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**MACROECONOMIC EFFECTS OF PENSION REFORMS IN THE CONTEXT OF
AGEING POPULATIONS: OVERLAPPING GENERATIONS MODEL
SIMULATIONS FOR SEVEN OECD COUNTRIES
ECONOMICS DEPARTMENT WORKING PAPERS NO. 201**

by
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ABSTRACT/RÉSUMÉ

Using overlapping generations (OLG) models calibrated on seven OECD countries -- the United States, Japan, France, Canada, Italy, the United Kingdom and Sweden -- the authors investigate the macroeconomic impact of possible pension reform strategies as populations age. Simulations include a reduction in the level of pensions, phased abolition of PAYG schemes and general fiscal consolidation. By raising the national saving rate future GDP levels are higher, but not enough to offset the affects of ageing. A rise in the retirement age has larger effects, but implies significant loss of leisure time.

En utilisant des modèles à générations imbriquées pour sept pays de l'OCDE -- Etats-Unis, Japon, France, Canada, Italie, Royaume-Uni et Suède -- les auteurs analysent les effets macro-économiques des différentes réformes de systèmes des pensions dans un contexte de vieillissement de la population. Les simulations considèrent une réduction des niveaux de pensions, une élimination graduelle des systèmes à répartition et une réduction généralisée des dépenses publiques. Dans la mesure où ces réformes augmentent les taux d'épargne, les niveaux futurs du PIB seront plus élevés, mais pas suffisamment pour compenser les effets du vieillissement de la population. Le recul de l'âge officiel de la retraite aurait un effet plus important, mais aussi des implications négatives sur le temps disponible pour les loisirs.

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Ketil Hviding and Marcel Mérette¹

1. Introduction

1. Most OECD countries are faced with a rapid increase in the proportion of elderly in the population. These trends reflect a combination of the ageing of the post-war “baby boom” generation, increased longevity, and low birth rates. Although the ratio of elderly non-active to the working age population is already rising, an accelerating pace is expected in the second decade of the next millennium, posing serious challenges for many public sector pension schemes. Recognising that the financial needs of public pensions could become intolerably high if benefit rates remain unchanged, several governments have been considering reforming their pension systems. Most reform proposals concentrate on putting the pension system on a sustainable footing by reducing the benefits or increasing contributions, while leaving the overall design of the system unaltered. More drastic reform proposals aim at systemic changes, such as improving the links between private contributions and prospective benefits, or various forms of privatisation.

2. The purpose of this paper is to analyse the macro-economic effects of different types of pension reforms in the context of ageing populations. In particular, the paper attempts to answer whether a given pension reform results in a significant reduction in the need to raise taxes (or contributions) when the effects of ageing are taken into account. Four basic reforms are analysed: i) a gradual abolition (privatisation) of the public pension system, phased in over 52 years; ii) an across-the-board cut in the replacement rate of 20 per cent; iii) fiscal consolidation, that is, a decline in the debt-GDP ratio of 20 percentage points; and, finally iv) an increase in the effective retirement age of four years. It should be noted, however, that the simulated reforms do not pretend to accurately represent any precise reform proposal, but rather a set of stylised reform types. The effects of policy reforms in the context of ageing

1. OECD and Department of Finance, Canada, respectively. A first version of this paper was prepared as part of an OECD project on Ageing Populations and presented at the Working Party 1 of the Economic Policy Committee of the OECD in September 1997. The authors are grateful for comments and suggestions by Paul O’Brien, Nick Vanston, Constantino Lluch, Mike Feiner, Robert Ford, Alain De Serres, Helmut Reisen, Douglas Fore, Peter Richardson and Richard Kohl. In particular, Paul O’Brien’s support in getting the model off the ground was valuable. We are also indebted to the invaluable assistance of Martine Levasseur, Sandra Raymond and Brenda Livsey-Coates. The views expressed in this paper are those of the authors and do not necessarily reflect those of the OECD or the Canadian Department of Finance.

populations were simulated for seven countries: the United States, Japan, France, Italy, United Kingdom, Canada, and Sweden.

3. The simulations were performed by using a general equilibrium model with an overlapping generations structure (OLG). The general equilibrium framework incorporates feed-back effects on capital accumulation from pension reform, as well as “ageing” itself. In order to make the model tractable, several simplifications had to be made, both regarding the structure of the pension schemes, as well as assumptions about economic behaviour. First, the pension systems are consolidated with general government and financed by general taxation. Second, one individual is assumed to represent each generation, thus abstracting from differences between men and women and income groups. Third, the agents are rational, forward-looking and have no liquidity constraints, embodying the *life-cycle hypothesis* of consumption behaviour and continuous *market clearing*. Fourth, individual labour supply is fixed. Finally, the economy is closed and all investment has to be financed out of domestic saving².

4. Despite the above limitations, the OLG model provides a rich description of the generational structure of the population, breaking down the population into different age-groups. Thus, aggregate labour supply is based on the size of the working-age population while pension expenditures are dependent on the size of retired age groups. Aggregate savings are dependent on the desired life-time consumption profile and disposable income of each generation, mirroring developments in factor returns. Capital accumulation and interest rates are thus endogenous, depending *inter alia* on the size of the working population, the design of the pension system or public debt policies.

5. OLG models have been criticised for their dependency on the life-cycle hypothesis. In particular, the assumption about “perfect foresight” -- i.e. no uncertainty and rational expectations -- overlooks precautionary saving motives. Moreover, household surveys indicate that, contrary to predictions of the life-cycle hypothesis, recent retirees save more than middle-aged workers, resulting in an initial positive saving effect of ageing. The life-cycle hypothesis has been retained, however, because it is fairly well supported by other empirical evidence. The main empirical support for the life-cycle hypothesis comes from cross-country evidence which shows a positive link between the old-age dependency ratio and lower savings³. Other predictions of the life-cycle hypothesis, such as the non-neutrality of government debt policies and negative saving effects of the introduction of a PAYG pension systems, are largely supported by the empirical evidence, although no firm conclusions can be reached.

6. The remainder of the paper is divided into seven sections. The second section establishes the demographic projections of the seven countries considered. The third section reviews the results from some previous studies on pension reforms that use OLG models. The fourth section presents the structure of the model. The fifth section details the calibration method, followed by a presentation of the simulation results in section six. Section seven is a conclusion.

2. See Turner *et al.* (1998) for a discussion of the international repercussions of ageing.

3. See, for example, Masson, Paul *et al.* (1996), Graham, J.W. (1987), and Miles, D. (1997). Weil (1994) offers a different kind of argument that reconciles empirical analysis based on macro and micro data and hence, support the life-cycle hypothesis. For a survey of the literature of the effect of pension on saving, see Kohl and O’Brien (1998).

2. Demographic projections

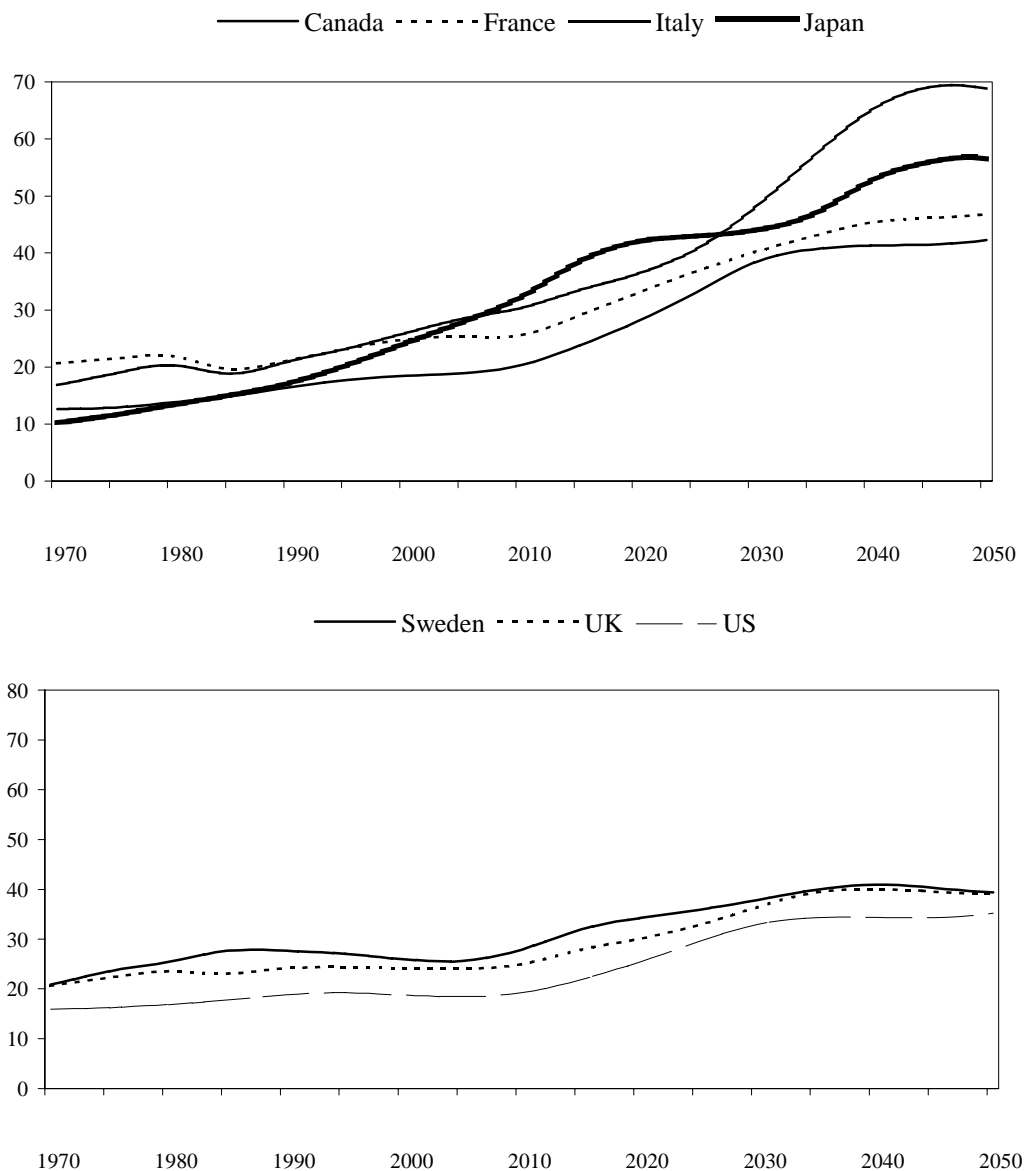
7. According to recent demographic projections by the United Nations, the share of older people (65 years old and above) in the total population is expected to increase substantially over the next 50 years for all the seven countries examined, with Italy and Japan projected to experience the largest increases (Table 1). The increase is projected to be less dramatic in Sweden, Canada, France, and the United States, whereas the United Kingdom ranks in middle of the countries considered.

Table 1. The share of older people in total population
(Per cent)

	1996	2050
Canada	12	24
France	15	24
Italy	17	34
Japan	15	30
Sweden	17	22
United Kingdom	15	23
United States	13	21

Source : United Nations

8. The old-age dependency ratio with regard to the working population is shown in Figure 1. This ratio gives a more accurate description of the economic burden arising from population ageing by measuring the ratio of older people (65 years old and above) to those of working-age (15 to 64 years old). In Japan and Italy, the dependency ratio is already increasing rapidly and is projected to increase even more rapidly in the future. In Japan, the increase is projected to be 190 per cent and in Italy 170 per cent, from 1996 to 2050. For the other five countries, the increase in the dependency ratio is gradual until 2010, but increases at a much faster pace thereafter. For Canada, France and the United States, the dependency ratio is expected — from 1996 to 2050 — to increase by 130 per cent, 100 per cent and 90 per cent respectively, compared to 60 per cent and 50 per cent for the United Kingdom and Sweden.

Figure 1. **Old-age dependency ratios in selected OECD countries**

1) The ratio of older people (more than 65 years old) to those of working age (15-64 years old).

Source: World population prospects (1996 revision), United Nations.

9. Clearly, demographic forecasts for the mid 21 century are subject of wide margins of error. Unexpected changes in life-expectancy is probably the most important factor of uncertainty. To the extent increased life expectancy also implies increased effective working life, an increased demographic old-age dependency ratio does not necessary imply an increased economic burden. An increased fertility rate, on the other hand, would have a delayed effect of at least 15 years before it affects the size of the working-

age population, but would cut or postpone the projected increase in the old-age dependency ratio. Immigration, e.g., from populations with many young people would have a similar but more rapid effect. To this extent that this immigration comes from countries with similar age-profile the problem would only be moved from one country to another. Due to the relative size of the “baby boom generation”, it is however unlikely that any of these effects would prevent a significantly increase in the ratio between older people in need of support and the working-age population.

3. Some earlier OLG simulations

10. The pioneering large-scale numerical OLG model was built by Auerbach and Kotlikoff (1987). Their model contained 55 generations, certain life-time, perfect foresight, exogenous technical change and endogenous individual labour supply. Although later models have extended the original Auerbach-Kotlikoff model by adding such factors as uncertain life-time⁴, traded and non-traded goods, heterogeneous consumers and credit restrictions, the main insights from A-K’s original model remain largely unchanged. In Auerbach *et al.* (1989), this model was employed to analyse the effects of demographic changes for four OECD countries: the United States, Japan, Germany, and Sweden. The effects of the projected increase in ageing were assessed in a series of dynamic simulations under different assumptions about pension formulas, fiscal policy and openness of the economy.

11. In their baseline scenario, Auerbach *et al.* (1989) simulated the “pure effect” of ageing. Hence it was assumed that the old-age pension replacement rate -- defined as the ratio of average pension benefits to wage-indexed life-time earnings -- would remain unchanged, while fiscal expenditures would rise in line with the growth rate of the economy. The estimated effect from demographic changes on national saving was large: over the period 1990 to 2030 the simulations showed a fall in the net national saving ratios by 4 percentage points in the United States, and by more than 18 percentage points in Japan. The implied increase in the “social security tax” was also quite dramatic: in the same period, payroll taxes were projected to increase by nearly 8 percentage points of GDP in Germany, and over 4½ percentage points of GDP in the United States.

12. Auerbach *et al.* simulated the effects of three different policy options: freezing non-pension government expenditures in per capita terms; a 2-year increase in the retirement age; and a 20 per cent cut in pension benefits. For all options there was a simulated increase in the national saving rate and a reduction in the need for an increase in payroll taxes relative to the baseline scenario. The effect on real wage growth varies, from almost significant to zero in the case of freezing government non-pension expenditures, to relatively significant in the case of a cut in benefits.

13. In very recent work by Kotlikoff *et al.* (1997), the effects of privatising United States Social Security have been simulated. The model contains 12 different income groups, imposes a ceiling on earnings subject to Social Security contributions, includes the progressive benefits schedule in US Social Security, and was calibrated on US household income data. Privatisation -- which in the model is equivalent to abolishing public old-age pensions -- was simulated to take place with constant population growth, excluding the effects of population ageing. The pension replacement rate was reduced gradually, starting 11 years after the beginning of the reform in order to ensure that workers aged 45 and above receive their full benefits.

4. See Chauveu and Loufir (1997) for a recent model with uncertain life-time.

14. Drawing on these simulations, Kotlikoff *et al.* (1997) estimated that the long-run effect of a tax financed “privatisation” would be to increase the capital stock by 37 per cent and per capita output by 11 per cent. These effects would take about 60 years to be achieved, but almost three-quarters of the effects are obtained after 30 years in most of the simulations. According to the simulations a “privatisation” would be redistributive: the poorest income groups would gain about 50 per cent more than the highest income groups (in the case the transition is financed by a consumption tax). This reflects the fact that -- in Kotlikoff’s model -- the progressive effect of current Social Security contributions embodied in the benefits schedule is outweighed by the ceiling on taxable earnings. But the overall welfare improvement embodies significant inter-generational effects: for example, in the case of consumption-tax financed transition, average earners aged 54 when the reform is partially implemented experience a 3.8 per cent drop in remaining life-time utility, while those born when the reform is fully implemented enjoy a 8.1 per cent increase in utility.

15. A number of authors have modelled the effects of pension reform in developing countries, with particular reference to Chile. In a model where it is not possible to borrow on the basis of human capital, and young workers are credit constrained, Cifuentes and Valdés-Prieto (1995) simulated the effect of an immediate introduction of a mandatory pension system in line with the Chilean reform. While allowing (explicit) government debt to increase in the transition period, the reform still has net positive effects on saving and capital stock. This is because young credit constrained workers cannot offset the “forced saving” imposed by the new mandatory pension system, thus raising aggregate private saving. In the case of 75 per cent debt financing, the capital-output ratio increases by approximately 28 per cent. In the case of credit constraints, whether or not the remaining part of transition induced deficit is financed with income or consumption taxes make little difference to the results.

16. In contrast to most of the above studies, this paper combines pension reforms and ageing populations. Therefore, it can be viewed as an extension of Auerbach *et al.* (1989). Our simulation results suggest that the benefits that can be expected from reforming pension schemes, such as the ones investigated in the above studies, will not be sufficient to fully offset the significant macroeconomic effects arising from ageing populations. Before commenting in more detail on the results, we present the model.

4. The model

17. The model is based on the life-cycle theory of saving behaviour. In the model, there are 15 generations living side by side at each point in time. Each new generation has 15 periods to live, with each period corresponding to 4 years of life. The structure of the model is similar to that of Auerbach and Kotlikoff (1987) and Auerbach *et al.* (1989), with the exception that labour supply is exogenous and bequest motives are included. Households are assumed to be rational, have perfect foresight, the production technology is given by a standard Cobb-Douglas function, and the one-good economy is assumed to be closed. Although the closed economy feature of the model excludes the assessment of international repercussion of the pension reforms, it is probably a fairly good representation of most OECD countries given that the ageing process is widespread (Figure 1)⁵. The model can be separated into several sets of equations relating to, household/consumer behaviour, the production sector, the government sector (including the pension system), and the aggregation and equilibrium conditions. In the

5. A more satisfactory treatment of the international consequences of ageing populations can be found in Turner *et al.* (1998).

following equations, subscript t is for time period and g for age-group: $g=1$ is for age-group 17 to 19 years old, $g=2$ for age-group 20 to 22 years old, up to $g=15$ for age-group 73 to 76 years old.

Household behaviour

18. The household sector is represented by a set of individual utility functions, each representing a generation living for 76 years. In each period of four years, the oldest generation dies and a new generation enters the labour force. The working life starts at the age of 17; younger children were assumed to be fully dependent on their parents to which they neither constitute extra burden nor provide any utility. Each generation retires at the age of 64, that is after 12 periods. Each generation maximises a utility-function U of consumption and bequest subject to their life-time income. The utility function is time-separable and of constant elasticity of substitution (CES) type:

$$(1) \quad U = \frac{1}{1-\theta} \sum_{g=1}^{15} \frac{1}{1+\rho} \left| \left(c_{g,t+g-1}^{1-\theta} + \beta_g^\theta Beq_{g,t+g-1}^{1-\theta} \right) \right|, \quad 0 < \theta < 1, \quad \beta_{g \neq 15} = 0, \quad \beta_{g=15} > 0,$$

where $c_{g,t}$ is consumption of an individual member of age-group g at time t , ρ the pure rate of time preference, θ the inverse of the intertemporal elasticity of substitution, β is a constant parameter and Beq is bequest. Equation (1) says that the utility of an individual is a weighted sum of 15 periods (of four years) of consumption from age-group $g=1$ at period t to age-group $g=15$ at period $t+14$, plus the (positive) utility of bequest for $g=15$ in period $t+14$. Leisure does not enter the utility function since individual's labour supply is assumed to be exogenous. Bequest is distributed at the end of each generation's life-time.

19. Following Blinder (1974), the level of bequest has been included in the utility function giving rise to intergenerational transfers in addition to public old-age pension benefits. It should be noted that this presentation of the utility function yields very different results than the alternative of introducing the utility of future generations directly into the utility of current generations. In the presentation chosen here, the utility of the current generation is independent of cash receipts extending beyond its death; hence, the timing of government disbursements has an effect on the current generation's utility.

20. Assuming no borrowing constraints and perfect capital markets, the present value of household income W of a generation starting adult life at time t , is the discounted sum of labour income lin after deducting for taxes and including public old-age pensions pen and inheritance inh :

$$(2) \quad W_t = \sum_{g=1}^{15} \frac{1}{1+r_{t+g-1}(1-\tau k)} \left| \left[lin_{g,t+g-1} (1-\tau w_{t+g-1}) + inh_{g,t+g-1} + pen_{g,t+g-1} \right] \right|,$$

where r is the interest rate, τk and τw are the tax rates on capital and labour income respectively.

21. Differentiating the household utility function (1) with respect to $c_{g,t}$ and $Beq_{g,t}$ and subject to the individual's life-time budget constraint (2) yields the following first-order conditions for consumption and bequest:

$$(3) \quad c_{g+1,t+g} = \frac{1+r_{t+g}(1-\tau k)^{1/\theta}}{1+\rho} \Big| c_{g,t+g-1}, \quad g = 1,2,\dots,14;$$

$$(4) \quad Beq_{g,t} = \beta_g c_{g,t}, \quad g = 15.$$

Inheritances arising from the oldest age-group's ($g=15$) bequests are assumed to be equally distributed to all working generations:

$$(5) \quad Inh_{j,t} n_{j,t} = \frac{1}{12} Beq_{m,t} n_{m,t}, \quad \text{for all } j = 1,2,\dots,12 \text{ and } m = 15,$$

where $n_{g,t}$ is the number of people in age-group g at period t .

The production sector

22. The economy's production technology is represented by a simple Cobb-Douglas function:

$$(6) \quad Y_t = AK_t^\varepsilon L_t^{1-\varepsilon},$$

where Y represents real output, K is the real value of the capital stock, L describes the effective labour force, ε stands for the capital income share and A is a scaling variable. In this simple presentation of the corporate sector it is assumed that the *corporate veil* is fully transparent – there are no “agency” problems. It is also assumed that there are no installation costs⁶ and that the companies operate in a perfectly competitive market. Hence, factor demand and output are determined by the two first-order conditions for maximum profit:

$$(7) \quad r_t = \varepsilon AK_t^{\varepsilon-1} L_t^{1-\varepsilon},$$

$$(8) \quad w_t = (1-\varepsilon)AK_t^\varepsilon L_t^{-\varepsilon},$$

where δ is the rate of capital depreciation and w is the wage rate per unit of effective labour.

23. It is assumed that technical change is exogenous and “labour embodied”; every new generation has a larger stock of technical knowledge than the previous generation and is more productive by a constant factor γ . Thus the technology embodied in the age-group g at period $t+1$ is $te_{g,t+1}$ where

6. Auerbach and Kotlikoff (1987) found that the presence of such costs do not affect much the simulation results.

$te_{g,t+1} = (1 + \gamma)te_{g,t}$. Moreover, the productivity of a generation is a quadratic function of its age g , so its earnings profile (ep) takes this form:

$$(9) \quad ep_g = \gamma + \lambda g - \psi g^2, \quad \gamma, \lambda, \psi \geq 0.$$

Using the wage rate, the labour embodied technical knowledge and the earnings profile, we can now define labour income of an individual in age-group g at period t as:

$$(10) \quad lin_{g,t} = w_t ep_g te_{g,t}, \quad g=1,2,\dots,12,$$

The government sector

24. The pension system is fully integrated into government accounts. This reflects the consideration that in most countries the government has the ultimate responsibility of the finances of the public pension funds: the “solvency” of the fund is ensured by the government’s power to tax future generations. Thus, for the purpose of this model, it would make little sense to analyse separately the public pension funds, whether partly or fully funded.

25. Given this simplification, the government sector can be fully described by two equations. The first equation expresses the tax income of the government as function of proportional taxes on labour income τw (including pension benefits), capital income τk and consumption τc :

$$(11) \quad T_t = \tau w_t \sum_g (lin_{g,t} + pen_{g,t}) n_{g,t} + \tau k \cdot r_t \sum_g a_{g,t} n_{g,t} + \tau c \sum_g c_{g,t} n_{g,t}, \quad g = 1,2,\dots,15.$$

The term $a_{g,t}$ is the holding of financial assets by age-group g at the beginning of period t . Capital and consumption taxes are constant over time. The second equation is the government’s dynamic budget constraint:

$$(12) \quad B_{t+1} - B_t = r_t B_t + G_t + PEN_t - T_t,$$

where $PEN_t = \sum_g pen_{g,t} n_{g,t}$ represents total pensions payments. This equation states that the government (cash) deficit has to be financed by an increase in government debt. The deficit is defined as the difference between government disbursements – i.e. government expenditure G , interest payments on outstanding government debt rB and pension payments PEN -- and taxes T . It is assumed that the government has no other income than what it collects through general taxes and does not invest in real capital.

Aggregation and equilibrium conditions

26. In order to ensure that the model is logically consistent and that no resources are wasted, three additional conditions are introduced. The first defines effective labour supply by summing over the twelve working generations a term that involves the multiplication of age-group productivity factor (ep), the labour embodied technology factor (te), and the number of workers belonging to that group (n):

$$(13) \quad L_t = \sum_{g=1}^{12} ep_g te_{g,t} n_{g,t} .$$

With the presence of labour embodied technical change, the supply of labour L is growing over time with a constant rate in excess of the growth rate of the working-age population. The second requires that the stock of real capital K_t in the economy plus government debt be equal to total financial assets in the economy, represented by the sum of all age-groups' wealth in period t :

$$(14) \quad K_t + B_t = \sum_g a_{g,t} n_{g,t}$$

27. The closed economy assumption of the model implies that foreign asset holdings are excluded. The third and final relationship in the model requires that aggregate supply Y_t is equal to total demand (Walras Law):

$$(15) \quad Y_t = C_t + G_t + K_{t+1} - (1 - \delta)K_t ,$$

where $C_t = \sum_g c_{g,t} n_{g,t}$

5. Calibration and baseline simulations

28. Calibration of the model proceeded in two steps⁷. The first step consisted of fitting the “steady state” version of the model – i.e. the long-run path with constant population and productivity growth – to a set of macroeconomic variables for the 1950s/60s, a period with relatively constant population growth. The model was easier to solve for the steady state, since tax rates, the national saving rate, the debt-to-GDP ratio and public spending to GDP, are all constants on such a path. In the calibration procedure, several of country specific parameters and ratios were based on OECD data and empirical studies. These include the capital share of output, the ratio of net public debt to GDP, the tax rates (Table 2), the rate of depreciation of physical capital, and the old-age pension replacement rates. The old-age replacement rates were based on the 1995 population averages of pension benefits over earnings, used in Roseveare *et al.* (1996) and shown in Table 3. Other parameters, such as the intertemporal elasticity of substitution ($1/\theta$) and the age-wage profile function coefficients were assumed identical in all countries, because of lack of satisfactory country-specific data. The elasticity of substitution was taken from Auerbach and Kotlikoff

7. Both the static and dynamic solutions to the model were found by using numerical algorithms provided by General Algebraic Modelling System (GAMS), copyright World Bank.

(1987)⁸, whereas the age-wage profile parameters were set to produce a maximum at the age of 52. The initial population growth rate was taken to fit the average observed old-age dependency ratio in the period 1950 to 1965. The technical progress and the capital stock were adjusted to generate the level of national saving found in the data.

Table 2. Average effective tax rates: 1965-1994¹

	τ_k	τ_L	τ_c
Canada	41	22	9
France	22	36	18
Italy	25	30	11
Japan	33	16	5
Sweden	51	47	18
United Kingdom	54	23	13
United States	41	20	5

Notes:

τ_k	average tax rate on capital
τ_L	average tax rate on wage income
τ_c	average tax rate on consumption

1. For Sweden, the data are averages of 1975-1994.

Source : Leibfritz *et al.* (1997)

8. Auberbach and Koltikoff (1987) used an intertemporal rate of substitution at 0.25. This figure corresponds to an approximate average of estimates made by Weber (1970), and Grossman and Shiller (1981), Mankiw (1981, 1985), Mankiw, Rotemberg, and Summers (1985) and others.

Table 3. Calibration results

	ϵ	δ	η	ρ	r	K/Y	S/Y	B/Y	α
Canada	34.5	3.10	2.4	0.0047	8.3	2.7	0.22	0.27	0.46
France	33.2	3.02	1.6	0.0002	4.8	4.0	0.23	0.08	0.52
Italy	34.4	2.58	2.6	0.0050	6.2	3.6	0.29	0.62	0.45
Japan	34.2	4.54	2.4	0.0025	6.4	2.9	0.32	0.09	0.54
Sweden	30.0	2.70	2.4	-0.0030	5.1	3.6	0.23	-0.08	0.49
United Kingdom	30.4	2.75	2.9	0.0035	8.1	2.5	0.18	0.35	0.24
United States	32.6	3.52	2.4	0.0055	8.2	2.5	0.19	0.34	0.42

Parameters common to all countries: $1/\theta = 0.25^1$, $\gamma = 1$, $\lambda = 0.25$ $\psi = 0.012$

Notes:	ϵ	business sector capital income share
	δ	rate of capital stock depreciation (per cent)
	η	rate of technical growth (per cent)
	ρ	consumer time preference
	r	real return on capital (per cent)
	K/Y	capital to GDP ratio
	S/Y	gross national saving ratio
	B/Y	public debt to GDP ratio
	$1/\theta$	intertemporal elasticity of substitution
	α	average pension replacement rate
	γ	constant term in the age-wage profile function
	λ	coefficient on age term in the age-wage profile function
ψ	coefficient on the quadratic term in the age-wage profile function	

1. Auerbach and Kotlikoff (1987).

29. Table 3 details the calibration results. National saving rates (from 19 per cent of GDP in the US to 32 per cent of GDP in Japan) and public debt levels (from minus 8 per cent of GDP in Sweden to plus 62 per cent of GDP in Italy) vary quite significantly among countries. Similarly, consumers' time preferences generated by the calibration procedure vary substantially, from a positive rate of 0.55 per cent in the United States, to a negative rate of 0.3 per cent in Sweden. By contrast, real rates of return at the initial steady state are in a relatively narrow range, from 5 per cent to 8 per cent.

30. The second step of the calibration consisted of finding the adjustment path to a demographic shock, such as an increase followed by a decline in the birth rate. The model was solved numerically over 60 periods (240 years) until a new steady state was found. This dynamic solution is considered to be the *baseline* for policy simulations. In the baseline scenario, the public sector debt-GDP ratio is assumed to remain constant, requiring wage-income taxes to adjust in order to balance government accounts, whereas other taxes are kept constant. The baseline scenario can be considered to represent the "pure" ageing effect. The demographic shock was imposed by changes in the birth rate to replicate, as closely as possible, the rise in the old-age dependency ratio for the period 1950 to 2050. Due to the assumption of a certain death at a given age, the projected developments in the demographic structure could only be replicated approximately. The top panel of Figure 2 for each country, compares the dependency ratio obtained with the United Nations' projections. After 2050, it is assumed that the birth rate converges slowly to a population replacement rate.

31. In all countries, the effect of ageing results in large increase in the wage-income tax that exhibits larger amplitude at the beginning of the next millennium. Italy and Japan are the most extreme cases, with an increase of about 40 and 25 percentage points of wage-income tax rate respectively, whereas for other countries the rise is between 10 and 25 percentage points. In all countries, the tax rate peak occurs

in the middle of the next century, which is consistent with the dependency ratio projections. The national saving rates are also severely affected by the increasing old-age dependency ratios, of which the amplitude and the timing are more strongly correlated with the demographic projections. In Italy, the national saving rate drops to as low as 3 per cent of GDP, whereas for the other countries it drops to between 10 and 15 per cent of GDP. In a partial equilibrium analysis, such a decline in national saving would normally raise the rate of return on capital. By contrast, the OLG simulations show a substantial decline of capital return in all countries (Figure 2). This is due to the fact that investment demand falls more than supply of national saving, because a smaller labour force requires less capital investment.

32. In line with most other studies (e.g. Chauveau and Loufir, 1997), the return on physical capital net of depreciation is identical to the real rate of interest in this model. Thus, it could be argued that the simulations are inconsistent with the observed increase in real interest rates in the period 1950 to 1990. It should, however, be noted that the simulations were conducted to illustrate the influence of ageing and consequently neglect the many other macroeconomic shocks that plagued the OECD economies during that period. Hence many factors considered important in explaining the observed rise in real long-term interest rates -- such as the two oil shocks, the insufficient inflation credibility, the foreign exchange risk premium, or the effects of increasing public sector deficits -- are ignored in the simulation model (Orr *et al.*, 1995).

6. Simulations of different policy options

33. In order to illustrate the potential short and long-term effects of different policy options, four scenarios were examined. Three of them consist of different ways of building up the level of national capital stock, thereby increasing potential output and the sustainable level of per capita consumption. These scenarios include: (i) reducing the build-up of new pension rights, (ii) decreasing the present value of pensions by an across-the-board cut in the replacement rate; (iii) and a reduction in conventional public debt. In all these cases, private or public saving will increase, resulting in an increase in the capital stock and the future level of potential output. The fourth scenario acts directly on the size of the labour force by increasing the retirement age. All the simulated policy changes were assumed to begin in 1998. Details of the scenarios are:

- *Scenario I (“Gradual removal of public pensions”)*. Recent retirees keep their pensions in full as do all workers who have been in the system for more than 40 years; other workers are treated *pro rata* according to the number of years worked and new entrants receive no public pension at the end of their working life. Full removal is achieved after 52 years and the fiscal balance is targeted at keeping the government debt-GDP ratio constant. The wage-income tax rates adjust to balance government accounts. The design of this scenario is common in all countries, thereby the magnitude of the shock depends on the initial pension benefits replacement rate, which is country-specific.
- *Scenario II (“20 per cent cut in the replacement rate”)*. In this scenario, all benefits are cut by 20 per cent immediately, including the benefits of current retirees. As in scenario I, government debt-GDP ratio is kept constant throughout the simulation horizon, wage-income taxes adjusting.
- *Scenario III (“Fiscal consolidation”)*. In this scenario, the government aims to offset the decline in private saving by increasing government saving. The government debt-GDP ratio is reduced by 20 percentage points over a period of 20 years. In order to achieve the debt reduction target, wage-income taxes need to increase temporarily. This type of fiscal

consolidation would be equivalent to a pension reform entailing a build-up of public pension fund assets, without changing the way the pension rights are calculated and without a concomitant draw-down of other types of government assets.

- *Scenario IV (“Raising the retirement age”)*. The retirement age is raised from age 64 to 68. The government debt-GDP ratio is maintained as in Scenarios I and II.

34. The simulation results are summarised in Figure 2, Table 4 and Table 5, which illustrate the simulated effects on the wage tax rate, the national saving rate and the rate of return on capital by country, and in Table 6, which report changes in per capita GDP and consumption by country.

Figure 2. **Canada**

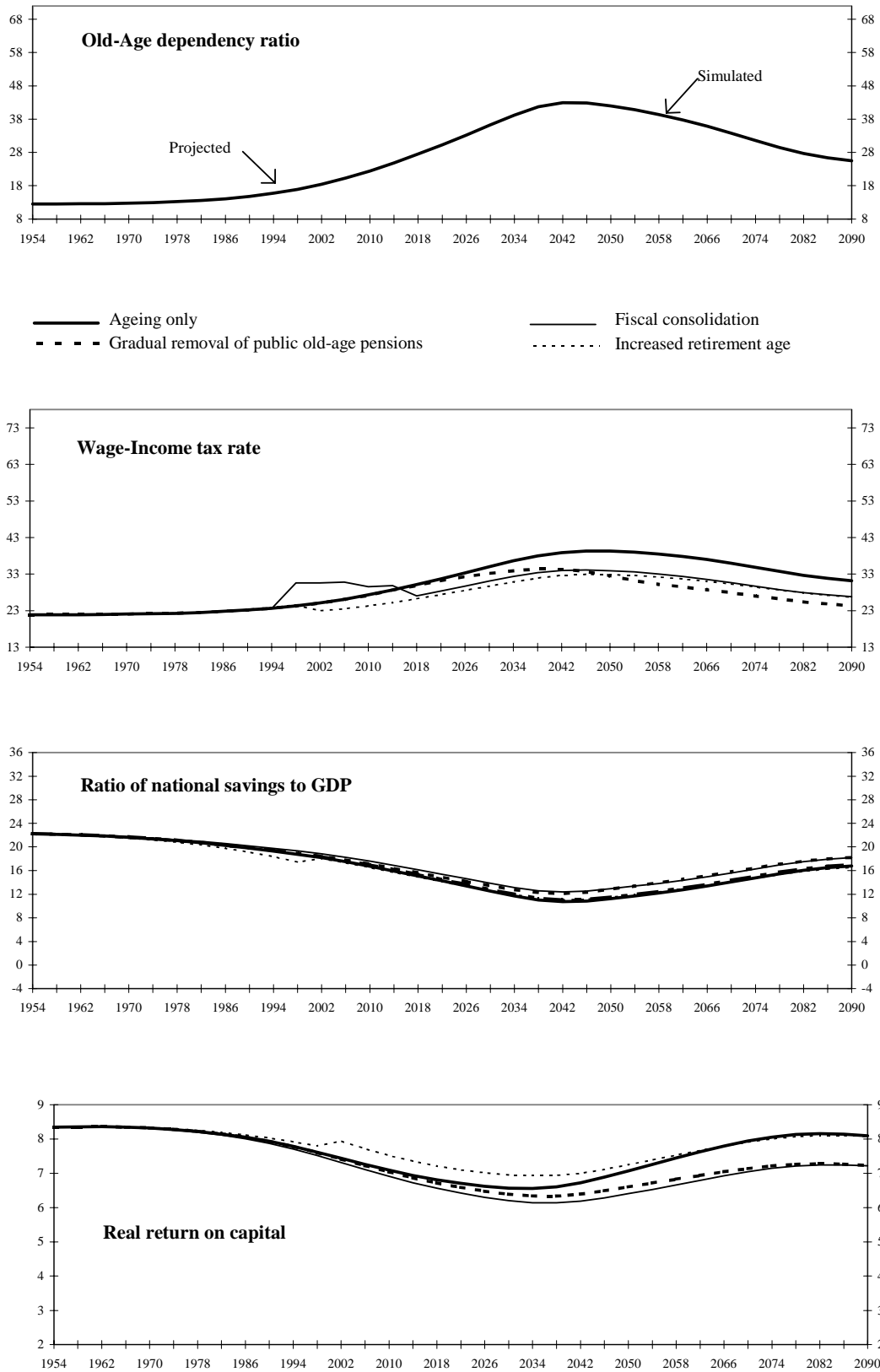


Figure 2. France

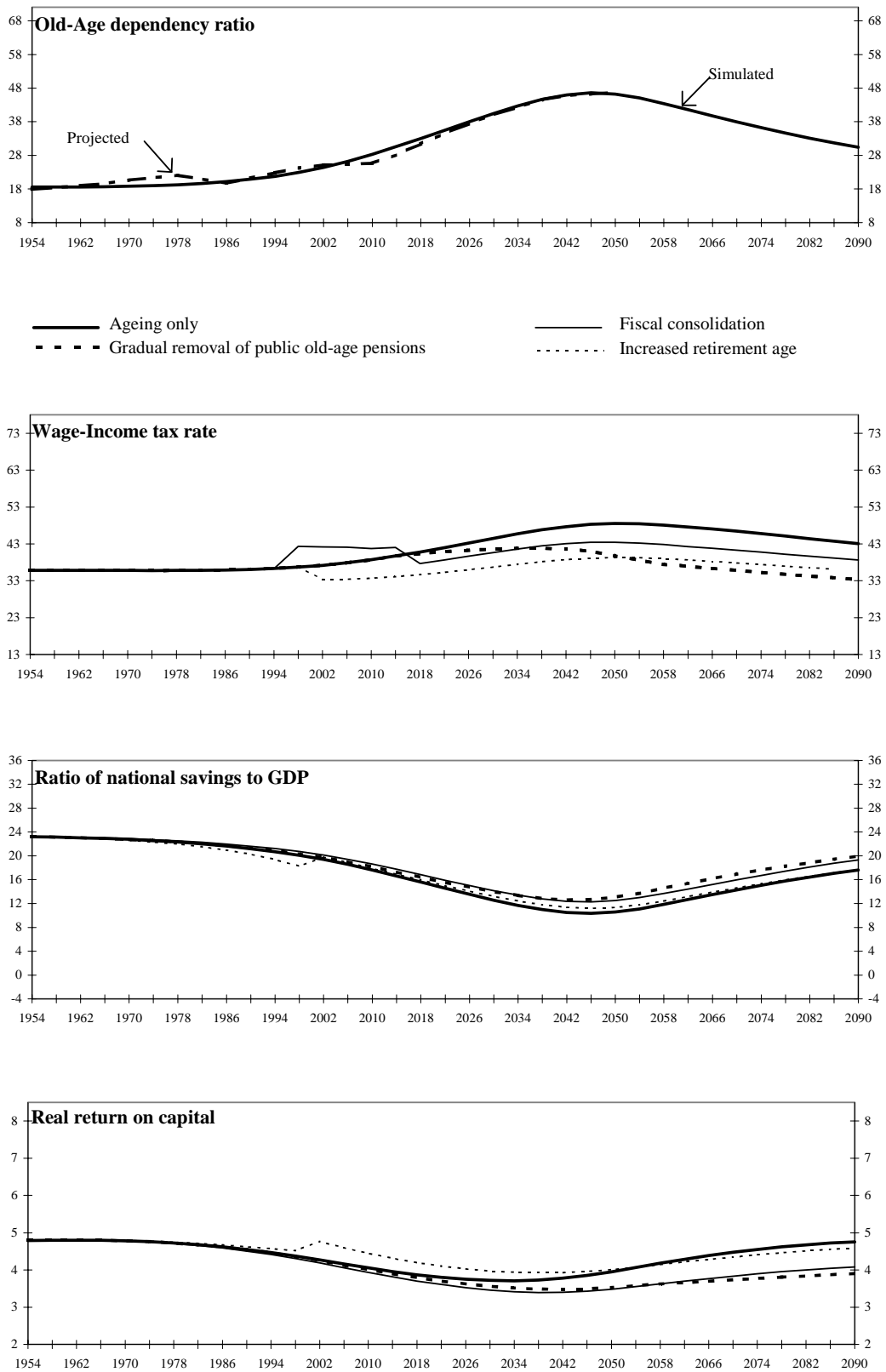


Figure 2. Italy

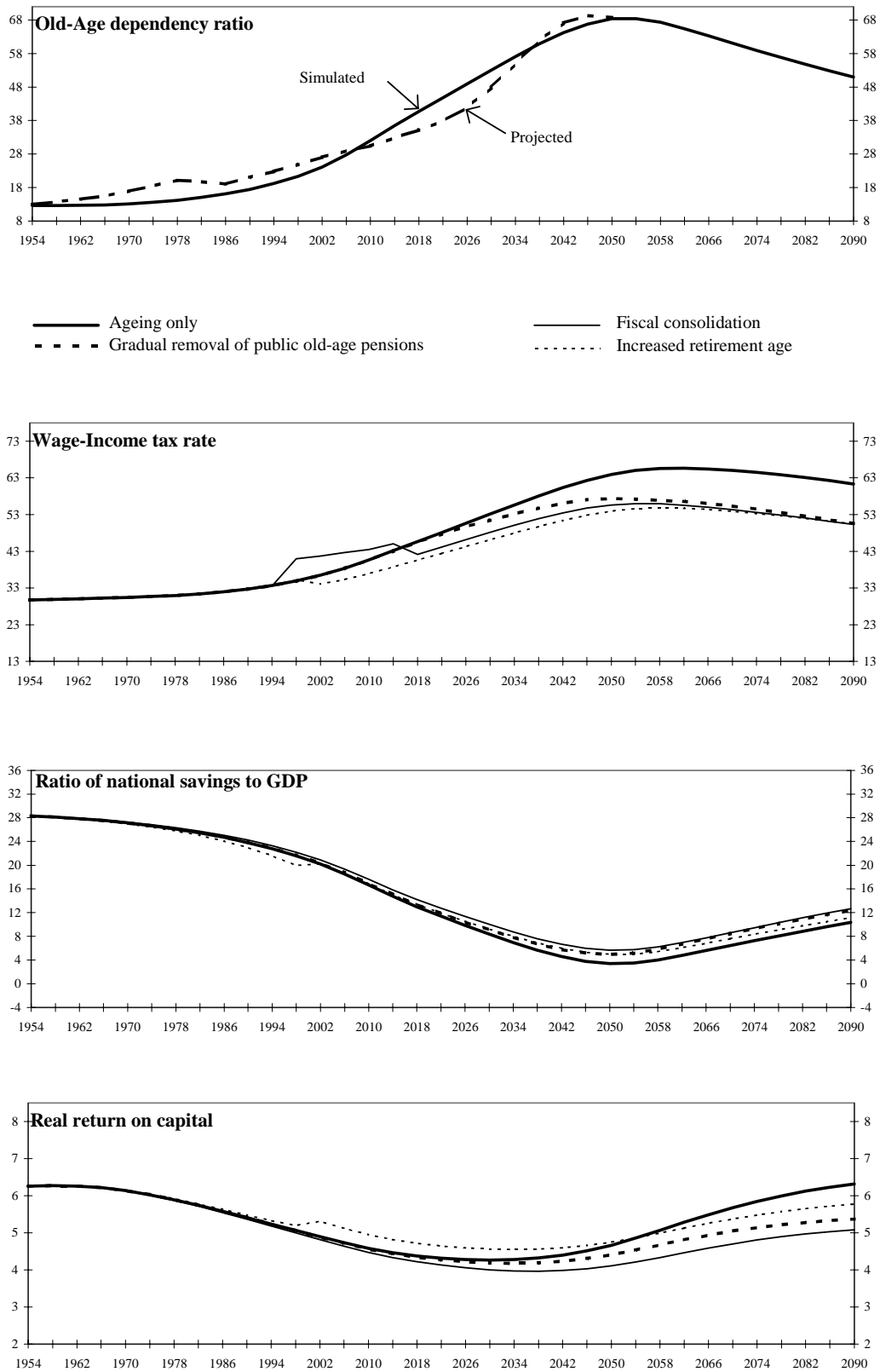


Figure 2. Japan

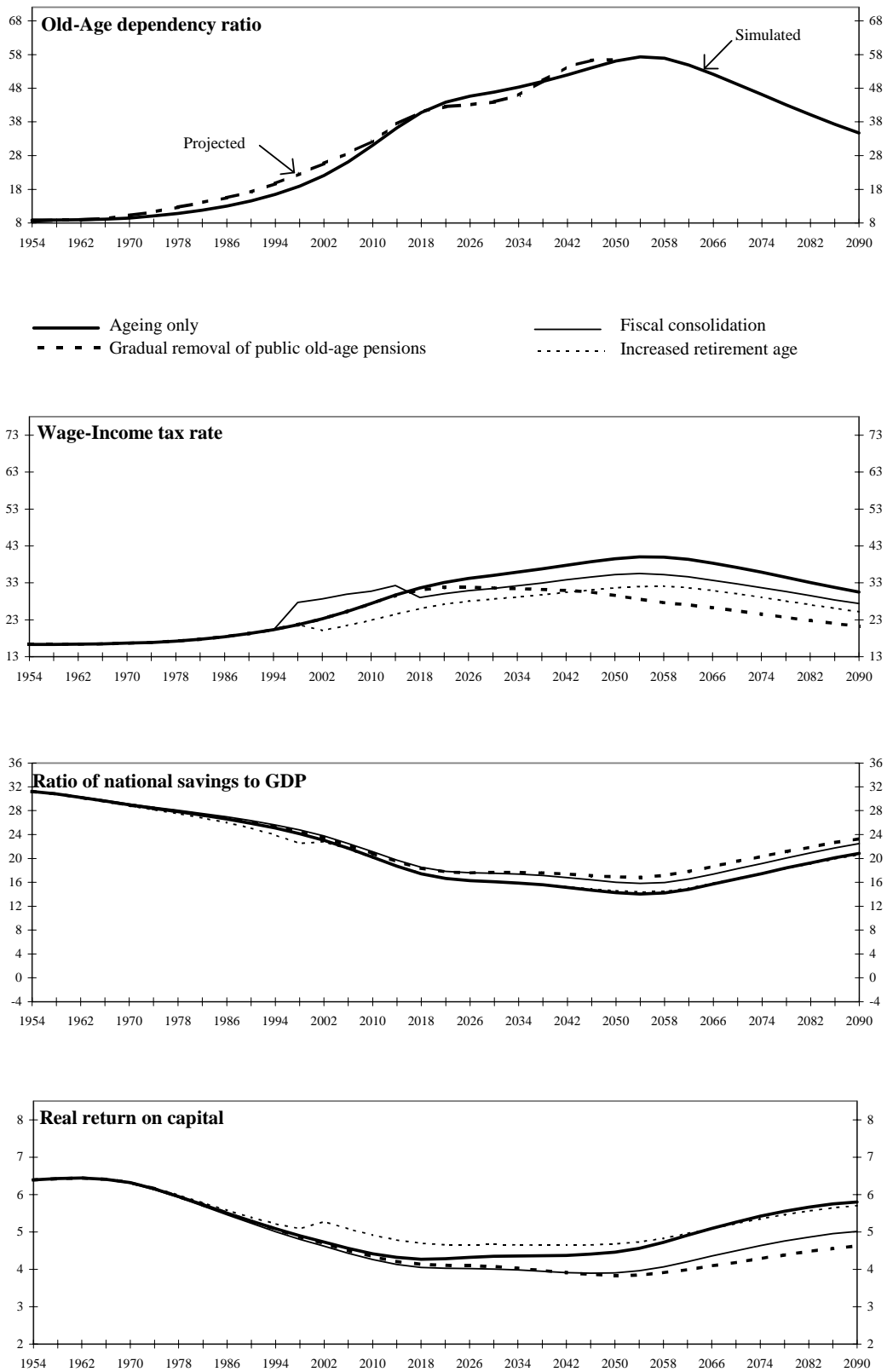


Figure 2. Sweden

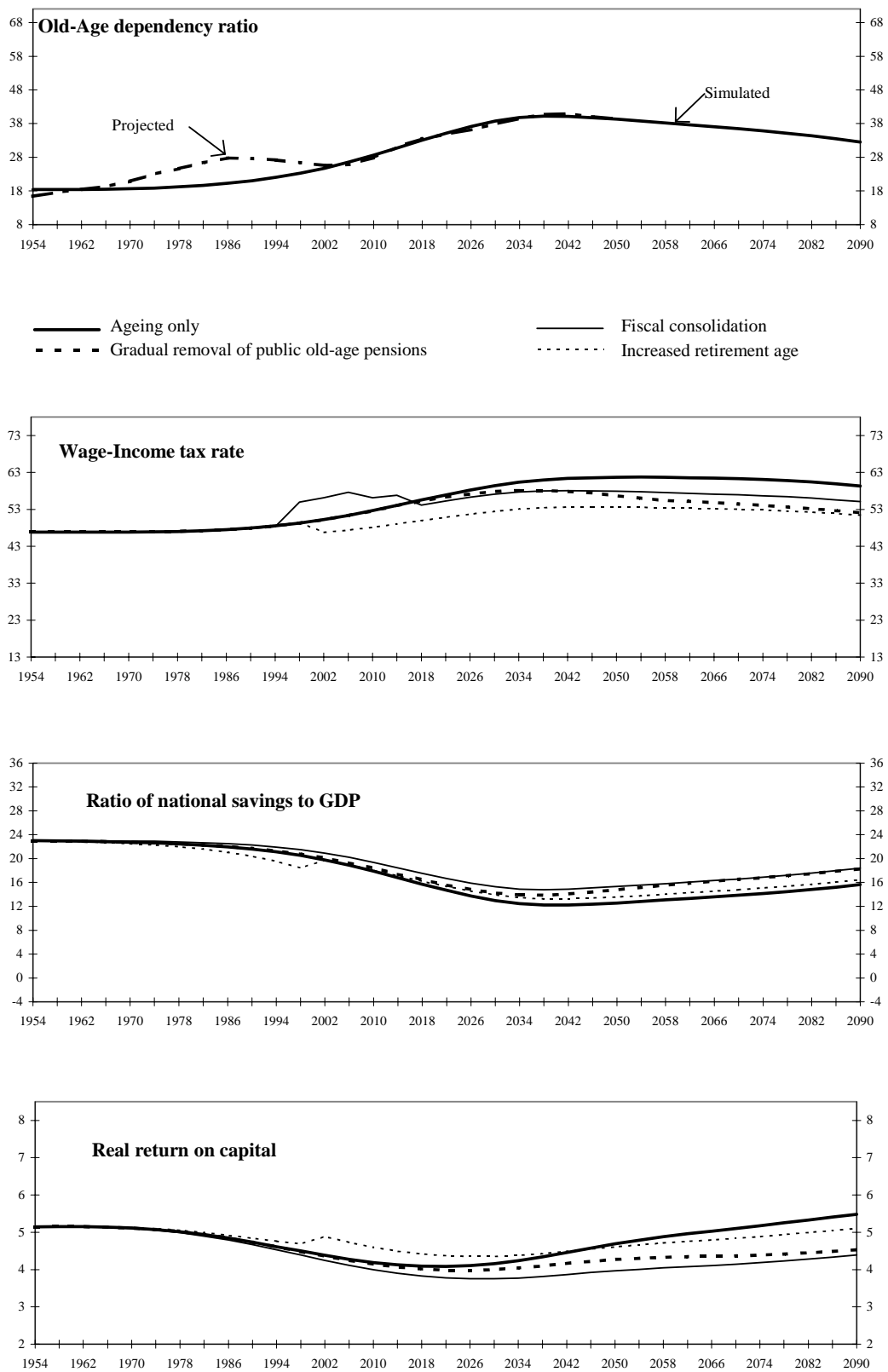


Figure 2. United Kingdom

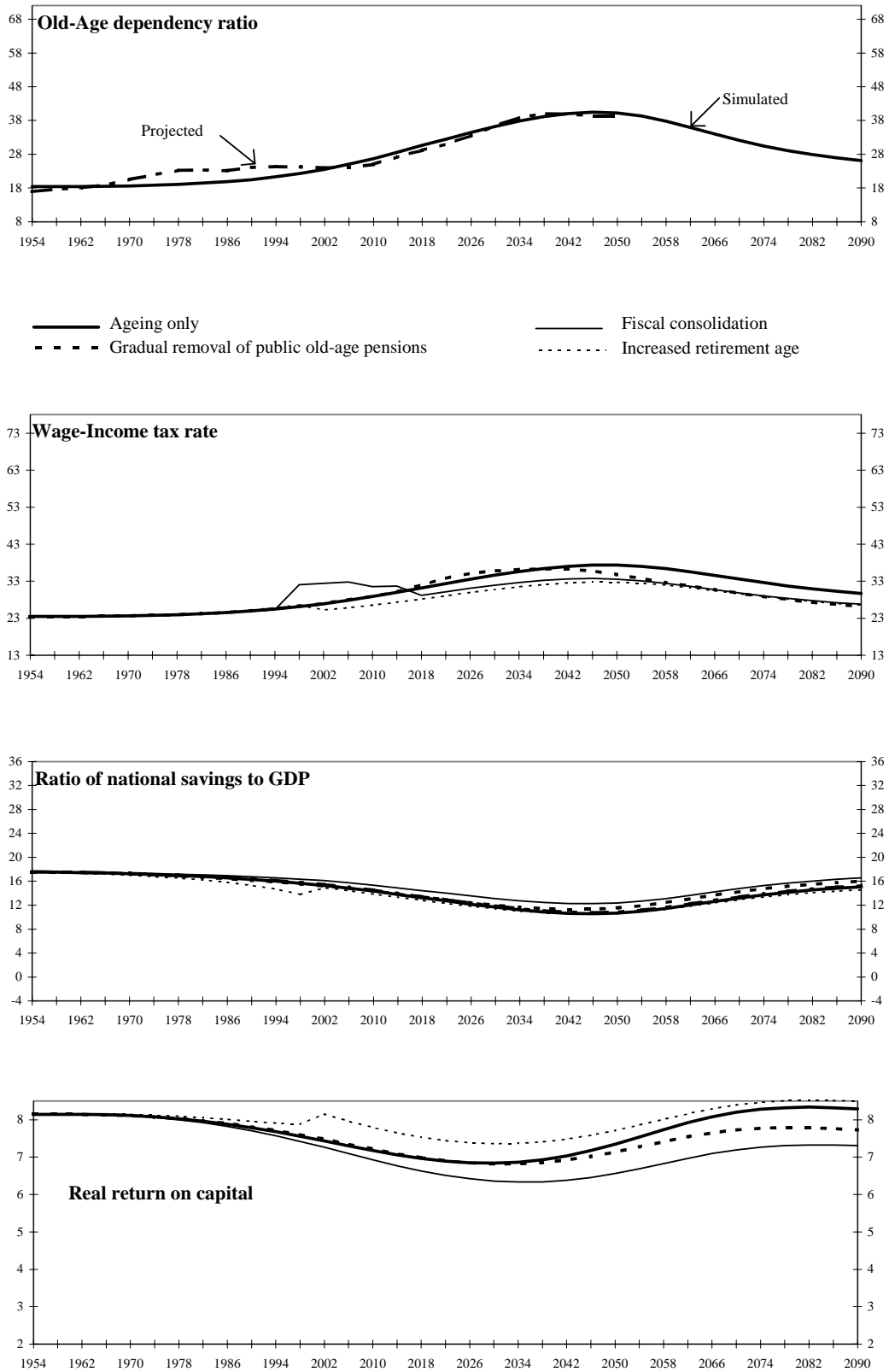
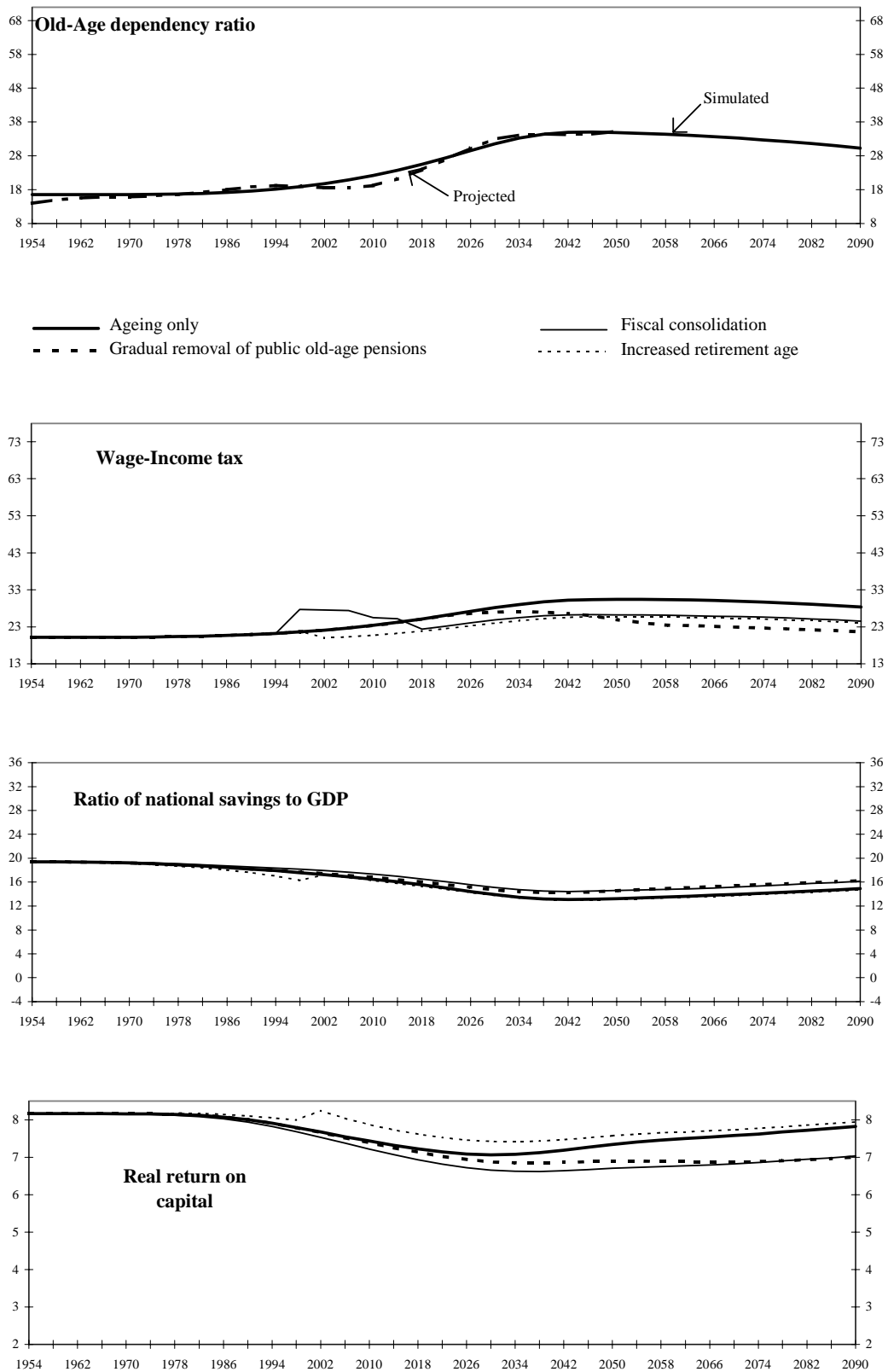


Figure 2 United States



ECO/WKP(98)14

Table 4. Effects of Policy Reform on Wage-income Tax Rates and National Savings (Per cent difference from baseline)

Scenario I: Gradual removal of public old-age pensions (Pension Reform I)

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate
2002	-0.1	1.2	0.0	1.7	-0.1	0.8	-0.1	1.7	0.0	1.5	0.3	-0.5	-0.1	1.0
2010	-0.3	2.2	-0.1	3.0	-0.1	1.5	-0.3	3.1	-0.1	2.8	0.4	0.1	-0.2	1.9
2018	-0.7	3.6	-1.1	5.2	-0.3	3.0	-1.9	5.3	-0.5	4.7	2.7	0.8	-0.1	3.2
2050	-17.3	14.3	-18.0	23.6	-10.4	45.1	-25.2	18.5	-8.1	17.6	-6.8	8.2	-18.1	9.9
Long run (2194)	-19.7	8.3	-17.7	10.6	-28.8	6.2	-27.1	9.5	-14.4	11.9	-12.4	5.8	-23.2	7.6

Scenario II: 20 per cent reduction in the replacement rate policy (Pension Reform II)

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate
2002	-3.0	1.1	-3.1	1.6	-2.1	1.0	-4.3	1.3	-1.5	1.6	-1.8	0.9	-3.5	1.1
2010	-3.3	1.3	-3.4	2.1	-2.4	1.5	-4.8	1.8	-1.6	2.1	-1.9	1.1	-3.7	1.3
2018	-3.6	1.6	-3.7	2.5	-2.6	2.1	-5.2	2.3	-1.8	2.5	-2.0	1.3	-4.0	1.5
2050	-4.3	2.6	-4.3	3.7	-2.8	7.6	-5.6	3.0	-2.2	3.4	-2.4	1.7	-4.5	1.8
Long run (2194)	-3.9	1.5	-3.6	1.8	-2.8	1.1	-4.9	1.6	-1.5	2.1	-2.1	1.1	-4.2	1.3

Scenario III: Fiscal Consolidation

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate
2002	22.0	3.7	13.4	3.8	14.3	3.5	23.4	3.0	11.8	5.7	20.4	5.2	24.6	3.8
2010	8.3	5.1	7.9	5.6	6.9	5.7	12.2	4.4	6.6	8.2	9.4	6.9	9.0	5.1
2018	-10.2	6.8	-7.7	7.9	-7.7	9.4	-8.3	6.3	-2.4	11.5	-6.4	8.9	-11.0	6.3
2050	-13.6	15.2	-10.5	18.3	-13.0	66.3	-10.9	12.3	-6.1	22.1	-10.2	15.9	-13.7	10.3
Long run (2194)	-12.4	8.2	-8.5	8.1	-11.6	6.7	-6.3	6.5	-5.3	11.5	-8.2	9.4	-12.1	7.5

Scenario IV: Increased retirement age

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate	Wage tax rate	National saving rate
2002	-8.6	-0.9	-10.3	1.9	-6.6	0.1	-13.4	-1.1	-6.8	-0.2	-6.2	-2.5	-9.5	-0.2
2010	-11.1	-1.4	-13.0	1.6	-9.3	1.0	-16.5	-0.4	-8.6	0.8	-8.2	-3.4	-11.5	-1.3
2018	-12.9	-1.3	-15.1	2.3	-11.1	3.1	-17.8	0.6	-10.0	3.1	-9.6	-3.4	-13.1	-1.6
2050	-16.3	2.3	-19.0	7.4	-15.7	45.7	-20.0	2.3	-13.0	8.1	-12.3	-0.4	-15.5	-1.0
Long run (2194)	-13.6	-1.2	-15.1	-0.2	-13.9	-1.8	-15.5	-1.3	-11.6	0.6	-9.9	-3.3	-14.1	-1.8

Table 5. Effects of policy reform on net real wages and real return on capital ¹ (Per cent difference from baseline)

Scenario I: Gradual removal of public old-age pensions (Pension Reform I)

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital
2002	0.2	-0.3	0.2	-0.6	0.1	-0.2	0.3	-0.9	0.2	-0.5	-0.3	0.6	-2.6	-0.2
2010	0.4	-0.7	0.4	-1.1	0.3	-0.5	0.6	-1.8	0.4	-1.0	-0.3	0.5	0.3	-0.6
2018	0.8	-1.3	1.4	-2.0	0.6	-0.8	1.7	-3.1	1.1	-1.9	-0.3	0.3	0.5	-1.2
2050	14.4	-6.7	20.9	-10.6	20.9	-5.6	21.2	-14.0	16.2	-9.0	5.1	-2.8	10.4	-6.1
Long run (2194)	13.1	-9.6	17.2	-15.0	29.5	-9.4	14.3	-14.7	22.7	-15.7	7.5	-6.5	11.8	-9.1

Scenario II: 20 per cent reduction in the replacement rate policy (Pension Reform II)

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital
2002	1.3	-0.7	2.1	-1.0	1.4	-0.6	1.7	-1.3	1.8	-1.1	0.9	-0.6	1.3	-0.7
2010	1.6	-0.9	2.6	-1.4	2.0	-0.8	2.3	-1.7	2.2	-1.4	1.0	-0.7	1.5	-1.0
2018	2.0	-1.1	3.1	-1.9	2.6	-1.1	3.0	-2.3	2.7	-1.9	1.2	-0.9	1.8	-1.2
2050	3.7	-2.1	5.2	-3.5	5.9	-2.4	4.8	-4.0	4.6	-3.2	2.0	-1.5	2.7	-1.9
Long run (2194)	2.5	-1.8	4.0	-2.8	1.0	-1.8	2.5	-2.7	2.8	-3.0	1.3	-1.3	2.1	-1.7

Scenario III: Fiscal Consolidation

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital
2002	-6.7	-1.7	-7.4	-2.0	-7.7	-1.6	-6.4	-2.4	-11.1	-3.1	-6.7	-2.3	-6.3	-1.8
2010	-2.1	-2.6	-4.1	-3.0	-3.9	-2.5	-3.7	-3.6	-6.1	-4.5	-2.6	-3.4	-1.7	-2.9
2018	6.0	-3.6	6.7	-4.4	7.9	-3.7	5.3	-5.1	4.9	-6.4	4.7	-4.8	5.2	-4.0
2050	13.2	-9.5	14.0	-11.9	28.8	-12.0	10.9	-12.4	15.2	-15.4	10.4	-10.7	9.6	-8.7
Long run (2194)	9.8	-9.5	9.7	-11.8	15.0	-10.9	5.5	-10.4	11.6	-15.8	7.4	-10.3	7.8	-9.0

Scenario IV: Increased retirement age

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital	Net real wages	Real return on capital
2002	0.1	6.7	2.4	11.6	0.7	8.4	0.8	11.6	3.5	11.6	-1.1	9.7	-0.1	7.4
2010	1.6	6.1	5.2	9.6	3.3	8.1	3.1	11.2	6.7	9.8	0.3	8.6	1.3	5.9
2018	3.1	6.0	7.7	8.4	6.4	7.8	5.4	10.1	10.1	8.1	1.5	8.2	2.3	5.5
2050	9.4	2.5	17.4	1.5	27.0	1.8	11.6	4.9	21.6	-1.7	5.5	5.0	5.6	3.1
Long run (2194)	5.1	1.6	9.7	0.2	11.8	0.3	4.5	2.2	14.1	-1.7	2.4	4.1	3.9	2.3

¹⁾ Net wage per efficiency unit of labour.

Table 6. Effects of policy reform on GDP and consumption (Per cent difference from baseline)

Scenario I: Gradual removal of public old-age pensions (Pension Reform I)

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption
2002	0.1	-0.2	0.2	-0.4	0.1	-0.2	0.3	-0.4	0.1	-0.6	-0.2	-0.2	0.1	-0.2
2010	0.3	-0.2	0.3	-0.5	0.2	-0.2	0.5	-0.4	0.3	-0.8	-0.2	-0.4	0.2	-0.2
2018	0.5	-0.2	0.6	-0.6	0.3	-0.3	0.9	-0.4	0.5	-0.9	-0.1	-0.4	0.5	-0.2
2050	2.8	1.6	3.3	0.8	2.1	0.9	4.1	1.2	2.8	0.5	1.0	0.1	2.3	1.1
Long run (2194)	4.3	4.1	5.2	4.2	3.9	3.7	4.8	2.5	5.1	5.4	-8.5	2.5	3.6	3.0

Scenario II: 20 per cent reduction in the replacement rate policy (Pension Reform II)

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption
2002	0.3	0.1	0.3	-0.1	0.2	-0.1	0.4	0.0	0.3	-0.2	0.2	0.1	0.3	0.1
2010	0.4	0.2	0.4	0.0	0.3	0.0	0.5	0.0	0.4	-0.1	0.3	0.1	0.4	0.1
2018	0.5	0.3	0.5	0.1	0.4	0.1	0.6	0.2	0.5	0.1	0.3	0.2	0.4	0.2
2050	0.9	0.9	1.1	1.1	0.9	1.1	1.1	0.9	1.0	1.3	0.5	0.6	0.7	0.6
Long run (2194)	0.8	0.8	0.9	0.8	0.7	0.7	0.8	0.5	0.9	1.1	0.5	0.5	0.6	0.6

Scenario III: Fiscal Consolidation

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption
2002	0.7	-0.2	0.6	-0.5	0.6	-0.5	0.7	-0.3	0.9	-1.3	0.8	-0.2	0.7	-0.1
2010	1.1	0.1	0.9	-0.5	0.9	-0.4	1.0	-0.2	1.3	-1.3	1.2	0.1	1.1	0.1
2018	1.5	0.4	1.3	-0.3	1.3	-0.2	1.4	0.0	1.8	-0.9	1.7	0.6	1.5	0.4
2050	4.1	3.4	3.7	2.7	4.6	4.1	3.6	2.1	4.9	4.3	4.0	3.8	3.4	2.5
Long run (2194)	4.3	4.0	4.0	3.4	4.6	4.5	3.3	1.8	5.2	5.7	4.0	3.9	3.5	2.9

Scenario IV: Increased retirement age

	Canada		France		Italy		Japan		Sweden		United Kingdom		United States	
	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption	Per capita GDP	Per capita consumption
2002	1.2	2.1	2.7	3.9	2.0	3.2	1.8	2.9	1.9	5.0	0.9	2.4	1.4	2.0
2010	2.4	4.2	4.4	6.9	3.8	5.9	4.0	5.7	3.3	7.9	2.0	4.4	2.5	3.9
2018	3.5	5.9	5.9	9.3	5.4	8.3	5.8	7.9	4.6	10.3	2.8	5.9	3.4	5.3
2050	7.0	11.0	10.2	16.5	11.6	18.2	9.6	13.4	8.2	19.0	5.1	9.5	5.7	8.5
Long run (2194)	4.4	7.3	6.2	11.1	4.6	8.9	4.4	6.6	5.6	14.2	2.9	6.2	4.1	6.5

35. All the above simulations suggest a number of general observations (Figure 2). First, the increase in the wage-income tax rate and the decline in national saving and capital returns, are inevitable, with or without the simulated policy reforms. Second, compared with the wage-income tax rate, the national saving path is less sensitive to policy reforms in most cases. Third, except for the increase in retirement age scenario, it takes a long time for the policy reforms to have significant macroeconomic impacts. Fourth, the gradual removal policy reform is the most effective in the long run, but the increase in retirement age scenario is the most effective in the short and medium run. Fifth, despite the large increase in wage-income taxes, the simulation results suggest that population ageing will increase the (net of tax) wage rate-capital return ratio (Table 5).

36. The first three simulations illustrate the effects of reducing the generosity of the pension system. Although the effects are large in the long run, in the short to medium-term they are rather small. In the case of a reduction of as much as 20 per cent in pension benefits (for current and future retirees), the wage-income tax rate (Table 4) falls by only 1.8 to 5.2 per cent by 2018 and national saving rate increases by 1.3 to 2.5 per cent. Similarly, in most countries, significant effects of a gradual but full removal of the pension system only materialise around 2030-2040, which is too late to prevent a sharp rise in the wage-income tax. The exception is France, where the effects are sufficient to prevent a sharp rise in the wage-income tax (see Figure 2). Noteworthy is the fact that the fiscal consolidation scenario has significant medium and long-term effects on the wage-income tax, saving and interest rates, and hence illustrates the potential use of fiscal consolidation to smooth the rise in future tax increases. However, the large effects from fiscal consolidation come at the expense of a sharp temporary increase in the wage-income tax and a drop in per capita consumption.

37. The simulated rise in the retirement age has significant effects on per capita consumption and the wage tax rate with a negligible effect on aggregate saving⁹. The increase in per capita consumption and the fall in the wage tax reflect the rapid reduction in the number of retirees and a corresponding increase in the number of wage-tax contributors. In contrast to the fiscal consolidation scenario, per capita consumption rises even in the short run and by more than per capita GDP, relative to the baseline. This is due to the fact that the larger labour force allows less of the extra output to be devoted to saving, so that the permanent increase in consumption per capita are larger. Gains to GDP and consumption are somewhat smaller in the long run than in the mid-21st century because in the long run dependency ratios are assumed to fall back from their peaks, thus reducing the relative increase in the labour force. In assessing welfare, the gains from increased consumption would have to be set against reduced leisure¹⁰.

38. The specific country effects depend on a combination of institutional, demographic and economic factors. As all calibrated parameters differ across countries, it is difficult to identify the factors that explain the different macroeconomic impacts of policy reforms when comparing countries. However, the simulations suggest that policy reform would be more successful in offsetting the effects from ageing in countries with initially high steady-state wage income tax rate and high pension benefit replacement rate, but with moderate increase in the old-age dependency ratio. Among the seven countries examined, France has the second highest pension benefit replacement rate, the second highest initial wage-income tax rate, but its old-age dependency ratio is projected to increase moderately. These factors may explain the comparably larger macroeconomic effects (see Figure 2) of the gradual removal and increased retirement age scenarios in France. The latter scenario has also relatively larger effects in Canada,

9. The exception is Italy, where the per cent difference for national saving rate tends to be large at some point since the baseline rate is very low.

10. It is noteworthy that for Canada, France, Sweden and the United States, this scenario results in short-run dip in the wage-income tax rate below its 1954 level.

Sweden and the United States, that is, in countries with relatively high replacement rates and moderately ageing populations. Partly due to previous pension reforms, the United Kingdom has a very low replacement rate. The design of the gradual removal scenario is such that it implies a temporary increase in the generosity of pension benefits for some cohorts in this country. This is why the United Kingdom suffers from an increase in the wage-income tax rate in the short and medium-term, under the gradual removal scenario. In Italy and Japan, the effects of the reforms in comparison with the baseline scenario are important in absolute terms, but their highly and rapidly ageing populations remain the dominating factor in determining the direction and magnitude of the macroeconomic outcomes.

39. As a final comment, note that a debt-financed transition to a funded policy system is not directly represented in any of the simulations. Such a reform could be done by simply recognising outstanding pension liabilities by the distribution of conventional debt. Such a simulation would be similar to a combination of Scenario I (“Removal of the old-age pension system”) and the *opposite* of Scenario III (“Fiscal consolidation”). If “old” pension liabilities were converted into conventional debt as they come due, the debt-finance scenario would result in an *increase* in conventional debt to GDP ratio, equal to the reduction in unfunded pension liabilities in the PAYG system. As a consequence, the net effect on national saving would be negligible¹¹, since the government deficit would offset the increase in private saving.

Concluding comments

40. The simulations presented here suggest that a reduction in the generosity of the public sector pension system would alleviate the problems linked to the rapidly ageing populations in two ways: first, through a direct reduction in the fiscal burden of future pension liabilities; second, through an increase in national saving and future potential output. However, these positive effects would only be realised if the reduction in the generosity of the pension system were “financed” by taxation or the present value of accrued pension liabilities were cut for instance by an across-the-board reduction in the replacement rate. A debt-financed transition runs the risk of being counterproductive, as an increase in conventional government debt would crowd out private investment more or less proportional to the increase in private saving.

41. The simulated effects of policy reforms on saving and taxes are, in most cases, rather small and overshadowed by the effects of increased ageing. Thus, in order to prevent dramatic increases in future taxes, more drastic cuts in benefits, or a combination of the simulated measures, are necessary. A general reduction in benefits could usefully be supported by partial “privatisation” of the pension system, introduced gradually for new entrants to the labour market, together with the removal of incentives for early retirement. In the same vein, fiscal consolidation, either in the form of repayment of public debt or the accumulation of pension fund assets, could also be used to alleviate future pressures on the pension system.

42. The short-term costs of reform are significant. Most of the simulated policy reforms result in a sustained period of depressed per capita consumption of goods or leisure (Table 6). Only after about 12 to 20 years, would the income increase be sufficiently large to offset the reduction in the propensity to consume. While an increase in the retirement age seems to be most effective in reducing the need for future tax increases, it comes at the cost of reducing life-time leisure. All the other reforms are, in fact, very similar and entail increased national saving, either as a result of a reduction in expected pension

11. Unless workers are credit constrained as in Cifuentes and Valdes-Prieto (1995).

benefits or increases in public saving (fiscal consolidation). The combination of short-term costs and long-term gains implies inter-generational welfare redistribution; it is very difficult to introduce a reform where all generations experience a net increase in life-time consumption, unless the overall efficiency gains are very large.

43. There are reasons to believe that the simulations underestimate the efficiency gains from the reforms, or overestimate the negative effects of ageing populations. First, the assumption concerning a fixed individual labour supply omits any positive effects on output and welfare derived from reduced labour market distortions. Second, a purely neo-classical production function does not include any positive spillover effects from increased investment in human capital, for example, as predicted in the "new growth theory". Indeed, the increase in the ratio of the wage to the rate of return on capital obtained in the simulations supports the presumptions that ageing populations may stimulate labour supply and human capital investment. Third, the saving effect from mandatory and funded pension schemes might be larger than simulated, due to effective borrowing constraints, making it difficult for many households to offset the effects of "forced saving". Fourth, the closed economy assumption results in a decline in the average rate of return on capital. With an open economy, the depressive effect on the rate of return should be smaller, as the current account would absorb the "excess saving", unless the whole world is ageing and every country follow the same policy¹².

44. In spite of the uncertainties attached to the size of the effects, the simulations presented here show that there is no easy way to reduce the burden of the projected increase in the number of older people relatively to those of working-age. To the extent that ageing implies that a larger share of the population contribute less to productive activities, the society at large can only alleviate the pressures on future working-age populations by either increasing the productive capacity or through increased national saving, i.e. foregoing current consumption. The simulations also show that most pension reform proposals would require much time before having a significant effect on saving and incomes. To the extent that policy actions can alleviate the economic burden of ageing, it should act on a broad front, involving a combination of reduced pension benefits, fiscal consolidation, an increase in the retirement age at least in line with increased longevity, as well as policies to improve the allocation of resources and promote economic growth.

12. See Turner *et al.*, 1998.

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