Netspar

Network for Studies on Pensions, Aging and Retirement

NETSPAR ACADEMIC SERIES

Effectiveness of Early Retirement Disincentives

Individual Welfare, Distributional and Fiscal Implications

Timm Bönke, Daniel Kemptner and Holger Lüthen

DP 10/2015-044

Effectiveness of early retirement disincentives: individual welfare, distributional and fiscal implications

Timm Bönke*
Freie Universität Berlin

Daniel Kemptner
DIW Berlin

Holger Lüthen
Freie Universität Berlin and DIW Berlin

October 2015

Abstract: In aging societies, information on how to reform a pension system is essential to policy makers. This study scrutinizes the introduction of early retirement disincentives by a major pension reform in Germany. Employing administrative pension data and a detailed model of the German tax and social security system, we estimate a structural retirement model to examine to what extent disincentives are able to steer retirement behavior. We find that labor market participation and retirement behavior in general are strongly influenced by the level of disincentives. Looking at distributional, individual welfare and fiscal implications, we identify non-negligible individual welfare losses. For cohorts 1939 to 1945, the actually implemented disincentive level translates into net public returns of about 10 billion €.

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

JEL Classification: C61, H55, J26

Acknowledgement: We thank Netspar for financial support (Research grant: The introduction of disincentives for early retirement and its effect on labor market participation). Earlier drafts of this paper were presented at various venues. We thank the participants for valuable comments. Furthermore, we are grateful to the team at the Research Data Center at the German Federal Pension Insurance. The usual disclaimer applies.

*Corresponding author: timm.boenke@fu-berlin.de

1 Introduction

Aging populations exert increasing financial pressure on pension systems around the globe. Therefore, this central feature of modern welfare states is and has been subject to many fundamental reforms. Typical examples are the elevation of eligibility ages (Mastrobuoni, 2009; Staubli and Zweimüller, 2013; Ataly and Barret, 2015), pension level adjustments (Haan and Prowse, 2014) or pension system restructuring (Laun and Wallenius, 2013).[1] Apart from debates fueled by the Great Recession, the imminent retirement of the baby-boomer cohorts calls for fundamental reforms in most welfare states in the near future. Thus, evaluations on different pension reforms are highly relevant when discussing future pension policy design.

The German case serves as excellent example. 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 1970s, however, caused a rising fiscal imbalance. Particularly since the early 1990s, 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 et al., 2010). These reforms 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 (e.g. Börsch-Supan, 2000; Blundell, 2002). The effects are essential as statutory pensions account for about 85 % of the average household disposable income of the elderly population (Börsch-Supan and Reil-Held, 2001). While many of these reforms have been undertaken in other countries in a similar fashion, some reforms are not fully investigated yet and deserve further attention.

Notably, there are reforms that implement incentives in the pension scheme and give individuals the choice to retire within a certain time period at the cost of actuarial adjustments. Since individuals still have a (limited) choice, it is possible to use the implementation of such a reform for a study on actual as well as potential behavior. An analysis of these (potential) outcomes provides a valuable blueprint for future pension reforms. We model forward-looking agents that consider the option values of possible retirement decisions. The agents therefore recognize the impact of their choices on the accumulation of pension wealth and future consumption possibilities.

[1] An overview about recent reforms is given in Gruber and Wise (2007).

We contribute to the debate by providing evidence on distributional, individual welfare and fiscal implications of reducing pensions for early retirees. The focus lies on disincentives that increase with the distance between the actual/early and the regular retirement age and lead to permanent pension deductions. We model different disincentive levels and analyze to what extent disincentives are able to steer retirement behavior. We also compute changes in the expected remaining lifetime consumption, individual welfare losses and net public returns of pension behavior adjustments by disincentive level. Our results are conclusive for a broad variety of disincentive levels.

We pay particular attention to the 1992 pension reform in Germany, which introduced permanent pension deductions of 0.3% per month of early retirement (Hanel, 2010; Lüthen, 2015). The institutional changes were phased in and impact birth cohorts to a different degree. Therefore, the evaluation is non-trivial due to the lack of intra-cohort variation. We incorporate the comprehensive dynamic incentives of labor market participation and retirement behavior by estimating a structural dynamic retirement model (e. g. Rust and Phelan, 1997; French and Jones, 2011). Dynamic incentives are particularly relevant when modeling retirement choices because individuals account for the entire future stream of retirement incentives (Coile and Gruber, 2007). For an accurate estimation, we model the German tax and social security system in great detail and utilize high quality German administrative pension data.

For working males and the actually implemented disincentive level, we find a retirement entry delay of 5 month. The reform thus explains 63% of the overall increase in retirement age for the cohorts considered. The "dose-response" relationship between disincentive level and retirement entry suggests that a tripling of the actually implemented disincentive level incentivizes individuals to abolish early retirement completely. We further identify average individual welfare losses of about € 4000 and a pension loss that corresponds to about one year of average pension contributions. The losses are heterogeneously distributed and highest for medium income earners. The effects on remaining lifetime consumption and its distribution are rather small. Still, the reforms' fiscal implications correspond to about € 23,500 per individual, which translates into roughly € 10 billion for our fully affected cohorts 1939 to 1945. The dose-response relationship shows that for high levels of disincentives, this number even doubles.

The remainder of the article is structured as follows. The next Section describes the institutional setting in Germany and the data. Section 3 illustrates the conceptual framework. The core of the paper is Section 4, where we display our estimation results and conduct a policy analysis. Section 5 concludes.

2 Institutional setting and data

2.1 German 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. For their contributions the insurants acquire pension entitlements in form of earnings (or remuneration) points. Earnings points are calculated as ratio of employee's wage to average wage.[2] Hence, the number of earnings points corresponds to one (per year) if the employee's yearly wage corresponds to the average yearly wage. Over their working live employees accumulate earnings points until retirement. At retirement the individual pension level is calculated on the basis of these accumulated earnings points (EP). Thus, the pension level mirrors the length of the working live and the average position in the earnings distribution. The *pension formula* (§ 64, Sozialgesetzbuch VI) provides the details on how to calculate the monthly pension $p_{n,t}$ for individual n:

$$p_{n,t} = A_t \cdot RA_n \cdot Z_n \cdot EP_n$$

where A_t corresponds to the *pension value*. Basically, the *pension value* is the amount of money that is multiplied with the sum of earnings points EP to calculate the monthly pension. The value is adjusted every calendar year (for an overview see Table 2 below). RA represents the pension type, which is 1 for old-age pensions. At last, Z, the age factor, is introduced by the reform and contains the potential deductions due to early retirement: $Z = (1 - deduction)$.

The pension scheme offers various retirement possibilities depending on the retiree's individual situation. We focus on agents who have a choice between continuing to work and retirement and therefore abstract from previously unemployed or disabled individuals. The individuals considered are able to claim the *regular old-age pension* at age 65 or the *pension for long-term insured* after age 63, which is conditioned on having spent at least 35 years in the pension system.[3] Retiring before age 65 is viewed as early retirement. Women are excluded due to their diverging pension prospects and the

[2] Appendix A1 provides an overview on key institutional figures. For further details on the accumulation of earnings points or the pension formula see Lüthen (2015).

[3] We disregard individuals claiming the following old-age pensions: pension for previously unemployed, disability pension and the special pension for women. These can be claimed at age 60 under different eligibility criteria like time spend in the pension system. These “waiting periods” consist of periods of contributions, wage replacement benefits (unemployment, sick-pay, invalidity), child-raising and times of education. A detailed overview on eligibility and pension types is provided in Lüthen (2015).

low number of cases when conditioning on similar early retirement eligibility. In sum, we concentrate on men with a strong labor marked attachment whom are eligible to retire at age 63 even if they choose to work longer

2.2 Introduction of early retirement disincentives

In 1992, Germany introduced a major pension reform to equalize the different retirement ages monetarily. The aim was to balance the pension wealth of early retirees and regular retirees. Since early retirees have a prolonged benefit period, one possibility was to lower their pension wealth. Therefore, the reform implemented permanent pension deductions of 0.3 % per month of early retirement. The deduction level results from the distance (in month times 0.3 %) between the actual retirement age and regular retirement age 65.[4] Still, all cohorts were allowed to retire at 63. The deductions were gradually phased in for cohorts 1937 and 1938 and fully affect those born thereafter. At this, the maximum deduction starts at 0.3% for those born in January 1937 and increases by 0.3 % points per month of birth up to 7.2 % for cohorts born after 1938. Thus, the individuals born during the phase-in are only partially affected by the reform. Table 1 provides an overview and exemplary date of birth examples.

Table 1: Phase-in of disincentives

Date of birth	Retirement age without deductions	Distance to 65 without deduction (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%

2.3 Data

To calculate pension entitlements as described above, the pension insurance collects information on all contributors' earnings biographies. The dataset we use, the Insurance Account Sample (*Versicherungskontenstichprobe*, VSKT), is a stratified random sample of these records. Each wave

[4] See Lüthen (2015) 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 workers to retire at 65.

contains information on individuals aged between 30 and 67 in the reference year.[5] From age 14 until age 65, the VSKT provides a monthly history of employment, unemployment, sickness, and earnings points. The latter are used to compute monthly gross earnings. The total sum of earnings points then provides the foundation to calculate the gross pensions. To obtain net incomes, we subtract taxes and social security contributions. Thereby, we account for all regulations and changes affecting monthly disposable income and pensions. For further details, see Appendix A.

To ensure early retirement eligibility, we restrict the sample to those having spent at least 35 years in the pension system before turning 63. This also ensures that the sample does not include individuals with substantial labor market earnings unnoticed by the Federal Pension Insurance (i. e. self-employed, civil servants or long-term emigrants). Further, we exclude individuals who have worked in East Germany or the former German Democratic Republic (GDR). For the cohorts considered, neither labor market situation nor working life is comparable to the West German context.[6] In the final sample, 43 to 141 individuals remain per cohort (Table 2).

While German social security data records earnings very accurately, one major drawback is the top coding of earnings information at the contribution ceiling. For a better approximation of true distribution of earnings above the ceiling, we impute earnings of 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.[7] Further, the VSKT lacks information on other income sources, wealth or household context. A comparison with survey data reveals these limitations not to be harmful. The considered group of retirees receives almost exclusively income from PAYG-pensions and wages.[8] This income accounts on average for more than 90% of their total household income. About ¾ are married.[9]

Table 2 provides key descriptives of the sample. Column 1 shows that the observed average retirement entry age increases by about 8 month across cohorts. Column 2 reveals declining average pensions in

---

[5] We use the scientific use files for on-site-use (waves SUFVSKT2002 and SUFVSKT2004 to SUFVSKT2012), provided to researchers by the Data Research Center of the German Federal Pension Insurance. We use all 10 waves in our analysis (see Appendix B for further information).

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

[7] Bönke et al. (2015) provide a detailed description of the imputation procedure in Online Appendix III.3. They find that, on average, top coding affects 7 % of all West German men in the VSKT.

[8] Tables A3 and A4 provide information on the relevance of different income sources and marital status. For the overall population, Bönke et al. (2015) document that the VSKT represents about 80 % of the total male labor force in West Germany and that its cross-sectional earnings distributions are similar to those found in survey data.

[9] Most of the retirees in our sample are married and thus eligible for joint taxation. However, Table A4 shows that the spouses contribute only a very small fraction to total household income. For robustness, we calculate a scenario assuming joint taxation without spousal income. Our results robust to this variation (Tables B1 and B2).

real terms, although pension entitlements remain stable across cohorts (column 3). Columns 4 and 5 add further insights to this development by showing the *pension value* and the average amount of disincentives. At age 65, the *pension value* slightly increases up to cohort 1937 and then decreases for later cohorts (calendar years 2000-2010). The column "disincentives" gives the average deduction on the monthly pension realized by each cohort. For fully affected cohorts, the average deduction fluctuates between 2.6% and 4.3%. All changes are accounted for when modeling the institutional background.

Table 2: Sample descriptives

Cohort	Entry age	Monthly pension	Earnings points	Pension value age 65	Disincentives in %	Number of observations
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	64.32	1580.62	56.08	27.28	2.67	95
1943	64.36	1574.17	55.01	26.81	2.56	122
1944	64.31	1555.39	54.57	27.18	2.73	115
1945	64.23	1562.70	55.82	27.20	3.08	141

Note: The average pensions and the pension values are in 2010 Euro values. The numbers of observations represent the final sample. Source: SUFVSKT2002 and SUFVSKT2004 to SUFVSKT2012, Deutsche Rentenversicherung (2014), (own calculations)

3 Model and estimation

3.1 Dynamic retirement model

Based on assumptions about individual preferences (consumption and leisure time/disutility of work) and our detailed modeling of the institutional setting, our model explains individual retirement choices. We assume that individuals are forward looking and maximize expected lifetime utility in each time period (month) by deciding between continued 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 a certain choice (e.g. working also involves the option of working in future periods and further increasing pension wealth). The following subsections outline the model in greater detail.

A. Objective function

Each month between ages 63 and 65, individuals decide whether to continue working or to retire. The total number N of individuals is indexed by n. Discrete time is measured in months t, running up until age 100 (period T). Each individual n receives the utility flow $U(\boldsymbol{s}_{nt}, d_{nt})$ in each period t. $\boldsymbol{s}_{nt}$ denotes a vector of state variables (age, birth cohort, accumulated pension points, gross wage, and previous period's choice) and $d_{nt} \in \{0,1\}$ is a dummy variable indicating the 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 64, month 12 ($t = 24$).

Each month t, individual n observes the state variables $\boldsymbol{s}_{nt}$ and makes the retirement choice d_{nt} to maximize expected lifetime utility:

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

with β denoting a monthly subjective time discount factor, which is set to $\sqrt[12]{0.96}$ (Gourinchas and Parker, 2002). p_{bt+j} indicates the individual's conditional survival of being alive in period $t + j$, given survival until period t and belonging to cohort b. Cohort specific mortality rates ensure a realistic setup and also help identifying the parameters in the estimation procedure by inducing cohort-specific heterogeneity in the dynamic incentives.[10]

B. Utility function

The following time separable random utility model represents individual preferences regarding consumption and disutility of work:

[10] To account for rising life expectancy, we use official mortality tables supplying cohort-specific projections (Statistisches Bundesamt, 2006).

(2) $$U(\boldsymbol{s}_{nt}, d_{nt}) = \alpha \frac{c(\boldsymbol{s}_{nt}, d_{nt})^{(1-\rho)} - 1}{(1-\rho)} + L(d_{nt}) + \epsilon_{nt}(d_{nt})$$

$$\begin{aligned} L(d_{nt}) = \delta_1 + [&\delta_2\, min(t, 3) + \\ &\delta_3\, min(t-3{,}3)\,(t > 3) + \\ &\delta_4\, min(t-6{,}3)\,(t > 6) + \cdots + \\ &\delta_9\, min(t-21{,}3)\,(t > 21)] \times [1 - d_{nt}] \end{aligned}$$

The random component $\epsilon_{nt}(d_{nt})$ is assumed to be type 1 extreme value distributed. $c(\boldsymbol{s}_{nt}, d_{nt})$ denotes the level of consumption associated with state $\boldsymbol{s}_{nt}$ and choice d_{nt} and thus corresponds to individual disposable income.[11] ρ is the coefficient of relative risk aversion and α a consumption weight. $L(d_{nt})$ depicts a linear spline function modeling a flexible specification of individual disutility of labor. The function is allowed to change the slope every three month of age. We also estimate a model specification allowing for unobserved heterogeneity in δ_1. Neither the central preference parameter ρ nor any of our postestimation outcomes are sensitive to this change.[12] We further define the vector $\boldsymbol{\theta} = (\alpha, \rho, \delta_1, .., \delta_9)$ to contain all parameters of the utility function.

C. Value function

Let the Markov transition function $q(\boldsymbol{s}_{nt+1}|\boldsymbol{s}_{nt}, d_{nt})$ capture individual beliefs about future states. Since all state variables evolve deterministically, $q(\boldsymbol{s}_{nt+1}|\boldsymbol{s}_{nt}, d_{nt})$ is a deterministic function. The only exception is the utility shock $\epsilon_{nt}(d_{nt})$, which we do not regard as a state variable. By Bellman's principle of optimality, the value function $V_t(\boldsymbol{s}_{nt})$ can be written recursively as

[11] Before retirement, individuals earn a gross wage. In case of early retirement, some monthly wages between ages 63 and 65 are unobserved. We impute the counterfactual wage relying on the last real wage observed in the respective month of the previous year. This corresponds to the wage observed 12 or 24 month before the imputation. Thus, we account for monthly wage volatility.

[12] In a robustness check, we also estimate a specification that allows for unobserved heterogeneity in the disutility of work by assuming two unobserved types (Heckman and Singer, 1984). The second type is estimated to represent only about 7% of the population. Central parameters are unaffected and the model fit only improves marginally, but precision is lowered. We therefore refrain from modeling unobserved heterogeneity in the baseline model. Tables B1 and B2 in the Appendix display parameters and postestimation outcomes for the alternative specifications.

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

where $g(\cdot)$ denotes the probability density function of the utility function's unobserved random components. $D(\boldsymbol{s}_{nt})$ is the choice set available to individual n in period t and contains the choice between employment and retirement. This choice has to be made each month after the eligibility age 63 until retirement (age 65 at the latest). After retirement, individuals have no more options to choose from. 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 dynamic choice framework. The difference in the expected discounted future utility between working and not working reflects the option value of the respective choices.

D. Choice probabilities and log-likelihood

Given the finite horizon of the individual's optimization problem, it can be solved recursively. For the last period T, the expected value function $v_t(\boldsymbol{s}_{nt}, d_{nt})$ corresponds to the current period's expected utility flow:

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

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

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

The computation of the expected value functions between mandatory retirement (age 65) and T is comparatively simple as individual choices are limited until age 65. Thereafter, the real net income stream remains constant. Rust (1987) shows that when assuming additive separability and conditional independence, the conditional choice probabilities have a closed form solution (here mixed logit probabilities):

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

The log-likelihood function of the sample is given by

(8) $$\sum_{n=1}^{N}\sum_{t=1}^{T} \log\left\{\sum_{d_{nt}} Prob(d_{nt}|\boldsymbol{s}_{nt}, \boldsymbol{\theta}) \times I(d_{nt})\right\}$$

with $I(d_{nt})$ indicating the individual choice observed in period t. The likelihood contributions then correspond to the respective conditional choice probabilities, abstracting from random transitions of state variables.

3.2 Estimation and model fit

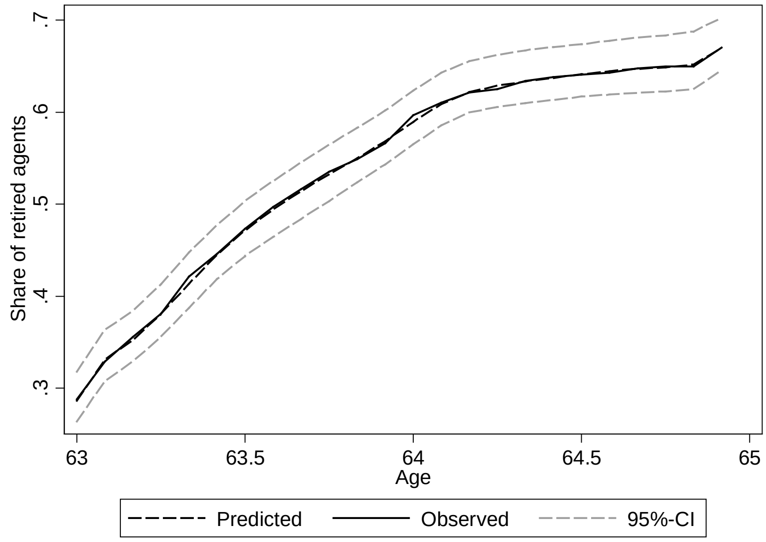
The model is estimated by maximum likelihood. An overview on parameter estimates is displayed in Table 4. Our estimate of the relative risk aversion, $\rho = 1.5$, is in line with previous studies (see e.g. Chetty, 2006), although our identification is based on retirement choices only. The estimates are independent of their starting values and the small standard errors indicate precise estimation. In the following, confidence intervals of postestimates are computed by applying a parametric bootstrapping method. Based on the inverse of the Hessian of the log-likelihood function, the procedure relies on 200 draws from the asymptotic sampling distribution of the estimated model parameters. Figure 1 compares predicted and observed shares of retirees by age and reveals a very good internal validity.

Table 3: Parameter estimates, baseline scenario

α	0.213	δ_3	-0.166	δ_7	0.221
	(0.0294)		(0.0635)		(0.1377)
ρ	1.502	δ_4	0.040	δ_8	-0.156
	(0.0876)		(0.0614)		(0.1372)
δ_1	-3.004	δ_5	0.075	δ_9	1.109
	(0.2283)		(0.0706)		(0.1179)
δ_2	1.058	δ_6	-0.255		
	(0.1093)		(0.0952)		
Log-likelihood	-1878.41				

Note: Standard errors in parenthesis.

Figure 1: Comparison of predicted and observed shares of retirees



Source: SUFVSKT2002 and SUFVSKT2004 to SUFVSKT2012

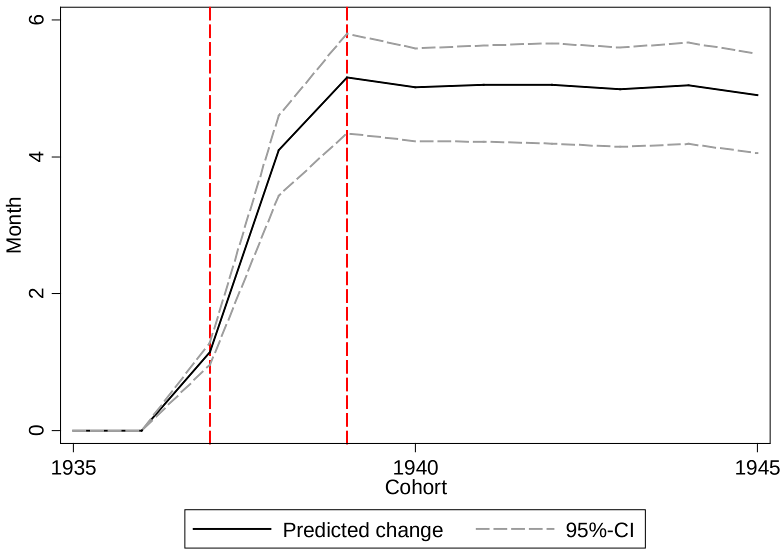
4 Results and policy analysis

We use the model to simulate economic outcomes and confidence intervals for counterfactual scenarios. We obtain the results by simulating a counterfactual baseline scenario without retirement disincentives and then compare these results to the baseline scenario. We start with the effects of the actually implemented disincentive level and then provide results on the dose-response-relationship of our outcomes and the disincentive level in general.

4.1 Actually implemented disincentive level

Figure 2 provides changes in expected retirement age by birth cohort. The reform causes an average postponement of the retirement entry of 5 months. This finding is stable across fully affected cohorts 1939 to 1945. We also identify smaller effects for cohorts 1937 and 1938, who were affected by the reforms phase-in. Hence, the introduction of disincentives through the reform explains 5/8 of the observed change in retirement patterns across cohorts.[13]

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



Source: SUFVSKT2002 and SUFVSKT2004 to SUFVSKT2012

Table 4 provides an overview on average reform effects, which are based on fully affected cohorts 1939-1945. Table 4 reveals modest reform effects on the NPVs of expected remaining lifetime consumption[14] at age 63 and the Gini of these NPVs. Without disincentives, retirement behavior is more heterogeneous, which offsets some initial inequalities in pension claims at age 63. However, we find that pensions decrease by € 38.8 per month. Put another way, the average individual loses a bit more than the equivalent of one year of average pension entitlements (i.e. one EP).

The fiscal implications of delayed retirement entries are substantial – the average net public return amounts to € 23,485 per individual. About half of the return stems from reduced pension wealth (€ 14,071). The remaining amount stems from increases in pension contributions (€ 3748) and increases in tax payments and other contributions (€ 5665). Resorting to aggregate data of the German pension insurance, we find that our sample population corresponds to 424,286 individuals for cohorts 1939 to

[13] Average retirement age increased by about 8 months between cohorts 1935 to 1945 (Table 2).
[14] The NPV constitutes the sum of the discounted expected consumption stream at age 63.

1945 (Deutsche Rentenversicherung, 2014). We assess that the simulated public returns per capita translate into overall public gains of 424,286 $\times$ € 23,485 $\approx$ € 10 billion for these cohorts.

Table 4: Simulated effects of the actually implemented disincentive level

	Reform effects	CI (95%)
ΔE[retirement age] (months)	5.03	[4.2;5.64]
ΔE[NPV of consumption]	-1,415	[-3,081;-307]
ΔE[NPV of consumption] (%)	-0.62%	[-1.22%;-0.24%]
ΔGini coefficient (%)	3.6%	[2.4%;4.6%]
ΔMonthly retirement income	€ -38.8	[-42.1; -37]
Average compensating variation	€ 3,929	[3655;4334]
Average equivalent variation	€ 3,795	[3881;4442]
NPV of net public returns	€ 23,485	[21,292;25,234]
ΔE[NPV of pension wealth]	€ 14,071	[13,376;14,667]
ΔE[NPV of pension contributions]	€ 3,748	[3,155;4,216]
ΔE[NPV of other contr. & taxes]	€ 5,665	[4,751;6,374]

Note: See text for details; Source: SUFVSKT2002 and SUFVSKT2004 to SUFVSKT2012

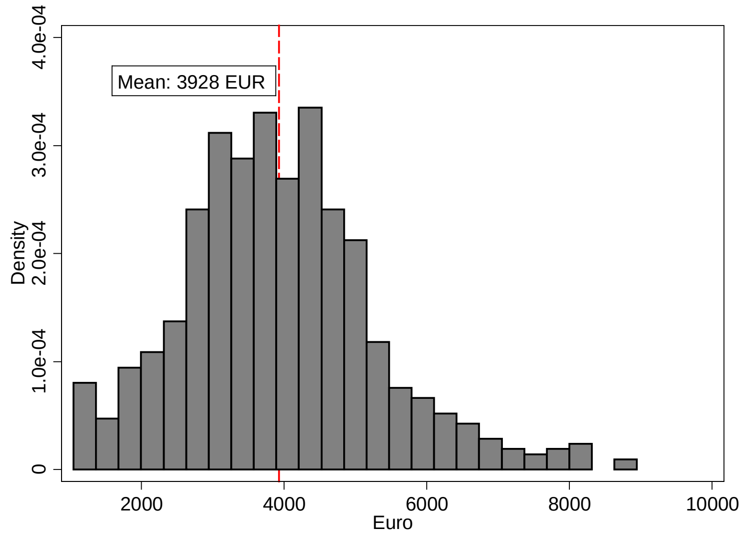
Still, we find non-negligible individual welfare losses in terms of compensating and equivalent variations, which amount to about € 4000. The equivalent variation (EV) indicates how much an individual would be willing to pay at age 63 to avoid the introduction of the retirement disincentives. The compensating variation (CV) indicates the amount that an individual would have to receive at age 63 to be fully compensated for the reform. The variations refer to NPVs at age 63 that are annuitized over the remaining lifetime. Obviously, individuals who would have worked until age 65 even without disincentives are unaffected. The estimates provide quantifications for the average decline in individual welfare and further allow a disaggregated analysis of individual welfare losses along the income distribution.

Figures 3 and 4 are concerned with some interesting details regarding the compensating variation. From Figure 3 it is clear, that the losses are very heterogeneously distributed in the sample population. This complicates compensation through e.g. saving subsidies because such a scheme may not allow targeting individuals according to their specific losses.[15] Figure 4 shows a non-parametric regression of estimated compensating variations on NPVs of expected consumption. The results suggest that medium income earners lose most through the introduction of retirement disincentives. This is driven by earnings-level heterogeneity in the expected retirement age. Low and high income individuals tend

[15] Indeed, Germany introduced subsidies for private pension plans in 2002 to compensate employees for lower levels of expected PAYG-pensions due to various reforms. For a distributional analysis and further details see Corneo et al. (2015).

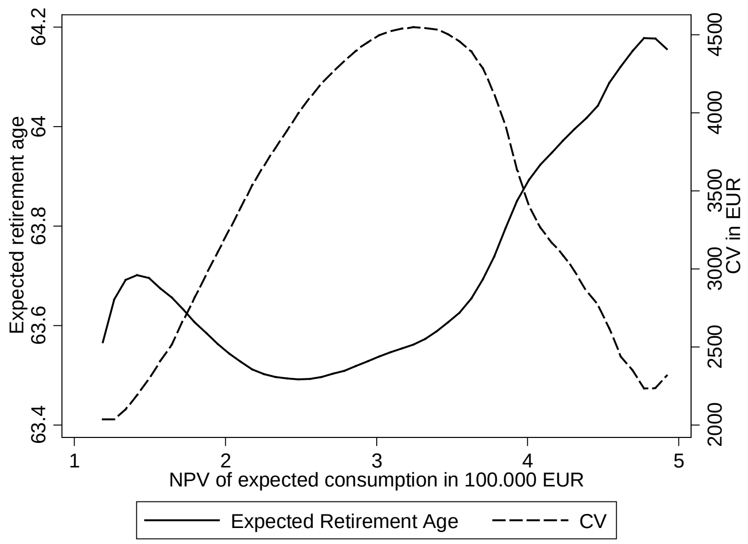
to retire closer to age 65 anyway, which is due to low pension claims and high opportunity costs of retirement, respectively.

Figure 3: Distribution of compensating variations



Note: Euro in 2010 real values. Source: SUFVSKT2002 and SUFVSKT2004 to SUFVSKT2012

Figure 4: Predicted CVs and E(retirement age) by NPVs of consumption



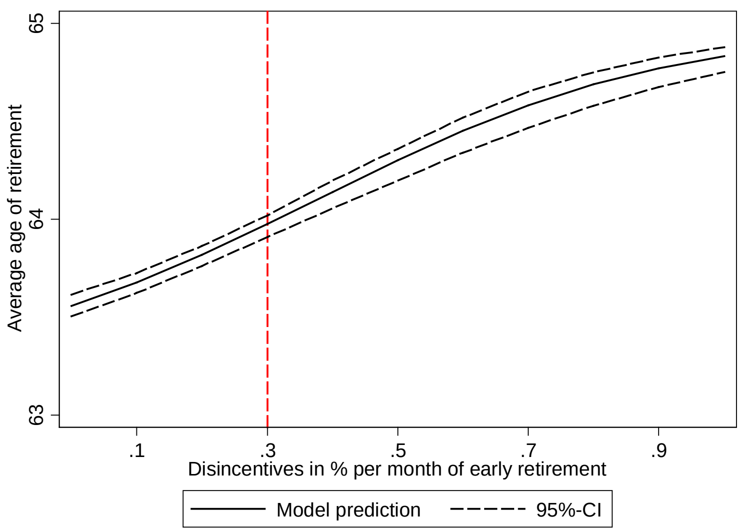
Note: Euro in 2010 real values. Source: SUFVSKT2002 and SUFVSKT2004 to SUFVSKT2012

4.2 Varying disincentive levels

To analyze the effects of retirement disincentives in general, we simulate scenarios for different disincentive levels. Those levels range from 0% to 1% per month of early retirement. We set the distance between each disincentive level to 0.1%, resulting in 10 counterfactual scenarios. The simulations are based on fully affected cohorts 1939 to 1945. This section presents graphical results; the actually implemented reform level of 0.3% per month is marked with a vertical dashed line. The exercise sheds light on the "dose-response" relationship between disincentive level and outcome measure.

Figure 5 displays the average retirement age by disincentive level. The simulations suggest a concave relationship and demonstrate how disincentives can be used to steer retirement behavior. For high disincentive levels, most individuals retire at age 65 such that hardly any penalties are realized ("prohibitive effect"). The introduction of the highest disincentive level would have delayed retirement by about 15 instead of 5 months.

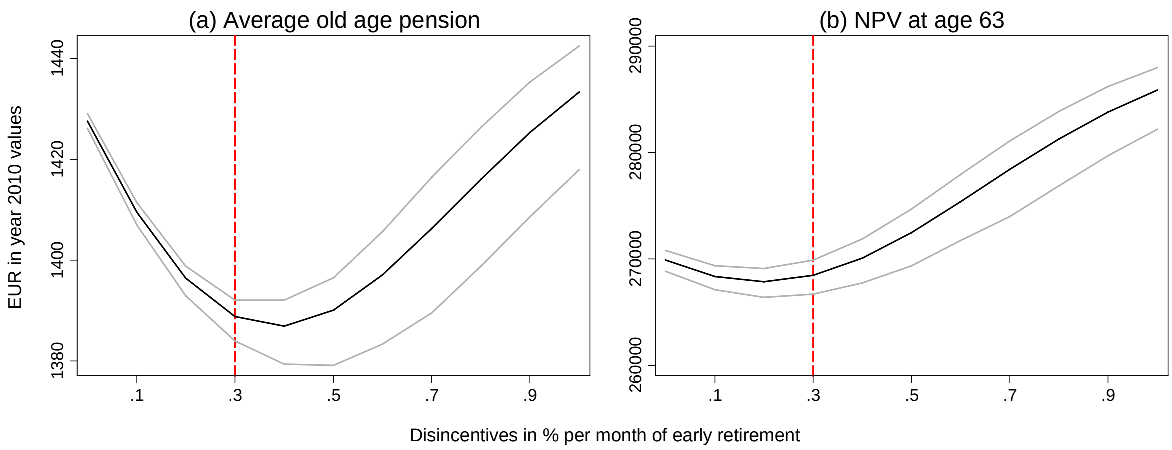
Figure 5: Expected retirement age by disincentive level



Source: SUFVSKT2002 and SUFVSKT2004 to SUFVSKT2012

The individual pension level is affected by two countervailing effects induced by the reform. First, early retirement entails a penalty on pension benefits. Second, individuals delay exiting the labor market and receive labor earnings for a longer period of time (notice that wage exceeds pension benefits in most cases). More contributions then translate into higher pension claims. Thus, the behavioral effect of delayed retirement is able to counteract the disincentive effect at some point. With that in mind, it is not surprising that Figure 6 shows a u-shaped relationship between pension and disincentive level. For that reason, a disincentive level of 0.4 % per month yields the lowest average pension — both reducing and enhancing the disincentive level increases average retirement income. When decreasing the disincentive level, the behavioral reactions are small but pensions still rise. When increasing, the behavioral effect outweighs the penalty effect and pensions increase. Figure 6 also shows a similar relationship between disincentive level and remaining lifetime consumption. The lowest NPV however is realized at a disincentive level of 0.2%. At 0.3%, the increases in labor market earnings almost outweigh the decreases in pension level. At higher disincentive levels, both pension level and labor market earnings increase due to delayed retirement.

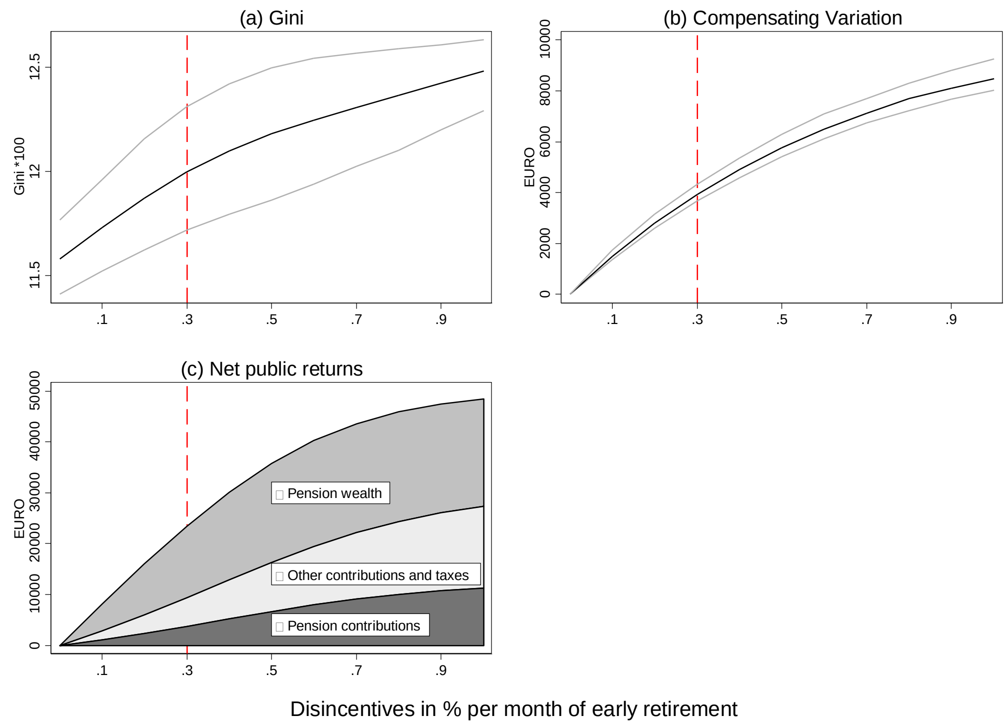
Figure 6: NPVs of expected consumption and retirement income by disincentive level



Note: Euro in 2010 real values. Source: SUFVSKT2002 and SUFVSKT2004 to SUFVSKT2012

Figure 7 reveals concave relationships between disincentive level and net public returns, inequality of remaining lifetime consumption and individual welfare losses. For low disincentive levels, further advances yield large increases in net public returns, inequality and welfare losses. For already high disincentive levels, further gains are small as individuals retire close to age 65 already. Thus, there is some scope for higher public returns by increasing the disincentive level. Even after the reform's introduction, increasing the disincentive level would thus further foster the pension system's financial sustainability. The net public returns can also be related to the pension expenditures under the 0%-disincentive scenario. This reveals that the net public returns correspond to 10% of average pension wealth under 0.3%-scenario and for 20% at the 1%-disincentive level. However, the increase in financial stability comes at the cost of increasing inequality and non-negligible individual welfare losses within the population of retirees. Higher disincentive levels intensify these effects and diminish at the margin. Still, for each disincentive level, the net public return are about six times as high the average individual welfare losses.

Figure 7: Gini, CVs and net public returns by disincetive level



Note: Euro in 2010 real values. Source: SUFVSKT2002 and SUFVSKT2004 to SUFVSKT2012

5 Conclusion

This study evaluates the effectiveness of early retirement disincentives and its distributional, individual welfare and fiscal implications. The focus lies on disincentives that increase with the distance between the actual/early and the regular retirement age and lead to permanent pension deductions. We model different disincentive levels and analyze to what extent disincentives are able to steer retirement behavior. We also compute changes in the expected remaining lifetime consumption, individual welfare losses and net public returns of pension behavior adjustments by disincentive level. Our results are conclusive for a broad variety of disincentive levels.

We pay particular attention to the 1992 pension reform in Germany, which introduced permanent pension deductions of 0.3% per month of early retirement. For the actually implemented level, we estimate an increase in retirement age of about 5 months. This implies that the reform can account for 63% of the observed change in retirement patterns across cohorts. Further simulations demonstrate that tripling the actually implemented level essentially prevents individuals from claiming early retirement at all. Whereas the actually implemented disincentive level lowers expected consumption at age 63 and pensions, higher levels increase both consumption and pensions. This insights are especially interesting in regard of recently introduced reforms in Germany, namely the abolishment of disincentives for some pensioners with very long employment histories and the elevation of the regular retirement age to 67.

Disincentives are found to increase inequality in expected consumption, cause individual welfare losses and lead to positive net public returns. All three show a concave relationship with the disincentive level. The individual welfare losses are largest for medium income earners and difficult to compensate due to their heterogeneous distribution. The net public returns amount, if multiplied with the number of affected individuals of cohorts 1939-1945, to about 10 billion Euros. It follows that early retirement disincentives substantially increase the pension system's financial stability. The higher the level, the greater the net public returns, although with diminishing marginal returns. However, this comes at the cost of more inequality and non-negligible individual welfare losses within the population of retirees. Of course, overall welfare in the economy may still increase, given that longer life expectancies and demographic change requires a reform of either the contribution scheme or the calculation of pension benefits.

Appendix

Appendix A: Taxation, social security contributions and sample selection

The income from PAYG- pensions and employment constructed from the available information provided in the VSKT are gross. To obtain net incomes, we subtract social security contributions and personal income taxes from gross earnings and pensions. Because the burden of taxes and social security contributions heavily depends on whether being an employee or retiree, a concise overview of the procedure and underlying assumptions to obtain net incomes is provided in subsections A.1 and A.2.

A.1 Social security contributions

The calculation of social security contributions is straight forward. Regular employees considered in our sample have to contribute to the pension, unemployment, health and long term care insurance. Pensioners only have to contribute to the health and long term care insurance. Note, rates for pensioners and regular employees differ. Assessment basis is insurable income up to the respective contribution ceiling. Tables A1 and A2 list the key determinants to calculate statutory social security contributions for assessment years 1998 to 2011. Displayed contribution rates are annual averages. In case of the statutory health insurance, actual contribution rates differ between insurance providers. Our calculation assumes the average contribution rates published by Deutsche Rentenversicherung (2014). Further, employees with earnings above the compulsory insurance exemption limit may opt for a private health insurance instead of the statutory. We disregard this possibility.

Between years 1998 and 2011, employees face a joint burden on gross earnings from contributions of roughly 23 %, not including the employer's share. Social security contributions are usually almost evenly split between employee and employer. Gross earnings are net of employer's contribution and therefore only the employee's contributions need to be deducted. 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. Social security contributions are calculated on hypothetical gross annual earnings and then deducted from gross monthly earnings. In contrast to employees, pensioners are subject to a combined average burden of 8 - 10%, which is deducted from the monthly pension.

Table A1: Pension and unemployment insurance

Year	Average social security income	Contribution ceiling	Contribution rates	
			Pension insurance	Unemployment insurance
1998	52925	100800	10.15	3.25
1999	53507	102000	9.85	3.25
2000	54256	103200	9.65	3.25
2001	55216	104400	9.55	3.25
2002	28626	54000	9.55	3.25
2003	28938	61200	9.75	3.25
2004	29060	61800	9.75	3.25
2005	29202	62400	9.75	3.25
2006	29494	63000	9.75	3.25
2007	29951	63000	9.95	2.1
2008	30625	63600	9.95	1.65
2009	30506	64800	9.95	1.4
2010	31144	66000	9.95	1.4
2011	32100	66000	9.95	1.5

Note: Values until 2001 in DM and in Euro thereafter. Contribution rates are annual averages for employees, contributions for employers differ slightly. Pensioners are not subject to pension or unemployment insurance contributions. Source: Deutsche Rentenversicherung (2014) (own calculations)

Table A2: Health and long-term care insurance

Year	contribution ceiling	contribution rates		
		Health insurance – employees	Long-term care insurance- employees	Health and long term care insurance - pensioners
1998	75600	6.8	7.575	0.85
1999	76500	6.8	7.6253	0.85
2000	77400	6.8	7.6	0.85
2001	78300	6.8	7.6	0.85
2002	40500	7	7.725	0.85
2003	41400	7.2	7.925	0.85
2004	41856	7.2	8.27505	0.85
2005	42300	8	9.05	1.1
2006	42756	7.4	9.25	1.1
2007	42756	7.7	9.4	1.1
2008	43200	7.8	9.7	1.1
2009	44100	7.9	10	1.225
2010	45000	7.9	9.85	1.225
2011	44550	8.2	10.15	1.225

Note: Values until 2001 in DM and in Euro thereafter. Contribution rates are annual averages for employees/pensioners, contribution rates for employers/pensions insurance differ slightly. Source: Deutsche Rentenversicherung (2014) (own calculations)

A.2 Personal income tax

In Germany, personal income tax depends on several characteristics of the tax unit not available in our data. For our calculation we assume that all taxable income solely stems either from employment and/or PAYG pensions. Other sources of income are not recorded in our data. In Table A3 and A4 we provide an overview of the actual composition of household and individual incomes for the considered population according to the SOEP. The population depicted in Tables A3 and A4 mirrors our sample regarding age, region, employment status, earnings biography and gender. For our sample, household and individual incomes are predominantly comprised of earnings from employment and PAYG-pensions, which can be observed in our data. Other pensions, transfers or asset income are negligible small.

Table A3: Composition of individual income and marital status

Age	employment				pensions				unempl. benefit		married	
	employed		self		PAYG		other					
	Share	sd	Share	sd	share	sd	share	Sd	share	Sd	share	sd
62	0.96	0.16	0.00	0.02	0.03	0.14	0	0	0.01	0.07	0.78	0.48
63	0.92	0.24	0.01	0.10	0.07	0.21	0	0	0.01	0.07	0.76	0.48
64	0.83	0.32	0.01	0.09	0.16	0.31	0.00	0.03	0.00	0.04	0.70	0.47
65	0.58	0.46	0.00	0.03	0.41	0.46	0.01	0.07	0.00	0.02	0.73	0.48
66	0.36	0.41	0.00	0.06	0.64	0.41	0.00	0.01	0.00	0.01	0.72	0.47
67	0.10	0.22	0.01	0.08	0.89	0.23	0	0	0	0	0.72	0.44
68	0.08	0.21	0.01	0.07	0.92	0.22	0	0	0	0	0.76	0.44

Note: Income shares of total individual income. Sample comprised of West German males born between 1935 and 1945 in regular insurable employment at age 62. Source: SOEP waves 1984-2012.

Table A4: Composition of household income

Age	Labor income		PAYG Pensions		Asset incmoe	
	Share	sd	Share	sd	share	sd
62	0.8781	0.1869	0.061	0.1583	0.0418	0.0896
63	0.8465	0.2248	0.0877	0.1901	0.0353	0.0682
64	0.7571	0.2865	0.1723	0.2531	0.039	0.084
65	0.5669	0.3886	0.3222	0.3473	0.0512	0.0872
66	0.3922	0.354	0.4793	0.3281	0.0458	0.0759
67	0.2024	0.2577	0.6367	0.2814	0.0637	0.1038
68	0.1754	0.2669	0.6773	0.2865	0.0557	0.0905

Note: Income shares of total household income. Sample comprised of households with a West German male born between 1935 and 1945 in regular insurable employment at age 62. Source: SOEP waves 1984-2012.

Our baseline calculation further assumes the tax units to be single because the martial status is not recorded in the data. Table A3 shows that roughly ¾ are married. Hence, for robustness, we assume all tax unit to be married and eligible for joint assessment.[16] Due to the ages considered, we do not regard the case of tax relevant children.

In general, after deductions of e. g. social security, the income tax schedule is applied. The income tax is calculated on yearly taxable income (earnings and pensions). To obtain the monthly income tax, the yearly tax burden is distributed according to the monthly share of taxable income on yearly taxable income. From 1998 to 2011, the code was subject to several changes, e.g: top marginal tax rates were reduced from 53 % to 45; taxation of pensions was reformed by the introduction of deferred taxation and changes in the deductibility of social security contributions. In addition, there were some minor alterations like changes in lump sum deductions. To account for this, we model tax law regarding the taxation of income from employment and PAYG-pensions in great detail:[17]

- Income from employment: In order to obtain the taxable portion of income, gross earnings are reduced by a lump sum deduction for work related expenses (*Werbungskostenpauschale*).
- Income form PAYG-pension: In case of pensions, only the return portion (*Ertragsanteil*) is taxable if the pensioner retired before 2005. For our sample, the return portion varies between 27 % and 29 %, depending on retirement age. Beginning with 2005, the taxable portion (*Besteuerungsanteil*) depends on the year of retirement and ranges from 50% in 2005 to 62% in 2011. Further, The lump sum deduction for pensions are subtracted.
- Special expenses (*Sonderausgaben*): The modelling concerning the deduction of social security contribution from taxable income (*Vorsorgeaufwendungen*) accounts for all changes between 1998 and 2011. Further, the lump sum deduction for special expenses (*Sonderausgabenpauschbetrag*) is subtracted.

A.3 Data

The dataset consists of the waves of SUFVSKT of calendar years 2002 and 2004-2012. Each SUF is a 25 % stratified random sample of the VSTK of the respective year and includes the same information. Since we need completed biographies to clearly identify the timing of old-age retirement, we focus on

[16] Married couples profit from a splitting rule (see Bönke and Eichfelder 2010 for details). We assume joint assessment and a single earner/pensioner without spousal income.
[17] For a detailed description of work related deduction and special expenses see Bönke und Eichfelder (2010).

cohorts aged 66 or 67 in the respective year only. This means that usable observations for cohorts 1938-1945 appear in two different waves, once aged 66 and once aged 67. Due to the sampling structure it is possible to match those two waves for each of these cohorts and enhance the number of observations. Since there is no unique identifier across all waves, we identify duplicates (whom appear in both waves) on the basis of their employment biographies. For the selected cohorts, those biographies consist of monthly earnings points observations included from age 14 onwards up to the age of 66. Therefore, we draw on a large number of data points for the matching procedure and do not have to make any assumptions. For identification we use all of the at least 420 month (35 years) and the year and month of birth. Verification checks further confirmed the correctness of our procedure. Certainly, the matching procedure might be problematic for individuals without a strong labor market attachment - but those are not the persons we focus on.

Appendix B: Model estimation and robustness

Table B1 displays parameter estimates for both the baseline and the preference heterogeneity specification. Preference heterogeneity in disutility of work is implemented by assuming two unobserved types[18] that comprise a fixed proportion of the population (Heckman and Singer, 1984). The second type is estimated to make up about 7% of the population. While the model fit slightly improves, central model parameters remain stable. However, this somewhat richer specification gives less precise estimates – in particular those related specifically to type 2. Table B2 shows a robustness check on postestimation outcomes of the alternative specification. It turns out that our results are insensitive to the inclusion of preference heterogeneity. Therefore, we refrain from modeling preference heterogeneity in the baseline specification.

Estimation including preference heterogeneity: Each type $m \in \{1, \ldots, M\}$ comprises a fixed proportion of the individuals in the population. We assume that the constant in the spline function of the disutility of work δ_{1m} is heterogeneous for the unobserved types. The probability of an individual n being of type m is given by γ_m, where γ_M is normalized to zero and $\sum_{m=1}^{M} \gamma_m = 1$. Then, the log-likelihood function of the sample is given by

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

[18] We could not identify more than two unobserved types. For three unobserved types, the optimization algorithm did not converge.

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

Table B1: Parameter estimates and robustness

	Main specification	With unobserved heterogeneity	Married
α (consumption)	0.213	0.282	0.224
	(0.0294)	(0.0372)	(0.0263)
ρ (CRRA)	1.502	1.563	1.504
	(0.0876)	(0.0819)	(0.0738)
δ_1, δ_{11} (disutility, constant)	-3.004	-3.036	-3.025
	(0.2283)	(0.2322)	(0.2373)
δ_{12} (disutility, constant)	–	-2.012	–
	–	(1.1926)	–
δ_2 2 (disutility, spline)	1.058	1.058	1.057
	(0.1093)	(0.1111)	(0.1138)
δ_3 (disutility, spline)	-0.166	-0.166	-0.164
	(0.0635)	(0.0673)	(0.0674)
δ_4 (disutility, spline)	0.040	0.041	0.033
	(0.0614)	(0.0652)	(0.0710)
δ_5 (disutility, spline)	0.075	0.073	0.077
	(0.0706)	(0.0767)	(0.0807)
δ_6 (disutility, spline)	-0.255	-0.255	-0.253
	(0.0952)	(0.0976)	(0.0962)
δ_7 (disutility, spline)	0.221	0.218	0.221
	(0.1377)	(0.1391)	(0.1304)
δ_8 (disutility, spline)	-0.156	-0.147	-0.165
	(0.1372)	(0.1517)	(0.1400)
δ_9 (disutility, spline)	1.109	1.062	1.116
	(0.1179)	(0.1271)	(0.1166)
γ (type probability)	–	0.934	–
	–	(0.0381)	–
Log-likelihood	-1882.4	-1876.2	-1878

Table B2: Simulated effects of the actually implemented disincentive level and robustness

	Baseline	Unobserved Heterogeneity	Married
ΔE[retirement age] (months)	5.03	5.08	5.5
ΔE[NPV of consumption]	€ -1,415	€ -1,020	€ 1,538
ΔE[NPV of consumption] (%)	-0.62%	-0.46%	0.41%
ΔGini coefficient (%)	3.6%	3.6%	4.8%
ΔMonthly retirement income	€ -38.8	–	–
Average compensating variation	€ 3,929	€ 4,384	€ 4,282
Average equivalent variation	€ 3,795	€ 4,152	€ 4,084
NPV of net public returns	€ 23,485	€ 23,677	€ 22,557
ΔE[NPV of pension benefits]	€ 14,071	€ 13,998	€ 14,344
ΔE[NPV of pension contributions]	€ 3,748	€ 3,799	€ 4,091
ΔE[NPV of other contr. & taxes]	€ 5,665	€ 5,880	€ 4,122

References

Atalay, K., and G. F. Barrett (2015): “The Impact of Age Pension Eligibility Age on Retirement and Program Dependence: Evidence from an Australian Experiment,” The Review of Economics and Statistics, 97(1), 71–87.

Blundell, R., C. Meghir and S. Smith, (2002): “Pension Incentives and the Pattern of Early Retirement,” Economic Journal 112(478), 153-170.

Bönke, T., G. Corneo, and H. Lüthen (2015): “Lifetime earnings inequality in Germany,” Journal of Labour Economics, forthcoming.

Bönke, T., and S. Eichfelder (2010): “Horizontal Equity in the German Tax- Benefit System: A Simulation Approach for Employees,” FinanzArchiv: Public Finance Analysis, 3(37), 295–331.

Bönke, T., C. Schröder, and K. Schulte (2010): “Incomes and Inequality in the Long Run: the Case of German Elderly,” German Economic Review, 11, 487–510.

Börsch-Supan, A. (2000): "A Model under Siege: A Case Study of the Germany Retirement Insurance System," The Economic Journal, 110(461), 24-45.

Börsch-Supan, and A. Reil-Held (2001): “How Much is Transfer and How Much is Insurance in a Pay-as-you-go System? The German Case,” The Scandinavian Journal of Economics, 3(103), 505–524.

Börsch-Supan, A. (2002): “Incentive Effects of Social Security on Labor Force Participation: Evidence in Germany and Across Europe,” Journal of Public Economics, 78, 25–49.

Coile, C. and J. Gruber (2007): “Future social security entitlements and the retirement decision,” The Review of Economics and Statistics 89(2), 234-246.

Giacomo Corneo, G., C. Schröder and J. König (2015): “Distributional Effects of Subsidizing Retirement Savings Accounts: Evidence from Germany,” Economics Discussion Paper, School of Business & Economics, FU Berlin, Nr. 2015/18.

Deutsche Rentenversicherung (2014): Rentenversicherung in Zeitreihen, vol. 22 of DRV-Schriften.

French, E., and J. B. Jones (2011): “The Effects of Health Insurance and Self- Insurance on Retirement Behavior,” Econometrica, 79(3), 693–732.

Fuchs-Schündeln, N., and M. Schündeln (2009): “Who stays, who goes, who returns?” Economics of Transition, 17, 703–738.

Gourinchas, P.-O., and J. A. Parker (2002): “Consumption Over the Life Cycle,” Econometrica, 70(1), 47–89.

Gruber, j. and D. Wise (2007): “Social Security Programs and Retirement around the World,” NBER Publications, University of Chicago Press, Chicago.

Haan, P., and V. Prowse (2014): “Longevity, life-cycle behavior and pension reform,” Journal of Econometrics, 178(P3), 582–601.

Hanel, B. (2010): “Financial incentives to postpone retirement and further effects on employment - Evidence from a natural experiment,” Labour Economics, 17, 474–486.

Heckman, J., and B. Singer (1984): “A Method for Minimizing the Impact of Distributional Assumptions in Econometric Models for Duration Data,” Econometrica, 52(2), 271–320.

Laun, T., and J. Wallenius (2015): “A Life Cycle Model of Health and Retirement: The Case of the Swedish Pension Reform,” Journal of Public Economics, forthcoming.

Lüthen, H. (2015): “Rates of Return and Early Retirement Disincentives: Evidence from a German Pension Reform,” German Economic Review, forthcoming.

Mastrobuoni, G. (2009): “Labor supply effects of the recent social security benefit cuts: Empirical estimates using cohort discontinuities,” Journal of Public Economics, 93(11-12), 1224–1233.

R., B., C. Meghir, and S. Smith (2002): “Pension Incentives and the Pattern of Early Retirement,” The Economic Journal, 112, 153–170.

Rust, J. (1987): “Optimal Replacement of GMC Bus Engines: An Empirical Model of Harold Zurcher,” Econometrica, 55(5), 999–1033.

Rust, J., and C. Phelan (1997): “How Social Security and Medicare Affect Retirement Behavior in a World of Incomplete Markets,” Econometrica, 65(4), 781–832.

Statistisches Bundesamt (2006): Generationen-Sterbetafeln Für Deutschland, Modellrechnungen für die Geburtsjahrgänge 1871-2004. Wiesbaden.

Staubli, S., and J. Zweimüller (2013): “Does raising the early retirement age increase employment of older workers?” Journal of Public Economics, 108, 17–32.