Risk Sharing and Efficiency Implications of Progressive Pension Arrangements

Author(s): Hans Fehr and Christian Habermann

Source: *The Scandinavian Journal of Economics*, Vol. 110, No. 2 (Jun., 2008), pp. 419-443
Published by: Wiley on behalf of The Scandinavian Journal of Economics
Stable URL: http://www.jstor.org/stable/25195350
Accessed: 20-07-2016 11:15 UTC

Scand. J. of Economics 110(2), 419–443, 2008
DOI: 10.1111/j.1467-9442.2008.00545.x

Risk Sharing and Efficiency Implications of Progressive Pension Arrangements*

Hans Fehr
University of Wuerzburg, D-97070 Wuerzburg, Germany
hans.fehr@uni-wuerzburg.de

Christian Habermann
MLP Finanzdienstleistungen AG, D-97070 Wuerzburg, Germany
christian.habermann@mlp.de

Abstract

This paper aims to quantify the welfare effects of progressive pension arrangements in Germany. Starting from a purely contribution-related benefit system, we introduce basic allowances for contributions and a flat benefit fraction. Since our overlapping-generations model takes into account variable labor supply, borrowing constraints as well as stochastic income risk, we can compare the labor supply, the liquidity and the insurance effects of the policy reform. Our simulations indicate that it would be optimal to introduce a flat benefit share of 50 percent and a basic allowance that amounts to 30 percent of average income. Such a reform would yield an aggregate efficiency gain of 3.3 percent of resources.

Keywords: Bismarck vs. Beveridge pension systems; idiosyncratic labor income uncertainty
JEL classification: *H*55; *J*26

I. Introduction

Pay-as-you-go financed pension systems are often distinguished according to their benefit rule which pertains to the link between contributions and benefits. So-called Bismarck-type programs offer variable benefits which are tightly linked to former contributions, whereas so-called Beveridgean schemes are more redistributive since they typically offer uniform (or flat-rate) benefits which are independent of former contributions. Consequently, a move from a strictly Bismarckian scheme to a more Beveridge-type program increases pension progressivity as well as the implicit tax on labor

* We thank Lans Bovenberg, Markus Knell, Niku Määttänen, Lex Meijdam, Olivier Pierrard, Justin van de Ven, two referees, and the participants of presentations at workshops and conferences in Aachen, Amsterdam, Bonn, Garmisch-Partenkirchen, Mannheim, Paris and Tilburg for helpful comments. Stefan Zimmermann and Fabian Kindermann provided excellent research assistance. Financial support from the European Commission's research project "Demographic Uncertainty and the Sustainability of Social Welfare Systems" (QLK6-CT-2002-02500) is also gratefully acknowledged.

income so that labor supply incentives deteriorate. Some numerical results for Germany indicate that the induced labor market distortions of such a reform would be quite significant; see Fehr (2000). However, these considerations are rather incomplete since they do not take into account labor income risk and liquidity constraints on the household side. This is the starting point for the present analysis where we compare the labor supply distortions, the liquidity as well as the risk-sharing effects of pension progressivity. Our results show that the introduction of a more progressive pension system with basic allowances for contributions and flat-rate benefit elements enhances overall efficiency in Germany. The latter is due to the fact that the losses from higher labor supply distortions are overcompensated by (positive) liquidity and income-insurance effects.

The risk-sharing characteristics of alternative tax and social security arrangements have recently gained increasing attention among economists. Krueger and Kubler (2006) find that the introduction of an unfunded social security system can lead to a Pareto improvement in a model with stochastic production shocks if markets are incomplete and households are fairly risk averse. Matsen and Thøgersen (2004) derive the optimal mix between funded and unfunded pension saving in a portfolio choice model with wage income, demographic and stock market risk. The adjustment of the pay-go pension budget, on the other hand, determines the intergenerational allocation of such macroeconomic shocks. Thøgersen (1998) as well as Wagener (2003) demonstrate that a constant contribution rate shifts future economic risks mainly onto pensioners, while a constant replacement ratio would shift economic risks onto contributors.

Of course, the applied "pension formula" is not only an important intergenerational risk-sharing device for aggregate shocks, it might also provide an insurance for idiosyncratic shocks. If benefits are strongly linked to former contributions, individual labor income fluctuations are carried over to the retirement period and the pension system amplifies lifetime income risk. On the contrary, a flat-rate benefit system could be interpreted as an intragenerational risk-sharing device for individual labor income shocks. Whereas the progressive income tax schedule (at least in practice) measures income on an annual basis, the pension system can redistribute income based on a lifetime average of earnings. By doing so, the transfers could be targeted more accurately to the people who most need the assistance. Therefore, as long as the progressive income tax is not based on the average of lifetime earnings, a Beveridge-type pension system might be a necessary supplement in an optimal lifetime income insurance setting.

The progressivity of the pension system also depends on calculation of the individual contribution. If the average contribution rate rises with income due to a basic allowance, young low-income individuals who anticipate higher future income will experience positive liquidity effects. Since they are restricted in borrowing against their future income, lower contributions allow them to better smooth their consumption over the life cycle. Hubbard and Judd (1987) have shown that such borrowing constraints could significantly alter the welfare consequences of social security. Since our model also includes labor income risk, borrowing constraints might be even more important for specific individuals who expect to end up in higher income classes in the future.

Since the insurance and the liquidity effect work in an opposite direction to the labor supply effect, it is a quantitative question which one dominates the other. We therefore apply an overlapping-generations model in the Auerbach–Kotlikoff (1987) tradition in order to simulate the efficiency consequences of higher pension progressivity in Germany. Our model splits the individual life cycle into a working phase, where employees pay contributions to the pension system, and a retirement phase, where pensioners receive the payroll-financed benefits. In each period the household chooses optimal consumption, labor supply and savings given uncertain future labor income, life-span uncertainty, borrowing constraints and the public tax and transfer system. Starting from an initial equilibrium which features a purely Bismarck-type pension system, we introduce progressive benefit elements and basic allowances for contributions and compute the resulting welfare and efficiency consequences. Since our preference structure allows us to distinguish between risk aversion and intertemporal substitution effects, we are able to disaggregate the overall efficiency consequences into risk-sharing, liquidity and labor supply components.

We find that a move towards a more progressive pension system yields a potential Pareto improvement. With optimal progressivity, half of the pension consists of flat benefits and the basic allowance amounts to 30 percent of average income. In this case the aggregate efficiency gains are maximized at 3.3 percent of initial resources. The aggregate effect is decomposed into an insurance effect which amounts to 3.8 percent, a liquidity effect of 0.4 percent and a labor supply effect of -0.9 percent of initial resources. The sensitivity analysis demonstrates that the efficiency gains are quite robust for various parameter choices. Moreover, it is shown that the optimal progressivity of the pension system supplements the progressivity of the tax system.

Although the quantitative analysis is based on the German institutional setting, we believe that our results have important implications for other OECD countries as well. The previous literature always emphasizes the optimality of the Bismarck-type pension system from an efficiency point of view; see e.g. Sinn (2000). Consequently, in order to explain the redistributive structure of observed pension systems, Casamatta, Cremer and Pestieau (2000) or Conde-Ruiz and Galasso (2005) had to apply political-economy models, where the progressivity is determined by the voting outcome. In contrast, our study demonstrates that pension progressivity in countries such as Japan, the US or the UK can also be justified on efficiency grounds.

In the next section, we discuss in more detail how our study extends the previous quantitative literature. Then we describe in brief the German pension system and sketch the structure of the simulation model in Section III. Section IV explains the calibration and simulation approach. Finally, Section V reports the simulation results and Section VI offers some concluding remarks.

II. Related Literature

Our paper is in line with various recent studies that quantify the welfare and efficiency consequences of social security reforms with an overlapping-generations model in the Auerbach–Kotlikoff (1987) tradition that includes idiosyncratic income risk. Huggett and Ventura (1999) quantify the distributional consequences if the current pension system in the US would be replaced by a two-tier system where the first tier is strictly connected to former contributions and the tax-financed second tier would guarantee a minimum pension for all households with low income. Their simulations suggest that such a reform would result in long-run aggregate welfare losses for the US. However, the analysis is restricted to the steady state, which makes it difficult to interpret their distributional findings. Storesletten, Telmer and Yaron (1999) consider the long-run effects when the current US pension system is either partially or completely eliminated. Both reforms deliver a long-run welfare gain, but incomplete privatization is preferred to complete privatization. In contrast to Huggett and Ventura (1999), Storesletten *et al.* (1999) do not include a labor–leisure choice, but try to neutralize the intergenerational income redistribution and to decompose the computed long-run welfare gains.

However, without explicit computation of the transition path across steady states, the (implicit) intergenerational redistribution can only be captured partially. Huang, İmrohoroğlu and Sargent (1997) were the first to study alternative transition paths of social security privatization in a model with fixed labor supply and idiosyncratic endowment shocks. Whereas in the first experiment social security is terminated immediately and entitled generations are compensated with government bonds, the pension system is phased out in the second and the government builds up a capital stock to pay for social security retirement benefits in later years. The efficiency gains are larger in the latter experiment, which the authors attribute to the improved public provision of insurance against life-span risk and labor income volatility. De Nardi, İmrohoroğlu and Sargent (1999) extend this model by including realistic US demographics and variable labor supply. The latter allows for analysis of reforms where the tax–benefit linkage of the pension system is improved, which increases welfare in their framework. Similarly, Conesa and Krueger (1999) extend the Huang *et al.* (1997) framework by including variable labor supply and idiosyncratic efficiency (not endowment) shocks. They simulate an immediate, a gradual and an announced elimination of the pension system and compute the political support for the three proposals. Although for all cases of intra-cohort heterogeneity agents would prefer to be born into the final steady state, no proposal receives an initial voting majority. Due to the assumed flat pensions in the initial steady state, the redistribution of the system is abolished if privatization is implemented. Therefore, political support is declining if intra-cohort heterogeneity is increasing.

While Conesa and Krueger (1999) can explain why pension reforms may be delayed in democratic systems, their study does not include efficiency calculations. The latter is done by Nishiyama and Smetters (2007) who analyze a stylized 50 percent privatization of the US social security system. Such a reform would reduce the labor supply distortions but also the insurance provision of the existing progressive pension system. As in Auerbach and Kotlikoff (1987), agents are compensated along the transition path and the positive (in the case of overall efficiency gains) or negative (in the case of overall efficiency losses) assets of the lump-sum redistribution authority are distributed to newborn agents. While their privatization experiment yields an aggregate efficiency gain when labor income is certain, they derive significant efficiency losses in the model with uncertain labor income. In addition, they demonstrate that increasing the progressivity of the social security system after privatization may enhance aggregate efficiency as long as the gains from risk sharing outweigh additional labor supply distortions.

The present study implements the same aggregate efficiency calculations as in Nishiyama and Smetters (2007), but we focus on different issues. First, we derive an optimal progressivity of the German pension system without altering the existing pension level. Second, pension progressivity in our model is two-dimensional; it relates to the calculation of benefits and contributions. Third, as in Storesletten *et al.* (1999), we disaggregate the computed welfare effects and isolate the insurance, liquidity and labor supply components numerically. In order to put the German pension system into perspective, Table 1 compares the level and the progressivity of different pension systems within the OECD. Progressivity is indicated by the change in the net replacement rates across income levels. In Germany, as in Italy, the Netherlands, Poland and Spain, replacement rates are almost constant. All other countries operate a progressive pension system, where a fraction of retirement income consists of flat-rate benefits. Consequently, the net replacement ratios are falling when income levels increase.

Table 1. *Cross-country pension levels and progressivity*

	Net replacement rates by individual earnings level (multiple of average)			Basic allowance in percent of average wage
	0.5	1.0	2.0	
Australia	77.0	52.4	36.5	—
France	98.0	68.8	59.2	—
Germany	61.7	71.8	67.0	10.0[a]
Ireland	63.0	36.6	21.9	55.4
Italy	89.3	88.8	89.1	—
Japan	80.1	59.1	44.3	—
Netherlands	82.5	84.1	83.8	—
Poland	69.6	69.7	70.5	—
Spain	88.7	88.3	83.4	—
UK	78.4	47.6	29.8	22.8
USA	61.4	51.0	39.0	—
OECD average	84.9	69.1	61.4	—

Source: Meister and Ochel (2005) and OECD (2005).
[a]Currently proposed.

But replacement rates alone could be misleading as a measure of progressivity. In the UK and Ireland, the pension system is progressive in terms of the expenditure and the contribution. The latter is due to the basic contribution allowance which amounts to 22.8 and 55.4 percent of average income in the UK and Ireland, respectively. Recently, the German trade unions proposed a reform towards a system of basic allowances which would amount to 10 percent of average income; see Meister and Ochel (2005).[1]

Next we introduce the simulation model, which is applied to quantify the optimal flat-rate fraction of benefits and the optimal basic allowance level for contributions in Germany.

III. The Model Economy

Preliminaries

We consider an economy populated by overlapping generations of individuals who face random survival up to a maximum possible life span of $J = 16$ periods, i.e., each model period covers five years. In addition to life-span uncertainty, individuals also face productivity shocks during

[1] Currently, social security contribution rates are reduced in Germany if annual income is below 14.2 percent of average income. However, if annual income passes this threshold, contribution rates are phased-in again so that finally one has to pay normal contribution rates on the full income.

their working time. Labor supply is variable, but consumers are forced to retire at the retirement age $j_R = 9$ (i.e., real age 60). During retirement, pensioners receive payroll-financed social security benefits and run down their accumulated assets. Apart from the pension system, the government levies a progressive personal tax on income from labor, capital and pensions as well as proportional taxes on consumption and corporate profits. Tax revenues are used to finance public goods and the interest payments on public debt. The production sector comprises a constant-returns-to-scale Cobb–Douglas production function without technological progress and no aggregate uncertainty.

The initial equilibrium of our model economy is a steady state. Then the social security reform is implemented before the individual productivity of the next period is revealed and a new equilibrium path in the assumed closed economy is calculated. We assume zero population growth and keep the survival probabilities constant at initial values. Consequently, all agents face a probability s_j of surviving up to age j, conditional on surviving up to age $j-1$. Every age j cohort N_j is fragmented into subgroups $\xi_j(z)$ where $\sum_z \xi_j(z) = 1$, reflecting their state z at a specific age j. The state $z = (ep_j, a_j, e_j)$ of an age j agent describes the agent's earnings points for pension claims ep_j, asset holdings a_j and efficiency e_j. In the following, we concentrate on the long-run equilibrium and omit the state index z for every variable whenever possible. Agents are then only distinguished according to their age j.

The Individual Decision Problem

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 recursively as

$$V_j(z) = \max_{\ell_j, c_j} \left\{ u(c_j, \ell_j)^{1-\frac{1}{\gamma}} + \frac{s_{j+1}}{1+\theta} \left[\sum_{e_{j+1}} \pi(e_{j+1}|e_j) V_{j+1}(z')^{1-\eta} \right]^{\frac{1-\frac{1}{\gamma}}{1-\eta}} \right\}^{\frac{1}{1-\frac{1}{\gamma}}}, \quad (1)$$

where ℓ_j and c_j denote leisure and consumption at age j, respectively, and the parameter θ represents the "pure" rate of time preference. Since life span is uncertain, the expected utility in future periods is weighted with the survival probability s_{j+1}. Productivity e_j at each age j is uncertain and depends on the productivity in the previous period. Consequently, $\pi(e_{j+1}|e_j)$ denotes the probability of experiencing productivity e_{j+1} in the next period if the current productivity is e_j. The parameters γ and η define the intertemporal elasticity of substitution between consumption and leisure in different years and the degree of (relative) risk aversion, respectively. Note that for the special case $\eta = 1/\gamma$ we are back at the traditional expected utility specification; see Epstein and Zin (1991, p. 266).

The period utility function is defined by

$$u(c_j, \ell_j) = \left[(c_j)^{1-\frac{1}{\rho}} + \alpha(\ell_j)^{1-\frac{1}{\rho}}\right]^{\frac{1}{1-\frac{1}{\rho}}}, \tag{2}$$

where ρ denotes the intratemporal elasticity of substitution between consumption and leisure at each age j. The leisure preference parameter α is assumed to be age independent. The budget constraint is defined as follows:

$$a_{j+1} = a_j(1+r) + w_j(1-\tau_j) + p_j - T(y_j) - (1+\tau^c)c_j + b_j, \tag{3}$$

with $a_1 = a_{J+1} = 0$. Most of the simulations also assume borrowing constraints. Then we restrict $a_j \geq 0$, for all j. In addition to income from savings, households receive gross labor income $w_j = (1-\ell_j)we_j$ but have to pay progressive income taxes $T(y_j)$ and pension contributions τ_j. Due to the basic allowance and a contribution ceiling, the average contribution rate depends on income. We define the progressive tax function $T(\cdot)$ which computes the income tax burden from taxable income y_j. The price of consumption goods $(1+\tau^c)$ includes consumption taxes, p_j is the pension payment after retirement and r defines the gross interest rate. Since we abstract from annuity markets, agents who die might leave positive assets. Those assets are aggregated and distributed among all cohorts following an exogenous age- and productivity-dependent distribution scheme,[2] where an age j agent receives the accidental bequests b_j.

We assume that contributions to public pensions are exempted from tax while the benefits are fully taxed. Consequently, taxable income y_j in (3) is computed from gross labor income net of pension contributions and a fixed work-related allowance d_w, nominal[3] capital income net of a saving allowance d_s and—after retirement—public pensions:

$$y_j = \max[w_j(1-\tau_j) - d_w; 0] + \max[\hat{r}a_j - d_s; 0] + p_j. \tag{4}$$

[2] The age distribution of bequests is computed in the initial steady state where we assume that heirs always receive the assets of the generation which was 25 years older. In order to reflect empirical evidence and to highlight their stochastic nature, we assume that bequests are distributed within a generation proportional to the current productivity level e_j.

[3] In order to reflect realistic features of capital income taxation in a model without inflation, we assume for taxation purposes a nominal interest rate $\hat{r}$, i.e., real interest rate r plus a fictive inflation of 2 percent. The latter exacerbates the distortions of *real* capital income taxation; see Feldstein (1997).

The Production Side

The economy is populated by a large number of competitive firms, the sum of which we normalize to unity. Aggregate output Y is produced using a Cobb–Douglas production technology, i.e.,

$$Y = \varrho K^{\varepsilon} L^{1-\varepsilon}, \tag{5}$$

where K and L are aggregate capital and labor, ε is capital's share in production, and ϱ is a technology parameter. Firms have to pay corporate taxes $T^k = \tau^k[Y - wL - \delta K]$ where the corporate tax rate τ^k of 15 percent is applied to the output net of labor costs wL and depreciation δK.

Firms will employ labor up to the point where the marginal product of labor equals labor costs. Similarly, they will employ capital up to the point where the net marginal product of capital is equal to the interest rate:

$$w = (1-\varepsilon)\varrho \left(\frac{K}{L}\right)^{\varepsilon}, \tag{6}$$

$$r = (1-\tau^k)\left[\varepsilon\varrho\left(\frac{L}{K}\right)^{1-\varepsilon} - \delta\right]. \tag{7}$$

The Government

In each period the government issues new debt ΔB and collects taxes and social security contributions from households and firms in order to finance general government expenditures G as well as interest payments on its debt:

$$\Delta B + \sum_j \sum_z [T(y_j(z)) + \tau^c c_j(z)]\xi_j(z)N_j + T^k = G + rB. \tag{8}$$

General government expenditures G consist of government purchases of goods and services which are fixed per capita. In the initial equilibrium, government debt is fixed at 60 percent of output and the consumption tax rate τ^c is adjusted to balance the budget. After the reform, the intertemporal budget is balanced by an endogenous consumption tax and the periodical budget is balanced by debt.

In each year, the pension system pays old-age benefits and collects payroll contributions from wage income above the basic allowance and below the contribution ceiling. In the initial equilibrium, the basic allowance is zero while the contribution ceiling is fixed at two times the average income. Individual pension benefits p_j of a retiree of age $j \geq j_R$ in a specific year are computed from the product of the earning points ep_{j_R} the retiree has accumulated at retirement and the actual pension amount (*APA*) of the respective year:

$$p_j = ep_{j_R} \times APA. \tag{9}$$

The accumulated earning points consist of two parts. The first depends on the relative income position $\min[w_j/\bar{w}; 2.0]$ of the worker at working age $j < j_R$. Since the contribution ceiling is fixed at the double of average income, the maximum earning points that could be collected are 2. The second part is normalized to one and therefore independent of individual income. The weights are $(1-\lambda)$ and λ, respectively. Accumulated earning points at age j are therefore

$$ep_j = ep_{j-1} + \min[w_j/\bar{w}; 2.0](1-\lambda) + \lambda. \tag{10}$$

The actual pension amount (*APA*) in equation (9) is computed in order to yield a standard pension (i.e., where $ep_{j_R} = j_R - 1$) which amounts to 60 percent of net average earnings. The budget of the pension system must be balanced in each period. Therefore, the general contribution rate τ has to be adjusted to fulfill the period budget constraint:

$$\sum_{j=j_R}^{J} \sum_{z} p_j(z)\xi_j(z)N_j = \tau \sum_{j=1}^{j_R-1} \sum_{z} \max[\min[w_j(z); 2.0\bar{w}] - \beta\bar{w}; 0]\xi_j(z)N_j. \tag{11}$$

The RHS of equation (11) shows the individual contribution base. Households do not pay a contribution on income below the basic allowance and above the contribution ceiling. Note that the general social security contribution rate τ which is calculated from (11) is not necessarily identical with the individual contribution rate τ_j in the budget constraint (3). The latter is given by

$$\tau_j = \begin{cases} 0 & \text{if} \quad w_j < \beta\bar{w}, \\ \tau[w_j - \beta\bar{w}]/w_j & \text{if } \beta\bar{w} \le w_j \le 2.0\bar{w}, \\ \tau[2.0 - \beta]\bar{w}/w_j & \text{if} \quad w_j > 2.0\bar{w}. \end{cases} \tag{12}$$

For income below the basic allowance, the individual contribution rate is zero. With rising income, the individual approaches the general contribution rate. When income passes the contribution ceiling, the individual contribution rate falls again. Of course, the individual contribution rates computed above are not responsible for the labor supply distortions, which are instead reflected in the marginal contribution rates taken implicitly into account when individuals decide upon their labor supply. If labor income is below the basic allowance level or above the contribution ceiling, marginal contribution rates are zero. For income in between, marginal contribution rates are below the general social security rate τ and falling with rising age as long as $\lambda < 1$. If $\lambda = 1$, marginal contribution rates are equal to τ

and independent of age. For $\lambda > 1$, marginal contribution rates are above τ and rising with age.

IV. Calibration

In order to solve the model we have to specify the income process, preference and technology parameters and tax rates. We now introduce our parameter choices and describe the initial equilibrium. For more information on our computational approach, see Habermann and Kindermann (2007).

The Income Process

In order to model the income process, we distinguish six productivity profiles across the life cycle. Fehr (1999) has estimated five such profiles on data from 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 the Appendix. These matrices were computed from SOEP data for different years between 1984 and 2001. Specifically, we sorted the primary earners in the years 1984, 1990 and 1996 into seven cohorts and divided those within each cohort into six income classes. For each cohort and income class we then compiled the respective income classes of its members from the surveys for the years 1989, 1995 and 2001 in order to calculate the age-specific transition matrices.

Preferences, Technology and Demographics

Table 2 reports the other important parameter values. A discussion of preference and technology parameters can be found in Auerbach and Kotlikoff (1987, pp. 52f.) or Fehr (1999, p. 57). The literature typically perceives values for the coefficient of relative risk aversion between 1 and 5 as reasonable, while values above 10 are considered unrealistic; see Cecchetti, Lam and Mark (2000, p. 792). This perception is consistent with the evidence from survey questions; see Barski, Juster, Kimball and Shapiro (1997) for the US or Dohmen, Falk, Huffman, Sunde, Schupp and Wagner (2005) for Germany.

As already explained, 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 (including solidarity

Table 2. *Parameter values of the model*

	Symbol	Value
Utility function		
Time preference rate (p.a.)	θ	0.02
Intertemporal elasticity of substitution	γ	0.50
Intratemporal elasticity of substitution	ρ	0.60
Coefficient of relative risk aversion	η	4.00
Leisure preference parameter	α	1.50
Production function		
Technology level	ϱ	1.48
Capital share in production	ε	0.30
Economic depreciation (p.a.)	δ	0.05

surcharge). Consequently, after the basic allowance of 7,800 euros the marginal tax rate rises linearly from 15.8 to a maximum of 44.3 percent when taxable income y_j exceeds 52,000 euros. We assume that our individuals are married couples and apply the German income-splitting method. There is a special allowance for labor income of $d_w = 1{,}200$ euros, while for capital income the special allowance amounts to $d_s = 3{,}600$ euros.

As regards the demographic parameters, we compute average survival probabilities from Bomsdorf (2003) for the ages 20 to 99.

Initial Equilibrium

Table 3 reports the structure of the model's initial equilibrium (where $\lambda = \beta = 0$) and compares it with the respective actual figures for 2005. All in all, the model represents the basic economic and fiscal structure of Germany quite well. Since the model is simulated as a closed economy, the interest rate is endogenous and the trade balance is zero. The key characteristics of the tax and pension systems match the current German situation. Note that 20 percent of labor market entrants (i.e., the two lowest income classes) would like to borrow on the capital market in the initial equilibrium. This fraction falls for the elderly cohorts. Borrowing constraints disappear completely for cohorts older than 46. Table 4 shows the distribution for net income and assets, respectively. The percentage share of income (assets) is the share that accrues to subgroups of the population ranked by net income (assets). Our initial equilibrium replicates the German income distribution quite well; however, it underestimates the wealth inequality.[4] This should suffice to explain our calibration and initial equilibrium.

[4] Such underestimation is quite common in numerical models. Heer and Trede (2003, p. 96) point out that it might be due to having neglected business ownership.

Table 3. *The initial equilibrium*

	Model	Germany 2005[a]
Expenditures on GDP (% of GDP)		
Private consumption	64.2	59.2
Government purchases	18.1	18.6
Gross investment	17.7	17.2
Exports–Imports	—	5.0
Government indicators		
Aggregate 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
Income tax	7.5	6.4
Consumption tax	10.9	10.4
Corporation tax	1.8	2.1
Consumption tax rate (in %)	17.0	—
Interest rate p.a. (in %)	3.4	—
Bequest (in % of GDP)	4.3	5.2
Capital–Output ratio	2.9	3.0
Borrowing constraints (in % of cohort)		
Age 20–24	20.0	—
Age 25–29	7.3	—
Age 30–34	5.5	—

[a]Institut der Deutschen Wirtschaft (2006).

Table 4. *Income and wealth distribution*

		Percentage share of income/assets		Gini index
		Lowest 10%	Highest 10%	
Model	Net income	3.1	22.7	0.296
	Assets	0.0	33.5	0.539
Germany[a]	Net income	3.1	23.9	0.299
	Assets	0.2	44.2	0.613

[a]DIW (2005, p. 202).

V. Simulation Findings

Here we compare the macroeconomic and welfare consequences of a switch from the current contribution-related to a more progressive pension system in Germany. Before reporting the numerical results of the simulations, we explain the computation of the welfare changes.

Experimental Design and Social Welfare

Our intention is to find the values for β and λ which yield the highest aggregate efficiency gains. For that reason we increase both parameters from their benchmark value of zero. As a consequence, the tax–benefit linkage will be reduced, the marginal contribution rate will increase, and labor market distortions will rise. But higher progressivity also improves the risk-sharing characteristics of the pension system. The welfare criterion we use to assess this reform is the *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). For an agent who enters the labor market, the expected utility is computed from

$$V = \left[\sum_{i=1}^{6} \pi_i V_i^{1-\eta} \right]^{\frac{1}{1-\eta}},$$

where $\pi_1 = \pi_2 = 0.1$ and $\pi_3 = \cdots = \pi_6 = 0.2$. From this point of view one has some desire for redistribution, which provides insurance for being born as a low-productivity type. Following Auerbach and Kotlikoff (1987, p. 87) we compute the proportional increase in consumption and leisure (W) which would make an agent in the baseline scenario as well off as in the reform scenario. If the expected utility level after the reform is $\hat{V}$ and the expected utility level on the baseline path is $\bar{V}$, the necessary increase (decrease) in percent of initial resources is computed from

$$W = \left[\left(\frac{\hat{V}}{\bar{V}} \right) - 1 \right] \times 100. \tag{13}$$

Consequently, a value of $W = 1.0$ indicates that this agent would need 1 percent more resources in the baseline scenario to attain expected utility $\hat{V}$.

In order to quantify the aggregate efficiency consequences, we introduce a lump-sum redistribution authority (LSRA) in the spirit of Auerbach and Kotlikoff (1987, pp. 65f.) as well as Nishiyama and Smetters (2005, 2007). The LSRA pays a lump-sum transfer (or levies a lump-sum tax) to each living household in the first period of the transition to bring their expected utility level back to the level of the initial equilibrium. Since utility depends on age and state, these transfers (or taxes) have to be computed for every agent in period one. Note that transfers differ only between the states of the earning points ep_j and asset holdings a_j but not between efficiencies for agents with the same ep_j and a_j. This is because the reform is announced before the productivity shock in period 1 is revealed. Consequently, age-j agents who already worked before the reform are compensated by the transfer $v_{j1}(\bar{V}(z), z)$ which guarantees, for each individual at state z, the initial expected utility level $\bar{V}(z)$. On the other hand, those who enter the labor market in period t of the transition receive a transfer $v_{1t}(V^*)$ which guarantees them an expected utility level V^*. Note that the transfers v_{1t} may differ among future cohorts but the expected utility level V^* is identical for all. The value of this level is chosen by requiring the present value of all LSRA transfers to be zero:

$$\sum_{j=2}^{J}\sum_{z} v_{j1}(\bar{V}(z), z)\xi_j(z)N_j + \sum_{t=1}^{\infty}\left[\Pi_{k=0}^{t}(1+r_k)^{-1}\right]v_{1t}(V^*)N_1 = 0. \quad (14)$$

With $V^* > \bar{V}$ (i.e., $W > 0$), all households in period 1 who have 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 off. Hence, the new policy is Pareto improving after lump-sum redistributions. With $V^* < \bar{V}$ (i.e., $W < 0$), the policy reform is Pareto inferior after lump-sum redistributions. The value of W after compensation is reported in the tables below as our measure of aggregate efficiency.

Numerical Results for the Benchmark Calibration

In order to discuss the macroeconomic and long-run welfare consequences, Table 5 considers a scenario where half of the pension consists of flat benefits and the basic allowance amounts to 30 percent of average income (i.e., $\lambda = 0.5$ and $\beta = 0.3$). Since this reform reduces the tax–benefit linkage and increases marginal contributions, labor supply, employment, consumption and GDP fall after the reform. Note that aggregate savings and (one period later) the capital stock are even falling more strongly, which reflects the reduced need for precautionary savings after the reform.[5] Initially wages increase, but due to the crowding-out of capital they fall back even below the initial level during the transition. Due to the basic allowance, contribution rates have to increase by almost 10 percent. However, since the

Table 5. *Macroeconomic effects of progressive pensions*

Period	2005–09	2010–14	2015–19	2020–24	2025–29	2050–55	∞
Employment[a]	−5.1	−4.5	−4.1	−3.9	−3.7	−3.6	−3.5
Consumption[a]	−2.7	−3.7	−4.3	−4.7	−5.0	−5.5	−5.8
GDP[a]	−3.6	−4.2	−4.5	−4.7	−4.9	−5.3	−5.5
Capital stock[a]	0.0	−3.2	−5.3	−6.7	−7.5	−9.1	−9.9
Wage[a]	1.6	0.4	−0.4	−0.9	−1.2	−1.7	−2.0
Interest rate p.a.[b]	−0.3	−0.1	0.1	0.2	0.2	0.3	0.4
Pension outlays[c]	13.6	13.7	13.7	13.7	13.7	13.6	14.0
Contribution rate[b]	10.7	10.8	10.9	10.8	10.8	11.0	11.4
Consumption tax rate[b]	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Public debt[c]	60.0	59.8	58.3	57.2	56.3	53.4	52.6

[a]Changes are reported in percentage over baseline simulation.
[b]Changes in percentage points.
[c]In percent of GDP.

[5] We are grateful to a referee who pointed this out to us.

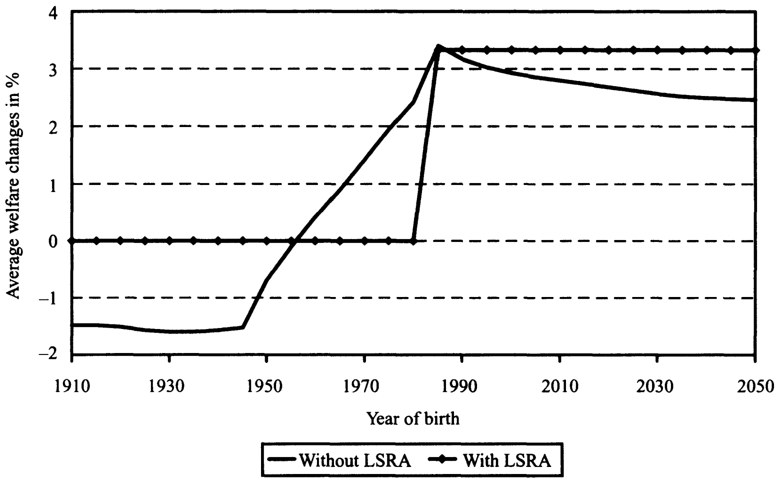

Fig. 1. Welfare effects of progressive pensions

reform only changes the progressivity of the system, aggregate pension outlays remain almost constant during the transition. Moreover, since income tax revenues are reduced and the consumption tax base is smaller, the consumption tax rate has to be increased by 2.6 percent in all transitional periods in order to balance the intertemporal budget. Given this increase, the government runs a surplus in the initial periods of the transition so that public debt could be reduced throughout the transition, as shown in the last line of Table 5.

Figure 1 reports the average *ex-ante* expected welfare changes for current and future agents computed from (13).[6] Given the negative long-run macroeconomic consequences from Table 5, one would expect at least all future agents to be worse off with a progressive pension system. However, this basic intuition is misleading, since it neglects the insurance effects of the reform. As Figure 1 shows, the reform clearly reduces the welfare of most elderly households, while younger and future-living households gain. Due to the increase in consumption taxes, elderly who are already retired (i.e., are born before 1940) lose about 1.5 percent of remaining lifetime income.[7] Since workers benefit from the improved insurance effects, households that are born after 1960 realize increasing welfare gains, which reach a maximum for those who enter the labor market in the reform

[6] Since we have to distinguish agents living in the reform year according to their current state, we report in Figure 1 the average welfare change for each cohort.

[7] Note that our measure of lifetime resources also includes the value of leisure time, whereas the consumption tax increase is only related to disposable income.

year 2005. For future workers, welfare effects are still positive but decrease again due to the long-run fall in wages. Next we compute a new transition path where households are compensated with lump-sum transfers from the LSRA.[8] Figure 1 shows that the progressive pension reform under consideration would yield a Pareto improvement! If all current households are compensated with LSRA transfers, young and future households could still experience a welfare increase which amounts to 3.34 percent of initial resources.

The upper part of Table 6 reports the compensated welfare gains for alternative levels of the basic allowances and flat-benefit shares. Without a basic allowance the insurance effect always dominates the labor-supply effect as long as pensions are positively related to the wage level. For $\lambda > 1$, pensions fall with rising wages and the labor supply distortions dominate the insurance effects. Consequently, the first line shows an efficiency gain which rises with the flat-benefit level until $\lambda = 1$ and decreases thereafter. The introduction of basic allowances increases the efficiency gains initially, since the latter not only provide an insurance, but also reduce the liquidity constraints of some households. Due to the insurance provision, the optimal share of flat benefits falls with a rising basic allowance level. However, labor supply distortions are also rising with the allowance level. As a result, the highest efficiency gain is computed with the combination $\beta = 0.3$ and $\lambda = 0.5$, which is assumed in Table 5 above.

Table 6. *Compensated welfare changes*[a]

		λ						
	β	0.00	0.25	0.50	0.75	1.00	1.25	1.50
Benchmark	0.0	0.00	0.61	1.04	1.28	1.33	1.31	1.18
	0.1	0.96	1.54	1.92	2.11	2.10	2.04	1.83
	0.2	2.07	2.58	2.90	3.00	2.90	2.75	2.43
	0.3	2.72	3.13	**3.34**	3.33	3.09	2.74	2.16
	0.4	2.85	3.11	3.17	2.98	2.55	1.83	0.86
Risk-neutral preferences	0.0	0.00	−0.17	−0.38	−0.64	−0.97	−1.39	−1.91
	0.1	0.18	−0.03	−0.25	−0.54	−0.94	−1.43	−2.01
	0.2	0.32	0.09	−0.16	−0.54	−1.01	−1.57	−2.21
	0.3	0.20	−0.05	−0.43	−0.88	−1.45	−2.15	−3.03
	0.4	−0.25	−0.60	−1.08	−1.76	−2.52	−3.61	−4.61
No liquidity constraints	0.0	0.00	0.94	1.76	2.36	2.70	2.78	2.53
	0.1	0.70	1.56	2.30	2.83	3.08	3.07	2.73
	0.2	1.43	2.18	2.80	3.23	3.35	3.12	2.64
	0.3	1.97	2.56	2.99	3.26	3.19	2.65	1.92
	0.4	2.07	2.47	2.65	2.57	2.14	1.14	−0.17

[a]In percentage of remaining resources.

[8] Here, we do not report the macroeconomic adjustment on the new transition path, but these figures are available on request.

In order to isolate the insurance effect of a specific reform, the middle part of Table 6 reports the efficiency consequences of risk-neutral preferences (i.e., $\eta = 0$) which, of course, are due to labor supply distortions and liquidity effects. In most cases the losses due to higher labor supply distortions dominate the potential gains from improved liquidity so that overall efficiency declines. It should be clear that the efficiency losses are increasing with the progressivity of the system. The insurance effect of a specific reform can be roughly recovered from the difference between the respective figures in the top and middle parts of Table 6. Consequently, for our preferred reform (i.e., $\lambda = 0.5$, $\beta = 0.3$), the insurance effect amounts to roughly 3.8 percent of aggregate resources.[9]

In order to isolate the liquidity effect, we again assume risk-averse individuals and remove the borrowing constraints in the bottom part of Table 6. Consequently, the reported figures show the insurance and labor supply effect, while the difference between the respective numbers in the top and bottom part of Table 6 quantifies (roughly) the liquidity effect of each reform. Note first that for $\beta = 0$ the efficiency gains in the bottom parts of Table 6 are always higher than in the respective top part. When precautionary savings are reduced due to the progressive pension system, the liquidity constraints in the top part have a stronger bite which dampens aggregate efficiency. On the other hand, the efficiency gains of the first column are higher in the top compared to the bottom part, since the basic allowance only provides an insurance in the bottom part, whereas it also relaxes liquidity constraints in the top part. The liquidity effect for our preferred reform is roughly 0.4 percent of aggregate resources. Therefore, if insurance and liquidity effects sum up to 4.2 percent and the aggregate effect is 3.3 percent, the welfare loss due to labor supply distortions must be due to roughly 0.9 percent of aggregate resources.

Given the welfare consequences of the reform for the different households, we follow Conesa and Krueger (1999) and check whether the optimal progressivity level $\lambda = 0.5$ and $\beta = 0.3$ is politically feasible. Consequently, we compute the fraction of each cohort living in the initial equilibrium which would benefit from the reform. Of course, all elderly will lose and all entrants in the labor market will gain. In the middle-age cohort, the productivity realization and the remaining time horizon until retirement determines the judgment of the reform. In general, high productivity types are against the reform, whereas a long time horizon works in favor of the reform. Consequently, at younger ages only high productivity types are against the reform, while with rising age more and more lower productivity agents join the group of opponents. If we combine the pro-shares

[9] However, it should be kept in mind that the initial equilibria in the top and middle part also differ slightly. Consequently, the percentage figures refer to different bases!

of the various cohorts with German population data, we arrive at a fraction of 40.7 percent of total voters who will be in favor of the reform. Consequently, a more progressive pension system would be rejected by a majority of voters, although it yields a potential Pareto improvement. We do not intend to overemphasize this political-economy aspect of our reform. However, it indicates that in practice politicians have to implement such a reform very gradually in order to shield older generations and to achieve political feasibility.

Sensitivity Analysis

In our benchmark calibration of Table 2, the intertemporal substitution elasticity (γ) is fairly high, compared to the standard calibration in Auerbach and Kotlikoff (1987). Therefore, we reduce this parameter to 0.25 in the upper part of Table 7.[10] As a consequence, the optimal consumption profile of households becomes flatter and the borrowing constraints now have a stronger bite for poor young households in the initial equilibrium. Flat benefits and basic allowances now have a quite different impact on aggregate efficiency compared to the benchmark in the top part of Table 6. Flat benefits reduce precautionary savings and increase the (already higher) borrowing constraints further. Consequently, the efficiency gains of flat

Table 7. *Compensated welfare changes: sensitivity analysis I*[a]

				λ						
γ	ρ	η	β	0.00	0.25	0.50	0.75	1.00	1.25	1.50
0.25	0.6	4.0	0.0	0.00	0.27	0.42	0.49	0.41	0.21	−0.16
			0.1	1.66	1.91	2.05	2.08	1.99	1.74	1.35
			0.2	3.53	3.75	3.86	3.85	3.72	3.40	3.03
			0.3	4.39	4.56	**4.65**	4.63	4.42	4.10	3.56
			0.4	4.52	4.63	4.61	4.32	4.06	3.44	2.62
0.5	0.7	4.0	0.0	0.00	0.45	0.78	0.89	0.82	0.66	0.35
			0.1	0.82	1.23	1.52	1.57	1.48	1.19	0.79
			0.2	1.71	2.04	2.29	2.27	2.03	1.61	1.05
			0.3	2.09	2.39	**2.47**	2.33	1.85	1.23	0.47
			0.4	2.09	2.20	2.05	1.54	0.74	−0.21	−1.32
0.5	0.6	2.0	0.0	0.00	0.15	0.23	0.20	0.04	−0.27	−0.77
			0.1	0.54	0.66	0.68	0.60	0.39	−0.02	−0.60
			0.2	1.12	1.19	1.18	1.02	0.69	0.18	−0.56
			0.3	1.34	**1.35**	1.24	0.99	0.51	−0.15	−1.11
			0.4	1.18	1.04	0.78	0.30	−0.47	−1.63	−3.00

[a]In percentage of remaining resources.

[10] Note that this specific (γ, η)-combination also implies that we move from Epstein–Zin (1991) preferences to traditional preferences.

benefits in the first line of Table 7 are much lower than the respective figures in Table 6. On the other hand, the (positive) liquidity effect of the basic allowance is now stronger than in the benchmark. Consequently, the efficiency gains in the first column of Table 7 rise compared to the respective figures in Table 6.

Next we change the labor supply elasticity. In the initial equilibrium, the assumed intratemporal substitution elasticity (ρ) of 0.6 from Table 2 implies an uncompensated wage elasticity of labor supply of -0.03 and a compensated elasticity of 0.3. The figure for the uncompensated elasticity is in line with the empirical literature. A recent study by Flood, Hansen and Wahlberg (2004) reports estimates for uncompensated wage elasticities which range from -0.04 to 0.15; the reported figure for Germany was 0.0. Of course, the compensated elasticity is responsible for the computed labor supply distortions. In the middle part of Table 7 we increase the intratemporal substitution elasticity to 0.7 which yields an uncompensated labor supply elasticity of 0.0 and a compensated elasticity of 0.4. As one would expect, the efficiency gains from pension progressivity are sharply reduced compared to the benchmark case of Table 6. The most extreme combinations in Table 7 now even yield aggregate efficiency losses. The optimal (β, λ)-combination, however, is not affected.

We now alter the relative risk aversion (η) from Table 2. Although the benchmark value of $\eta = 4$ is fairly low,[11] we reduce the coefficient of relative risk aversion further from 4 to 2 in the lower part of Table 7. Not surprisingly, the aggregate efficiency gains fall sharply compared to Table 6. Without basic allowances, the optimal share of flat pensions is now only 50 percent. If basic allowances are introduced, the optimal level remains at 30 percent of average income and the respective flat-benefit share is reduced to 25 percent. Note that the efficiency gain of the optimal combination is reduced sharply from 3.34 percent (in Table 6) to 1.35 percent of aggregate resources.

Of course, the optimal progressivity of the pension system also depends on other institutional arrangements in the economy that may provide risk sharing. If, for example, the tax system or the bequest distribution provides for more (less) risk sharing, the required insurance provision of the pension system will be reduced (increased). Consequently, the sensitivity analysis of Table 8 reports the aggregate efficiency gains when we change some benchmark institutional arrangements.

In the top part of Table 8 we assume that the introduction of the basic allowance is financed by an increase in consumption taxes. While the first

[11] In an attempt to extract the degree of relative risk aversion from hypothetical questions administered to a sample of respondents in the Health and Retirement Survey, Barsky *et al.* (1997) find evidence that a substantial proportion of people are much more risk averse.

line remains as in the benchmark of Table 6, the introduction of basic allowances shifts the overall tax structure towards consumption taxation. As Nishiyama and Smetters (2005) show, consumption taxes reduce the insurance properties of the tax system in models with uncertain wage income. In addition, consumption taxation also moderates the liquidity constraints of low-income households compared to the benchmark simulation. Consequently, the aggregate efficiency gains are lower, the optimal basic allowance is smaller and the optimal share of flat benefits is higher compared to the benchmark simulation in the top part of Table 6. In the second part of Table 8 we assume that the government levies a proportional income tax of 10 percent in the initial equilibrium. Since the tax system is now less redistributive, Table 8 shows that the insurance gains as well as the optimal progressivity of the pension system increase compared to the benchmark economy. In the third part we return to the progressive tax system of the benchmark economy but assume that bequests are distributed within a generation independent of actual productivity. Since bequests now offer a partial insurance against income shocks, the insurance gains from pension progressivity are dampened and liquidity constraints are less binding compared to the benchmark economy. In the bottom part we follow Nishiyama

Table 8. *Compensated welfare changes: sensitivity analysis II*[a]

		λ						
	β	0.00	0.25	0.50	0.75	1.00	1.25	1.50
Increase in consumption tax	0.0	0.00	0.61	1.04	1.28	1.33	1.31	1.18
	0.1	0.64	1.22	1.64	1.85	1.86	1.66	1.24
	0.2	1.17	1.71	2.08	**2.27**	2.24	2.02	1.57
	0.3	1.21	1.72	2.06	2.21	2.14	1.97	1.47
	0.4	0.91	1.36	1.66	1.79	1.73	1.54	1.04
Proportional income tax	0.0	0.00	0.88	1.55	2.04	2.33	2.44	2.37
	0.1	1.25	2.09	2.73	3.18	3.41	3.47	3.33
	0.2	2.65	3.45	4.04	4.44	4.61	4.59	4.32
	0.3	3.57	4.29	4.82	5.14	5.20	5.04	4.58
	0.4	4.12	4.72	5.13	**5.31**	5.12	4.61	3.62
Uniform bequest	0.0	0.00	0.49	0.86	1.06	1.10	0.97	0.69
	0.1	0.85	1.30	1.62	1.78	1.76	1.55	1.17
	0.2	1.80	2.20	2.45	2.54	2.43	2.12	1.58
	0.3	2.28	2.58	**2.76**	2.74	2.50	2.03	1.37
	0.4	2.36	2.54	2.58	2.35	1.79	1.02	−0.12
Halved transitory shocks	0.0	0.00	0.97	1.70	2.15	2.35	2.37	2.31
	0.1	1.27	2.17	2.83	3.24	3.45	3.34	3.20
	0.2	2.73	3.53	4.09	4.43	4.52	4.30	4.15
	0.3	3.70	4.37	4.83	**5.10**	5.01	4.35	3.64
	0.4	3.84	4.28	4.57	4.65	4.25	3.34	2.33

[a]In percentage of remaining resources.

and Smetters (2007) and assume that transitory shocks are reduced to half of their previous values.[12] At first glance, an increased progressivity of the pension system would now be expected to produce lower aggregate efficiency gains. However, as shown in Table 8, the opposite occurs. This corresponds to the findings of Nishiyama and Smetters (2007) who explain this counterintuitive result by the fact that the reduction in transitory shocks also increases the persistence of any shocks. When negative shocks become more permanent, the value of risk sharing is increased.

Finally, without reporting it explicitly, aggregate efficiency effects are hardly affected when the closed economy is replaced by a small open economy, since the factor-price repercussions in the closed economy mainly represent income redistribution across generations.

VI. Discussion

Despite our extensive sensitivity analysis, the simulations reported above only provide an incomplete picture of the labor supply and risk-sharing effects of social security arrangements. Since retirement is exogenous in our model, we do not fully capture the distortions of the retirement decision implied by our reforms. In practice, individuals can choose the age when they claim pension benefits and a more progressive pension system would presumably induce most households to retire earlier. Of course, this would reduce the efficiency gains computed above. The same is likely to happen if we would take into account Germany's means-tested social assistance system. However, the consequences of basic income guarantee programs should not be too dramatic since they only apply to a small group of individuals.

On the other hand, this study also abstracts from important real-world features that highlight the insurance role of social security. Since private annuity markets are missing due to adverse selection problems, the public pension system also provides a longevity insurance which is not captured by the above simulations. In a companion study, Fehr, Habermann and Kindermann (2008) keep the existing tax–benefit linkage but reduce the *level* of the unfunded pension system in order to isolate the welfare consequences of the longevity insurance. The simulations indicate that for most parameter combinations the benefits from the longevity insurance dominate the labor supply distortions and liquidity effects. Finally, taking into account aggregate risk and intergenerational risk sharing will also most likely reinforce the claim for social security as a risk-sharing device. If wages and

[12] More precisely, we halve the probabilities of the diagonals in the transition matrices and increase the diagonal values accordingly.

interest rates are uncertain and not perfectly correlated, unfunded pensions will reduce portfolio risk and thereby improve the welfare of risk-averse individuals. Of course, these benefits have to be weighted against labor market distortions and liquidity effects of social security. To our knowledge, Krueger and Kubler (2006) are the first to simulate the transition path of a numerical overlapping-generations model with aggregate risk. They introduce social security and compute the welfare changes for existing and future generations. However, they abstract from labor supply distortions, idiosyncratic risk and do not compensate the transitional generations. Consequently, although their analysis is an important first step, considerable research is still necessary in order to develop a comprehensive quantitative analysis of the overall risk-sharing properties of social security.

Appendix

Table A1. *Age-dependent Markov transition matrices*

		Age 20–24 Future productivity level						Age 25–29 Future productivity level					
		1	2	3	4	5	6	1	2	3	4	5	6
	1	0.30	0.16	0.27	0.07	0.06	0.13	0.31	0.17	0.22	0.08	0.10	0.11
	2	0.15	0.18	0.19	0.24	0.12	0.13	0.15	0.22	0.28	0.13	0.10	0.11
Current	3	0.07	0.18	0.39	0.17	0.12	0.08	0.08	0.11	0.33	0.25	0.14	0.09
productivity	4	0.09	0.07	0.15	0.33	0.22	0.15	0.08	0.08	0.21	0.31	0.22	0.09
level	5	0.07	0.05	0.13	0.24	0.34	0.17	0.05	0.05	0.12	0.21	0.32	0.24
	6	0.05	0.04	0.10	0.12	0.23	0.46	0.06	0.06	0.09	0.12	0.22	0.46
		Age 30–34 Future productivity level						Age 35–39 Future productivity level					
		1	2	3	4	5	6	1	2	3	4	5	6
	1	0.33	0.22	0.21	0.09	0.09	0.07	0.37	0.20	0.22	0.13	0.05	0.05
	2	0.18	0.25	0.30	0.14	0.05	0.07	0.22	0.29	0.32	0.12	0.03	0.02
Current	3	0.09	0.15	0.35	0.24	0.11	0.06	0.12	0.16	0.38	0.20	0.09	0.05
productivity	4	0.07	0.06	0.24	0.33	0.21	0.09	0.04	0.04	0.24	0.40	0.22	0.07
level	5	0.05	0.02	0.11	0.24	0.38	0.20	0.02	0.04	0.07	0.21	0.44	0.22
	6	0.03	0.04	0.05	0.08	0.23	0.58	0.02	0.02	0.04	0.07	0.22	0.63
		Age 40–44 Future productivity level						Age 45–49 Future productivity level					
		1	2	3	4	5	6	1	2	3	4	5	6
	1	0.49	0.24	0.15	0.04	0.06	0.02	0.45	0.26	0.22	0.04	0.01	0.01
	2	0.17	0.31	0.36	0.09	0.05	0.03	0.15	0.32	0.33	0.14	0.03	0.03
Current	3	0.07	0.13	0.40	0.25	0.10	0.05	0.08	0.11	0.44	0.27	0.07	0.02
productivity	4	0.06	0.06	0.20	0.40	0.21	0.08	0.05	0.04	0.16	0.40	0.29	0.06
level	5	0.02	0.02	0.09	0.21	0.47	0.18	0.04	0.02	0.08	0.19	0.46	0.20
	6	0.02	0.02	0.05	0.07	0.16	0.66	0.02	0.03	0.05	0.04	0.15	0.70

Continued

Table A1. *(Continued)*

		Age 50–54 Future productivity level					
		1	2	3	4	5	6
	1	0.42	0.22	0.21	0.07	0.04	0.04
	2	0.14	0.30	0.35	0.11	0.06	0.04
Current	3	0.11	0.12	0.37	0.25	0.11	0.03
productivity	4	0.04	0.05	0.19	0.41	0.24	0.07
level	5	0.04	0.03	0.09	0.20	0.45	0.19
	6	0.03	0.05	0.07	0.05	0.15	0.66

Source: Authors' own calculations from 1984–2001 SOEP data.

References

Auerbach, A. J. and Kotlikoff, L. J. (1987), *Dynamic Fiscal Policy*, Cambridge University Press, Cambridge.

Barsky, R., Juster, T., Kimball, M. and Shapiro, M. (1997), Preference Parameters and Behavioral Heterogeneity: An Experimental Approach in the Health and Retirement Survey, *Quarterly Journal of Economics 12*, 537–580.

Bomsdorf, E. (2003), *Sterbewahrscheinlichkeiten der Periodensterbetafeln für die Jahre 2000 bis 2100*, Eul Verlag, Köln.

Casamatta, G., Cremer, H. and Pestieau, P. (2000), The Political Economy of Social Security, *Scandinavian Journal of Economics 102*, 503–522.

Cecchetti, S. G., Lam, P. S. and Mark, N. C. (2000), Asset Pricing with Distorted Beliefs: Are Equity Returns too Good to be True?, *American Economic Review 90*, 787–805.

Conde-Ruiz, J. I. and Galasso, V. (2005), Positive Arithmetic of the Welfare State, *Journal of Public Economics 89*, 933–955.

Conesa, J. C. and Krueger, D. (1999), Social Security Reform with Heterogeneous Agents, *Review of Economic Dynamics 2*, 757–795.

De Nardi, M., İmrohoroğlu, S. and Sargent, T. J. (1999), Projected U.S. Demographics and Social Security, *Review of Economic Dynamics 2*, 575–615.

DIW (Deutsches Institut für Wirtschaftsforschung) (2005), Verteilung von Vermögen und Einkommen in Deutschland, Wochenbericht des DIW Berlin nr. 11, 199–207.

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J. and Wagner, G. G. (2005), Individual Risk Attitudes: New Evidence from a Large, Representative Experimentally-validated Survey, DIW Discussion Paper no. 511, Berlin.

Epstein, L. G. and Zin, S. E. (1991), Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: An Empirical Analysis, *Journal of Political Economy 99*, 263–286.

Fehr, H. (1999), *Welfare Effects of Dynamic Tax Reforms*, Mohr Siebeck, Tuebingen.

Fehr, H. (2000), Pension Reform during the Demographic Transition, *Scandinavian Journal of Economics 102*, 419–443.

Fehr, H., Habermann, C. and Kindermann, F. (2008), Social Security with Rational and Hyperbolic Consumers; forthcoming in *Review of Economic Dynamics*.

Feldstein, M. (1997), The Costs and Benefits of Going from Low Inflation to Price Stability, in C. Romer and D. Romer (eds.), *Monetary Policy and Inflation*, University of Chicago Press, Chicago, 123–156.

Flood, L., Hansen, J. and Wahlberg, R. (2004), Household Labor Supply and Welfare Participation in Sweden, *Journal of Human Resources 39*, 1008–1032.

Habermann, C. and Kindermann, F. (2007), Multidimensional Spline Interpolation: Theory and Applications, *Computational Economics 30*, 153–169.

Heer, B. and Trede, M. (2003), Efficiency and Distribution Effects of a Revenue-neutral Income Tax Reform, *Journal of Macroeconomics 25*, 87–107.

Huang, H., İmrohoroğlu, S. and Sargent, T. J. (1997), Two Computations to Fund Social Security, *Macroeconomic Dynamics 1*, 7–44.

Hubbard, R. G. and Judd, K. L. (1987), Social Security and Individual Welfare: Precautionary Saving, Borrowing Constraints, and the Payroll Tax, *American Economic Review 77*, 630–646.

Huggett, M. and Ventura, G. (1999), On the Distributional Effects of Social Security Reform, *Review of Economic Dynamics 2*, 498–531.

Institut der Deutschen Wirtschaft (2006), *Deutschland in Zahlen*, Köln.

Krueger, D. and Kubler, F. (2006), Pareto-improving Social Security Reform when Financial Markets are Incomplete!?, *American Economic Review 96*, 737–755.

Matsen, E. and Thøgersen, Ø. (2004), Designing Social Security—A Portfolio Choice Approach, *European Economic Review 48*, 883–904.

Meister, W. and Ochel, W. (2005), Sozialabgabenfreibetrag und Beschäftigung, *ifo Schnelldienst 58*, Munich, 16–20.

Nishiyama, S. and Smetters, K. (2005), Consumption Taxes and Economic Efficiency with Idiosyncratic Wage Shocks, *Journal of Political Economy 113*, 1088–1115.

Nishiyama, S. and Smetters, K. (2007), Does Social Security Privatization Produce Efficiency Gains?, *Quarterly Journal of Economics 122*, 1677–1719.

OECD (2005), *Pensions at a Glance: Public Policies across OECD Countries*, OECD, Paris.

Sinn, H.-W. (2000), Why a Funded Pension is Useful and Why it is Not Useful, *International Tax and Public Finance 7*, 389–410.

Storesletten, K., Telmer, C. I. and Yaron, A. (1999), The Risk-sharing Implications of Alternative Social Security Arrangements, *Carnegie-Rochester Conference Series on Public Policy 50*, 213–259.

Thøgersen, Ø. (1998), A Note on Intergenerational Risk Sharing and the Design of Pay-as-you-go Pension Programs, *Journal of Population Economics 11*, 373–378.

Wagener, A. (2003), Pensions as a Portfolio Problem: Fixed Contribution Rates vs. Fixed Replacement Rates Reconsidered, *Journal of Population Economics 16*, 111–134.

First version submitted September 2006;
final version received December 2007.