Early retirement disincentives: Effectiveness and implications for distribution and welfare*

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Abstract

This paper evaluates the effectiveness of early retirement disincentives introduced in Germany and investigates the distributional, individual welfare, and fiscal implications. Therefore, we set up a detailed model of the German social security and tax system with a focus on the PAYG-pension system. Building on the fact that the institutional changes were phased in - impacting birth cohorts to a different degree - we are able to estimate the parameters of a structural dynamic retirement model. This enables us to analyze whether and to what extend disincentives are able to steer retirement behavior. The estimates are based on high quality administrative data. We also compute changes in Gini coefficients of expected remaining lifetime consumption as well as equivalent and compensating variations to assess individual welfare effects. We show that the associated welfare losses are largest for medium income individuals and are only partially compensated by recently introduced subsidies for private old age provisions. At last, we consider the fiscal implications and compute the net public returns of the introduction of retirement disincentives. The simulated public returns per capita translates into overall public gains for the cohorts 1939-1945 of about 10 billion Euros.

Keywords: dynamic programming, discrete choice, retirement behavior, tax and pension system, pension reform.

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1 Introduction

Aging and for some countries even declining populations exert increasing financial pressure on public pension systems around the globe. Therefore, this central feature of modern welfare states is and has been subject to fundamental reforms (e.g. Mastrobuoni (2009); Staubli and Zweimüller (2013); Haan and Prowse (2014); Laun and Wallenius (2015) Ataly and Barret (2014)). In some countries fundamental pension reforms were implemented as early as in the 1980s. However, in most welfare states the reform process is still ongoing and sometimes has not even started yet. The recent economic crises also fueled the debate about fiscal sustainability of public pension systems. In addition, the imminent retirement of the baby-boomer cohorts will soon call for fundamental reforms in most welfare states to secure their sustainability in the near future. In this context, experiences of spearheading countries in terms of different pension reforms can be looked upon as guidance.

The emphasis of this study lies in the reform evaluation of early retirement disincentives introduced in Germany. We investigate the distributional, individual welfare and fiscal implications. Our contributions are manifold: (i) we employ high quality administrative data to estimate the parameters of a structural dynamic retirement model and use these to analyze how disincentives are able to steer retirement behavior. (ii) We compute changes in the distribution of expected remaining lifetime consumption as well as equivalent and compensating variations to assess individual welfare effects. Here the estimates suggest that the associated welfare losses are largest for medium income individuals and are only partially compensated by recently introduced subsidies for private old age provisions. (iii) At last, we consider fiscal implications and compute net public returns of the introduction of retirement disincentives. The simulated public returns per capita translate into overall public gains for the cohorts 1939-1945 of about 10 billion Euros.

Since some of Germany's major reforms undertaken in the early 1990's are fully implemented now, its experiences can serve as a blueprint for other countries pension reform processes. This is why a broad interest in the German case exists. Until the late 1970s, the German pay-as-you-go (PAYG) system was expanded to one of the world's most generous ones, both in terms of replacement rates and early retirement provisions. Population aging, the German reunification and high unemployment rates since the late 70's, however, caused a rising fiscal imbalance. Therefore, the eligibility age has been elevated, replacement rates have been lowered and subsidies have been introduced to stimulate private old-age provisions (e.g. Bönke, Schröder, and Schulte (2010)).

A more recent reform also introduced disincentives for early retirement through permanent pension reductions (Hanel (2010); Lüthen (2014)). The reforms undertaken and in preparation have direct implications for the financial situation of Germany's current and future pensioners. They alter the legal framework under which individual labor supply, retirement, savings or fertility decisions are made (R., Meghir, and Smith (2002); Börsch-Supan (2002); Hirte (2002); Schnabel (1999); Siddiqui (1997)). The effects are essential as statutory pensions account for about 85% of the average disposable income of the elderly population (Börsch-Supan and Reil-Held (2001)). In order to evaluate the effectiveness of the disincentives introduced for early retirement, we build on the fact that the institutional changes were phased in, impacting birth cohorts to a different degree. The evaluation of this reform is non-trivial because of a lack of intra-cohort variation such that no good control group can be constructed. We cope with this issue by investigating the comprehensive dynamic incentives regarding labor market participation and retirement behavior created by the German pension system. These dynamic incentives are taken into account by estimating a structural dynamic retirement model (e. g. Rust and Phelan (1997); French and Jones (2011)). The data used covers complete earnings biographies of mandatorily insured employees.

Based on assumptions regarding individual preferences (over consumption and leisure time) and a detailed modeling of the German pension, social security and tax system, the model rationalizes individual behavior. Individuals are assumed to be forward looking and maximize expected life-cycle utility in each period of time by deciding between labor market participation and retirement. Since retirement is an absorbing state, this results in an optimal stopping problem (Rust (1987); Rust and Phelan (1997)). An individual's rationale is based on the current period's utility flow and the option value that is associated with the respective choices in a certain period of time. The model is estimated by the method of maximum likelihood. The estimation procedure benefits from behavioral responses to changes in the institutional framework because the additional variation helps identifying the structural parameters. This not only enables us to simulate the implications of the reform, but also serve as basis for further simulations of distributional outcomes, welfare effects and fiscal implications. These results are highly relevant when discussing policy options for reforming statutory PAYG pension schemes.

The remainder of the article is structured as follows. The next Section describes the institutional setting in Germany with a focus on its PAYG-pension scheme, the introduced pension reforms and a concise overview of key features regarding the social security and the income tax system. Section 3 is devoted to the conceptual framework of the dynamic retirements model. In the following Section 4 we present our data. The core of the paper is Section 5 where we display our estimation results and conduct a policy analysis. Section 6 concludes.

2 Institutional setting

2.1 PAYG-pension scheme

The German statutory pension system is a pay-as-you-go system of Bismarckian variety. The greater majority of employees is mandatorily insured and has to pay a contribution rate up to a contribution ceiling based on their gross wage.[1] For their contributions the insurants acquire pension entitlements in form of earnings points. Earnings points are calculated as ratio of employee's wage to average wage (see Table A.1). Hence, the number of earnings points is one if the employee's yearly wage corresponds to the average yearly wage. Over the working life, employees accumulate earnings points until retirement. At retirement, the pension level is calculated on the basis of these cumulated earnings points. Thus, the pension level mirrors the length of the working live and the average position in the earnings distribution (e.g. Lüthen (2014) for a detailed synopsis).

The pension scheme offers various retirement possibilities depending on the retiree's individual situation. For the cohorts considered five different types of old-age pensions

[1]Roughly 80% of the male German workforce are covered (Bönke, Corneo, and Lüthen (2015). An overview of key feature of the pension scheme in terms of contribution rates and ceilings is provided in Table A.1.

exist: regular old-age pension, pension for long-term insured, pension for the previously unemployed, disability pension and a special pension for women. In the context of this study, only the first two are considered. The regular old-age pension can be claimed after age 65 and the pension for long-term insured is accessible after age 63 under the condition of having spent at least 35 years in the pension system.[2] This study thus focusses on agents who have a choice between continuing to work and retirement. Therefore we abstract from previously unemployed and/or disabled individuals. Women are excluded due to the low number of cases when conditioning on consistent employment biographies. Summarizing we concentrate on men with a stable working career, whom are eligible to retire at age 63 even if they choose to work longer.

2.2 Introduction of early retirement disincentives

Cohorts born after 1936 are affected by a major pension reform in 1992, which introduces permanent pension deductions of 0.3% per month retiring before 65. The deductions are gradually phased in and come into full affect for birth cohorts born after 1938. The deductions start for those born in January 1937 and increase by 0.3% per month up to 7.2% for cohorts after 1938. The deduction level results from the distance (in month times 0.3%) between the actual retirement age and 65.[3] Still, all cohorts are allowed to retire at 63. Table 1 provides an overview and exemplary date of birth examples.

Table 1: Pension reform effects

Date of birth	Retirement age without deduction	Distance to 65 without deductions (in month)	Maximal deduction
Before 1937	63	24	0%
Januar 1937	63 + 1 month	23	0.3%
June 1937	63 + 6 month	18	1.8%
Januar 1938	64 + 1 month	11	3.9%
June 1938	64 + 6 month	5	5.7%
After 1938	65	0	7.2%

[2]These "waiting periods" consist of periods of contributions, wage replacement benefits (unemployment, sick-pay, invalidity), child-raising and times of education. The unemployment pension, the disability pension and the pension for women can be claimed at age 60 under different eligibility criteria. A detailed overview of pension eligibility is provided in Lüthen (2014).

[3]See Lüthen (2014) for further details. The reform also introduces a pension bonus of 0.5% per month retiring after 65, but this affects only a negligible amount of individuals as most contracts force worker to retire at 65.

2.3 Income tax and social security contributions

The burden of taxes and social security contributions heavily depends on whether being an employee or an retiree and therefore influences retirement decisions. For instance, a portion of retirement income is exempt from taxation. In addition, retirees pay neither contributions to the pension nor unemployment insurance. In the following, key features are described with a focus on differences between employees and pensioners.[4]

Between years 1998 and 2011, employees face a joint burden on gross earnings from contributions to the PAYG-pension scheme, unemployment insurance, health care and long term care of roughly 23% on average, not including the employer's share.[5] Social security contributions are calculated on hypothetical gross yearly earnings and are deducted from gross monthly earnings up to the respective contribution ceiling.[6] In contrast to employees, pensioners are subject to a combined average burden of 8 - 10% which is deducted from the monthly pension.

The income tax is calculated on yearly taxable income and, in our case, income is solely comprised of gross earnings and gross pensions.[7] In order to obtain the taxable portion of income, gross earnings are reduced by a lump some deduction for work related expenses (*Werbungskostenpauschale*), and partially by the employee's social security contributions.[8] In case of pensions, only the return portion (*Ertragsanteil*) is taxable. The return portion varies between 17% and 29%, depending on retirement age and assessment year.

After deductions, the income tax schedule is applied (for married couples joint assessment and a single earner/pensioner without spousal income is assumed). Income tax and solidarity tax surcharge are calculated on yearly taxable income. To obtain the monthly income tax, the yearly tax burden is distributed according to the monthly

[4]The tax code is considered in much greater detail as described. For a thorough overview see Bönke and Eichfelder (2010).

[5]Social security contributions are usually almost evenly split between employee and employer. Gross earnings are net of the employer's contribution and therefore, only the employee's contributions need to be deducted. Of course, the burden differs with total remuneration. Low income earners and those who receive incomes above the respective contribution ceilings of the various branches of the social security system are subject to a lower relative burden.

[6]Contribution ceiling and contribution rates are displayed in Tables A.1 and A.2 in the Appendix.

[7]This mirrors the actual income situation of German pensioners (Börsch-Supan and Reil-Held (2001)). For the population in the focus of this study, other income sources even play a less important role. A decomposition of total income is provided in Table A.3.

[8]For a detailed description of work related deduction and special expenses see Bönke and Eichfelder (2010).

share of taxable income on yearly taxable income. Disposable net income equals then gross income from earnings and pensions net the social security contributions and monthly taxes.

Our period of interest covers assessment years 1998 to 2011. Over this period, some minor changes in social security contributions rates and ceiling (see Tables A.1 and A.2) and, more notable, the tax code occur. Most prominent is the reduction of tax rates (e.g. top marginal tax rates were reduced from 53% to 45%) and the reform of pension taxation (introduction of deferred pension taxation and changes in the deductibility of social security contributions). In addition, some minor alteration (e.g. changes in lump sum deduction) took place. In sum, all of which has an impact on monthly disposable income and pensions is accounted for to insure an accurate estimation of retirement behaviour.

3 Conceptual framework

3.1 Dynamic retirement model

We set up a dynamic retirement model that is estimated using administrative data covering complete earnings biographies of mandatorily insured employees. Based on assumptions about individuals' preferences (consumption and leisure time) and a detailed modeling of the institutional setting (German tax code, social security contributions and the pension system) the model explains the observed individuals' retirement choices. Thereby, individuals are assumed to be forward looking and maximize expected lifetime utility in each time period by deciding between employment and retirement. Since retirement is an absorbing state, this results in an optimal stopping problem. An individual's rationale is based on the current period's utility flow and the option value associated with the respective choices in a certain period of time (Bellman's principle of optimality). The model accounts for time-constant unobserved heterogeneity in leisure preferences by allowing the agents to belong to a finite set of unobserved types. The model is estimated by the method of maximum likelihood. In the following subsections, we outline the features of the dynamic retirement model in greater detail.

3.1.1 Objective function

We specify a dynamic programming discrete choice (DPDC) model of individuals' retirement behavior. Since the analysis focuses on employees who enter old age retirement after regular employment, individuals only choose between employment and retirement (unemployment and disability are not considered). Individuals are finitely lived and die no later than period T, which corresponds to the period where the agent's age 100. Discrete time is measured in months and indexed with t. Hence, the individual's decision whether to retire or not is made on a monthly basis. There is a total number N individuals indexed n. Each individual n receives in each period t the utility flow $U(\mathbf{s}_{nt}, d_{nt})$, where $\mathbf{s}_{nt}$ denotes a vector of state variables (age, birth cohort, accumulated pension points, gross wage, and previous period's choice), and d_{nt} indicates the individual's retirement choice. The earliest possible retirement choice is at $t = 1$ in the month following the 63rd birthday, the latest possible early retirement decision is at age 65 ($t = 24$). All individuals who do not opt for early retirement during these 24 months are assumed to retire upon reaching the statutory pension age (the first month after turning 65).

Every period t, individual n observes the state variables $\mathbf{s}_{nt}$ and makes the retirement choice d_{nt} that maximizes expected lifetime utility:

$$E\left\{\sum_{j=0}^{T-t} p_{bt+j}\beta^j U(\mathbf{s}_{nt+j}, d_{nt+j})\right\} \tag{1}$$

with β denoting a subjective time discount factor and p_{bt+j} is the individual's conditional survival to be alive in period $t+j$ given survival until period t and belonging to cohort b. Following Gourinchas and Parker (2002) the discount factor is set to 0.96.

Information on conditional survival probabilities originates from official mortality tables provided by the German Federal Statistical Office (Statistisches Bundesamt (2006)). These mortility tables supply cohort-specific projections such that the rising life expectancy of the German population can be taken into account. This not only makes the set up of the model more realistic, but also helps identifying the parameters in the estimation procedure by inducing cohort-specific heterogeneity in the dynamic incentives.

3.1.2 Utility function

As mentioned above, individuals have preferences regarding their consumption and leisure time. Explicitly, these preferences are represented by the following time separable random utility model:

$$\begin{aligned} U(\mathbf{s}_{nt}, d_{nt}) =& \alpha_1 \frac{c(\mathbf{s}_{nt}, d_{nt})^{(1-\rho)} - 1}{(1-\rho)} + \alpha_{2n} retirement(d_{nt}) + \epsilon_{nt}(d_{nt}) \\ \alpha_{2n} =& \alpha_{21n} + \alpha_{22} ret63_1(d_{nt}) + \alpha_{23} ret65_1(d_{nt}) \end{aligned} \tag{2}$$

where the random component $\epsilon_{nt}(d_{nt})$ is assumed to be type 1 extreme value distributed. $c(\mathbf{s}_{nt}, d_{nt})$ denotes the level of consumption associated with state $\mathbf{s}_{nt}$ and choice d_{nt}. $retirement(d_{nt})$ captures the retirement decision and indicates if an individual chooses retirement in the current period or already retired. However, given a certain level of consumption, individuals with high preferences for leisure might even prefer retiring before age 63. A very low preference for leisure could result in extending the working life well beyond the 65th birthday. Due to the institutional setting, individuals cannot retire before age 63 or after age 65 and agents exhibiting these extreme preferences have to retire in first or respectively last possible month. Empirically this shows in peaks at age 63 and age 65 in the aggregate retirement pattern. Therefore, the utility function must take individuals behaviour to retire at the earliest or last possibility into account. This is difficult to capture by an optimization rationale based only on age-constant consumption and leisure preferences. For this purpose, $ret63_1(d_{nt})$ and $ret65_1(d_{nt})$ are introduced and interacted with $retirement(d_{nt})$. According to the constraints, they indicate if an individual opts for retirement in the first month after having turned 63 or in the first month after having turned 65, respectively. This allows for an increased utility flow for one period if an individual retires in one of these periods.

ρ represents the coefficient of relative risk aversion. α_1 is a consumption weight. Unobserved heterogeneity in the leisure preferences is reflected by α_{2n}, where the individual-specific coefficient depends on the individual's type (see below). The utility function assumes additive separability between consumption and leisure time as well as its unobserved random component. The vector $\boldsymbol{\theta} = (\alpha_1, \rho, \alpha_{21n}, \alpha_{22}, \alpha_{23})$ contains all the parameters of the utility function.

3.1.3 Value function

The individuals' beliefs about future states are captured by a Markov transition function $q(\mathbf{s}_{nt+1}|\mathbf{s}_{nt}, d_{nt})$. Except for the random component in the utility function which we do not interpreted as a state variable, the state variables evolve deterministically. Hence $q(\mathbf{s}_{nt+1}|\mathbf{s}_{nt}, d_{nt})$ is a deterministic function (see next subsection about the accumulation of pension points and our assumptions on gross wages). By Bellman's principle of optimality, the value function $V_t(\mathbf{s}_{nt})$ can be represented recursively as

$$V_t(\mathbf{s}_{nt}) = \max_{d_{nt}\in D(\mathbf{s}_{nt})} \left\{ U(\mathbf{s}_{nt}, d_{nt}) + p_{bt+1}\beta \int_{\epsilon} \left[\sum_{\mathbf{s}_{nt+1}} V_{t+1}(\mathbf{s}_{nt+1}) q(\mathbf{s}_{nt+1}|\mathbf{s}_{nt}, d_{nt}) \right] g(\epsilon_{nt+1}) \right\} \quad (3)$$

where $D(\mathbf{s}_{nt})$ is the choice set available to individual n in period t. $g(\cdot)$ denotes the probability density function of the utility function's unobserved random components. $D(\mathbf{s}_{nt})$ simply contains the choice between employment and retirement until the irreversible retirement decision which can be made as soon as individuals become eligible (age 63). Again, mirroring the institutional constraints, individuals have to enter retirement at age 65 at the latest.[9] After retirement, individuals have no more options to choose from.

3.1.4 Wages, pension claims and budget constraint

Before retirement, individuals earn a gross wage. As soon as the individual opts for retirement, monthly wages are unobserved and a counterfactual wage has to be imputed. The imputation relies on the last real wage observed in the respective month. Hence, we resort to the wage observed 12 or 24 month prior to the imputed value. This procedure accounts for monthly wage volatility. It follows that our model assumes that real wages do not rise between age 63 and age 65 if the wages are unobserved. In line with the rules and regulations of the pension system, working individuals accumulate pension claims that are proportional to real wages. This creates dynamic incentives for the individuals that are taken into account by the DPDC framework.

Next to public pensions, wealth and wealth accumulation impact the pre- and post

[9] The model abstracts from the fact that there is a small - empirically irrelevant - share of individuals that is allowed to retire later than age 65.

retirement level of consumption and therefore the retirement decision itself. To include this in our model, individuals are assumed to save prior to retirement according to an expected saving rate conditional on their net wages. Analogously, we assume that the individuals' initial net wealth at age 63 corresponds to expected net wealth.[10] After retirement individuals are assumed to dissave according to an actuarially fair lifetime annuity that could be bought with the accumulated wealth at retirement. Hence, the model contains the following budget constraint:

$$\begin{aligned} c(\mathbf{s}_{nt}, d_{nt}) &= G\left(\mathbf{s}_{nt}, d_{nt}\right) - savings\left(\mathbf{s}_{nt}, d_{nt}\right) \\ wealth(\mathbf{s}_{nt+1}) &= \left(wealth(\mathbf{s}_{nt}) + savings\left(\mathbf{s}_{nt}, d_{nt}\right)\right)(1+r) \end{aligned} \tag{4}$$

where $c(\mathbf{s}_{nt}, d_{nt})$ is the level of consumption associated with state $\mathbf{s}_{nt}$ and choice d_{nt}. $G(\cdot)$ indicates net income by applying the rules and regulations of the German tax and pension system. The second equation accounts for the net wealth transitions, where the real interest rate r is assumed to be 0.02 after taxes.

3.1.5 Unobserved heterogeneity

Following the approach of Heckman and Singer (1984), unobserved heterogeneity is accounted for semi-nonparametrically by allowing for a finite number of unobserved types $m \in 1, ..., M$ (random effects). Each type comprises a fixed proportion of the population's individuals. Therefore, the individual-specific parameter α_{21n} that characterizes the preference for leisure time is assumed to be equal to the respective type-specific parameter α_{21m}. The probability of an individual n being of type m is given by γ_m, where γ_M is normalized to zero and $\sum_{m=1}^{M} \gamma_m = 1$. Allowing for unobserved heterogeneity is crucial in order to account for some individuals' strong preference for working until the statutory pension independent of the financial incentives.

3.1.6 Choice probabilities and log-likelihood

Given the finite horizon of the individual's optimization problem, it can be solved recursively. The expected value function, $v_t(\mathbf{s}_{nt}, d_{nt})$, for period T is simply given by

[10] In the current version of the model that we estimate, both savings and net wealth are set to be zero.

this period's expected utility flow:

$$v_T(\mathbf{s}_{nT}, d_{nT}) = u(\mathbf{s}_{nT}, d_{nT}) \tag{5}$$

By Bellman's principle of optimality, the individual's optimization problem can be written as a two-period problem for other time periods. It follows from the type 1 extreme value distribution of $\epsilon_{nt}(d_{nt})$ that the expected value function has a closed form solution (Rust (1987)):

$$\begin{aligned} v_t(\mathbf{s}_{nt}, d_{nt}) =& u(\mathbf{s}_{nt}, d_{nt}) + p_{bt+1}\beta \\ & \sum_{\mathbf{s}_{nt+1}} \log \left\{ \sum_{d_{nt+1} \in D(\mathbf{s}_{nt+1})} exp(v_{t+1}(\mathbf{s}_{nt+1}, d_{nt+1})) \right\} q(\mathbf{s}_{nt+1} | \mathbf{s}_{nt}, d_{nt}) \end{aligned} \tag{6}$$

The computation of the expected value functions between age 66 and age $T = 100$ is comparatively simple because individuals make choices only until age 65 and from age 66 onwards the real net income stream remains constant in all cases. Rust (1987) shows that under the assumptions of additive separability and conditional independence, the conditional choice probabilities have a closed form solution (here mixed logit probabilities):

$$Prob(d_{nt} | \mathbf{s}_{nt}) = \frac{exp(v_t(\mathbf{s}_{nt}, d_{nt}))}{\sum_{j \in D(\mathbf{s}_{nt})} exp(v_t(\mathbf{s}_{nt}, j))} \tag{7}$$

The log-likelihood function of the sample is given by

$$\sum_{n=1}^{N} \log \left\{ \sum_{m=1}^{M} \gamma_m \prod_{t=1}^{T} \left[\sum_{d_{nt}} Prob_m(d_{nt} | \mathbf{s}_{nt}, \boldsymbol{\theta}) \times I(d_{nt}) \right] \right\}$$

where $I(d_{nt})$ indicates individual n's observed choice in period t. The likelihood contributions simply correspond to the respective conditional choice probabilities because the model does not include random transitions of state variables.

4 Data

Our analysis is based on an excerpt of administrative German pension register data. The data covers most employees in Germany due to the mandatorily participation in the pay-as-you-go pension system. Being of the Bismarckian variety, the system carefully records all contributors' earnings biographies. The particular data we analyze stems from the Insurance Account Sample (*Versicherungskontenstichprobe*, VSKT) of the Federal Pension Insurance.[11] Each wave of the VSKT is a stratified random sample of individuals living in Germany, having at least one entry in their social security record and are between thirty and sixty-seven years old in the wave's reference year. For each individual, recording of the earnings biography starts at age 14 and continues until the respective reference year of the wave, thus including individual data over time like panel data. For each individual, the VSKT includes a monthly history of employment, unemployment, sickness, and contributions to the pension system. Information on individual contributions serves as the basis to reconstruct the original earnings information and to compute monthly earnings.

The current investigation focuses on West German males who never worked in East Germany. The restriction is necessary because -for the observed cohorts- neither the labor market situation nor the working life careers of individuals from the former German Democratic Republic (GDR) are comparable to their West German counterparts.[12] To ensure that individuals have indeed the required retirement choice at age 63, we restrict the sample to those that spent at least 35 years in the pension system before turning 63. This results in the exclusion of incomplete earnings biographies applying predominantly to self-employed, civil servants or long-term emigrants. Therefore the sample does not include individuals with substantial labor market earnings unnoticed by the Federal Pension Insurance. We are left with a number of individuals for each cohort that oscillates between 44 and 122. The number of observations per cohort are displayed in Table 2.

While the data records earnings very accurately, one major drawback is the top coding of earnings information. In Germany, the employees' gross wage is the base of assessment to calculate contribution to the mandatory pension system. However, wages are only assessed up to a contribution ceiling. As a result, social security data is right-censored – individuals whose wages exceed the ceiling are treated as if their wages correspond to the ceiling. In the VSKT of all years and cohorts, 7 % of all West German

[11] We work with the scientific use files for on-site-use (SUFVSKT2002 and SUFVSKT2004 to SUFVSKT2011), provided to researchers by the Data Research Centre of the German Federal Pension Insurance. We use all nine samples in our analysis. A detailed description of the data and its shortcomings is provided in the Appendix of Bönke, Corneo, and Lüthen (2015).

[12] West-East migration only affects an empirically negligible share of the population, see Fuchs-Schündeln and Schündeln (2009).

men are affected by censoring. For a better approximation of the true distribution of earnings above the ceiling, we impute earnings to all individuals affected by top coding. The imputation method is based on the assumption of Pareto-distributed earnings in the upper tail of the distribution.[13]

Table 2: Sample descriptives

Cohort	Entry age	Monthly pension	Earnings-points	Pension value age 65	Disincentives in %	Number of Observarions
1935	63.55	1680.97	57.73	28.91	0.00	53
1936	63.67	1660.76	55.98	28.71	0.00	43
1937	63.61	1636.40	55.72	29.18	1.06	50
1938	63.75	1565.26	54.42	29.03	3.70	72
1939	63.89	1607.84	56.33	28.70	4.28	84
1940	64.03	1558.46	54.84	28.27	3.77	93
1941	64.06	1564.30	55.85	27.83	3.69	77
1942	64.34	1555.65	55.18	27.28	2.67	95
1943	64.37	1558.10	54.43	26.81	2.56	122
1944	64.32	1538.50	53.96	27.18	2.73	115
1945	64.27	1532.81	54.71	27.20	2.91	81

Note: The average pensions and the pension values are in 2010 values. The number of observations represents the final sample.

The key characteristics of the sample in use are given in Table 2. For each cohort, the first three columns show the average observed age of retirement entry, the realized monthly pension in 2010 prices and the accumulated earnings points. There are two interesting findings. First, the average entry age gradually increases up to cohort 1942 and remains stable afterwards. Second, accumulated earnings points decrease. Hence, albeit working longer, less pension entitlements are accumulated which might reflect differences in earning careers.[14] Further, two key parameters of the institutional setting are displayed in the columns 'pension value' and 'disincentives'. The pension values is the amount of Euros the earnings points are multiplied with to obtain the monthly pension. Pension values are adjusted every year, therefore the pension value

[13] Bönke, Corneo, and Lüthen (2015) provides a detailed description of the procedure in Online Appendix III.3.

[14] For example longer spells of unemployment, longer periods of education and lower remuneration. See Bönke, Corneo, and Lüthen (2015) for further details.

of the year the cohort turns 65 is reported in prices of 2010. We find the real values to slightly increase up to cohort 1937 and continuously decreasing afterwards. The column 'disincentives' gives the average deduction realized by the retirees of a cohort. Cohorts 1935 and 1936 are not affected by the reform, accordingly average deductions are zero. Cohorts 1937 and 1938 are partially affected, which is mirrored by the increasing average deductions (see also Table 1). The realized average deductions peak for cohort 1939, the first cohort where the reform is in full effect and gradually decrease afterwards to a value well below 3 for retirees born in 1942 and subsequent years. In sum, the real reduction of monthly pension is caused by decreasing pension values, the introduction of incentives and a decline of cumulated earnings points.

Albeit of high quality, the sample is highly selective due to the immense data requirements for the analysis. In order to establish the representativeness, we construct a mirrored population for comparison with SOEP data, i.e. a sample that mirrors our population in age, region, employment status, earnings biography and gender. The SOEP reveals that our sample covers about 50% of the population of men still working at age 62 (see Table A.3).[15] Further, information on other incomes than public pensions and earnings subject to social security contributions are not recorded. Especially self employment and private pension or other wealth might be important sources of income. However, looking into the income sources of the relevant population displayed in Table A.3 reveals that PAYG-pensions and employment income account for well above 97% of total income for the considered group of retirees.

5 Results

5.1 Estimation

The model is estimated by the method of maximum likelihood allowing for two unobserved types ($M = 2$). The results are robust to a different specification where estimation relies on the Expectation Maximization algorithm. In this case, we approximate the distribution of leisure preferences through a fixed point mixing distribution (100 fixed grid points/types). This non-parametric approximation of leisure prefer-

[15] Bönke, Corneo, and Lüthen (2015) find that the VSKT in general represents about 80 % of the total male labor force in West Germany and that its cross-sectional earnings distributions are fairly equal to those found in survey data.

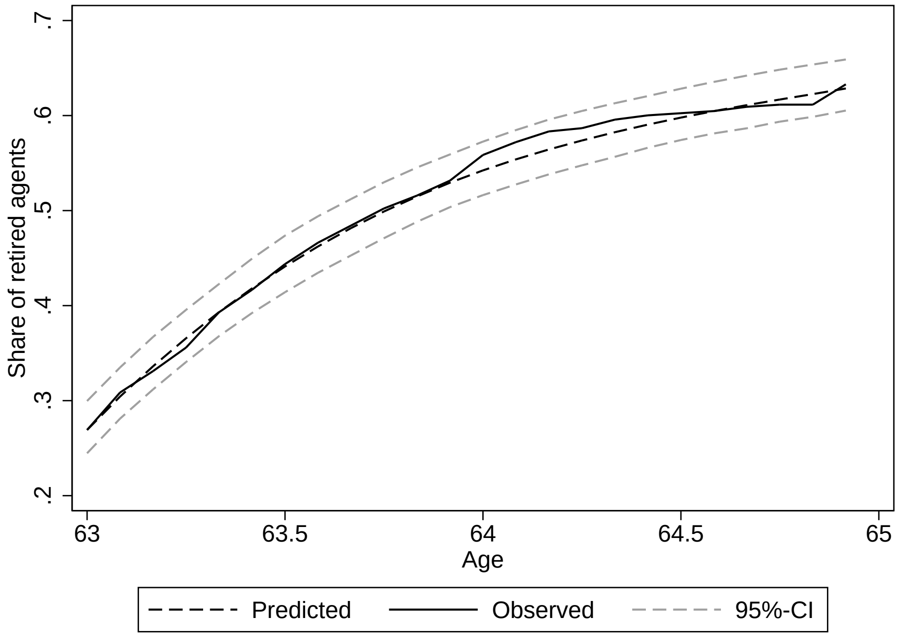
ences shows that the distribution is bimodal with peaks at the two types. Hence, we opt for a simpler specification because both specifications lead to almost identical postestimation outcomes but the classical maximum likelihood approach facilitates the estimation of standard errors substantially. Based on the inverse of the Hessian of the log-likelihood function, we can apply a parametric bootstrapping method in order to construct confidence intervals for the postestimation outcomes. The bootstrapping procedure relies on 200 draws from the asymptotic sampling distribution of the model's parameters.

Table 3: Maximum likelihood procedure

	Estimates	Standard errors
Utility function:		
α_1 (consumption)	0.384	(0.0760)
ρ (crra)	1.662	(0.1685)
α_{211} (leisure, type 1)	-0.758	(0.2823)
α_{212} (leisure, type 2)	0.279	(0.0312)
α_{22} (leisure $\times$ $ret63_1$)	1.898	(0.1172)
α_{23} (leisure $\times$ $ret65_1$)	3.954	(0.0146)
γ_1 (prob. of type 1)	0.144	(0.0338)
Log-likelihood:	-1,851.4	

Table 3 shows the parameter estimates of the maximum likelihood estimation. These estimates are independent of the choice of starting values and we obtain the same estimates when applying the Expectation Maximization algorithm. The coefficient of relative risk aversion ρ is estimated to be 1.66 which is in line with the findings from other recent studies. There is substantial heterogeneity in the leisure preferences with a negative parameter value for individuals of type 1 (14.4% of the individuals). Those have a very high probability of working until they reach the statutory pension age of 65 years, independent of the financial incentives. On the contrary, type-2-individuals optimize a trade-off between leisure time (positive preferences) and consumption when making their retirement decision. The estimates for α_{22} and α_{23} capture the fact that individuals seem to have a particular preference to retire in the first month after having turned 63 or in the first month after having turned 65.

Figure 1: Comparison of predicted and observed shares of retirees



We base model predictions on the posterior type probabilities of the individuals that can be computed by applying Bayes' rule. Figure 1 demonstrates a very good internal validity by comparing the observed shares of retirees in the sample with the shares of retirees that are predicted by the model for the different ages.

5.2 Policy Analysis

Employing the estimated parameters and their sampling distribution, we use the model to simulate confidence intervals for postestimation outcomes of counterfactual scenarios. This not only enables us to simulate behavioral responses to the reform and effects on consumption and retirement income, but also serve as the basis for further simulations of distributional outcomes, welfare effects and the fiscal implications.

Table 4: Simulated effects that are induced by reform

	Reform effects	CI (95%)
ΔE[retirement age] (months)	5.24	[4.46,6.09]
ΔE[NPV of consumption]	€-839	[€-2331,€416]
ΔE[NPV of consumption] (%)	-0.37%	[-0.88%,0.02%]
ΔGini coefficient (%)	3.28%	[1.75%,4.87%]
ΔMonthly retirement income	€-32.8	[€-37.7,€-28.1]
Average equivalent variation	€-6369	[€-7051,€-5776]
Average compensating variation	€6823	[€6089,€7623]
NPV of net public returns	€25,017	[€22,764,€27,146]
ΔE[NPV of pension benefits]	€13,677	[€12,932,€14,391]
ΔE[NPV of pension contributions]	€4075	[€3441,€7623]
ΔE[NPV of other contr. & taxes]	€7264	[€6178,€8147]

Confidence intervals have been computed using a parametric bootstrapping procedure by taking 200 draws from the asymptotic sampling distribution of the model's parameters and computing postestimation outcomes for each of these draws. The reform effects are estimated relative to a baseline scenarios where no retirement disincentives are introduced. Expected consumption is measured as net present value of expected remaining lifetime consumption at age 63. The equivalent and compensating variations refer to NPVs at age 63 that are annuitized over the remaining lifetime. The NPV of the net public returns per individual at age 63 of the reform is composed of the change in pension benefits, pension contributions, and other contributions and tax payments.

Table 4 shows the average simulated changes in expected retirement age at age 63, changes in the net present value (NPV) of expected remaining lifetime consumption and its Gini, compensating and equivalent variations, and the net public returns per individual at age 63. The net public returns are composed of the change in pension payout, pension contributions, and other contributions and tax payments. The simulations are implemented by simulating a counterfactual baseline scenario without retirement disincentives and, then, comparing simulated outcomes under the observed scheme with the outcomes under the baseline scenario. The average effects are computed for the cohorts 1939-1945 that are fully affected by the reform. In addition to the effects of the actually implemented reform, we simulate a variety of scenarios for different levels of retirement disincentives. While the actually implemented reform introduces retirement disincentives of 0.3% per month, we also look at the whole range of incentive levels between 0 and 1% per month. This sheds some insights on the "dose-response" relationship between the level of incentives and our outcome measures.

The average simulated change in expected retirement age at age 63 is 5.24 months. Hence, the change in incentives induced by the reform explains a substantial part of the observed change in retirement patterns by cohorts (average retirement age increased by about 7 months between the 1935 and the 1945 cohort). Figure 2 shows simulated changes in expected retirement age at age 63 by birth cohort. Note that the cohorts 1937 and 1938 are those where the reform phased in.

Figure 2: Effects of reform on expected retirement age by birth cohort

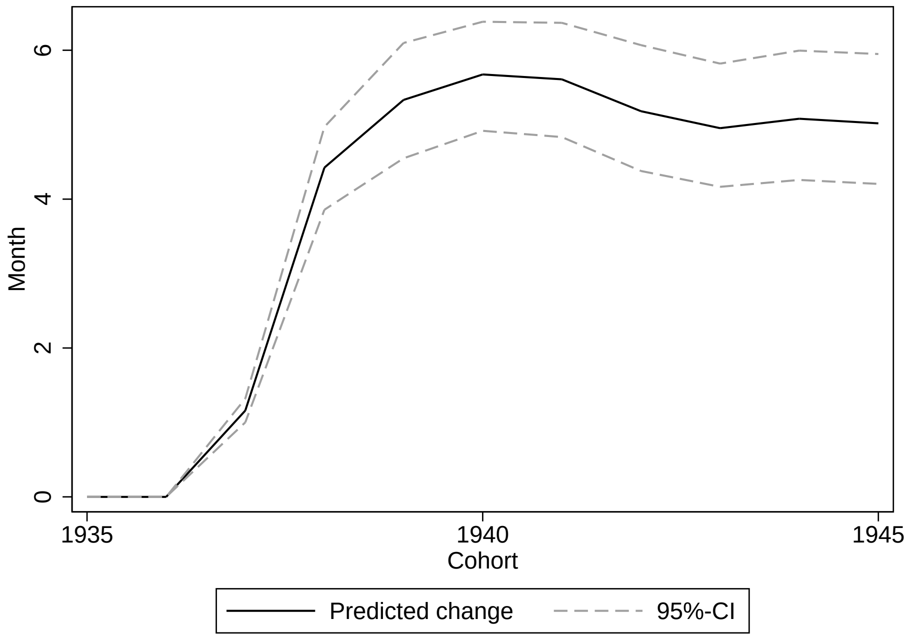
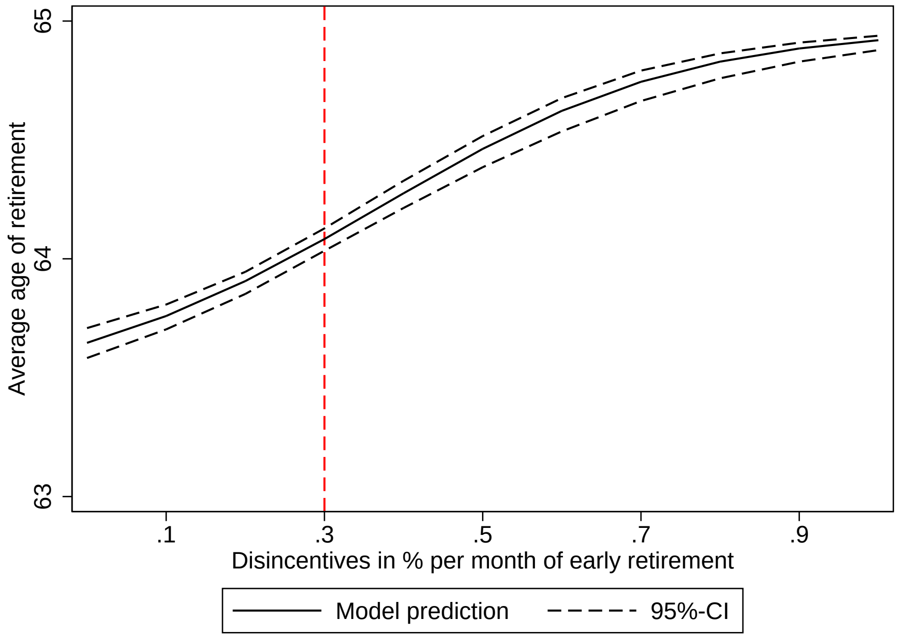


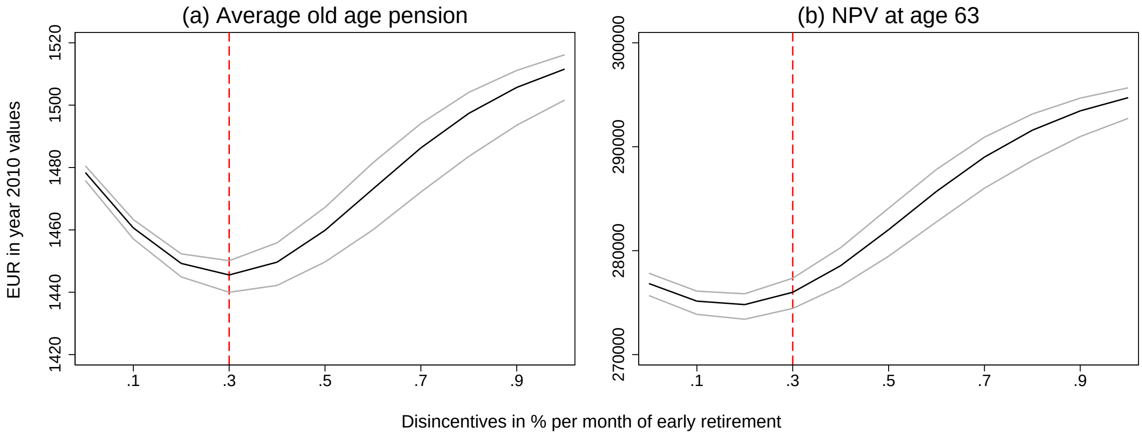
Figure 3 displays the average simulated retirement age by the level retirement disincentives. The figure presents simulation results regarding 11 counterfactual scenarios that we simulated for the cohorts 39-45 (the cohorts that have been fully affected by the actual reform). In these scenarios, we allow retirement disincentives to vary between 0 and 1 % per month of early retirement. These simulations suggest a concave relationship and demonstrate how retirement disincentives can be used to steer these individuals' retirement behavior.

Figure 3: Expected retirement age by disincentive level



Individuals' consumption is affected by two countervailing effects. First, early retirement is associated with a penalty on pension benefits. Second, individuals participate longer in the labor market and receive labor earnings for a longer period of time (notice that wage > pension benefits in most cases). Thus, they pay more contributions to the pension scheme and earn higher pension claims. The simulations suggest that expected consumption at age 63 declines on average by 0.37%. This effect is small and significant. It appears that the two countervailing effects cancel out. For other levels of disincentives, the situation is different. Figure 4 shows that when increasing the level of disincentives the behavioral effect at some point overcompensates the effect of the penalties on expected consumption. For very high levels of disincentives, most individuals retire at age 65 such that almost no more penalties are realized ("prohibitive effect"). However, we do find an effect on average retirement income (€-32.8). The relationship between the level of disincentives and retirement income exhibits a U-shape with the lowest average income at the actually implemented disincentive level of 0.3% per month. Hence, both reductions and increases in the disincentive level would lead to a higher average retirement income. The Gini coefficient of expected consumption is predicted to rise by about 3.28%. This is mainly due to more heterogeneous retirement behavior in the absence of disincentives, offsetting to some extent initial inequalities in pension claims at age 63.

Figure 4: NPVs of expected consumption and retirement income by disincentive level



For individuals with positive leisure preferences, we can directly infer that welfare declines or remains constant (less leisure and less consumption). Individuals that would have worked until age 65 even without disincentives are unaffected. We assess welfare effects of the reform by computing compensating and equivalent variations. The variations refer to NPVs at age 63 that are annuitized over the remaining lifetime. Hence, the equivalent variation indicates how much an individual would be willing to pay at age 63 to avoid the introduction of the retirement disincentives. The compensating variation indicates the amount that an individual would have to receive at age 63 to be fully compensated for the reform. The estimates provide a quantification for the average decline in welfare and also allow a disaggregated analysis of the individual welfare losses along the income distribution. The mean compensating variation suggests an average loss of €6823 in monetary terms. Figure 5 shows that the losses are very heterogeneously distributed in the sample population. This complicates a compensation through e.g. saving subsidies because such a scheme may not allow targeting individuals according to their specific losses.[16]

[16]The annual savings subsidy for a private pension plan are 154 Euros. Assuming no behavioural responses and a real interest rate of 2%, even a 30 year contract would only partially compensate for welfare losses of average individual.

Figure 5: Distribution of compensating variations

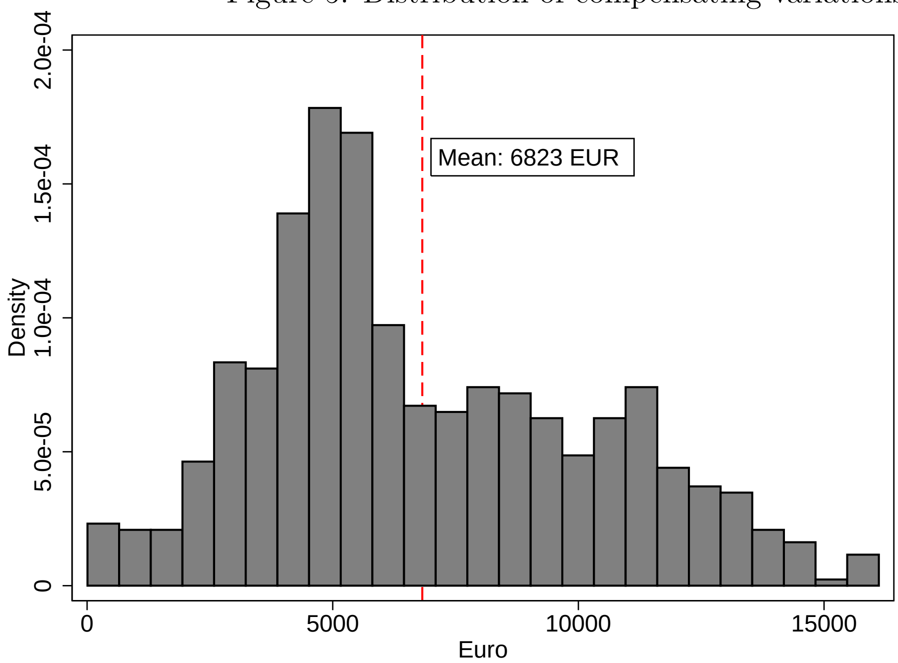
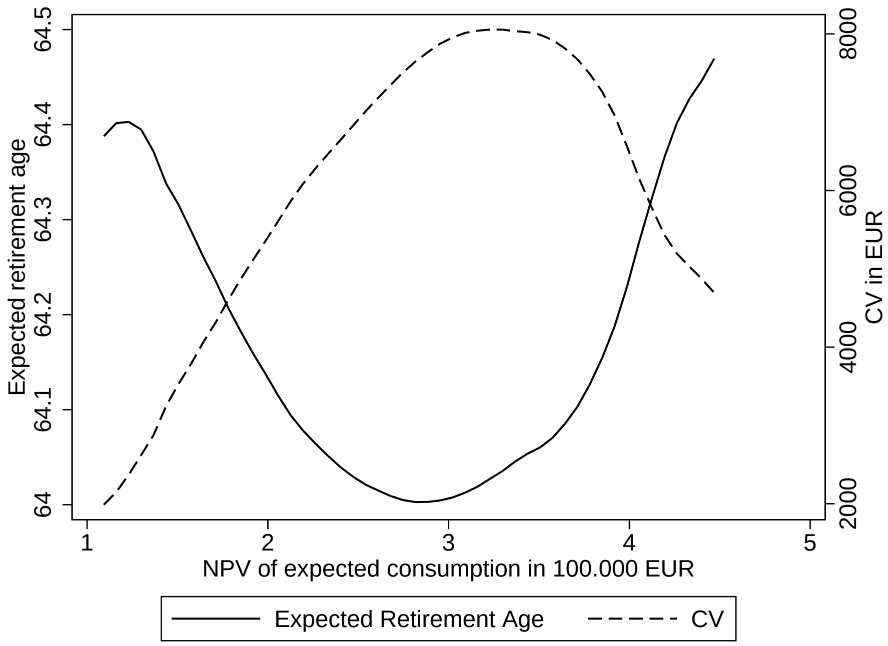


Figure 6 shows predicted compensating variations from a non-parametric regression of the estimated compensating variations on the NPVs of expected consumption. These predictions suggest that medium income individuals lose most through the introduction of retirement disincentives. As can be seen in Figure 6, this is driven by heterogeneity in the expected retirement age. Low and high income individuals tend to retire closer to age 65 anyway, which is due to low pension claims and high opportunity costs of retirement, respectively.

Figure 6: Predicted CVs and E(retirement age) by NPVs of consumption



At last, we also shed some light on the reform's fiscal implications. The average simulated net public returns of the reform amount to €25,017. This return is composed of the average change in pension benefits, pension contributions, and other contributions and tax payments. About half of the returns stem from the reduction in pension benefits while the other half stems from the increase in contributions and tax payments due to increases in the expected retirement age. Resorting to aggregate data of the German pension insurance, we find that our sample population corresponds to 424,286 individuals for the cohorts 1939-1945 (Deutsche Rentenversicherung (2013)). Hence, The simulated public returns per capita translate into overall public gains of 424,286 $\times$ €25,017 = €10,614,362,862 for these cohorts. It follows that the pension system's financial stability can be substantially increased by the introduction of retirement disincentives. However, this comes at the cost of more inequality and non-negligible welfare losses within the population of employees. Of course, overall welfare in the economy may still increase, given that longer life expectancies and demographic change required a reform of either the contribution scheme or the calculation of pension benefits. An analysis of overall welfare in the economy is beyond the scope of our study.

Figure 7: Net public returns of retirement disincentives

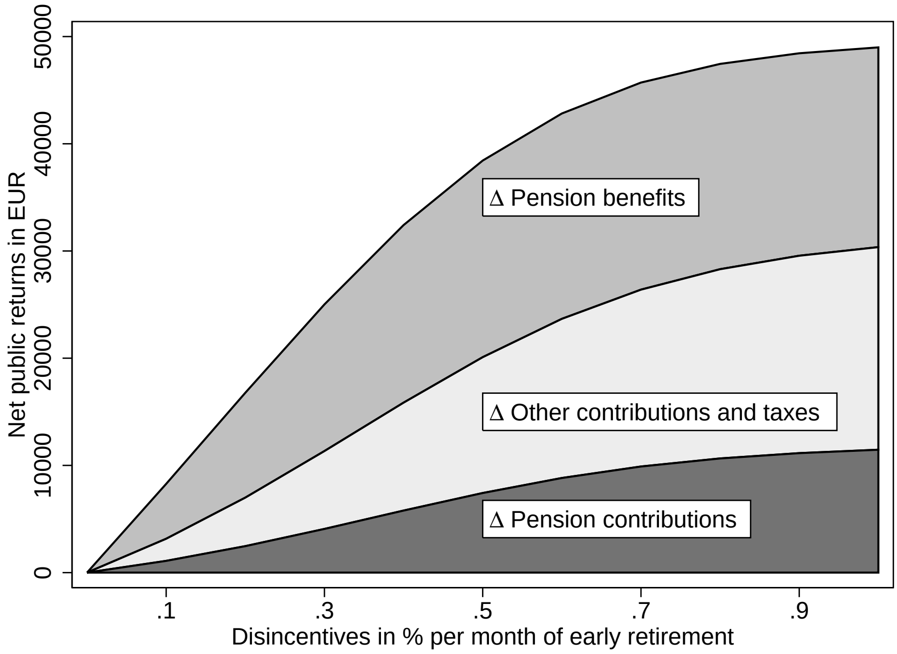


Figure 7 shows the fiscal implications by the level of retirement disincentives. As expected, the relationship is concave. The simulations demonstrate that there is still some scope for higher public returns by increasing the level of disincentives. Hence, the level of disincentives may still be a useful adjustment tool to further increase the pension system's financial sustainability.

6 Conclusion

We employ high quality administrative data to evaluate the effectiveness of early retirement disincentives introduced in Germany and to investigate the distributional, individual welfare and fiscal implications. We consider German males born between 1935 and 1945. Building on the fact that these birth cohorts are gradually affected by the disincentives, we are able to estimate parameters of a structural dynamic retirement model. Our model accounts in great detail for taxes and social security contributions which have a profound impact on net disposable income. This ensures a very good model fit.

The average simulated increase in expected retirement age through the reform is estimated to be 5.24 months. Hence, changes in incentives explain a substantial part of the observed change in retirement patterns of the considered cohorts. Further simulations demonstrate how retirement disincentives can be used to steer these individuals' retirement behavior. The effect of the reform on expected consumption is small and insignificant. When increasing the level of disincentives, the behavioral effect at some point overcompensates the effect of the penalties on expected consumption. We do find an effect of the implemented reform on average monthly retirement income (€-32.8).

We also compute changes in Gini coefficients of expected remaining lifetime consumption as well as equivalent and compensating variations to assess individual welfare effects. The simulated Gini coefficients indicate an increase in inequality through the reform. Furthermore, the average compensating variations suggest an average loss of €6823 in monetary terms. We show that the associated welfare losses are largest for medium income individuals and are only partially compensated by recently introduced subsidies for private old age provisions.

At last, we consider the fiscal implications and compute the net public returns of the introduction of retirement disincentives. The average simulated net public returns of the reform amount to €25,017. About half of the returns stem from the reduction in pension benefits while the other half stems from the increase in contributions and tax payments due to the rise in expected retirement age. The simulated public returns per capita translate into overall public gains for the cohorts 1939-1945 of about 10 Billion Euros. It follows that the pension system's financial stability can be increased by the introduction of retirement disincentives. However, this comes at the cost of more inequality and non-negligible welfare losses within the population of employees.

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7 Appendix

7.1 Appendix A: Dataset construction

The dataset consists of the SUFVSKT waves from 2002 and from 2004-2011. We can only use cohorts aged 66 or 67 in the respective year of the wave, as we need completed earnings bioraphies to clearly identify the time of old-age retirement. The cohorts 1938-1944 appear in two different waves, because they are included both at the age of 66 and at the age of 67. Since every SUF is a 25% sample of the VSKT, it is possible to match two waves for each of these cohorts and enhance the number of observations. There is no distinct case number (which is equal in all waves) and thus we identify duplicates (whom appear in two waves) on the basis of their employment biography and their collected earnings points. Since the employment biograhpies are included from age 14 onwards and completed at the age of 66, we draw on a large number of data points for the matching procedure and do not loose information.

Table A.1: Determinants of the pension system

Year	Average social security income	Pension insurance contribution ceiling	Pension insurance contribution rate
1970	13343	21600	8.5
1971	14931	22800	8.5
1972	16335	25200	8.5
1973	18295	27600	9
1974	20381	30000	9
1975	21808	33600	9
1976	23335	37200	9
1977	24945	40800	9
1978	26242	44400	9
1979	27685	48000	9
1980	29485	50400	9
1981	30900	52800	9.25
1982	32198	56400	9
1983	33293	60000	9.0833
1983	34292	62400	9.25
1985	35286	64800	9.4542
1986	36627	67200	9.6
1987	37726	68400	9.35
1988	38896	72000	9.35
1989	40063	73200	9.35
1990	41946	75600	9.35
1991	44421	78000	8.98
1992	46820	81600	8.85
1993	48178	86400	8.75
1994	49142	91200	9.6
1995	50665	93600	9.3
1996	51678	96000	9.6
1997	52143	98400	10.15
1998	52925	100800	10.15
1999	53507	102000	9.85
2000	54256	103200	9.65
2001	55216	104400	9.55
2002	28626	54000	9.55
2003	28938	61200	9.75
2004	29060	61800	9.75
2005	29202	62400	9.75
2006	29494	63000	9.75
2007	29951	63000	9.95
2008	30625	63600	9.95
2009	30506	64800	9.95
2010	31144	66000	9.95
2011	32100	66000	9.95

Table A.2: Other determinants of the social security system

	Health insurance		Unemployment insurance		Long-term care	
Year	contribution ceiling	contribution rate	contribution ceiling	contribution rate	contribution rate	VPI 2010
1998	75600	6.8	100800	3.25	0.85	82.34
1999	76500	6.8	102000	3.25	0.85	82.79
2000	77400	6.8	103200	3.25	0.85	83.97
2001	78300	6.8	104400	3.25	0.85	85.60
2002	40500	7	54000	3.25	0.85	86.87
2003	41400	7.2	61200	3.25	0.85	87.77
2004	41856	7.2	61800	3.25	0.85	89.22
2005	42300	8	62400	3.25	1.1	90.58
2006	42756	7.4	63000	3.25	1.1	92.03
2007	42756	7.7	63000	2.1	1.1	94.11
2008	43200	7.8	63600	1.65	1.1	96.56
2009	44100	7.9	64800	1.4	1.225	96.92
2010	45000	7.9	66000	1.4	1.225	98.01
2011	44550	8.2	66000	1.5	1.225	100.00
2012	45900	8.2	67200	1.5	1.225	101.90
2013	47250	8.2	69600	1.5	1.275	103.43

Table A.3: Composition of individual incomes - mirrored population (SOEP)

Age	Employment				Pensions				Unempl. benefit		married	population
	Employed		Self		PAYG		Other					
	share	sd	share	sd	share	sd	share	sd	share	sd	share	share
62	0.9640	0.1615	0.0004	0.0178	0.0283	0.1444	0.0000	0.0000	0.0073	0.0733	0.7802	0.4817
63	0.9155	0.2372	0.0100	0.0996	0.0657	0.2061	0.0000	0.0000	0.0089	0.0734	0.7555	0.4787
64	0.8274	0.3200	0.0092	0.0912	0.1581	0.3062	0.0010	0.0313	0.0043	0.0377	0.7010	0.4741
65	0.5773	0.4570	0.0020	0.0330	0.4103	0.4563	0.0064	0.0738	0.0039	0.0244	0.7326	0.4806
66	0.3563	0.4095	0.0048	0.0575	0.6377	0.4087	0.0010	0.0068	0.0002	0.0061	0.7235	0.4684
67	0.0989	0.2222	0.0138	0.0838	0.8873	0.2344	0.0000	0.0000	0.0000	0.0000	0.7248	0.4417
68	0.0755	0.2116	0.0090	0.0656	0.9155	0.2184	0.0000	0.0000	0.0000	0.0000	0.7555	0.4387

Source: SOEP waves 1984-2012

Note: West German men, cohorts 1935 to 1945, all numbers obtained from pooled cohorts.