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Title	PUBLIC PENSIONS IN AN OVERLAPPING-GENERATIONS MODEL OF THE FRENCH ECONOMY
Sub Title	
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Publisher	Keio Economic Society, Keio University
Publication year	1994
Jtitle	Keio economic studies Vol.31, No.1 (1994.) ,p.1- 19
JaLC DOI	
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Notes	
Genre	Journal Article
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=AA00260492-19940001-0001

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PUBLIC PENSIONS IN AN OVERLAPPING-GENERATIONS MODEL OF THE FRENCH ECONOMY[1]

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Abstract: Due to the likely ageing of the French population over the coming decades, the future financing of the current public, « pay-as-you-go » pension system is quite worrisome. This article offers a framework for evaluating the long-run economic consequences of various possible scenarios: it uses an overlapping-generations, general equilibrium model of the French economy. After the description of the model, we present the results of two demographic variants, which clearly show that the current system would be sustainable in the long run only if population growth is positive. Finally the comparison of macroeconomic outcomes and the—individual and social—welfare analysis suggest that, if the forecast of a stagnating French population comes true, raising the legal retirement age would clearly dominate other alternatives such as curtailing benefits or switching to a pure capitalization scheme.

Key-words: computable overlapping-generations models, public pensions, ageing.
JEL classification: D58, H55.

Some recent French studies (INSEE, 1990; Cornilleau and Sterdyniak, 1991; *Livre blanc* 1991) have evaluated the prospective financial requirements of the French pension system. These studies rely on the official demographic projections (Dinh and Labat, 1986) and strong assumptions about the future values of many macroeconomic variables. The increase in social contribution rates ensuring the financial equilibrium of the public pension fund is then calculated, but feedbacks from these institutional prospects to the economic equilibrium are ignored.

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[1] We are grateful to participants in the OFCE Seminar (Paris), the Cournot Seminar (University of Paris-I), the 1992 European Meeting of the Econometric Society (Brussels), the VII[th] Annual Congress of the European Economic Association (Dublin), the V[th] Franco-American Economic Meeting on Economics of Ageing (Paris), the Fondation Liège Université d'Europe Conference on Insurance and Pensions (Liège), the *Séminaire d'économie monétaire internationale* (Paris), the 1993 Workshop on Policy Formulation in Interdependent Markets (Vienna), the 1993 International Symposium on Economic Modelling (Athens), and, especially, an anonymous referee, for helpful comments on earlier drafts. All remaining errors are the authors' responsibility.

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Other studies of the prospects of the retirement schemes in industrialized countries (e.g., Feldstein, 1980; Modigliani and Sterling, 1980; Heller, 1989) have attempted to take account of some of these likely feedbacks by using econometrically estimated, aggregate consumption or aggregate saving equations which demographic ratios enter as independent variables. The conclusions are generally that the financial prospects of public pension schemes are rather worrisome in all countries and that national saving rates are likely to decline in the first decades of the next century.

Almost simultaneously, following the pioneering work of Auerbach and Kotlikoff (1987), economists have developed applied, overlapping-generations-general-equilibrium (OGGE) models, mainly to analyze fiscal policies. Two such models of the French economy (Perraudin and Pujol, 1991; Schubert and Letournel, 1991) have recently been published, while another OGGE model has been specifically used to study the prospects of public pension schemes in some OECD countries (Auerbach, Kotlikoff, Hagemann and Nicoletti —hereafter AKHN—, 1989).

In order to analyze the economic implications of the new French demographic trends and of possible reforms in the French public pension scheme, we have built an OGGE model which is in the spirit of AKHN's one.

This paper is organized as follows: specification choices are discussed in Section 1, together with calibrating procedures. Comments on individual lifecycle profiles, on distributions over living cohorts and on macroeconomic equilibrium are given in Section 2. We then explore the economic consequences and welfare implications of two contrasted demographic scenarios (Section 3). Finally we turn to an evaluation of the economic consequences and welfare implications of various possible modifications of the public pension scheme. The results presented in this paper are all about the long-run, steady growth equilibrium of the model.

1. AN OVERLAPPING-GENERATIONS, GENERAL EQUILIBRIUM MODEL

The economy we depict is a closed economy[4]: there are three sectors —households, firms and the public sector— and three perfectly competitive markets —one for goods, one for labor and one for capital. There is only one good, used for both consumption and investment; labor is also assumed to be homogeneous, except for a factor related to seniority; and there is only one kind of financial assets, shares in the existing firms, i.e. ownership certificates on the productive capital stock of the economy. There is no money in the model, hence no inflation.

[4] Both existing applied, general-equilibrium models of the French economy (Perraudin and Pujol, 1991; Schubert and Letournel, 1991) have adopted the open-economy framework. Although this may seem desirable from the point of view of realism, it tends to sever the link between domestic saving and domestic accumulation of productive capital, which is one of the major advantages of this type of general equilibrium models.

1.1. *The Household Sector*

The household sector comprises 60 overlapping generations of identical adults and 20 overlapping generations of identical children. Each year, a new cohort of children is born to the generation of child-bearing age adults. The size of this new cohort depends on the specific assumption made with regard to population growth. From birth to age 20, individuals are supposed to be dependent. At the beginning of their 21st year, individuals become adults: they enter the labor market. They retire when they are 60 —the legal retirement age in France— and die at age 80, leaving a bequest to their heirs.

In any period, the economy is therefore populated with 20 cohorts of dependent children, of age between 1 and 20, and 60 cohorts of adults, of age between 21 and 80, 20 of which are retired. Adults determine their lifecycle profiles by maximizing their expected utility subject to the various constraints, including their expected earnings profile, real interest rate and taxes, contributions and benefits, all summarized in the household's intertemporal budget constraint. Since perfect certainty holds, choices are never revised; therefore, only one program —the one for young adults, aged 20— has to be taken into account. As usual in such models, individual utility is assumed to be time-separable, while annual utility is a CES function of consumption and leisure, with a specific bequest motive. The young adult's maximization program is as follows:

$$\underset{C_{j,t},l_{j,t},B_{80,t}}{\text{MAX}} \; U_t$$

$$U_t=\frac{1}{1-1/\gamma}\left[\sum_{j=21}^{80}\frac{1}{(1+\delta)^{j-21}}[C_{j,t}^{1-1/\rho}+\alpha_j(q_j l_{j,t})^{1-1/\rho}]^{\frac{1-1/\gamma}{1-1/\rho}}+\frac{\beta}{(1+\delta)^{59}}B_{80,t}^{1-1/\gamma}\right]$$

Subject to

$$\sum_{i=t}^{t+59}\left[\prod_{s=t}^{i}\frac{1}{1+r_s(1-\tau_s^y)}[(w_i e_j(1-l_{j,t})(1-\theta_i^r)+PR_{j,t})(1-\tau_i^y)+PA_{j,t}\right.$$

$$\left.-C_{j,t}f_j(1+\tau_i^c)]\right]-\prod_{s=t}^{t+59}\frac{1}{1+r_s(1-\tau_s^y)}(1-\tau_i^b)m_t B_{80,t}+\prod_{s=t}^{t+39}\frac{1}{1+r_s(1-\tau_s^y)}B_{80,t-21}=0$$

where U_t is the expected utility of the young adult aged 21 in period t, which depends upon his/her consumption ($C_{j,t}$) and leisure ($l_{j,t}$) over his/her entire lifetime, as well as on the amount of the bequest ($B_{80,t}$) he/she leaves. Other parameters are defined in Table 1. $q_i=(1+g)^i$, where g is the annual rate of labor augmenting technical progress. In the household's intertemporal budget constraint, omitting the time subscripts, r is the real interest rate, w the (gross) real wage rate, e the age-related factor reflecting seniority rules in career profiles, m the ratio of 80$^{\text{th}}$ to 61$^{\text{rst}}$ cohort sizes, f an indicator of the «cost of child-rearing» (see below). B_t is the bequest left to heirs and B_{t-21} the bequest received from parents. The tax rates are the following: τ^y the income tax rate, τ^c the VAT rate, τ^b the inheritance tax rate. θ^r is the sum of the employee's social contribution rates. Finally PR is

Table 1.

Parameters		Exogenous variables		Endogenous variables	
Production		*Population*			
• elasticity of substitution	$\sigma=0.05$	• growth rate	$n=0$	• real interest rate	$r=4.61\%$
• capital intensity	$\varepsilon=0.05$	• age of the parents at the date of birth's	$AE=21$	• consumption/output	$C/Y=63.0\%$
Households					
• preference for leisure		*Production*		• savings/output	$S/Y=17.2\%$
$\alpha=0.55$		• depreciation rate	$d=5\%$	• capital/output	$K/Y=2.46$
for individuals of age 21 to 40		• productivity growth rate	$g=2\%$	• bequests/capital	$B/K=4.6\%$
$\alpha=0.792$				• bequests/output	$B/Y=11.2\%$
for individuals of age 41 to 80		*Tax system*		• govermment spending/output	$G/Y=19.8\%$
• intertemporal elasticity	$\gamma=0.95$	• VAT	$\tau^c=10\%$		
• intratemporal elasticity	$\rho=1.2$	• average income tax rate	$TMOY=17.4\%$	• pensions contribution's rates:	
• pure rate of time preference	$\delta=0.015$	• bequest's tax rate	$\tau^b=10\%$	– employer	$\theta_{RE}=15.9\%$
• preference for bequest	$\beta=6$			– employee	$\theta_{RS}=13.7\%$
		Social contributions		• total health and family allowances/output	$PAT/Y=12.33\%$
		• employer's rate	$\theta_{ME}=15.6\%$		
		• employee's rate	$\theta_{MS}=5.9\%$	• pensions/output	$PRT/Y=16.96\%$
		Pensions			
		• replacement rate	$TRP=73.6\%$		
		• shares of contribution			
		– employer	$STRE=0.54$		
		– employee	$STRS=0.46$		

the pension benefit and PA the sum of non-taxable allowances (health expenditures and family allowances when eligible).

In addition leisure must always be such that $l \leq 1$, and $l = 1$ during retirement.

• *Children in the household's utility function.* When the fertility rate is exogenously imposed, as is the case in this study, it is appropriate to model children's consumption as complementary to their parents', rather than assuming substitutability (as in AKHN, 1989). Hence, we have introduced the « cost of child-rearing » into the budget constraint of adults with dependent children, using « equivalence scales » to account for the fact that such a cost varies with the child's age (Bloch and Glaude, 1983). Panel data (Glaude and Moutardier, 1991) clearly indicate that the share of children's consumption in total household's consumption, while growing with the child's age, is independent of the level of the household's income, as predicted by our assumptions.

• *Technical progress and the labor supply decision.* Most existing applied, OGGE models (e.g., Auerbach and Kotlikoff, 1987; Schubert and Letournel, 1991) are built with the assumption of zero rate of technical progress, which is clearly unsatisfactory. In our model, a steady growth of labor productivity is introduced in the production function. However, the presence of steady technical progress would, without any further assumption, tend to distort individual lifecycle choices of leisure and consumption: indeed, because individuals would know that they will be more and more productive —i.e. that the wage rate steadily grows over time—, they would choose to concentrate their labor supply over the last part of their working life, and work as little as possible during the first years of adulthood. Combined with the existence of seniority-type career profiles of earnings (see below), this would result in a highly unrealistic lifecycle labor supply profile, as well as an excessive growth of individual consumption over the life cycle.

The most natural remedy to this problem is to assume that the instantaneous marginal rate of substitution between consumption and leisure in the individual's utility function is invariant with respect to technical progress. The leisure variables that enter the households' utility function are thus multiplied by a factor which is one plus the rate of technical change. With this correction[5], the lifecycle profiles of households' labor supply and consumption are clearly much flatter than otherwise, which seems in better agreement with micro data.

1.2. *Closing the Model*

Closing the model requires the specification of the behavior of the production sector and the public sector.

1.2.1. *The production sector*

Firms are assumed to operate on perfectly competitive goods and factor markets.

[5] Note that it is admittedly an extreme « neutrality » assumption, in which the treatment of technical progress in the utility function is symmetrical to that in the production function (see below). Less extreme assumptions could possibly be tried, but they would all tend to produce a lifecycle growth of consumption that appears excessive with regard to available evidence.

The production decision of the firms is modelled in a very standard fashion: the representative firm maximizes its profit under a technological constraint— a CES[6] production function with exogenous technological progress at a constant annual rate augmenting the marginal productivity of labor:

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

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

$$Y_t = A\left[\varepsilon K_t^{1-1/\sigma} + (1-\varepsilon)((1+g)^t L_t)^{1-1/\sigma}\right]^{\frac{1}{1-1/\sigma}}$$

where Π_t is firms' profit, Y_t output, L_t total employment, K_t the productive capital stock, ω_t the total real cost of a unit of labor —including all social contributions—, c_t the cost of capital, A the scale constant of the production function. Other parameters and exogenous variables are defined in Table 1.

Productive capital depreciates at a constant annual rate (d). Hence the cost of capital for the firms is simply $r+d$. In the long-run equilibrium, the stock of productive capital per worker is constant, so that gross investment is simply equal to depreciation when there is no population growth and no technical progress.

1.2.2. *The public sector*

The public sector of the economy has three separate branches: general government, a public health and family allowance department, and a public pension department.

- *General government* has expenditures on final consumption of goods and services and levies taxes. It provides collective goods and services that are supposed not to affect households' utility. Public expenditures are made up of two elements: spending on education, the amount of which is proportional to the number of children in the population; general administration spending, the amount of which is proportional to the total population. Both categories are specified in such a way that the rate of growth of the basic, per-capita amount is equal to the rate of increase of labor productivity, so that, in equilibrium with constant population, the share of public expenditures in national income is constant.

The tax system is also meant to reflect those characteristics of the French system that are important in the study of demographic evolutions. General government has three sources of tax revenues: a proportional tax on households' consumption, which is equivalent to the French VAT; a proportional tax on bequests; and an income tax. There is no public debt in the model. Tax rates are assumed to be constant over time and the general government budget is balanced on an annual basis by adjusting the total amount of spending on actual tax revenues.

- *The public health and family allowance department* has a budget that is also kept in balance on an annual basis. Its revenues come from social contributions levied

[6] In CCLL (1992b), we also present the results obtained with a Cobb-Douglas production function. They are not qualitatively different and the conclusions of the various scenarios are preserved.

on wage incomes at a given, proportional rate[7]. Total expenditures, again adjusted to total annual revenues, are made up of two types of —tax exempt— transfers to households: lump-sum child allowances, proportional to the number of dependent children in the household; health expenditures, that are assumed to be globally indexed on technical progress —so that, in stationary-growth equilibrium, their total amount is a constant fraction of national income[8]—, while the transfer received by each individual depends on age.

• *The public pension department* is modelled as a pure « pay-as-you-go », social-security system. As opposed to all types of capitalization pension schemes, such a system is characterized by the requirement that its budget be balanced on an annual basis: in any given year, the total amount of pension disbursed to those currently in retirement must equal the total amount of contributions levied on the earnings of the currently working population. However, in all our scenarios, households do also save for retirement: part of their asset accumulation over their working life is meant to finance part of their consumption during retirement. Hence, the overall retirement system we depict is never a pure social-security scheme, but more realistically a hybrid in which households' accumulation for retirement is endogenously determined and is all the more important as the public pension scheme is less generous.

The amount of the individual pension granted to each person in retirement in a given year is uniformly distributed over the currently retired population —which is assumed to include all individuals over the legal retirement age. Public pensions are indexed on the contemporaneous average wage, according to various formulas that are investigated below: hence the purchasing power of public pensions is, in each of the schemes studied, a given fraction of the average real wage of the currently working population. In order to ensure annual budget balance, the rates of social contributions levied on the earnings of the currently working population —again distinguishing, for the sake of comparison with the actual French system, employer's and employee's rates— are endogenously determined.

1.3. *Calibrating the Model*

The choices of parameter values were adjusted in such a way that the model fit as well as possible available French micro and macro data[9]. In this calibration process, we have attempted to obtain lifecycle profiles and distributions over living cohorts as close as possible to their observed counterparts. Numerical values of exogenous variables and parameters are summarized in Table 1, along with the

[7] As in the actual French system, a distinction is made between employer's and employee's social contributions, although in a general equilibrium model they are perfectly equivalent.

[8] We therefore assume that, contrary to what has been observed so far in France, the ratio of health expenditures to national income will eventually stabilize, as has been the case in a number of countries.

[9] For more details about the lifecycle profiles, robustness to specification choices and sensitivity analysis, see Cazes, Chauveau, Le Cacheux and Loufir —hereafter CCLL—, 1992b (available upon request from the authors).

values of major aggregate endogenous variables in the reference account.

1.3.1. *Exogenous variables*

The values of three kinds of exogenous variables have to be chosen to completely specify the demographic and institutional environment in which households make their lifecycle decisions: the demographic structure of the economy, the career profile of earnings, and the public sector policy variables —tax and social contribution rates, and benefits.

• *Demographics.* Available demographic projections for France (Dinh and Labat, 1986) show that, provided the birth rate stabilizes at the level that ensures the replacement of cohorts —i.e. 2.1 children per woman— and provided the mortality rate evolves along the same path as observed in recent decades, the age structure of the French population is likely to be fairly smooth by the years 2040–2050: grouping together all the individuals over 80, the age pyramid forecasted at this time horizon is characterized by cohorts of approximately identical sizes. We have therefore chosen, for our reference equilibrium account, a demographic scenario with zero population growth and all mortality concentrated at age 80. Hence, two children are born to each household —more specifically, one child to each adult— when parents turn 21[10], and cohorts are of exactly identical sizes.

Because of the consumption-complementarity assumption, the cost of child-rearing is a fraction (s_t), increasing with age, of the parents' own consumption; the value of the ratio reaches .99 when the child turns 20, i.e. just before he/she becomes an adult and enters the labor market. Empirical observation suggests that the more costly the children, the more the parents work. Such a result implies that the parameter representing the household's preference for leisure (α_t) depends on the cost of child-rearing ($f_t = 1 + s_t$). We have thus written

$$\alpha_t = \alpha_i (1/f_t)^y \qquad \text{with} \quad \alpha_i = .55 \text{ for } i = 21, \ldots, 40$$
$$\alpha_i = .792 \text{ for } i = 41, \ldots, 80$$

where y characterizes the sensitivity of α_t with respect to f_t. In order to avoid a discrete drop in labor supply —and discrete jumps in income and consumption— at the time when children leave the household ($f_{40} = 1.9$ whereas $f_t = 1$ for $t \geq 41$), we have chosen different numerical values for the parameter α_i, calibrated in such a way as to obtain smooth lifecycle profiles[11].

• *Career profiles.* Two exogenous factors influence the time profile of individual earnings: the trend growth of labor productivity, and the seniority —or learning by doing— age profile of compensation, which is observed in all developed economies. With regard to labor productivity growth, we have followed consensus forecasts (see, e.g., Cornilleau and Sterdyniak, 1991) and assumed that its annual

[10] In one of the demographic scenarios presented in Cazes, Chauveau, Le Cacheux and Loufir (1992a and b), we explore the economic consequences of delayed births —i.e. of first child's birth when parents turn 31.

[11] For details concerning the choices of y and α_i, and the corresponding profiles, see CCLL (1992b).

rate will be 2%. The instantaneous distribution of compensation rates by age groups has been chosen in such a way as to obtain an individual lifecycle profile as close as possible to those observed in French studies on micro data over the last few decades (Fournier, 1988), as well as to obtain satisfactory individual labor supply profiles (see figures below).

With our assumptions, the compensation rate of an individual is multiplied by a factor of 2.6 over the lifecycle (from age 21 to age 60), while in any given year the ratio of maximum wage rate (reached at about 45) to the rate when the individual enters the labor market is 1.4, and the ratio of the final wage rate (at age 60) to that of the young adult aged 21 is 1.2.

• *Taxes, social contributions and benefits.* The choice of numerical values for tax rates is based on French national accounts, with some corrections to account for current trends in tax policy, in particular the progress of tax harmonization in the European Community. Hence, the VAT rate has been assumed to be a uniform 10%. The actual revenues from this tax represented approximately 12.5% of GDP in France in 1988, but have been steadily decreasing since then. The tax rate on bequests is also supposed to be 10%, again a figure fairly close to the estimated effective rate in France.

For the sake of simplicity[12], the income tax has also been specified as a proportional scheme and taxable income has been defined as the sum of households' earnings, capital incomes and old-age pensions. However, adults with dependent children benefit from the so-called « *quotient familial* » rebate mechanism: in the determination of taxable income, each dependent child is counted as half an adult, which effectively reduces the tax rate on the income of adults with one dependent child by 1/3. Taking the figure quoted in Schubert and Letournel (1991) for the effective average ratio of income tax revenues to households' gross disposable income (17.4%), our proportional income tax rate has been calculated to be 20% in the reference account.

The condition that the state budget be balanced on a yearly basis then yields the total amount of public spending on goods and services. The per-capita amount of each type of expenditures —« education » for dependent children and « general purpose» for adults— has been assumed to be the same, which yields the share of education expenditures in total government spending: in the reference account, dependent children represent exactly 1/4 of the total population, so that education expenditures are 25% of total government spending on goods and services.

However, when comparing the economic and welfare outcomes of the various scenarios investigated hereafter, the determination of public expenditures has not

[12] In a model in which all individual are identical except for age, specifying the tax system as a progressive one does not make much difference. What would however make a difference would be to differentiate the taxation of income according to its source, i. e. wages or capital income (see, Auerbach and Kotlikoff, 1987; Perraudin and Pujol, 1991). In France, effective tax rates on capital income are currently much lower than those on earnings (Sterdyniak, Blonde, Cornilleau, La Cacheux and Le Dem, 1991). Moreover, there is no tax on firms' profits, since in the long-run, balanced-growth equilibrium of the model profits are zero.

been left endogenous in this way. Doing so would tend to bias the welfare analysis in favor of those scenarios that endogenously produce a reduction in tax rates, either because of demographic growth or because of increasing tax bases[13]. Instead, the lump-sum amount of the basic per-capita expenditure determined in the reference account has been imposed in all other scenarios, so that the average tax burden on households' income (TMOY) becomes endogenous.

Social contribution rates meant to finance the system of health insurance and family allowances have been exogenously imposed at their levels observed in the late 1980s ($\theta_{ME} = 15.6\%$ for employers, $\theta_{MS} = 5.9\%$ for employees). The condition that this fund also be balanced on a yearly basis then endogenously determines the total amount of spending on such benefits, which are tax-exempt. The age-related distribution of benefits is taken from a study by Mizrahi and Mizrahi (1985); it is U-shaped over the life cycle from birth, with a sharp increase over the last two decades of life (see CCLL, 1992a and b).

All individuals over the legal retirement age are assumed to take advantage of the possibility to retire and get a public pension. Pension benefits are uniformly distributed to all living retirees in any given year; they are taxable. Their amount is determined by imposing an exogenous replacement rate (TRP). Contributions rates are then endogenous, and a sharing formula —based on the current one— yields the rates paid respectively by the employer and the employee.

1.3.2. *Parameter values*

Numerical values also have to be picked for two categories of —unobservable— parameters: those in the individuals' utility function and those in the firms' production function. The selection of the values listed in Table 1 has been guided by the conclusions of a number of empirical studies on micro data (see Auerbach and Kotlikoff, 1987), whenever they were available and non-contradictory, as well as by comparing the lifecycle profiles obtained with available evidence.

With regard to technical coefficients in the firms' CES production function, values have been chosen so that the degree of substitutability between capital and labor be relatively low, as is generally found in econometric estimates of production functions on French macro data[14]. As a result of such a selection, the capital/labor ratio, an endogenous variable in our model, is not very sensitive to variations in the relative factor prices, a feature which is common to the other two applied general-equilibrium models of the French economy cited above. With regard to the depreciation rate, the value used in national accounts is mostly conventional and empirical evidence is relatively scant. We have chosen a plausible

[13] This is a well-known property of general equilibrium models. In the case of transfer payments and redistribution, the mechanisms yielding endogenous variations in contribution rates and/or benefits do produce welfare results that appear significant, in that they entail a redistribution of income and welfare amongst individuals and generations.

[14] Empirical studies on micro data generally yield a much higher degree of substitutability, and tend to validate Cobb-Douglas specification. For results of the model with a Cobb-Douglas production function, see, CCLL (1992b).

value of 5%[15].

On the various parameters entering the utility function, empirical evidence is even less than on those characterizing the production function, and they appear quite controversial. Given the lack of evidence from French data on the five parameters in the households' utility function, we have opted for values similar to those suggested in recent econometric studies on US micro data. Our selection procedure has been guided by three sets of considerations: that elasticities ought not be too far from one; that lifecycle profiles of participation rates fit observed (see below), and that lifecycle consumption profiles yield a plausible total increase over the entire life cycle[16]. With regard to the so-called « preference for bequests », the value was chosen in such a way as to ensure that the annual amount of bequests as a proportion of GDP be of the same order of magnitude as that observed for the French economy in recent years, that is slightly under 10%.

2. MAJOR FEATURES OF THE REFERENCE ACCOUNT

The features of the reference account may be grouped in three subsets: households' lifecycle profiles, instantaneous distributions over living cohorts, and aggregates.

2.1. *Lifecycle Profiles*

• *Leisure and labor-force participation rates.* Since everybody is assumed to take the opportunity offered by the public pension scheme to retire at age 60, individual labor supply drops to zero at this point. From 21 to 42, it is growing, albeit at a moderate and decreasing annual rate, under the combined influences of a rapidly increasing wage rate and of the growing consumption needs. From age 42 to 46, the individual labor supply is almost flat; afterwards, it is slowly decreasing, simply reflecting the profile of the —gross and net— wage rate over these years. This individual labor supply profile seems rather realistic as may be judged by comparing with available data for France (INSEE, 1990a, p. 96; Marc and Marchand, 1987). Of course, two difficulties inherently plague this kind of exercise, though:

(i) observations from actual labor supply behavior are contaminated by the

[15] In French national accounts, the rate of depreciation of the nation's total capital stock —including non-productive capital goods, such as housing, infrastructure, ... — is assumed to be 4.17%. Available studies on French micro data for manufacturing (Cette and Szpiro, 1988; Chevalier, Legendre and Morin, 1988) have found values of the annual rate of depreciation of productive capital between 6.25% and 7.4%. Auerbach and Kotlikoff (1987) have taken 1% for the rate of depreciation of the US capital stock; but theirs seem to be referring to the total stock, as opposed to only productive. In comparable, applied general-equilibrium models of the French economy, Perraudin and Pujol (1991) opted for a 10% annual depreciation rate, while Schubert and Letournel (1991) chose 5%, as we did.

[16] Our parameter values differ somewhat from those of other existing overlapping-generations, general equilibrium models:

• Auerbach and Kotlikoff (1987): $\alpha=1.5$, $\rho=0.8$, $\delta=0.015$, $\gamma=0.25$, $\beta=0$;
• Schubert and Letournel (1991): $\alpha=2.23$, $\rho=1.2$, $\delta=0.015$, $\gamma=0.8$, $\beta=0$;
• Perraudin and Pujol (1991): $\alpha=0.56$, $\rho=2.2$, $\delta=0.02$, $\gamma=0.8$, $\beta=0$.

existence of unemployment, which tends, among other things, to induce young people to enter the labor market belatedly —probably more than they would in the absence of unemployment— and to force early retirement —the so-called « *pré-retraites* »— onto a number of wage earners over 50;

(ii) over the past decades, there has been an almost continuous rise in female participation rates, which also makes observed data difficult to reconcile with the assumptions of our model where men and women are not distinguished.

• *Income, consumption and saving.* Due to the assumed trend in labor productivity, the lifecycle profile of net disposable income is growing over the entire life-span: at 80, it reaches a level that is almost 3 times as high as the initial level, at the beginning of adulthood, when individuals enter the labor market. During the first 20 years of adult life, wage rates are rapidly rising, labor supply is steadily increasing and income taxes are relatively low, due to the presence of dependent children in the household; in addition, while health allowances remain fairly low, family allowances add to the household's income. Over these first 20 years, households' disposable income is multiplied by a factor of more than 2. The drop of disposable income at 41 is the consequence of the decline in labor participation and the increase of the income tax rate, when children leave. Over the next 20 years, disposable income is still growing, albeit more slowly. It is almost flat over the last 10 years of labor-force participation, the rise in interest income from accumulated assets offsetting the decline in wage earnings. At age 61, individuals inherit from their parents. During retirement years, the growth of disposable income essentially reflects the fact that public pensions are indexed on current average wage rates, as well as a step increase in the health allowances received occurring at age 70, while interest income is steadily declining as a share of total income as households dissave.

Households' consumption expenditures are smooth, as may be expected from a model based on the lifecycle hypothesis. Consumption is growing over the entire adult life span; from 21 until death, it is multiplied by a factor close to 4. Note that, with ageing, health expenditures —financed from public allowances— represent an increasing fraction of households' total consumption expenditures: when health expenditures are substracted from real consumption, the lifecycle profile is, thus, much flatter.

• *Asset holdings.* Over most of adult life time, households save. The resulting asset holdings profile is therefore quite similar to the standard « hump-shaped » profile of simple lifecycle models (e.g. Modigliani, 1986), with three major differences: first accumulation is very fast over the first 20 years, then slows down over the next 15 years; second, working households actually dissave a little over the five years preceding retirement, an uncommon outcome of our model which is due to the fact that they anticipate the bequest they will receive at 61; third, this bequest results in a step increase in households' asset holdings. For the same reason, dissaving over retirement never drives the households' asset stock all the way down to zero, since they plan to leave a bequest to their children when they die.

2.2. *Distributions over Living Cohorts*

• *Income and consumption distributions.* Income distribution over living cohorts in any given year is much more concentrated than the distribution of individual disposable income over the life cycle, due to the influence of productivity growth on the latter. Thanks to inheritance « young retirees » benefit from a disposable income that is marginally more than that of the contemporaneous young, working adult. Maximum disposable income accrues to the cohort aged 40, who is working hardest and benefits from family allowances and a lighter tax burden on income through the « *quotient familial* »; their disposable income is however only 1.7 times that of contemporaneous young adults. Over living cohorts, consumption increases from age 21 to 40. It is multiplied by a factor of about 1.4. However, its profile is, for elder generations, almost flat. Moreover, if health expenditures were substracted from the total, consumption would appear as decreasing after age 60. Finally, the comparison between total consumption expenditures and disposable income confirms that cohorts over 56 are dissavers, and more and more so as they age.

• *Wealth distribution.* In any given year, the bulk of the nation's total wealth is owned by those cohorts between 40 and 80, with maximum wealth being in the hands of those who have just received their inheritance from their parents, and also happen here to be those who have just retired. Young adults under 40 hold only a small, but growing fraction of total national wealth; there is very little dispersion in asset holdings of those cohorts between 40 and 60, whereas people over 61 decumulate.

2.3. *Aggregates and Economy-wide, Endogenous Variables*

The values of endogenous variables obtained in the reference account are summarized in Table 1, along with those selected for parameters and exogenous variables. Apart from the real interest rate, all aggregate variables are expressed in an arbitrarily chosen unit, and represent per-capita magnitudes, measured in a reference year and steadily growing at an annual rate equal to the rate of growth of labor productivity.

In the zero-population-growth, steady-growth equilibrium we use as a reference, the real interest rate is 4.6%, which appears reasonably close to the levels recently observed in France and in Europe. The households' saving rate is 17.2%, slightly less than the measured gross private saving rate of the French economy in recent years, as the overall saving rate of a no-longer-growing population might be expected to be less than the currently observed one, and also because the capital stock in our model is assumed to exclude housing. The capital/output ratio

($K/Y = 2.46$) is, however, slightly greater than the current estimates[17].

Solving for the steady-growth equilibrium of the model yields the endogenously determined amount of the real, per-capita family and health allowances (PA) and pensions (PR), as well as the —endogenous— rates of contributions to the public pension scheme. In the reference case with no population growth and a formula to calculate pensions that is fairly close to the current one, the sum of the employer's (θ_{RE}) and the employee's (θ_{RS}) rates reaches 29.6%, an overall rate that is much higher than the current one, but in broad agreement with those obtained at this time horizon in other studies using simple projections of the demographic trends[18]. The drastic increase in contribution rates which would be necessary to reach this level in the years 2040–2050 should be judged by comparison with the much greater increase in real wages that would take place in the meantime if productivity growth were indeed proceeding at an annual rate of 2%: real wages and all other real magnitudes would then be multiplied by a factor of 2 in 35 years and by a factor of 3 in 55 years, that is more or less from now till 2050.

3. DEMOGRAPHIC SCENARIOS

We investigate the long-run, static consequences associated with two demographic scenarios, while maintaining the same hypothesis about mortality: a permanent increase in birth rates, so that in the steady state, population is growing at an annual rate of 1% and the opposite case of permanent drop in birth rates, yielding a steady-state decline of the population at an annual rate of -1%.

In most OGGE models, any reduction in tax rates necessarily makes individuals better off, insofar as public expenditures have no utility; public transfers do not suffer from the same problem, since they are redistribution mechanisms. In order to avoid this paradox, we have kept the endogenous determination of public transfers and contribution rates, while making per-capita public expenditures exogenous —and therefore making the total amount of taxes endogenous, through the endogeneity of the income tax rate.

The macroeconomic outcomes of the various scenarios are presented in Table 2, which shows the deviations with respect to the reference account. The comparisons ought to be made with care, as they simply refer to long-run, steady-growth equilibrium values of two economies that are identical in all respects but the modified hypothesis. They do not provide any insight as to how the economy would fare when demographic or institutional conditions are altered, i.e.

[17] For the late 80s, the consensus estimate of the capital/output ratio for the French economy is around 2.2 (se, e.g., Artus, 1991). But given the conventional way in which the productive capital stock is estimated in national accounts, this figure should not be taken at face value. In addition, it seems to have been characterized, over the last decades, by a mild upward trend, so that our endogenously generated magnitude would appear plausible for the years 2040–2050.

[18] For instance, Cornilleau and Sterdyniak (1991), with slightly different assumptions about mortality rates, conclude that the overall rate contribution to the public pension scheme should reach 27.6% in France in 2040–2050 if the current level of benefits is to be maintained.

TABLE 2.

Variations	Variables	Demographic variants		Institutional variants		
		$n=+1\%$	$n=-1\%$	*TM*20	*CAPC*	*RET*65
Relative	C	5.49	−8.31	2.96	15.84	16.03
	G	10.13	−7.55	0	0	0
	S	25.46	−23.48	2.51	16.72	12.23
	Y	9.84	−10.77	2.29	12.86	12.21
	B	4.30	−6.98	6.16	74.30	13.84
	W_N	6.47	−7.68	6.47	53.52	8.95
	PR	6.85	−8.07	−12.79	−100	11.11
	PA	12.58	−13.21	5.66	47.17	16.98
	PAT	12.44	−13.49	5.65	46.97	16.53
	PRT	−13.69	10.80	−12.93	−100	−16.73
Absolute	r	0.14	−0.09	−0.38	−4.61	−0.11
	θ_{RE}	−3.69	4.46	−2.79	−15.87	−4.53
	θ_{RS}	−3.19	3.85	−2.41	−13.71	−3.92
	TMOY	0.62	0.45	−0.56	−2.64	−3.06
	UPOP	−2.47	0.41	0.56	−1.06	3.23
	RRP	0	0	−14.60	−73.60	0

C : Consumption
G : Public expenditures
S : Savings
Y : Output
B : Bequest
W_N : Net real wage rate
PR : Per capita pension
PA : Per capita family and health allowances
PAT : Total family and health allowances
PRT : Pensions (total amount)
r : Real interest rate
θ_{RE} : Employer's rate
θ_{RS} : Employee's rate
TMOY : Average income tax rate
UPOP : Social welfare
TRP : Replacement rate.

nothing is said here about the transition path dynamics.

• *A steadily growing population* ($n=+1\%$): Steady population growth is clearly very beneficial from an aggregate economic point of view (Table 2), and especially for the financing of the public pension scheme. As expected, all per-capita aggregates are higher than in the reference account; while the nation's stock of productive capital and the aggregate saving rate are markedly higher, the interest rate is only slightly superior in this steady-growth equilibrium. Because a fraction of public expenditures is proportional to the number of dependent children in the total population, the average income tax rate (TMOY) is also marginally higher. However, very generous per capita allowances can be financed from unchanged rates of social contributions as total earnings are much higher —both the average wage rate and the total labor supply are higher.

Also due to this larger basis for contributions, the financial situation of the public pension scheme is much more favorable than in the reference account: a substantially more generous basic pension —since the relative purchasing power of pensions is indexed on the average real wage rate— can be afforded along with

sharply reduced contribution rates (almost a quarter less than in the reference account).

• *A steadily shrinking population* ($n = -1\%$): In the opposite case of a steadily shrinking population —at an annual rate of -1%—, the various aggregate outcomes are, naturally, less favorable than in the baseline scenario (Table 2). The same applies to the various aspects of public sector interventions, and the financial situation of the public pension scheme has deteriorated considerably, which clearly confirms that it would probably not be sustainable with its current provisions if population growth went negative.

4. CHANGING THE RULES OF THE PUBLIC PENSION SCHEME

In this section, we investigate three markedly different institutional options for the public pension scheme: a sizeable (20%) reduction in pensions (TM20); the complete abolition of the public pension scheme, replaced by a purely private capitalization scheme (CAPC)[19]; finally, the maintenance of all the features of the current system —as modelled here— except one: the legal retirement age would be postponed to 65 (RET65). In all these institutional scenarios, the demographic hypotheses are those of the reference account and, just as in the demographic scenarios, per-capita public expenditures on goods and services have been held constant. Aggregate outcomes are summarized in Table 2.

4.1. *A Substantially Less Generous Public Pension Scheme (TM20)*

In this first institutional scenario, the « replacement rate » has been cut by 20%, so that instead of 73.6% as in the baseline scenario, it is now assumed to be 59%. The aggregate outcomes are somewhat different from those of the reference account. However improvements are mostly minor, compared with the large reduction in pensions that has been assumed.

Global welfare comparisons may attempted by using the simplest criterion, namely the egalitarian one: social welfare (UPOP) —defined as the unweighted sum of the individual instantaneous utilities of living adult cohorts— is only marginally higher than in the baseline scenario, because the various lifecycle profiles are little altered: individuals work slightly less during the first 10 years, slightly more during the next 10 years and substantially more over the 20 years preceding retirement, in anticipation of a less generous pension; their disposable income is accordingly more until retirement, but less afterwards; their consumption profile is somewhat less steep —due to a lower interest rate; they accumulate more during their working life and dissave more actively during retirement as pension benefits are less generous.

[19] Note that in this model, households in all cases save for retirement; the difference is therefore more a matter of degree than of substance.

4.2. *A Purely Private System (CAPC)*

A much more radical option would consist in a complete abolition of the public pension scheme, leaving it entirely to households to care for their consumption during retirement by accumulating assets over their working life. To be realistic enough, we have imposed a non-negativity constraint on net wealth. All aggregates are much higher than in the baseline scenario, except, of course, for the interest rate, which is, now, almost zero (Table 2). Because households' earnings are much higher, the per-capita allowance that can be financed from unchanged social contribution rates is also much higher, while the average income tax rate is considerably reduced.

As a result of the drop in the real interest rate —now much lower than the pure rate of time preference—, all lifecycle profiles are profoundly different from the baseline scenario. In particular, adults now work more and more. As a consequence, disposable income is steeply rising over the working life, but collapses to a very low level after retirement. And in this scenario, households' consumption is only growing over the first 10 years of adulthood, when the non-negativity constraint on assets is binding; afterwards, it steadily declines, to reach very low levels during retirement. Due to the low interest rate, the asset holdings profile is very steep, while the pattern of instantaneous utilities is downward sloping. Social welfare is somewhat lower than in the baseline scenario.

It is worth emphasizing that the model is built upon the assumption that the capital market is perfect and that there is no uncertainty as to the future income to be earned on accumulated assets. Such an assumption is in sharp contrast with the way in which households' perception of the public pension scheme is modelled: they do not regard it as anyway nearly as secure as investment in financial assets. This is clearly a particular assumption concerning the kind of rationality that dictates households' decisions. But, given the uncertainty that surrounds demographic prospects and given the fact that, in the actual French system, individual pension rights are in no way property rights, and governments can in no way commit their successors to honor pension rights, it may well be rational for individual households to entertain this kind of skepticism.

4.3. *Increasing the Legal Retirement Age (RET65)*

An alternative to making the system less generous and alleviating the contribution burden on the working population would be to lengthen working life, by postponing the legal retirement age, to 65 instead of 60. Considered complexively, aggregate outcomes appear fairly favorable on all accounts (Table 2, RET65). In particular, they allow for a more generous per-capita allowance (+16.5%), as well as more generous pensions (+17.0%) along with sharply reduced contribution rates; indeed, lifecycle earnings are considerably higher thanks to a higher average wage rate and five more years of work.

Apart from the change introduced in the lifecycle labor supply profile with the postponement of legal retirement, households' profiles are not markedly different

from those in the reference account, except, of course, that they are all above the latter ones. Instantaneous utilities are higher for all living cohorts save those between 61 and 65, who experience a small welfare loss since they no longer benefit from their forced leisure over these years. In this scenario, social welfare is markedly improved compared to the baseline case (Table 2).

5. CONCLUDING REMARKS

While the analysis of the demographic scenarios clearly makes the point that the current features of the French public pension scheme are sustainable at a reasonable cost only if population will not decline in the future, the main findings of the analysis of the various institutional scenarios may be summarized as follows: first, the option in which the legal retirement age is postponed to 65 clearly appears to dominate all other options from a social welfare point of view; the second best is the TM20 option; then comes the reference account and, past, CAPC.

However, it should be emphasized again that our results are relevant but for long-run, steady-growth equilibria. An altogether different, but equally interesting issue is that of the transition path of the economy from the current situation to any one of these long-run equilibrium outcomes (see Chauveau and Loufir, 1993).

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