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THE FUTURE OF PUBLIC PENSIONS IN JAPAN

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Abstract: Among the seven major economies, Japan is one where ageing of the population is most worrying. This paper is a new attempt for studying the future of public pensions in Japan using a computable general equilibrium model with overlapping generations allowing for time-varying life-expectancy. The main result is that an active Fund policy outclasses a constant replacement rate policy from any point of view: (macroeconomic performance, actuarial fairness and social welfare). In addition, it also should be better than a constant contribution rate policy due to the low level of the Japanese tax pressure.

JEL Classification: D58, H55.

Key-words: Ageing, Japan, life expectancy, overlapping generations, pensions, welfare.

1. INTRODUCTION

In an earlier paper (Chauveau and Loufir (1995)), we have provided some new evidence on the consequences of an ageing population on the financial burden of public pensions in the seven major economies. Two polar scenarios were under review: (i) the instantaneous replacement rate was held constant and this implied, in turn, that contributions had to increase, to match current public expenditure or (ii) the adjustment was made on the expenditure side, assuming a constant pension contribution rate so that any demographic change were balanced by a change in the benefit level. The main conclusions were: (i) ageing of the population is a worrying problem very similar from one developed country to another even though policies where "Pay-As-You-Go" (PAYG) financing is maintained and the retirement age held constant appear to be sustainable; (ii) there is no "one best social security policy" since using different criteria (macroeconomic aggregates, actuarial fairness or welfare) lead to different ranking of the two basic policies mentioned above (and consequently, any combination of these policies); (iii) on the contrary, there is a trade-off between, on the one hand, lowering (raising) interest rates, increasing (decreasing) investment and output, lowering

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(increasing) taxes, ... and, on the other hand, increasing (decreasing) the standard of living of the retired.

However, it must be pointed out that among the seven countries considered, two groups should be considered: (i) countries in which pensions are financed on a PAYG basis (this is the mode of financing adopted in Canada, France, Germany, Italy, and United Kingdom); (ii) countries in which the pension system is funded; the members of funds are working and contributing; the retirement benefits are paid from contributions and interest earnings; expenditures and receipts have to balance over the life-span of the scheme. This latter mode of financing prevails in Japan[1] and the United States. Therefore, for these two countries in which the public pension system is, at present, funded, it was implicitly assumed, in our earlier study, that the reserves held by the Japanese and US Funds would increase by the amount of their interest receipts during the period under review.

The following question, thus, arises: to which extent can we improve the two benchmark policies by relaxing the assumption of holding reserves constant? In this paper, we answer such a question for Japan which is the country where ageing of the population is most worrying. We show that an active Fund policy outclasses the constant replacement rate (CRR) one from any point of view: macroeconomic performance, actuarial fairness and social welfare. Such a result prevails under the standard assumptions of a "closed economy" and of a "small open economy". In addition, an active Fund policy should be better than a constant contribution rate (CCR) one due to the low level of the Japanese tax pressure.

We use the same dynamic computable general equilibrium model with overlapping generations (hereafter CGEM-OG) as in our previous paper (1995) which rules out the well-known weakness of former CGEM-OG in which the simulated age structure (and total population) cannot coincide with the actual (projected) ones. Indeed, this model allows for time-varying life expectancy.

Two antagonistic assumptions have been made as far as the accounting framework is concerned: (a) the Japanese economy is assumed to be a closed economy or (b) it is a "small open economy". Perfect mobility of capital is then assumed, i.e. the domestic interest rate of Japan must equalize the "world" rate of interest.

This paper is organized as follows: Section 2 provides prospective demographic trends and contributes to a better understanding of the extent of the problems that lie ahead. It is also devoted to a brief review of the Japanese public pension system. Section 3 gives a very short description of our new CGEM-OG and of its calibration. Section 4 is devoted to the economic consequences and the welfare effects of three benchmark policies (Fund, CRR and CCR). Section 5 concludes.

[1] For a discussion of the basis on which the Japanese pension scheme operates, see Section 2.B.

2. DEMOGRAPHIC TRENDS AND INSTITUTIONAL ASPECTS OF PUBLIC PENSION SYSTEMS IN JAPAN

A. Demographic Trends

The set of demographic projections which have been used are, once again, those prepared by the World Bank in 1992 which possess the following interesting feature: their horizon is year 2150, where total population becomes stationary. Therefore, the horizon of the prospects are long enough for using Fair-Taylor algorithm (1983).

The demographic projections by the World Bank (see Table 1) are based on rather standard assumptions regarding fertility, mortality, and international migration. The Japanese fertility rate is assumed to move up, from year 2000, to the replacement rate by year 2030. The mortality rate is based on recent trends in life expectancy until 2030 and assumed to remain constant thereafter. The international migration rate is extrapolated from past and present evolutions of migration trends and policies, and their net level is assumed to reach zero by year 2025.

The evolution, from 1990 to 2100, of total population and of the demographic structure is plotted on Fig. 1. The Japanese population is projected to peak at around 130 million in 2015 and to decline marginally during the subsequent 40

TABLE 1. Demographic Structure in Japan: 1990–2050.
(Total population in million, others in percent of total population)

	1990	1995	2000	2005	2010	2020	2030	2040	2050
Total Population	123.5	125.7	127.6	129.2	130.0	129.0	126.3	122.7	119.7
Less than 20 years	26.5	23.4	21.6	20.9	20.7	20.6	20.6	21.6	22.0
Between 20 and 59 years	56.1	56.5	55.7	53.6	50.4	48.0	46.3	43.4	43.6
60 years and more	17.3	20.1	22.7	25.5	29.0	31.4	33.0	35.1	34.4

Source: World Bank, 1992.

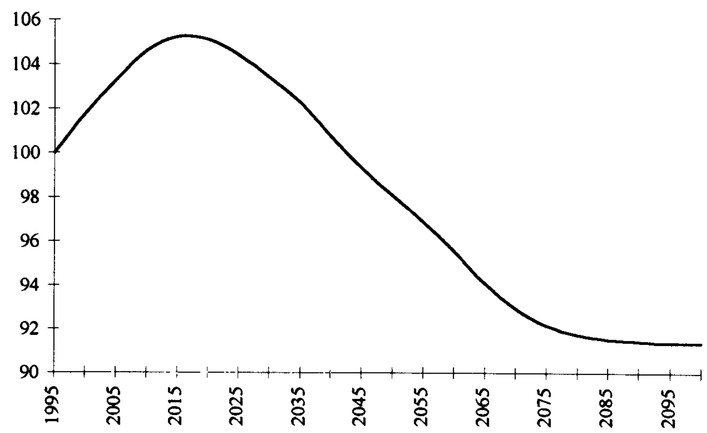


Fig. 1. Total Population (1995 = 100).

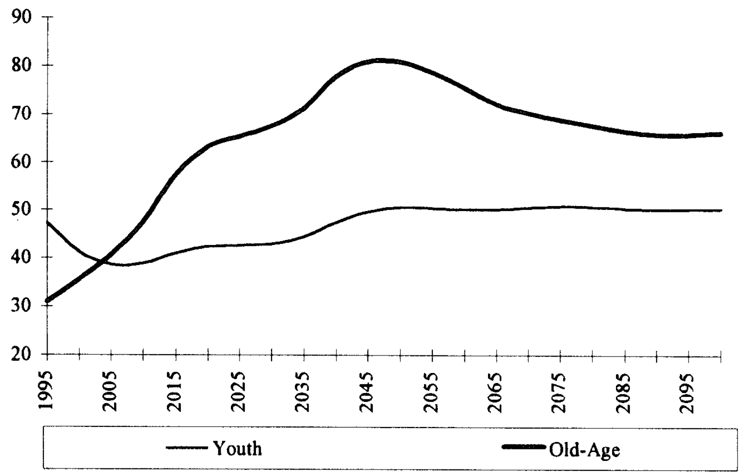


Fig. 2. Dependency Ratios (in %).

years. In the long run, the level of total population is noticeably below the initial one (-8%).

As shown in Table 1, the share of 0–19 age-group in the population will decline, from 1990 to 2050, by 4.5 percentage points and conversely the share of 60 and more age-group in the population will increase by 17.1 percentage points. The corollary of this phenomenon is a decrease of the share of 20–59 age group in total population. Ageing, defined as the increase of the share of elderly people (usually persons above 65 years of age) in total population, will increase considerably. This pronounced ageing will be accompanied by a steep increase of the so-called old-age dependency ratio i.e. the number of elderly persons in proportion to the number of those in active age-groups during the next 50 years. According to the projections of the World Bank (see Fig. 2), there will be, in year 2040, 12 working-age individual for 10 retired in Japan whereas they were 32 in year 1990; finally, the profile of the so-called youth dependency ratio, i.e. the number of children in proportion to the number of those in active age-groups, is much flatter than the ones of the old-age dependency ratio. No real compensation can be expected, in the long run, between the evolutions of the two dependency ratios.

B. Institutional Aspects

The general scheme, the *Kokumin-Nenkin* scheme (KN) provides a basic flat-rate pension to all residents. Five other schemes provide supplementary earnings-related pensions. All these schemes are financed on a PAYG basis, except the main programme : the *Kosei-Nenkin-Hoken* (KNH) scheme, which held assets of around 18 per cent of GDP at the end of 1990.

At present, contribution rates match current benefits while the interest earnings are entirely used to accumulate further assets. Hence, the KNH system can be viewed as operating on a PAYG basis. However, with pension payments gradually

TABLE 2. A Summary of Pension Formula for General Old-Age Benefit Scheme in Japan in 1988.

Retirement Age:	Statutory (M/F)	60/55
	Average (M/F)	62.3/60.6
Minimum Contribution Period		25
Contribution Period for Full Pension		40
Maximum Replacement Rate		30%
Indexation of Benefits on:		Prices and wages

Source: OECD, 1988.

increasing, the contribution rates should rise drastically. Therefore, this situation, which is officially projected to persist in the next century,[2] will not last with certainty. Hence, the KNH scheme can alternatively be viewed as working on a revised funded basis. A summary of the main features of the current scheme is given below (Table 2).

3. MODELLING THE JAPANESE ECONOMY

A. The Model

Three agents (firms, households and a public sector) operate in three markets (goods, labor and capital).

a. Firms

A representative firm is assumed to operate on perfectly competitive markets. It produces a single good which can be consumed or invested. The production function is of the Cobb-Douglas type, with constant returns to scale. Technical progress is labor augmenting and its rate is constant. Productive capital depreciates at a constant annual rate. In equilibrium, the firm's profit is zero, because of perfect competition and constant returns to scale. One must notice that no adjustment costs are introduced although transition paths are considered[3]; the program of the representative firm is given in Appendix.

The cost of capital is the sum of the real interest rate and the rate of depreciation of capital and the cost of labor is the gross wage rate including social contributions i.e. the net wage multiplied by one plus the sum of the employer's social contributions rates. Both factor prices are perfectly flexible. In equilibrium, the former equalizes the marginal productivity of capital, and the latter the marginal productivity of labor.

The reasons for the choice of a Cobb-Douglas function have already been discussed (Chauveau and Loufir, 1993); they are briefly as follows: first, it is easier to compare our results to other authors' ones (Auerbach and Kotlikoff, 1987; Auerbach, Kotlikoff, Hagemann and Nicoletti, 1991; Steigum, 1993) since they all chose a function of the Cobb-Douglas type. Second, the robustness of the

[2] See Van den Noord and Herd, 1994.

[3] For a justification of this omission see earlier works (e.g. Auerbach and Kotlikoff, 1987).

results with respect to the change of the production function has been established (see Cazes, Chauveau, Le Cacheux and Loufir, 1994).

b. Households

The household sector comprises two kinds of individuals: children, who are pooled in four age groups[4] (0–4, 5-9, ···, 15–19 years) and adults who are grouped among fourteen generations: eight for the working population (20–24, 25–29, ··· , 55–59 years) and six for the retired (60–64, ··· , 85–89 years). Only adults take economic decisions so that our model actually comprises fourteen overlapping generations.

At each period, individuals belonging to the youngest generation of adults (generation n°1) enter the labor market; they become, at this very time, parents; they will rear their children during four periods (20 years) and work during eight periods (40 years); when they are 8 periods old (i.e. 60–64 year old), they will receive a bequest left by their parents (i.e. 75–79 year old people) and they, simultaneously, retire.

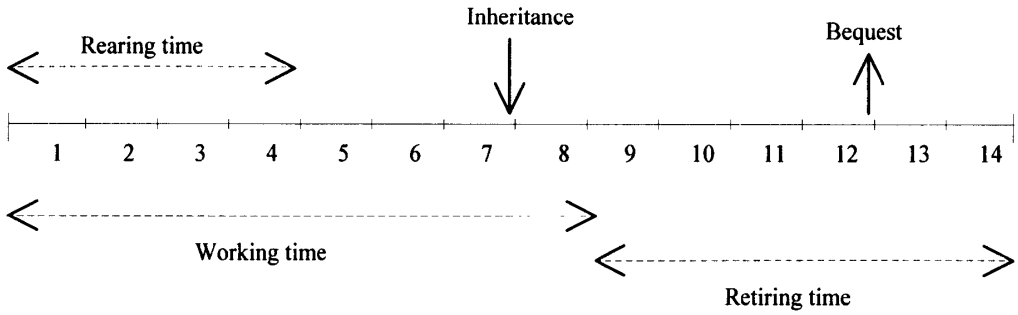
At each period, children and adults may die: when a child dies, the expenditures of the representative adult who was in charge of his/her rearing are reduced, at the next period, by the corresponding amount; when an adult dies, two polar cases must be distinguished:

- if, at his death, he/she was bringing children up, then: (i) adults belonging to his/her generation are put in charge of his/her children; these children will, later, inherit their adoptive parents; (ii) his/her wealth is given to the adoptive parents of his/her children; this is a compensation for the adults in charge of orphans.
- if he/she is no more breeding children then his/her wealth is given to the adults belonging to his/her generation. These last assumptions are equivalent to a fair insurance mechanism. Moreover, we assume, as in Blanchard (1985), that even if individual households are uncertain about their date of death (microeconomic lifetime uncertainty), the population is large enough to insure that a certain fraction of each generation dies with probability one every year.

Each representative grown-up individual entering the a^{th} period of his life cycle at the beginning of period t determines the intertemporal profile of his/her consumption and leisure and the amount of the bequest he/she will leave according to the program given in Appendix. It must be pointed out that, in earlier CGEM-OG models, everybody was assumed to die with certainty, at a given age (last year of his life). Hence demographic trends depended on but one parameter-the number of birth- and important discrepancies appeared, between simulated and actual or projected pyramid-shaped diagrams. Allowing for uncertain lifetime or, more precisely, for time-varying life-expectancy rules out this drawback which, in earlier studies lead to non negligible errors for macroeconomic aggregates, fairness ratios and social welfare (for a comparison of the results of the two kinds of models see e.g. Chauveau and Loufir (1994a)). To sum up, the behavior of

[4] Such a pooling has been done because taking into account periods of one year would have led to implementing a too large model.

households obey the lifecycle theory (Ando and Modigliani, 1963; Modigliani, 1986), augmented for a bequest motive, for children being taken into account and for demographic uncertainty (Yaari, 1965; Merton, 1981). The life cycle of an individual can be schematized as follows:



c. Public sector

The public sector has three separate branches: the government, which levies taxes and provides collective goods or services; a public health and family allowance department and a pensions department; these two departments provide health or family allowances or pensions and levy social contributions on wage incomes at a proportional rate. The government expenditures are the sum of three elements: (i) general administration spending; (ii) spending on education and (iii) subsidies given either to households or to the public pensions department. We assume that the per adult amount of general administration spending discounted by the technical progress factor is constant and, similarly, that spending on education again discounted by the technical factor is proportional to the number of children; transfers are assumed to be proportional to total output. There are three taxes: a VAT which is proportional to households' consumption, an inheritance tax proportional to bequests and an income tax. There is no public debt since the budget is balanced. The first two tax rates are exogenous and constant, whereas the third one (the income tax rate) is adjusted so that total tax revenues equal total spending. Social contribution rates are exogenous and total outlays adjust to them. Note that health and family expenditure are assumed to be indexed on technical progress so that in steady-growth equilibrium, their amount is a constant fraction of national income. Pensions are assumed to be uniformly distributed among the retired population which is assumed to include all individuals over the legal retirement age.

We assume a continuing PAYG financing: matching flows of pension contributions and pension expenditure on a year-by-year basis. Public pensions are indexed on the contemporaneous average net wage. To ensure that annual budgets are balanced, three basic assumptions can be made: (i) the pension contribution rates are endogenously determined, given a level of per-head pension benefit, by the budget constraint of the pensions department; for the sake of simplicity and with no loss of generality, we assume that employers' and employees' rates are, again, proportional; (ii) the social contribution rates are exogenous (and constant) and the per-head pension benefit is endogenously determined; (iii) when a Fund option is considered, the intertemporal profile of the reserves, as expressed in proportion of GNP, has been chosen with an iterative procedure, leading to the "best" smoothing" of the contribution rate (see below).

Finally, seven major assumptions have been made: (A1) Expectations are rational and, since macroeconomic uncertainty is ruled out,[5] they are exact. (A2) Technical progress is exogenous and neutral with respect to the choice between consumption and leisure. (A3) There is an adjustment factor characterizing the time path of individual earnings i.e. the seniority age profile of compensation. (A4) Consumption of children is complementary to their parents'. (A5) The effective age of retirement coincides with the legal one. (A6) At each period only one generation gives a bequest to one's heirs. (A7) The fair insurance mechanism is compulsory. These assumptions have already been discussed in earlier works (see e.g. Chauveau and Loufir, 1995).

B. Calibration

The parameters are adjusted in such a way that simulated aggregates match those observed between 1985 and 1989. Table 3 provides the values of these parameters together with the values of exogenous variables. With regard to the Public sector's parameters and exogenous variables, and the endogenous ratios and macroeconomic variables on the other hand, they are chosen in accordance with average historical values (OECD data between 1985 and 1989). The goodness of the fit can be appreciated from Table 3.

4. SIMULATION RESULTS

The interplay of an ageing population and a PAYG financed pension system may raise important issues for the Japanese government in the coming decades. Many policies may be considered, among which we have selected three as benchmarks: (i) holding constant the replacement rate[6]; (ii) holding constant the contribution rate; (iii) "Smoothing" the profile of the contribution rate by an active Fund policy. Moreover, two standard assumptions have been made as far as the accounting framework is concerned: (i) the Japanese economy is a closed economy or (ii) it is a "small open economy". With the former assumption, the rate of interest is endogenously determined together with the wage rate. With the latter assumption, the accounting framework used is analogous to the one most often used in this kind of studies (see e.g. Auerbach, Kotlikoff, Hagemann and Nicoletti, 1989); perfect mobility of capital is assumed and the domestic interest

[5] As there is no uncertainty at the aggregate level (see above).

[6] In this paper, the phrase "replacement rate" may be misleading. It corresponds to an "instantaneous" replacement rate. For details, see Chauveau and Loufir (1995).

TABLE 3. Calibration.

a. Parameters and Exogenous Variables

Parameters and Exogenous Variables	
Households	
Annual Time Preference Rate	0.0050
Intertemporal Elasticity	0.95
Intratemporal Elasticity	1.20
Preference for leisure	
for individuals of 21 to 40	0.550
for individuals of 41 to 90	0.792
Preference for bequest	0.625
Firms	
Annual depreciation Rate	0.05
Annual productivity growth rate	0.02
Share of capital	0.30
Public Sector	
V.A.T. rate	0.020
Average tax rate	0.235
Bequest's tax rate	0.061
Social contribution rate	0.078
Pension contribution rate	0.052
Replacement rate	0.296

b. Endogenous Variables
Simulated Values (average 1990–1994)
Observed Values (average 1985–1989)

Endogenous Variables	Simulated Values (average 1990–1994)	Observed Values (average 1985–1989)
Annual real interest rate (%)	4.32	4.36
Capital/Output ratio	3.30	n.a.
Saving (Investment) rate	29.59	29.95
Consumption/Output ratio	61.24	60.38
Public expenditure/Output ratio	9.17	9.67
Total taxes/Output ratio	29.58	29.32
Taxes/Output ratio	20.38	20.86
Total social contributions/Output ratio	8.50	8.50
Pensions/output ratio	5.56	4.76
Bequests/Output ratio	7.48	n.a.

n.a.: not available.
Sources: OECD, 1992a. and b.

rate equalizes the world rate of interest.[7] For the sake of simplicity, the world rate of interest is, in its turn, identified to the US one (obtained from the simulation assuming the US economy to be closed). This is because opening the frontiers of the US should lead to antagonistic capital movements. Indeed, among the G7 countries, some have interest rates greater than the US one and others lower. Moreover, the differences between these rates are moderate (see Chauveau and Loufir 1995). A rigorous general equilibrium analysis has not been undertaken since its implementation was not possible due to the size of the corresponding model.

Six dynamic simulations have, thus, been undertaken: they are referred to as CCR-CE, CCR-OE, CRR-CE, CRR-OE, FUND-CE or FUND-OE, where CCR (CRR) stands for "Constant Contribution Rate" ("Constant Replacement Rate"), and CE (OE) for closed (open) economy.

Of course, the assumption about the social security policy to be undertaken has to be coupled with an assumption about the rhythm of technical progress: indeed, we limit ourselves to the usual assumption that the corresponding rate is constant at the level of 2% per year. The sensitivity of the solutions to the rate of technical progress has already been studied, for the French case by Chauveau and Loufir (1994b).[8]

A. Macroeconomic outcomes

We focus on results relative to output, prices, saving rates, pensions, taxes, actuarial fairness and welfare.

a. Output

In the long run, the demographic transition occurring in Japan implies that discounted per-head output (the discount factor is the technical progress factor will tend to decrease (see Fig. 3). Whatever the assumption about the openness of the Japanese economy, the CCR option leads to higher outputs than the CRR one, since the interest rates are markedly lower (see below). However, this is not the only reason for a higher output; indeed, since wages are somewhat higher, people also work more and, consequently, the difference between the two polar options is quite important. Note that the unfavorable effects, on per-head output, of the demographic transition are both important and sensitive to the scenario under review. As could be guessed, the Fund options lead to outputs which are intermediate between the two benchmark scenarios (CCR and CRR). However, as far as the assumption of a closed economy is made, the Fund option leads to higher outputs at the beginning of the transition period, due to a marked fall of the rate of interest (see below).

[7] Simultaneously, the wage rate becomes exogenous, since the production function is a Cobb-Douglas one. The first order conditions of the program of the representative firm make both the wage rate and the real rate of interest dependent but on capitalistic intensity.

[8] The rate of technical progress is assumed to slowly increase (decrease) to reach the steady-growth value of 3% (1%).

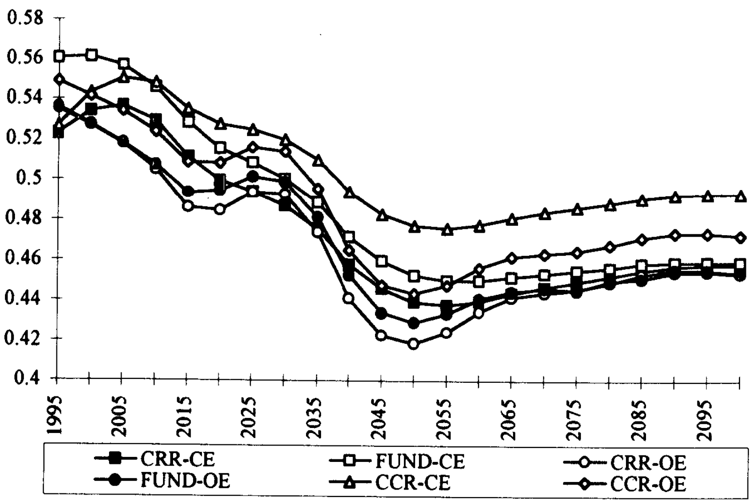


Fig. 3. Discounted Per Head Output.

The fluctuations of discounted per-head output essentially depend on the evolution of the ratios Working Population/Total Population. The same could be said about per-head labor supplies which are closely related to these ratios.

Since the rate of technical progress is not negligible, the paths of *current* outputs are always sloping upward. One must notice that, if the rate of technical progress were very low, a slump—i.e. a fall in current per-head output—could be ruled out. However, such a contingency is unlikely to happen, since it requires very low values—almost zero values—for the rate of technical progress which are unrealistic.

b. Interest rate

The CCR option leads to lower interest rates than the CRR one because households must, when the former option prevails, save much more than when the latter does, since the benefits they will get during their retirement are much lower. This, in turn, tends to lower the rate of interest (see Fig. 4). It is rather intuitive that a higher efficiency in labor will lead to a higher price of labor (i.e. an increase in the wage rate) and a lower price of capital (i.e. a decrease of the interest rate). The fluctuations of the wage rate (real interest rate) are moderate and parallel (opposite) to the ones of capitalistic intensity or of average efficiency of labor supply. Again, real interest rates lie, when the Fund option is considered, between the CCR and the CRR rates. Note that, at the beginning of the period under review, the interest rate corresponding to the Fund-CE option is much lower than the CRR (and, *a fortiori*, the CCR one) and, that, in the long run the Fund-CE scenario converge to the CRR-CE one.

Whatever the closed economy scenario considered, the real rate of interest is lower than the one prevailing with the antagonistic assumption (recall that the "world" interest rate is assumed to be the American one).

c. Saving rate

The life-cycle theory of saving assumes that people distribute their saving and consumption, over time and between themselves and their descendants, according

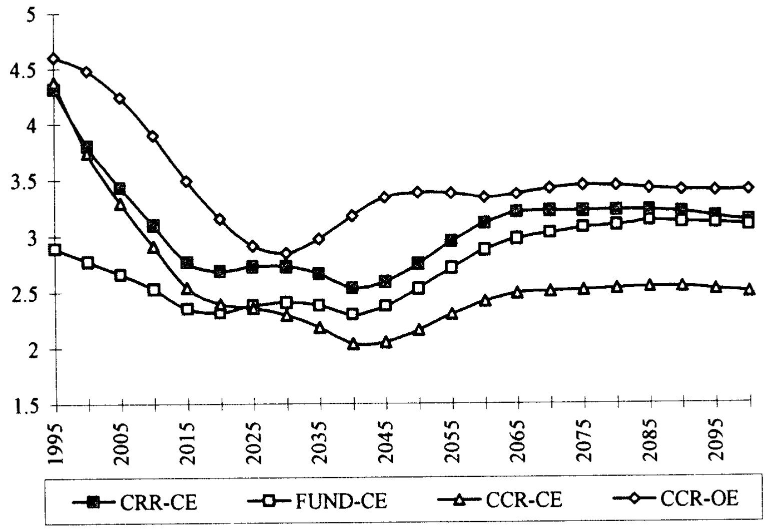


Fig. 4. Real Interest Rate (in %).

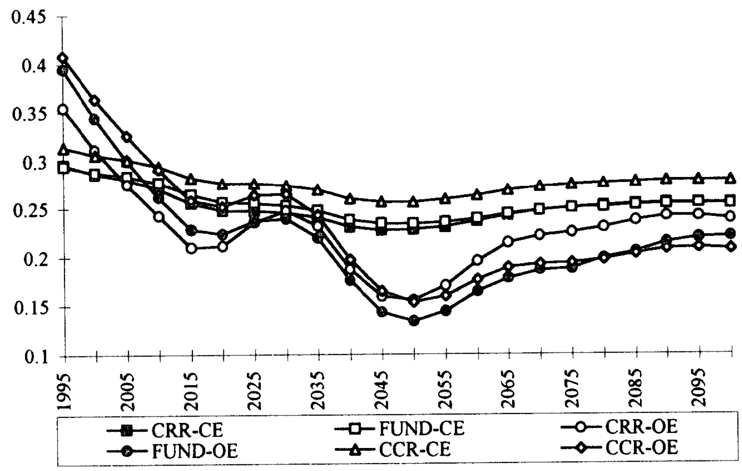


Fig. 5. Saving Rate.

to a system of preferences expressed in utility functions. According to this model, they save during their active lives to sustain for a higher consumption during their retirement and to leave something to their descendants. A rise in the proportion of old people in the total population would therefore lead to a fall in households' overall saving rate and, consequently, in national saving rate. This phenomenon may be partially or totally offset by a decrease in the replacement rate which occurs when the CCR option is considered; indeed, holding constant the contribution rate when the old-age dependency ratio raises sharply, implies a steep decrease of the discounted per-head benefit which, in its turn, involves an increase of savings. When Japan is assumed to be a closed economy, the saving rate falls almost steadily and, later, stabilizes (see Fig. 5). Only very little differences between the three scenarios can be exhibited. When the assumption of a small open economy is made, the saving rate fluctuates markedly, due to the fluctuations of capital

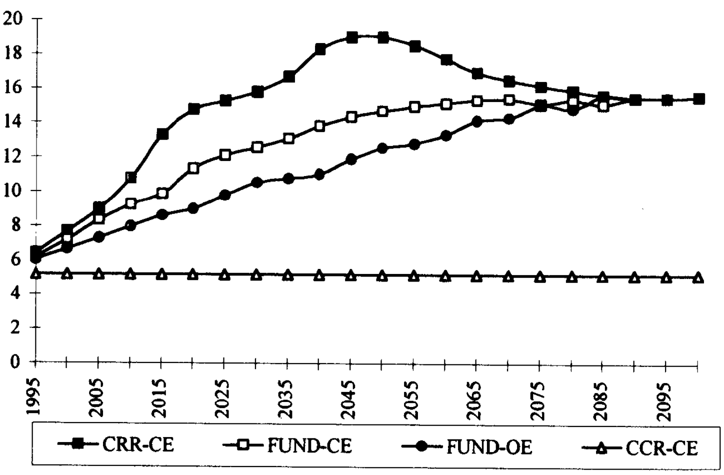


Fig. 6. Pension Contribution Rate (in %)

movements. Whatever the scenario considered (CE or OE), the Fund options lead, again, to saving rates lying between the two benchmark ones (CCR and CRR).

d. Pensions

If the CRR option prevails, the increase of benefits induced by the increase in the total of the retired population must be compensated by an almost equivalent rise in pensions contributions, since public subsidies are quite moderate. As these contributions are levied on wages, the profile of a contribution rate essentially depends on the evolution of two variables: (i) the old-age dependency ratio; (ii) the indexation of pensions on wages. Since we have assumed a perfect indexation of pensions on wages, the fluctuations of the pensions contribution rate (see Fig. 6) are almost perfectly analogous to the ones of the old-age dependency ratio (see above Fig. 2). To avoid a drastic jump in the contribution rate (18% in 2045 against 6% in 1995), a Fund policy can be undertaken allowing for a steadily rise of this rate (see Fig. 6). Of course, the smoothing is better when the open economy assumption is made, since higher interest rate allow for more important interest receipts. In year 2045, the Fund-CE (Fund-OE) contribution rate is 4 percentage (6) points lower than the CRR one. Finally, recall that the pension contribution rates are, as far as the CRR and CCR options are considered the same in the two cases of closed and open economies and that, if the rate of contribution is held constant, the replacement rate falls drastically as the contribution rate rises in the polar case.

When a Fund option is considered, the intertemporal profile of the reserves, as expressed in proportion of GNP, has been chosen with an iterative procedure, leading to the "best smoothing" of the contribution rate. The corresponding profiles are given on Fig. 7; when the Japanese economy is assumed to be closed, the reserves are, first, held almost constant (up to year 2015) and then decrease almost steadily to compensate the rise of the burden of the pensions. When the assumption of an open economy is made, an initial rise in the reserves (7 percentage

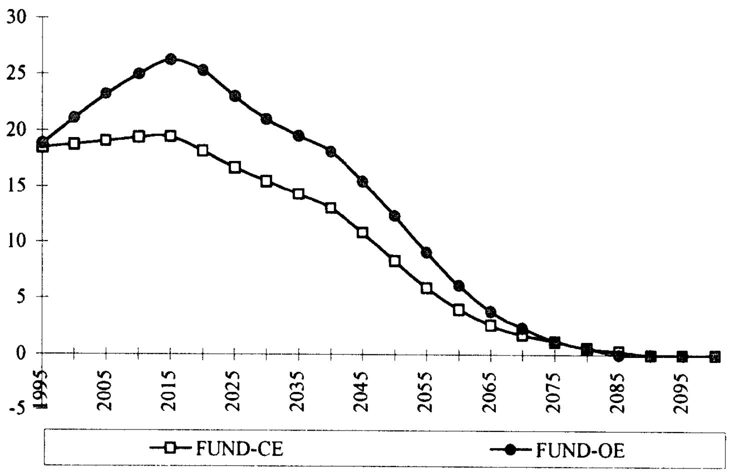


Fig. 7. Fund Reserves/Output (in %).

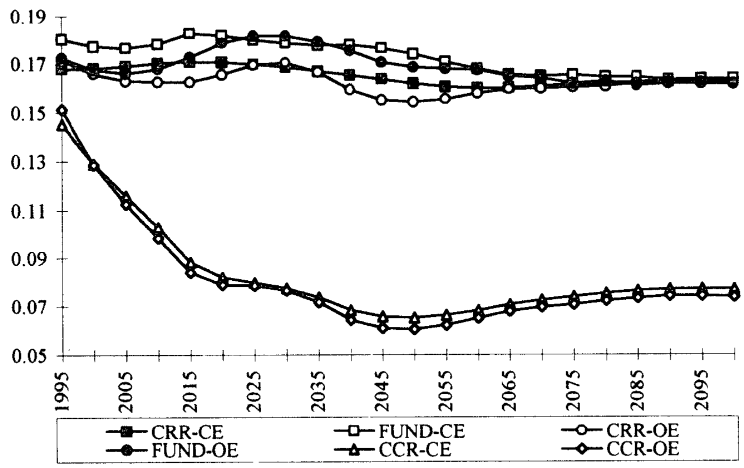


Fig. 8. Discounted Per Head Pension.

points in 20 years) appears to be better, due to higher interest rates. Finally, Fig. 8 shows that, if benefits are discounted with the technical factor, holding constant the contribution rate (CCR) induces a marked decrease of their level. Fund scenarios obviously lead to higher benefits than the corresponding CRR ones.

When *discounted* benefits are considered, an implicit criterion is used for appraising the situation of the retired: their relative standard of living. Another point of view is to look at the evolution of the absolute level of their standard of living, i.e. to consider *current* benefits. Whereas the CRR option leads to an almost steadily increasing profile of the level of current per-head pension benefits, the CCR option induces some important inflections of the profile of their level. In contrast with the results for current per-head output, a fall in the level of current per-head pension benefits can no more be ruled out, even with the CRR option, if the rate of technical progress is not high enough. Two "sustainability rules" may, thus, be thought of:

TABLE 4. Floor Values of the Rate of Technical Progress (in %).

	CRR-CE	FUND-CE	CRR-OE	FUND-OE	CCR-OE	CCR-OE
Rule No. 1	0.1	0.2	0.4	0.3	2.0	2.4
Rule No. 2	0.2	0.4	0.9	0.6	3.1	3.3

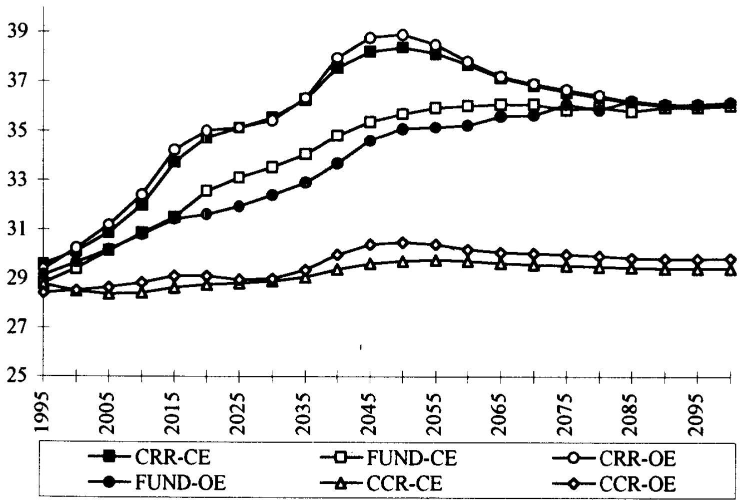


Fig. 9. Total Taxes/Output (in %).

(i) rule n° 1: set that the level of per-head pensions should never be lower than its initial level (1990 = 1), or;

(ii) rule n° 2: offset scenarios in which a decrease in the level of current per-head pensions may happen. Such a rule implies that the standard of living of the retired should always grow. Table 4 exhibits the floor-values of the rate of technical progress compatible with the two "sustainability rules".

As far as the first rule is considered, four options are sustainable if the rate of technical progress is, as usually thought, about 2%; on the contrary, the CCR options should be ruled out. Moreover, CCR scenarios are riskier than the other ones since the floor-values of the rate of technical progress for the former options are much higher and much more likely than the corresponding ones for the latter. If the second rule were lay down, the CCR options should again be ruled out. Differences between Fund and CRR options are not noticeably marked.

e. Total taxes

Three cases must be distinguished: (i) if a CRR option is considered total taxes appear to become a huge burden. This is due, essentially, to the profiles of pension contribution rates which increase sharply. (ii) with the CCR options, there is no problem of excessive tax pressure since the contribution rate is held constant. (iii) Fund options, again, lead to intermediate results; as shown for the pension contribution rate, a steady rise of tax pressure is exhibited, converging to the long term value of the CRR one. Finally, note that the previous results do not really

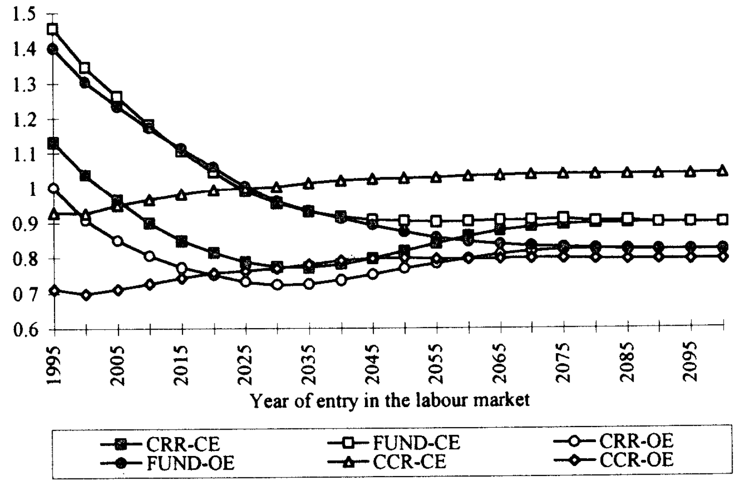


Fig. 10. Actuarial Fairness Ratio.

depend on the rhythm of technical progress (see Chauveau and Loufir, 1994a).

B. Actuarial Fairness

Actuarial fairness is generally measured, for any individual or for any generation, by the ratio of the present value of lifetime benefits to the present value of lifetime contributions. When uncertainty is allowed for, expected benefits and expected contributions must be taken into account.

The profiles of the fairness ratios (see Fig. 10) are quite different according to the option under review: in CRR scenarios, these ratios decrease from a high initial value to a rather low minimum value; they, next, increase a little, steadily and slowly, since the minimum value is close to the corresponding long-term equilibrium value. On the contrary CCR scenarios are characterized by a regular growth of fairness ratios, from an initial value which is markedly lower than the corresponding CRR value to a final value which is somewhat higher than the CRR long-term equilibrium value. Finally, Fund scenarios lead to an improvement of the fairness ratio since reserves can be used to increase benefits but such an improvement ends when reserves are exhausted.

C. Welfare

Social security policies may also be appraised, by valuing the corresponding social welfare. Many definitions may be considered: according to Samuelson (1958, 1959), one should consider the intertemporal utility of each generation; note that such a point of view is compatible with Pareto-efficiency. A preliminary remark must be made: many theoretical studies (see e.g. Breyer and Straub (1993)) point out that, with a standard overlapping-generations model, unfunded pension systems are Pareto-efficient unless one of the following assumption prevails: (i) there is no utility attached to labor; (ii) the contributions are levied in a lump sum fashion; (iii) the benefits are actuarially fair, given the contributions.

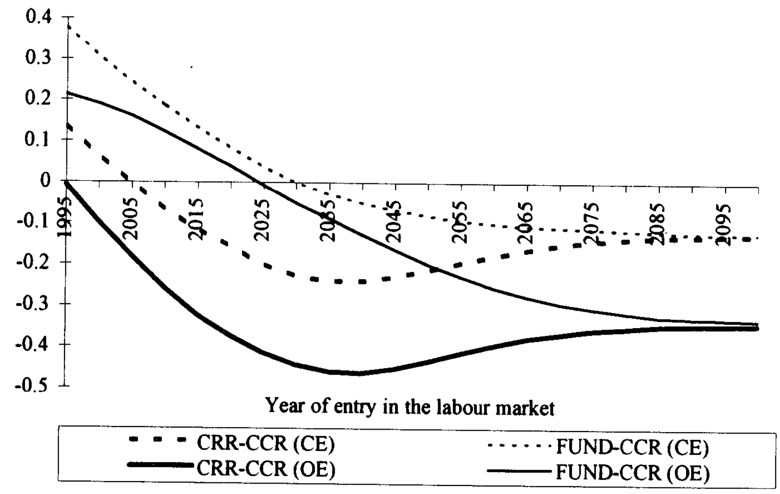


Fig. 11. Samuelson's Criterion.

In most empirical studies Pareto efficiency is reached since modifying the replacement rate or the contribution rate would lead to hurting some generations while improving the welfare of some others; this is due to the fact that, in the first order conditions characterizing the behavior of households, the partial derivative of the per-head level of future pensions relative to current labor supply is but zero; indeed, in the real world, neither the contribution nor the replacement rate is fixed once for all, but, on the contrary, their value may be modified by the government at each period, whatever the "rights" accumulated by the generations who have, at the current date, already contributed. Contributions should, thus, be considered as lump-sum.

The next figures exhibit the differences between welfare assessed with a Fund or a CRR option and welfare assessed with a CCR option used as baseline. Two baselines have been used according to the assumption about the openness of the economy. Hence CRR-CCR (CE) (FUND-CCR (CE)) refers to the difference of welfares when a CRR (Fund) and a CCR option are considered, with the assumption of a closed economy. CRR-CCR (OE) (FUND-CCR (OE)) refer to the corresponding policies when the economy is open. As shown on Fig. 11, the generations entering the labor market, at the beginning of the period under review, are better off in the CRR scenario than in the CCR one. Later, an opposite configuration occurs, in which people are better off in the CCR scenario. However, it should be noticed that:

(i) the differences between utilities in the scenario CRR and the CCR one are negative but, with the closed economy assumption, for generations entering the labor market before 2005. Moreover, with such an assumption, the absolute values of these differences are much higher when the spreads are negative than when they are positive. Therefore, if social welfare is defined as a linear combination of the elementary intertemporal utilities of each generation, it is higher in the CCR option than in the CRR one, unless very odd weights were chosen (It is

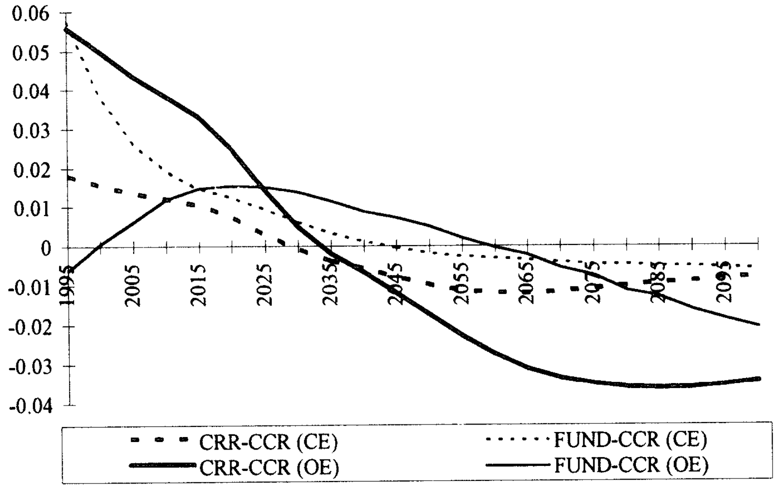


Fig. 12. Lerner's Criterion.

always the case, whatever the weights, with the open economy assumption).

(ii) Fund options always lead to higher lifetime utilities than the CRR options do. However, no clear-cut results hold, when comparing CRR and Fund scenarios: generations entering the labor market before 2030 (2025) are better off when the Fund-CE (Fund-OE) scenario is considered but an opposite result holds for later generations. From a social welfare point of view, no conclusion can be drawn (social welfare highly depends on the weights of elementary lifetime utilities).

Another way of doing is Lerner's (1959), for whom one should aggregate the instantaneous utilities of all living generations. The weights that are most often used are either proportional to the size of each generation (this is Lerner's way of doing) or equal to one another (this is our point of view). Lerner's criterion is commonly used, for the sake of simplicity, by politicians. Comparing the options (see Fig. 12) leads to ambiguous results but for one. When the closed economy assumption is made, the Fund option is undoubtedly better than the CRR one.

One could also consider the minimum of the instantaneous utility of a generation. This is Rawls' (1974) criterion. However, using this criterion leads, here, to some indeterminacy. To rule out this drawback, we consider another criterion which we call dispersion criterion; it indicates whether the dispersion of the instantaneous utilities of all living generations is narrowing or not. Among all possible measures, we have selected the simplest, i.e. the difference between the highest instantaneous utility and the lowest. Note that the highest utility generally refers to a generation of retired whereas the lowest generally characterizes a young working generation so that this criterion is a rough indicator of the difference of welfare between the retired and working population. Since maintaining the replacement rate benefits to the retired and injures the working population, the higher the replacement rate the higher should be the dispersion of social welfare.

Figure 13 exhibits the difference between dispersion social welfares calculated for our scenarios. The better option corresponds to the minimum value of the

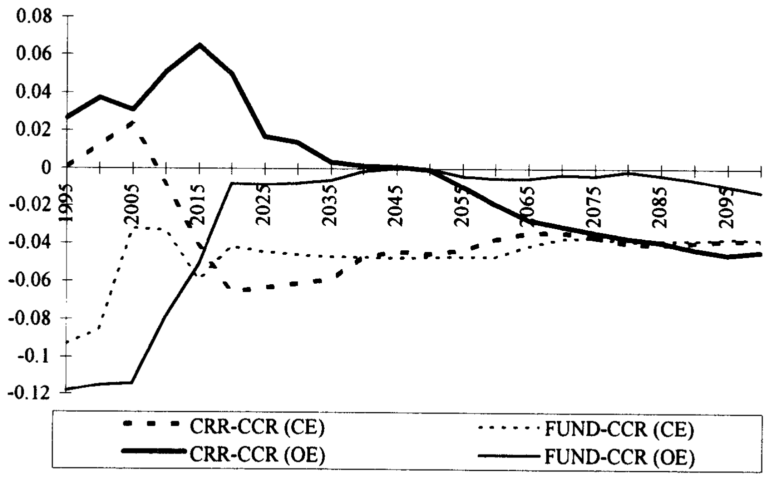


Fig. 13. Dispersion Criterion.

dispersion criterion; hence, Fund options clearly dominates the CCR ones since they lead to a better distribution among generations as already pointed out in the case of fairness ratios. Such a result again prevails when CRR-CE option is considered.[9]

5. CONCLUSION

Ageing of the Japanese population will have two major macroeconomic consequences: (i) a more or less marked slowdown of growth and (ii) a more or less marked fall of the relative standard of living of the retired. There is a trade-off between, on the one hand, lower contribution rates, tax pressure and interest rates, lower per-head pensions, higher investment and output, and, on the other hand, higher contribution rates, tax pressure, hence interest rates, higher per-head pensions, lower investment and output. However, the main result of this paper is that an active Fund policy outclasses the constant replacement rate (CRR) one from any point of view: macroeconomic performance, actuarial fairness and social welfare. Such a result prevails under the assumption of a "closed economy" as well as under the opposite one of a "small open economy". Moreover, since, as pointed out in earlier works (see e.g. Chauveau and Loufir, 1995), a CRR policy seems to be more valuable, for Japan, than a constant contribution rate (CCR) one, an active Fund policy seems, all the more, preferable; the major reason for this result is that a CRR policy would lead to a far too sharp decrease in the standard of living of the retired (see above the discussion about the sustainability rules). If a Fund policy is undertaken, a legal problem relative to the rights accumulated by the previous generations will have to be coped with. Such a

[9] However people are slightly better off with the CRR option at the beginning of the transition period (before 2010).

question is beyond the scope of this paper. Finally, it is worth noting that the use of a new CGEM-OG model, allowing not only for uncertain lifetime (see e.g. Blanchard (1985)), but also for time-varying lifetime expectancy, has led to a far much better calibration than the ones used in earlier models.

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APPENDIX

A. Firms

The program of the representative firm reads:

$$\underset{K_t,\, L_t}{\text{MAX}}\ \Pi_t$$

$$\Pi_t = Y_t - \omega_t L_t - c_t K_t$$

subject to:

$$Y_t = A_t K_t^{\varepsilon} \left(\prod_{i=1}^{t} (1+g_i) L_t \right)^{1-\varepsilon}$$

where Π_t, Y_t, ω_t, L_t, c_t, K_t and g_t are profit, output, real wage rate, labour, real cost of capital, capital, and technical progress rate at time t; A_t is a scaling constant, and ε is the constant capital share. The gross investment is given by:

$$I_t = K_{t+1} - (1-d_t) K_t$$

where d_t, and I_t are respectively the rate of depreciation of capital, and gross investment at time t.

B. Households

The program of the representative consumer reads:

$$C_{j,t+j-a},\ l_{j,t+j-a}^{\text{MAX}},\ B_{12,t+12-a}^{E(U_{a,t})}$$

with:

$$E(U_{a,t}) = \frac{1}{1-\frac{1}{\gamma}} \sum_{j=a}^{14} \frac{s_{j,t+j-a}}{(1+\delta)^{j-a}} \left[C_{j,t+j-a}^{1-(1/\rho)} + \alpha_{j,t+j-a} (q_{j,t+j-a} l_{j,t+j-a})^{1-(1/\rho)} \right]^{(1-(1/\gamma))/(1-(1/\rho))} + \frac{1}{1-\frac{1}{\gamma}} \frac{\beta s_{12,t+12-a}}{(1+\delta)^{12-a}} B_{12,t+12-a}^{1-(1/\gamma)}$$

where $E[U_{a,t}]$ is expected intertemporal utility function of a representative grown-up individual entering the ath period of his life cycle at the beginning of period t, $C_{j,t+j-a}$, $a_{j,t+j-a}$, and $l_{j,t+j-a}$ are respectively consumption, leisure preference, and leisure in age-period j at time $t+j-a$, $B_{12,t+12-a}$ is bequest to offspring in age-period 12 at time $t+12-a$, $q_{j,t+j-a}$ is technical progress factor, γ is intertemporal elasticity of substitution, δ is time preference rate, ρ is intratemporal elasticity of substitution, β is bequest preference parameter and $s_{j,t+j-a}$ is the probability to survive such that:

$$s_{j,t+j-a}=\prod_{k=a}^{j}(1-\pi_{k,t+k-a})$$

where $\pi_{k,t+k-a}$ is the probability of death before $t+k-a+1$ of a representative individual of generation j at $t+k-a$.

The intertemporal budget constraint reads:

$$\begin{aligned} CB_{a,t}=&\sum_{j=a}^{14}\left[\sum_{s=a}^{j}\frac{s_{j,t+j-a}}{+r_{t+s-a}(1-\bar{\tau}^{y}_{s,t+s-a})}X_{j,t+j-a}\right] \\ &-\prod_{s=a}^{12}\frac{s_{12,t+12-a}}{1+r_{t+s-a}(1-\bar{\tau}^{y}_{s,t+s-a})}B_{12,t+12-a} \\ &+\prod_{s=a}^{8}\frac{s_{8,t+8-a}}{1+r_{t+s-a}(1-\bar{\tau}^{y}_{s,t+s-a})}\frac{N_{12,t+8-a}}{N_{8,t+8-a}} \\ &\times(1-\tau^{b}_{t+8-a})B_{12,t+8-a}+s_{a,t}A_{a,t}(1+r_t(1-\bar{\tau}^{y}_{a,t}))=0 \end{aligned}$$

with

$$\begin{aligned} X_{j,t+j-a}=&(w_{t+j-a}e_{j,t+j-a}(1-l_{j,t+j-a})(1-\theta^{s}_{t+j-a})+PR_{j,t+j-a})(1-\bar{\tau}^{y}_{j,t+j-a}) \\ &+PA_{j,t+j-a}-C_{j,t+j-a}f_{j,t+j-a}(1+\tau^{c}_{t+j-a}) \end{aligned}$$

where $CB_{a,t}$ is the difference between expected discounted earnings and expenses of a representative grown-up individual entering the ath period of his life cycle at the beginning of period t. $A_{a,t}$ is his/her wealth; $X_{j,t+j-a}$, $PR_{j,t+j-a}$, $PA_{j,t+j-a}$, $f_{j,t+j-a}$, $e_{j,t+j-a}$, and $\bar{\tau}^{y}_{j,t+j-a}$ are, respectively, pensions, family and health sustainance benefits, "human capital" adjustment factor, equivalence scale, and average income tax rate in age-period j at time $t+j-a$. $N_{12,t+8-a}(N_{8,t+8-a})$ is the number of adults belonging to generation 12 (8) in time period $t+12-a$ $(t+8-a)$ and $B_{12,t+8-a}$ is bequest. r_{t+j-a} is real interest rate at $t+j-a$, τ^{b}_{t+j-a} is inheritance tax rate, τ^{c}_{t+j-a} is V.A.T. rate, θ^{s}_{t+j-a} is employee's contribution rate, θ^{ms}_{t+j-a} is employee's health and family contribution rate, and θ^{rs}_{t+j-a} is employee's pension contribution rate. Finally, the non-negativity of the labour supply constraint reads:

$$l_{j,t+j-a}<1, j=1, 14eta=1, 14\,.$$