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# Pension reform with entrepreneurial choice

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## Abstract

This paper presents an overlapping generations model with occupational choice that allows for entrepreneurial entry, exit and investment decisions in the presence of idiosyncratic productivity risk and borrowing constraints. The model is applied to analyze the consequences of pension reforms in Germany where we introduce either a comprehensive paygo system, flat benefits or a fully funded system. Compared to previous studies we compute the full transition path after the reform and quantify the intergenerational welfare effects as well as aggregate efficiency consequences.

Our simulation results indicate that the design of the pension system directly affects occupational choice when employees and self-employed are treated differently by the pension system. As a consequence, the labor supply distortions induced by pension reforms are significantly higher than in previous studies which do not consider this extensive margin explicitly. In addition, pension systems influence occupational choice indirectly through changes in financial constraints and factor prices. We also show that the pension system might have opposite effects on different types of entrepreneurs. Finally, pension reforms have a strong impact on wealth inequality in our set up.

JEL Classifications: C68, D91, H55, J24

Keywords: overlapping generations, stochastic general equilibrium, wealth distribution, financial constraints

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# 1 Introduction

The importance of entrepreneurial activities in promoting innovation, growth and economic development has been recognized at least since Schumpeter (1942). Entrepreneurs typically save more than ordinary workers and invest in risky projects which yield higher than average expected returns. Consequently, wealth-income ratios are higher for self-employed households even after controlling for age, education and other demographic variables. Not surprisingly, governments in all industrialized countries try to foster entrepreneurs by subsidized credit programs, tax breaks and special treatment in public insurance schemes.

The problem is, however, that it is by far not clear what are the main drivers of occupational choice. For a long time the conventional view was that mainly financial constraints affect the decision to become an entrepreneur. However, recently a number of theoretical and empirical studies have cast some doubt on the existence and importance of borrowing constraints, see Quadrini (2009). Another natural important source affecting occupational choice are personal characteristics such as entrepreneurial skills or risk preferences. But at the same time studies which analyze the consumption, saving and investment behavior of existing entrepreneurs document an enormous heterogeneity so that they are not able to isolate such characteristics in more detail. Even the higher savings characteristic is not unambiguous. In Germany self-employed households are not covered by the public pension system so that they typically save more on average than ordinary worker households. But this relation turns upside down in the lower income classes where self-employed save less on average than employed households. Therefore, while the majority of self-employed has the necessary funds for adequate old-age provision, there is also a significant number of formerly self-employed households who have to rely on social assistance in retirement, see Ziegelmeyer (2010). This finding can be interpreted that on the one side households with high entrepreneurial skills become (successfully) self-employed, but also households with low labor productivity (and low entrepreneurial skills) may become self-employed in order to avoid low wages.

Given the fact that determinants of occupational choice are very diverse and existing entrepreneurs are extremely heterogeneous, the optimal design of public policy towards entrepreneurship is quite complicated. While during past years numerous theoretical and empirical papers have analyzed the interplay between tax policy and entrepreneurial activities, little consensus has arisen from these studies. For example, rising income tax rates or tax progressivity not only reduces the expected return from self-employment, but also the risk of entrepreneurial activity through higher loss offsets. Consequently, rising tax rates and progressivity might decrease or increase the number of self-employed in the economy depending on which effects dominates, see Cullen and Gordon (2007) for a recent discussion of this literature. Another line of arguments highlights the fact that tax evasion seems to be easier with entrepreneurial activities than with salaries. Therefore rising taxes may induce more self-employment in order to avoid taxes. But again, the empirical literature does not clearly support this line of argument. For example, Parker (2003) finds no evidence that the decision to be self-employed is sensitive to opportunities for tax evasion.

Entrepreneurship may reduce individual tax burdens also in a legal way. As already mentioned above, self-employed are typically excluded from the public pension system. They pay no contributions during working years but also have to rely fully on private savings during retirement. The design of the pension system may therefore affect the occupational choice in various ways: Higher generosity may reduce entrepreneurial activity since the coverage of the pension system becomes

more attractive and at the same time higher contribution rates dampen the build-up of private assets. However, when contribution rates rise too much, agents may be induced to become self-employed in order to avoid social security contributions. The question is therefore to what extent entrepreneurs should be covered by the public pension system and how do reforms of the current system affect occupational choice. Can we use the social security system to encourage or discourage entrepreneurship? Existing theoretical and empirical studies on these issues are quite scarce and highly inconclusive. For example, the comparative static general equilibrium analysis of Wagener (2000) finds no general rule to what extent entrepreneurs need more or less insurance in old-age than workers.

The present study introduces a numerical general equilibrium model with occupational choice in order to analyze the interplay of pension policy and entrepreneurial choice in Germany. In recent years various quantitative models have been developed that analyze the impact of entrepreneurs in the macroeconomy. Typically these approaches apply a representative agent or a very stylized life cycle framework and focus on long run effects of specific capital market or taxation issues. In contrast, our study introduces an overlapping generation model which accounts for the full transition path in order to compute the intergenerational welfare effects and aggregate efficiency consequences of policy reforms. We take Germany as an example since the current unfunded pension system offers a high tax-benefit linkage and is tailored to employed workers. Given rising old-age poverty rates among former self-employed, recent reform proposals call for mandatory coverage of self-employed persons in the German public pension scheme, see Gasche and Rausch (2013). We compare the consequences of such a reform with two radical alternatives where the current system for employees is transformed to either a flat benefit or a fully funded system.

The remainder of the paper is organized as follows: The next section briefly surveys the existing quantitative simulation studies with occupational choice on which our quantitative approach is based. Section 3 describes the structure of the simulation model, while section 4 explains the calibration and simulation approach. Finally, Section 5 presents the simulation results and the last section offers some concluding remarks.

## 2 Relationship to the existing literature

Our approach builds on dynamic general equilibrium models where heterogeneous agents face uninsurable shocks of earnings developed among others by Aiyagari (1994) or Huggett (1996). Early versions of these models were not able to reproduce the distribution of wealth in the U.S. As a consequence, researchers who were interested in wealth and income dynamics extended the approach by introducing entrepreneurial activities. Quadrini (2000) was among the first who analyzed occupational choice and wealth concentration in a heterogeneous agent model with infinitely-lived households. Entrepreneurs save more than ordinary workers since they want to minimize additional borrowing cost from investing in very risky new innovations. Their activity is associated with a learning process that generates additional payoffs from successful projects. The approach is able to explain the large wealth concentration among the rich in the US economy and the observed wealth mobility patterns of entrepreneurs and workers. Alternatively, Cagetti and De Nardi (2006) develop a stylized overlapping generations model with endogenous credit constraints and a specific role for intergenerational transmissions of wealth and entrepreneurial abilities. They show that relaxing existing borrowing constraints would generate more entrepreneurs and increase the wealth concentration in the economy. Bassetto et al. (2015) extend this approach by considering the impact of credit

shocks on the number of entrepreneurs, their firm size and the wealth concentration.

Of course, the same approach can be also applied to study the effects of fiscal reforms on entrepreneurial activity and macro aggregates. Therefore, extending Quadrini (2000), Li (2002) introduces a government which uses tax revenues to subsidize credits to entrepreneurs. While such a policy effectively reduces borrowing constraints, the higher tax burden crowds out capital. Consequently, only programs that effectively target the poor and capable entrepreneurs could promote entrepreneurial activities and raise total output. Similarly, Meh (2005) studies the switch from a progressive to a proportional income tax system. Again, such a reform increases entrepreneurial investment and savings, but this also leads to higher labor demand narrowing the income gap between workers and entrepreneurs. Overall, wealth inequality is only slightly affected by the reform in the model with entrepreneurs. Kitao (2008) as well as Meh (2008) study the taxation of capital income in an economy with entrepreneurs. While Kitao (2008) highlights the importance of a differential taxation of corporate and entrepreneurial capital, Meh (2008) focuses on the importance of investment risk. Both studies demonstrate that the complete elimination of capital income taxation is not efficient in such a framework. Finally, Cagetti and De Nardi (2009) as well as Kumru and Nakornthab (2015) analyze estate taxation in a life-cycle framework with entrepreneurs where young and old households are connected by intergenerational altruism. Estate tax revenues are fairly small and distortions mainly affect households in the top half of the wealth distribution. Therefore, the aggregate effects of eliminating estate taxation are modest and depend mainly on the tax instrument that is used to balance the budget. Quite surprisingly, Cagetti and De Nardi (2009) find that the U.S. wealth distribution is hardly affected when estate taxes are eliminated. Kumru and Nakornthab (2015) on the other hand indicate that estate taxation has a strong impact on annuity ownership. In their model annuities not only provide an insurance against longevity risk but also shelter from estate taxation.

To our knowledge, Kumru and Nakornthab (2015) provide the only numerical study that (at least indirectly) links occupational choice and the design and coverage of the pension system. This is quite surprising given the fact that entrepreneurs invest in highly risky projects so that a significant number of them enters retirement with very little or even insignificant savings. What are efficient ways to avert old-age poverty of self-employed? Should they be forced into the public pension system or is it more efficient to exclude them completely? If public pensions are tailored to workers only, how strong does their progressivity and funding affect occupational choice? In order to analyze these questions the next section develops a fully-fledged overlapping generations model where households may enter or exit entrepreneurial activities at different ages until retirement. Upon retirement they may be covered by public pension provisions or may rely on own savings.

### 3 The model economy

#### 3.1 Demographics and intracohort heterogeneity

We consider an economy populated by  $J$  overlapping generations. At the beginning of each period  $t$ , a new generation is born where we assume a population growth rate  $n$ . When individuals enter the economy, they are assigned a skill level  $s \in \mathcal{S} = \{1, \dots, S\}$  according to the probability distribution  $\omega_s$ . Since they remain in it forever, skill level may be interpreted as a permanent shock. During their life-cycle agents only survive from period to period with skill and age dependent probabilities  $\psi_{j,s}$  which denotes the conditional survival probability from age  $j - 1$  to age  $j$  for skill class  $s$  with

$\psi_{j+1,s} = 0$ . All households start their economic life as workers, but in the following periods they act as entrepreneurs or workers, depending on the occupational choice made in the previous period. At each age  $j$  this decision depends on the available resources and the existing tax and pension system, but most importantly on the comparison of current and expected future labor productivity  $\eta_j \in \mathcal{E}$  and managerial abilities  $\theta_j \in \mathcal{D}$ . While workers supply labor in the corporate sector and receive a wage in return, entrepreneurs run their own business by combining their own labor with employed capital for production. Workers stop working at age  $j_R$  when they retire and start to live from their savings and accumulated pension benefits up to their maximum age of  $J$  years. Entrepreneurs also start to receive pension benefits at age  $j_R$ , but they may still work in their own business.

Consequently, an agent faces the individual state vector

$$z = (j, s, a_j, ep_j, \eta, \theta, o_j) \in \mathcal{Z} = \mathcal{J} \times \mathcal{S} \times \mathcal{A} \times \mathcal{P} \times \mathcal{E} \times \mathcal{D} \times \mathcal{O}$$

where  $a_j \in \mathcal{A} = [0, \infty]$  denotes assets held at the beginning of age  $j \in \mathcal{J} = \{1, \dots, J\}$ . Assets are initially zero ( $a_1 = 0$ ) and restricted throughout the whole life cycle to be greater or equal to zero, i.e. agents might be liquidity constrained. Until reaching retirement age  $j_R$ , workers and entrepreneurs may accumulate earnings points  $ep_j \in \mathcal{P}$  which determine their pension benefits. They also receive productivity and ability shocks at each age which follow a skill-specific finite-state Markov process. Therefore, households know their current productivity and ability levels at the beginning of each period, but have to take expectations about next period abilities. Finally,  $o_j \in \mathcal{O} = \{E, W\}$  denotes the current occupational status.

Consequently, in each period  $t$ , the population is fragmented into subgroups  $\xi_t(z)$ , according to the initial distribution at age  $j = 1$  as well as mortality, population growth, the Markov processes and optimal household decisions. Let  $X_t(z)$  be the corresponding cumulated measure to  $\xi_t(z)$ . Hence,

$$\int_{\mathcal{S} \times \mathcal{E} \times \mathcal{D}} dX_t(z) = 1 \quad \text{with } z = (1, s, 0, 0, \eta, \theta, W) \quad (1)$$

must hold since we normalized the cohort size of newborns to be unity. Let  $\mathbf{1}_{h=x}$  be an indicator function that returns 1 if  $h = x$  and 0 if  $h \neq x$ . Let  $Z_t = (\xi_t(z), \Psi_t)$  denote the state of the economy at the beginning of period  $t$ , where  $\Psi_t$  defines the known policy schedule of the government at  $t$ . Then, the law of motion of the measure of households is

$$\xi_{t+1}(z) = \frac{\psi_{j+1,s}}{1+n} \int_{\mathcal{Z}} \mathbf{1}_{a_{j+1}=a_{j+1}(z,Z_t)} \times \mathbf{1}_{ep_{j+1}=ep_{j+1}(z,Z_t)} \times \mathbf{1}_{o_{j+1}=o_{j+1}(z,Z_t)} \times \pi^w(\eta^+|\eta)\pi^e(\theta^+|\theta) dX_t(z), \quad (2)$$

where  $\pi^w(\cdot)$  and  $\pi^e(\cdot)$  denote the transition probabilities for productivity of workers and entrepreneurs from one period to the next, respectively and "+" indicates next periods' shock.

In the following, we will omit the time index  $t$  and the state indices  $z$  and  $Z_t$  for every variable whenever possible. Agents are then only distinguished according to their age  $j$ .

### 3.2 Household sector

During their working phase, agents may work  $l_j$  time units up to the maximum time endowment of 1 in each period. Time that is not devoted to working is then consumed as leisure  $1 - l_j$ . When working in their own business, entrepreneurs always supply time  $l_j = \bar{l}$  inelastically. Consequently, individuals have preferences over streams of consumption  $c_j$  and leisure  $1 - l_j$ . Utility is additively

separable and individuals discount future periods with the discount factor  $\beta$ . The utility function then reads

$$E_0 \left[ \sum_{j=1}^J \beta^{j-1} \left( \prod_{i=1}^j \psi_i \right) u(c_j, 1 - l_j) \right] \quad \text{with} \quad u(c_j, 1 - l_j) = \frac{[(c_j)^\sigma (1 - l_j)^{1-\sigma}]^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}},$$

where  $\gamma$  measures the intertemporal elasticity of substitution,  $\sigma$  the fraction of consumption in utility and expectation is taken from an ex ante perspective. At the beginning of each period  $t$ , each age- $j$  entrepreneur or worker with assets  $a_j$  and earning points  $ep_j$  realizes the current ability and productivity levels  $\theta$  and  $\eta$ , respectively and then decides about consumption, savings, working time (if currently worker) or investment (if currently entrepreneur) at age  $j$  and next period's occupation. In what follows, we solve the problem recursively. For simplicity, let  $V_j^W$  and  $V_j^E$  define the current value functions of a worker and entrepreneur, respectively.

### 3.2.1 Workers' problem

The optimization problem of the worker is given by

$$V_j^W = \max_{c_j, l_j, a_{j+1}, o_{j+1}} \left\{ u(c_j, 1 - l_j) + \beta \psi_{j+1} \left( \mathbf{1}_{o_{j+1}=W} E_j[V_{j+1}^W | \eta, \theta] + \mathbf{1}_{o_{j+1}=E} E_j[V_{j+1}^E - \Phi | \eta, \theta] \right) \right\} \quad (3)$$

subject to the constraints

$$\begin{aligned} a_{j+1} &= (1 + r)a_j + y_j^w + b_j + p_j - \tau \min[y_j^w; 2\bar{y}] - T(y_j^w, a_j, 0, p_j) - (1 + \tau^c)c_j \\ c_j &> 0, \quad 0 \leq l_j \leq 1, \quad a_{j+1} \geq 0. \end{aligned} \quad (4)$$

with  $a_1 = a_{j+1} = 0$ . The expectation operators  $E_j$  in equation (3) are with respect to the stochastic processes of  $\eta$  and  $\theta$ . The parameter  $\Phi$  denotes start-up costs that are paid in terms of utility if the worker decides to become an entrepreneur.<sup>1</sup> According to the budget constraint (4) future assets  $a_{j+1}$  are derived from current assets (including interest), gross income from labor  $y_j^w = we_j\eta l_j$  (which is due to the wage rate  $w$  for effective labor times individual productivity  $e_j\eta$  and hours worked), accidental bequests  $b_j$  and pensions  $p_j$  net of payroll taxes (which are subject to a contribution ceiling that is double times average income  $\bar{y}$ ), income taxes  $T(\cdot)$  and consumption expenditure (including consumption taxes). The deterministic part of age-specific labor productivity  $e_j$  per time unit depends on individual's skill level  $s$ . Of course, consumption and labor supply have to be positive with the latter restricted by the time endowment. Finally, the borrowing constraint must hold.

### 3.2.2 Entrepreneurs' problem

Similarly, an entrepreneur's optimization problem is given by

$$V_j^E = \max_{c_j, k_j, a_{j+1}, o_{j+1}} \left\{ u(c_j, 1 - l_j) + \beta \psi_{j+1} \left( \mathbf{1}_{o_{j+1}=W} E_j[V_{j+1}^W | \eta, \theta] + \mathbf{1}_{o_{j+1}=E} E_j[V_{j+1}^E | \eta, \theta] \right) \right\} \quad (5)$$

which is now subject to the constraint

$$a_{j+1} = a_j + r \max[a_j - k_j; 0] + y_j^e + b_j + p_j - \phi \tau \min[y_j^e; 2\bar{y}] - T(y_j^e, a_j, k_j, p_j) - (1 + \tau^c)c_j, \quad (6)$$

<sup>1</sup> Luo et al. (2010) model general effort cost to be an entrepreneur in a similar way.

$$c_j > 0, \quad 0 \leq k_j \leq (1+d)a_j, \quad a_{j+1} \geq 0.$$

Entrepreneurs always supply an amount  $\bar{l}$  of their time endowment and decide instead how much capital  $k_j$  should be invested in their business. According to their budget constraint (6) their future assets are derived from current assets (including interest from assets invested in the capital market), gross income from entrepreneurial activity  $y_j^e$ , accidental bequests and public pensions net of payroll taxes (which are again subject to a contribution ceiling), income taxes  $T(\cdot)$  and consumption expenditure. Since entrepreneurs have been workers at least in one period before retirement, they have accumulated some pension wealth at retirement. However, they only contribute *as entrepreneurs* to the public pension system if they are included there. The policy parameter  $\phi$  allows to distinguish the inclusion ( $\phi = 1$ ) and exclusion ( $\phi = 0$ ) of entrepreneurs in the public pension system. Entrepreneurs pay progressive income taxes on their gross income which is defined by

$$y_j^e = \theta_j [k_j^\alpha (e_j \bar{l})^{1-\alpha}]^\nu - \delta k_j - r \max[k_j - a_j; 0].$$

Consequently, entrepreneurial income  $y_j^e$  is derived from entrepreneurial output net of depreciation and interest cost. As in Kitao (2008) the production technology combines the same shares for capital and (effective) labor input as the corporate sector and adds the entrepreneurial ability  $\theta$  and an additional exponent  $\nu$ . Of course, interest cost can be only deducted for borrowed capital. As in Evans and Jovanovic (1989), entrepreneurs can borrow up to a limit determined as a linear function  $da_j$  of current net worth. Entrepreneurial ability  $\theta$  is not publicly observed and therefore the borrowing limit can not depend on this parameter. This implies that even if an agent is lucky with a high entrepreneurial ability the lack of assets might constrain him from expanding his business. It also prevents him from starting a business in the first period and maybe in later years when returns from small-scale projects are less attractive than wage earnings.

Our model abstracts from annuity markets. Consequently, private assets of all agents who died are aggregated and then distributed among all working age cohorts  $i < j_R$  following an exogenous age-dependent distribution scheme  $\Gamma_i$  (which will be explained below), i.e.

$$b_i = \frac{\Gamma_i}{1+n} \int_{\mathcal{Z}} (1 - \psi_{j+1,s})(1 + r_{t+1})a_{j+1}(z, Z_t) dX_t(z). \quad (7)$$

### 3.3 The corporate sector

In addition to the entrepreneurial sector populated by the entrepreneurial households, the corporate sector is populated by large firms. These firms hire capital  $K_c$  and effective labor  $L_c$  on perfectly competitive factor markets to transform it into a single good according to the Cobb-Douglas production technology

$$Y_{c,t} = K_{c,t}^\alpha L_{c,t}^{1-\alpha},$$

with  $\alpha$  the capital share in production. Capital is rented from households through an intermediary at the riskless rate and depreciates over time again with depreciation rate  $\delta$  and firms have to pay corporate taxes  $T_{k,t} = \tau^k [Y_{c,t} - w_t L_{c,t} - \delta K_{c,t}]$  where the time-invariant corporate tax rate  $\tau^k$  is applied to the output net of labor cost and depreciation. Factor prices are determined competitively by marginal productivity conditions, i.e.

$$w_t = (1 - \alpha) \left( \frac{K_{c,t}}{L_{c,t}} \right)^\alpha \quad (8)$$



$$r_t = (1 - \tau^k) \left[ \alpha \left( \frac{L_{c,t}}{K_{c,t}} \right)^{1-\alpha} - \delta \right]. \quad (9)$$

### 3.4 Government sector

The government sector in our model is split into a tax and a pension system. The budgets of both systems are closed separately. While during the transition the consumption tax rate is used to balance the tax system, the pension contribution rate is chosen in a way that pension contributions equal pension benefits in each period.

*The tax system* In each period  $t$  the government issues new debt  $(1+n)B_{G,t+1} - B_{G,t}$  and collects taxes from workers and entrepreneurs in order to finance general government expenditure  $G$  which is fixed per capita as well as interest payments on its debt, i.e.

$$(1+n)B_{G,t+1} - B_{G,t} + T_{y,t} + T_{k,t} + \tau_t^c C_t = G + r_t B_{G,t}. \quad (10)$$

where revenues of income taxation are computed from

$$T_{y,t} = \int_{\mathcal{Z}} T(y(z, Z_t), a(z, Z_t), k(z, Z_t), p(z, Z_t)) dX_t(z)$$

and  $C_t$  defines aggregate consumption (see (17)). In the initial long-run equilibrium we specify the debt-to-output ratio  $B_G/Y$  as well as the public consumption-to-output ratio  $G/Y$  and adjust the consumption tax rate  $\tau^c$  endogenously to balance the budget.

We assume that contributions to public pensions are exempted from tax while benefits are fully taxed. Consequently, taxable labor income  $\tilde{y}_j$  is computed from gross income  $y_j$  net of pension contributions and a fixed work related allowance  $d_w$  and - after retirement - public pensions, i.e.

$$\tilde{y}_j = \max[y_j - \tau \min[y_j, 2\bar{y}] - d_w; 0] + p_j.$$

Of course, entrepreneurs can only deduct pension contributions if they are included in the public pension system, i.e.  $\phi = 1$ . Given taxable labor income  $\tilde{y}_j$ , we apply the progressive tax code of 2014  $T14(\cdot)$  in Germany and add the proportional tax  $\tau^r$  on capital income net of a savings allowance of  $d_s$ , i.e.

$$T(y_j, a_j, k_j, p_j) = T14(\tilde{y}_j) + \tau^r \max[r \max[a_j - k_j; 0] - d_s; 0].$$

*The pension system* In each period, the pension system pays old-age benefits and collects payroll contributions at a rate  $\tau$  from working and maybe entrepreneurial households below the contribution ceiling  $2\bar{y}$ . 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  $ep_{j_R}$  he has accumulated at retirement age and the replaced average income, i.e.

$$p_j = ep_{j_R} \times \kappa \times \bar{y},$$

where  $\kappa$  denotes the replacement rate of average income  $\bar{y}$ . Of course, pensions are zero at all ages before retirement age, i.e. we do not consider early retirement. The accumulated pension claims may consist of both a flat and a perfectly earnings related part. Specifically we let

$$ep_{j+1} = ep_j + \mu \times \left\{ \lambda + (1 - \lambda) \min \left[ \frac{y_j}{\bar{y}}; 2 \right] \right\} / (j_R - 1), \quad (11)$$

where  $\mu \in \{0, 1\}$  indicates whether earning points are accumulated or not. Note that  $y_j$  may also reflect income of entrepreneurs. When  $\lambda = 0$ , agents face a perfectly earnings related system, whereas  $\lambda = 1$  means that the pension system is completely flat. In a perfectly earnings related system households who always receive average labor income during working years, would accumulate an average earning point at retirement of exactly  $ep_{j_R} = 1$ . If the pension system would be completely flat then all contributing households would accumulate an average earning point at retirement independent of former income.

Workers are not allowed to work beyond retirement age when they receive pensions. Entrepreneurs may instead continue to work after retirement age  $j_R$ . In this case they neither pay contributions nor do they receive higher pensions if entrepreneurs are included in the pension system (i.e. if  $\phi = 1$ ). The budget of the pension system must be balanced in the long-run. Consequently, in some simulations we allow in the transitional periods for new pension debt  $(1+n)B_{P,t+1} - B_{P,t}$  in order to balance the periodical budgets

$$(1+n)B_{P,t+1} - B_{P,t} + \tau \int_{\mathcal{Z}} \left( \min[y^w(z, Z_t); 2\bar{y}] + \phi \min[y^e(z, Z_t); 2\bar{y}] \right) dX_t(z) = r_t B_{P,t} + \int_{\mathcal{Z}} p(z, Z_t) dX_t(z) \quad (12)$$

where the left hand side defines revenues from debt and aggregate contributions and the right hand side sums up interest payments and aggregate benefits. In the initial long-run equilibrium  $B_P = 0$  and the contribution rate  $\tau$  is computed endogenously. After the reform we adjust the contribution rate either periodically or only once to balance the intertemporal budget.

### 3.5 Equilibrium

Given public policy  $\Psi_t = \{\tau^k, \tau^r, \tau^c, d_w, d_s, B_G, T(\cdot), \kappa, \mu, \phi, \lambda\} \quad \forall t$ , a recursive equilibrium path is a set of value functions  $V^W(z, Z_t), V^E(z, Z_t)$ , household decision rules  $c(z, Z_t), l(z, Z_t), k(z, Z_t), a^+(z, Z_t), o^+(z, Z_t)$ , distribution of unintended bequest  $b(z, Z_t)$ , measures of households  $\zeta_t(z)$ , relative prices of labor and capital  $w, r$  such that the following conditions are satisfied  $\forall t$ :

1. households' decision rules solve the households decision problems of workers (3) and entrepreneurs (5) subject to the respective constraints;
2. factor prices are competitive, i.e. (8) and (9) hold;
3. individual and aggregate behavior are consistent:

$$K_{e,t} = \int_{\mathcal{Z}} k(z, Z_t) dX_t(z) \quad (13)$$

$$Y_{e,t} = \int_{\mathcal{Z}} \theta \left[ k(z, Z_t)^\alpha (e_j \bar{l})^{1-\alpha} \right]^v dX_t(z) \quad (14)$$

$$L_{c,t} = \int_{\mathcal{Z}} l(z, Z_t) e_j dX_t(z) \quad (15)$$

$$A_t = \int_{\mathcal{Z}} a(z, Z_t) dX_t(z) \quad (16)$$

$$C_t = \int_{\mathcal{Z}} c(z, Z_t) dX_t(z) \quad (17)$$

4. total production is the sum of the corporate and the entrepreneurial sectors:  $Y_t = Y_{c,t} + Y_{e,t}$ ;

5. the laws of motion (1) and (2) for the measure of households hold;
6. unintended bequests satisfy

$$(1+n) \int_{\mathcal{Z}} b(z, Z_{t+1}) dX_{t+1}(z) = \int_{\mathcal{Z}} (1 - \psi_{j+1,s})(1+r_{t+1})a^+(z, Z_t) dX_t(z); \quad (18)$$

7. the budgets of the government and the pension system (10) and (12) are balanced;
8. the capital market clears, i.e.  $A_t = K_{c,t} + K_{e,t} + B_{G,t} + B_{P,t} + B_{F,t}$ , with net foreign assets  $B_{F,t} = 0$  in the closed economy;
9. the goods market clears, i.e.  $Y_t = C_t + (1+n)K_{t+1} - (1-\delta)K_t + G + NX_t$ , with net exports  $NX_t = 0$  in the closed economy.

## 4 Calibration of the initial equilibrium

Table 1 provides the central parameters of our model. In order to reduce computational time, each model period covers five years. Agents start life at age 20 ( $j = 1$ ), are forced to retire at age 65 ( $j_R = 10$ ) and face a maximum possible life span of 100 years ( $J = 16$ ). In order to get a reasonable classification of skills, we use the International Standard Classification of Education (ISCED) of the UNESCO. We thereby merge levels 0 to 2 (primary and lower secondary education), levels 3 and 4 (higher secondary education) and levels 5 and 6 (tertiary education) in order to receive 3 skill levels, i.e.  $\mathcal{S} = \{1, 2, 3\}$ . The initial probability distribution  $\omega_s$  is calculated using data from the German Socio-Economic Panel (SOEP), a description of which can be found in Wagner, Frick and Schupp (2007). In this representative data set, low-, medium- and high-skilled individuals represent 26, 55 and 19 percent of the population, respectively. Survival probabilities for the medium skill class  $\psi_{j,2}$  are taken from the 2012/14 Life Tables for Germany reported in Statistisches Bundesamt (2016). von Gaudecker and Scholz (2007) document a positive correlation between lifetime earnings and life expectancy at age 65 which differs up to 6 years between the lowest and the highest earnings group considered in their study. Since our skill-levels are less differentiated, we compute probabilities  $\psi_{j,s}$  for the low- and the high-skilled individuals, so that life expectancy between those two differs by about 5 years, i.e. it increases from 78.1 to 80.8 and 83.9 for the low-, medium- and high-skilled class, respectively. Therefore, the models average life expectancy almost exactly matches the respective one from the 2012/2014 German life tables. The population growth rate is set at  $n = 0.032$  which roughly corresponds to an annual growth rate of 0.64 percent. Since population growth is negative in Germany, this figure mainly reflects labor productivity growth.

With respect to the preference and technology parameters we applied a similar procedure as Conesa et al. (2009) or Kitao (2008). Therefore we set the intertemporal elasticity of substitution  $\gamma$  to 0.5, and adjusted the leisure share  $\sigma$  to 0.32 in order to get for employees an average fraction of working time in total time endowment of one third. The time preference parameter  $\beta$  is set to 0.98 in order to generate a realistic capital output ratio. Finally, the start-up cost  $\Phi$  (in terms of lost utility) are taken from Luo et al. (2010). They induce a realistic entrepreneurial activity over the life cycle and it can be shown that they roughly represent an annual average wage income. With respect to technology parameters we set the capital share in production  $\alpha$  at 0.36. The annual depreciation rate for capital is set at 6 percent which implies  $\delta = 0.27$ . With respect to the entrepreneurial production function we followed again Kitao (2008) and set  $\nu$  at 0.88 while we assumed that entrepreneurs work  $\bar{l} = 0.41$

so that they spend about thirty percent more time in their business than employees in the corporate sector. As in Kitao (2008), entrepreneurs are allowed to invest 150 percent of their assets, i.e.  $d = 0.5$ . We assume that only cohorts between ages 30 and 64 years receive bequest. The youngest and the oldest cohort receive 1/16 of total bequest, then cohort shares increases symmetrically from both sides up to age group 45-49 which receives a quarter of total bequest. Within cohorts bequest are distributed flat. Finally, the processes for labor productivities  $\pi^w(\cdot)$  were taken from Fehr et al. (2013) while the processes entrepreneurial abilities  $\pi^e(\cdot)$  were taken from Kitao (2008).

Table 1: Exogenous parameter selection

Demographic parameters	Preference parameters	Technology parameters	Government parameters
$J = 16$	$\gamma = 0.5$	$\alpha = 0.36$	$\tau^k = 0.15, \tau^r = 0.264$
$j_R = 10$	$\sigma = 0.32$	$\delta = 0.27(6\% \text{ p.a.})$	$B_G/Y = 0.80, G/Y = 0.19$
$S = 3$	$\beta = 0.99$	$\nu = 0.88$	$d_w = 0.04\bar{y}, d_s = 0.025\bar{y}$
$n = 0.032 (0.64\% \text{ p.a.})$	$\Phi = 0.55$	$\bar{l} = 0.41$	$\lambda = \phi = 0.0$
$\psi_j$ : StaBu (2016)		$d = 0.5$	$\kappa = 0.55, \mu = 1.0$

Government tax policy in our model reflects quite well the German tax system in 2014. Specifically, we set the debt to output ratio at 80 percent and fix the public consumption to output ratio at 19 percent, which guarantees a consumption tax revenue to output share of 10.9 percent. This share is slightly higher than the value of 10.5 percent reported in IdW (2016). We apply the German income tax code of the year 2014 to labor and pension income, i.e. the marginal tax rate schedule rises after a basic allowance from 14.8 to 44.3 percent. We assume, in line with German law, that pension contributions are deductible from tax while pension income is fully taxable and apply the German income splitting method. In addition we tax returns from savings above a threshold of 1600€ linearly at the rate 26.4 percent. This reflects the flat rate taxation of capital income in Germany. Finally, we set the corporate tax rate  $\tau^k$  at 15 percent which yields a revenue to output ratio of 1.4 percent that is slightly lower than the value of 2.2 percent reported in IdW (2016). With respect to the pension system we set the retirement age  $j_R$  at age 65 in order to get a realistic dependency ratio and specify the replacement rate  $\kappa$  in order to generate a realistic contribution rate.

Table 2 shows the resulting initial equilibrium with and without entrepreneurial choice. We tried to calibrate a realistic share of entrepreneurs, government sector and distribution of income and wealth for Germany. With respect to entrepreneurs we distinguish between low-, medium and high-skilled as an approximation of different motives to become an entrepreneur. Low-skilled entrepreneurs are more self-employed because of low labor income prospects while high-skilled entrepreneurs are more likely self-employed because they have high entrepreneurial skills. In the initial equilibrium there are much more high-skilled than low-skilled entrepreneurs, which is quite realistic. With respect to the public sector aggregate pension benefits are too low although the contribution rate, the replacement rate and the dependency ratio is quite realistic. On the other hand, aggregate tax revenues are quite realistic as well as the capital-output ratio. The fraction of bequest in GDP seems to be too low, but one has to keep in mind that our model only accounts for unintended bequest. Finally, the model captures quite realistically the wealth and income distribution in Germany. Typically, especially the top tail of the wealth distribution can be hardly matched in such aggregated models. The consideration of entrepreneurs has a big impact especially on the wealth distribution. As can

Table 2: The initial equilibrium with and without entrepreneurs

	Initial equilibrium		Germany
	with	without	2014*
	entrepreneurs		
Calibration targets			
Life expectancy		80.7	81.0
Dependency ratio (65+/20-64 in %)		34.6	34.6
Fraction of entrepreneurs (in %)	9.8	0.0	9.8 <sup>a</sup>
Low skilled	1.6		–
High skilled	2.7		–
Pension benefits (% of GDP)	8.7	11.4	11.0
Pension contribution rate (in %)	19.3	19.1	18.9
Tax revenues (in % of GDP)	20.5	21.4	22.0
Capital-output ratio	3.9	3.1	3.8
Other benchmark coefficients			
Interest rate p.a. (in %)	2.4	3.4	–
Bequests (in % of GDP)	4.4	3.9	7.6 <sup>b</sup>
Gini index gross income	0.492	0.388	0.485 <sup>c</sup>
Gini index wealth	0.707	0.624	0.746 <sup>d</sup>
Top wealth shares (in %)			
1%	14.5	7.8	23.9 <sup>d</sup>
5%	38.3	27.3	45.4 <sup>d</sup>
10%	54.7	40.8	59.0 <sup>d</sup>

\*Source: IdW(2016), <sup>a</sup>Hatfield(2015), <sup>b</sup>Braun (2015), <sup>c</sup>SVR(2014), <sup>d</sup> Bach et al. (2015).

be seen from the column "without entrepreneurs", if we keep all parameters constant but simulate the model without entrepreneurial choice, then mainly the wealth and income distribution changes dramatically.

In order to solve our model numerically we distinguish a micro- and a macroeconomic solution method. The former applies a multidimensional spline interpolation in order to solve the household problem. The latter follows the Gauss-Seidel iteration procedure in order to compute equilibrium prices and quantities. For more information see the computational appendix in Fehr et al. (2013).

The remainder of this paper will mainly focus on the macroeconomic, welfare and efficiency consequences of alternative pension arrangements for workers and entrepreneurs in Germany. In order to quantify the various effects of the considered reforms, we always proceed in the same fashion. We start from the initial equilibrium ( $t = 2014$ ) described in Table 2. Then, we change different parameters once and for all in period  $t = 2015$  and compute a full transition path up to a new long run equilibrium  $t = \infty$ . Note that the changes in  $\lambda, \phi, \mu$  will affect only the accumulation of new earnings point  $ep_{j+1}$  along the transition. Those points that were earned in the initial equilibrium will be unaffected by the reforms. This especially applies to households that were already retired before the reform took place.

## 5 Simulation results

The following subsections consider three reform scenarios:

- (1) A "comprehensive paygo" reform, where all entrepreneurs are forced to contribute to the public pension system (i.e.  $\phi = 1.0$ );
- (2) A "flat benefit" reform, where the tight tax-benefit linkage of the paygo system is completely eliminated (i.e.  $\lambda = 1.0$ );
- (3) A "pension funding" reform, where the paygo system is completely eliminated (i.e.  $\mu = 0.0$ ) so that all households have to build up own savings for retirement.

All considered reforms are evaluated with respect to their macroeconomic, distributional and efficiency consequences. Of course, they all have a direct impact on occupational choice and an indirect impact due to the induced factor price changes. Any induced wage increase (decrease) will dampen (boost) entrepreneurial activities and it is not clear per se whether direct and indirect effects will go in the same direction. In order to separate the two effects, we simulate each reform in a closed economy and then repeat it in a small open economy. Before we proceed with the numerical results we explain how welfare and efficiency effects are computed after a policy reform.

### 5.1 Computation of welfare and efficiency effects

The concept we apply to quantify welfare effects is compensating variation à la Hicks. Due to the homogeneity of our utility function,

$$u((1 + \Delta)c_j, (1 + \Delta)\ell_j) = (1 + \Delta)^{1 - \frac{1}{\gamma}} u(c_j, \ell_j)$$

holds for any  $c_j, \ell_j$  and  $\Delta$ . In consequence, since utility is additively separable with respect to time, if consumption and leisure were simultaneously increased by the factor  $1 + \Delta$  at any age, life-time utility would increase by the same factor. With this considerations lets again turn to our simulation model. Assume an individual at state  $z$  had utility  $V_{2014}(z)$  in the initial long-run equilibrium path and  $V_t(z), t > 2014$  after the policy reform. The compensating variation between the baseline and the reform scenario for the individual characterized by  $z$  is then given as

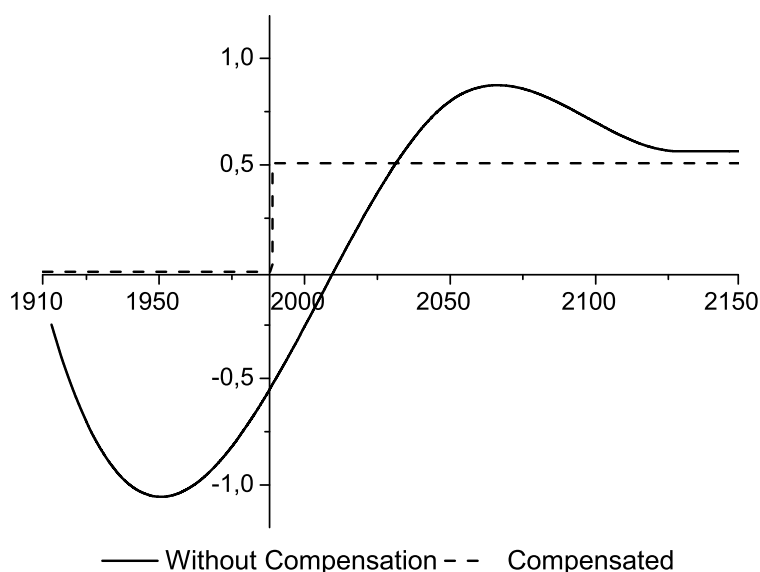
$$\Delta = \left[ \frac{V_t(z)}{V_{2014}(z)} \right]^{\frac{1}{1 - \frac{1}{\gamma}}} - 1.$$

$\Delta$  then indicates the percentage change in both consumption and leisure individual  $z$  would require in the initial equilibrium in order to be as well off as after the policy reform. The other way round we may say that an individual is  $\Delta$  better (or worse) off in terms of resources after the reform. If  $\Delta > 0$ , the reform is therefore welfare improving for this individual and vice versa.

A special rule applies to individual not having entered their economically relevant phase of life in the year before we conduct our pension reforms (the so-called future generations). We evaluate their utility behind the Rawlsian veil of ignorance, i.e. from an ex-ante perspective where neither their skill level nor any labor market shock has been revealed. The concept of compensating variation thereby applies likewise.

The solid line in Figure 1 shows the possible individual welfare consequences resulting from a generic reform experiment. For the sake of simplicity, we only consider a representative individual for each cohort. The numbers on the abscissa denote birth years of different cohorts. Since households become

Figure 1: Generic welfare consequences of a reform



economically active at age 20, the last cohort that was already participating in markets in year 2014 was born in 1994. This point is indicated by the intersection of the two axes. Consequently, when talking about future generations in the following, we mean all cohorts born after 1995.

The solid line in Figure 1 indicates cohort-specific welfare consequences. As can be seen, the considered reform redistributes from currently living to future cohorts. In order to isolate the pure efficiency effects of the reform, we apply the hypothetical concept of a Lump-Sum Redistribution Authority (LSRA) used by Auerbach and Kotlikoff (1987) in a separate simulation. The LSRA thereby proceeds as follows: to all generations already being economically active in 2014 it pays lump-sum transfers or levies lump-sum taxes in order to make them as well off after the reform as in the initial equilibrium. Consequently their compensating variation amounts to zero. Having done that, the LSRA might have run into debt or build up some assets. It now redistributes this debt or assets across all future generations in a way that they all face the same compensating variation, confer the dashed line in Figure 1. This variation can be interpreted as a measure of efficiency. Consequently, if the variation is greater than zero, the reform is Pareto improving after compensation and vice versa. With this concepts in hand, we can now proceed to our simulation results.

## 5.2 Comprehensive coverage in statutory pension system

In the first experiment we force all entrepreneurs to contribute to the public pension system and receive pension benefits in exchange. The contribution base is the entrepreneurial income  $y^e$  which is typically above the contribution ceiling so that they earn two earning points for each year of contributions. The lower part of Table 3 shows that in the first year of the reform the contribution rate falls

by roughly 4 percentage points.<sup>2</sup> This reflects the fact that the number of contributors increases by roughly 10 percent who are all at the contribution ceiling (which is at the double of average labor income). In the first year, no additional benefits are due so that expenditure remains constant. In the following years, however, the new contributors retire so that expenditures and contribution rates rise again.

Table 3: Macroeconomic effects of comprehensive paygo (in %)

Year	2015	2020	2030	2040	2050	2060	$\infty$
<i>Macroeconomic aggregates</i>							
No. entrepreneurs <sup>a</sup>	0.0	0.6	0.7	0.7	0.7	0.7	0.8
low-skilled <sup>a</sup>	0.0	0.2	0.2	0.2	0.2	0.2	0.2
high-skilled <sup>a</sup>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Corp. labor hours ( $l$ )	1.0	1.0	0.7	0.3	-0.2	-0.5	-0.4
Corp. labor input ( $L_c$ )	0.7	0.1	-0.3	-0.7	-1.0	-1.3	-1.3
Corp. capital input ( $K_c$ )	0.1	-0.5	-1.4	-3.0	-4.7	-6.6	-9.9
Total output ( $Y$ )	0.3	0.5	0.1	-0.7	-1.6	-2.3	-3.4
Assets ( $A$ )	0.0	-0.4	-1.1	-2.3	-3.8	-5.2	-7.8
<i>Prices</i>							
Wage	-0.2	-0.2	-0.4	-0.8	-1.4	-2.0	-3.3
Interest rate <sup>a</sup>	0.0	0.0	0.1	0.1	0.2	0.2	0.4
Consumption tax rate <sup>a</sup>	0.4	0.3	0.4	0.7	1.2	1.6	2.1
<i>Pension system</i>							
Expenditure (in % of GDP) <sup>a</sup>	0.0	0.1	0.3	0.8	1.3	1.8	2.1
Contribution rate <sup>a</sup>	-3.8	-3.8	-3.3	-2.5	-1.5	-0.6	-0.1

<sup>a</sup>In percentage points.

Due to lower social security contributions average labor hours in the corporate sector increase on impact by 1.0 percent. In addition, those entrepreneurs who before the reform became workers in order to accumulate pension wealth now remain in their occupation. Consequently, the number of (especially middle-skilled) entrepreneurs increases steadily. Note that high-skilled entrepreneurs do not change their behavior since they mainly rely on their private savings. Since entrepreneurs reduce their investment already in the initial year, the capital stock in the corporate sector has to increase slightly. Higher labor input in the corporate sector reduces wages on impact. Finally, since entrepreneurs now can deduct their pension contributions from their income tax base, income tax revenues fall significantly (despite the higher tax base of workers) and the consumption tax rate has to increase by 0.4 percentage points.

During the transition, aggregate savings fall because entrepreneurs reduce their savings for old-age. Therefore, the capital input in the corporate sector decreases which in turn reduces the wage rate. Of course, investment in the entrepreneurial sector falls also but less than in the corporate sector due to the fall in the marginal income tax rate. Since income tax revenues decline due to falling wages and capital income, the consumption tax rate increases steadily. The pension contribution rate almost reaches the pre-reform level, since the contributions of entrepreneurs now finance the pensions of

<sup>2</sup> Gasche and Rausch (2013) assume that only entrepreneurs up to a certain age will be covered by the pension system. Therefore their initial fall in contributions is much smaller.



former entrepreneurs.<sup>3</sup>

We have also simulated the reform in a small open economy (smopec) in order to isolate the impact of the factor price adjustment. The reduction of wages should induce workers to become entrepreneurs so that we would expect a lower increase in entrepreneurs in the smopec. However, it turns out that the occupational choice is hardly affected by the openness of the economy. Since wages fall in the medium and long run, households have a longer planning horizon. When wages remain constant due to capital inflows, they will work more in the corporate sector on average so that output even increases slightly in the long run. Nevertheless the adjustment of the pension system and tax system is almost identical to the closed economy.

Table 4: Welfare effects of comprehensive paygo\*

Birth year	Age in 2015	without LSRA						with LSRA
		employees			entrepreneurs			
<i>Retirees</i>								
			<i>low</i>	<i>medium</i>	<i>high</i>			
1930	85		0.03	0.04	0.04			0.00
1950	65		0.01	0.00	-0.01			0.00
<i>Workforce</i>		<i>low</i>	<i>medium</i>	<i>high</i>	<i>low</i>	<i>medium</i>	<i>high</i>	
1960	55	0.29	0.27	0.23	1.97	1.78	1.45	0.00
1975	40	0.47	0.47	0.43	1.80	1.72	1.57	0.00
1990	25	0.54	0.54	0.49	0.94	1.02	0.92	0.00
<i>Future Generations</i>								
1995	20				0.55			0.16
2015	–				-0.22			0.16
2035	–				-1.02			0.16
∞	–				-1.27			0.16

\*In percent of initial resources.

With the above discussion in mind, we can now turn to the welfare effects of our reform. Table 4 summarizes welfare consequences measured in compensating variation for different cohorts and household types. Agents who entered the labor market before the reform year, we distinguish between retirees and the workforce. For retirees it is not necessary to distinguish the work status, therefore we only separate the three skill classes. Cohorts in the workforce are split between current employees and entrepreneurs, which are both further grouped by their skill level. For future generations which enter the labor force in and after the reform year 2015 the concept of ex ante welfare is applied and therefore we only report one aggregate number per cohort. The first two columns indicate birth year of the respective cohorts and their age in the reform year 2015.

Not surprisingly, the upper part of Table 4 shows that the considered policy reform hardly affects already retired cohorts. They slightly receive higher pensions since average labor income rises but at the same time they suffer a little bit from higher consumption taxes. Agents who are still in the workforce in the reform year are affected much stronger. It should be clear that employees benefit since their contribution rate declines while they still accumulate the same pension wealth as before. Wel-

<sup>3</sup> If we would assume as Gasche and Rausch (2013) that entrepreneurs in Germany systematically have a higher life expectancy than employees, the long run contribution rate would increase slightly.

fare gains are higher for younger employees since they benefit longer from lower contribution rates. Surprisingly on first sight, also entrepreneurs benefit from the forced inclusion in the pension system especially when they are close to retirement. The reason is that before the reform some entrepreneurs became employees (and sacrificed entrepreneurial income) in order to accumulate pension wealth. After the reform this is not necessary any more. Consequently, entrepreneurial activity increases after the reform. Younger entrepreneurs still benefit but they already face increasing contribution rates during employment years. Consequently their welfare gains are declining. Those cohorts who enter the labor market in and shortly after the reform year may still benefit slightly. In later years, however, they suffer rising welfare losses, which are mainly due to three reasons: Rising contribution and consumption tax rates, falling bequest due to lower capital accumulation and lower wages.

Next we consider the welfare effects after LSRA compensation payments in the right column of Table 4. As mentioned above, the LSRA makes all existing cohorts as well off as in the benchmark simulation and redistributes resources across future generations to make them all face the same welfare changes. We find that the reform induces slight gains for any future generation of 0.16 percent of initial resources. The main reason for this efficiency gain is the implied move from the income towards more consumption taxation.<sup>4</sup>

Note that these welfare and efficiency results hardly change when we simulate the reform in the small open economy.

### 5.3 Flat benefits

Next we consider the macroeconomic and welfare implications of a move towards fully flat benefit pension system in year 2015. As already explained above, this implies that we set the parameter  $\lambda = 1$  once and for all in period  $t = 2015$  of the transition so that for each year of future employment one new earnings point is received independent of income and contributions.

To clarify the impact of the reform on factor markets, Table 5 reports in the middle part the changes of employment and capital in and after year 2015. When accumulated pension points become independent of contributions the whole contribution to the pension system is perceived as a tax. This severely distorts labor supply so that labor input in the corporate sector falls by 12.9 percent immediately. Average working hours even fall by 15 percent on impact. As a consequence, wages rise and the interest rate falls on impact by 0.5 percentage points which induces a reallocation of capital from the corporate to the entrepreneurial sector in the reform year. Finally, lower labor incomes reduce tax revenues and induce an increase in the consumption tax rate as well as an increase in the contribution rate.

After the reform year especially elderly entrepreneurs become now workers again in order to pick up earning points from the pension system. This increases temporarily the corporate labor input and dampens the wage increase. In the following years, the reduction in individual savings (due to lower income) dampens capital accumulation and reduces the wage rate. In the long run, the latter even declines compared to the initial equilibrium by 1.4 percent. Lower wages also dampen the incentive for entrepreneurs to become a worker. Especially high-skilled workers now become entrepreneurs in order to avoid the pension system.

The lower factor inputs reduce output and private consumption during the transition. As govern-

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<sup>4</sup> If we simulate the reform without a tax system the efficiency gains disappear completely.

Table 5: Macroeconomic effects of flat benefits (in %)

Year	2015	2020	2030	2040	2050	2060	$\infty$
<i>Macroeconomic aggregates</i>							
No. entrepreneurs <sup>a</sup>	0.0	-1.1	-0.7	-0.6	-0.5	-0.3	0.0
low-skilled <sup>a</sup>	0.0	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2
high-skilled <sup>a</sup>	0.0	0.0	0.0	0.0	0.0	0.2	0.2
Corp. labor hours ( <i>l</i> )	-15.1	-14.9	-15.3	-16.1	-16.6	-17.3	-17.2
Corp. labor input ( <i>L<sub>c</sub></i> )	-12.9	-11.9	-12.5	-13.2	-13.7	-13.9	-14.6
Corp. capital input ( <i>K<sub>c</sub></i> )	-1.4	-3.5	-7.3	-10.4	-12.7	-14.6	-17.9
Total output ( <i>Y</i> )	-8.9	-9.0	-10.6	-12.2	-13.3	-14.6	-15.8
Assets ( <i>A</i> )	0.0	-2.1	-5.4	-7.6	-9.3	-10.6	-12.9
<i>Prices</i>							
Wage	4.5	3.3	2.1	1.1	0.4	0.0	-1.4
Interest rate <sup>a</sup>	-0.5	-0.4	-0.2	-0.1	-0.1	0.0	0.2
Consumption tax rate <sup>a</sup>	2.3	2.9	3.8	4.5	4.9	5.4	5.8
<i>Pension system</i>							
Expenditure (in % of GDP) <sup>a</sup>	0.0	0.1	0.7	1.3	1.9	2.6	3.3
Contribution rate <sup>a</sup>	1.1	1.1	2.4	4.1	5.6	7.4	9.3

<sup>a</sup>In percentage points.

ment expenditure is held fix per capita and income tax revenues decline, the consumption tax rate has to increase in order to balance the government budget. In the pension system, the reductions in labor income also reduce pension benefits in our model. However, the fall in output and labor dominate, so that the expenditure share in GDP as well as the contribution rate steadily increase during the transition to the new long-run equilibrium.

Table 6: Welfare effects of flat benefits\*

Birth year	Age in 2015	without LSRA						with LSRA
		employees			entrepreneurs			
<i>Retirees</i>								
		<i>low</i>	<i>medium</i>	<i>high</i>				
1930	85	-2.37	-2.37	-2.36				0.00
1950	65	-2.73	-2.77	-2.78				0.00
<i>Workforce</i>								
		<i>low</i>	<i>medium</i>	<i>high</i>	<i>low</i>	<i>medium</i>	<i>high</i>	
1960	55	0.96	0.05	-1.13	-1.12	-1.28	-1.49	0.00
1975	40	2.39	1.17	-0.59	0.25	-0.23	-0.79	0.00
1990	25	2.07	1.05	-0.49	0.81	0.22	-0.60	0.00
<i>Future Generations</i>								
1995	20			1.07				-1.99
2015	–			-0.37				-1.99
2035	–			-1.46				-1.99
$\infty$	–			-1.98				-1.99

\*In percent of initial resources.

Table 6 reports the welfare and efficiency effects of this reform. Retirees now face significant welfare losses from the reform due to the reduction in pension benefits and the increase in consumption taxes. Welfare losses even increase for younger retirees since they have to accept even stronger reductions in pension benefits and higher consumption taxes. For the working cohorts in the reform year, welfare effects are not so clear-cut. Here the intra-generational redistribution from rich towards poor households induced by the progressive pension formula becomes most obvious. As a consequence, low-skilled workers realize significant welfare gains of roughly 1 to 2.5 percent of remaining resources while high-skilled employees clearly lose. Of course, this pattern is not so obvious for entrepreneurs. Elderly entrepreneurs lose since they have to pay higher consumption taxes in retirement and face lower pension benefits (from contributions in previous years as employees). Younger entrepreneurs may become workers in later years and benefit from the reform especially when they are low-skilled. Again, high-skilled entrepreneurs lose significantly, since they typically cannot benefit from the redistribution of the pension system. Future generations initially gain from the introduction of flat pensions, which is mainly due to the sharp increase in wages and the insurance provision through the pension system outweighing the losses from labor market distortions. However, these welfare gains turn into welfare losses which increase steadily throughout the transition. In the new long run equilibrium cohorts lose roughly 2 percent of their initial resources. Of course this reflects the long run reduction in wages and the steady decline of individual assets and therefore accidental bequests.

Finally, let us turn to the aggregate efficiency effects after LSRA compensation payments in the right column of Table 6. We find that the reform induces an efficiency loss of roughly 2 percent of initial resources. As explained in Fehr et al. (2013) the introduction of flat pensions comes along with two major efficiency consequences: on the one hand, insurance provision against labor market risk causes efficiency to rise while, on the other hand, increasing labor market distortions reduce it. Our results confirm the previous study in Fehr et al. (2013) which also found that the higher labor supply distortions outweigh improved insurance provision. However, now the labor supply distortions are much higher since there is also an extensive margin where labor supply is distorted.<sup>5</sup>

In a sensitivity analysis we simulate the progressive pension system in the model without entrepreneurs and generate only slightly lower aggregate efficiency losses (1.85 percent). The general adjustment is the same as in Fehr et al. (2013) but all effects are much stronger. Finally, we also simulate the same reform in a small open economy where the reduction in corporate labor input is immediately balanced by capital outflows so that wages and interest rates remain constant. If wages do not increase on impact (and fall in the long run), the number of entrepreneurs increases in the short run (and declines in the long run) compared to the closed economy. Due to capital imports total output declines less during the transition while private savings decline even stronger than before. Nevertheless the adjustment is quite similar and also the welfare and efficiency consequences differ only slightly.

## 5.4 Pension funding

In last simulations we phase-out the existing pay-as-you-go financed German pension system and substitute it by private savings. This is accomplished by simply setting  $\mu = 0$  in equation (11) so that individuals keep their existing earning points, but do not accumulate additional ones in the

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<sup>5</sup> When the reform is simulated without a tax system it generates even efficiency gains since now increased tax distortions are more than balanced by positive insurance effects.

future. We finance the existing pension claims by a time-invariant payroll tax rate computed from the intertemporal budget of the pension system in order to smooth the burden across current and future generations. As a consequence, the periodical budget (12) is now balanced by endogenous pension debt. Of course, such reforms have been analyzed in the past quite often, see Fehr et al. (2008). However, at least to our knowledge no study so far considered the impact on occupational choice.

Table 7 reports the macroeconomic effects of our funding reform. Since now no additional pension claims can be accumulated after the reform year, aggregate pension expenditure declines steadily until it reaches zero roughly in year 2090 when the last cohort with previous pension claims dies. Of course, the contribution rate only adjusts in the reform year where it is reduced by roughly 12 percentage points forever. Despite lower contribution rates, labor supply declines on impact similar as in the previous simulation, since again all contributions are now perceived as taxes. Since households can now only deduct much lower contribution rates, the income tax base and the respective revenues increase triggering a reduction in consumption taxes to balance the budget. During the transition, income tax revenues increase further due to higher savings, so that the consumption tax rate could be reduced by more than 4 percentage points in the long run. The resulting tax shift towards the progressive labor income tax has a negative effect on labor supply and effectively shifts part of the income tax base from retirement to employment periods.

Of course, younger workers will now save for old-age the additional income available so that assets increase throughout the transition. In the new long-run equilibrium, private assets have risen by almost 60 percent compared to the initial equilibrium. Note however, that only a fraction of these additional savings can be used to accumulate corporate capital, since most of it is needed to finance the accumulating debt of the pension system. Overall, higher savings trigger an increase of corporate capital input by almost 7 percent in the long run so that wages increase steadily. Since contributions are now pure taxes, it is attractive to become an entrepreneur. The number of entrepreneurs increases by 0.9 percentage points initially, and then rises further up to 1.3 percentage points despite rising wages in the corporate sector.

Table 8 shows the welfare and efficiency consequences. As in the previous simulation, already retired elderly agents in the reform year will suffer from lower pension benefits, while younger retirees already benefit from lower consumption taxes. But now also the working households are all worse off after the reform since they have to pay contributions but do not receive any pension benefits in return. Entrepreneurial agents may benefit from lower consumption taxes and interest rates. But younger ones are also hurt because they might become workers again in future years. However, as one would expect the welfare losses are much smaller than those of employees. Consequently, cohorts entering the labor market in the reform year realize a significant drop in welfare by roughly one percent of resources. Future cohorts are again better off since they benefit from rising wages and higher bequest. In the long run equilibrium welfare has increased by roughly 1.5 percent of initial resources.

The right column of Table 8 again reports the aggregate efficiency effects after LSRA compensation. As in Fehr et al. (2008) the funding reform implies significant efficiency losses of 1.1 percent since the loss of the longevity insurance by far outweighs the lower distortions of labor supply.

Note that in the small open economy our reform induces massive outflows of domestic capital so that factor prices remain constant. Since interest rates remain stable, assets increase stronger in the long run. Therefore, despite the lower wages, future cohorts are still slightly better off since they receive

Table 7: Macroeconomic effects of pension funding (in %)

Year	2015	2020	2030	2040	2050	2060	$\infty$
<i>Macroeconomic aggregates</i>							
No. entrepreneurs <sup>a</sup>	0.0	0.9	1.2	1.2	1.3	1.3	1.3
low-skilled <sup>a</sup>	0.0	0.2	0.2	0.3	0.3	0.3	0.3
high-skilled <sup>a</sup>	0.0	0.3	0.4	0.4	0.4	0.4	0.3
Corp. labor hours ( <i>l</i> )	-4.0	-4.2	-4.5	-4.8	-5.2	-5.7	-6.6
Corp. labor input ( <i>L<sub>c</sub></i> )	-3.9	-4.7	-5.1	-5.1	-5.4	-5.7	-6.2
Corp. capital input ( <i>K<sub>c</sub></i> )	-0.5	-2.0	-2.8	-1.1	0.8	2.7	6.9
Total output ( <i>Y</i> )	-1.8	-1.0	0.1	1.0	1.8	2.4	3.4
Assets ( <i>A</i> )	0.0	5.1	18.0	31.4	42.9	51.2	59.4
<i>Prices</i>							
Wage	1.3	1.0	0.8	1.5	2.3	3.1	4.8
Interest rate <sup>a</sup>	-0.1	-0.1	-0.1	-0.2	-0.3	-0.3	-0.5
Consumption tax rate <sup>a</sup>	-0.5	-1.1	-2.3	-3.0	-3.6	-3.9	-4.2
<i>Pension system</i>							
Expenditure (in % of GDP) <sup>a</sup>	0.0	-0.2	-1.2	-2.9	-4.9	-6.9	-8.7
Contribution rate <sup>a</sup>	-11.9	-11.9	-11.9	-11.9	-11.9	-11.9	-11.9

<sup>a</sup>In percentage points.

Table 8: Welfare effects of pension funding\*

Birth year	Age in 2015	without LSRA						with LSRA
		employees			entrepreneurs			
<i>Retirees</i>		<i>low</i>	<i>medium</i>	<i>high</i>				
1930	85			-0.13	-0.08	-0.03		0.00
1950	65			0.23	0.27	0.30		0.00
<i>Workforce</i>		<i>low</i>	<i>medium</i>	<i>high</i>	<i>low</i>	<i>medium</i>	<i>high</i>	
1960	55	-1.21	-1.26	-1.30	0.19	0.17	0.16	0.00
1975	40	-1.66	-1.99	-2.42	-0.16	-0.31	-0.33	0.00
1990	25	-1.10	-1.60	-2.23	-0.30	-0.60	-0.69	0.00
<i>Future Generations</i>								
1995	20				-0.98			-1.11
2015	–				0.21			-1.11
2035	–				1.18			-1.11
$\infty$	–				1.54			-1.11

\*In percent of initial resources.

higher bequest and lower consumption taxes than before. The aggregate efficiency losses are also slightly higher, since the initial adjustment of capital is much faster in the small open economy.

Finally, we can also simulate the reform without pension debt and an annual adjustment of the contribution rate. In this case the intergenerational redistribution towards future cohorts more than doubles since then only younger cohorts have to finance pension benefits. The complete elimination

of the pension system in the long run induces additional intertemporal distortions so that aggregate efficiency losses now amount to more than 3 percent of aggregate resources.

## 6 Conclusions and future extensions

The intention of this study was to analyze to what extent pension systems and pension reforms affect the occupational choice to become an entrepreneur. Quite surprisingly previous studies in this direction mainly focussed on the tax system and did not pay any attention to the pension system. In this sense this paper supplements existing studies. We compare the transitional and long run macroeconomic and welfare effects of different pension systems in an overlapping generations model which accounts for entrepreneurial activities. In addition, we isolate the aggregate efficiency consequences of each reform by compensating already existing cohorts numerically.

Our simulation results indicate at least four major conclusions. First, considering entrepreneurial activities in this set up is important to generate a realistic wealth distribution in the top tail. Second, the pension system affects occupational choice works through three channels: a direct effect that depends on the level of intergenerational (and intragenerational) redistribution, an indirect effect that works through changes in factor prices and an indirect effect that changes financial constraints. Third, pension reforms might affect different types of entrepreneurs in opposite directions. A more progressive pension system will induce households with low labor productivity to remain employees and at the same time induce households with high labor productivity to become entrepreneurs. Third, pension reforms might have opposite effects on intensive and extensive labor supply. For example, if the reform reduces financial constraints and increases the wage level at the same time, corporate labor input as well as the number of entrepreneurs will rise at the same time.

Of course, there are a number of ways to improve the present analysis. First of all, we need to fuel the calibration of our model with micro data that reflects the structure of earnings as well as age related entry and exit rates. Then we need to improve the heterogeneity of our households in order to clearly distinguish different skill classes with respect to their entrepreneurial choice. Next we want to link the initial distribution of skills with the bequest received in order to take into account the intergenerational transmission of abilities. Finally, we plan to include a more detailed tax system with estate taxation, entrepreneurial subsidies and tax evasion of entrepreneurs.

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