CHOOSING A PENSION REFORM: A FRAMEWORK FOR THE SOCIAL PLANNER

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This paper investigates the issue of which reform of the pay-as-you-go pension system a social planner should choose given its aversion to intergenerational inequality and its discount rate of the welfare of future generations. For this purpose, an applied normative economics methodology is develops which uses as a starting point the results of a dynamic general equilibrium model with overlapping generations (GE-OLG). This model simulates the economic impact of different PAYG pension reforms in the United States, Japan, France and Germany.

It shows that a social planner can hardly decide for one pension reform or another on the exclusive basis of the GDP criterion (except in the case of tax hikes balancing the regime which have sizeable detrimental effects on the growth rate).

Taking account of the intergenerational redistributive effects of the reforms thus becomes crucial for the social planner because it allows for discriminating between different possible scenarios. Freezing the age of retirement in an ageing context triggers strong intergenerational redistributive effects, whereas reforms incorporating a rise in the average age of retirement limit strongly these intergenerational redistributive influences. However, in the four countries considered here, no pension reform is found to be Pareto-improving. Compared to a no-reform, baseline tax hikes scenario, PAYG pension reforms weigh down more or less on the intertemporal welfare of the baby-boomers and increase the welfare of their children and of future generations.

Social welfare functionals encapsulating a variable degree of aversion to intergenerational inequality and a variable discount rate of the welfare of future generations show that the social planner in the United States and Japan is likely to favor reforms bolstering private savings at unchanged age of retirement. In Germany and France, the social choice favors scenarios increasing the age of retirement. In all countries, the status quo corresponding to tax hikes balancing the pension regime characterizes a social planner with rawlsian preferences.

1 Introduction and main results

1 This paper investigates the issue of which reform of the pay-as-you-go pension system a social planner should choose given its aversion to intergenerational inequality and its discount rate of the welfare of future generations.

2 With population ageing, reforms of PAYG systems have become of paramount importance in most OECD countries. They typically involve either a rise in the contribution rate, a decline in the replacement rate and/or an increase in the average age of retirement – otherwise public debt would follow an unsustainable path in most cases.[1] Such reforms can have a significant impact on capital accumulation and labor supply, thus on economic growth and aggregate welfare. From a microeconomic point of view, the impact of pension reforms on households' welfare also depends on their age when the reform is announced. Accordingly, pension reforms bring about intergenerational equity issues. Overall, the choice for a pension reform by a social planner caring about growth as well as intergenerational equity is not trivial *a priori* and deserves investigation.

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1 See European Commission (2006) for long-term projections of debt levels on unchanged policy settings.

3 In this paper, the simulations of the effects of pension reforms on macroeconomic variables, growth, households' intertemporal utility and social welfare rely on results from a computable, dynamic general equilibrium model with overlapping generations (GE-OLG) parameterised on data available for 4 countries with different demographic patterns (the United States, Japan, France and Germany). Such a modelling framework fits well with the need to measure the impact of ageing on growth since it encapsulates a production function, and with the need to address intergenerational issues thanks to overlapping generations. The available empirical literature shows that the dynamics of GE-OLG models and, accordingly, the associated policy recommendations, are robust for reasonable values of its parameters.

4 This paper focuses on the issues related with the modelling of the social planner's decision. It is mainly an exercise of applied normative economics. Accordingly, it provides with only a brief and non-technical presentation of the modelling characteristics of the GE-OLG model used. The interested reader is referred to Cournède and Gonand (2006) which presents a GE-OLG model with endogenous labour market. The version of the model used in this paper does not include, however, any health-care regime, public debt and non-ageing-related public spending, as in Cournède and Gonand (2006). In other words, this paper is concerned with the decision of the social planner as concerns pension reforms only, not the decision of a government trying to restore the sustainability of the finances of the whole public sector as in the referred paper.

5 Four standard scenarios of PAYG pension reforms are considered in this exercise. The average retirement age is unchanged in a first pair of scenarios where the pension system remains balanced each year during the next decades thanks to either higher tax rates (scenario 1) or lower replacement rates for future retirees (scenario 2). Scenario 1 can be thought of as a no-reform, reference scenario. A second pair of scenarios incorporates increases in the effective average age of retirement by one year and a quarter every ten years from 2005 until 2045, in line with forecasts of future life expectancy increases.[2] The small residual imbalances of the PAYG regime are covered either by adjusting the pension tax rate (scenario 3) or the replacement rate (scenario 4).

6 Results obtained from the GE-OLG model show that the GDP growth rate is higher in scenarios 2, 3 or 4 than in scenario 1 by around +0.2 per cent per year on average. Pension reforms indeed bolster labour supply and/or capital accumulation whereas raising taxes to balance the regime, as in scenario 1, fosters neither the former nor the latter. Since the favourable impacts of reforms on growth are very comparable, a social planner can hardly decide for one pension reform or another on the exclusive basis of the GDP criterion. Taking account of the intergenerational redistributive effects of the reforms thus becomes crucial for determining the social choice.

7 If the age of retirement is unchanged, as in scenario 2, the pension reform triggers strong intergenerational redistributive effects compared to the baseline, with many baby-boomers bearing most of the welfare cost associated with lower pensions while younger generations clearly benefit during their whole active life from much lower tax rates than in the baseline scenario 1. Scenarios incorporating a rise in the average age of retirement (scenarios 3 and 4) strongly smooth the intergenerational redistributive effects associated with the pension reform. The loss of leisure over the life cycle is shared among all cohorts of active age when the reform is announced.

8 However, no pension reform is Pareto-improving in the four countries considered in this exercise. Compared to the baseline scenario 1, PAYG pension reforms all tend to weigh down more or less on the intertemporal welfare of the baby-boomers and to increase more or less the welfare of their children and of future generations. In the absence of any Pareto-improvement, the social choice is not trivial and the use of a social welfare function is required.

[2] In these scenarios, age-specific participation rates of older workers are assumed to increase in line with the changes in the retirement age.

9 Two types of social welfare functions are considered here which both aggregate intertemporal utilities of the households and encapsulate a variable degree of aversion of the social planner to intergenerational inequality and a variable discount rate of the welfare of future generations. A first type of function ranks intertemporal utilities by decreasing order and then weights the utility of a cohort the more as it is lower (Gini generalised function). A second type applies an increasing and concave transformation when aggregating the utilities of the cohorts (Kolm Pollack function). Depending on the value of the parameter measuring the degree of aversion of the social planner to intergenerational inequality, social preferences tend to the utilitarianism of the mean, the maximin or lie in-between.

10 Overall, the social planner in the United States and Japan is likely to implement a PAYG pension scenario diminishing the replacement rate for future retirees while leaving the age of retirement unchanged (scenario 2). In Germany, the social choice favors scenario 3 which encapsulates a rising age of retirement and a slightly higher tax rate. In France, a social planner which does not care about the welfare of future generations but is reasonably averse to intergenerational inequality among living cohorts, increases the average age of retirement and slightly diminishes the replacement rate (scenario 4). In all countries, the *status quo* – defined here as scenario 1 with only tax hikes balancing the regime – can only be implemented by a social planner with rawlsian preferences.

11 This paper is divided into three sections. Section 2 briefly presents the GE-OLG model which provides with the data used in Sections 3 and 4. Section 3. analyzes the intra-generational redistributive effects of the four scenarios considered here. Section 4. develops a normative economics analysis aiming at determining the conditions of the social choice when reforming PAYG pension systems. Section 5 concludes by summing up the main results.

2 A short presentation of the model providing the data

12 This paper uses the results of a general equilibrium model with overlapping generations (GE-OLG) and endogenous labour market which is a modified version of Cournède and Gonand (2006). Contrary to the latter paper, the version used here does not include any health-care regime, public debt and non-ageing-related public spending. In other words, this paper is concerned with the decision of the social planner as concerns pension reforms only, not the decision of a government trying to restore the sustainability of the finances of the whole public sector as in the referred paper.

13 The dynamics of the GE-OLG model are exclusively driven by demographics, the pension reforms and the behavioural responses of economic agents. In line with most of the literature on dynamic GE-OLG models, the model used here does not account explicitly for effects stemming from the external side of the economy. Accounting for external linkages would smooth the dynamics of the variables but only to a limited extent. Home bias (the "Feldstein-Horioka puzzle"), exchange rate risks, financial systemic risk and the fact that many countries in the world are also ageing and thus competing for the same limited pool of capital all suggest that the possible overestimation of the impact of ageing on capital markets due to the closed economy assumption is small, especially for the United States.

14 The model embodies around 60 cohorts each year (depending on the average life expectancy), thus capturing in a detailed way changes in the population structure. Demographic projections are obtained from a specific simulation model (Gonand, 2005) and rely on official demographic assumptions. Participation and unemployment rates by age-groups are frozen from

2000 onwards, unless in scenarios with rising retirement ages which include corresponding changes in the participation rate of older workers.[3]

15 The household sector is modelled by a standard, separable, time-additive utility function and an intertemporal budget constraint. The instantaneous utility function has two arguments, consumption and leisure. The average individual of a given cohort decides how much to work, consume and save so as to maximise the discounted value of his/her lifetime utility subject to his/her intertemporal budget constraint. Households endogenously choose how long they work, but their decision to participate in the labour force is exogenous. In other words, the intensive margin of labour supply is endogenous in the model while the extensive margin is exogenous. Households receive wage and pension income and pay proportional taxes on labour income to finance the PAYG pension regime. The pension income depends on the age of the individual and the age at which he/she is entitled to obtain a full pension.[4] The pensions are not wage-indexed. The annual saving is invested in the capital market and the interest payments are capitalised into individual wealth.[5]

16 Production is modelled through a standard constant elasticity of substitution (CES) function with two inputs: capital and efficient labour. Exogenous technical progress drives the variation of multi-factor productivity (MFP) over time (+1.5 per cent *per annum*). As mentioned above, working time – thus the stock of hours worked – is endogenous and results from households' optimising behaviour. Accordingly, the labour force, defined as the total stock of hours worked in the economy, is endogenous in the model.

17 The intertemporal equilibrium of the model is obtained through a simple numerical convergence applying to the intertemporal vectors of demand and supply of capital per unit of efficient labour. The convergence process begins with an educated guess for the demand of capital per unit of efficient labour, from which the model derives a supply of capital by households per unit of efficient labour. A Gauss-Seidel algorithm is used so that both vectors converge.

18 Four scenarios of reform of PAYG pension systems are considered:

- in a first pair of scenarios, the average retirement age is unchanged. In scenario 1, the PAYG pension regime is balanced each year through higher contribution rates while the replacement rate and retirement age remain unchanged. Scenario 1 is used as a no-reform, reference scenario. In scenario 2, the tax rate financing pensions is frozen from 2005 on and the PAYG system is balanced thereafter by gradually decreasing replacement rates for *new* retirees. As households anticipate future cuts in the replacement rate, they rethink their labour supply, consumption and saving plans accordingly. More specifically, lower replacement rates motivate agents to increase savings in order to sustain consumption levels upon retirement;
- a second pair of scenarios incorporates increases in the effective average age of retirement by one year and a quarter every ten years from 2005 until 2045, in line with forecasts of future life expectancy increases. Age-specific participation rates of older workers are assumed to increase in line with the changes in the retirement age. The (small) residual imbalances of the PAYG regime are covered by adjustments in the pension tax rate in Scenario 3 or the replacement rate for new retirees in Scenario 4.

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3 The year 2000 is used as a starting point for participation and unemployment rates because the unemployment gap was then close to nil in OECD countries.

4 If he/she is over 50 but below the full-right retirement age, he/she receives a pension reduced by a penalty.

5 The life-cycle framework used here introduces a link between saving and demographics. In such a setting, aggregate saving rate is positively correlated with the fraction of older employees in total population, and negatively with the fraction of retirees. When baby-boom cohorts get older but remain active, aging increases the saving rate. When these large cohorts retire, the saving rate declines.

19 Table 1 shows some results obtained for the four pension reform scenarios in the GE-OLG model. It suggests that ageing weighs down significantly on the GDP per capita annual growth rate. However, the GDP per capita growth rate is also higher in scenarios 2, 3 or 4 than in scenario 1 by around +0.2 per cent per year on average. Pension reforms indeed bolster labour supply and/or capital accumulation whereas raising taxes to balance the regime fosters neither the former nor the latter.

20 However, the differences between scenarios 2, 3 and 4 as regards economic growth and aggregate welfare are very small. Scenario 2 performs slightly better on both accounts in the United States and Japan and scenario 3 in Germany. Results on French data are completely indecisive.

21 The differences between pension reforms as concerns economic growth and aggregate welfare are too small to allow for delivering strong normative conclusions and policy recommendations. Accordingly, a social planner can hardly decide for one pension reform or another on the exclusive basis of the GDP criterion. Taking account of the intergenerational redistributive effects of the pension reforms thus becomes crucial for determining the social choice.

3 Analysing the intergenerational redistributive effects of pension reforms with Lexis surfaces and intertemporal utilities

22 A first look at the losers and winners in the pension reforms modelled here is possible by computing Lexis surfaces. A Lexis surface represents in 3 dimensions the level of a variable associated with a cohort of a given at a given year. The variable considered here is the gain (or loss) of current welfare of a cohort in a scenario relative to its current welfare in the baseline scenario 1.[6]

23 A few notations are in order here. Let's define a function $\Phi_{SCi}(a, t)$ such that:

$$\Phi_{SCi}(a,t) = \frac{\lfloor U(c_{t,a}, l_{t,a} \rfloor_{SCi}}{\lfloor U(c_{t,a}, l_{t,a} \rfloor_{SC1}} - 1$$

where $\Phi_{SCi}(a, t)$ stands for the gain (or loss) of current welfare of a cohort aged a at year t in a scenario i (with $i \in \{1,2,3,4\}$) relative to its current welfare in the baseline scenario 1. $[U(c_{t,a}, l_{t,a})]$ stands for the current utility level of the cohort aged a at year t in scenario i, which depends on the optimal level of consumption ($c_{t,a}$) and the optimal level of leisure ($l_{t,a}$) both computed in the GE-OLG model. By definition, the graph of this function is a Lexis surface.

24 Figures 1 to 3 show the Lexis surfaces obtained on French data in scenario 2, 3 and 4 respectively. Lexis surfaces for the United States, Japan and Germany (which are not shown here) display similar patterns with only orders of magnitude changing (see below). Before the reform is implemented in 2005, $\Phi_{SCi}(a, t)$ is zero for every cohort because the informational set of the households before 2005 is assumed to correspond to the one of the baseline scenario 1. From 2005 on, the deformations of the Lexis record the intergenerational redistributive effects triggered by the reforms:

- a declining replacement rate for new retirees after 2005 (scenario 2) at unchanged age of retirement entails sizeable intergenerational effects. It weighs down on current welfare for cohorts aged 37 or more while younger cohorts and future generations are favoured as

[6] Current welfare refers here to the instantaneous welfare of a cohort, or equivalently its welfare at a given year, which is computed from the instantaneous utility function of a household in the GE model.

Table 1

Impact of PAYG Pension Reforms on Different Variables of the GE-OLG Model

United States

(yearly average)	2001-10	2011-20	2021-30	2031-40	2041-50	Average 2001-50
Scenario 1: Increasing tax rates, replacement rate and age of retirement unchanged						
GDP per capita growth rate	1.6%	1.3%	1.0%	1.2%	1.5%	**1.3%**
Tax rate of the PAYG pension regime balancing the regime	6.3%	7.9%	9.6%	9.6%	8.8%	
Replacement rate for new retirees	58%	58%	58%	58%	58%	
Average age of retirement *(years)*	62.0	62.0	62.0	62.0	62.0	
Interest rate (real, 1989=3.5%)	3.3%	3.1%	3.0%	3.1%	3.2%	
Dependency ratio[(1)]	20%	24%	29%	32%	32%	
Scenario 2: Tax rates unchanged, diminishing replacement rate, age of retirement unchanged						
GDP per capita growth rate	1.7%	1.4%	1.2%	1.3%	1.6%	**1.4%**
Tax rate of the PAYG pension regime	6.1%	6.1%	6.1%	6.1%	6.1%	
Replacement rate for new retirees balancing the regime	53%	37%	36%	39%	41%	
Average age of retirement *(years)*	62.0	62.0	62.0	62.0	62.0	
Interest rate (real, 1989=3.5%)	3.3%	2.9%	2.8%	2.8%	2.8%	
Dependency ratio[(1)]	20%	24%	29%	32%	32%	
Scenario 3: Increasing age of retirement, replacement rate unchanged, slight adjustement of the tax rate						
GDP per capita growth rate	1.7%	1.4%	1.1%	1.2%	1.6%	**1.4%**
Tax rate of the PAYG pension regime balancing the regime	5.9%	5.8%	6.4%	5.7%	4.2%	
Replacement rate for new retirees	58%	58%	58%	58%	58%	
Average age of retirement *(years)*	62.2	63.3	64.6	65.8	66.9	
Interest rate (real, 1989=3.5%)	3.4%	3.2%	3.1%	3.3%	3.5%	
Dependency ratio[(1)]	20%	20%	22%	23%	21%	
Scenario 4: Increasing age of retirement, tax rate unchanged, slight adjustement of the replacement rate						
GDP per capita growth rate	1.7%	1.4%	1.1%	1.2%	1.6%	**1.4%**
Tax rate of the PAYG pension regime	6.1%	6.1%	6.1%	6.1%	6.1%	
Replacement rate for new retirees balancing the regime	63%	56%	55%	68%	91%	
Average age of retirement *(years)*	62.2	63.3	64.6	65.8	66.9	
Interest rate (real, 1989=3.5%)	3.4%	3.2%	3.2%	3.4%	3.5%	
Dependency ratio[(1)]	20%	20%	22%	23%	21%	

Japan

(yearly average)	2001-10	2011-20	2021-30	2031-40	2041-50	Average 2001-50
Scenario 1: Increasing tax rates, replacement rate and age of retirement unchanged						
GDP per capita growth rate	1.0%	1.0%	1.0%	1.2%	1.0%	**1.0%**
Tax rate of the PAYG pension regime balancing the regime	9.5%	11.6%	13.0%	13.7%	16.1%	
Replacement rate for new retirees	51%	51%	51%	51%	51%	
Average age of retirement *(years)*	66.0	66.0	66.0	66.0	66.0	
Interest rate (real, 1989=3.5%)	3.0%	3.0%	3.0%	3.0%	2.8%	
Dependency ratio[(1)]	29%	37%	44%	49%	57%	
Scenario 2: Tax rates unchanged, diminishing replacement rate, age of retirement unchanged						
GDP per capita growth rate	1.0%	1.1%	1.2%	1.3%	1.2%	**1.2%**
Tax rate of the PAYG pension regime	9.0%	9.2%	9.2%	9.2%	9.2%	
Replacement rate for new retirees balancing the regime	44%	37%	35%	32%	26%	
Average age of retirement *(years)*	66.0	66.0	66.0	66.0	66.0	
Interest rate (real, 1989=3.5%)	3.0%	2.9%	2.7%	2.6%	2.4%	
Dependency ratio[(1)]	29%	37%	44%	49%	57%	
Scenario 3: Increasing age of retirement, replacement rate unchanged, slight adjustement of the tax rate						
GDP per capita growth rate	1.0%	1.0%	1.2%	1.3%	1.1%	**1.1%**
Tax rate of the PAYG pension regime balancing the regime	9.4%	10.4%	9.6%	9.1%	10.6%	
Replacement rate for new retirees	51%	51%	51%	51%	51%	
Average age of retirement *(years)*	66.2	67.3	68.6	69.8	70.9	
Interest rate (real, 1989=3.5%)	3.0%	3.0%	3.1%	3.1%	3.0%	
Dependency ratio[(1)]	29%	35%	36%	38%	43%	
Scenario 4: Increasing age of retirement, tax rate unchanged, slight adjustement of the replacement rate						
GDP per capita growth rate	1.0%	1.1%	1.2%	1.3%	1.2%	**1.2%**
Tax rate of the PAYG pension regime	9.0%	9.2%	9.2%	9.2%	9.2%	
Replacement rate for new retirees balancing the regime	47%	44%	53%	49%	41%	
Average age of retirement *(years)*	66.2	67.3	68.6	69.8	70.9	
Interest rate (real, 1989=3.5%)	3.0%	3.0%	3.0%	3.0%	2.8%	
Dependency ratio[(1)]	29%	35%	36%	38%	43%	

[(1)] Population receiving a pension /labour force.

Table 1 (continued)

Impact of PAYG Pension Reforms on Different Variables of the GE-OLG Model

France

(yearly average)	2001-10	2011-20	2021-30	2031-40	2041-50	Average 2001-50
Scenario 1: Increasing tax rates, replacement rate and age of retirement unchanged						
GDP per capita growth rate	1.1%	0.9%	0.7%	0.8%	1.1%	0.9%
Tax rate of the PAYG pension regime balancing the regime	19.5%	22.8%	27.0%	28.5%	28.5%	
Replacement rate for new retirees	64%	64%	64%	64%	64%	
Average age of retirement *(years)*	59.0	59.0	59.0	59.0	59.0	
Interest rate (real, 1989=3.5%)	3.8%	3.6%	3.7%	3.9%	4.1%	
Dependency ratio[1]	44%	54%	64%	71%	76%	
Scenario 2: Tax rates unchanged, diminishing replacement rate, age of retirement unchanged						
GDP per capita growth rate	1.1%	1.2%	1.0%	1.2%	1.3%	1.1%
Tax rate of the PAYG pension regime	19.1%	19.1%	19.1%	19.1%	19.1%	
Replacement rate for new retirees balancing the regime	58%	45%	43%	44%	41%	
Average age of retirement *(years)*	59.0	59.0	59.0	59.0	59.0	
Interest rate (real, 1989=3.5%)	3.7%	3.4%	3.3%	3.3%	3.3%	
Dependency ratio[1]	44%	54%	64%	71%	76%	
Scenario 3: Increasing age of retirement, replacement rate unchanged, slight adjustement of the tax rate						
GDP per capita growth rate	1.2%	1.2%	0.9%	1.2%	1.4%	1.2%
Tax rate of the PAYG pension regime balancing the regime	19.2%	19.8%	21.1%	20.0%	18.2%	
Replacement rate for new retirees	64%	64%	64%	64%	64%	
Average age of retirement *(years)*	59.2	60.3	61.6	62.8	63.9	
Interest rate (real, 1989=3.5%)	3.8%	3.8%	3.9%	4.2%	4.3%	
Dependency ratio[1]	43%	48%	53%	55%	55%	
Scenario 4: Increasing age of retirement, tax rate unchanged, slight adjustement of the replacement rate						
GDP per capita growth rate	1.2%	1.2%	1.0%	1.2%	1.3%	1.2%
Tax rate of the PAYG pension regime	19.1%	19.1%	19.1%	19.1%	19.1%	
Replacement rate for new retirees balancing the regime	64%	56%	55%	68%	63%	
Average age of retirement *(years)*	59.2	60.3	61.6	62.8	63.9	
Interest rate (real, 1989=3.5%)	3.8%	3.8%	3.9%	4.1%	4.2%	
Dependency ratio[1]	43%	48%	53%	55%	55%	

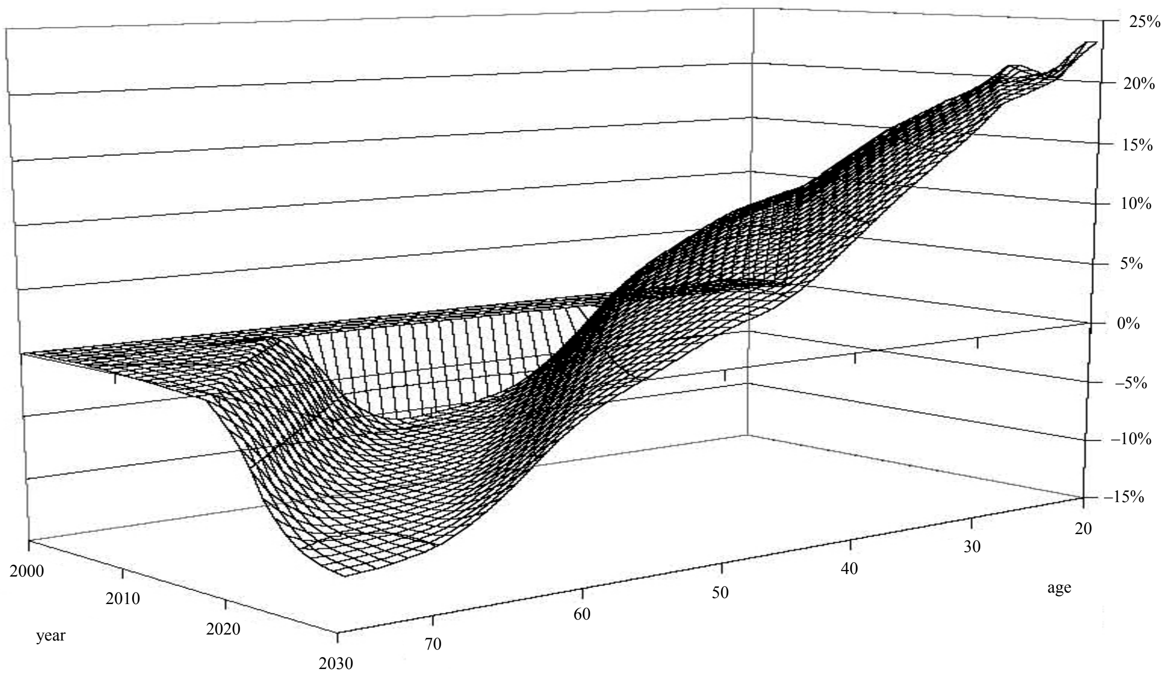
Germany

(yearly average)	2001-10	2011-20	2021-30	2031-40	2041-50	Average 2001-50
Scenario 1: Increasing tax rates, replacement rate and age of retirement unchanged						
GDP per capita growth rate	1.0%	1.0%	0.9%	1.0%	1.2%	1.0%
Tax rate of the PAYG pension regime balancing the regime	16.5%	17.8%	20.5%	22.5%	22.0%	
Replacement rate for new retirees	52%	52%	52%	52%	52%	
Average age of retirement *(years)*	61.0	61.0	61.0	61.0	61.0	
Interest rate (real, 1989=3.5%)	3.6%	3.6%	3.5%	3.6%	3.7%	
Dependency ratio[1]	48%	55%	65%	72%	76%	
Scenario 2: Tax rates unchanged, diminishing replacement rate, age of retirement unchanged						
GDP per capita growth rate	1.0%	1.1%	1.1%	1.2%	1.3%	1.1%
Tax rate of the PAYG pension regime	16.3%	16.4%	16.4%	16.4%	16.4%	
Replacement rate for new retirees balancing the regime	49%	44%	37%	39%	39%	
Average age of retirement *(years)*	61.0	61.0	61.0	61.0	61.0	
Interest rate (real, 1989=3.5%)	3.6%	3.5%	3.3%	3.3%	3.3%	
Dependency ratio[1]	48%	55%	65%	72%	76%	
Scenario 3: Increasing age of retirement, replacement rate unchanged, slight adjustement of the tax rate						
GDP per capita growth rate	1.1%	1.2%	1.0%	1.3%	1.4%	1.2%
Tax rate of the PAYG pension regime balancing the regime	16.3%	15.5%	16.1%	16.1%	13.8%	
Replacement rate for new retirees	52%	52%	52%	52%	52%	
Average age of retirement *(years)*	61.2	62.3	63.6	64.8	65.9	
Interest rate (real, 1989=3.5%)	3.6%	3.8%	3.7%	3.9%	4.0%	
Dependency ratio[1]	47%	50%	55%	56%	55%	
Scenario 4: Increasing age of retirement, tax rate unchanged, slight adjustement of the replacement rate						
GDP per capita growth rate	1.1%	1.2%	1.0%	1.3%	1.4%	1.2%
Tax rate of the PAYG pension regime	16.3%	16.4%	16.4%	16.4%	16.4%	
Replacement rate for new retirees balancing the regime	53%	57%	48%	59%	61%	
Average age of retirement *(years)*	61.2	62.3	63.6	64.8	65.9	
Interest rate (real, 1989=3.5%)	3.7%	3.8%	3.8%	4.0%	4.1%	
Dependency ratio[1]	47%	50%	55%	56%	55%	

[1] Population receiving a pension /labour force.

Figure 1

Gain (or Loss) of Current Welfare of a Cohort in Scenario 2 (Lower Replacement Rate, Unchanged Age of Retirement) Compared to Scenario 1 (Higher Tax Rate, Unchanged Age of Retirement)



compared to the baseline. For active cohorts, scenario 2 involves a lower tax rate and a lower replacement rate from 2005.[7] For active cohorts about to retire, the discounted, unfavourable effect of a replacement rate that is lower over the remaining lifetime than in scenario 1 dominates the discounted, favourable impact of a tax rate lower over only a few remaining working years before retiring. The associated loss of permanent income entails lower consumption for older active generations. For young active generations, the net effect of the reform on current welfare is reversed and thus favorable, bolstering consumption as well as leisure. For future generation, the favorable influence on welfare is still bigger;

- intergenerational redistributive effects are far more limited in scenario 3 where the age of retirement is increased by 1.25 year per decade from 2005 on and the tax rate is marginally adjusted to balance the pension system. This reform enhances current welfare for many cohorts and over most of the simulation period. Compared to scenario 1, the welfare cost of the reform is borne by the cohorts aged between 50 and 70 each year. Their future current welfare is indeed lower than in the baseline scenario 1, reflecting lower leisure for cohorts which would have been retired had scenario 3 not been implemented;
- in scenario 4 – which encapsulates a rising age of retirement as in scenario 3 and where the pension regime is balanced by adjusting the replacement rate and not the tax rate – the intergenerational redistributive effects are qualitatively similar to those observed in scenario 2 but quantitatively far more limited, in particular for future generations.

[7] For individuals already retired in 2005, the reform has a small detrimental effect on welfare. Since capital deepening is stronger in scenario 2 than in the baseline, the interest rates are lower and the return on the capital accumulated by the retirees also declines.

Figure 2

Gain (or Loss) of Current Welfare of a Cohort in Scenario 3 (Increasing Age of Retirement, Adjusted Tax Rate) Compared to Scenario 1 (Higher Tax Rate, Unchanged Age of Retirement)

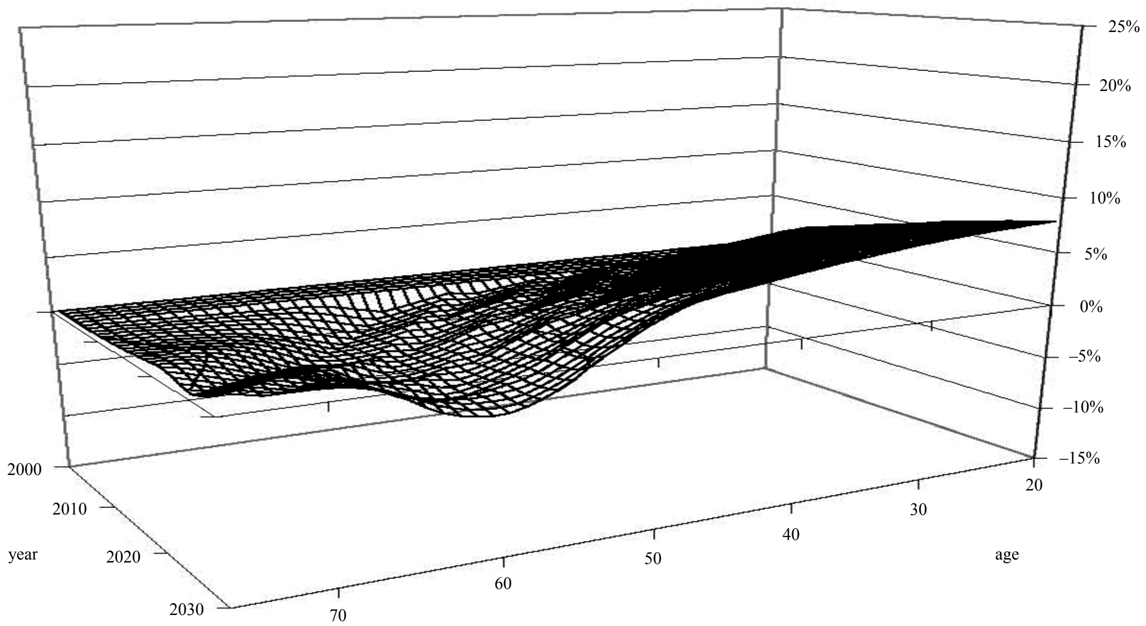
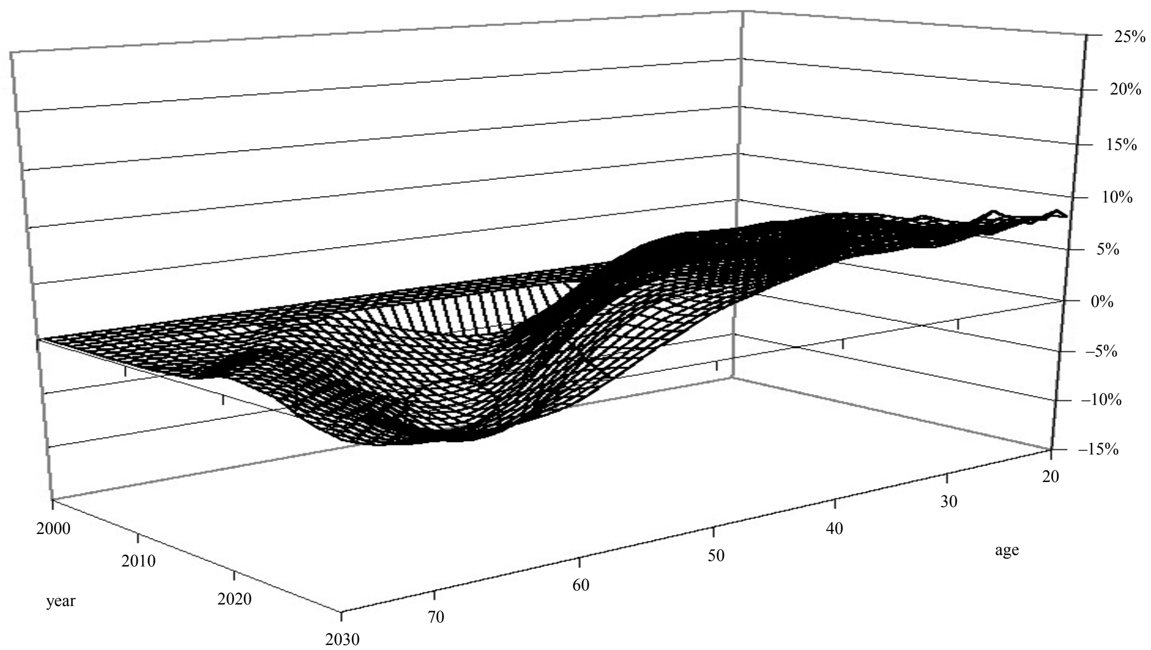


Figure 3

Gain (or Loss) of Current Welfare of a Cohort in Scenario 4 (Increasing Age of Retirement, Adjusted Replacement Rate) Compared to Scenario 1 (Higher Tax Rate, Unchanged Age of Retirement)



25 The Lexis surfaces for the United States, Japan and Germany –which are not shown here – display similar patterns but orders of magnitude differ:

- in the United States, the intergenerational redistributive effects in all scenarios are far more limited than in France. For instance, the welfare gain of the cohort aged 20 in 2030 compared to scenario 1 is 7 per cent in the US whereas it is above 20 per cent on French data. This difference illustrates divergent demographic dynamics between the two countries, with an ageing problem less acute in the US than in France and therefore smaller adjustments needed in the PAYG pension system;
- in Japan and Germany, welfare gains in scenarios 2, 3 and 4 are slightly more limited than in France. In Japan, welfare gains in case of a reform increasing the age of retirement are smaller than in France because the age of retirement in Japan is already high at the beginning of the simulation period (*i.e.*, 66 years) and because the GE-OLG model encapsulates a declining labor productivity of individuals above 60.

26 Overall, Lexis surfaces show that increasing the age of retirement allows for smoothing the intergenerational redistributive effects associated with pension reforms. However, from a normative point of view, they hardly help determining whether a Pareto-improving reform exists among the scenarios considered here. Comparing intertemporal utilities among different scenarios – and not current utility as in Lexis surfaces – proves to be more useful on this issue (see below).

27 In contrast with the Lexis surfaces, intertemporal utilities take account of all the influences on households' welfare over his/her entire lifespan. Let's $W_t^{intertemp}$ stand for the intertemporal utility of the representative individual of a cohort born in t in the GE-OLG model. Figure 4 shows the levels of the intertemporal utility for the cohorts born between 1940 and 2000 in the United States, Japan, France and Germany respectively, and in the four scenarios of pension reform modeled here.

28 Figure 4 clearly shows that the level of the intertemporal utility of a representative individual tends to increase with its year of birth.[8] This trend comes from strictly positive gains of multifactor productivity (MFP) in the GE-OLG model. Technical progress indeed increases the level of the real wage over time and thus pushes up optimal consumption and leisure. Thus the intertemporal utility of a household is all the higher as this household is younger, *ceteris paribus*.

29 Many common features emerge from the profiles of intertemporal utilities in the four countries considered here, in particular as concerns the intergenerational redistributive effects of pension reforms:

- A reform bolstering private saving (as scenario 2 and, to a lesser extent, scenario 4) is always more favorable to younger cohorts and future generations than other scenarios, and weighs down relatively more on the intertemporal welfare of the baby-boomers.
- An increase in the age of retirement (as in scenarios 3 and 4) moderates the intergenerational redistributive effects of the reform as compared to scenario 2, because they are simultaneously less detrimental to the welfare of the baby-boomers and less favorable to younger and future cohorts.
- In all countries a group of cohorts exists for which the social choice for one reform or another is almost neutral as concerns their intertemporal welfare. This group encompasses cohorts born between 1970 and 1975.

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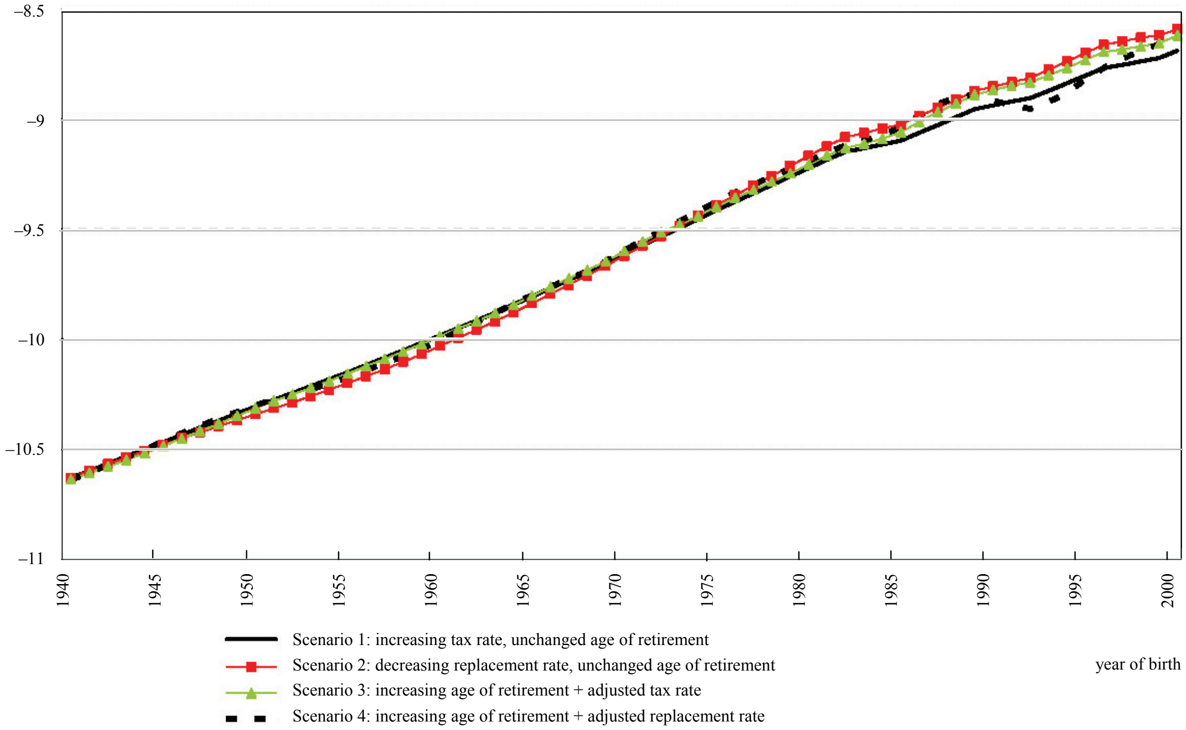
[8] In some exceptional cases, the intertemporal utility of a cohort is slightly lower than the one of the immediately preceding cohort, due to the influence on welfare of pension reforms which depends on age.

Figure 4

Intertemporal Utilities of the Representative Individuals of the Cohorts Born Between 1940 and 2000

United States



Japan

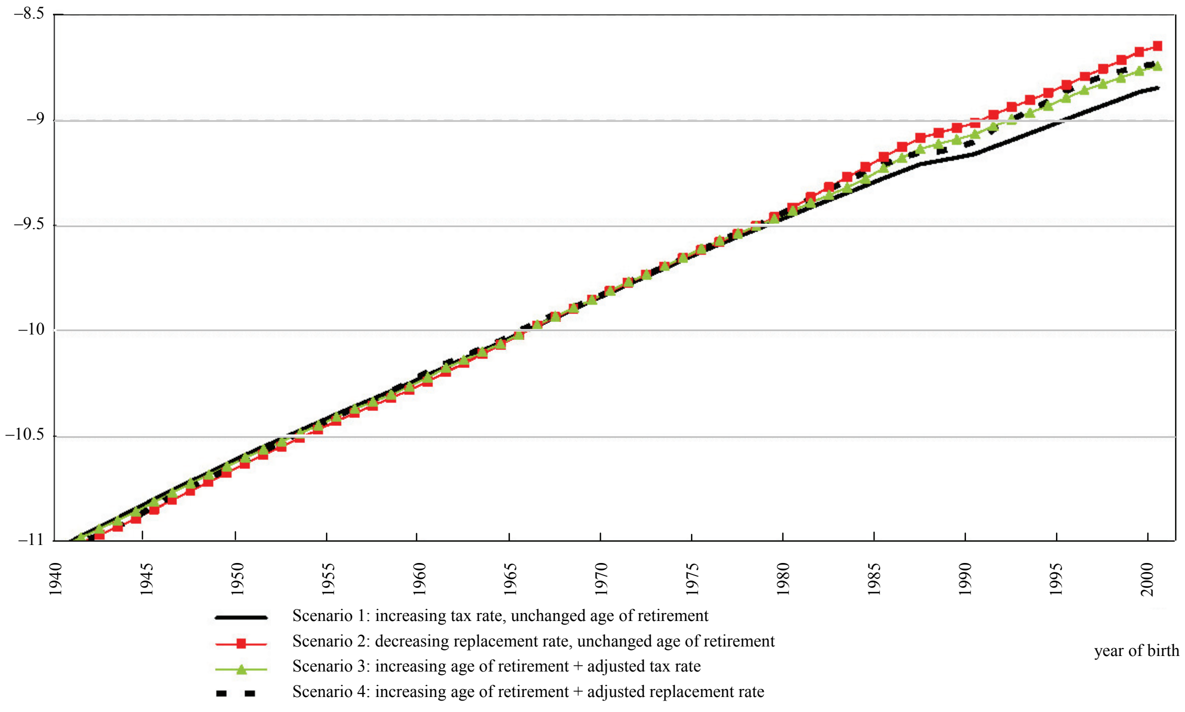
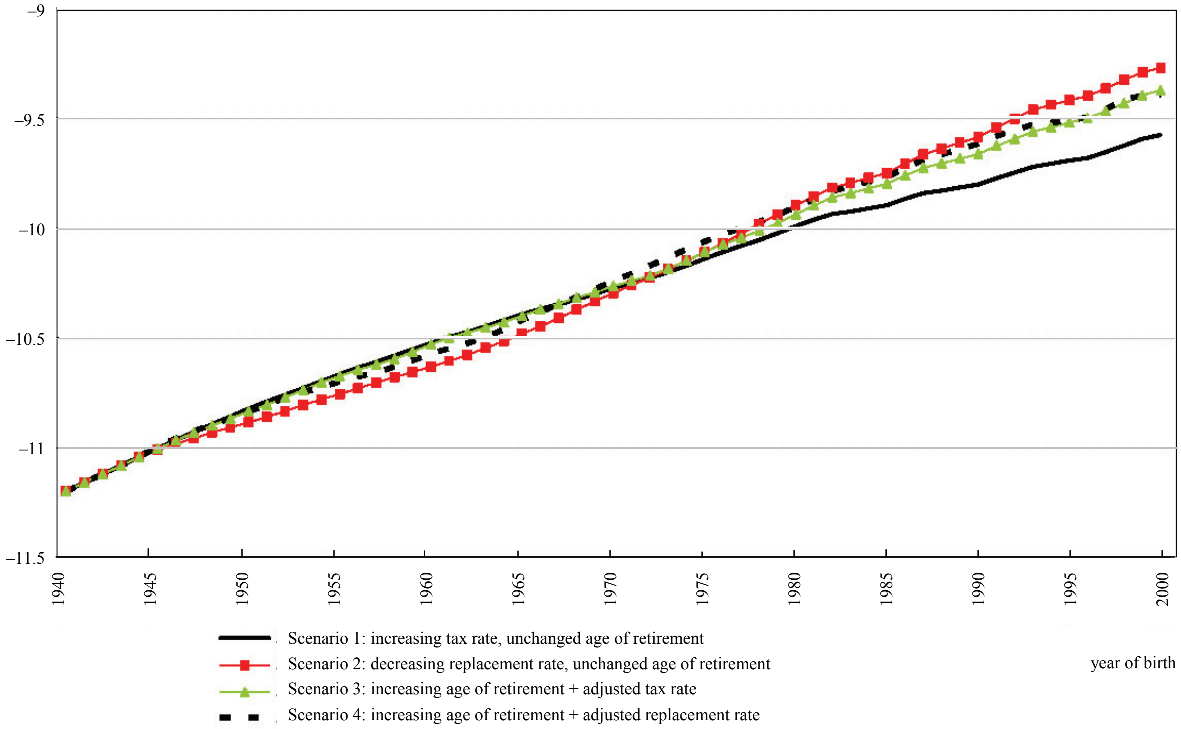


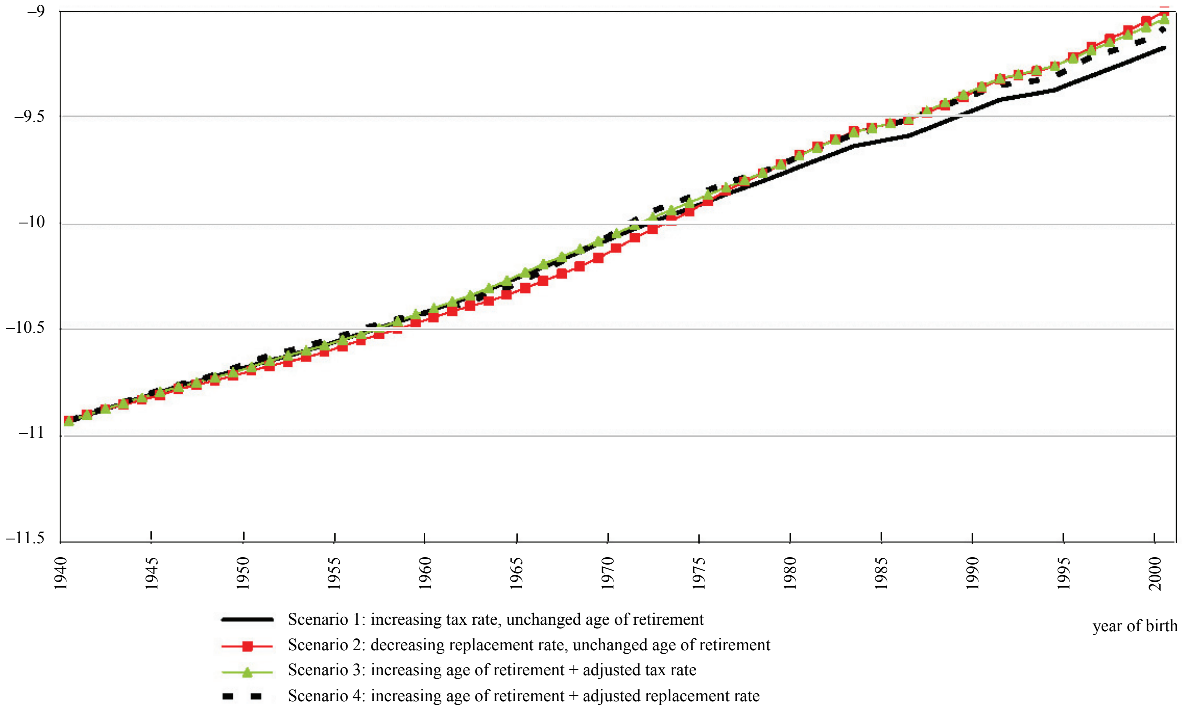
Figure 4 (continued)

Intertemporal Utilities of the Representative Individuals of the Cohorts Born Between 1940 and 2000

France



Germany



30 However, significant differences appear among the different scenarios in each country as concerns intertemporal utilities:

- in the United States, the differences between the scenarios are relatively limited, in line with a relatively slow ageing of the population;
- on Japanese data, the respective influences of the reforms on intertemporal utility are very limited for cohorts born before the mid-1980's. This reflects a demographic context characterized by an ageing process already advanced, in which the upward effect on savings of a declining replacement rate remains small and increasing the age of retirement is of little impact when the initial age of retiring is already high (66 years). For the intertemporal welfare of cohorts born after the 1980's, scenario 2 is relatively more favorable;
- in France and Germany, differences among intertemporal utilities are coherent with the results obtained with Lexis surfaces and reflect the same mechanisms.

31 Most importantly, *intertemporal utilities in Figure 4 shows that no reform scenario is Paret-improving* compared to any other scenario, and especially compared to the baseline, no-reform scenario 1. This result holds in the four countries considered here. PAYG pension reforms all tend to weight down more or less on the intertemporal welfare of the baby-boomers and to increase more or less the welfare of their children and of future generations. In this context, the social choice is not trivial and the use of a social welfare functional is required.

4 Modelling the social choice for a pension reform: an applied normative analysis

32 Among possible welfarist social choice functionals, the criterion of the maximin has brought about a large and controversial literature. In the modelling context of our GE model with overlapping generations which involves a strictly positive technical progress, the use of the maximin raises serious and interesting problems that were first formulated in Arrow's (1973) criticism of Rawls' (1971) *Theory of Justice*.

33 By definition, the maximin requires that the decision of a welfarist social planner among a set of possible choices should be the one which maximizes the welfare of the most detrimentally affected social unit (Rawls, 1971). However, Arrow (1973) shows that applying this maximin criterion in an intertemporal environment with strictly positive technological progress amounts to selecting the reform maximising the welfare of the oldest cohort alive, which corresponds in our model to the group of survivors dying in 2005 when the reform is announced. Figure 4 clearly illustrates Arrow's point. Reforming pensions on the exclusive basis of their impact on the intertemporal welfare of the oldest individual of a society seems hard enough to advocate for.

34 Arrow's criticism can be extended to social welfare functionals taking account of the welfare of future generations.[9] The issue of whether the welfare of future generations should be discounted in the social planner's function has been bringing about difficult issues in normative economics. Welfarism requires the social choice to depend only on information about well-being, disregarding all other information – such as, for instance, the year of birth of a cohort. This implies *not* discounting the welfare of future cohorts. Such a proposal usually appears problematic since, for instance, it can call for large sacrifices from current generations for the benefit of cohorts appearing far in the future.

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9 In one paragraph, Arrow (1973) advocates for discounting the welfare of future cohorts mainly because it is common sense; however, when criticising the use of the maximin in an intertemporal environment, he implicitly assumes that the welfare of future generations is not discounted.

35 Discounting the well-being of future generations is not without drawbacks either. If the number of future generations whose well-being is discounted is *not* finite, applying the maximin in an intertemporal modelling environment does not allow for defining a solution to the social choice problem. Indeed, the further the cohorts in time, the lower their discounted intertemporal utility. Thus if the number of future cohorts taken into account is not finite, applying the maximin criterion does not yield a defined result. If the number of future generations whose well-being is discounted is finite, then applying the maximin in an intertemporal modelling environment amounts to selecting the reform maximizing the welfare of either the further cohort in time or the oldest living cohort (the latter case corresponding to Arrow's critique), depending on the values of the social discount rate and the number of future cohorts taken into account.

36 From a more empirical point of view, it seems reasonable to take account of the welfare of a finite number of future generations. Determining this number is unavoidably arbitrary but the implications are all the more limited as the value of the social discount rate is higher. In what follows, the analysis takes account of the welfare of the cohorts born before or in 2030. Thus, our applied normative economics analysis does not abide by strict welfarist standards which would have required not discounting the well-being of an infinite number of future generations – an empirically non-tractable requirement here.

37 Arrow's criticism of the maximin criterion in an intertemporal context with positive technical progress applies to any social welfare functional aggregating intertemporal utilities. The following paragraphs dig deeper into this issue.

38 Blackorby, Bossert and Donaldson (2005) distinguish two types of social welfare functionals which both encapsulate a variable parameter measuring the degree of aversion of the social planner to intergenerational inequality. A first category of functionals ranks intertemporal utilities by decreasing order and then weights the utility of a cohort the more as it is lower (Gini generalised function). A second category applies an increasing and concave transformation when aggregating the intertemporal utilities of the cohorts (Kolm Pollack function). Depending on the value of the parameter measuring the aversion of the social planner to intergenerational inequality, social preferences tend to the utilitarianism of the mean, the maximin or lie between these polar cases.

39 A few notations can be helpful. The Gini generalised social welfare functional in a given scenario and for a given country can be written as:

$$\Delta^{Gini}\,(\mathrm{W}_t^{\text{intertemp}})_{t\in T} = \frac{\sum_t \left[N_t\,(1+\rho_s)^{-c(t)}\,\left(i^\theta-(i-1)^\theta\right)\left[\mathrm{W}_t^{\text{intertemp}}\right]_{[i]}\right]}{\left(\sum_t N_t\,(1+\rho_s)^{-c(t)}\right)^\theta}$$

where Δ^{Gini} stands for the Gini generalised social welfare functional. Its arguments are the intertemporal utilities $W_t^{intertemp}$ of the representative individuals of each cohort born in $t \in T$ where T is the set of cohorts alive in 2005 when the reform is announced and/or born before or in 2030. N_t stands for the number of individuals in a cohort in 2005.[10] The expression $(1+\rho_S)^{-c(t)}$ refers to the social rate discounting the welfare of future generations in the social welfare functional.[11] The parameter $\theta \geq 1$ stands for the degree of aversion of the social planner to intergenerational inequality. The parameter i refers to the rank order of $W_t^{intertemp}$ – the intertemporal utility of the representative individual of the cohort born in t – after applying a rank-ordered permutation such that:

[10] If $t \in (2005;2030]$, then N_t equals the initial number of individuals of the cohort.

[11] with $\rho_s \in [0;1]$ and $c(t)$ such that $\{[t \leq 2005\,] \rightarrow [c(t)=0];[t \in (2005;2030\,]] \rightarrow [c(t)=t-2005\,]\}$.

$$[W_t^{intertemp} \geq W_{t^*}^{intertemp}] \rightarrow [[W_t^{intertemp}]_{[i]} \geq [W_{t^*}^{intertemp}]_{[i+1]}] \ \forall\, t,\ \forall\, t^* \neq t,\ \forall\, i$$

40 These specification and notations rely on simple intuitions. The Δ^{Gini} function aggregates the intertemporal utilities of the cohorts weighting them all the more as their level is lower and associating them with increasing values of i. If $\theta = 1$, then Δ^{Gini} corresponds to the utilitarism of the mean. For $\theta \rightarrow \infty$, Δ^{Gini} tends to the maximin because the weight of the lowest intertemporal utility is increasingly higher that the other weights. Between these two polar cases, the degree of aversion of the social planner to intergenerational inequality can vary in a continuous fashion.

41 Such a specification assumes cardinal comparability of the preferences since the utilities are weighted by the number of individuals in each cohort (*i.e.*, by N_t). Incidentally, it avoids Parfit's (1982 and 1984) repugnant conclusion by taking account of the size of the total population – as it clearly appears, for instance, when $\theta = 1$.

42 This standard Gini-generalised social welfare functional is biased in favor of the well-being of the oldest cohorts alive, however. In our intertemporal context with positive technical progress, the intertemporal utility of the representative individual of a cohort ($W_t^{intertemp}$) increases with the year of birth. Accordingly, permuting the intertemporal utilities in the Gini function amounts basically to classifying these utilities by decreasing order of date of birth. For $\theta \rightarrow \infty$ which models Rawls' maximin criterion, Arrow's critique thus still fully applies because the social choice takes only account of the welfare of the oldest cohort alive.

43 The same problem arises with social welfare functionals applying an increasing and concave transformation when aggregating the utilities of the cohorts. Blackorby *et al.* (2005) present a so-called Kolm Pollack function in which the transformation is logarithmic, such as:

$$\Delta^{Kolm}\ (W_t^{\text{intertemp}})_{t\in T} = -\frac{1}{\gamma}\ln\left[\frac{\sum_t \left[N_t\ (1+\rho_s)^{-c(t)}\ \exp\left[-\gamma W_t^{\text{intertemp}}\right]\right]}{\left(\sum_t N_t\ (1+\rho_s)^{-c(t)}\right)}\right]$$

where Δ^{Kolm} stands for the Kolm Pollack social welfare functional. Its arguments are the intertemporal utilities $W_t^{intertemp}$ of the representative individuals of each cohort born in $t \in T$ (see above). N_t stands for the number of individuals in a cohort in 2005.[12] The expression $(1+\rho_S)^{-c(t)}$ refers to the social rate discounting the welfare of future generations in the social welfare functional (see above). The parameter γ stands for the degree of aversion of the social planner to intergenerational inequality. For $\gamma \rightarrow 0$, social preferences tend to the utilitarism. For $\gamma \rightarrow \infty$, they tend to the maximin.

44 Given the intertemporal context of modelling with positive technological progress and the increasingness of the exponential function, applying the maximin criterion for the social choice in the Kolm Pollack function ($\gamma \rightarrow \infty$) still favors the well-being of the oldest cohort alive, which again is in line with Arrow's critique.

45 Non-biased results can nevertheless be obtained by slightly modifying the specification of the social welfare functionals and using, as arguments, the *differences* between the intertemporal utilities in a given scenario and the same utility in the baseline, no-reform scenario 1, such that:

$$\Delta^{Gini}\ (W_t^{\text{intertemp}})_{t\in T} = \frac{\sum_t \left[N_t\ (1+\rho_s)^{-c(t)}\ \left(i^\theta - (i-1)^\theta\right)\left[W_{t,SCi}^{\text{intertemp}} - W_{t,SC1}^{\text{intertemp}}\right]_{[i]}\right]}{\left(\sum_t N_t\ (1+\rho_s)^{-c(t)}\right)^\theta}$$

[12] If $t \in \left(2005;2030\right]$, then N_t equals the initial number of individuals of the cohort.

for the Gini-generalised function where stands for the intertemporal utility of the $W_{t,SCi}^{intertemp}$ stands for the intertemporal utility of the representative individual of the cohort born in *t* in scenario *i* with $i \in \{1,2,3,4\}$), and

$$\Delta^{Kolm}\ (W_t^{\text{intertemp}})_{t\in T} = -\frac{1}{\gamma}\ln\left[\frac{\sum_t \left[N_t\ (1+\rho_s)^{-c(t)}\ \exp\left[-\gamma\, W_{t,SCi}^{\text{intertemp}} - W_{t,SC1}^{\text{intertemp}}\right]\right]}{\left(\sum_t N_t\ (1+\rho_s)^{-c(t)}\right)}\right]$$

for the Kolm Pollack function. These specifications of the social welfare functionals model the social preferences of a government comparing the intertemporal utilities of the cohorts in different scenarios of pension reforms with the same utilities in the no-reform, baseline scenario 1.

46 These specifications avoid the problems stemming from associated with the positive correlation between the intertemporal utilities of the representative individual of a cohort and his/her year of birth. Computing the difference between $W_{t,SCi}^{intertemp}$ and $W_{t,SC1}^{intertemp}$ indeed mechanically cancels out the trend since it is common to both $W_{t,SCi}^{intertemp}$ and $W_{t,SC1}^{intertemp}$.

47 Interestingly, applying the maximin becomes meaningful with these modified specifications. The rawlsian social planner always prefers the *status quo* and chooses to implement scenario 1, in which the welfare of the most detrimentally affected cohort is maximised – indeed, it is nil by construction. Since no scenario is Pareto-improving, some cohort are loosing from the reform in all the other scenarios. Thus a rawlsian social planner chooses to increase taxes in our model.

48 Figures 5 to 8 depict the pay-as-you-go pension system reform which the social planner chooses given its degree of aversion to intergenerational inequality and its discount rate of the welfare of future generations, in the four countries analysed and with the two social welfare functionals used in this paper (Gini generalised and Kolm Pollack). These results provide with a synthetic policy recommendation which takes account of the impact of pension reforms on growth as well as the intergenerational redistributive effect.

49 Since results as concerns the impact of reforms on growth were especially indecisive on French data (see section 2), the case for France is examined first. For an infinite degree of aversion to intergenerational inequality (*i.e.*, $\theta \to \infty$ or $\gamma \to \infty$), the social planner always select scenario 1 (with tax hikes and unchanged age of retirement) (see above).[13] In the case of a purely utilitarist social planner with no aversion to intergenerational inequality (*i.e.*, $\theta = 1$ or $\gamma \to 0$), the selected reform depends on the value of the social discount rate. If it is low, the social planner implements scenario 2 (with cuts in the replacement rate and unchanged age of retirement). If it is higher than 24 per cent in the Gini function and 19 per cent in the Kolm Pollack case, the government chooses scenario 4 (which incorporates a rise in the age of retirement and slightly diminishes the replacement rate).

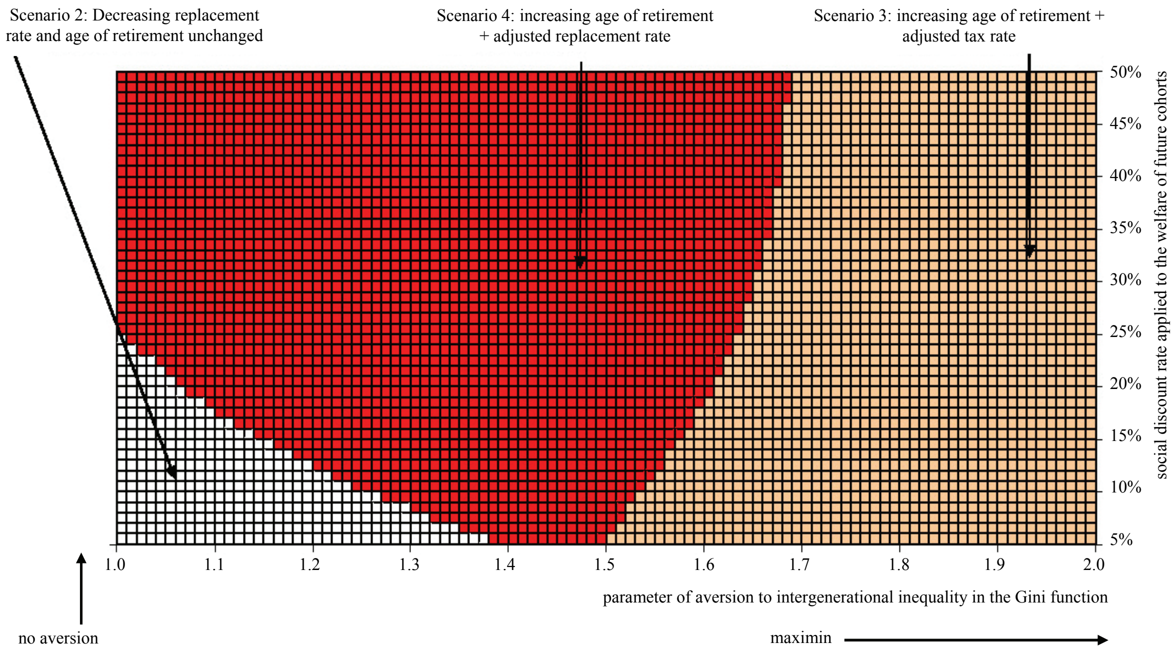
50 From an empirical point of view, the social planner can reasonably be thought of as being relatively averse to intergenerational inequality but not taking much care for the welfare of future cohorts. Different cases can be distinguished here. For increasing values of $\theta \geq 1$ (or $\gamma > 1$), the social planner in France selects firstly scenario 4, then – for still higher aversion to intergenerational inequality – scenario 3 and ends up, for Rawlsian preferences, selecting scenario 1 (see above).

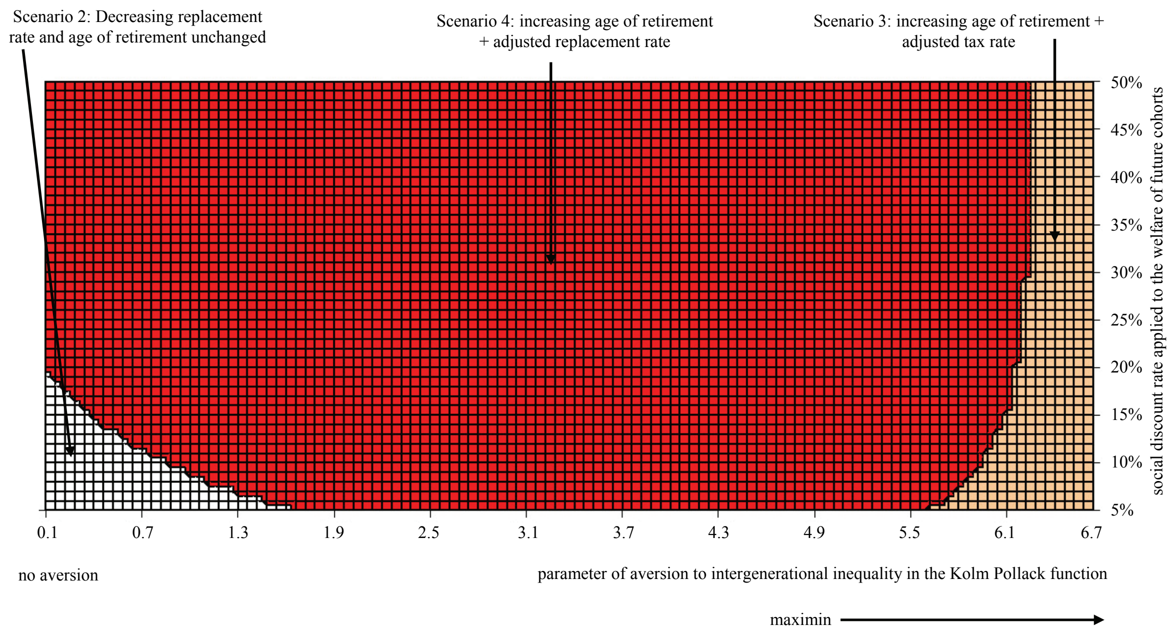
51 In order to yield clear normative results, threshold levels for θ and γ have to be determined. On French data, values of $\theta = 1.6$ or $\gamma = 2.6$ characterize a government weighting the welfare of a baby-boomer born in 1950 50 per cent more than the well-being of an individual born in 1985. Values of 2.0 and 4.4, respectively, correspond to a social planner taking account of the welfare of

13 The values above which the social choice favors scenario 1 can be high and are not necessarily shown in the Figures 5 to 8.

Figure 5

Pension Reform Implemented by the Social Planner (France)





a baby-boomer born in 1950 twice as much as the well-being of someone born in 1985. We consider ($\theta = 1.6$, $\gamma = 2.6$) as characterizing a social planner moderately averse to intergenerational inequality, and ($\theta = 2.0$, $\gamma = 4.4$) as associated to a government with strong aversion to intergenerational inequality.

52 Four types of social preferences, each defined by a pair (θ, ρ_s) (or (γ, ρ_s)), can be defined:

- a utilitarist social planner with moderate aversion to intergenerational inequality and *not* caring about future cohorts (θ = 1.6 or γ = 2.6 and ρ_s =100 per cent) implements, on French data, scenario 4 (rising age of retirement and slight decline in the replacement rate) in the Gini function as well as in the Kolm Pollack function;
- a utilitarist social planner with moderate aversion to intergenerational inequality and caring about future cohorts (θ = 1.6 or γ = 2.6 and ρ_s = 5 per cent) implements, on French data, scenario 3 (rising age of retirement and slight adjustment of the tax rate) in the Gini function and scenario 4 in the Kolm Pollack function;
- a utilitarist social planner with strong aversion to intergenerational inequality and not caring about future cohorts (θ = 2.0 or γ = 4.4 and ρ_s =100 per cent) implements, on French data, scenario 3 (rising age of retirement and slight adjustment of the tax rate) in the Gini function and scenario 4 in the Kolm Pollack function;
- a utilitarist social planner with strong aversion to intergenerational inequality and caring about future cohorts (θ = 2.0 or γ = 4.4 and ρ_s =100 per cent) implements, on French data, scenario 3 (rising age of retirement and slight decline in the replacement rate) in the Gini function and scenario 4 in the Kolm Pollack function.

53 In a democratic system, the social planner is most probably moderately averse to intergenerational inequality. Indeed, its aversion to inequality is not nil and is strictly positive (Tocqueville, 1840). However it can not be too high because favoring a limited number of cohorts in the social choice could end up alienating the vote of many cohorts in a one-man-one-vote system and lead to defeat in democratic elections. As regards the plausible value of the social discount rate, democratic government usually does not care much of the welfare of future generations.

54 In our model parameterized on French data, such a standard democratic social planner chooses to implement scenario 4 (rising age of retirement and slight decline in the replacement rate) in the Gini function as well as in the Kolm Pollack function.

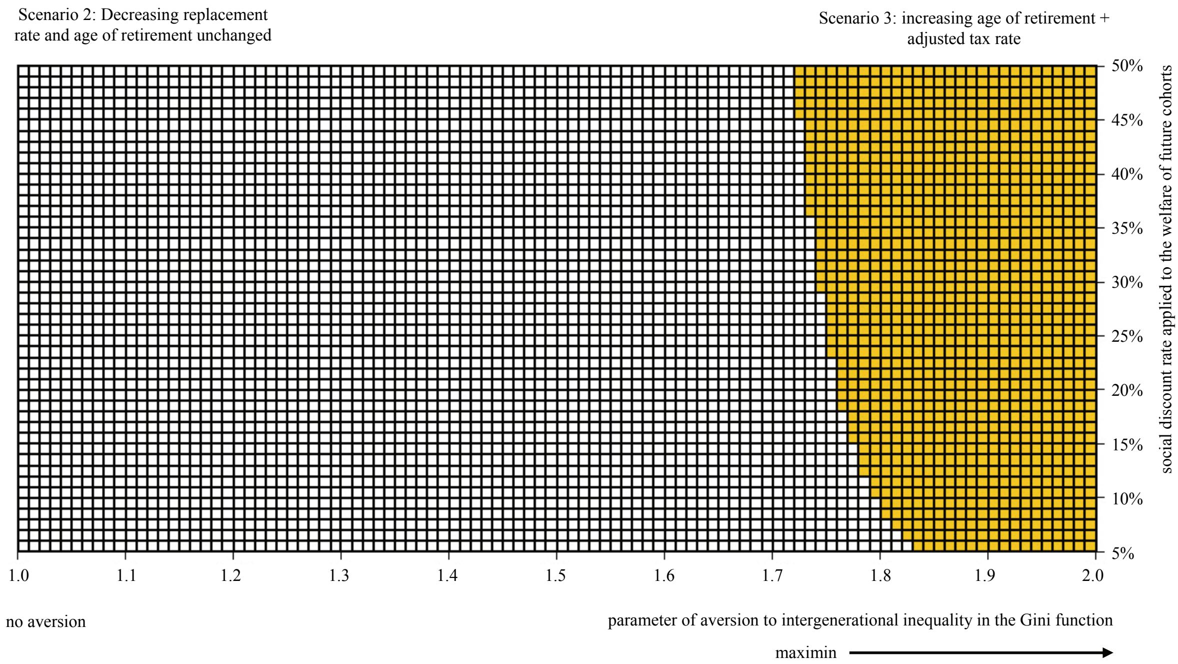
55 The normative results as concerns the United States, Japan and Germany confirm and complement the results obtained in Section 2 in a positive fashion:

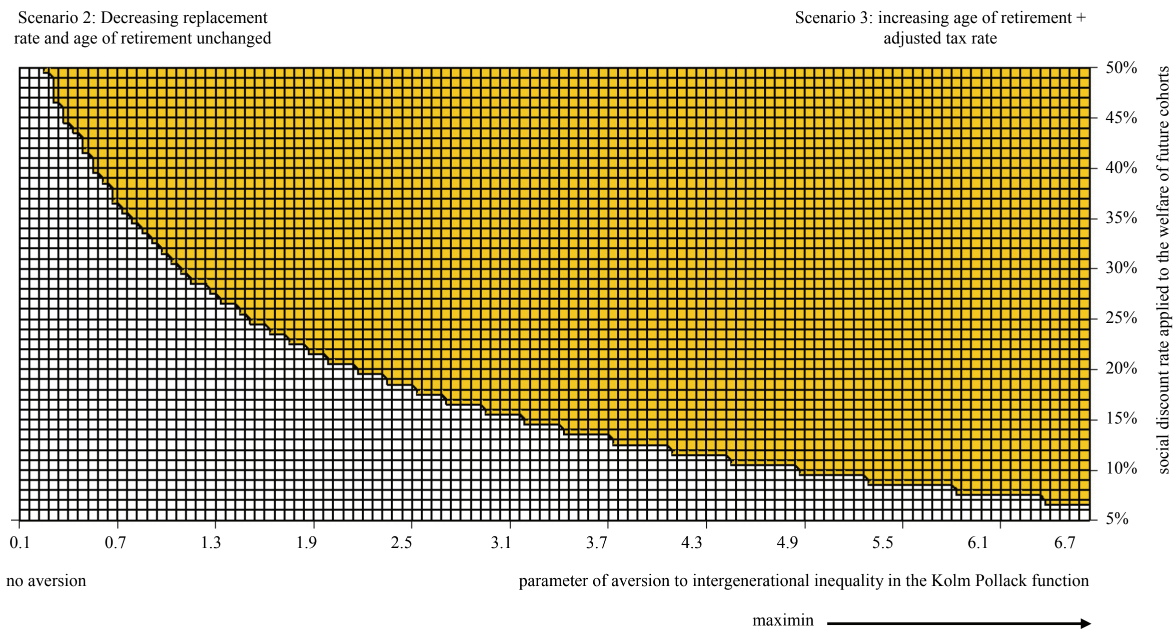
- in the United States and Japan, the social planner chooses to implement, in most cases, the reform scenario 2 where the replacement rate is diminished and the age of retirement unchanged. If its aversion to intergenerational inequality is strong, the social planner selects scenario 3 in the US and scenario 4 in Japan, which both incorporate a rise in the age of retirement. In the US, if the social planner does not care of the welfare of future generations (so if the value of the social discount rate is high), it may favor scenario 3 (rising age of retirement and slight decline in the tax rate);
- in Germany, the social planner almost always select scenario 3 (rise in the age of retirement and slight adjustment of the tax rate) in line with the demographic structure of this country characterized by relatively very large cohorts born in the 1950's. In this demographic context, the favourable effect on growth of increasing the age of retirement is sizeable and adjusting slightly the tax rate rather than the replacement rate weighs down less on the intertemporal welfare of older workers.

56 Overall, these results suggest that taking account of the intergenerational redistributive effects of the reform helps discriminating between scenario 2, 3 and 4 whereas this is not possible if only aggregate welfare is taken into account (see section 2).

Figure 6

Pension Reform Implemented by the Social Planner (United States)



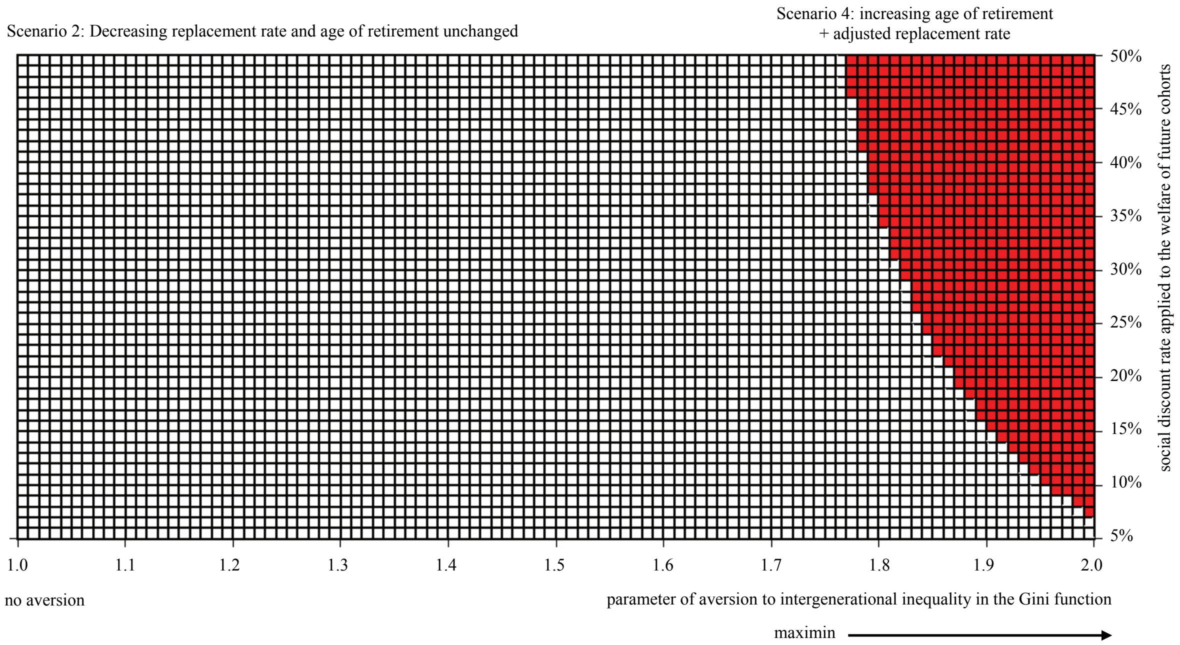


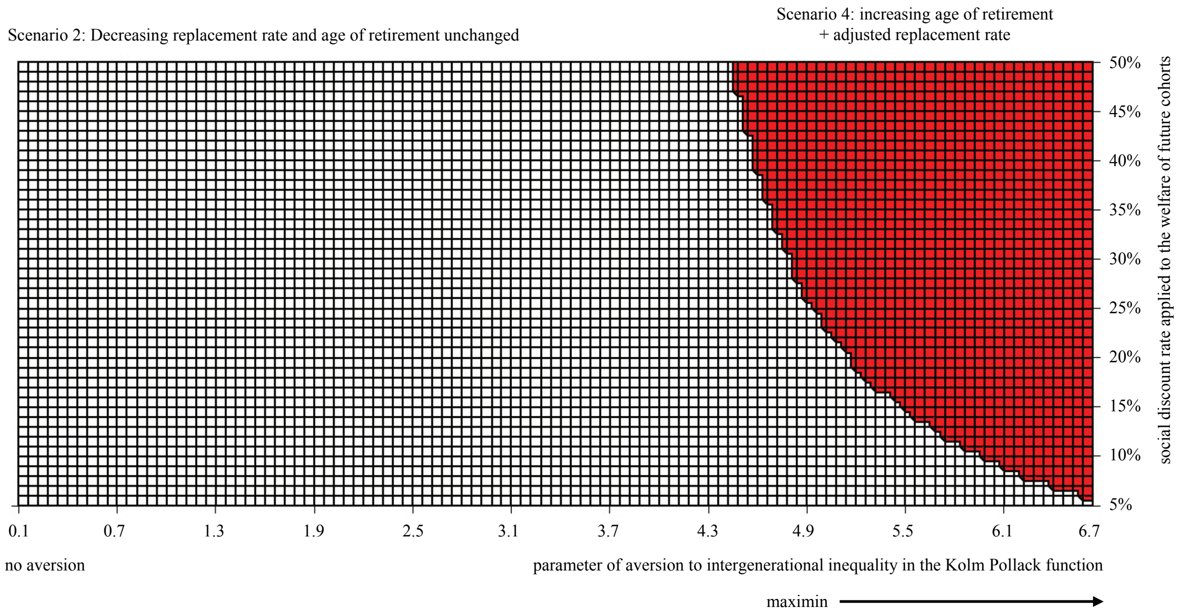
5 Conclusion

57 This paper has investigated the issue of which reform of the pay-as-you-go pension systems a social planner should choose given its aversion to intergenerational inequality and its discount rate of the welfare of future generations.

Figure 7

Pension Reform Implemented by the Social Planner (Japan)

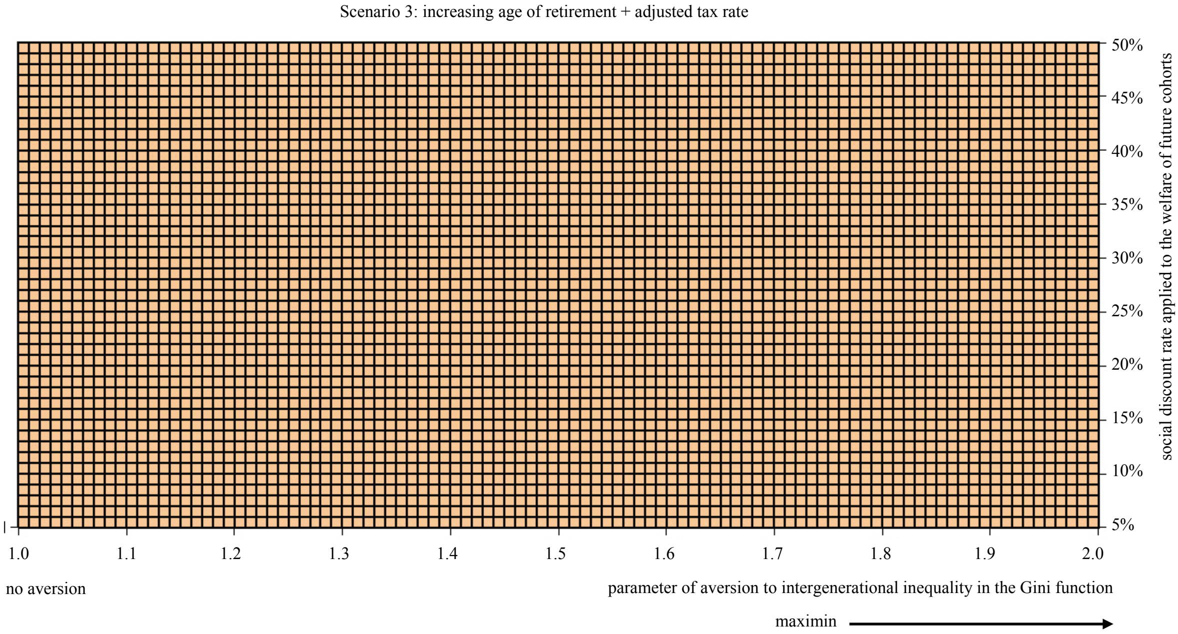


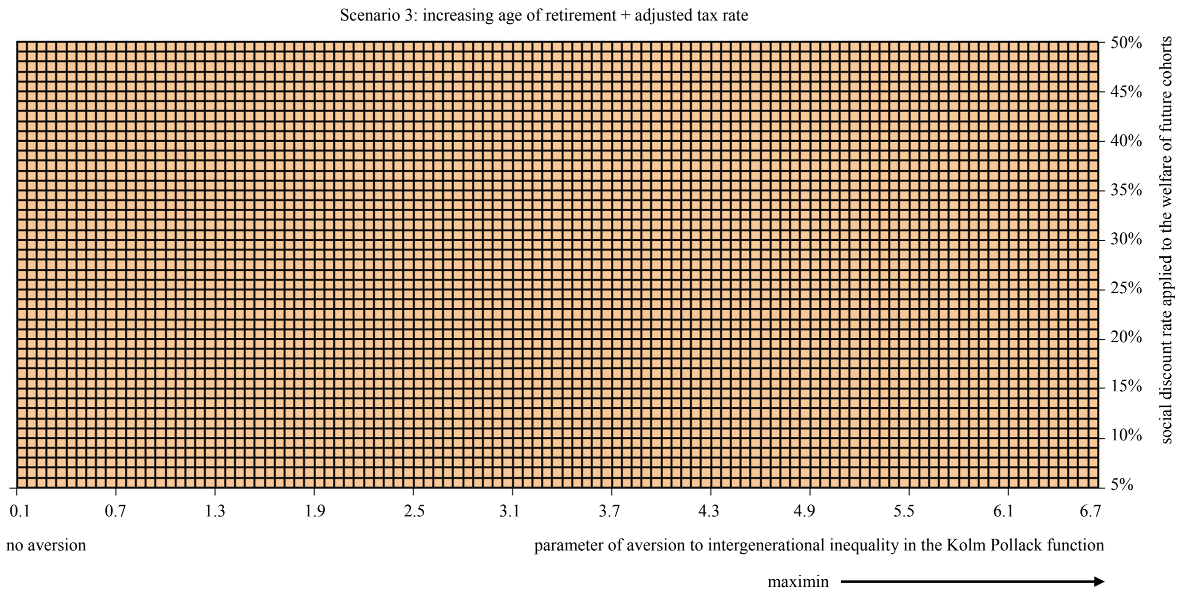


58 Four scenarios of PAYG pension reforms have been considered. The average retirement age is unchanged in a first pair of scenarios where the pension system remains balanced each year during the next decades thanks to either higher tax rates (scenario 1) or lower replacement rates for future retirees (scenario 2). A second pair of scenarios incorporates increases in the effective average age of retirement by one year and a quarter every ten years from 2005 until 2045 with

Figure 8

Pension Reform Implemented by the Social Planner (Germany)





age-specific participation rates of older workers assumed to increase in line with the changes in the retirement age. The small residual imbalances of the PAYG regime are covered either by adjusting the pension tax rate (scenario 3) or the replacement rate (scenario 4).

59 Using the results of a computable, dynamic general equilibrium model with overlapping generations (GE-OLG) parameterised on data for the United States, Japan, France and Germany, an

applied normative economics methodology has been developed yielding the following main results:

- the GDP growth rate is higher in scenarios 2, 3 or 4 than in scenario 1 by around +0.2 per cent per year on average in the next decades. Pension reforms indeed bolster labour supply and/or capital accumulation whereas raising taxes to balance the regime, as in scenario 1, fosters neither the former nor the latter;
- however, since the favourable impacts of reforms on growth are very comparable, a social planner can hardly decide for one pension reform or another on the exclusive basis of the GDP criterion. Taking account of the intergenerational redistributive effects of the reforms thus becomes crucial for determining the social choice;
- If the age of retirement is unchanged, as in scenario 2, the pension reform triggers strong intergenerational redistributive effects compared to the baseline, with many baby-boomers bearing most of the welfare cost of the reform while younger generations clearly benefit from it. Scenarios incorporating a rise in the average age of retirement (scenarios 3 and 4) strongly smooth the intergenerational redistributive effects associated with the pension reform;
- no pension reform is Pareto-improving in the four countries considered here. Compared to the baseline scenario 1, they all tend to weigh down more or less on the intertemporal welfare of the baby-boomers and to increase more or less the welfare of their children and of future generations;
- social welfare functionals aggregating the households' intertemporal utilities and encapsulating a variable degree of aversion of the social planner to intergenerational inequality and a variable discount rate of the welfare of future generations show that the social planner in the United States and Japan is likely to implement scenario 2. In Germany, the social choice favors scenario 3 in most cases. On French data, a social planner which does not care about the welfare of future generations but is reasonably averse to intergenerational inequality among living cohorts, chooses to implement scenario 4;
- in all countries, the scenario 1, which corresponds to tax hikes balancing the pension regime, characterizes a social planner with rawlsian preferences.

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