity with the above hypothesis and general theoretical predictions.

Next, we critically examine the issue in the optimality of PAYG pensions with respect to fully-funded pensions. While fully-funded pensions are regarded as an intertemporal income allocation mechanism through a capital market, PAYG pensions induce an income transfer between generations. Therefore these two types of pension scheme obviously have different welfare implications. Aaron (1966) asserts that if the sum of the rate of increase in per capita wage and the rate of population

[7] In Atkinson (1999), results of ten econometric studies on the growth rate and social transfers are summarised. However, none of them has used the panel data analysis.

[8] Table S.1 in Statistical Annex shows these indicators for six OECD countries. (Note that figures are shown as a percentage of the National Income.)

Table 4. Effects of tax and social security burden on growth, capital and savings

Explanatory variable (x)	Share of tax and social security burden in the GDP					
Dependent variable (y)	Growth rate of real per capita GDP		Growth rate of capital stock		Household savings rate	
Estimation method	Pooled OLS	F.E.	Pooled OLS	F.E.	Pooled OLS	F.E.
Coefficient (beta)	-0.139	-0.302	-0.129	-0.409	-0.196	-0.186
t-ratio	-14.86 (*)	-17.60 (*)	-7.62 (*)	-14.23 (*)	-9.12 (*)	-6.19 (*)
adjusted R^2	0.409	0.632	0.197	0.734	0.208	0.760
S.E.	1.373	1.083	2.031	1.168	3.195	1.760
D-W statistic	0.20	0.32	0.04	0.14	0.02	0.07
F-ratio	-	17.021 (**)	-	40.098 (**)	-	60.704 (**)

Explanatory variable (x)	Share of tax and social security burden and the budget deficit in the GDP					
Dependent variable (y)	Growth rate of real per capita GDP		Growth rate of capital stock		Household savings rate	
Estimation method	Pooled OLS	F.E.	Pooled OLS	F.E.	Pooled OLS	F.E.
Coefficient (beta)	-0.143	-0.274	-0.137	-0.364	-0.158	-0.056
t-ratio	-16.62 (*)	-20.48 (*)	-8.22 (*)	-15.17 (*)	-7.33 (*)	-2.16 (***)
adjusted R^2	0.464	0.688	0.222	0.750	0.144	0.733
S.E.	1.308	0.998	1.998	1.132	3.321	1.854
D-W statistic	0.20	0.33	0.04	0.10	0.02	0.07
F-ratio	-	19.904 (**)	-	41.923 (**)	-	58.409 (**)

Source. Furukawa et al. (2000)
Notes: 1. For the t-tests, * and *** mean the coefficient is significant at 1% level and 5% level, respectively.
2. The F-test compares pooled data versus fixed effects, and ** means the test is significant at 1% level.

growth is greater than the interest rate, then the PAYG social security is Pareto improving with respect to the fully-funded social security. The argument is summarised as follows.

Consider a steady-state overlapping generations model with two life periods[9]. The following Table 5 illustrates how the budget constraint is calculated under each financing method. Assume that each person born in time t works in the first period with wage w_t then she retires in the second period and receives a pension equal to $p_{t+1} = \theta w_{t+1}$. Here, θ is a fixed benefit rate and w_{t+1} is the wage earned by the next generation. Let N_t denote the population of the generation born in t; and, let n be the rate of population growth, g the rate of wage increase, and r the interest rate.

Table 5. Illustration of resource allocation under fully-funded pension and PAYG pension

(a) Fully-funded pension

Generation \ Year	t	t+1	t+2
N_t	w_t $\Rightarrow$	p_{t+1}	
N_{t+1}		w_{t+1} $\Rightarrow$	p_{t+2}

(b) PAYG pension

Generation \ Year	t	t+1	t+2
N_t	w_t	p_{t+1} $\Uparrow$	
N_{t+1}		w_{t+1}	p_{t+2}

Under the fully-funded scheme, the contribution rate c_F is determined so that the pensions of a generation be equal to the contributions paid earlier by the same generation and the interest earned thereon:

$$c_F \cdot w_t (1+r) N_t = p_{t+1} N_t . \tag{9}$$

On the other hand, under the PAYG scheme, the contribution rate c_P is determined by equating the pensions of a retired generation to the contributions paid by the next generation in the same period. Hence we have

$$c_P \cdot w_{t+1} N_{t+1} = p_{t+1} N_t . \tag{10}$$

From (9) and (10), it follows that

$$c_F / c_P = (1+g)\cdot(1+n) / (1+r) \approx (1+g+n) / (1+r). \tag{11}$$

Hence, approximately, if the inequality $g+n > r$ holds then $c_F > c_P$. Therefore, in this case all generations will be better off because they need to pay a lower contribution rate for the same amount of pension. The reverse conclusion will follow if the converse inequality holds.

Table S.2 in Statistical Annex indicates the data relevant to the Japanese EPI scheme. Generally, the sum of wage increase rate and population growth rate exceeded the rate of return in the 1960s and 1970s but the relation was reverse in the 1980s and 1990s. To interpret these results, however, two remarks are in order.

[9] The above-mentioned result can be generalised to the case with more than two periods and survival probabilities. For detail, see Hirose (1999).

First, in the above analysis n, g and r are assumed to be exogenous. However, if the depressive effect of PAYG social security on the aggregate savings is taken into account[10], the interest rate could be higher under the PAYG scheme than under the fully-funded scheme.

Second, the above analysis concerns steady states only and does not consider the transition dynamics. As the undertaking of full analysis is beyond our scope, we only refer to a study by Merton (1969), which showed that under varying population growth the Golden rule no longer gives the optimal path. This suggests that it would probably be inadequate to simply extend the above results to the situation in which a population is rapidly ageing.

[10] See Aaron (1982) and Feldstein (1974) in the North American context. In Japan, however, no direct empirical evidence has been known so far that supports this theoretical prediction.

2 Evaluation of the long-term viability of the Japanese PAYG pension scheme

2.1 Overview of the development of the EPI scheme

Since its creation in 1942, the EPI scheme has been playing a key role in providing income protection for Japanese workers and their families. As of end-March 2001, the scheme covered 32 million private sector workers in 1.7 million establishments and collected contributions equal to 17.35 percent of payrolls which were shared equally by workers and employers. The total number of pensioners stood at 19.5 million, or 60.7 percent of the covered population. The average old-age pension represented around 55 percent of the average wage of the active workers.

For background information, we shall briefly summarise the historical development of the contribution rate setting and benefit provision, as well as the resulting financial status of the EPI fund[11].

Table 6 summarises the historical change in the setting of the EPI contribution rates. It is seen that the scheme initially collected contributions on the basis of the actuarial premium. In other words, the scheme was intended to be fully funded at the outset. (It should be noted that the scheme was implemented during the World War II. It is reported that the introduction of the social security programme was proposed as a national strategy to accelerate the capital formation.) During the post-war hyperinflation period, the scheme adopted temporarily low contribution rates. In 1954, a complete revision of the EPI Act was made, which restructured the benefit into a multi-pillar system (the wage-related pension and the flat-rate pension). On the financing side, in order to avoid the devaluation of reserves due to inflation, the contribution rate was set at a level lower than the actuarial premium and was planned to be gradually increased to the equilibrium level in conjunction with the actuarial review which would have to be conducted at least every five years.

As the scheme expanded its coverage during the 1960s and 1970s, benefits were increased successively. Particular mention should be made to the year 1973, in which the indexation of benefits (in line with an increase in per capita gross wage) was introduced. The intention was to compensate the loss of real value of pensions due to inflation caused by the oil price shock crises. At the same time, the determination of future contribution rates was to be made based on the actuarial projections taking into account the future demographic and economic changes.

Since the early 1980s until present, a series of reforms have been implemented. Apart from the increase in the contribution rates, the main adjustments to the benefit provision include the following:

- Gradual reduction of benefit accrual rate by 25 percent (1985)[12].
- Gradual increase in the pension age from 60 years to 65 years (1994 for the wage-related pension; 1999 for the flat-rate pension).
- Modification of the method of benefit indexation (1994 from gross wage increase to net wage increase; 1999 from net wage increase to increase in the consumer price).

[11] Detailed statistics of the EPI scheme are found in Tables S.3-S.5 in Statistical Annex. For more complete information in English, refer to Social Insurance Agency (2000).

[12] The year in parentheses indicates the year in which the amendment law passed in Parliament.

Table 6. Determination of contribution rates of the EPI, 1942 to present

Time of change in contribution rates	Contribution rates			Actuarial premia			Ultimate contribution		Financing method
	Males	Females	Miners	Males	Females	Miners	Rate	Year	
	%	%	%	%	%	%	%		
1942 (June)	6.4	-	8.0	6.4	-	8.0	-	-	Level premium method
1944 (October)	11.0	11.0	15.0	11.0	11.0	15.0	-	-	Level premium method
1947 (September)	9.4	6.8	12.6	9.4	6.8	12.6	-	-	Level premium method
1948 (August)	3.0	3.0	3.5	9.4	5.5	12.3	-	-	Level premium method
1954 (May)	3.0	3.0	3.5	5.0	3.6	6.0	-	-	Scaled premium method
1960 (May)	3.5	3.0	4.2	4.4	3.1	5.2	-	-	Scaled premium method
1965 (May)	5.5	3.9	6.7	6.9	5.3	15.8	-	-	Scaled premium method
1969 (November)	6.2	4.6	7.4	8.5	6.4	20.4	-	-	Scaled premium method
1973 (April)	7.6	5.8	8.8	10.5	13.9	46.9	19.6	2010	Scaled premium method based on projections
1976 (August)	9.1	7.3	10.3	13.9	20.0	61.5	20.7	2010	Scaled premium method based on projections
1980 (October)	10.6	8.9	11.8	19.1	26.4	65.6	35.4	2021	Scaled premium method based on projections
1985 (October)	12.4	11.3	13.6	-	-	-	28.9	2021	Scaled premium method based on projections
1990 (January)	14.3	13.8	16.1	-	-	-	31.5	2020	Scaled premium method based on projections
1994 (November)	16.5	16.5	18.3	-	-	-	29.8	2024	Scaled premium method based on projections
1996 (October)	17.35	17.35	19.15	-	-	-	-	-	-
2000 (March) - to present	17.35	17.35	19.15	-	-	-	27.8	2025	Scaled premium method based on projections

Source. Ministry of Health, Labour and Welfare, Japan.

Table 7 presents the performance indicators and Figure 2 (page 4) depicts the phase diagram for the EPI[13]. As noted earlier, the overall increase in the PAYG cost rate is ascribed to the increase in the demographic dependency ratio and the average replacement ratio. For the EPI, as shown in Table 7, the average replacement ratio nearly doubled with the introduction of the benefit indexation in 1973, after which it has increased modestly. On the other hand, the demographic dependency ratio has increased continuously; it has been doubled for the last 15 years. As a combined effect of these two factors, the PAYG cost rate has shown a steady and substantial increase since the mid-1970s. Attention should be paid to the fact that the balance ratio has turned positive since 1998. In other words, the EPI has entered into Stage II as defined earlier. The funding ratio has been in the decreasing trend; however, the fund still retains the reserve equivalent to 5.2 times the annual expenditure.

In summary, although the EPI started with full funding, its funding level has *de facto* declined over the years and eventually its financing has turned out to be pay-as-you-go.

2.2 Projection of the fund operations

As the base data of our analysis, we shall use the results of the 1999 actuarial valuation of the EPI fund, carried out by the Ministry of Health, Labour and Welfare of Japan[14]. Concerning the demographic assumptions, the valuation is based on the population forecast by the National Institute of Population and Social Security Research carried out in 1997. The underlying macroeconomic assumptions are as follows:

Rate of return on investment:	4.0 percent per annum,
Rate of increase in per capita wage:	2.5 percent per annum,
Rate of inflation as measured by Consumer Price Index:	1.5 percent per annum.

In the 1999 actuarial valuation of the EPI fund, the future contribution rate was determined by the following conditions:

1. The contribution rate is raised every five years at a constant rate until a certain target year.
2. From the target year, an actuarial level premium, called the ultimate rate, is applied. The target year is chosen so that the ultimate rate is contained within 20 percent of gross earnings.
3. The scheme secures liquid income sufficient to meet the benefit payment in each year.
4. A certain amount of contingency reserve is retained for unanticipated shocks.

Figure 3 compares the resulting contribution rates with the estimated PAYG cost rates for the period 2000-2060 (See also Figure A.1 in Appendix A). Assuming the current benefit provision, the current contribution rate of 17.35 percent should be increased by 2.5 percentage-points every five years until it reaches the ultimate rate of 27.8 percent in 2025 and after. Consequently, the contribution rate should be increased by more than 10 percentage-points. Table 8 shows the projected financial operations of the EPI fund under this contribution schedule, as well as the relevant performance indicators.

The PAYG cost rate shows a rapid increase from 2010 to 2015, when the post-war baby boomers (cohorts born in 1946-1948) are expected to retire. It attains its peak around 2050, by which time the second baby boomers (born in 1971-1975) will retire. As the balance ratio is positive for the

[13] The fluctuation of the curve in Figure 2 is mainly due to delays in payment of the Government subsidy.

[14] For our analysis, we shall take the results of projection under the Reform Bill with the Government subsidy being kept at the current level (Case 1). For detail, see Appendices A and B.

Table 7. Performance indicators of the EPI, 1942-2000

Fiscal Year	Contribution rate	PAYG cost rate	Demographic dependency ratio	Average replacement ratio	Balance ratio	Funding ratio
1942	6.4%	0.0%	-	-	-	-
1945	11.0%	2.1%	0.0%	-	-	9.00
1950	3.0%	0.4%	1.0%	-	-9.08	13.94
1955	3.0%	0.7%	2.2%	29.7%	-4.18	14.37
1960	3.5%	0.7%	2.7%	27.7%	-3.14	27.14
1965	5.5%	0.6%	3.2%	26.3%	-3.37	25.69
1970	6.2%	1.1%	5.4%	26.2%	-2.47	26.44
1971	6.2%	1.1%	6.2%	25.1%	-2.31	27.65
1972	6.2%	1.2%	7.0%	23.2%	-2.23	27.45
1973	7.6%	1.4%	7.7%	43.0%	-2.32	23.38
1974	7.6%	2.2%	8.9%	40.6%	-2.33	14.28
1975	7.6%	2.8%	10.2%	45.7%	-1.86	12.67
1976	9.1%	3.4%	12.0%	48.4%	-1.85	10.73
1977	9.1%	4.2%	14.3%	47.7%	-1.70	9.58
1978	9.1%	4.8%	15.9%	50.7%	-1.37	9.13
1979	9.1%	5.2%	17.4%	50.2%	-1.15	8.99
1980	9.1%	5.9%	18.8%	53.7%	-1.04	8.21
1981	10.6%	6.6%	20.3%	55.0%	-1.04	7.88
1982	10.6%	7.2%	21.9%	55.0%	-0.78	7.83
1983	10.6%	7.7%	23.6%	53.6%	-0.63	7.86
1984	10.6%	8.1%	25.2%	53.2%	-0.52	7.90
1985	12.4%	8.5%	27.1%	52.7%	-0.59	7.86
1986	12.4%	12.2%	29.6%	54.0%	-0.24	5.92
1987	12.4%	12.5%	31.2%	52.2%	-0.14	5.98
1988	12.4%	12.3%	32.3%	53.2%	-0.48	6.19
1989	12.4%	12.2%	33.2%	52.7%	-0.18	6.10
1990	14.3%	12.6%	33.9%	51.9%	-0.58	6.02
1991	14.3%	13.0%	34.7%	51.5%	-0.53	5.95
1992	14.3%	13.6%	36.3%	52.1%	-0.44	5.92
1993	14.3%	14.3%	38.4%	54.0%	-0.33	5.92
1994	16.5%	15.0%	40.5%	55.5%	-0.27	5.83
1995	16.5%	16.3%	44.0%	55.2%	-0.32	5.65
1996	17.35%	16.9%	46.2%	54.7%	-0.19	5.68
1997	17.35%	17.6%	50.2%	54.3%	-0.31	5.61
1998	17.35%	19.2%	53.6%	55.3%	0.02	5.46
1999	17.35%	20.5%	57.2%	55.9%	0.16	5.36
2000	17.35%	21.3%	60.7%	55.2%	0.52	5.22

Source: Ministry of Health, Labour and Welfare, Japan

Table 8. Projected financial operations of the EPI fund and performance indicators, 2000-2060

Year	Contribution rate	Revenue				Expenditure	Balance	Reserve at the end of the year	Performance indicators		
			Contributions	State subsidy	Investment income				PAYG cost rate	Funding ratio	Balance ratio
	%	trillion JPY	trillion JPY	trillion JPY	trillion JPY	trillion JPY	trillion JPY	trillion JPY	%		
2000	17.35	33.1	22.9	4.0	6.2	28.1	5.0	177.2	21.3	6.3	0.2
2001	17.35	33.9	23.4	4.3	6.2	29.8	4.1	181.3	22.1	6.1	0.3
2002	17.35	35.1	24.4	4.4	6.3	31.5	3.6	184.9	22.4	5.9	0.4
2003	17.35	35.7	24.7	4.6	6.4	33.4	2.3	187.2	23.5	5.6	0.6
2004	19.85	38.2	26.7	4.9	6.6	35.2	3.0	190.2	26.2	5.4	0.5
2005	19.85	41.6	29.5	5.0	7.1	37.1	4.5	194.8	25.0	5.3	0.4
2010	22.35	50.8	36.4	6.3	8.1	47.7	3.1	209.2	29.3	4.4	0.6
2015	24.85	60.7	44.7	7.6	8.4	57.9	2.7	216.3	32.2	3.7	0.7
2020	27.35	71.9	54.4	8.5	9.0	65.0	6.9	234.2	32.7	3.6	0.2
2025	27.80	80.6	60.9	9.1	10.6	71.2	9.5	275.1	32.5	3.9	0.1
2030	27.80	88.7	66.1	10.0	12.6	78.5	10.2	327.1	33.0	4.2	0.2
2040	27.80	103.6	75.2	12.9	15.5	101.7	1.9	396.9	37.6	3.9	0.9
2050	27.80	118.6	87.7	15.8	15.1	121.8	-3.2	383.7	38.6	3.2	1.2
2060	27.80	137.8	105.3	17.6	14.9	134.9	3.0	382.3	35.6	2.8	0.8

Source. Ministry of Health, Labour and Welfare, Japan. (2000)

Figure 3. Comparison of the future contribution rates and PAYG cost rates of the EPI, 2000-2060

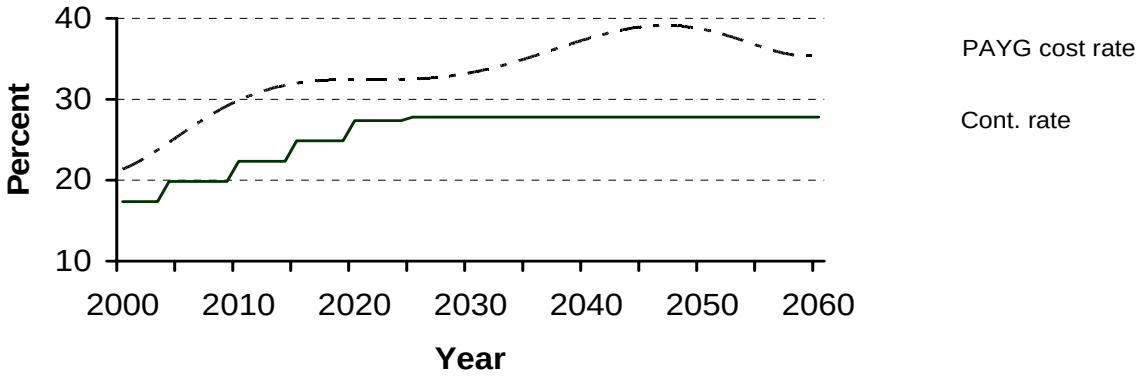
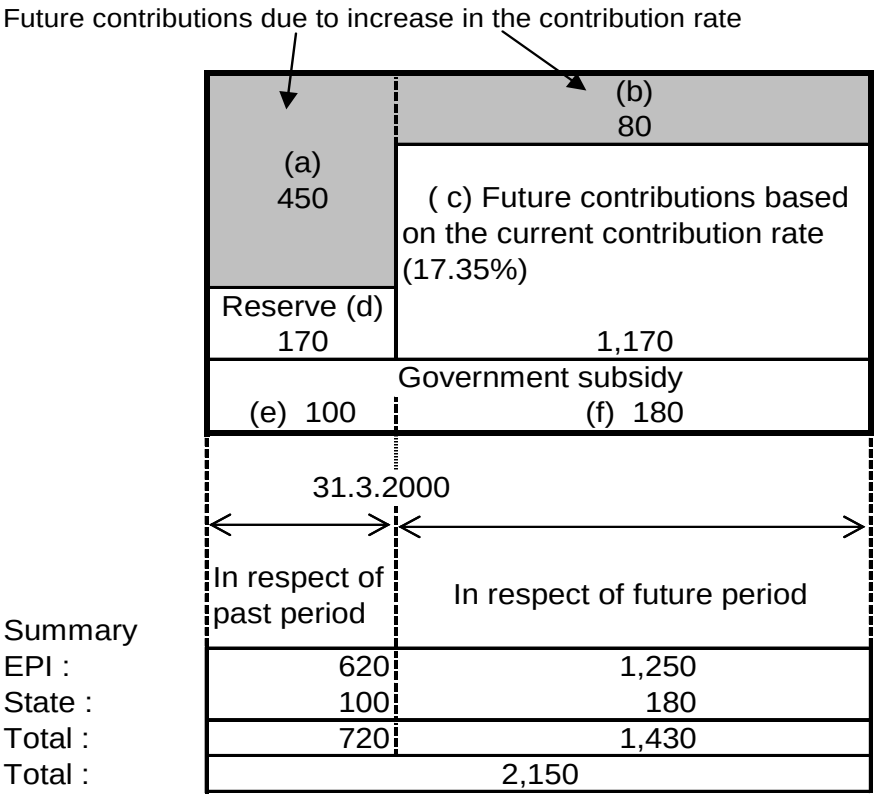


Figure 4. Illustration of present values of contributions and expenditure for the EPI



Assumptions: interest rate 4.0% p.a., wage increase 2.5% p.a., price increase 1.5 % p.a.

future, the PAYG cost rate is expected to exceed the contribution rate (see Figure 3). Furthermore, in 2050 the balance ratio becomes greater than 1, which implies that the fund will not only have to use all investment income but will also have to liquidate assets in investment. This gives a warning that the EPI may face a liquidity problem unless it increases the liquidity of its asset portfolio prior to that period. As a result of these trends, the funding ratio will gradually decrease until it reaches a level of 2.8 times the annual expenditure by 2060.

2.3 Evaluation of the unfunded pension liabilities

We next examine the long-term fiscal balance of the EPI fund. For this purpose, projected contributions and benefits are discounted to the present values and summarised in the actuarial balance sheets. It might be helpful to refer to the graphical representation in Figure 4 (page 15). It should be noted that the Government subsidies are payable from the current general revenue and thus are not included in the scope of our analysis here. We shall, however, take up this issue in the next section.

The following tables indicate the actuarial balance sheets of the evaluated at 31.3.2000 on the accrued-to-date basis and on the open fund basis.

Table 9. Actuarial balance sheet of the EPI (accrued-to-date basis) evaluated as of 31.3.2000

(In trillions JPY)

Assets		Liabilities	
- Reserves (d)	170	- Benefits (in respect of past credit; a+d)	620
		- Actuarial balance (–a)	– 450
Total	170	Total	170

Source: Ministry of Health, Labour and Welfare (2000).

Table 10. Actuarial balance sheet of the EPI (open fund basis) evaluated as of 31.3.2000

(In trillions JPY)

Assets			Liabilities		
Items	Present value	As a % of the present value of tax base	Items	Present value	As a % of the present value of tax base
- Reserves (d)	170	2.52	- Benefits	1,870	27.73
			In respect of:		
- Contributions (c)	1,170	17.35	(past credit; a+d)	(620)	(9.19)
			(future credit; b+c)	(1,250)	(18.54)
			- Actuarial balance (–a–b)	–530	–7.86
Total	1,340	19.87	Total	1,340	19.87

Source: Ministry of Health, Labour and Welfare (2000).

These results lead us to the following observations.

- On the accrued-to-date basis, an unfunded liability of JPY 450 trillion, or 88 percent of GDP in the same year, is disclosed. This amount has been accumulated as a result of the past scheme operations. Unless the benefits are drastically reduced by 73 percent, additional resources must be found to cover this deficit. A perpetual repayment of this amount would require 6.67 percent of the payroll tax rate throughout the future.

- In contrast, on the open fund basis, the future period is taken into account assuming the current legislation. On the assets side, the present value of future contributions (JPY 1,170 trillion) is added to the existing reserve (JPY 170 trillion), yielding the total assets of JPY 1,340, or 19.87 percent of premium. On the liability side, in addition to the present value of benefits in respect of the past period (JPY 620 trillion), the present value of benefits for the future period (JPY 1,250 trillion) is included in the liability, resulting in the total present value of benefits equal to JPY 1,870 trillion, or 27.73 percent of premium. Consequently, the fund has an unfunded liability of JPY 530 trillion, or 7.86 percent of premium.

- This unfunded liability can be eliminated either (i) by immediately and permanently increasing the current contribution rate by 7.86 percentage-points (i.e. from 17.35 percent to 25.21 percent), (ii) by gradually increasing the contribution rate to 27.8 percent as indicated in Figure A.1, or (iii) by uniformly reducing the benefit level by 28 percent from the current level.

- In addition, Table 10 shows that if the past period were neglected and a new scheme with the same benefit provision were implemented, then a constant contribution rate of 18.54 percent[15] would be necessary for the new scheme to be fully-funded.

The actuarial balance sheet analysis can also be applied to assess the effect of the reform. For instance, the present value of the benefits under the previous provision was estimated to be JPY 2,050 trillion, or 30.4 percent of premium. Therefore, the current provision has reduced the benefits by 8.8 percent. The reduced amount is JPY 180 trillion on a present value basis, or 2.7 percentage-points in terms of the premium.

It should be noted that the present values depend on the discount rate. Therefore, a different discount rate may result in a substantially different present value in nominal terms. In relative terms, however, results of the sensitivity analysis reveal that if the return on investment were higher by 0.5 percentage-points per annum, the ultimate contribution rate would decrease by about 1 percentage-point.

2.4 Unfunded pension liability as a hidden public debt

Recently the Japanese Government has been accumulating a massive public debt as a result of its expansionary fiscal policy to cope with the recession since the mid-1990s. The overall debt of the Government and local Governments now stands at more than JPY 600 trillion, or 117 percent of GDP. Therefore, it is also of interest to consider the pension liability in the context of the overall public debt. The following table provides the summary of the balance sheet of Japan.

Table 11. Balance sheet of Japan as of 31.3.1999

(In trillions JPY)

Assets		Liabilities	
- Currencies	33.24	- Treasury bonds (held by the private sector)	212.17
- Securities	106.52	- Contingency reserves	112.81
- Loans	267.81	- Deposits in postal savings	252.58
- Real estates	169.10	- **Social security reserves**	**153.00**
- Others	82.05	- Others	60.73
Total:	658.72	Total:	791.29
		Net worth/debt	– 132.56

Source: Ministry of Finance (2000).

[15] This rate is usually called the "normal cost".

It is seen that Japan has a net debt of JPY 132.56 trillion, or 26 percent of GDP. However, note that there are no established accounting rules to impute the liability on social security in the states' balance sheet. In the above table, only the portion of social security reserves held by the Trust Fund Bureau of the Ministry of Finance[16] is counted.

Alternatively, if we include the present value of the state subsidy (shown in Figure 4 for the EPI), then the liability on social security would increase from JPY 153.00 trillion to JPY 290.30 trillion, which yields a net debt of JPY 269.86 trillion, or 53 percent of GDP. Furthermore, if we view the Government as the ultimate guarantor of social security, the entire unfunded pension liability would fall under the responsibility of the Government. From this point of view, the liability on social security would increase to JPY 1,435.19 trillion, resulting in the net debt of JPY 776.46 trillion, or 151 percent of GDP.

2.5 Measurement of the intergenerational inequity

We now move on to the analysis of intergenerational transfer induced by the EPI scheme. Since it is impossible to consider all types of households, we consider here an average household consisting of a married couple with two children. The underlying scenario is as follows. The husband enters the labour market at 20 years of age and retires at 60 years of age. The average wage profile has been assumed throughout his career. The wife, 2 years younger than her husband, works from 20 years of age and stops working at 26 years of age when she marries. Then she becomes a housewife but continues to be covered by the National Pension until 60 years of age.

The contributions and benefits for the whole life cycle of the household are simulated for different generations by using the contribution rates and benefit rules applicable to each cohort. For the future, the benefit provision under the present law and the contribution schedule as shown in Figure A.1 in Appendix A have been assumed. Further, the same macroeconomic assumptions for the cost estimates have been made. Results are summarised in the following table.

Table 12. Net pension transfers under the EPI for selected cohorts of the model household

(In millions JPY in 1999 prices)

Year of birth of the household head	Cumulative contributions with interest (A)	Present value of benefits (B)	Net transfer (B) – (A)	Effective net transfer (B) – (A)/2
1929	12	68	56	62
1939	24	65	41	53
1949	34	57	23	40
1959	44	51	7	29
1969	52	50	– 2	24
1979	60	49	– 11	19
1989	64	49	– 15	17
1999	68	49	– 19	15
2009	68	49	– 19	15

Source: Ministry of Health, Labour and Welfare (2000).

For each generation, the second column shows the cumulative contributions with interest thereon evaluated at the time that the husband is 60 years of age and adjusted to 1999 prices. It should be noted that values in this column include not only the worker's contributions but also the equal amount paid by the employer. The third column shows the expected present value of benefits evaluated in the same manner. This value includes all types of benefits payable by the scheme,

[16] These monies are used as resources for various public investment projects under the Fiscal Investment and Loan Programme.

namely, old-age pensions, permanent disability pensions, survivors' pensions, and lump-sum payments[17].

In the fourth and fifth columns, we have calculated the net transfer, as well as the effective net transfer that takes into account the worker's contributions only. Although all generation have positive effective net transfer, a considerable difference among generations is detected. The discrepancy increases as the interval between generations gets wider. In terms of the net transfer, the critical line that separates winners and losers lies between the birth cohorts born in 1959 and in 1969. Whilst generations born in 1959 or earlier receive a positive net transfer from the pension scheme, those born in 1969 or later will have to accept a negative net transfer[18].

We need to comment on two counter arguments to the above analysis. One view is that since social security is a social contract based on a broad solidarity between generations it is not appropriate to discuss it in the context of money's worth issue. However, participation in social security is mandatory in most developed countries and the opinions of the future generations are not fully reflected in current policy decision. Therefore, if a scheme causes an unacceptable distortion, it may invoke a serious erosion of confidence in the scheme and ultimately render the contract untenable for future generations.

The second criticism is that in order to measure the net transfer one should also take into account other forms of income transfer such as intra-family support, education (which is regarded as an investment in human capital), bequests and taxation. For instance, those generations who benefit from the EPI had to support their parents who had not been fully insured by the scheme. If these offsetting factors are taken into account, the effective intergenerational inequity is not as large as indicated above.

[17] For the purposes of the simulation, the same contingency rates have been assumed as for the cost estimates.

[18] For comparison, Leimer (1999) reports inflation-adjusted internal rates of return for various cohorts under the Old Age and Survivors Insurance (OASI) in the United States. Assuming the average long-term real interest of 2 percent, the net transfer changes its sign between the cohort born in 1950 and that in 1975.

Birth cohort	1876	1900	1925	1950	1975	2000
Rate of return (%)	36.5	11.9	4.8	2.2	1.9	1.7

3 Conclusion: Policies to sustain PAYG pension schemes

In view of the analysis made so far, we conclude this paper by discussing measures to restore the long-term financial balance and to adjust intergenerational inequity for the EPI scheme.

There are two extreme ways of approaching the problem; namely, (i) increasing the revenue while keeping the same benefit level, or (ii) reducing the benefit level without further increasing the tax rate. Any combination of these measures will lie in between these two extremes.

3.1 Measures to reinforce the income to the fund

We have seen that in order to ensure the liquidity requirement and long-term solvency while maintaining the current benefit level, a considerable increase in contribution rate is unavoidable. The question should therefore be put as follows: How much contribution rate could workers in the future generations agree to pay? In Japan, it has been a policy target to contain the taxes and social security contributions to less than 50 percent of the National Income. However, the international comparison in Table S.1 as well as the presence of the fixed effect in the study of the OECD panel data in section 1.2 suggest that there is a large heterogeneity amongst countries. Therefore, there seems to be no *a priori* maximum level in absolute terms. Rather, the upper limit of contribution rate is determined relative to the expected benefit amount. The crucial factor for each country is thus the national consensus on what the extent of the social transfer should be for the support of the elderly.

Achieving a higher return on investment is an important policy objective as it reduces the need to increase the contribution rate. If the return on investment were improved by 0.5 percentage-points in the long-term, then the ultimate contribution rate would decrease by 1 percentage-point. In the past, most reserves of the EPI were kept by the Trust Fund Bureau in the Treasury, with a limited possibility of own investment by the EPI fund. However, with the abolishment of the Fiscal Investment and Loan Programme, these reserves are going to be redeemed to the EPI fund over the period from 2001 to 2008. This paves the way for the EPI fund to diversify the portfolio and thus yield a higher rate of return[19]. Further, as the investment income will be needed to cover the expenditure in excess of contributions, not only risk and return but also liquidity requirement should be taken into account in the portfolio selection. (Since a large fraction of the reserve is continued to be held in bonds, one idea is to match the duration of bonds in anticipation of the estimated cash flow.)

In Japan, various policy debates have been ongoing about the increase in the state subsidy and about the conversion of the current social insurance system into a tax-financed system. However, from a financial point of view this concerns the allocation of the burden between contribution and tax and the overall cost remain unchanged. In principle, for a scheme that collects specific contribution to finance its expenditure, the problem of unfunded liability should be resolved by self-reorganisation of the scheme. Above all, under the severe fiscal situation as we have seen, the Government would not be capable of allocating further resources to social security.

[19] It has been decided that the composition of the assets of the pension funds should be gradually changed to the following benchmark portfolio by 2009. The table also shows the current transitional portfolio in 2002.

	Domestic bonds	Domestic shares	Foreign bonds	Foreign shares	Short-term assets
Benchmark portfolio	68%	12%	7%	8%	5%
Transitional portfolio in 2002	87%	5%	2%	3%	3%

Nevertheless, Government interventions as the lender of the last resort should be secured in the event of an emergent insolvency of the fund. In the case of pensions, unlike other kinds of debts, the failure to pay benefits may cause serious social disorders. The Government support should, however, be limited only to allow time for cost containment measures to restore the solvency of the scheme.

3.2 Measures to reduce the benefit expenditure

The overall benefit expenditure comprises such components as the benefit level at the award, the duration of benefit, and the adjustment of the benefit in payment. In this respect, three possible measures merit consideration. The first is to modify the pension formula (e.g. pension accrual rates) so that the new formula yields a lower pension. The second is to raise the pension age. The third is to change the method of indexation. As we have seen in section 2.1, these reforms have actually been implemented.

However, we need to note the following aspects of the implementation process of these measures. First, once awarded, pension rights are protected by law. This makes it difficult to reduce the already awarded pensions[20]. Thus the reduction applies only for the newly awarded pensions. Second, since these amendments are implemented in a phased manner to avoid abrupt policy changes, it takes time for the effects of reform to appear.

These restrictions limit the scope of feasible responses to two choices. One, is to reduce the increase in the benefit for the already retired population. Specifically, this implies that pensions are adjusted in line with an index with a lower rate of increase. The other, is to make the transition period as short as possible. This implies a faster benefit reduction for the future and a faster increase in the contribution rate so that it attains a lower ultimate rate at an earlier point of time.

From a distributional point of view, these measures attempt to reduce the positive net transfer for the retired generation and to redistribute the negative net transfer between the current active population and the future generation. It should be noted that since not all positive net pension transfers to the retired generation can be extracted, some current generations might be eventually worse off as a result of this redistribution.

Another approach from a different angle is to change the design of the scheme so that it can achieve stronger link between contributions and benefits. One proposed policy is the introduction of individual retirement accounts and eventually switching the scheme from a defined-benefit to a defined-contribution system[21]. A more radical approach in this direction is to privatise social security. These proposals also raise an important issue with respect to the utilisation of the market allocation

[20] The only exception known so far in Japan is the case of the National Railway Mutual Aid Association Fund, which became insolvent around 1985. As an emergent cost containment measure, pensions based on the last drawn salary were reduced to the level based on the career average salary. In this scheme, to increase the amount of retirement pension, a special salary increase used to be made on the date of retirement.

[21] See, for example, Tobin (1998). The main disadvantage of the defined-contribution system is its uncertainty of the benefit level. A noteworthy case is the recent trend in Sweden. In the reform carried out in 1998, Sweden introduced a defined-contribution system within the framework of PAYG system. Of the total contribution of 18.5 percent, 2.5 percent goes to the so-called “notional individual account” that accumulate interest (a different interest rate from the market rate is used for this purpose) and the remainder of 16 percent is used to finance the current expenditure. Minimum guarantee is given for the total amount of the defined-contribution pension and the PAYG pension. It should be noted that this reform was financially feasible because the scheme held reserves that covered 3.5 years expenditure which were enough to cover the liability.

mechanism. Such policies could produce less unfunded liabilities for the future[22]. However, the problem of financing the existing significant amount of unfunded liability should be resolved separately.

The intergenerational inequity is not fundamentally rectified unless we cut into the protected rights of the already awarded pensions. Results of several household surveys show that, on average, the elderly households are better off than the working households in terms of stock (e.g. house). Further, owing to social security, the income level of the elderly households is not so inferior to that of the working households. At the same time, these surveys show a large heterogeneity in the living standards of the households with the elderly, reflecting the income and savings during the working period. These observations suggest that although some elderly suffer from low income it is not entirely correct to presume that all the elderly are a vulnerable group. A considerable part of the wealth of the elderly can thus be regarded as a tax base. At a more fundamental level, this requires us to reconsider the scope of the state's responsibility.

3.3 Concluding comments

With rapid population ageing, low economic growth and severe fiscal situation, the Japanese PAYG pension scheme has been put in a difficult situation. Under these circumstances, the long-term viability of the scheme depends on whether or not different generations can reach an agreement by mutual concessions. In view of the long-term nature of the pension scheme, corrective measures should be set forth as soon as possible. At the same time, we are required to redefine the responsibility of the state and to consider to what extent we can utilise the market mechanism. By efficient monitoring of the scheme and pre-emptive actions can we ensure the financial governance of social security and make it serve as a veritable safety net for the society.

[22] Providing a minimum pension guarantee can produce an unfunded liability. For example, in the Chilean privatised pension system, low compliance rates and a relatively high minimum pension may involve such a risk.

Appendix A

The 1999 Actuarial Valuation of the Employees' Pension Insurance and the National Pension[23]

Summary

In Japan, social security pensions have been playing a key role in providing income security for the elderly, the invalids and the survivors. Maintaining the long-term financial viability of the pension schemes is, therefore, one of the most important current issues. However, there have been significant changes in the demographic and economic context since the previous actuarial valuation conducted in 1994. The population forecast shows a much severer picture of population ageing than expected in the past. Furthermore, the recent slowdown of economic growth also raises concerns on the financing of social security pension schemes.

The main results of the 1999 Actuarial Valuation of the Employees' Pension Insurance (EPI) and the National Pension (NP) are summarised as follows.

- Under the *status quo* conditions[24], the contribution rate of the EPI is estimated to increase to 34.5% in 2025 and after. Under the Pension Reform Bill, the ultimate contribution rate is estimated to be 27.8% (in 2025 and after) if the state subsidy is kept at one-third of the expenditure on the Basic Pension, and 25.4% (in 2000 and after) if the state subsidy is increased to half of the Basic Pension expenditure from 2004.

- Under the *status quo* conditions, the contribution rate of the NP (in respect of covered persons in the first category) is estimated to increase to JPY 26,400 (in 1999 values) in 2025 and after. Under the Pension Reform Bill, the ultimate contribution rate is estimated to be JPY 25,200 (in 1999 prices) in 2020 and after if the state subsidy is kept at one-third of the expenditure on the Basic Pension, and JPY 18,500 (in 1999 prices) if the state subsidy is increased to half of the Basic Pension expenditure from 2004.

1 The 2000 Pension Reform

1.1 Outline of the Japanese pension system

Japan has implemented a multi-tier pension system since 1986. All residents between 20 years of age and 59 years of age are compulsorily covered by the first-tier National Pension. In the second-tier, employees in the private sector are compulsorily covered by the Employees' Pension Insurance, and civil servants in central and local governments, by Mutual Aid Associations (MAAs). In the third-tier, there are supplementary corporate pension funds and private savings plans. These third-tier schemes fall outside of the scope of this valuation.

[23] This Appendix is taken from the English summary of the "Report on 1999 Actuarial Valuation of the Employees' Pension Insurance Fund and the National Pension Fund", prepared by the Actuarial Affairs Division, Pension Bureau, Ministry of Health, Labour and Welfare of Japan. For further information, see Sakamoto (2001). The projection results were revised when the population projection was revised in 2002. The revised results are found in Appendix B.

[24] By the "*status quo* conditions" we mean the provision prior to the 2000 reform. See the postscript at the end of this Appendix.

The NP provides flat-rate Basic Pensions (in 1999 the full pension amount is JPY 67,017 per month). The EPI and MAAs provide additional earnings-related pensions. The pension formula for the EPI takes into account (i) the accrual rate of 7.5/1000 per year of contribution, (ii) the average "revaluated contributory salaries" over the whole contribution period, and (iii) the period of contribution. Here, "contributory salaries" do not include bonuses, and "revaluated" means that the past contributory salaries are indexed in line with the increase in the disposable income of the active workers. The rates of revaluation of past salaries are adjusted every five years in conjunction with the actuarial valuation. For inter-valuation years, the pension amount is adjusted in line with the increase in the Consumer Price Index(CPI).

The insured population of the NP is divided into three categories. The first category comprises of self-employed workers, farmers, their dependent spouses, unemployed, students, etc. Insured persons in this category pay flat-rate contributions to the NP scheme (in 1999 the monthly contribution rate is JPY 13,300). Low income earners, subject to an income test, can be exempted from contributions to the NP. Each exempted period is counted as one-third of the contribution period when calculating the amount of Basic Pension.

The second category consists of employees in both private and public sectors covered by the EPI and MAAs, and the third category consists of the dependent spouses of these workers. The workers covered by the EPI and MAAs pay earnings-related contributions to their schemes (in 1999, the EPI contribution rate is 17.35% of the contributory salaries, shared equally by employers and workers). These workers do not pay contributions directly to the NP scheme. The expenditure for Basic Pension is financed by the financial transfer from each employees' scheme as well as contributions from the insured persons in the first category. One-third of the expenditure on Basic Pensions is subsidized by general revenue. The amount of transfer by each employees' scheme is determined every year on the basis of the number of insured persons (aged between 20 years and 59 years) of the second and third categories in the respective scheme. Insured persons in the third category do not pay contributions, but for the purpose of calculating the Basic Pension, their period of coverage is regarded as the full contribution period.

1.2 Socio-economic context

Since the previous Actuarial Valuation carried out in 1994, significant changes have been taken place in the socio-economic environment of the social security pension schemes. The decline in fertility rates and the increase in life expectancies turned out to be much larger than those assumed in the previous valuation. Consequently, the population projection, carried out by the National Institute of Population and Social Security Research (NIPSSR) in January 1997, shows further rapid population ageing as compared with the previous population projection in 1992.

The labour force is estimated to decrease in the beginning of the twenty-first century even if labour force participation rates are expected to increase for female workers and elderly workers (in the first half of their sixties). The rapid ageing of the population structure will lead to an increase in contribution rates for pensions and other social security schemes, as well as tax rates. These upward pressure on the tax and social security burden raises concerns on the loss of international competitiveness of the Japanese economy in the future.

1.3 Issues in the 2000 Pension Reform

In May 1997, the Minister of Health and Welfare called for the Pension Council, an advisory body of the Minister, to discuss the measures to cope with the problems caused by the recent socio-economic changes. In December 1997, the Ministry of Health and Welfare (MHW)[25] presented five scenarios (ranging from the status quo to the complete privatisation of the EPI, and various combinations of benefit and contribution levels) as a guideline for reform. After discussions over a

[25] It is now called the Ministry of Health, Labour and Welfare (MHLW).

one-and-a-half year, the Pension Council issued a report to the Minister for Health and Welfare in October 1998. In response to this report, the MHW formulated three reform options and presented them to the ruling Liberal Democratic Party (LDP). In December 1998, the LDP announced its reform plans, which were based on one of the three reform options of the MHW. After the coordination between the LDP and the coalition Liberal Party, the MHW submitted the Pension Reform Bill to the Parliament in July 1999.

The main points of reform in the Pension Reform Bill are as follows.

- Gradually reduce the level of the earnings-related pension of the EPI by 5% (effective 1 April 2000).

- Index the pensions in payment to beneficiaries over 65 years of age in line with the increase in the CPI, instead of in line with the increase in the disposable income of active workers (effective 1 April 2000).

- Gradually raise the pension age for the earnings-related pensions of the EPI from 60 years to 65 years (effective 1 April 2013).

- Extend the maximum age of coverage by the EPI from 65 years to 70 years. At the same time, introduce the reduction of pensions for working pensioners over 65 years of age (effective 1 April 2002).

- Extend the contributory salaries to cover bonuses and reflect them in the formula of the earnings-related pensions. (Under the current legislation, 1% of the bonus is deducted as contributions, but is not reflected in the pension). The contribution rate and the benefit accrual rate are adjusted so that the total amount of contributions and benefits remain unchanged[26] (effective 1 April 2003).

In addition to the above points, which are based on the MHW reform options of October 1998, the following issues were proposed by the LDP in its reform plans in December 1998.

- Keep the contribution rates of the EPI and of the NP at their current level, as an emergency measure to the recent economic recession.

- Increase the state subsidy from one-third of the expenditure on Basic Pensions to half of that by securing its resources by 2004.

2 The 1999 Actuarial Valuation

2.1 Need for the actuarial valuation

The Employees' Pension Insurance Act and the National Pension Act prescribe that actuarial valuations should be carried out at least once every five years. Actuarial valuations are indispensable not only because the financial status of pension schemes need to be reviewed on a regular basis, but also because they provide an opportunity to take necessary measures to ensure the long-term viability of pension schemes. In Japan, it has been usually the case that the Government proposes a reform of the pension schemes when the actuarial valuation is undertaken.

[26] Due to the extension of the contributory salary, the current contribution rate of 17.35% is translated into 13.58%.

2.2 Methods and assumptions of the actuarial valuation

The projection of the financial status of the pension scheme involves the specification of the benefit structure, collection of the initial data, demographic and economic assumptions, and the method to set the future contribution schedule.

When the benefit structure is specified, the projection is made in the following three steps. First, demographic and economic assumptions are set out. Second, the expenditure and contributory earnings are projected into the future starting from the initial data. Third, the future contribution schedule is determined in accordance with the adopted financing method.

2.3 Financing method

The future contribution rate is set by a stepwise contribution-raising schedule. Under this method, the contribution rate is increased every five years by the same step until it reaches a constant rate (this rate is called the ultimate contribution rate) which ensures the long-term financial equilibrium. In setting the contribution rates, special attention is paid to inter-generational equity, as well as the effect of interest income on the reduction of the ultimate contribution rate. This financing method thus has characteristics of both the funding and the pay-as-you-go methods.

Specifically, the future contribution rate of the EPI has been determined by the following conditions:

1. The contribution rate is raised every five years at a constant rate until a certain target year.
2. From the target year, an actuarial level premium, called the ultimate rate, is applied. The target year is chosen so that the ultimate rate is contained within 20 percent of gross earnings.
3. The scheme secures liquid income sufficient to meet the benefit payment in each year.
4. A certain amount of contingency reserve is retained for unanticipated shocks.

Similar conditions have been applied for the determination of the future contribution rate of the NP. Note, however, that since the contribution rate of the NP is flat-rate, it is raised every year.

2.4 Demographic assumptions

The population projections undertaken by the NIPSSR in January 1997 have been used as the basis for the 1999 Actuarial Valuation. These population projections have been made under three assumptions on future fertility rates; namely, the high fertility variant, the low fertility variant, and the medium variant. Of these, the medium variant has been chosen for the valuation. Under this scenario, a rapid population ageing is expected; the population of 65 years of age and over, which stood at 16% of the total population in 1997, is estimated to increase to 27% of the total population by 2025.

The labour force projections carried out by the Ministry of Labour in October 1998 have been taken as the basis for the valuation. These projections show that the labour force participation rate of female workers and elderly workers (aged 60-64) will increase in the future.

In addition, various actuarial rates such as mortality rates, withdrawal rates and salary scales, have been constructed based on the experience of the schemes during the last three years.

2.5 Economic assumptions

To project the future contribution base, the benefit expenditure and the development of reserves, assumptions on certain economic factors are necessary. In the present Actuarial Valuation, the following assumptions have been made based on historical data in recent years and the available economic forecasts.

- The rate of increase in the salary base per worker: 2.5% per annum;
- The rate of increase in the disposable income : 2.3% per annum until 2024, and 2.5% per annum in 2025 and after;
- The rate of increase in the CPI : 1.5% per annum; and,
- The rate of return on investments : 4% per annum.

2.6 Policy options

Actuarial projections have been made under the following two options with respect to the future increase in the state subsidy.

Case 1 Keep the state subsidy at one-third of the expenditure on Basic Pensions throughout the projection period.

Case 2 Increase the state subsidy from one-third of the expenditure on Basic Pensions to half of that from October 2004.

2.7 Results of the Actuarial Valuation of the EPI

Figure A.1 compares the future contribution rates of the EPI based on the projected financial operations. In the *status quo* case, if the contribution rate of the EPI is raised by 2.5%-points every five years as assumed in the previous valuation, the ultimate contribution rate is estimated to be 34.5% in 2025 and after. This ultimate contribution rate is twice the current contribution rate. Under the Pension Reform Bill, in Case 1, the contribution rate is increased by 2.5%-points every five years until it attains 27.8% in 2025 and after; and, in Case 2, the increase in contribution rate is 2.3%-points, and the ultimate contribution rate is estimated at 25.4% in 2020 and after.

2.8 Results of the Actuarial Valuation of the NP

Figure A.2 illustrates the future contribution rates of the NP based on the projected financial operations of the NP scheme (in respect of covered persons in the first category). In the *status quo* case, if the monthly contribution rate of the NP is raised by JPY 500 (in 1999 prices) every year, the ultimate contribution rate is estimated to be JPY 26,400 (in 1999 prices) in 2025 and after[27]. Again, this ultimate contribution rate is twice the current contribution rate. Under the Pension Reform Bill, in Case 1, the contribution rate is increased by JPY 800 (in 1999 prices) every year until it attains JPY 25,200 (in 1999 prices) in 2020 and after; and, in Case 2, the annual increase in contribution rate is JPY 600 (in 1999 prices), and the ultimate contribution rate is estimated at JPY 18,500 (in 1999 prices) in 2020 and after.

[Postscript]

The Pension Reform Bill passed the Parliament in March 2000. In the course of the Parliament discussion, it was agreed to revise the Regulation on the early retirement pensions. As a consequence, the reduction rate for early retirement pension has been changed from 8% per year of anticipation to 6% per year of anticipation. The new reduction rate is applied to those who attain 60 years of age after April 2001. All results of the actuarial projection under the Reform Bill in this Appendix are based on the revised reduction rate.

[27] After 1999, the nominal contribution rate of the NP is assumed to be adjusted every year in line with the adjustment rate for the Basic Pension. The nominal contribution rate of the NP is assumed to be frozen at the current rate of JPY 13,300 (the rate in 1999 prices would decline) until 2004.

Figure A.1. Estimated contribution rates of the EPI, 2000-2030

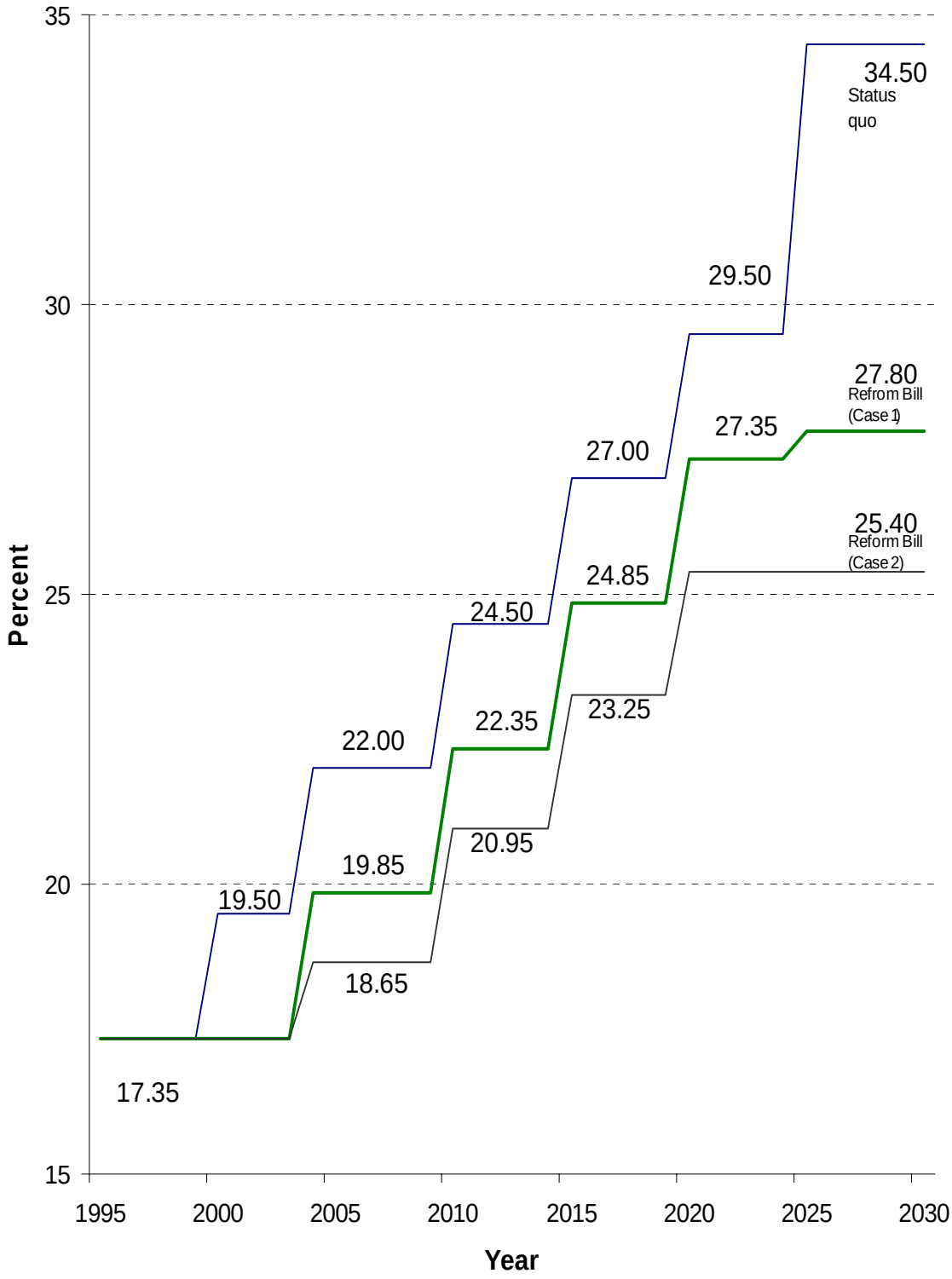
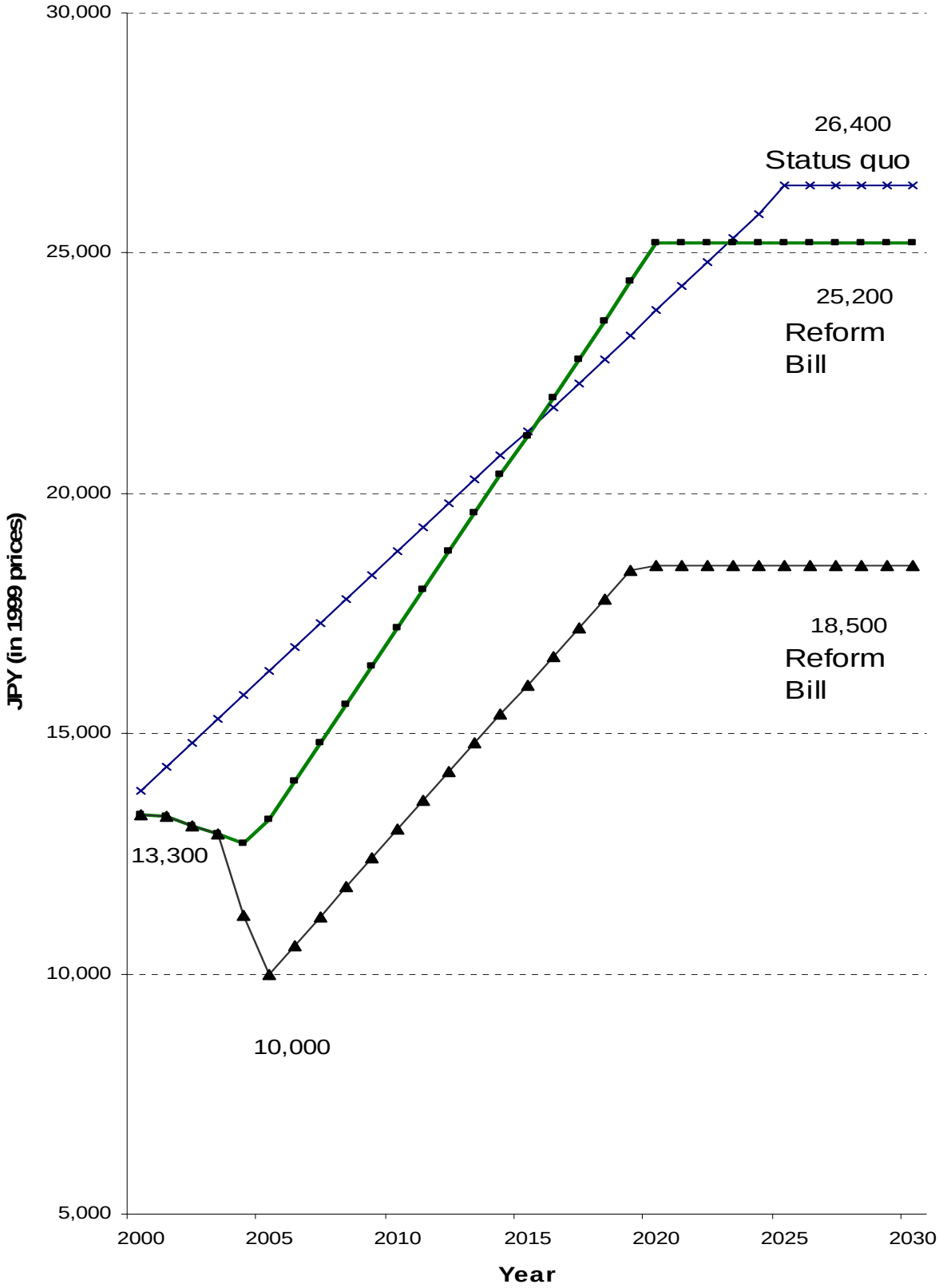


Figure A.2. Estimated contribution rates of the NP, 2000-2030



Appendix B

Impact of low fertility rates on the cost of social security and its financing : A revision based on the 2002 population projection[28]

In January 2002, the National Institute of Population and Social Security Research (NIPSSR) revised the population projection for Japan. Due to a rapid decrease in fertility rates and a continuous rise in life expectancy, a further acceleration is expected in the ageing of the Japanese population. In this context, a preliminary revision has been made on the actuarial projections and the estimates of costs of social security to provide updated information for the debate on the future social security reform. Two major changes have been made in this revision. First, the demographic framework was changed from the previous 1997 population projection to the 2002 projection. Second, economic assumptions have been revised in view of the recent performance of the Japanese economy.

1 Revision of the 1999 actuarial valuation of the pension schemes

1.1 Demographic assumptions

The 2002 population projection has been made under three assumptions concerning the fertility level: low, medium and high. The following Table B.1 compares the key results of the three variants of the 2002 projection with those of the medium variant of the 1997 projection. The base year of actuarial projection has been assumed to be 2001. Accordingly, the demographic and financial data in the base year of projection have been replaced by the data of 31 March 2001.

Table B.1. Comparison of population projections, 1997 and 2002 revisions

	1997 projection	2002 projection		
	Medium variant	High variant	Medium variant	Low variant
Assumed long-term TFR	1.61	1.63	1.39	1.10
Assumed long-term life expectancy at birth	Males 79.43 Females 86.47	Males 80.95 Females 89.22	Males 80.95 Females 89.22	Males 80.95 Females 89.22
Total population				
2000	126.89	126.93	126.93	126.93
Peak (year)	127.78 (2007)	128.15 (2009)	127.74 (2006)	127.48 (2004)
2025	120.91	124.04	121.14	117.76
2050	100.50	108.25	100.59	92.03
Percentage of the population aged 65 and over				
2000	17.2 %	17.4 %	17.4 %	17.4 %
2025	27.4 %	28.0 %	28.7 %	29.5 %
2050	32.3 %	33.1 %	35.7 %	39.0 %

Source: NIPSSR (2002).

[28] Sources of this Appendix are as follows:

- National Institute of Population and Social Security Research (2002), "Population projections for Japan: 2001-2050 with long-range population projections: 2051-2100";
- Ministry of Health, Labour and Welfare (2002), Effects of 2002 population projection on the pension financing;
- Idem. (2002), Estimates of expenditure and revenues of social security (October 2000 revision).

In terms of the percentage of the population aged 65 and over, results of the medium variant of the 1997 projection are similar to the results of the high variant of the 2002 projection. Comparing the results of the medium variant of the 1997 and 2002 projections, the percentage of the population aged 65 and over has become 1.3 percentage-points higher in 2025, and 3.4 percentage-points higher in 2050.

1.2 Economic assumptions

In view of the recent performance of the Japanese economy, the economic assumptions have been revised. Specifically, nominal growth rates of macroeconomic variables have been set 1.5 percentage-points downwards for the period from 2002 to 2007. For the remainder of the projection period, the same economic assumptions have been used as the 1999 actuarial valuation. The assumed rates are summarised as follows.

- The rate of increase in the salary base per worker: 1.0% per annum until 2007, and 2.5% per annum in 2008 and after;
- The rate of increase in the disposable income : 0.8% per annum until 2008, 2.3% per annum from 2009 to 2024, and 2.5% per annum in 2025 and after;
- The rate of increase in the CPI : 0.0% per annum until 2007, and 1.5% per annum in 2008 and after; and,
- The rate of return on investments : 2.5% per annum until 2007, and 4% per annum in 2008 and after.

1.3 Key results

Projections have been made under the following two policy options:

- Case 1 : The Government subsidy is kept one-third of the expenditure on Basic pensions.
- Case 2 : The Government subsidy is increased to half of the expenditure on Basic pensions from October 2004.

The following tables present the revised future contribution rates of the Employees' Pension Insurance (EPI) and the National Pension (NP). Comparing these results with the 1999 actuarial valuation results, we have the following observations.

- Under the high variant, the long-term contribution rate is 5 percent higher than the 1999 valuation result. Because the assumed fertility rates are almost the same, this increase is mainly due to the extension of life expectancy.
- Under the medium variant, the long-term contribution rate is 15 percent higher than the 1999 valuation result, of which 5 percent can be attributed to the extension of life expectancy and 10 percent, to the reduction of fertility rates.
- Under the low variant, the long-term contribution rate is 25 to 30 percent higher than the 1999 valuation result, of which 5 percent can be attributed to the extension of life expectancy and 20 to 25 percent, to the reduction of fertility rates.

Table B.2. Estimated contribution rates of pensions in 2025 (Case 1)

	1999 actuarial valuation	Revision (based on 2002 population projection)		
		High variant	Medium variant	Low variant
Employees' Pension Insurance	27.8% (21.6%)	29.4% (22.8%)	31.9% (24.8%)	35.4% (27.5%)
National Pension (in 1999 prices)	JPY 25,200	JPY 27,100	JPY 29,600	JPY 33,000

Note: Figures in brackets indicate the contribution rates in terms of the extended contributory salary[29].

Table B.3. Estimated contribution rates of pensions in 2025 (Case 2)

	1999 actuarial valuation	Revision (based on 2002 population projection)		
		High variant	Medium variant	Low variant
Employees' Pension Insurance	25.4% (19.8%)	26.5% (20.6%)	28.8% (22.4%)	32.0% (24.8%)
National Pension (in 1999 prices)	JPY 18,500	JPY 19,900	JPY 21,600	JPY 24,000

Note: Figures in brackets indicate the contribution rates in terms of the extended contributory salary.

2 Revision of the estimate of social security expenditure and revenues

Following the revision of the actuarial projections of pension schemes, a revision was made to the estimate of the overall social security expenditure and revenues[30]. The scope of the social security expenditure covers pensions, health care, social welfare and other programmes. Long-term care for the elderly, which is included in social welfare, is shown separately. The Government has to finance the spending on social security by collecting contributions from insured population and/or by allocating general tax revenue. In revising these estimates, full consistency has been ensured with respect to the demographic and economic assumptions[31]. As with the actuarial projections, results are presented under two assumptions concerning the future increase in the Government subsidy for the basic pensions (See section 1.3 earlier).

In both cases, the sum of contributions and tax allocated for social security is expected to increase from the current 22 ½ percent of National Income (NI) to 32 ½ percent of NI by 2025. In addition, other tax revenues that are allocated to other activities than social security are recently at the level of around 20 percent of the NI. Moreover, the public debt (of the Government and local Governments) currently stands at 8.6 percent of the NI. In view of the anticipated increase in the level of general tax and social security contributions, reform measures are sought to sustain the social security system in the long-term.

[29] It should be noted that from 2003 the definition of contributory salary of the EPI is changed so that it include bonuses. For the purpose of comparison, contributions are expressed as a percentage of previous contribution base. However, when the contribution base is changed in 2003, the contribution rate will have to be adjusted. The figures in brackets shows the adjusted contribution rates.

[30] The baseline estimate was made in October 2000.

[31] The rate of increase in the NI has been assumed as 1.0% per annum throughout the projection period.

Table B.4. Estimated social security expenditure and revenues (Case 1)

(In trillions JPY)

	2002 Budget	2005	2010	2025
Social security expenditure	**82 (22 ½)**	**91 (24)**	**110 (26 ½)**	**176 (31 ½)**
i) Pensions	44 (12)	48 (13)	57 (14)	84 (15)
ii) Health care	26 (7)	28 (7 ½)	35 (8 ½)	60 (11)
iii) Social welfare and others	12 (3 ½)	14 (3 ½)	17 (4)	32 (5 ½)
Of which: Long-term care for the elderly	5 (1)	6 (1 ½)	8 (2)	20 (3 ½)
Sources of revenue	**82 (22 ½)**	**86 (23)**	**103 (25)**	**182 (32 ½)**
i) Pensions	43 (12)	44 (11 ½)	50 (12)	90 (16)
ii) Health care	26 (7)	28 (7 ½)	35 (8 ½)	60 (11)
iii) Social welfare and others	13 (3 ½)	14 (3 ½)	17 (4)	32 (5 ½)
Of which: Long-term care for the elderly	5 (1)	6 (1 ½)	8 (2)	20 (3 ½)
1. Contributions	**58 (16)**	**59 (15 ½)**	**70 (17)**	**124 (22)**
i) Pensions	36 (10)	36 (9 ½)	42 (10)	77 (14)
ii) Health care	17 (4 ½)	17 (4 ½)	21 (5)	33 (6)
iii) Social welfare and others	6 (1 ½)	6 (1 ½)	7 (2)	14 (2 ½)
Of which: Long-term care for the elderly	2 (½)	2 (½)	4 (1)	9 (1 ½)
2. General taxes	**24 (6 ½)**	**27 (7)**	**33 (8)**	**58 (10 ½)**
i) Pensions	7 (2)	8 (2)	9 (2)	13 (2 ½)
ii) Health care	9 (2 ½)	11 (3)	14 (3 ½)	27 (5)
iii) Social welfare and others	7 (2)	8 (2)	10 (2 ½)	18 (3 ½)
Of which: Long-term care for the elderly	3 (½)	3 (1)	5 (1)	11 (2)
National Income (NI)	365	376	414	557

Note: Figures in brackets are shown as a percentage of the National Income.

Table B.5. Estimated social security expenditure and revenues (Case 2)

(In trillions JPY)

	2002 Budget	2005	2010	2025
Social security expenditure	**82 (22 ½)**	**91 (24)**	**110 (26 ½)**	**176 (31 ½)**
i) Pensions	44 (12)	48 (13)	58 (14)	84 (15)
ii) Health care	26 (7)	28 (7 ½)	35 (8 ½)	60 (11)
iii) Social welfare and others	12 (3 ½)	14 (3 ½)	17 (4)	32 (5 ½)
Of which: Long-term care for the elderly	5 (1)	6 (1 ½)	8 (2)	20 (3 ½)
Sources of revenue	**82 (22 ½)**	**87 (23)**	**104 (25)**	**180 (32 ½)**
i) Pensions	43 (12)	44 (12)	51 (12 ½)	88 (16)
ii) Health care	26 (7)	28 (7 ½)	35 (8 ½)	60 (11)
iii) Social welfare and others	13 (3 ½)	14 (3 ½)	17 (4)	32 (5 ½)
Of which: Long-term care for the elderly	5 (1)	6 (1 ½)	8 (2)	20 (3 ½)
1. Contributions	**58 (16)**	**57 (15)**	**67 (16)**	**116 (21)**
i) Pensions	36 (10)	33 (9)	39 (9 ½)	70 (12 ½)
ii) Health care	17 (4 ½)	17 (4 ½)	21 (5)	33 (6)
iii) Social welfare and others	6 (1 ½)	6 (1 ½)	7 (2)	14 (2 ½)
Of which: Long-term care for the elderly	2 (½)	2 (½)	4 (1)	9 (1 ½)
2. General taxes	**24 (6 ½)**	**30 (8)**	**37 (9)**	**64 (11 ½)**
i) Pensions	7 (2)	11 (3)	12 (3)	19 (3 ½)
ii) Health care	9 (2 ½)	11 (3)	14 (3 ½)	27 (5)
iii) Social welfare and others	7 (2)	8 (2)	10 (2 ½)	18 (3 ½)
Of which: Long-term care for the elderly	3 (½)	3 (1)	5 (1)	11 (2)
National Income (NI)	365	376	414	557

Note: Figures in brackets are shown as a percentage of the National Income.

References

Aaron, H. (1966), "The social insurance paradox", Canadian Journal of Economics and Political Science, 32: 371-374.

Aaron, H. (1982), Economic effects of social security, Washington, The Brookings Institute.

Atkinson, A. B. (1999), The economic consequences of rolling back the welfare state, The MIT Press.

Feldstein, M. (1974) "Social security, induced retirement, and aggregate capital accumulation", Journal of Political Economy, 82: 505-529.

Hirose, K. (1999), "Topics in quantitative analysis of social protection systems", ILO Working paper, Issues in social protection No. 6, Geneva.

Holzman, R. et al. (2000), "On the economics and scope of implicit pension debt: an international perspective", paper prepared for the ASSA meeting on "Public sector debt: international experiences".

International Labour Organisation (2002), The ILO Pension Model (A technical guide), Social Protection Sector, Geneva.

International Labour Organisation (2002), The ILO Population Projection Model (A technical guide), Social Protection Sector, Geneva.

Kane, C. and Palacios, R. (1996), "The implicit pension debt", Finance and Development, June: 36-38.

Kotlikoff, L. J. (1987), "Social security", Entry in The New Palgrave : A Dictionary of Economics, edited by Eatwell, J. et al., London, Macmillan.

Kotlikoff, L. J. (1989), "On the contribution of economics to the evaluation and formulation of social insurance policy", American Economic Review, 79: 184-190

Leimer, D. R. (1999), "Lifetime redistribution under the social security program: a literature synopsis", Social Security Bulletin, 62 (2): 43-51.

Merton, R. C. (1969), "A golden golden-rule for welfare-maximization in a economy with a varying population growth rate", Western Economic Journal, 4 (Dec): 307-318.

Miller, M. and L. Zhang (1999), "Creditor panic, asset bubbles and sharks: three views of the Asian crisis", Chap. 10 in U. Dadush et al. (eds.) Private capital flows in the age of globalization, Cheltenham, E. Elgar.

National Institute of Population and Social Security Research (2002), "Population projections for Japan: 2001-2050 with long-range population projections: 2051-2100". Available from http://www.ipss.go.jp/

Sakamoto, J. (2001), "Japan: Pension Reform and Funding Options", Zeitschrift für ausländisches und internationales Arbeits- und Sozialrecht, 1.15: 1-42.

Scherman, K. G. (1999), "The Swedish pension reform", ILO Working paper, Issues in social protection No. 7, Geneva.

Social Insurance Agency (2000), Outline of Social Insurance in Japan, Tokyo.

Tobin, J. (1998) “The future of social security: one economist’s assessment” in T. R. Marmor and J. L. Mashaw (eds.), Social security in contemporary American politics, Princeton University Press.

United Nations (2001), World Population Prospects : The 2000 revision, New York, United Nations.

References available in Japanese

Commission on the structural reform of social security (2000), “Final report : Social security in the twenty-first century”, Prime Minister’s Office, Tokyo, Japan.

Furukawa, T. et al. (2000), “Tax and social security burdens and economic growth: empirical analysis of OECD countries panel data”, Bank of Japan Working paper 00-6.

Ministry of Finance (2000), Balance Sheet of the State, Tokyo.

Ministry of Health, Labour and Welfare (1999), White Paper on Pensions: Building the pension system for the 21st century, Tokyo.

Ministry of Health, Labour and Welfare (2000), White Paper on Pensions: Choosing the pension system for the 21st century, Tokyo.

Ministry of Health, Labour and Welfare (2000), Report on 1999 Actuarial Valuation of the Employees’ Pension Insurance Fund and the National Pension Fund, Tokyo. (with English summary)

Ministry of Health, Labour and Welfare (2002), Effects of 2002 population projection on the pension financing. Available from http://www.mhlw.go.jp/.

Ministry of Health, Labour and Welfare (2002), Estimates of expenditure and revenues of social security (October 2000 revision). Available from http://www.mhlw.go.jp/.

Statistical Annex

Table S.1. Comparison of tax and social security burden for selected OECD countries, 1970-2001

(as a % of National Income)

	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Japan																				
Tax	18.9	18.3	22.2	24.0	24.9	26.4	27.3	27.6	27.4	26.4	24.8	24.4	23.1	23.4	23.2	23.4	22.8	22.0	22.6	22.6
Social security	5.4	7.5	9.1	10.4	10.6	10.6	10.6	10.8	11.3	11.4	11.8	12.1	12.5	13.2	13.3	13.6	13.9	13.6	13.9	14.3
Total	24.3	25.7	31.3	34.4	35.5	37.0	37.9	38.4	38.8	37.8	36.6	36.6	35.6	36.6	36.5	37.0	36.7	35.6	36.5	36.9
United States																				
Tax	27.6	25.3	25.4	23.5	23.6	24.5	23.7	24.4	24.1	24.3	24.1	24.6	25.0	25.3	25.7	26.1	26.7	...	...	...
Social security	6.2	7.8	8.5	9.3	9.6	9.4	9.6	9.7	9.8	10.0	10.0	10.0	10.0	10.0	9.8	9.7	...	...	...	...
Total	33.8	33.2	33.9	32.9	33.2	33.9	33.3	34.1	33.9	34.2	34.1	34.6	35.1	35.3	35.5	35.8	...	...	...	...
United Kingdom																				
Tax	41.0	37.4	39.4	41.0	41.0	41.0	40.7	40.4	40.2	39.7	37.9	36.5	36.4	38.5	38.2	38.4	40.0	...	...	...
Social security	7.8	9.6	9.7	11.0	11.2	11.0	10.7	10.5	10.1	10.5	10.4	10.5	10.2	10.3	10.1	...	...	...	...	...
Total	48.8	47.0	49.1	52.0	52.2	52.0	51.4	50.9	50.4	50.2	48.2	47.0	46.6	48.8	48.3	...	...	...	...	...
Germany																				
Tax	29.1	30.5	32.4	31.3	30.5	30.6	30.2	31.2	29.4	29.5	30.6	31.0	31.4	31.2	29.8	29.2	29.4	...	...	...
Social security	16.0	20.9	21.8	22.8	22.5	22.6	22.4	22.0	21.7	22.7	23.4	24.4	25.4	25.5	26.3	26.7	...	...	...	...
Total	45.1	51.4	54.2	54.1	53.0	53.2	52.6	53.2	51.1	52.2	54.0	55.4	56.8	56.7	56.2	55.9	...	...	...	...
France																				
Tax	28.9	28.5	30.9	33.7	33.4	33.8	33.2	32.7	32.7	33.1	32.2	32.3	33.6	34.3	36.0	36.7	39.4	...	...	...
Social security	18.2	21.6	25.4	28.2	27.6	27.9	27.7	27.8	28.0	28.2	28.3	28.5	28.4	28.9	29.4	28.6	...	...	...	...
Total	47.1	50.1	56.3	61.9	61.0	61.6	60.9	60.5	60.7	61.3	60.5	60.8	62.0	63.2	65.4	65.3	...	...	...	...
Sweden																				
Tax	43.5	44.8	44.5	51.1	53.4	57.2	55.9	55.7	56.7	53.5	50.0	51.0	49.0	46.5	48.9	51.2	52.4	...	...	...
Social security	11.5	12.8	19.5	19.1	19.3	18.8	19.2	20.8	21.8	21.7	20.5	20.1	19.1	19.5	21.3	...	...	...	...	...
Total	54.9	57.7	63.9	70.1	72.7	76.0	75.1	76.5	78.5	75.2	70.5	71.0	68.1	66.0	70.2	...	...	...	...	...

Source: Ministry of Finance, National Institute of Population and Social Security Research, Japan.

Table S.2. Comparison of increase rates in the covered population and contributory wage, and rates of return of the EPI, 1960-1998

(in percent)

Fiscal Year	Increase in the covered population of the EPI (n)	Increase in contributory wage (g)	n+g	Rate of return on investment (r)	Dummy indicator (n+g>r)
1960	31.84	12.57	44.41	5.88	1
1961	10.95	11.22	22.17	6.40	1
1962	10.06	5.96	16.02	6.42	1
1963	7.73	7.52	15.25	6.46	1
1964	9.22	6.53	15.75	6.45	1
1965	22.36	3.05	25.41	6.37	1
1966	8.51	4.18	12.69	6.41	1
1967	9.54	3.83	13.37	6.47	1
1968	9.99	4.01	14.00	6.46	1
1969	23.89	4.16	28.05	6.45	1
1970	23.73	3.14	26.87	6.46	1
1971	9.34	1.14	10.48	6.47	1
1972	12.10	2.66	14.76	6.47	1
1973	24.08	2.74	26.82	6.38	1
1974	24.41	-0.39	24.02	6.60	1
1975	10.14	-0.02	10.12	6.93	1
1976	16.64	0.84	17.48	7.03	1
1977	8.74	0.23	8.97	7.13	1
1978	5.53	1.14	6.67	7.00	0
1979	5.62	2.23	7.85	6.88	1
1980	8.82	2.12	10.94	7.06	1
1981	5.17	1.81	6.98	7.25	0
1982	4.52	1.30	5.82	7.22	0
1983	2.79	1.28	4.07	7.20	0
1984	3.43	1.48	4.91	7.17	0
1985	5.09	1.17	6.26	7.16	0
1986	2.42	-0.27	2.15	7.11	0
1987	1.78	2.53	4.31	6.77	0
1988	3.03	3.95	6.98	6.29	1
1989	5.27	4.00	9.27	5.94	1
1990	4.50	3.60	8.10	5.90	1
1991	3.89	3.10	6.99	5.97	1
1992	2.37	1.67	4.04	5.82	0
1993	1.36	0.49	1.85	5.52	0
1994	2.88	0.27	3.15	5.34	0
1995	1.29	0.21	1.50	5.24	0
1996	1.24	0.58	1.82	4.99	0
1997	1.29	0.00	1.29	4.66	0
1960-1970	15.26	6.02	21.27	6.38	1
1971-1980	12.54	1.27	13.81	6.80	1
1981-1990	3.80	2.09	5.89	6.80	0
1991-1997	2.05	0.90	2.95	5.36	0

Source: Ministry of Health, Labour and Welfare, Japan.

Table S.3. Insured population and pensioners of the EPI, 1942-2000

Fiscal Year	Number of establishments (in thousands)	Insured population (in thousands	Number of pensioners (in thousands)						Number of pensioners as a percentage of the insured population					
			Total	Old-Age (full*)	Old-Age (partial*)	Disability	Survivors (full*)	Survivors (partial*)	Total	Old-Age (full*)	Old-Age (partial*)	Disability	Survivors (full*)	Survivors (partial*)
1942	64	3,557	-	-	-	-	-	-	-	-	-	-	-	-
1945	91	4,411	1	-	-	-	1	-	0.0%	-	-	-	0.0%	-
1950	173	6,237	65	-	-	10	55	-	1.0%	-	-	0.2%	0.9%	-
1955	273	8,402	185	1	-	61	120	-	2.2%	0.0%	-	0.7%	1.4%	-
1960	409	11,978	328	44	-	87	198	-	2.7%	0.4%	-	0.7%	1.7%	-
1965	565	18,670	602	203	10	79	311	-	3.2%	1.1%	0.1%	0.4%	1.7%	-
1970	743	22,522	1,224	534	90	99	501	-	5.4%	2.4%	0.4%	0.4%	2.2%	-
1971	757	22,775	1,423	617	140	108	558	-	6.2%	2.7%	0.6%	0.5%	2.5%	-
1972	788	23,372	1,630	708	198	114	610	-	7.0%	3.0%	0.8%	0.5%	2.6%	-
1973	826	24,003	1,843	794	268	120	661	-	7.7%	3.3%	1.1%	0.5%	2.8%	-
1974	847	23,910	2,117	910	359	128	720	-	8.9%	3.8%	1.5%	0.5%	3.0%	-
1975	867	23,893	2,449	1,056	479	139	775	-	10.2%	4.4%	2.0%	0.6%	3.2%	-
1976	888	24,084	2,894	1,262	652	150	830	1	12.0%	5.2%	2.7%	0.6%	3.4%	0.0%
1977	904	24,131	3,439	1,516	843	168	900	12	14.3%	6.3%	3.5%	0.7%	3.7%	0.0%
1978	926	24,392	3,881	1,676	1,030	186	963	25	15.9%	6.9%	4.2%	0.8%	3.9%	0.1%
1979	979	24,927	4,334	1,874	1,194	200	1,027	39	17.4%	7.5%	4.8%	0.8%	4.1%	0.2%
1980	997	25,445	4,773	2,063	1,359	206	1,090	55	18.8%	8.1%	5.3%	0.8%	4.3%	0.2%
1981	1,012	25,896	5,255	2,279	1,503	219	1,179	75	20.3%	8.8%	5.8%	0.8%	4.6%	0.3%
1982	1,022	26,223	5,745	2,508	1,645	234	1,263	96	21.9%	9.6%	6.3%	0.9%	4.8%	0.4%
1983	1,031	26,549	6,256	2,787	1,755	246	1,350	118	23.6%	10.5%	6.6%	0.9%	5.1%	0.4%
1984	1,040	26,932	6,797	3,047	1,910	258	1,439	143	25.2%	11.3%	7.1%	1.0%	5.3%	0.5%
1985	1,040	27,234	7,384	3,342	2,082	272	1,521	168	27.1%	12.3%	7.6%	1.0%	5.6%	0.6%
1986	1,059	26,994	8,003	3,716	2,217	287	1,609	174	29.6%	13.8%	8.2%	1.1%	6.0%	0.6%
1987	1,114	27,676	8,642	4,165	2,273	299	1,733	171	31.2%	15.0%	8.2%	1.1%	6.3%	0.6%
1988	1,216	28,769	9,279	4,222	2,724	307	1,858	168	32.3%	14.7%	9.5%	1.1%	6.5%	0.6%
1989	1,320	29,921	9,919	4,507	2,947	320	1,981	164	33.2%	15.1%	9.8%	1.1%	6.6%	0.5%
1990	1,418	30,997	10,519	4,760	3,173	327	2,100	160	33.9%	15.4%	10.2%	1.1%	6.8%	0.5%
1991	1,496	31,959	11,092	4,993	3,389	336	2,219	156	34.7%	15.6%	10.6%	1.1%	6.9%	0.5%
1992	1,544	32,493	11,803	5,293	3,666	344	2,348	152	36.3%	16.3%	11.3%	1.1%	7.2%	0.5%
1993	1,572	32,651	12,535	5,598	3,960	353	2,476	148	38.4%	17.1%	12.1%	1.1%	7.6%	0.5%
1994	1,595	32,740	13,273	5,921	4,244	363	2,602	144	40.5%	18.1%	13.0%	1.1%	7.9%	0.4%
1995	1,613	32,808	14,448	6,592	4,603	372	2,742	139	44.0%	20.1%	14.0%	1.1%	8.4%	0.4%
1996	1,659	32,999	15,239	6,933	4,920	380	2,872	134	46.2%	21.0%	14.9%	1.2%	8.7%	0.4%
1997	1,710	33,468	16,813	7,822	5,299	393	3,169	130	50.2%	23.4%	15.8%	1.2%	9.5%	0.4%
1998	1,698	32,957	17,679	8,217	5,625	404	3,309	124	53.6%	24.9%	17.1%	1.2%	10.0%	0.4%
1999	1,698	32,481	18,571	8,580	5,975	415	3,601		57.2%	26.4%	18.4%	1.3%	11.1%	
2000	1,698	32,192	19,529	9,014	6,352	425	3,737		60.7%	28.0%	19.7%	1.3%	11.6%	

Source: Ministry of Health, Labour and Welfare, Japan.

Note (*) : Pensions based on contributions more than 25 years are called "full" pensions, otherwise called "partial" pensions.

Table S.4. The average contributory wage and the average monthly pensions of the EPI, 1942-2000

Fiscal Year	Average monthly contributory wage (JPY)	Average monthly pensions (JPY)					Average monthly pensions as a percentage of average contributory wage				
		Old-Age (full*)	Old-Age (partial*)	Disability	Survivors (full*)	Survivors (partial*)	Old-Age (full*)	Old-Age (partial*)	Disability	Survivors (full*)	Survivors (partial*)
1942	72	-	-	-	-	-	-	-	-	-	-
1945	92	-	-	51	48	-	-	-	55.4%	52.2%	-
1950	6,335	-	-	1,519	1,024	-	-	-	24.0%	16.2%	-
1955	11,913	3,541	-	2,672	1,895	-	29.7%	-	22.4%	15.9%	-
1960	12,765	3,530	-	3,927	1,972	-	27.7%	-	30.8%	15.4%	-
1965	29,413	7,736	3,054	6,466	5,419	-	26.3%	10.4%	22.0%	18.4%	-
1970	54,913	14,400	5,742	11,259	8,422	-	26.2%	10.5%	20.5%	15.3%	-
1971	64,402	16,193	6,412	12,519	9,132	-	25.1%	10.0%	19.4%	14.2%	-
1972	72,203	16,772	6,435	12,778	9,267	-	23.2%	8.9%	17.7%	12.8%	-
1973	89,540	38,498	13,007	29,151	20,301	-	43.0%	14.5%	32.6%	22.7%	-
1974	111,371	45,195	15,207	34,155	23,940	-	40.6%	13.7%	30.7%	21.5%	-
1975	122,661	56,021	18,231	41,659	29,296	-	45.7%	14.9%	34.0%	23.9%	-
1976	143,148	69,315	20,647	49,778	35,938	11,533	48.4%	14.4%	34.8%	25.1%	8.1%
1977	155,656	74,188	22,089	55,331	39,452	12,270	47.7%	14.2%	35.5%	25.3%	7.9%
1978	164,204	83,209	23,565	59,222	42,756	13,049	50.7%	14.4%	36.1%	26.0%	7.9%
1979	173,379	86,976	24,034	61,669	45,146	13,461	50.2%	13.9%	35.6%	26.0%	7.8%
1980	188,637	101,349	25,345	70,451	52,704	14,437	53.7%	13.4%	37.3%	27.9%	7.7%
1981	198,341	109,113	26,901	75,822	56,135	15,466	55.0%	13.6%	38.2%	28.3%	7.8%
1982	207,260	113,896	27,587	78,946	58,124	16,006	55.0%	13.3%	38.1%	28.0%	7.7%
1983	213,005	114,217	26,726	79,363	58,278	15,929	53.6%	12.5%	37.3%	27.4%	7.5%
1984	220,288	117,244	27,025	81,151	59,495	16,185	53.2%	12.3%	36.8%	27.0%	7.3%
1985	231,460	122,002	27,711	84,256	61,709	16,669	52.7%	12.0%	36.4%	26.7%	7.2%
1986	237,022	127,977	29,060	88,690	66,502	17,425	54.0%	12.3%	37.4%	28.1%	7.4%
1987	241,299	125,957	28,898	88,433	67,194	17,520	52.2%	12.0%	36.6%	27.8%	7.3%
1988	248,667	132,308	28,588	87,804	67,561	17,538	53.2%	11.5%	35.3%	27.2%	7.1%
1989	261,839	137,978	29,406	90,721	71,054	18,233	52.7%	11.2%	34.6%	27.1%	7.0%
1990	273,684	141,963	29,827	92,255	72,906	18,651	51.9%	10.9%	33.7%	26.6%	6.8%
1991	284,362	146,577	32,680	94,504	75,305	19,217	51.5%	11.5%	33.2%	26.5%	6.8%
1992	291,145	151,667	36,006	96,835	77,975	19,855	52.1%	12.4%	33.3%	26.8%	6.8%
1993	295,125	159,483	39,481	97,850	79,432	20,183	54.0%	13.4%	33.2%	26.9%	6.8%
1994	303,611	168,405	43,751	102,269	83,767	21,232	55.5%	14.4%	33.7%	27.6%	7.0%
1995	307,530	169,700	46,035	102,542	84,445	21,387	55.2%	15.0%	33.3%	27.5%	7.0%
1996	311,344	170,259	47,880	102,413	87,214	21,403	54.7%	15.4%	32.9%	28.0%	6.9%
1997	316,881	172,168	49,570	102,716	88,905	21,410	54.3%	15.6%	32.4%	28.1%	6.8%
1998	316,186	174,906	52,023	104,360	90,536	21,802	55.3%	16.5%	33.0%	28.6%	6.9%
1999	315,353	176,161	53,705	106,120	91,470	n.a.	55.9%	17.0%	33.7%	29.0%	-
2000	318,688	175,865	54,929	106,829	91,405	n.a.	55.2%	17.2%	33.5%	28.7%	-

Source: Ministry of Health, Labour and Welfare, Japan.

Note (*) : Pensions based on contributions more than 25 years are called "full" pensions, otherwise called "partial" pensions.

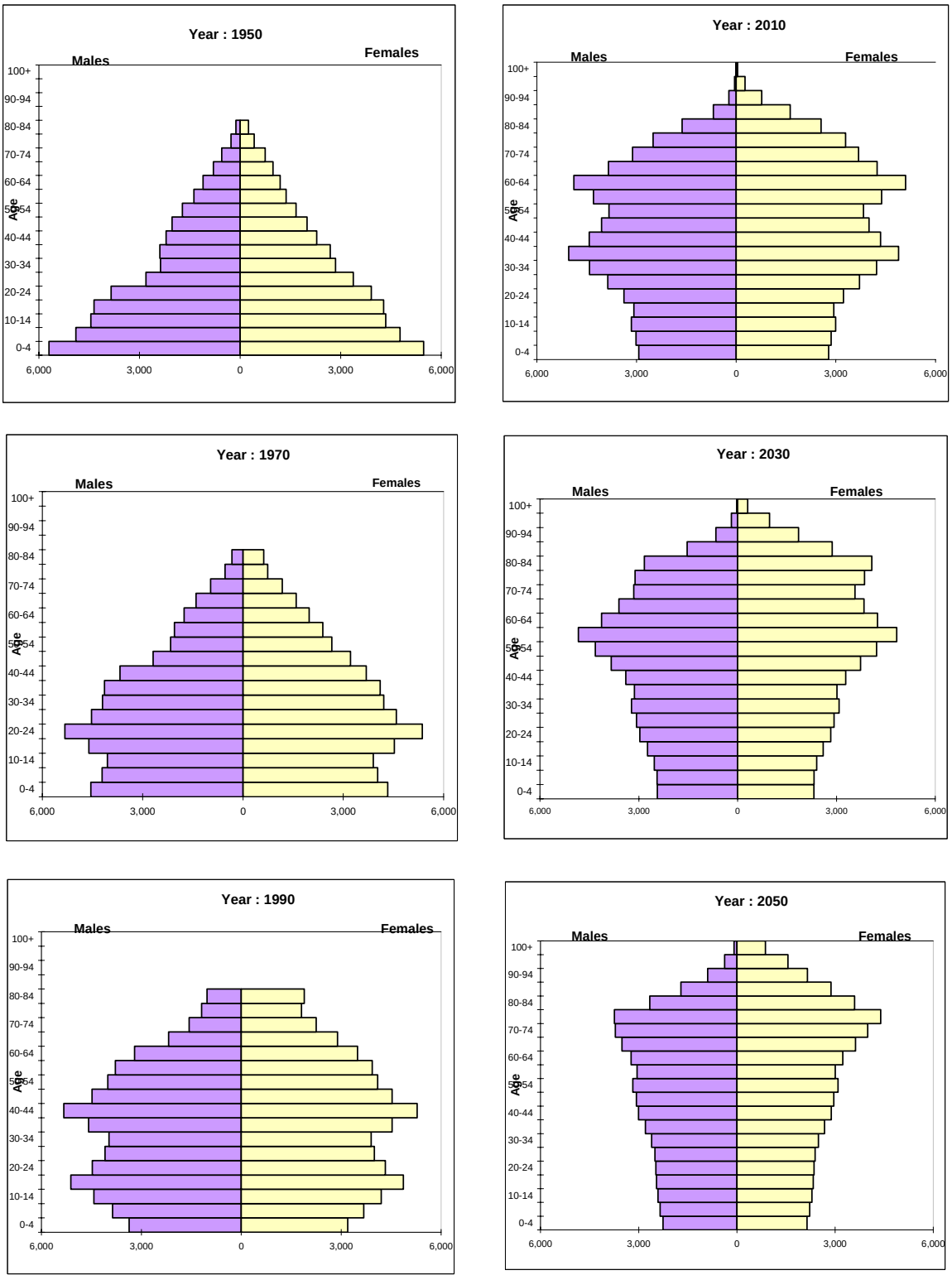
Table S.5. Financial operations of the EPI fund, 1942-2000

(in billion JPY)

Fiscal Year	Revenue				Expenditure		Balance		Reserves at the end of the fiscal year
	Total	of which			Total	of which	without investment income	including investment income	
		Contributions	State subsidy	Investment income		Benefit payments			
1942	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1
1945	0.6	0.6	0.0	0.0	0.1	0.1	0.5	0.5	1
1950	15	13	0.4	1.3	1.7	1.3	11.8	13.1	24
1955	43	34	1.8	6.8	7.9	6.5	28	35	114
1960	107	81	2	23	13	11	71	94	350
1961	137	102	2	31	14	12	91	122	444
1962	167	122	2	40	17	14	110	150	566
1963	197	141	3	50	21	16	126	176	715
1964	232	164	3	62	22	18	147	210	891
1965	385	297	6	78	43	38	264	342	1,100
1966	480	361	12	103	62	54	315	418	1,441
1967	551	403	12	132	73	65	346	478	1,859
1968	634	451	14	163	86	77	385	549	2,336
1969	780	554	18	201	109	99	469	671	2,884
1970	1,033	748	28	250	167	155	617	866	4,420
1971	1,219	872	30	309	197	183	713	1,022	5,447
1972	1,471	1,043	38	380	243	226	848	1,228	6,674
1973	1,876	1,347	56	460	351	331	1,066	1,526	8,194
1974	2,661	1,931	124	586	710	683	1,365	1,951	10,140
1975	3,116	2,202	159	751	970	954	1,395	2,146	12,287
1976	4,019	2,857	233	924	1,390	1,365	1,705	2,629	14,916
1977	4,935	3,458	338	1,132	1,877	1,845	1,927	3,058	17,974
1978	5,446	3,718	399	1,322	2,312	2,271	1,813	3,134	21,108
1979	5,954	3,988	443	1,511	2,710	2,656	1,732	3,244	24,352
1980	7,039	4,701	547	1,785	3,407	3,252	1,847	3,632	27,984
1981	8,392	5,628	649	2,109	4,096	3,922	2,187	4,296	32,280
1982	8,955	5,999	547	2,400	4,672	4,489	1,884	4,283	36,563
1983	9,587	6,291	595	2,692	5,208	5,010	1,686	4,379	40,942
1984	10,302	6,576	727	2,992	5,759	5,528	1,551	4,543	45,484
1985	11,760	7,505	914	3,329	6,461	6,227	1,969	5,299	50,783
1986	13,839	8,602	1,588	3,641	9,341	9,112	858	4,499	55,281
1987	14,356	8,914	1,644	3,788	10,035	9,829	533	4,321	59,964
1988	16,249	9,451	2,962	3,827	10,600	10,419	1,822	5,649	65,613
1989	16,110	10,491	1,694	3,916	11,506	11,373	689	4,605	70,218
1990	19,421	13,051	2,144	4,215	12,778	12,556	2,428	6,643	76,861
1991	21,264	14,214	2,374	4,665	14,127	13,871	2,471	7,137	83,997
1992	22,539	14,955	2,606	4,955	15,402	15,155	2,182	7,137	91,134
1993	23,275	15,348	2,838	5,077	16,538	16,247	1,659	6,737	97,871
1994	24,593	16,340	2,979	5,262	17,932	17,636	1,399	6,661	104,532
1995	27,062	18,693	2,830	5,527	19,783	19,488	1,753	7,279	111,811
1996	27,506	19,371	2,517	5,606	20,859	20,552	1,041	6,647	118,458
1997	29,700	20,683	2,712	5,564	22,402	22,082	1,734	7,298	125,756
1998	29,070	20,615	2,830	5,216	23,981	23,654	-128	5,089	130,845
1999	29,104	20,210	3,636	4,729	25,149	25,256	-774	3,954	134,799
2000	28,314	20,051	3,721	4,307	26,232	26,324	-2,225	2,082	136,880

Note: Transfers with other schemes are excluded from both revenue and expenditure.
Source: Ministry of Health, Labour and Welfare, Japan.

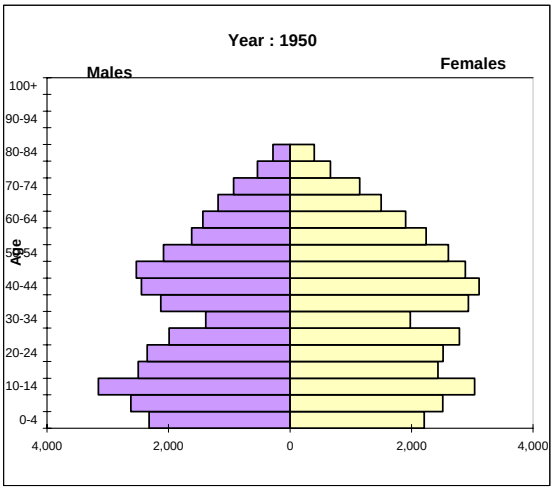
Figure S.1. Estimated population pyramids for selected OECD countries, 1950-2050[32]
(a) Japan

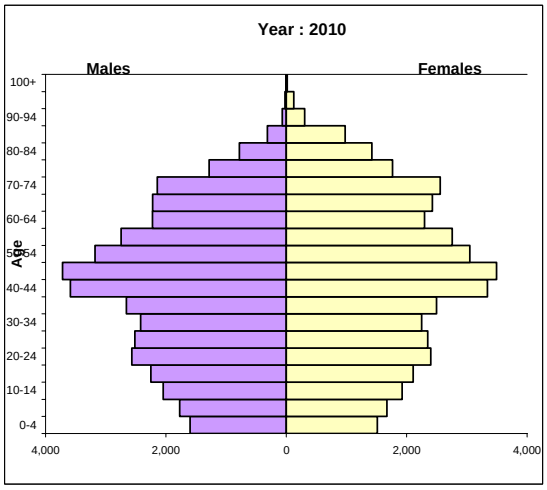


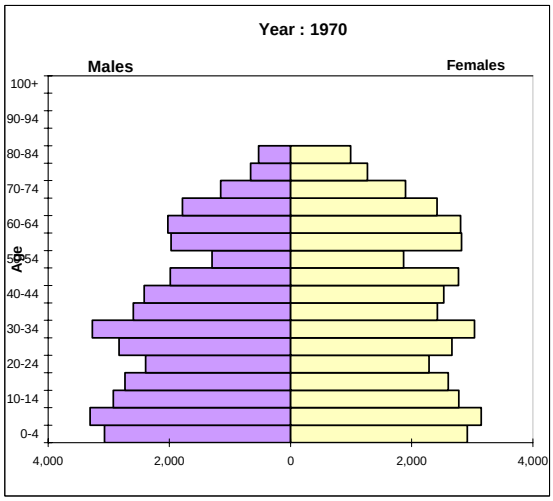
Source: United Nations "World Population Prospects, The 2000 Revision"

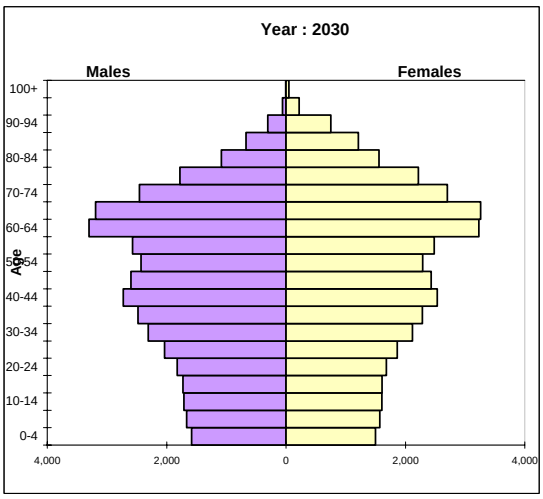
[32] Medium variants

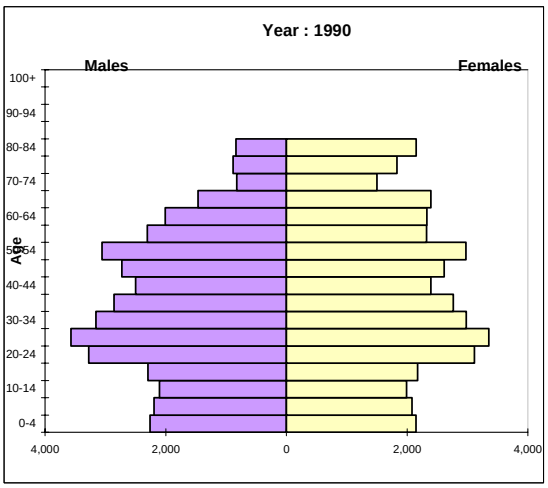
(b) Germany

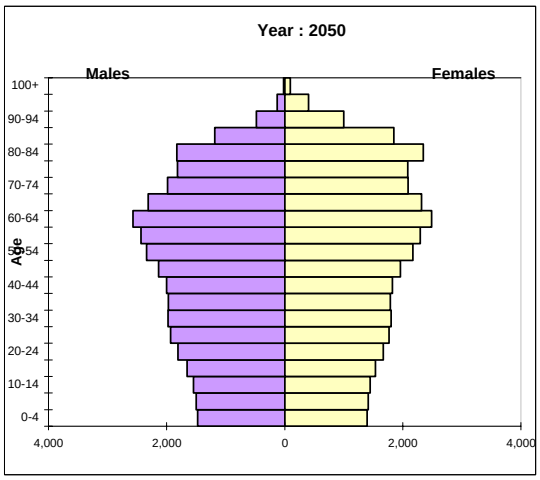






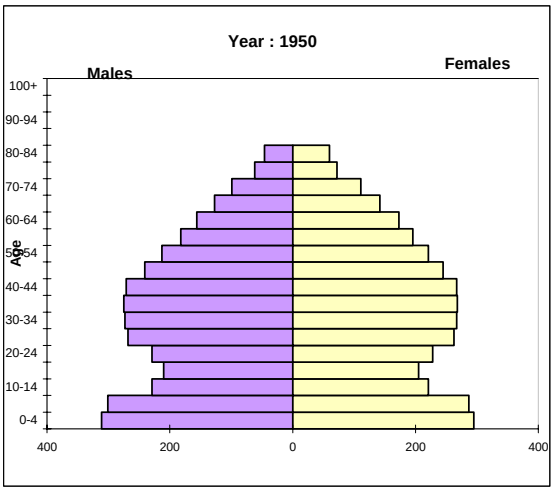


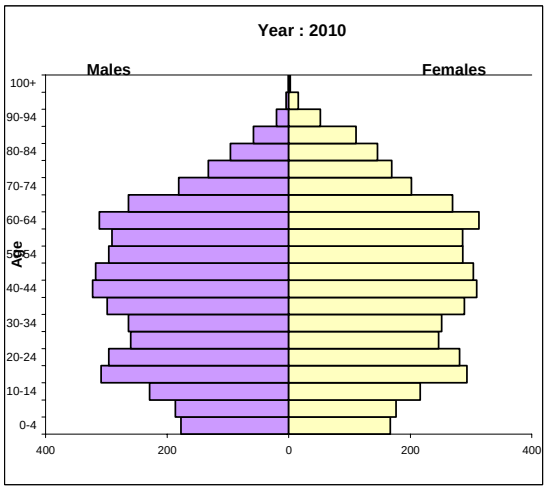


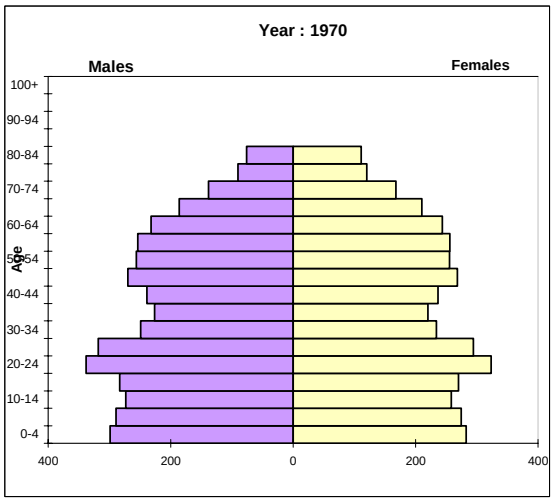


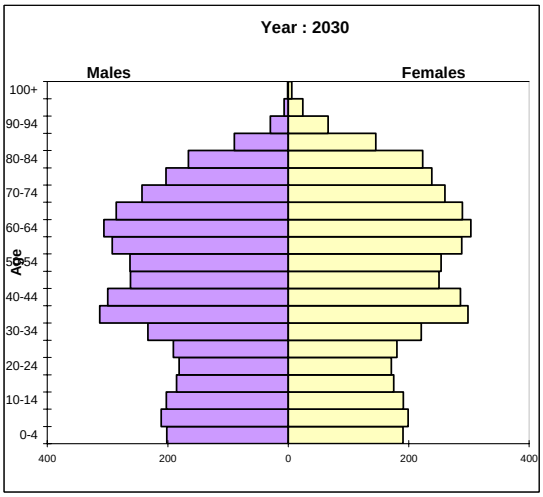
Source: United Nations "World Population Prospects, The 2000 Revision"

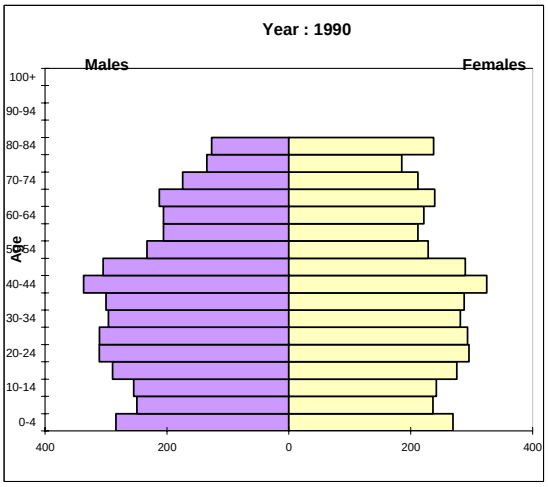
(c) Sweden

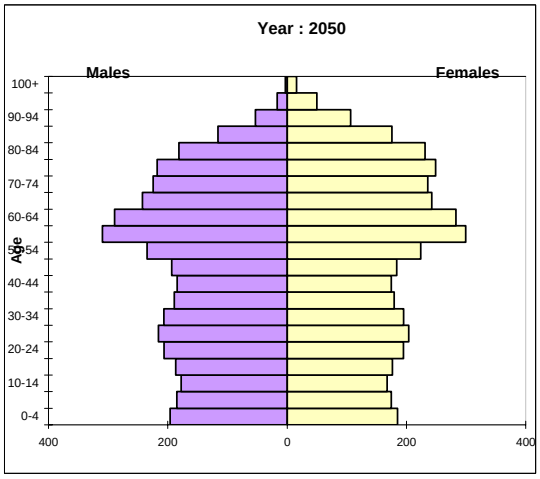






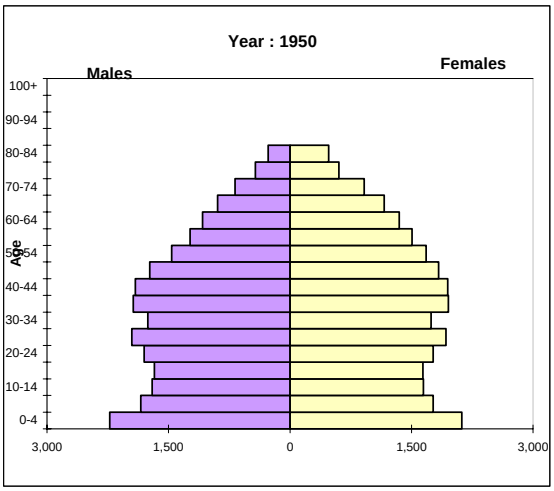


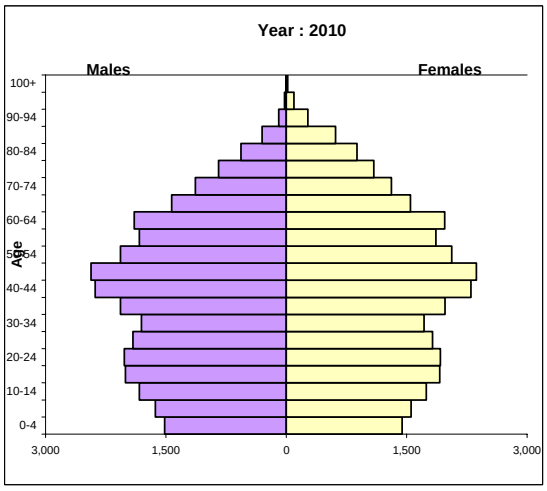


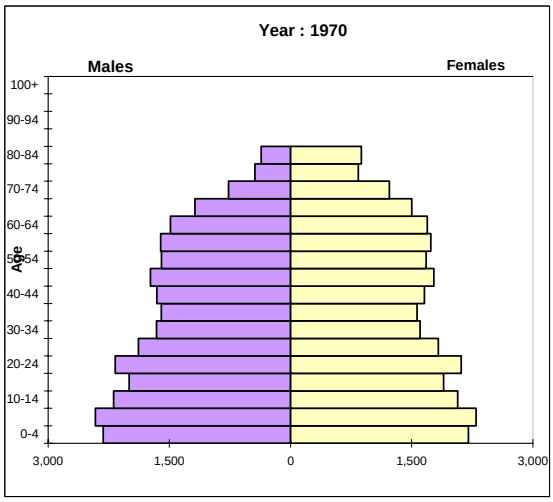


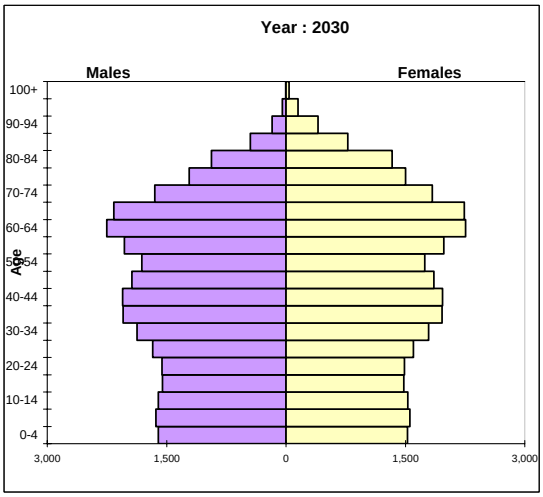
Source: United Nations "World Population Prospects, The 2000 Revision"

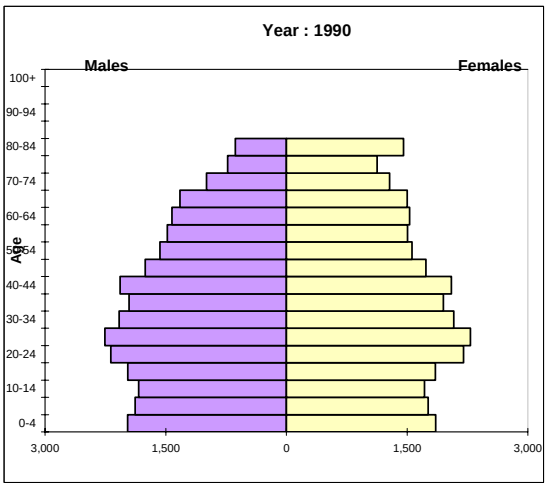
(d) United Kingdom

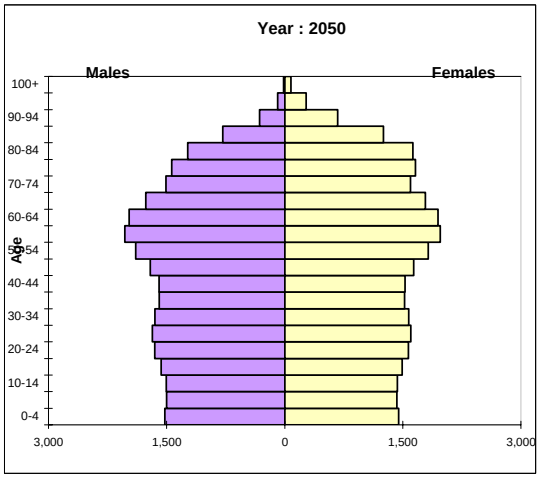






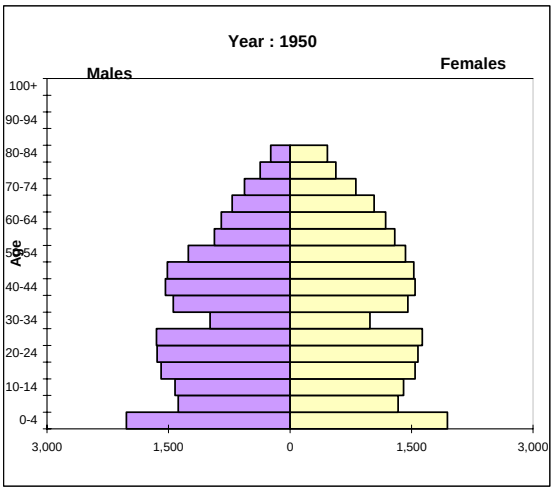


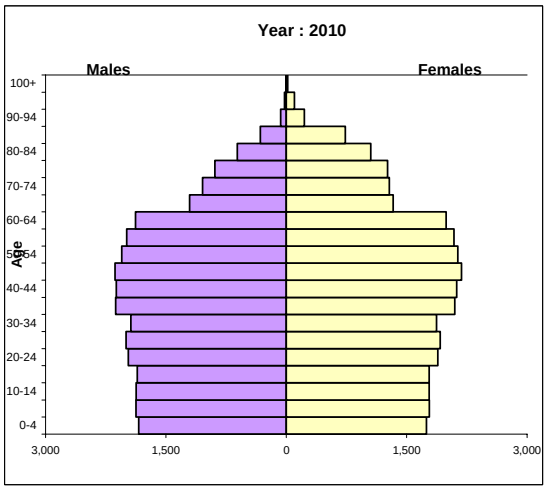


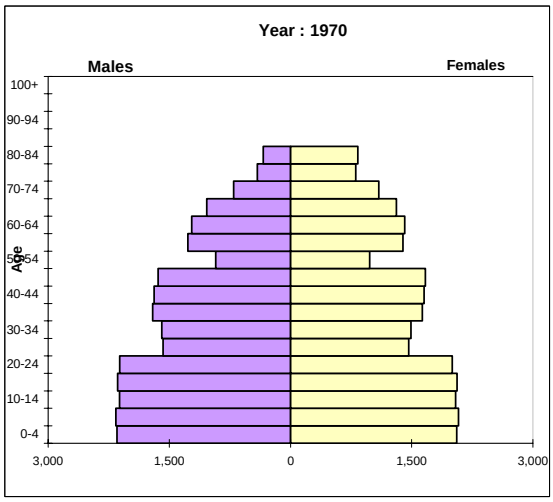


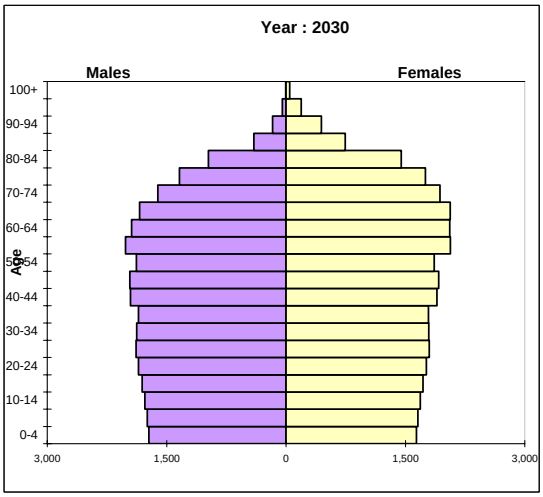
Source: United Nations "World Population Prospects, The 2000 Revision"

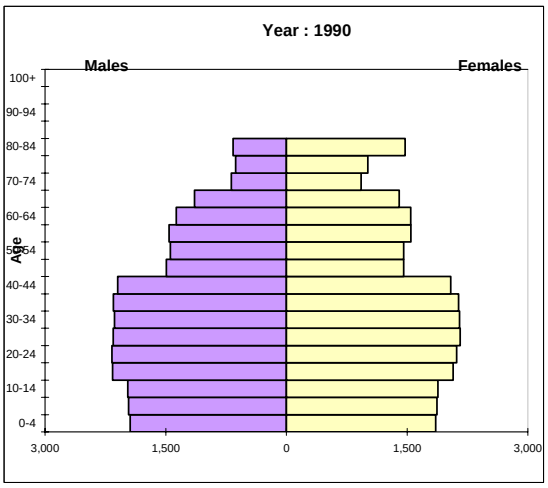
(e) France

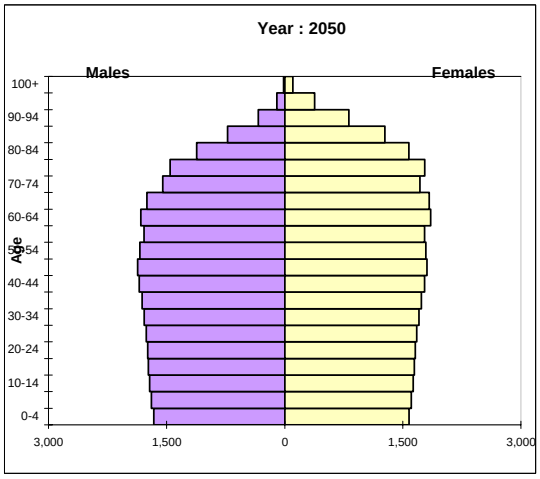






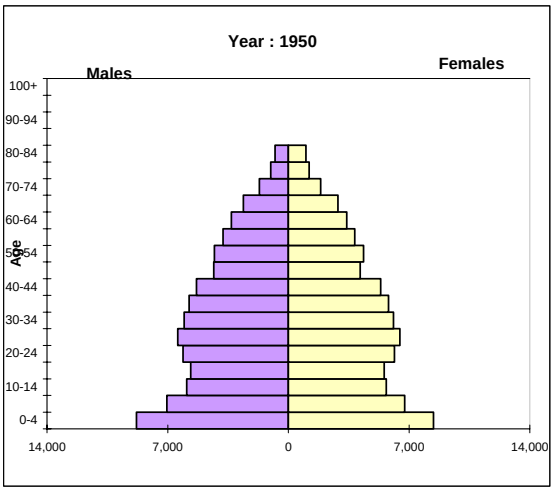


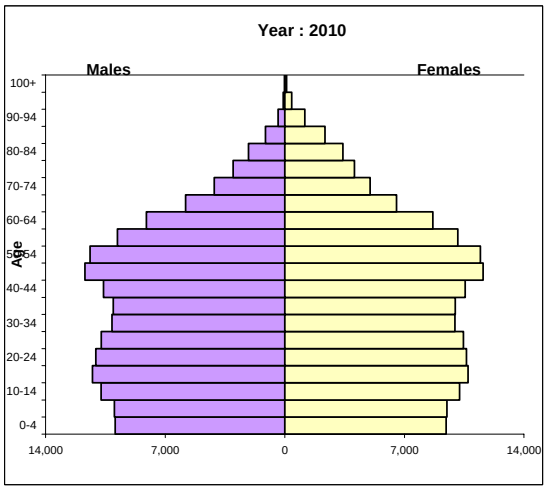


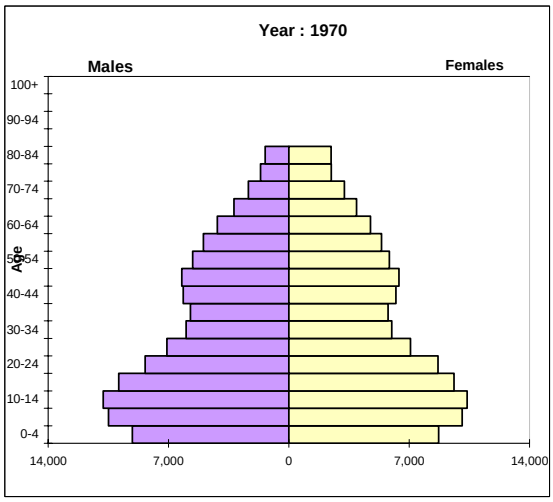


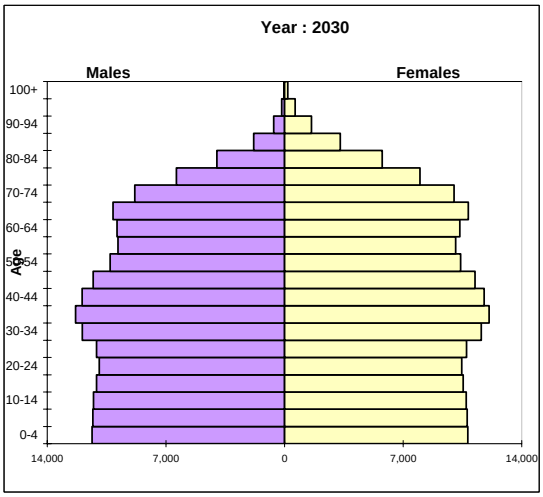
Source: United Nations "World Population Prospects, The 2000 Revision"

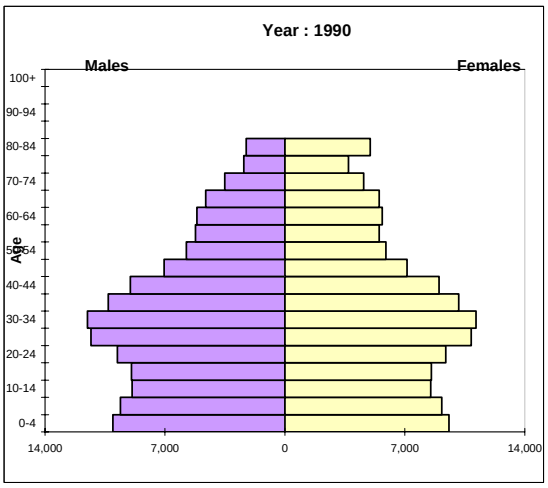
(f) United States

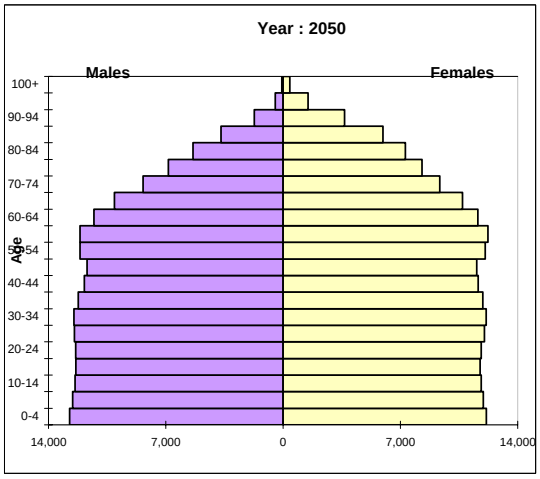












Source: United Nations "World Population Prospects, The 2000 Revision"