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# Pension Reform during the Demographic Transition

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## **Abstract**

Like in many other OECD countries, the population will age rapidly in Germany during the next decades. This undermines the future sustainability of the current unfunded public pension system and motivates the search for reform options. The present paper aims to evaluate some currently discussed pension reform proposals. The numerical analysis is based on an extended overlapping-generations model which accounts for rising life expectancy and declining fertility in order to replicate the demographic transition in Germany. Given the current unfunded pension system, the model first calculates a baseline path of the economy. Then it compares the macroeconomic impact as well as the distributional and efficiency effects of various reform measures such as partial funding and tax financed minimum pensions.

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## 1. Introduction

Like in many other industrialized countries, declining fertility and rising life expectancy will enormously alter the demographic structure of the German population in the future. While the elderly (those older than 60 years) currently constitute about 40 percent of the working population between age 20 to age 59, their share is projected to double in the next 50 years (Bundesministerium der Wirtschaft, 1998). This will undermine the sustainability of pay-as-you-go financed social insurance arrangements such as the statutory pension system (Gesetzliche Rentenversicherung, GRV). If current benefit levels and labor force participation rates are maintained, the contribution rate of the pension system is projected to increase from currently 20 percent to 31 percent in 2035 (Bundesministerium der Wirtschaft, 1998). In combination with the income taxes and the mandatory contributions to health and long term care insurance, the resulting payroll tax burdens would further distort individual labor supply decisions, erode the tax base and thereby exaggerate the strains on the social security system. Even the already existing contribution rate is considered to be too high. In order to finance a reduction of the contribution rate below the 20 percent limit, the government is currently planning to introduce green taxes. Of course, this reform is mainly motivated by short-term budgetary considerations and not by the long-term fiscal requirements. In order to gain long-run financial flexibility and to reduce the fiscal pressure from population ageing, a fundamental reform of the current system seems to be necessary.

During the last years, the pension reform debate in Germany mainly focused on two alternative options. The first direction was lined out by the previous conservative government. Their plan was to reduce the benefit level by raising the retirement age, tightening eligibility criteria and by lowering indexation. In addition, the federal grant would have been increased gradually. Although such a reform measure would reduce the future contribution rates significantly, they would still preserve the main characteristics of the current pension scheme. A growing number of analysts, however, argue that such reform measures only provide some short and medium run relieve, especially if future economic conditions are less favourable as expected. In order to promote national savings and economic growth, they propose a fundamental policy reform towards a partially funded pension system. The resulting (mandatory) pension scheme would consist of an unfunded tier that provides a minimum pension and a fully funded tier for saving. Such a multi-pillar approach is proposed by the World Bank (1994). It has been applied by countries such as Chile, United Kingdom, Australia, Mexico and Argentina. In the US, a partial privatization plan termed Personal Security Accounts (PSA) is currently under consideration<sup>1</sup>. In Ger-

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<sup>1</sup>For detailed information on these reforms, see the papers in Sass and Triest (1997), Feldstein

many, two variants of a minimum pension are discussed: (1) a tax financed flat-rate pension which provides an unconditional minimum income after retirement; (2) a obligatory minimum old-age insurance where the benefits are still linked to former contributions<sup>2</sup>.

Various studies have already analyzed the effects of different reform strategies for specific generations. For example, Börsch-Supan (1998a) computes the changes in tax burdens for different generations if the current unfunded system is completely substituted by a funded system within the next 50 years. Besendorfer et al. (1998) apply the generational accounting approach in order to compare the intergenerational redistribution effects of the moderate reform package of the government and two variants of a minimum pension. However, both studies share two central deficiencies: First, since they do not incorporate behavioral reactions and macroeconomic repercussion effects, it is not possible to quantify any efficiency consequences. Second, since both studies do not disaggregate within generations, they could not compare the intragenerational redistribution effects of different reforms. The purpose of the present paper is to address these issues and analyze various pension reform strategies within a full general equilibrium model. This entails to quantify the impact of each reform upon the macroeconomy as well as the efficiency and equity effects for different generations and households. The numerical analysis is based on an overlapping generations model in the Auerbach-Kotlikoff (1987) tradition. The model is based on earlier work (Fehr, 1999a,b) but it incorporates a number of new features that are particularly important in the present context. First, the model is able to replicate the demographic transition by allowing for rising life span and time-dependent fertility rates. Consequently, the reference simulation is not a steady state path but a baseline path of the economy which would result under the existing fiscal system. Ideally, this path is calibrated in such a way that it generates the expected rise in the contribution rate as explained above. Second, since in Germany a strong linkage between contributions and benefits exists, the statutory contribution rate exaggerates the distortions implied by the pension system. Consequently, the model incorporates an age-dependent tax-benefit linkage which reflects the redistributive elements of the pension system and the assumed difference between the rate of return on the capital market and the internal rate of return of the pension system. Compared to other papers such as Auerbach et al.

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(1998), Siebert (1998) or Congressional Budget Office (1999).

<sup>2</sup>Proposals for the tax financed flat-rate pension date back to the 1980ies, see Miegel and Wahl (1985). For a recent discussion of the pros and cons see Breyer (1998). A switch to a partially funded system where pensions are still linked to former contributions has been recently proposed by the Council of Economic Advisors to the Ministry of Economics (Bundesministerium der Wirtschaft, 1998) and Sachverständigenrat (1996).

(1989), Broer and Westerhout (1997), Chauveau and Loufir (1997), Miles (1999), Steigum (1993) or Thøgersen (1997) which simulate the demographic transition in a general equilibrium model, the present setup offers the following extensions. First, it distinguishes different lifetime income classes within each age cohort in order to assess the intragenerational effects of different pension reform policies. Second, the model is able to deal with kinks in the marginal tax rate structure. In the present context, this allows to replicate the marginal tax rate schedule of the German income tax code and the contribution ceiling of the pension system. Finally, in order to compare the efficiency implications of alternative pension reform scenarios, the paper isolates the resulting individual and aggregate efficiency effects via neutralizing any distributional gains and losses.

In the next section, I describe in brief the structure of the German pension system. Section 3 sketches the basic structure of the simulation model, while section 4 explains the calibration and simulation approach. Finally, section 5 presents the simulation results and section 6 offers some concluding remarks.

## **2. An introduction to the German pension system<sup>3</sup>**

In 1998, total expenditures of the statutory pension scheme (GRV) amounted to DM 400 billions or about 11.5 percent of GDP. Except for civil servants, whose pensions are directly paid from the budget, all dependent employees are compulsorily insured. Most self-employed are exempted from compulsory insurance, however, they may join the system as voluntary members. Apart from a liquidity reserve, which amounts to one months expenditure, the system currently has no funding. In 1998, the contribution rate was 20.3 percent, which was applicable up to a monthly contribution ceiling of DM 8400 or about 1.8 times the average gross earnings of all insured persons. Consequently, if the employee earned less than DM 8400, 10.15 percent is deducted from his gross wage and another 10.15 percent is paid directly by the employer into the public pension system. In addition to these private contributions, the federal government provides a grant which is meant to cover benefits which are not directly related to old age insurance. These include credits for military service or child-rearing and the cost of rehabilitation benefits and health insurance for pensioners. Normal retirement with full benefits is possible in Germany after age 63 after a contribution record of at least 35 years. However, the average retirement age is much lower due to the generous early retirement options. In 1996, the overall average retirement age was 60 years. In the case of early retirement before age 65, a strict earnings test has to be passed for working besides receiving an old age

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<sup>3</sup>This section draws on Fehr (1999a). For a detailed description of the German pension system see Börsch-Supan and Schnabel (1999).

pension. Since pensions are reduced quite dramatically if earnings exceed certain limits, partial retirement is relatively rare in Germany.

Pension benefits are computed by multiplying the number of “earning points” (EP) and the “actual pension amount” (APA). Additionally, there are two adjustment factors concerning the retirement age and the type of pension<sup>4</sup>. For each year of service, the worker receives an earning point which reflects his relative income position in that year. If he receives the average wage, then he gets exactly one earning point. If he receives more or less than average earnings he receives points on a pro-rata basis (i.e. 0.8 points if he earns 80 percent of the average etc.). Due to the contribution ceiling, there is an upper limit of about 1.8 points per year of service. Various credits are given for non-contributory periods such as child-rearing and military service. If the insured worker has contributed for 35 years, earning points below 0.75 are raised by 50 percent to a maximum of 0.75. This increase predominantly benefits female pensioners who made very low contributions during their work years. When the worker retires, the sum of his earning points is multiplied by the APA, i.e. the (monthly) payment in a certain year for one EP. The APA is adjusted annually according to the growth of net wages. Currently, the so-called standard pension which is received after a 45-year contribution history by a worker who always earned the average wage amounts to 70 percent of average net earnings. Summing up, although the system comprises some redistributive elements, pensions in Germany are mainly proportional to former contributions. Due to this tax-benefit linkage, the marginal contribution rate for most households is much lower than the respective average contribution rate. Furthermore, households who earn an income above the contribution ceiling face a zero marginal contribution rate. The simulation model which is described in the next section tries to take these important features into account.

### **3. The structure of the simulation model**

The model used in this paper is a modified version of the numerical general equilibrium model described in detail in Fehr (1999b). This section presents a brief review of the general structure and concentrates on the new features which have been introduced to capture the demographic dynamics and the functioning of the pension system.

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<sup>4</sup>The pension access factor – introduced in 1992 – is 1.0 for regular retirement and lower or higher for early or late retirement. The factor of pension type is 1.0 in the case of old age and invalidity pension, 0.66 in the case of vocational disability pension and 0.6 in the case of a widow’s pension.

### *Demographic structure*

The model's households are distinguished by their dates of birth and their lifetime labor productivity endowments. Each generation is split into five lifetime income quintiles  $j = 1, \dots, 5$ . All agents within one cohort live for the same number of periods with certainty. However, in order to account for rising life expectancy, economic lifetime  $a^d$  increases from 58 years in the initial year 1998 to 64 years in 2060. After 2060 it is kept constant at this level. Since each adult enters the labor force at age 21, this corresponds to an increase in the “natural” age from 78 to 84 years. Hence, in each period, the model distinguishes between 290 and 320 types of households according to age and income class. In each period a new generation enters economic life. In order to capture the demographic transition, population growth rates  $n_t$  differ across periods. Cohorts, therefore, grow according to

$$N_{t+1}^j = (1 + n_t)N_t^j, \quad (1)$$

where  $N_t^j$  denotes the number of the  $j$ -type cohort in period  $t$ . Note that the population growth rates are independent of the household type, i.e. the structure of lifetime incomes remains constant throughout the transition. Adding up all cohorts living in a specific year  $t$  gives the total population  $POP_t$  living in that year:

$$POP_t = \sum_{j=1}^5 \left( \sum_{s=1}^{a_t^d} N_{t+1-s}^j + \sum_{s=1}^{20} N_{t+s}^j \right). \quad (2)$$

The first term in the brackets sums the economic active generations in year  $t$ , while the second term takes into account the cohorts younger than 21 which enter the labor force in future years. Since it is assumed that each  $j$ -type cohort gives birth to a cohort of the same type at age 21, fertility of generation  $t$  is given by  $N_{t+20}/N_t$ . As we will see in the next section, these assumptions suffice to capture the current demographic structure as well as the ageing of the population in the next fifty years.

### *Household preferences and budget constraints*

Each household decides how much to consume and how many hours to work in each period, and when to withdraw from the workforce. As in the original Auerbach Kotlikoff (1987) model the preference structure is represented by a time-separable, nested CES utility function. Lifetime utility of a representative household of income class  $j$  takes the form<sup>5</sup>

$$U^j = \frac{1}{1 - 1/\gamma} \sum_{s=1}^{a^d} \left( \frac{1}{1 + \theta} \right)^{s-1} \left[ (c_s^j)^{1-1/\rho} + \xi_s (\ell_s^j)^{1-1/\rho} \right]^{\frac{1-1/\gamma}{1-1/\rho}}, \quad (3)$$

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<sup>5</sup>For the sake of notational simplicity, I omit a time index for the household sector and assume a long run equilibrium.

where  $c$  and  $\ell$  denote consumption and leisure respectively. The parameters  $\theta, \rho, \gamma$  and  $\xi_s$  represent the “pure” rate of time preference, the intra- and intertemporal elasticity of substitution between consumption and leisure, and the leisure preference respectively. The latter is assumed to be constant until age 55 and then increases slightly until the age of death. Note that preferences are identical for all lifetime income classes. This reflects the belief that poor households would behave as rich ones, provided they had the same (higher) income. Agents are only concerned with their own welfare, i.e. there is no bequest motive. This might appear to be quite restrictive on first sight. However, as will become clear in a later section, the present model is also able to represent the altruism model of Barro (1974), were all intra- and intergenerational redistribution effects are eliminated.

Households maximize (??) subject to the budget constraints given by

$$\sum_{s=1}^{a^d} \left[ \underbrace{(1 - \ell_s^j)w_s^j}_{y_s^j} - c_s^j - \Gamma_s^j - p_s^j \right] (1 + r)^{1-s} = 0, \quad (4)$$

where the time endowment is normalized to unity,  $r$  denotes the pre-tax return on savings and  $\Gamma_s^j$  and  $p_s^j$  represent the individual tax liabilities and payments to or from the pension system respectively. All taxes in the model are collected at the household level, the tax system includes progressive taxes on labor and capital income as well as consumption taxes. Pension benefits after retirement are represented in equation (??) as negative taxes. An individual's earning ability is an exogenous function of her age and her type. These skill differences by age and type are captured by the efficiency parameter  $\epsilon_s^j$ , which increases with age to reflect the accumulation of human capital. Thus, the wage rate for an agent of type  $j$  at age  $s$  is  $w_s^j = \epsilon_s^j w$ . For corner solutions ( $\ell_s^j = 1$ ) where the time constraint bites a shadow price of labor is computed to make the corner solution satisfy the first order condition.

#### *Production technology*

The economy's production technology is represented by a CES production function. Since capital formation is subject to convex installation costs, net production takes the form

$$Y_t = A \left[ \alpha K_t^{1-1/\sigma} + (1 - \alpha)L_t^{1-1/\sigma} \right]^{\frac{1}{1-1/\sigma}} - \frac{\psi}{2} \left( \frac{I_t}{K_t} - \delta - n_t \right)^2 K_t, \quad (5)$$

where  $Y_t$  represents the marketable output,  $K_t$  is the capital stock,  $L_t$  describes the labor force and  $I_t$  the investment in year  $t$ . Besides the scaling variable  $A$  the technology parameters  $\alpha, \sigma, \psi$  and  $\delta$  stand for the capital income share, elasticity of substitution between capital and labor, the adjustment cost coefficient and the depreciation rate respectively. Note that due to the specific normalization there are



no installation costs in the long run equilibrium. Investment decisions follow the Q-theory of investment, according to which firms will invest whenever the stock market value of their assets exceeds the cost of replacement. The model neglects completely corporate income taxes as well as other business taxes. This seems permissible since the study wants to concentrate on the reform of the pension system.

#### *Government sector*

To capture the interaction between the tax system and the pension system in Germany, the government in this model has two independent fiscal sectors. One sector uses the tax revenues to finance a stream of exogenous public consumption  $G_t$  and and a fraction  $\vartheta_t$  of aggregate pension benefits  $PB_t$ , i.e.

$$\sum_{j=1}^5 \sum_{s=1}^{a_t^d} \Gamma_{st}^j N_{t+1-s}^j = \underbrace{gPOP_t}_{G_t} + \vartheta_t \underbrace{\sum_{j=1}^5 \sum_{s=a_t^r}^{a_t^d} P_{st}^j N_{t+1-s}^j}_{PB_t} \quad (6)$$

where  $a_t^r$  is the retirement age in year  $t$ . Note that the per capita supply of public goods remains constant. Since by assumption public goods enter the utility function in an additively separate manner, it is possible to omit them in the utility function (??). The model also abstracts from government debt since I wanted to concentrate on the effects of population ageing for the pension system.

The second government sector is the pension system, which pays old-age benefits and collects payroll contributions in each year. Individual pension benefits of a retiree in year  $t$ ,  $p_{a_t^r}^j$  are computed from the sum of the earning points  $EP_{sk}^j$  the retiree has received during his past working life multiplied by the actual pension amount of the respective year  $APA_t$ :

$$p_{a_t^r}^j = \sum_{s=1}^{a_t^r-1} EP_{sk}^j APA_t \quad (7)$$

where  $k = t - a_t^r + s$ . The earning point received in working year  $k$  for his annual gross labor income  $y_{sk}^j$  is calculated according to the formula

$$EP_{sk}^j = \begin{cases} \min(1.5y_{sk}^j/\bar{y}_k; 0.75) & \text{if } y_{sk}^j \leq 0.75\bar{y}_k \\ y_{sk}^j/\bar{y}_k & \text{if } 0.75\bar{y}_k < y_{sk}^j < 1.8\bar{y}_k. \\ 1.8 & \text{if } 1.8\bar{y}_k \leq y_{sk}^j \end{cases} \quad (8)$$

This formulation reflects some of the redistributive features of the German pension system mentioned above. If the individual income in year  $k$ , is below 75 percent of average income  $\bar{y}_k$ , then the accounted earning point is increased up to 50 percent.

If the annual individual income is above the contribution ceiling, which exceeds the average income by 80 percent, then a maximum earning point of 1.8 is credited. Below the contribution ceiling and above the minimum threshold, earning points are computed from the ratio of individual income to the average income of the respective year. The actual pension amount in the second part of equation (??) is set by the government. As in reality, this number reflects the payments for one earning point. In the benchmark simulation, I assume that all individuals retire after 40 working years at age 61.  $APA_t$  is then computed so that the standard pension (i.e. where the sum of earnings points is 40) amounts to a given percentage  $\Theta_t$  of net average earnings  $\bar{y}_{t-1}^n$  of the previous year, i.e.

$$40APA_t = \Theta_t \bar{y}_{t-1}^n. \quad (9)$$

The budget of the pension system must be balanced in each period. Therefore the aggregate contribution rate,  $\tau_t$ , has to be adjusted to fulfill the period budget constraint

$$\sum_{j=1}^5 \sum_{s=1}^{a_t^j-1} p_{st}^j N_{t+1-s}^j = \tau_t PY_t = (1 - \vartheta_t) PB_t, \quad (10)$$

where  $PY_t = \sum_{j=1}^5 \sum_{s=1}^{a_t^j-1} \min(y_{st}^j, 1.8\bar{y}_t) N_{t+1-s}^j$  defines the aggregate compulsory earnings base. In principle, households still could choose to work after receiving pension payments. However, since the representative household retires early in the model, I assume that individuals face a labor income tax surcharge of 50 percent if they work after passing the retirement age. This assumption should capture the above mentioned earnings test applied to early retirement.

The aggregate social security contribution rate  $\tau_t$  which is calculated from (??) is not necessarily identical with the individual contribution rates. Due to the contribution ceiling, marginal and average contribution rates of a type- $j$  individual of age  $s$  in year  $t$  are given by

$$\tau_{st}^j = \begin{cases} \tau_t(1 - \varphi_{st}) & \text{if } y_{st}^j \leq 1.8\bar{y}_t \\ 0 & \text{if } y_{st}^j > 1.8\bar{y}_t \end{cases}$$

and

$$\bar{\tau}_{st}^j = \begin{cases} \tau_t & \text{if } y_{st}^j \leq 1.8\bar{y}_t \\ \tau_t 1.8\bar{y}_t / y_{st}^j & \text{if } y_{st}^j > 1.8\bar{y}_t. \end{cases}$$

Above the contribution ceiling, the marginal social security tax is zero and the average social security tax falls with increasing income for an individual. The tax benefit

linkage  $\varphi_s$  reflects the extent of redistributive elements within the pension system. If pensions would be perfectly proportional to former contributions, households would only perceive a proportion of their contributions as taxes which depends on the difference between the rate of return on the capital market and the implicit rate of return of the pension system. This proportion falls when the household approaches retirement age. In order to take this into account, I model the tax-benefit linkage as

$$\varphi_{st} = e^{\mu(s-a_t^r)}.$$

If pensions are exactly proportional to former contributions,  $\mu$  reflects the difference between the rates of return on the capital market and in the pension system. If pensions are completely independent of former contributions,  $\mu$  approaches infinity (i.e.  $\varphi_{st} = 0$ ).

This completes the description of the simulation model. On the equilibrium path, the goods market as well as the two factor markets for labor and capital are balanced in each period. The next chapter presents a discussion of the parameter values which are specified exogenously and the resulting baseline equilibrium path of the economy.

#### 4. Dynamic calibration and baseline simulation

Given a set of demographic, preference, technology and fiscal parameters, the model can be solved numerically. In the traditional model of Auerbach and Kotlikoff (1987), the initial equilibrium is a steady state due to the time-invariant population growth rate. With demographic dynamics, however, the problem is more complicated, since the initial year is not a long run equilibrium and the reference simulation for the policy reforms is a baseline path of the economy under the existing fiscal system. In order to start from an equilibrium which is not a steady state, households of the initial year are endowed in the present model with a profile of assets and pension claims. This profile is derived from an artificial steady state simulation where I combine the preference, technological and fiscal parameters of the base year with a constant population growth rate. Given the asset and pension wealth endowments of all households in the initial year it is possible to compute the initial equilibrium and the subsequent baseline path of the economy for a specific fiscal system. In the short and medium run, the baseline path of the economy mainly depends on the dynamics of the population structure. In the long run the model returns to a stable population structure and the economy, therefore, converges to a steady state.

In the following, I discuss the parameters which are exogenously supplied and report the resulting initial equilibrium and baseline path of the economy. I start with the demographic dynamics of the model. As already explained above, the life expectancy and the annual population growth rates determine entirely the demographic structure of the initial year and the following years of the transition. These

Table 1: Official and simulated population dynamics

Year	1996	1998	2000	2010	2020	2030	2040	2050	2100
Life expectancy									
$a^d + 20$	–	78	78	78	79	80	80	82	84
Population (in mio.)									
Model	–	83.1	82.7	80.1	77.1	74.5	70.9	67.4	62.3
Official <sup>a</sup>	82.8	–	82.2	81.0	78.4	74.3	68.8	–	–
Age groups	Off. <sup>b</sup>					Model			
1-20	22.6	19.5	19.0	18.6	19.2	19.9	20.9	22.0	23.8
21-40	29.2	31.2	30.8	24.9	20.4	19.9	20.9	22.0	23.8
41-60	26.6	26.9	26.9	31.0	33.1	26.8	22.2	22.0	23.8
61-84	21.4	22.4	23.2	25.5	27.3	33.4	36.0	33.9	28.6
Dependency ratios*									
Model		38.5	40.1	45.6	51.0	71.4	83.5	77.1	60.0
Official <sup>a</sup>	37.0	–	40.8	44.8	53.1	73.2	76.4	80.2	–

Source: <sup>a</sup> Bundesministerium für Wirtschaft (1998, p. 6);

<sup>b</sup> Statistisches Bundesamt (1998, p. 58).

\* Population aged 61-84 as percentage of population aged 21-60.

parameters have been chosen in a way that the demographic structure of the model follows an observed pattern. Of course, due to the assumption of a certain death at a given age, the projected demographic developments could only be replicated approximately. Table 1 reports the chosen life expectancy and compares some official population projections with the respective ones of the model.

The base year of the model is chosen to be 1998. In this year, people die at age 78. In the following years life-span of households increases up to 84 years in 2060 and remains constant thereafter. As shown in the second and third columns, the chosen population growth rates allow to replicate the demographic structure of the base year quite well. Although households do not die before the given life expectancy and no immigration is taken into account, the model also matches the official forecasts of future dependency ratios. In the long run, population size approaches 62.3 million, since I assume a zero population growth after 2020.

Table 2 presents the other exogenously chosen parameters. The preference parameters mainly reflect the values chosen by Auerbach and Kotlikoff (1987, p. 50f.). The leisure preference parameter is constant at 1.5 until age 55, then it increases until death up to 2.0. The age-wage profiles for each lifetime income class are based on estimates from the German Socio-Economic Panel (SOEP) study. The scaling parameter of the production function is normalized to yield a wage of unity in the

Table 2: Parameterization of the model

Parameter	Symbol	Value
Utility Function		
Pure rate of time preference	$\theta$	0.015
Intertemporal elasticity of substitution	$\gamma$	0.25
Intratemporal elasticity of substitution	$\rho$	0.7
Leisure preference parameter	$\xi_s$	1.5-2.0
Production Technology		
Capital share in production	$\varepsilon$	0.3
Elasticity of substitution between capital and labor	$\sigma$	0.9
Rate of economic depreciation	$\delta$	0.07
Adjustment cost parameter	$\psi$	7.5
Policy Variables		
Consumption tax rate	$\tau^c$	0.164
Retirement age	$a^r$	41
Pension level	$\Theta$	0.7
Government share in pension benefits	$\vartheta$	0.0
Tax-benefit linkage	$\mu$	0.06

initial equilibrium. The remaining technological parameters are roughly in accordance with econometric studies and generate a realistic investment rate in the initial year. On the government side I fix the initial consumption tax rate at 16.4 percent, since this value yields – given the other fiscal parameters – a realistic public consumption share in the initial equilibrium (see below). Labor and capital income is subject to a progressive tax. For the labor income tax, the model exactly reproduces the step function of the tax rate schedule of 1998. Taxable labor income in the base year is derived after deducting a personal allowance between DM 13,000 from gross labor earnings. In addition to personal allowances, a basic allowance of DM 12,000 is also not taxed. Then the marginal tax rate jumps to 26 percent and rises linearly to 53 percent at an annual taxable income of DM 120,000. The marginal capital income tax rate is set to 35 percent. For capital income, a uniform allowance of DM 6,000 is assumed for all households.

It was already explained above that households retire in the baseline simulation after 40 working years. The pension level of a standard pensioner is set to 70 percent of net average labor earnings. As discussed above, the government grant to the pension system mainly covers non-contribution related benefits. Since I cannot represent such benefits in the model, I assume in the baseline simulation that the government grant is zero. Finally, the tax-benefit linkage has to be specified. As

explained above, this parameter mainly depends on the difference between the rate of return in a funded system and the implicit rate of return of the unfunded system. This difference is between 4-6 percent in Germany, but expected to increase in the future (Börsch-Supan, 1998b, p. 147; Schnabel, 1998). Since in addition pension benefits are not completely proportional to contributions, I fix the parameter for the tax-benefit linkage in the baseline to 6 percent.

Table 3: The benchmark equilibrium

	Model benchmark	Germany 1998 <sup>a</sup>
Expenditures on GDP (% of GDP)		
Private consumption	63.7	57.5
Government consumption	21.0	18.9
Gross fixed investment	15.3	21.9
Export-import	0.0	1.7
General government indicators		
Aggregate pension benefits (% of GDP)	13.3	11.5
Aggregate contribution rates		
Average	18.8	20.3
Marginal	10.2	–
Tax revenues (% of GDP)	21.0	22.9
Labor income tax	9.1	7.7
Capital income tax	1.4	1.8
Tax on goods and services	10.5	9.0
Aggregate tax rates on labor income		
Average	12.4	–
Marginal	30.3	–
Aggregate tax rates on capital income		
Average	12.0	–
Marginal	35.0	–
Interest rate (in %)	4.1	5.6
Capital-output ratio	2.5	2.9

<sup>a</sup> Source: Deutsche Bundesbank (1999).

Of course, all parameters have been chosen that the resulting initial year reflects some stylized facts of the German economy. Table 3 reports the structure of the models initial equilibrium and compares it with the respective actual figures for 1998. All in all, the model represents quite well the basic economic and fiscal structure of Germany. As already mentioned above, the consumption tax rate was chosen so that aggregate tax revenues in the model approximates the respective actual figure. Of course, since the model neglects important features such as government debt and

corporate taxes, the government sector is not represented very well. On the other hand, the model captures the central interaction between the pension system and the remaining tax system which is mostly important in the present context. While the pension benefits are a little bit above the actual figures, the aggregate average contribution rate seems to be to low. Note, however, that this is mainly due to the overrepresentation of households with an income above the contribution ceiling. Households in the first four income quintiles face an average contribution rate of 19.9 percent in the base year, which almost exactly matches the actual figure of 20.3 percent. The aggregate marginal contribution rate also is in line with some recent estimates of Schnabel (1998).

Figure 1: Average and marginal contribution rates

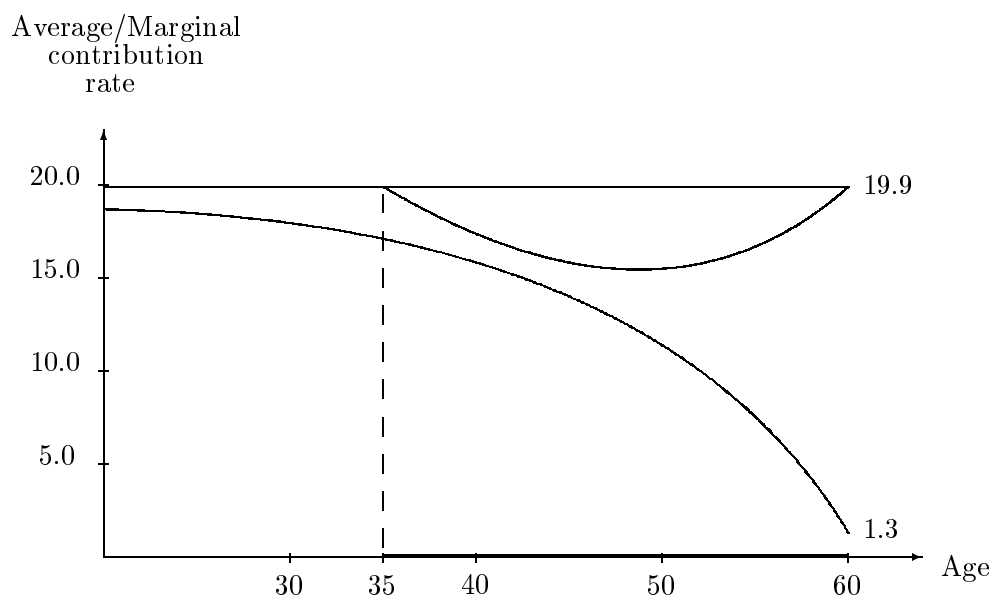


Figure 1 shows the effects of the tax-benefit linkage and the contribution ceiling on the average and marginal contribution rates across the life-cycle in the initial year. At the beginning of their working life, annual income is below the contribution ceiling for all households. The average contribution rate is consequently 19.9 percent. The marginal contribution rate is slightly below the average one at the beginning of working life but falls with age continuously. Households who are just about to retire consider only a small share of their contributions as taxes<sup>6</sup>. At age 35 households of the top income quintile pass the contribution ceiling. While their marginal contribution rate drops immediately to zero, their average contribution

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<sup>6</sup>Hirte and Weber (1997) explicitly take into account the tax-benefit linkage of the German pension system. The age profile of their marginal contribution rate has a very similar shape. For a similar modeling see also Kotlikoff et al. (1999).

Table 4: Baseline path of the economy\*

Year	2000	2010	2020	2030	2040	2050	2100
Employment	6.5	33.7	32.5	16.5	3.1	-2.0	-6.7
Capital	5.1	26.6	40.0	43.9	28.3	8.6	1.7
GDP	6.2	32.2	35.2	24.0	9.7	1.1	-3.9
Consumption	5.4	27.6	27.5	18.5	6.5	-0.7	-9.1
Wage	-0.3	-1.6	1.6	6.5	6.7	3.1	2.6
Interest rate	2.4	3.8	3.3	0.8	2.5	5.3	3.1
Cons. tax	18.5	15.5	13.2	13.1	14.4	14.4	16.0
Av. Wage tax	12.5	13.9	15.3	17.2	17.4	16.3	15.1
Av. Contr. rate	19.4	21.0	22.6	28.8	31.7	30.0	25.7

\*All changes expressed are percentage differences to base year, except for interest rates as well as tax and contribution rates which are already expressed in percentage points.

rate decreases down to about 15 percent until age 50 where they reach the peak in their annual income. Then it increases again, because of their falling annual income. In the last year before retirement, annual income falls below the contribution ceiling so that the average contribution rate is again 19.9 percent.

Next, let us turn to the baseline path of the economy. Table 4 reports the changes in some important macroeconomic variables after the base year 1998. Employment, capital stock, GDP and consumption are expressed per capita of the cohort which enters the labor force. Since the absolute number of this cohort falls in the first phase of the transition, the per capita values of the macro aggregates increase. In addition, the change in the age structure of the population also increases the labor force initially, since households work more in middle ages where their human capital endowment reaches a peak. After year 2010 it is assumed that the same number of households enters the labor force each year. Consequently, employment per capita starts falling again due to the now falling share of elderly (between ages 40-60) in the labor force. In the long run, employment per capita declines by almost 7 percent. The pattern of the capital stock changes is quite similar to the one of the labor force. However, the level is higher which might be due to the chosen initial endowment of assets. The changes in employment and the capital stock explain the changes in the GDP as well as the wage changes. Remember that in the overlapping generations model the consumption propensity rises with age. The observed changes in consumption per capita, therefore, also reflect the profound change in the age structure during the transition. The same applies to the savings behavior and the resulting path of the interest rate. While the latter falls in the first phase of the transition, it increases again after 2040. Rising pretax wages also



increase labor income tax revenues. In addition, consumption per capita rises too and, consequently, the consumption tax rate falls in the first phase of the transition in order to balance the budget. Finally, the change in the age structure has a dramatic impact on the pension system. Due to the rising share of pensioners, the contribution rate rises in the baseline simulation from currently 20 percent to almost 32 percent in 2040. This is consistent with the currently discussed projections mentioned above.

This suffices to explain the main characteristics of the baseline simulation. After all these preliminaries we finally can turn to the analysis of policy reform options in the following section.

## 5. Simulation findings

This section compares the macroeconomic and welfare consequences of alternative pension reform strategies. The specific policy reforms are first explained, then the computation of the welfare changes is discussed. Finally, the numerical results of the simulations are presented.

### 5.1. *Experimental design and welfare decomposition*

The pension reforms which are analyzed in this section can be separated into three categories. First, the moderate reform strategy of the former conservative government, second a transition to a partially funded system where the unfunded pensions are still contribution related but reduced to a minimum level and finally a move to a tax financed minimum (or flat benefit) pension system.

The moderate reform package mainly consisted of three measures: an increase in the retirement age, a gradual decline of the pension level and a phased-in increase in the tax-financed proportion of pension expenditures. In order to separate the effects of the different measures, they are introduced successively. In the first simulation, the retirement age ( $a^r$ ) is increased in year 1999 and year 2009 to 62 and 63 respectively and kept on this level in the future. Since also the two radical reform proposals call for an increase in the retirement age, this reform is maintained in all other simulations. In the second simulation, the benefit level ( $\Theta$ ) is reduced in years 2008, 2018 and 2028 by 2 percentage points respectively. Therefore, 30 years after the announcement, the pension level of a standard pensioner will be reduced from currently 70 percent to 64 percent of average net earnings. The third simulation includes the whole reform package. In addition to the two other measures, the tax-financed proportion of pension expenditures ( $\vartheta$ ) is increased between 1999 and 2009 from 0 to 0.2. Since such a measure is meant to improve the tax-benefit linkage, I also reduce  $\mu$  from 0.06 to 0.04 in and after year 2005.

The moderate reform measures reduce the future pension level by about 10 percent. The two other reforms are much more radical, since the pension level is reduced

by about 40 percent. Of course, such a dramatic switch requires a smooth transition, where the accrued claims from the old system are fully taken into account. Therefore, I directly alter the earnings point formula (??). This guarantees that households receive the same benefits for the earning points they have acquired in the old unfunded system and only receive the lower benefits for the contribution time they have spent in the new system. In addition, I assume that the reforms are implemented with a time-lag of seven years. In the partial funding simulation I eliminate the intragenerational redistribution towards low income households and change the earnings point formula in and after year 2005 to

$$EP_{sk}^j = \begin{cases} 0.6y_{sk}^j/\bar{y}_k & \text{if } y_{sk}^j \leq 1.8\bar{y}_k \\ 1.08 & \text{if } y_{sk}^j > 1.8\bar{y}_k. \end{cases} \quad (11)$$

As in the previous simulation, the new system features an improved tax-benefit linkage. Consequently, I reduce  $\mu$  again from 0.06 to 0.04 in and after year 2005. The last simulation differs from the previous one in two respects. First, when the unfunded tier is fully implemented, benefits will be uniform across all households. Therefore, under the ‘flat benefit’ scenario the earnings point formula in and after year 2005 changes to

$$EP_{sk}^j = 0.6. \quad (12)$$

Second, since the tax-benefit linkage is now completely lost,  $\varphi$  is set to zero in year 2005. Of course, both reforms also include a fully funded tier provided by the government through forced savings. However, since the present model features a perfect capital market, forcing individuals to private pensions accounts would make no difference, since it only crowds out voluntary private savings. Hence, there is no need for a explicit funded pension system in the model.

Given a baseline path of the economy as described in Table 4, all experiments start at the beginning of year 1999. As in the baseline, the consumption tax rate is adjusted in each year to balance the government budget (??) and the contribution rate adjusts to balance the pension budget (??). Given a new transition path of the economy and a new long run equilibrium, I compute the macroeconomic impact of a reform and the resulting changes in economic welfare or utility for the different generations and households. The welfare changes must be due either to (re)distributional effects or otherwise to efficiency effects. Distributional effects arise either because of changes in net tax burdens or because of changes in pretax prices. Efficiency effects reflect the behavioral reactions in order to avoid taxes. In order to isolate the latter, one has to eliminate the income effects by compensating households for any distributional

gains or losses. Therefore, in order to calculate the efficiency changes I simulate each policy reform again, but this time with neutralizing transfers<sup>7</sup>. After compensation, households' welfare changes are solely due to efficiency effects.

I close this subsection with a final remark regarding the no bequest assumption of the preference structure. Since the efficiency effects of a specific pension reform scenario are computed in a simulation without redistribution across and within cohorts, this corresponds to a Barro-Ricardo world, where all generations and households are linked by an operative altruistic bequest motive. In this sense, the present model incorporates bequests in an indirect way.

## *5.2 Numerical results*

Let us now turn to the numerical results. Table 5 shows the macroeconomic adjustment for the five reform scenarios described above. The table presents the changes in employment, capital stock, GDP, wages, interest rates, consumption tax rates and contribution rates at five years during the transition and in the long run equilibrium. Note that the changes in the interest, consumption tax and contribution rate are in percentage points, not in percentage of initial values.

Consider first the increase in the retirement age in the left column. Since the cohort age 61 is not allowed to retire, the contribution rate falls and the labor force increases immediately. On the labor market, wages fall slightly and employment rises. The higher employment also increases capital productivity which in turn induces a higher investment demand and a slowly rising capital stock. Of course, the reduction in the contribution rates is especially strong in 30 years, when the current baby boom generations retire. Note that the consumption tax rate increases during the transition although employment and consumption are higher than before. Mainly this is due to intertemporal labor supply substitution. Households reduce their labor supply during their middle years where they pay high taxes. Consequently, labor income tax revenues fall and consumption taxes have to be increased.

The next column displays the macroeconomic adjustment if, in addition to the increase in the retirement age, benefits are also reduced to 64 percent. In the short run this has only negligible effects, in the medium and long run, however, consumption tax and contribution rates fall significantly. While the reduced pension claims decrease human wealth of older households, younger and future households experience an increase of their human wealth endowment. Due to lower contribution rates and the negative human wealth effect, labor supply and employment rise in the short and medium run above the level of the first simulation. In addition, households save more in order to balance the reduced pension wealth. Therefore, the capital stock increases much stronger than before.

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<sup>7</sup>For the exact computation of these transfers see Fehr (1999b).

Table 5: Macroeconomic effects of pension reforms<sup>a</sup>

Variable	Increase in retirement age	Moderate reforms		Radical reforms	
		Benefit reduction	Increase in gov. grant	Partial funding	Flat benefit
<i>Employment</i>					
2000	0.8	1.0	0.5	1.1	1.9
2010	0.6	0.8	0.8	2.3	-1.8
2020	0.5	0.8	0.5	2.4	-1.9
2030	0.6	1.0	0.4	3.2	-1.5
2040	0.0	0.2	-0.2	3.0	-1.3
Long run	0.4	0.5	0.2	2.1	-0.6
<i>Capital stock</i>					
2000	0.0	0.1	0.0	0.1	0.3
2010	0.5	1.1	1.2	1.9	2.2
2020	1.1	2.4	3.3	4.9	3.5
2030	1.6	3.5	4.7	8.6	5.7
2040	1.8	4.7	6.3	13.8	9.5
Long run	1.1	5.7	8.0	30.6	23.7
<i>GDP</i>					
2000	0.6	0.7	0.4	0.8	1.3
2010	0.5	0.9	0.8	2.1	-0.8
2020	0.7	1.2	1.2	3.0	-0.5
2030	0.8	1.7	1.6	4.7	0.3
2040	0.4	1.4	1.5	5.9	1.5
Long run	0.6	1.9	2.2	9.0	5.3
<i>Wage rate</i>					
2000	-0.2	-0.2	-0.1	-0.3	-0.4
2010	0.0	0.0	0.1	-0.1	1.2
2020	0.1	0.4	0.8	0.7	1.6
2030	0.2	0.7	1.2	1.5	2.1
2040	0.5	1.2	1.8	2.9	3.1
Long run	0.2	1.4	2.2	7.5	6.7
<i>Interest rate</i>					
2000	-0.1	-0.1	0.0	-0.1	0.0
2010	-0.2	-0.2	-0.3	-0.2	-0.4
2020	-0.1	-0.2	-0.3	-0.2	-0.4
2030	-0.2	-0.3	-0.4	-0.4	-0.6
2040	-0.3	-0.5	-0.7	-1.0	-1.0
Long run	-0.1	-0.4	-0.6	-1.9	-1.7
<i>Consumption tax rate</i>					
2000	0.0	0.0	0.8	0.0	-0.4
2010	0.5	0.4	5.1	-0.2	1.0
2020	0.9	0.6	5.7	-0.2	1.1
2030	1.7	1.3	7.4	-0.1	1.2
2040	1.6	1.1	8.2	-1.0	0.4
Long run	0.9	0.3	6.1	-2.6	-1.5
<i>Contribution rate</i>					
2000	-1.2	-1.2	-1.9	-1.2	-1.3
2010	-1.8	-2.3	-5.4	-2.0	-1.8
2020	-2.2	-3.1	-6.3	-3.4	-3.0
2030	-2.9	-4.5	-8.3	-6.7	-6.2
2040	-1.6	-3.4	-7.5	-8.2	-7.9
Long run	-1.4	-3.0	-6.5	-10.4	-9.1

<sup>a</sup> All changes reported are in percentage over baseline simulation, except for changes in interest, consumption tax and contribution rates, which are already expressed as changes in percentage points.

Now consider the next column where the government grant is also increased gradually to 20 percent of pension outlays. Although their tax bases are quite similar, the increase in the consumption tax rate during the transition is significantly stronger than the fall in the contribution rate. Since labor supply and employment fall compared to the previous simulation labor income tax revenues have decreased. The reduction in labor supply is due to the fact that a significant share of households is above the contribution ceiling and, consequently, faces a zero marginal contribution rate. For them, a switch towards consumption tax financing increases labor supply distortions and reduces employment. At the same time, consumption tax financing redistributes towards younger and future generations, which in turn increases savings. Therefore, capital accumulation accelerates during the transition inducing a rise in wages and a fall in interest rates. Since labor income tax revenues and consumption rise again, the long run increase in the consumption tax rate is dampened in the second phase of the transition.

The last two columns of Table 5 report the macroeconomic impact of the two radical reform options. Due to the policy preannouncement, economic activity rises only slightly in the short run if the partial funding strategy is implemented. However, as soon as the contribution rate starts to fall after about ten years, labor supply, investment, output and wages rise much stronger than under the gradual reform scenario. This allows to reduce the contribution rates and the consumption tax rates steadily during the transition. In contrast, if the flat benefit option is implemented, economic activity will only increase in the short run due to intertemporal labor supply substitution effects. As soon as the tax-benefit linkage is eliminated, labor supply distortions increase significantly which leads to a strong reduction in employment although capital stock and wages rise. While the contribution rate falls steadily, the consumption tax rate has to be increased dramatically during the transition in order to finance pension outlays and to balance the lower revenues from labor income taxation.

So far we have seen that alternative pension reforms may have quite a different impact upon the macroeconomy. Although these effects are important, we are nevertheless mainly interested in the welfare consequences of the different reform options. Can we expect any efficiency gains from pension reforms and if so, what is their magnitude and how are they distributed across income classes and generations? Who are the winners and losers in the different reform scenarios? Before I turn to the details of the simulation results, I first present the aggregate efficiency effects in Table 6.

In the first row of Table 6 the aggregate efficiency effects are computed as a percentage of the present value of the pension payments in the baseline simulation. In order to get an idea about their magnitude, I calculate then the implied average annual

Table 6: Aggregate efficiency effects of pension reforms

	Moderate reforms			Radical reforms	
	Increase in retirement age	Benefit reduction	Increase in gov. grant	Partial funding	Flat benefit
in % of baseline benefits	1.03	1.64	1.58	6.08	-4.03
in bill. DM annually*	4.12	6.56	6.32	24.32	-16.12

\* Computed from aggregate pension benefits of base year.

efficiency effects in billion DM. Since the latter figures are computed from the aggregate pension benefits in the base year (i.e. 400 bill. DM), they are even understated, since pension outlays increase due to population ageing in the future. Despite these quantitative shortcomings, Table 6 reports three qualitative results. First, the efficiency gains of the moderate reform package are mainly due to the increase in the retirement age. The benefit reduction and the rising share of tax financing have only a minor impact on efficiency, even though the tax benefit linkage is increased slightly in the latter simulation. Second, partial funding yields a significant efficiency gain since it implies a strong reduction in the highly distortive contribution rates. Finally, flat benefits yield considerable efficiency losses, since they destroy the tax-benefit linkage completely and, therefore, increase the marginal tax rates on labor earnings. Of course, these numbers just give a first idea about the magnitude of the estimated effects. A valuable economic interpretation is only possible if we consider the welfare and efficiency effects of the different experiments for specific households and generations. This will be done in the following.

The head columns in Tables 7 and 8 list the different income quintiles and representative generations for which the welfare effects are reported. I have selected only the lowest, the middle and the top income quintile. In addition, I also report the aggregate effect for the entire generation. The numbers in the head column refer to the birth year of a household or generation. The policy reform starts at the beginning of 1999 (which is identical with the end of 1998). Households who are born in 1930 are therefore already retired and live for another 10 years after the reform. Households who are born in the “Long run” live in the new steady state equilibrium. The following columns report the individual welfare changes and the associated efficiency effect. All welfare changes are expressed as percentage of the remaining lifetime resources of the respective generation in the benchmark equilibrium. This is the standard practice in dynamic simulation models.

Consider now the increase in the retirement age in the left part of Table 7. Assume

Table 7: Welfare effects of moderate pension reforms<sup>a</sup>

Birth year	Increase in retirement age		Reduction in benefits		Increase in government grant	
	Welfare	Efficiency	Welfare	Efficiency	Welfare	Efficiency
<i>Lowest Quintile</i>						
1930	0.08	0.00	0.12	0.00	-0.17	0.00
1950	-0.93	0.28	-1.34	0.29	-1.68	0.25
1970	-0.02	0.11	-0.22	0.12	-0.21	0.05
1990	0.27	0.12	0.62	0.16	0.75	0.13
2010	0.22	0.10	1.01	0.19	1.27	0.27
2030	0.05	0.09	0.89	0.17	1.18	0.24
Long run	0.15	0.12	1.04	0.20	1.25	0.26
<i>Third Quintile</i>						
1930	0.08	0.00	0.12	0.00	-0.18	0.00
1950	-0.51	0.18	-0.85	0.19	-1.23	0.11
1970	0.16	0.04	-0.02	0.07	-0.05	0.13
1990	0.41	0.01	0.73	0.12	0.93	0.35
2010	0.29	-0.03	0.93	0.15	1.15	0.54
2030	0.18	0.02	0.88	0.17	1.11	0.43
Long run	0.26	0.05	0.95	0.19	1.11	0.44
<i>Top Quintile</i>						
1930	0.05	0.00	0.08	0.00	-0.14	0.00
1950	-0.41	0.12	-0.70	0.13	-1.01	-0.05
1970	0.23	0.08	0.11	0.08	0.22	-0.18
1990	0.49	0.07	0.78	0.11	0.98	-0.07
2010	0.40	0.09	1.03	0.25	1.47	0.37
2030	0.24	0.05	0.83	0.19	1.21	0.23
Long run	0.20	0.15	0.81	0.27	1.12	0.25
<i>Aggregate</i>						
1930	0.06	0.00	0.10	0.00	-0.15	0.00
1950	-0.53	0.17	-0.86	0.18	-1.20	0.07
1970	0.17	0.05	0.01	0.07	0.06	0.01
1990	0.43	0.04	0.75	0.12	0.98	0.17
2010	0.33	0.03	1.00	0.21	1.36	0.47
2030	0.19	0.03	0.86	0.17	1.18	0.33
Long run	0.23	0.08	0.92	0.21	1.18	0.35

<sup>a</sup> Changes expressed as percent of the present value of remaining lifetime resources.

for a moment that the model does not distinguish different lifetime income classes. In this case one would report the aggregate, generation specific welfare measures in the lower part. Note first that all generations who are not retired receive efficiency gains, especially generations born in 1950 who are close to retirement around 1999. Of course, the elderly mainly experience efficiency gains since the high marginal tax rate due to the income tax surcharge is reduced considerably for age 61 and 62. Younger and future generations, on the other hand, benefit from the future decline in consumption tax and contribution rates. However, the rising retirement age also increases the marginal contribution rates for households who are below the contribution ceiling – see equation (??). Consequently, the efficiency gains are relatively low for middle-aged generations. The difference between the efficiency column and the welfare column is mainly due to changes in tax burdens. Of course, those generations who are close to retirement now face a higher tax burden since they have to pay into the pension system for a longer period of time and receive less benefits than before. Since the increase in the tax burden overcompensates the efficiency gain, older generations who are close to retirement experience a reduction in welfare. Younger and future generations now face a lower tax burden, since the reduced contributions are earlier in their life than the reduced benefits. Therefore, the welfare gain is higher than the respective efficiency gain of these generations. Turning now to the different income quintiles, we note that the welfare effects are fairly similar across income classes. However, two observations deserve some comment. First, households who are close to retirement experience the highest efficiency gains in the lowest income quintile. As it seems, the labor income tax surcharge is more distortive for low-income households than for high-income households<sup>8</sup>. Despite the higher efficiency gains low-income households who are close to retirement experience stronger welfare losses than households of the other quintiles. Probably this reflects the reduced intragenerational redistribution towards low income households which is implied by the reduced retirement phase. Finally, note that due to the rise in marginal contribution rates some middle-aged households of the third quintile even realize some slight efficiency losses.

The middle part of Table 7 reports the welfare changes if, in addition to the increase in the retirement age, pension benefits are also reduced from 70 per cent of average net earnings to 64 percent. While the efficiency gains of older generations are hardly affected, efficiency gains of younger and future generations rise significantly due to the lower future tax and contribution rates. Of course, the intergenerational redistribution works in favour of younger generations too, since their tax burdens fall

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<sup>8</sup>Note that in the baseline simulation households of the middle and top quintile were still working in the first years after retirement despite the income tax surcharge.



further while the tax burden of the elderly now increases considerably. Consequently, the reduction in benefit reduces the welfare of the elderly, while younger and future generations experience welfare increases compared to the previous simulation. The borderline are generations who are born around 1970. For them, the additional burdens and benefits of the reform almost balance and consequently they are not affected by the reform. Note that the reform is intragenerationally neutral, i.e. the benefit reduction produces no significant differences between lifetime income classes. The right part of Table 7 finally reports the welfare effects of the complete reform package of the former government. The increase in consumption tax financing of pension outlays mainly hurts the elderly generations, since they do not benefit from the simultaneous reduction in pension contributions. While they experience efficiency losses due to the higher consumption tax rates and income losses due to increases in tax burdens, younger and future generations experience exactly the opposite. The reason is, of course, that consumption taxes are paid later in life than social security contributions. Consequently, tax burdens and distortions fall for younger cohorts. Note that the efficiency gains are not equally distributed across income classes. Households in the top income quintile born between 1950 and 1990 now even realize efficiency losses. Due to the contribution ceiling, these households face a zero marginal contribution rate. Consequently, their marginal contribution rate is not affected by the reform measure, while their consumption tax rate increases.

Next we turn to the welfare results of the more radical reform proposals, which are reported in Table 8. First compare the aggregate efficiency effects of the partial funding and the moderate reform in the right part of Table 7. The efficiency gains for all working generations increase strongly especially for those generations who are born in the future. Of course, this is due to the fact that contribution rates fall so strongly in the future. Compared to the previous simulation, tax burdens mainly increase for middle-aged generations born around 1970 since the reform is now phased-in very smoothly. On the other hand, future generations gain now much stronger than under the moderate proposal. Of course, this is both due to intergenerational redistribution and due to efficiency gains. Note that households of the lowest income quintile realize less than proportional efficiency and welfare gains in the long run. Since gross-of-tax wages increase now strongly, tax taxable labor income of low-income rises above the basic exemption level. Consequently, their marginal labor income tax rates as well as their tax burdens rise stronger than in other income classes. This dampens the efficiency and welfare gain.

Finally consider the welfare changes in the last simulation where a flat benefit is provided in the long run. During the preannouncement phase, households increase their labor supply. As soon as the tax-benefit linkage is eliminated, households who are working experience a sharp rise in their marginal tax rates. The resulting efficiency

Table 8: Welfare effects of radical pension reforms<sup>a</sup>

Birth year	Partial funding		Flat benefits	
	Welfare	Efficiency	Welfare	Efficiency
<i>Lowest Quintile</i>				
1930	0.33	-0.01	0.15	0.00
1950	-1.32	0.30	-1.43	-0.04
1970	-1.71	0.19	-0.27	-0.19
1990	-1.14	0.32	2.04	-0.13
2010	1.62	0.54	4.43	0.06
2030	2.90	0.57	5.60	0.17
Long run	3.53	0.61	6.59	0.24
<i>Third Quintile</i>				
1930	0.31	0.00	0.15	0.00
1950	-0.75	0.21	-1.43	-0.19
1970	-0.62	0.30	-0.79	-0.73
1990	0.12	0.67	0.88	-0.88
2010	2.15	1.08	2.56	-0.21
2030	3.47	1.05	3.54	0.00
Long run	3.83	1.06	3.91	0.05
<i>Top Quintile</i>				
1930	0.20	0.00	0.08	0.00
1950	-0.51	0.17	-1.77	-0.45
1970	-0.55	0.13	-2.31	-0.27
1990	0.57	0.28	-0.83	-0.30
2010	3.02	0.91	0.86	0.08
2030	3.86	0.89	1.20	0.24
Long run	4.22	0.91	1.34	0.31
<i>Aggregate</i>				
1930	0.24	0.00	0.11	0.00
1950	-0.70	0.21	-1.60	-0.31
1970	-0.77	0.22	-1.54	-0.54
1990	0.22	0.50	0.13	-0.63
2010	2.55	1.00	2.01	-0.10
2030	3.56	0.94	2.64	0.09
Long run	4.01	0.97	3.02	0.14

<sup>a</sup> Changes expressed as percent of the present value of remaining lifetime resources.

loss is very dramatic for households who are born around 1970 since they will not benefit from the lower tax rates in the future. Younger households and households born after the year 2000 experience a lower efficiency loss, since they also face much lower contribution rates (see Table 5). The intergenerational redistribution again favours the future generations. However, now the welfare losses of the elderly are much more pronounced. This is due to the fact that consumption taxes are now higher than in the partial funding simulation. Since the consumption propensity is higher for the elderly, tax burdens are shifted from younger towards older generations. Due to the contribution ceiling, households of the top quintile experience less than proportional efficiency losses. Of course, their marginal contribution rate increases not over the whole life-cycle. Nevertheless, the flat benefit pension system strongly favours low-income classes. Consequently, the last simulation shows a considerable intragenerational redistribution from rich towards poor households. This completes the interpretation of the simulation results. The final section provides a summary and discusses some of the underlying assumptions.

## 5. Conclusions

The above analysis highlights some important insights: First, since the reduction of future contribution rates might come at the cost of higher other taxes, pension reform options have to be evaluated within the context of the whole tax-benefit system. For Germany, this implies to model the indexation of benefits to net wages and the progressivity schedule of the labor income tax. Second, the simulations reveal that behavioral reactions matter quite significantly. Pension reforms should not be motivated alone by considerations of intra- and intergenerational equity, they may also induce significant efficiency effects. Models that do not allow for behavioral reactions are consequently only of limited use for a comprehensive evaluation.

The specific policy results of the present paper can be summarized as follows. First, from an efficiency point of view, the partial funding strategy is preferable compared to the moderate reform and to the flat benefit reform. The latter even yields efficiency losses. Second, all reforms redistribute towards future generations at the cost of currently living older generations. While this is hardly surprising, the extent of the intergenerational redistribution differs quite significantly. The future gains are strongest under the partial funding strategy, they are a little bit lower under the flat benefit system and considerably lower under the gradual reform. At the same time, the losses of the current elderly are much higher under the flat benefit proposal and they are concentrated on specific age groups under the gradual pension reform. In terms of intragenerational redistribution, the flat benefit reform redistributes strongly in favour of low-income classes, whereas the partial privatization redistributes slightly from poor to rich households. Since none of the proposed reforms

yields a pareto-improvement, a ranking has to be based on some value judgements. In my view, the flat benefit proposal cancels out because of the significant efficiency losses and the high burdens which are placed on currently elderly. With regards to the two remaining proposals, the partial funding option seems to be preferable since this scenario yields the highest efficiency gains and distributes the burden of the reform more evenly among current elderly.

Of course, although the simulation model incorporates many complex real world details, it also abstracts - as any model - in important ways from reality. The quantitative numerical results, therefore, have to be interpreted cautiously. Two important extensions of the present model would be relatively straightforward to incorporate. First, the tax-benefit linkage should be modeled endogenously in the line of Hirte and Weber (1997). In the present model this would imply that the changes in the population growth rates directly effect the tax-benefit linkage. A second extension would be to introduce liquidity constraints on the household side. In the presence of liquidity constrained households it makes a difference whether people are forced by the government into private saving accounts or whether they contribute voluntarily. Cifuentes and Valdés-Prieto (1997) indicate that liquidity constraints may have a tremendous impact on the macroeconomic adjustment after pension reform. In the present model, liquidity constraints would be especially useful, since they could be restricted to the households of the lowest income quintile. In future work I plan to incorporate these extensions.

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