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Discussion Paper 05/2010-042

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May 25, 2010

Abstract

The present paper studies the growth, welfare and efficiency consequences of tax-favored retirement accounts in a general equilibrium overlapping generations model with idiosyncratic lifespan and labor income uncertainty. We focus on the implicit differential taxation of savings motives and the mandatory annuitization of withdrawals after retirement. The simulations performed for the German economy indicate that the differential taxation of savings motives has only modest efficiency effects but especially low-income households benefit. On the other hand, mandatory annuitization improves overall economic efficiency significantly by about 0.4 percent of aggregate resources but future generations are hurt due to intergenerational income effects from reduced accidental bequest.

JEL Classification: H55, J26
Keywords: individual retirement accounts, annuities, stochastic general equilibrium,

*Previous versions of the paper were presented at conferences and workshops in Garmisch, Graz, Maastricht, Mailand, Mannheim, Prague, Utrecht and Wuppertal. We thank Peter Broer, Anette Reil-Held, Kerstin Schneider, Østein Thøgersen and other seminar participants for helpful comments and Fabian Kindermann for providing excellent research assistance. The final version of the paper benefitted from comments of an anonymous referee and the editor Jay Wilson. Financial support from the Forschungsnetzwerk Alterssicherung (FNA) of the Deutsche Rentenversicherung Bund is gratefully acknowledged.

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1 Introduction

Many OECD countries have introduced programs to promote the development of private pensions savings during the last decades. In principle, the program design of these so-called individual retirement accounts (IRAs) is very similar. Contributions to these accounts up to a certain contribution limit are voluntary, withdrawal before retirement is restricted, and the savings are tax deferred. Therefore, contributions are tax deductible, the accrued return on investment is tax exempt, but the pension benefits arising from these savings are fully taxed. However, when considering the details of the implementation, the specific national plans contain many differences in the financing and institutional arrangements. The present paper focusses at two specific features which distinguish the German IRA reform from 2001 from IRAs in other countries. First, preferential tax treatment of old-age savings is mainly financed by an increased taxation of returns from other savings. Second, the pension benefits must be disbursed as certain types of lifelong annuities.[1]

The present paper attempts to quantify the efficiency and distributional consequences of these two reform elements. The efficiency effects of the program originate from the differential taxation of saving motives and the implicit provision of a longevity insurance. As Nishiyama and Smetters (2005) have shown, it is not efficient to eliminate the taxation of capital income in a model with labor income uncertainty. Implicitly, capital income taxation acts as an insurance device in such a model which improves economic efficiency. However, uniform taxation of all savings might also not be efficient. Since precautionary savings appear to be less sensitive to changes in the after-tax rate of return than life cycle savings (see Cagetti (2001) or Bernheim (2002, p. 1199)), an optimal tax structure would tax life cycle savings at a lower rate than precautionary savings. The reduced taxation of savings in retirement accounts could be interpreted as a means to separate the two savings motives. If accounts are illiquid before retirement, only life cycle savings are allocated there, while precautionary savings are allocated in liquid savings accounts. The mandatory purchase of private life annuities at retirement also has efficiency implications. It is proposed in order to shelter participants against the risk of outliving their assets. When private annuity markets are absent, mandatory annuitization overcomes this market

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[1] More specifically, since 2005 lump-sum payments at retirement must not exceed 30 percent of the accumulated wealth. Remaining assets are disbursed either in private pension plans or in private saving plans. For the former, which make up about 80 percent of current accounts, only a choice between single and joint life annuities is allowed. For the latter, withdrawals are limited in size and a share of the assets must be turned into an annuity after age 85.

failure and increases aggregate efficiency, see Fehr and Habermann (2008a).
The distributional effects of the program originate from two sources. First, given the progressive income tax system and saving rates rising with income, mainly rich households take advantage of IRA schemes by shifting funds from ordinary to tax-favored accounts. Consequently, tax deferral is often combined with undesired distributional implications and considered as an expensive means of encouraging additional saving, see the discussion in Bernheim (2002) and OECD (2004). The question is here whether an IRA reform could be beneficial for low- and medium-income households within a cohort. Second, mandatory annuitization redistributes implicitly from future to existing generations since it reduces unintended bequest. Pecchenino and Pollard (1997) show that the bequest reduction decreases long-run capital accumulation and growth in an endogenous growth model. Fehr and Habermann (2008a) demonstrate in a stylized exogenous growth model that future generations will be hurt by annuitization, if the interest rate is sufficiently higher than the growth rate. In the latter case the bequest reduction dominates the benefits from the insurance provision.

In order to quantify the efficiency and distributional consequences of tax-favored accounts, we apply a general equilibrium overlapping generations model in the Auerbach-Kotlikoff (1987) tradition which includes mortality and individual income risk as well as borrowing constraints. Private insurance markets are closed by assumption, but the public sector provides partial insurance via the progressive tax system and the unfunded pension system.[2] İmrohoroğlu, İmrohoroğlu and Joines (1998) evaluate in this framework the long-run consequences of IRAs on the US capital stock for various contribution limits and tax savings instruments. They conclude that about 9 percent of IRA contributions during the 80ies constituted additional savings which raised the US capital stock by about 6 percent. Fuster, İmrohoroğlu and İmrohoroğlu (2008) extend their framework by introducing mandatory retirement accounts into a model with two-sided altruism where individual life expectancy and income are positively correlated. Their study either eliminates the existing pension system or substitutes halve of the contributions by mandatory savings in private accounts which are either annuitized or not. While the long-run capital stock increases in all reform scenarios, the mandatory saving programs outperform the full privatization policy in terms of long-run capital and consumption growth.
The present approach offers some methodological innovations compared to these previous US studies. First, we do not only compare steady states, but compute the complete transition to the new long-run equilibrium in order to quantify the intergenerational welfare

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[2] Krueger (2006) as well as Fehr and Thøgersen (forthcoming) survey recent studies in this tradition.

consequences. Second, after compensating existing households with lump-sum transfers, we are able to isolate the overall efficiency consequences of the policy reform. Third, we include a progressive tax system in order to capture the intragenerational implications of the reform. Finally, our model assumes a specific individual preference structure that allows to distinguish the effects of risk aversion and intertemporal substitution. The present approach is also applied in Fehr, Habermann and Kindermann (2008) where we analyze alternative IRA options by altering contribution limits, taxation and financing schemes as well as withdrawal restrictions. However, the previous study assumes a higher (or even unlimited) contribution ceiling and abstracts completely from annuitization after retirement. Therefore, the present paper and the previous one directly complement each other.

Our simulations indicate three central results. First, we find positive distribution effects within cohorts but only modest efficiency gains from the differential taxation of savings motives. Second, mandatory annuitization of withdrawals significantly increases economic efficiency by roughly 0.4 percent of aggregate resources due to the improved longevity insurance. Third, despite the significant gains in aggregate efficiency, future generations are most likely hurt by annuitization due to the reduction of accidental bequest. In our benchmark calibration, long-run welfare decreases by 0.85 percent of lifetime resources. The sensitivity analysis indicates that long-run welfare losses are robust for a wide range of parameter combinations as long as we abstract from a bequest motive.

The next section describes the structure of the simulation model. Section three explains the calibration of the benchmark equilibrium. Finally, section four presents the simulation results and section five offers some concluding remarks.

2 The model economy

2.1 Demographics and intracohort heterogeneity

We consider an economy populated by overlapping generations of individuals which may live up to a maximum possible lifespan of J periods. At each date, a new generation is born where we have normalized its size $N_1 = 1$, i.e. we assume zero population growth. Since individuals face lifespan uncertainty with $\psi_j < 1$ the time-invariant conditional survival probability from age $j-1$ to age j, i.e. $N_j = \psi_j N_{j-1}$ and $\psi_{J+1} = 0$.

Our model is solved recursively. Consequently, an agent faces the state vector $z_j = (j, \mathrm{a}_j, \mathrm{a}_j^R, ep_j, e_j)$ where $j \in \mathcal{J} = \{1, \ldots, J\}$ is the household's age, $\mathrm{a}_j \in A = [\underline{\mathrm{a}}, \bar{\mathrm{a}}]$ denotes (liquid) assets held at the beginning of age j, $\mathrm{a}_j^R \in R = [\underline{\mathrm{a}}^R, \bar{\mathrm{a}}^R]$ denotes assets in individual retirement accounts held at the beginning of age j, $ep_j \in P = [\underline{ep}, \overline{ep}]$ defines the agent's accumulated earning points for public pension claims and $e_j \in E_j = [\underline{e}_j, \overline{e}_j]$ is the individual productivity at age j.

Since income is uncertain the productivity state is assumed to follow a first-order Markov process described in more detail below. Consequently, in each period t the age-j cohort is fragmented into subgroups $\xi_t(z_j)$, according to the initial distribution (i.e. at $j = 1$), the Markov process and optimal decisions. Let $X_t(z_j)$ be the corresponding cumulated measure to $\xi_t(z_j)$. Hence,

$$\int_{A\times R\times P\times E_j} \mathrm{d}X_t(z_j) = 1 \quad \forall \quad j$$

must hold, as $\xi_t(z_j)$ is not affected by cohort sizes but only gives densities within cohorts. Let $Z_t = (\xi_t(z_j), B_{G,t}, B_{RA,t}, \Psi_t)$ denote the state of the economy at the beginning of period t, where $B_{G,t}$ and $B_{RA,t}$ are the beginning-of-period debt of the government and the redistribution authority, respectively, which will be described below, and Ψ_t denotes the known policy schedule of the government at t. In the following, we will omit the time index t and the state indices z_j and Z_t for every variable whenever possible. Agents are then only distinguished according to their age j.

2.2 The household side

Our model assumes a preference structure that is represented by a time-separable, nested CES utility function. In order to isolate risk aversion from intertemporal substitution, we follow the approach of Epstein and Zin (1991) and formulate the maximization problem of a representative consumer at age j and state z_j recursively as

$$V(z_j) = \max_{\ell_j, c_j, s_j} \left\{ u(c_j, \ell_j)^{1-\frac{1}{\gamma}} + \delta \left[\psi_{j+1} E[V(z_{j+1})]^{1-\frac{1}{\gamma}} + (1 - \psi_{j+1}) \mu q_{j+1}^{1-\frac{1}{\gamma}} \right] \right\}^{\frac{1}{1-\frac{1}{\gamma}}} \tag{1}$$

with

$$E[V(z_{j+1})] = \left[\int_{E_{j+1}} V(z_{j+1})^{1-\eta} \Pi_j(\mathrm{d}e_{j+1}|e_j) \right]^{\frac{1}{1-\eta}}. \tag{2}$$

In (1) the variables ℓ_j, c_j and q_{j+1} denote leisure, consumption and bequest at age j, respectively. The parameters δ and γ represent the discount rate and the intertemporal elasticity of substitution between consumption in different years while μ defines the strength of the bequest motive. Since lifespan is uncertain, the expected utility in future periods is weighted with the survival probability ψ_{j+1}. The expectation operator E in (1) indicates that future utilities are computed over the distribution of e_{j+1}. Hence,

$\Pi_j(\mathrm{d}e_{j+1}|e_j)$ in (2) denotes the cumulative density function of the respective probability $\pi_j(e_{j+1}|e_j)$ of experiencing e_{j+1} in the next period if the current productivity is e_j. The parameter η defines the degree of (relative) risk aversion. Note that for the special case $\eta = \frac{1}{\gamma}$ we are back at the traditional expected utility specification, see Epstein and Zin (1991, 266). The period utility function is defined by

$$u(c_j, \ell_j) = \left[(c_j)^{1-\frac{1}{\rho}} + \alpha(\ell_j)^{1-\frac{1}{\rho}}\right]^{\frac{1}{1-\frac{1}{\rho}}} \tag{3}$$

where ρ denotes the intratemporal elasticity of substitution between consumption and leisure at each age j. Finally, the leisure preference parameter α is assumed to be age independent.

The budget constraint is defined as follows:

$$\mathrm{a}_{j+1} = \mathrm{a}_j(1+r) + w_j + p_j + b_j + v_j - \tau \min[w_j; 2\bar{w}] - s_j - T(y_j) - \phi_j(s_j) - (1+\tau_c)c_j \tag{4}$$

with $\mathrm{a}_1 = 0$. In addition to interest income from savings $r\mathrm{a}_j$, households receive gross labor income $w_j = w(1-\ell_j)e_j$ during their working period as well as public pensions p_j during retirement. As time endowment is normalized to one, $1-\ell_j$ defines working time and w the wage rate for effective labor. They may receive (accidental) bequests b_j and in some simulations they receive (or have to finance) compensation payments v_j which are explained below. During employment, they contribute to the public pensions system but only up to the contribution ceiling which amounts to the double of average income $\bar{w}$. They also contribute to or withdraw from retirement accounts s_j and have to pay progressive income taxes $T(y_j)$ depending on taxable income y_j. In order to eliminate the liquidity of retirement accounts during employment and avoid positive contributions after retirement, the function

$$\phi_j(s_j) = \begin{cases} -s_j & \text{if} \quad j < j_R \quad \text{and} \quad s_j \leq 0 \\ \infty & \text{if} \quad j \geq j_R \quad \text{and} \quad s_j > 0 \\ 0 & \text{else.} \end{cases} \tag{5}$$

is added to the budget constraint (4). Consequently, before retirement (i.e. at age $j < j_R$) withdrawals from IRAs are not possible, since all the money would be lost.[3] On the other hand, positive contributions after retirement induce a prohibitive penalty. All remaining income is used for consumption where the consumer price includes consumption taxes τ_c. Of course, since leisure can only be consumed up to the time endowment and borrowing is restricted, the additional constraints

$$\ell_j \leq 1 \qquad \text{and} \qquad \mathrm{a}_j \geq 0 \quad \forall\, j$$

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[3] Of course, it would be no problem to consider lower penalties, see Fehr et al. (2008).

must hold.

Retirement account assets accumulate according to

$$\mathrm{a}_{j+1}^R = \mathrm{a}_j^R(1+r_j) + \min[s_j, \hat{s}] \qquad \text{with} \quad r_j = \frac{1+r}{\max[\omega_j, \psi_j]} - 1 \tag{6}$$

where $\mathrm{a}_1^R = 0$ and $\mathrm{a}_j^R \geq 0 \; \forall \; j$. Without annuitization at age j, we set $\omega_j = 1$, so that the survival probability ψ_j has no effect on the individual return, i.e. $r_j = r$. If retirement account assets are annuitized at age j, we set $\omega_j = 0$, so that the periodic returns are annuitized, i.e. $r_j > r$. Note that contributions cannot exceed the contribution limit $\hat{s}$. After retirement (i.e. $j \geq j_R$ and $s_j \leq 0$) we have to distinguish two cases: First, without mandatory annuitization, households can decide how much to withdraw. Second, with mandatory annuitization we follow Fuster et al. (2008) and assume that retirees receive a fixed benefit depending on their wealth at the beginning of retirement $\mathrm{a}_{j_R}^R$:

$$s_j = -\frac{(1+r_{j_R})\mathrm{a}_{j_R}^R}{\sum_{j=j_R}^{J} \Pi_{i=j_R+1}^{j}(1+r_i)^{-1}}. \tag{7}$$

Our model abstracts from other annuity markets. Consequently, private assets and non-annuitized retirement account assets of all agents who died are aggregated and then distributed among all working age cohorts following an exogenous age- and productivity-dependent distribution scheme $\Gamma_j(e_j)$, i.e.

$$b_j(z_j) = \Gamma_j(e_j) \sum_{i=1}^{J} (1-\psi_{i+1}) N_i \int_{A \times R \times P \times E_i} q_{i+1}(z_i) \mathrm{d}X_t(z_i) \quad \forall \quad j = 1, \ldots, j_{R-1}, \tag{8}$$

where $q_{i+1}(z_i) = (1+r_t)[\mathrm{a}_{i+1}(z_i) + \omega_{i+1}\mathrm{a}_{i+1}^R(z_i)(1-\tau_b)]$. The age distribution of bequests is computed in the initial steady state where we assume that the heirs always receive the assets of the generation which was 25 years older. Since bequest can be received only during employment, we adjust this rule at the beginning and at the end of employment. Within a generation, bequests are distributed proportional to the current productivity level e_j, which highlights their stochastic nature and also reflects empirical evidence.[4] Finally, inheritances from IRAs are due to a specific inheritance tax τ_b since they were accumulated tax free.

2.3 The production side

Firms in this economy use capital and labor to produce a single good according to the Cobb-Douglas production technology $Y_t = \varrho K_t^{\varepsilon} L_t^{1-\varepsilon}$ where Y_t, K_t and L_t are aggregate

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[4] De Nardi (2004) highlights the link between individual productivity and inheritance. Fehr et al. (2008) also report the consequences of alternative bequest distributions.

output, capital and labor in period t, ε is capital's share in production, and ϱ defines a technology parameter. Capital depreciates at a constant rate δ_k and firms have to pay corporate taxes $T_{k,t} = \tau_k\big[Y_t - w_t L_t - \delta_k K_t\big]$ where the corporate tax rate τ_k is applied to the output net of labor costs and depreciation. Firms maximize profits renting capital and hiring labor from households so that the marginal product of capital net of depreciation and corporate taxes equals the market interest rate r_t and the marginal product of labor equals the wage rate w_t for effective labor.

2.4 The government sector

Our model distinguishes between the tax system and the pension system. In each period t the government issues new debt $B_{G,t+1} - B_{G,t}$ and collects taxes from households and firms in order to finance general government expenditure G, which is fixed per capita, as well as interest payments on its debt, i.e.

$$B_{G,t+1} - B_{G,t} + T_{y,t} + T_{b,t} + T_{k,t} + \tau_{c,t} C_t = G + r_t B_{G,t}, \tag{9}$$

where revenues of income and bequest taxation are computed from

$$T_{y,t} = \sum_{j=1}^{J} N_j \int_{A\times R\times P\times E_j} [T(y_j(z_j, Z_t)) + \phi_j(s_j(z_j, Z_t))]\mathrm{d}X_t(z_j)$$

and

$$T_{b,t} = \tau_b \sum_{j=1}^{J} N_j \int_{A\times R\times P\times E_j} \omega_{j+1}(1-\psi_{j+1})(1+r_t)\mathrm{a}^R_{j+1}(z_j, Z_t)\mathrm{d}X_t(z_j).$$

and C_t defines aggregate consumption (see equation (23)).

We assume that contributions to public pensions are exempted from tax while the benefits are fully taxed. Consequently, taxable gross income y_j is computed from gross labor income net of pension contributions and a fixed work related allowance d_w, nominal[5] capital income (from ordinary savings) $\tilde{r}\mathrm{a}_j$ net of a saving allowance d_s and - after retirement - public pensions. If individuals contribute to retirement accounts they can reduce taxable income up to the contribution limit during working periods but have to tax all withdrawals after retirement.

$$y_j = \max[w_j - \tau\min[w_j; 2\bar{w}] - d_w; 0] + \max[\tilde{r}\mathrm{a}_j - d_s; 0] + p_j - \min[s_j, \hat{s}]. \tag{10}$$

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[5] In order to reflect realistic features of capital income taxation in a model without inflation, we assume for taxation purposes a nominal interest rate $\tilde{r}$, i.e. real interest rate r plus a fictive inflation of two percent per year. The latter exacerbates the distortions of *real* capital income taxation, see Feldstein (1997).

The pension system pays old-age benefits and collects payroll contributions from wage income below the contribution ceiling which is fixed at two times the average income $\bar{w}$. Individual pension benefits p_j of a retiree of age $j \geq j_R$ in a specific year are computed from the product of his earning points ep_{j_R} the retiree has accumulated at retirement and the actual pension amount (APA) of the respective year:

$$p_j = ep_{j_R} \times APA. \tag{11}$$

In each year of employment, the worker receives an earning point depending on his relative income position $w_j/\bar{w}$ up to the contribution ceiling. Since the latter is fixed at the double of average income $\bar{w}$, the maximum earning points that could be collected per year are 2. Accumulated earning points at age j are therefore

$$ep_{j+1} = ep_j + \min[w_j/\bar{w}; 2], \tag{12}$$

with $ep_1 = 0$.

The budget of the pension system must be balanced in every period. Consequently, the general contribution rate τ_t is computed from

$$\tau_t = \frac{\sum_{j=j_R}^{J} N_j \int_{A\times R\times P\times E_j} p_j(z_j, Z_t)\mathrm{d}X_t(z_j)}{\sum_{j=1}^{j_R-1} N_j \int_{A\times R\times P\times E_j} \min[w_j(z_j, Z_t); 2\bar{w}]\mathrm{d}X_t(z_j)}. \tag{13}$$

2.5 Welfare and efficiency calculation

The welfare criterion we use to assess the policy reform is ex-ante expected utility of an agent, before the productivity level is revealed (i.e. looking upon her life behind the Rawlsian veil of ignorance). Similar to (2), expected utility of a newborn in period t is computed from

$$E[V(z_1, Z_t)] = \left[\int_{A\times R\times P\times E_1} V(z_1, Z_t)^{1-\eta}\mathrm{d}X_t(z_1)\right]^{\frac{1}{1-\eta}},$$

where assets and earning points are all zero. In order to compare the welfare for a specific individual before and after the reform, we follow Auerbach and Kotlikoff (1987, 87) and compute the proportional increase (or decrease) in consumption and leisure ϕ which would make an agent in the initial equilibrium as well off as after the reform, i.e.

$$E[V(z_j, Z_t)] = E[V(z_j, Z_0, \phi)],$$

where

$$V(z_j, Z_0, \phi) = \Big\{u(c_j(1+\phi), \ell_j(1+\phi))^{1-\frac{1}{\gamma}} + \delta\Big[\psi_{j+1}E[V(z_{j+1}, Z_0, \phi)]^{1-\frac{1}{\gamma}} + (1-\psi_{j+1})\mu(q_{j+1}(1+\phi))^{1-\frac{1}{\gamma}}\Big]\Big\}^{\frac{1}{1-\frac{1}{\gamma}}}. \tag{14}$$

We can compare all existing cohorts in the reform year Z_1 and all newborn cohorts along the transition path with the respective cohorts in the initial equilibrium Z_0, since they have identical individual state variables. Due to the homogeneity of the utility function (3) and (14) we have $E[V(z_j, Z_0, \phi)] = (1+\phi)E[V(z_j, Z_0)]$. Therefore, for all agents living in the initial equilibrium the necessary increase (or decrease) in percent of resources is

$$\phi(z_j, Z_1) = \left[\frac{E[V(z_{j+1}, Z_1)]}{E[V(z_{j+1}, Z_0)]} - 1\right] \times 100 \tag{15}$$

where $z_{j+1} = (a_{j+1}(z_j), ep_{j+1}(z_j), e_{j+1})$ indicates that expected welfare is computed for each (already known) asset and earning point realization at age $j+1$, which depend on the individual state z_j. A value of $\phi(z_j, Z_1) = 1.0$ indicates that this agent would need one percent more resources in the initial long-run equilibrium to attain the expected utility level he receives after the policy reform. Next we aggregate for each productivity level e_j^i at age j the percentage changes across asset levels and pension points in order to derive the average changes for alternative productivity levels i:

$$\bar{\phi}(e_j^i) = \frac{1}{k_i}\int_{A\times R\times P} \phi(z_j, Z_1)\,\mathrm{d}X_0(z_j) \quad \text{with} \quad z_j = (a_j, a_j^R, ep_j, e_j^i), \tag{16}$$

where k_i denotes the proportion of workers at productivity level i. These figures are reported as (uncompensated) welfare changes of productivity classes of cohort $j+1$ in the following tables. Note that for newborn generations who enter the labor market during the transition we can only report the ex-ante welfare change for the whole cohort, i.e.

$$\phi(z_0, Z_t) = \left[\frac{E[V(z_1, Z_t)]}{E[V(z_1, Z_0)]} - 1\right] \times 100 \qquad \text{with } z_1 = (0, 0, 0, e_1). \tag{17}$$

Here $z_0 = (0, 0, 0, 0))$ indicates that there is only one state before productivity is revealed to a newborn cohort. Since we want to compare the intra-cohort welfare consequences of future born agents, we compute the ex-post welfare change

$$\hat{\phi}(e_1^i, Z_t) = \left[\frac{V(z_1, Z_t)}{V(z_1, Z_0)} - 1\right] \times 100 \quad \text{with} \quad z_1 = (0, 0, 0, e_1^i) \tag{18}$$

after the initial productivity level e_1^i has been revealed.[6]

In order to asses the aggregate efficiency consequences, we introduce a Lump-Sum Redistribution Authority (LSRA) in the spirit of Auerbach and Kotlikoff (1987, 62f.) as well as Nishiyama and Smetters (2005) or Fehr et al. (2008) in a separate simulation. The

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[6] Of course, it would have been possible to compute the ex-post welfare changes for all agents. However, ex-ante welfare changes are usually calculated since they are more intuitive (especially for future generations) and technically less demanding to implement.

LSRA treats those cohorts already existing in the initial equilibrium and newborn cohorts differently. To already existing cohorts it pays a lump-sum transfer (or levies a lump-sum tax) $v_j(z_j, Z_1), j > 1$ to bring their expected utility level after the reform back to the level of the initial equilibrium $E[V(z_j, Z_0)]$. Since utility depends on age and state, these transfers (or taxes) have to be computed for every agent in the first year of the transition. Consequently, after compensation, their relative welfare change is $\phi^c(z_j, Z_1) = 0.0$. Furthermore, those who enter the labor market in period $t \geq 1$ of the transition receive a transfer $v_1(z_1, Z_t, V^*)$ which guaranties them an expected utility level V^*. Note that the transfers $v_1(z_1, Z_t, V^*)$ may differ among future cohorts but the expected utility level V^* is identical for all. The value of the latter is chosen by requiring that the present value of all LSRA transfers is zero:[7]

$$\sum_{j=2}^{J} \int_{A\times R\times P\times E_j} v_j(z_j, Z_1)\mathrm{d}X_1(z_j) + \sum_{t=1}^{\infty} v_1(z_1, Z_t, V^*)\Pi_{s=0}^{t}(1+r_s)^{-1} = 0.$$

In the first period of the transition the LSRA builds up debt (or assets) from

$$B_{RA,2} = \sum_{j=1}^{J} \int_{A\times R\times P\times E_j} v_j(z_j, Z_1)\mathrm{d}X_1(z_j)$$

which have to be adjusted in each future period according to

$$B_{RA,t+1} = (1+r_t)B_{RA,t} - v_1(z_1, Z_t). \qquad (19)$$

Of course, LSRA assets are also included in the asset market equilibrium condition (24). Given the compensated expected utility V^* of newborns, we compute the (compensated) relative consumption change $\phi^c(z_1)$ which is identical for all newborn future cohorts. If $\phi^c(z_1) > 0$ ($\phi^c(z_1) < 0$), all households in period one who lived in the previous period would be as well off as before the reform and all current and future newborn households would be strictly better (worse) off. Hence, the new policy is Pareto improving (inferior) after lump-sum redistributions.

2.6 Equilibrium and the computational method

Given the fiscal policy $\{G, B_{G,t}, B_{RA,t}, T(y), \tau_b, \tau_{c,t}, \tau_k, \tau_t, \omega, \hat{s}\}\forall t$, a stationary recursive equilibrium is a set of value functions $\{V(z_j, Z_t)\}_{j=1}^{J}$, household decision rules $\{c_j(z_j, Z_t),$

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[7] In order to avoid that transfers have liquidity effects at young ages, they are actually given (with interest) to cohorts when they retire or later. Further information on the computation of V^* is available upon request.

$\ell_j(z_j, Z_t), s_j(z_j, Z_t)\}_{j=1}^J$, distributions of bequests $\{b_j(z_j, Z_t)\}_{j=1}^J$, measures of households $\{\xi_t(z_j)\}_{j=1}^J$ and relative prices of labor and capital $\{w_t, r_t\}$ such that the following conditions are satisfied $\forall t$:

1. Households' decision rules solve the households decision problem (1) subject to the given constraints.

2. Factor prices are competitive, i.e.

$$w_t = (1-\varepsilon)\varrho\left(\frac{K_t}{L_t}\right)^{\varepsilon}, \tag{20}$$

$$r_t = (1-\tau_k)\left[\varepsilon\varrho\left(\frac{L_t}{K_t}\right)^{1-\varepsilon} - \delta_k\right]. \tag{21}$$

3. In the closed economy aggregation holds:

$$L_t = \sum_j N_j \int_{A\times R\times P\times E_j} (1-\ell_j(z_j, Z_t))e_j \mathrm{d}X_t(z_j), \tag{22}$$

$$C_t = \sum_j N_j \int_{A\times R\times P\times E_j} c_j(z_j, Z_t) \mathrm{d}X_t(z_j), \tag{23}$$

$$K_t = \sum_j N_j \int_{A\times R\times P\times E_j} [\mathrm{a}_j(z_j, Z_t) + \mathrm{a}_j^R(z_j, Z_t)] \mathrm{d}X_t(z_j) - B_{G,t} - B_{RA,t}. \tag{24}$$

4. Let $\mathbf{1}_{h=x}$ be an indicator function that returns 1 if $h = x$ and 0 if $h \neq x$. Then, the law of motion of the measure of households is, for $j \in \mathcal{J}$,

$$\xi_{t+1}(z_{j+1}) = \int_{A\times R\times P\times E_j} \mathbf{1}_{\mathrm{a}_{j+1}=\mathrm{a}_{j+1}(z_j,Z_t)} \times \mathbf{1}_{\mathrm{a}_{j+1}^R=\mathrm{a}_{j+1}^R(z_j,Z_t)} \times \mathbf{1}_{ep_{j+1}=ep_{j+1}(z_j,Z_t)} \times \pi_j(e_{j+1}|e_j) \mathrm{d}X_t(z_j).$$

5. Bequests satisfy

$$\sum_{j=1}^{j_R-1} N_j \int_{A\times R\times P\times E_j} b_j(z_j, Z_{t+1}) \mathrm{d}X_{t+1}(z_j) = \sum_{i=1}^{J} (1-\psi_{i+1}) N_i \int_{A\times R\times P\times E_i} q_{i+1}(z_i, Z_t) \mathrm{d}X_t(z_i). \tag{25}$$

6. The budgets of the government (9), the pension system (13) and the redistribution authority (19) are balanced intertemporally.

7. The goods market clears, i.e.

$$Y_t = C_t + \delta_k K_t + G.$$

The computation method follows the Gauss-Seidel procedure of Auerbach and Kotlikoff (1987). For the initial steady state which reflects the current German tax and social security system without retirement accounts, we start with a guess for aggregate variables, bequests distribution and exogenous policy parameters. Then we compute the factor prices, the individual decision rules and value functions. The latter involves the discretization of the state space which is further explained in Fehr et al. (2008) or Fehr and Habermann (2008b). Next we obtain the distribution of households and aggregate assets, labor supply and consumption as well as the social security tax rate and the consumption tax rate that balances government budgets. This information allows us to update the initial guesses. The procedure is repeated until the initial guesses and the resulting values for capital, labor, bequests and endogenous taxes have sufficiently converged.

Next we solve for the transition path after the introduction of retirement accounts. We assume that the transition between the initial and the new final steady state takes $4 \times J$ periods. Given the alternative policy parameters we assume in the first guess that aggregate values and bequests of the initial equilibrium remain constant along the transition. Then we update for each period of the transition the individual and aggregate variables until we reach convergence.

3 Calibration of the initial equilibrium

In order to reduce computational time, each model period covers five years. Agents start life at age 20 ($j = 1$), are forced to retire at age 60 ($j_R = 9$) and face a maximum possible life span of 100 years ($J = 16$). The conditional survival probabilities ψ_j are computed from the year 2000 Life Tables reported in Bomsdorf (2003). With respect to the preference parameters we set the intertemporal elasticity of substitution γ to 0.5, the intratemporal elasticity of substitution ρ to 0.6, the coefficient of relative risk aversion η to 4.0 and the leisure preference parameter α to 1.5. This is within the range of commonly used values (see Auerbach and Kotlikoff, 1987, and Cecchetti et al., 2000) and yields a compensated wage elasticity of labor supply of 0.3 in our benchmark. Finally, we abstract from bequest motives in the benchmark (i.e. $\mu = 0.0$) and set the time preference rate δ to 0.91 in order to calibrate a realistic capital-output ratio, which implies an annual discount rate of about 2 percent.

With respect to technology parameters we chose the general factor productivity $\varrho = 1.5$ in order to normalize labor income and set the capital share in production ε at 0.3. The annual depreciation rate for capital δ_k is set at 6 percent. The annual APA value is currently about 310 €. We have adjusted this amount slightly in order to derive a realistic standard pension[8] and contribution rate for Germany. The taxation of gross income (from labor, capital and pensions) is close to the current German income tax code and the marginal tax rate schedule introduced in 2005. There is a special allowance for labor income of $d_w = 1200$ € while for capital income the special allowance amounts to $d_s = 3600$ € (per couple). Given taxable income y_j the marginal tax rate rises linearly after the basic allowance of 7800 € from 15 percent to maximum of 42 percent when y_j passes 52.000 €. In addition to the income tax payment, households pay a surcharge τ_z of 5.5 percent. In order to calibrate the income tax revenue, we assume that all households are married couples with a sole earner. Then we apply the German income splitting method which in this case doubles the tax payment resulting from halve of taxable income, i.e. $T(y_j) = 2(1 + \tau_z)T05(y_j/2)$. The consumption tax rate is set at $\tau_c = 0.17$ and the corporate tax rate is fixed at $\tau_k = 0.15$. Since the benchmark equilibrium is without retirement accounts, we set $\hat{s} = 0$. Given the exogenous tax rates, we specify the debt-to-output ratio at 60 percent and compute G endogenously to balance the budget. Table 1 summarizes the exogenous parameters.

Table 1: Parameter selection

Demographic parameters	Preference parameters	Technology parameters	Government parameters
$J = 16$	$\gamma = 0.5$	$\varrho = 1.5$	$\tau_c = 0.17, \tau_k = 0.15$
$j_R = 9$	$\rho = 0.6$	$\varepsilon = 0.3$	$B_G/Y = 0.6$
ψ_j :Bomsdorf (2003)	$\alpha = 1.5$	$\delta_k = 0.266$	$d_w = 1200$
	$\delta = 0.91$		$d_s = 3600$
	$\mu = 0.0$		$T(y), APA$ see text

In order to model the income process, we distinguish six productivity profiles across the life cycle. Fehr (1999) has estimated five such profiles from data of the German Socio-Economic Panel Study (SOEP). We split up the profile of the lowest income class in order to improve the income distribution. When an agent enters the labor market (at age 20-24) he belongs to the lowest productivity level with a probability of 10 percent, to the second lowest again with 10 percent and to higher levels with 20 percent, respectively. After the initial period, agents change their productivity levels according to the age-specific Markov transition matrices which are reported in Fehr et al. (2008) or Fehr and Habermann (2008b). The latter are computed also from SOEP data for different years

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[8] The standard pension is computed for a worker who has received an average wage during employment - i.e. $ep_{j_R} = j_R - 1$ - and amounts to roughly 60 percent of net average earnings.

between 1988 and 2003. Specifically we sorted the primary earners of the years 1988, 1993 and 1998 into seven cohorts and divided them within each cohort into six income classes. Then we compiled for each cohort and income class the respective income classes of its members in the surveys of the years 1993, 1998 and 2003 in order to calculate the age-specific transition matrices.

Table 2 reports the calibrated benchmark equilibrium and the respective figures for Germany in 2005. The reported bequest in Table 2 are purely accidental since annuity markets are missing. The models income and wealth distribution is more equal than in reality. Note that the two lowest productivity classes of the youngest cohort would like to borrow because they expect a higher productivity (and therefore income) in the future. For older cohorts, the fraction of liquidity constraint agents decreases sharply. After age 35 we hardly observe liquidity constrained households. Recent evidence from the SAVE survey[9] indicates that our model exaggerates borrowing constraints at young ages but understates the constraints in middle-ages.

Table 2: The initial equilibrium

	Model solution	Germany 2005*
Pension benefits (% of GDP)	13.1	12.7
Pension contribution rate (in %)	19.5	19.5
Tax revenues (in % of GDP)	20.3	20.0
Average income tax rate (in %)	7.9	–
Interest rate p.a. (in %)	3.4	–
Bequest (in % of GDP)	4.3	5.2
Capital-output ratio	2.9	3.0
Gini index net income	0.296	0.299
Gini index wealth	0.540	0.613
Households with borrowing constraints (in %)		
age 20-24	20.0	10.0
age 25-29	7.3	18.9
age 30-34	5.5	18.9

*Source: IdW(2007), DIW (2005), SAVE survey.

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[9] We would like to thank Anette Reil-Held for providing this data.

4 Simulation results

This section presents the quantitative results when we simulate the pension reform in three successive steps. In the first simulation we increase the taxation of capital income. Then we introduce traditional retirement accounts without mandatory annuitization. Finally, the accounts are annuitized after retirement.[10]

Our three reform simulations can be distinguished by alternative combinations of $d_s, \tau_b, \hat{s}$ and ω_j. In the benchmark equilibrium of Table 2 these parameters are set at $d_s = 1800$ €, $\tau_b = \hat{s} = 0$ and $\omega_j = 1$. In the first simulation we simply eliminate the saving allowance (i.e. we set $d_s = 0$). Next we combine the increase of ordinary capital income taxation with the introduction of traditional retirement accounts (i.e. $d_s = 0$ and $\hat{s} = 2.100$ €) where the contribution ceiling reflects the actual German setting. Due to the deferred taxation we assume that inheritances from these accounts are taxed at $\tau_b = 0.165$, which equals the average marginal income tax rate in the benchmark. In the third simulation we add the annuitization of accounts at the time of retirement, i.e. $\omega_j = 1$ if $j < j_R$ and $\omega_j = 0$ if $j \geq j_R$. Of course, all policy reforms affect the tax revenues of the government. In order to balance the intertemporal budget we compute a time-invariant consumption tax rate and balance the periodical budget by adjusting the deficit. Consequently, the public debt level is endogenous after the reform.

4.1 Macroeconomic effects

This section discusses the macroeconomic effects of the simulated reforms. The upper part ("Full capital income taxation") in Table 3 reports the changes in central macro variables when we extend the taxation of capital income by eliminating the capital allowance.[11]

The elimination of capital income allowances allows to reduce the consumption tax rate by 1.7 percentage points. Aggregate savings decrease by roughly 4.4 percent in the long run. Since public debt remains almost constant in the long run, the capital stock even decreases by 5.7 percent, so that the interest rate increases by about 0.3 percentage points. The lower capital stock reduces wages, labor supply and employment. Finally, due to lower savings also accidental bequest decrease by about 4 percent in the long run.

Next we introduce retirement accounts without ("Traditional") and with ("Annuitized") mandatory annuitization of withdrawals after retirement. Younger and future generations

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[10] Our simulation exercise only roughly represents the introduction of retirement accounts in Germany. Fehr and Habermann (2008b) also consider special provisions for low-income households. Börsch-Supan et al. (2008) provide a detailed discussion of the institutional arrangements and the transitional provisions.

[11] The reform starts in the second period, since we don't want to alter the taxation of existing assets.

Table 3: Macroeconomic effects of retirement accounts[a]

Period	Total assets	IRA-share[b]	Public debt[c]	Capital stock	Employ-ment	Wages	Bequest
1. Full capital income taxation ($\tau_c = 15.3\%$)							
1	0.2[d]	0.0	60.0[e]	-1.4	-0.1	0.0	0.0
3	-1.3	0.0	64.1	-2.9	-0.4	-0.7	-1.2
5	-3.1	0.0	63.0	-4.5	-0.2	-1.3	-2.5
∞	-4.4	0.0	62.2	-5.7	-0.1	-1.7	-4.1
2. Traditional retirement accounts ($\tau_c = 16.7\%$)							
1	1.2[d]	5.5	60.0[e]	-0.2	0.3	-0.1	0.1
3	0.9	11.8	65.0	-0.6	-0.3	-0.1	-0.9
5	2.1	26.0	68.5	-0.3	-0.1	-0.1	-0.1
∞	7.7	44.5	80.0	2.2	-0.2	0.7	12.9
3. Annuitized retirement accounts ($\tau_c = 16.8\%$)							
1	1.0[d]	6.3	60.0[e]	-0.4	-0.1	0.0	0.0
3	0.5	12.9	65.1	-1.1	-0.7	-0.1	-2.9
5	0.8	26.1	68.0	-1.6	-0.6	-0.3	-12.3
∞	3.9	46.2	79.1	-1.8	0.3	-0.6	-45.2

[a] Changes are reported in percentage over initial equilibrium.

[b] As a fraction of total assets. [c] In percent of GDP

[d] Period 2. [e] Initial period.

now increase savings in tax-favored accounts so that aggregate savings rise throughout the transition. Since tax revenues decline and are shifted from current to future periods, the consumption tax rate is higher than in the first simulation and public debt increases during the transition. Due to higher public debt, the capital stock and wages only increase slightly in the long run without annuitization. Note that we would get quite similar effects for savings and the capital stock as İmrohoroğlu et al. (1998) if we would not alter capital income taxation. From the figures in Table 3 we can also compute that in the long run about 16 percent of IRA contributions represent new savings.[12] This corresponds quite well with Attanasio and DeLeire (2002) who found that in the United Kingdom about 9 percent of IRA contributions are from new savings. However, matters are quite different when we introduce annuitized accounts in the next simulation. Assets of deceased are now transferred to surviving elderly. Consequently, while bequests still increase in the second simulation, they decrease now dramatically so that long-run savings are much lower than before so that the long-run capital stock and wages decrease compared to the benchmark. Whereas Table 3 documents that the share of savings in retirement accounts rises during

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[12] This figure is derived from $\frac{1}{0.445}(1 - \frac{1}{1.077}) = 0.161$.

the transition, Table 4 reports how cohorts contribute to the accounts in the new long-run equilibrium. As shown by Cagetti (2003), savings are mostly driven by precautionary motives at the beginning of the life cycle, whereas retirement savings become significant at the end of the working phase. Consequently, more than 50 percent of the youngest cohort do not contribute to the accounts at all. With rising age participation rates and contributions increase since existing precautionary savings reduce the exposure to income uncertainty.[13] Note that with annuitized accounts contributions rise especially before retirement. Since after retirement income uncertainty is eliminated, precautionary savings are reshuffled to retirement accounts in order to increase longevity insurance.

Table 4: Participation in retirement accounts (in %)

	Traditional RA			Annuitized RA		
Age	$s_j = 0$	$0 < s_j < \hat{s}$	$s_j = \hat{s}$	$s_j = 0$	$0 < s_j < \hat{s}$	$s_j = \hat{s}$
20-29	55	16	29	52	19	29
30-39	32	12	56	27	12	61
40-49	18	15	67	15	13	72
50-59	18	14	68	15	7	78

4.2 Welfare effects

Next we turn to welfare consequences for different cohorts in the reform year and the long run without and with compensation payments from the LSRA. As already explained above, we first compute the welfare changes of agents before their productivity is revealed and then derive an average welfare change for the different productivity types in each cohort that already lives in the initial equilibrium. Therefore, Table 5 distinguishes in each cohort between “poor”,“median”, and “rich” households. “Poor” agents are the 10 percent of the cohort with the lowest realized productivity level, “median” are those 20 percent who realize a medium productivity level and “rich” are those 20 percent of the cohort with the highest productivity.[14] For newborn cohorts along the transition path we are not able to disaggregate ex-ante welfare effects. Consequently, we report in the

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[13] This corresponds to the findings of Hrung (2002) who shows that in the U.S. IRA savings are lower for individuals exposed to high income risk. Börsch-Supan et al. (2008, p. 305) confirm for Germany that participation increases with age initially but then it declines again after age 50.

[14] For pensioners we aggregate the respective fractions in earning points.

middle column the ex-ante welfare change of the whole cohort and in brackets the (ex-post) welfare changes for "poor" and "rich" newborn households after their productivity is revealed to them. Table 5 reports the results for the extension of capital income taxation in the present model.

Not surprisingly, an increase in capital income taxation balanced by reduced consumption taxes is especially beneficial for medium and old-aged households with low wealth holdings. All households gain from the reduction of consumption taxation, but poor elderly are also hardly affected by the increase in capital income taxation. While medium-aged households have build-up assets already, they are hurt by the increase of capital income taxation. Since the reform reduces wages in the long run significantly, generations born in the future lose. The differences within the future cohorts are rather insignificant. Next we simulate the reform with lump-sum compensation payments of the LSRA in order to isolate the aggregate efficiency consequences of the rise in capital income taxation.[15] The compensated welfare changes for all generations alive in the initial equilibrium are then zero and newborn generations experience identical relative consumption increases. As shown in the right column, rising capital income taxes increase aggregate efficiency by 0.35 percent of remaining resources. This is due to the fact that the reformed tax system (with more income and less consumption taxation) offers more income insurance.[16]

Table 5: Welfare effects of capital income taxation[a]

Age in reform year	poor	Consumers median	rich	compen-sated
90-94	1.11	0.98	0.90	0.00
80-84	1.03	0.93	0.83	0.00
60-64	0.95	0.41	0.13	0.00
40-44	0.53	0.22	0.12	0.00
20-24	(0.35)	0.20	(0.00)	0.35
0-4	(-0.20)	-0.22	(-0.27)	0.35
∞	(-0.35)	-0.33	(-0.36)	0.35

[a] Changes are reported in percentage of initial resources.

The introduction of (non-annuitized) traditional retirement accounts in the left part of Table 6 neutralizes (at least partly) the increase in capital income taxation. Since con-

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[15] We do not report the macroeconomic effects of simulations with compensation payments, but they are available on request.

[16] This corresponds with the results of Nishiyama and Smetters (2005) who find in a similar set-up an aggregate efficiency loss after a switch from income to consumption taxation.

sumption taxes fall much less, the welfare gains of already retired generations are now much lower than in the first simulation. Medium-income and rich households who retire in the reform year even experience significant welfare losses. They can't benefit from the new accounts, but they fully bear the increase of capital income taxes and hardly benefit from reduced consumption taxes. Welfare of newborn and future generations now increases since these cohorts can reduce their capital income tax burden significantly by saving in the accounts and they benefit from the long-run wage increase. Note that due to the higher taxation of ordinary capital income poor households are significantly better off than the respective rich ones in the long run. With an almost constant consumption tax rate, the reform only changes the taxation of different saving motives. While the distributional implications of this reform are positive, the aggregate efficiency gains are fairly small although highly elastic old-age savings are exempt from taxation.

Table 6: Welfare effects of retirement accounts[a]

Age in	Traditional RA				Annuitized RA			
reform	Consumers			compen-	Consumers			compen-
year	poor	median	rich	sated	poor	median	rich	sated
90-94	0.22	0.20	0.18	0.00	0.12	0.10	0.09	0.00
80-84	0.22	0.19	0.15	0.00	0.10	0.09	0.06	0.00
60-64	0.01	-0.36	-0.57	0.00	-0.10	-0.46	-0.66	0.00
40-44	0.20	0.07	-0.08	0.00	1.34	1.11	0.53	0.00
20-24	(0.12)	0.07	(0.05)	0.06	(0.40)	0.41	(0.55)	0.48
0-4	(0.17)	0.11	(0.01)	0.06	(-0.35)	-0.32	(-0.16)	0.48
∞	(0.56)	0.42	(0.24)	0.06	(-0.90)	-0.85	(-0.74)	0.48

[a] Changes are reported in percentage of initial resources.

The right part of Table 6 shows that annuitization mainly reduces the welfare of newborn and future generations. Already retired cohorts are only affected by the slightly higher consumption tax rate. Since former intergenerational transfers are substituted by transfers within a generation, working generations in the reform year are significantly better off than before. They still receive bequest from the elderly and benefit from increased longevity insurance. On the other hand, future generations are much worse off than before since they are hurt by the significant reduction of unintended bequest. The long-run welfare reduction amounts to 0.85 percent of remaining resources. Note that future generations lose although aggregate efficiency rises significantly by roughly 0.5 percent of aggregate resources. The latter reflects the value of the longevity insurance which is provided by the annuity. These results confirm the back-of-the-envelop calculations in Fehr and Habermann (2008a).

4.3 Sensitivity analysis

The reported long-run welfare and efficiency effects of annuitization turn out to be quite robust. Table 7 compares the long-run macroeconomic, welfare and efficiency consequences for alternative parameter combinations and economic assumptions. For better comparison the first line repeats (in bold numbers) the results for the benchmark case from Tables 3 and 6. With risk neutral agents (i.e. when $\eta = 0.0$) precautionary savings decrease so that the time preference rate has to increase in order to recalibrate the initial equilibrium with the same capital-output ratio as in Table 2. Without precautionary savings people would like to consume more at young ages so that liquidity constraints in the initial equilibrium are tighter. The reform now induces especially young individuals to increase savings and shift resources into the accounts. Consequently, liquidity constraints decrease more although savings increase less than in the benchmark. The long-run IRA share is higher and wages are reduced more than in the benchmark. The wage decrease and the reduction of liquidity constraints work in opposite directions with respect to welfare so that the long-run welfare loss hardly changes. The efficiency gain is reduced from 0.48 to 0.25 percent of aggregate resources since risk neutral individuals don't value the insurance provision of the annuitized accounts.

Table 7: Sensitivity analysis for the German system

					Changes in long-run				
η	γ	ρ	μ	δ	savings	IRA share	wages	welfare	efficiency
4.0	0.5	0.6	0.0	0.91	**3.9**	**46.2**	**-0.6**	**-0.85**	**0.48**
0.0				0.97	3.3	49.2	-0.9	-0.83	0.25
	0.33			0.94	0.1	45.4	-1.5	-1.45	0.28
		1.5		0.95	7.3	44.2	0.3	-0.26	0.34
			0.7	0.84	7.4	29.7	0.4	0.14	0.18
Small open economy					3.0	45.9	0.0	-0.62	0.33

Next we reduce the intertemporal elasticity of substitution from 0.5 to 0.33. Since the consumption profile becomes flatter, initial savings fall and the time preference rate has to increase again to stabilize the capital-output ratio. Now savings incentives work much less than in the benchmark. Savings in retirement accounts mainly represent funds which are shifted from already existing accounts. As a consequence, aggregate savings remain almost constant in the long run. Since public debt increases as before, the capital stock decreases much stronger and wages fall by 1.5 percent. The latter hurts future generations so that long-run welfare decreases much stronger than in the benchmark. Aggregate efficiency increases less than in the benchmark since intertemporal distortions are reduced less when the intertemporal elasticity of substitution is low.

In the following simulation we assume an extremely high (compensated) labor supply elasticity of about 1 by setting $\rho = 1.5$. In this case households work and save less in the initial equilibrium so that again the time preference rate has to increase. The reaction of labor supply is now much stronger than in the benchmark simulation. Employment now even falls slightly in the long run. At the same time aggregate savings rise much stronger so that long-run wages now even increase by about 0.3 percent. Higher wages and higher bequest dampen long-run welfare losses compared to the benchmark. Since the reform increases distortions of labor supply, aggregate efficiency gains are reduced with a higher intratemporal elasticity of substitution.

Next we introduce a "joy of giving" bequest motive. Since savings rise, the time preference rate has to decrease significantly in order to recalibrate the initial equilibrium. A bequest motive has two major consequences for the reform. First, annuitized accounts are less attractive. Second, additional resources of the surviving elderly (from annuitized accounts) are now not consumed but saved for the descendants. As a consequence, aggregate savings increase quite strongly while at the same time the IRA share remains fairly small. Therefore, the capital stock increases much stronger so that wages rise and future generations even experience a welfare gain. Of course, since now people take less advantage of the insurance properties of accounts, aggregate efficiency decreases compared to the benchmark.

Finally, in the small open economy we start from the benchmark of Table 2 but keep factor prices constant. People save now slightly less compared to the benchmark and long-run generations lose slightly less due to constant wages. The aggregate efficiency gain is smaller compared to the benchmark probably because of the dampened savings reaction.

5 Discussion

This study evaluates the macroeconomic and welfare consequences of two specific institutional features of tax-favored retirement accounts. On the one side, we focus on the differential taxation of savings motives since the effective zero taxation of income from the accounts is financed by higher taxation of interest income from other savings. On the other side, we analyze the mandatory annuitization of withdrawals after retirement. The quantitative model is calibrated to the German IRA introduction after 2001 since both issues are important elements of that reform. Our simulation results indicate a significant impact of mandatory annuitization but only modest efficiency gains from the differential taxation of savings motives. If withdrawals from accounts after retirement are not annuitized, long-run capital stock and wages increase by roughly 2 and 0.7 percent, respectively. While the efficiency gains from the improved tax structure only amount to 0.06 percent of aggregate resources, long-run welfare increases on average by 0.4 percent of lifetime resources. Within future cohorts, low-income households benefit more than top-income households. With mandatory annuitization, the long-run capital stock and wages decrease by roughly 2 and 0.6 percent, respectively. Although economic efficiency now increases by roughly 0.5 percent of aggregate resources, welfare of future generations is reduced by 0.85 percent. Consequently, efficiency gains from the improved longevity insurance are overcompensated by income losses due to reduced accidental bequest. Our sensitivity analysis indicates that this pattern is quite robust as long as we abstract from an additional bequest motive.

We think that the results of our study are important for the theoretical as well as the more applied policy discussion. With respect to the former our analysis highlights the importance of including transitional dynamics in tax and pension reform analysis and to distinguish between welfare and efficiency effects. Studies such Fuster et al. (2008) which compute only long-run welfare effects have to be interpreted with caution since the aggregate efficiency consequences might be quite different. With respect to the latter, our study demonstrates that tax-favored retirement accounts can be designed in principle so that especially low-income individuals benefit from the reformed tax structure. In addition we show that mandatory annuitization can have quantitatively significant intergenerational income effects even with a fairly modest reform package. The previous discussion of distributional consequences from mandatory annuitization only highlights the intragenerational effects stemming from the positive correlation of life expectancy and income, see Brown (2003) or Gong and Webb (2008). But tax-favored accounts are typically introduced in order to reduce the burden of young and future generations from population ageing. Therefore, it is important to take such negative effects for future generations into account.

Of course, our results have to be interpreted with caution. On the one side, they are based on a specific preference structure which abstracts from a bequest motive. On the other side, we exclude typical arguments in favor of restrictions on withdrawals. For example, as discussed in Mackenzie (2006, p.134ff.), mandatory annuitization of retirement accounts might be justified because people have problems with planning or self-control or because such a policy mitigates the problem of free riding. Consequently, our results add some new aspects, but there is still room for additional future research.

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