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Individual Welfare, Distributional and Fiscal Implications

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

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Abstract: In aging societies, information on how to reform pension systems is essential to policy makers. This study scrutinizes effects of early retirement disincentives on retirement behavior, individual welfare, pensions and public budget. We employ administrative pension data and a detailed model of the German tax and social security system to estimate a structural dynamic retirement model. We find that retirement behavior is strongly influenced by the level of disincentives. Further, disincentives come at the cost of increasing inequality and individual welfare losses. Still, net public returns are about three times as high as monetarized individual welfare losses. Our estimates also suggest that similar levels of net public returns, if achieved by indiscriminating pension cuts, are associated with individual welfare losses that are more than twice as high.

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

JEL Classification: C61, H55, J26

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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. Facing similar problems, many governments opted for a variety of pension reforms (e.g. Gruber and Wise, 2007). Typical examples include increasing eligibility ages (Mastrobuoni, 2009; Staubli and Zweimüller, 2013; Ataly and Barret, 2015), pension level adjustments (Haan and Prowse, 2014), and pension system restructuring (Laun and Wallenius, 2013). Apart from austerity debates fueled by the Great Recession, the imminent retirement of baby-boomer cohorts calls for fundamental reforms of old age security 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 is an excellent example. Until the late 1970s, the German pay-as-you-go (PAYG) system was expanded. It became one of the world's most generous programs, both in terms of replacement rates and early retirement provisions. Population aging, German reunification, and high unemployment rates since the late 1970s, however, caused a rising fiscal imbalance. Since the early 1990s, the eligibility age has been increased, replacement rates have been lowered, and subsidies stimulating private old-age provisions have been introduced (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, and fertility decisions are made (e.g. Börsch-Supan, 2000; Blundell, 2002). The effects are vast as statutory pensions account for about 85% of the average household disposable income for the elderly population (Börsch-Supan and Reil-Held, 2001).

This study scrutinizes disincentives that lead to permanent pension deductions and increase with the distance between the actual/early and normal retirement age. Since individuals still have a (limited) choice, disincentives differ from indiscriminating pension cuts or an increase in the legal eligibility age for early retirement. Further, from a theoretical perspective, Diamond and Mirrless (1978) find similar reforms to reduce moral hazard problems in the pension scheme. We contribute to the existing literature with an analysis of both actual and potential behavior to provide a detailed overview on effects of retirement disincentives. At this, we contrast positive effects on public finances to negative effects on affected individuals. To provide comprehensive evidence on disincentives in general, we model a broad range of disincentive levels. This range includes pension deductions of 0.3% per month of early retirement, which were actually introduced through a major

pension reform in Germany in 1992 (Hanel, 2010; Lüthen, 2016). We analyze to what extent disincentives are able to steer retirement behavior and provide evidence on distributional, individual welfare and fiscal implications of reducing pensions for early retirees. Typical for pension reforms, the institutional changes were phased in, impacting birth cohorts to different degrees. Thus, evaluation is not trivial due to the lack of intra-cohort variation. We incorporate comprehensive dynamic incentives of labor market participation and retirement behavior by estimating a structural dynamic retirement model (e. g. Rust and Phelan, 1997; Gustman and Steinmeier, 2015). The model assumes forward-looking agents who consider option values of possible retirement decisions and recognize the impact of their choices on the accumulation of pension wealth and future consumption possibilities. Further, we account for the incentives of wealth on retirement behavior by considering savings and wealth accumulation over the life-cycle.

Early retirement disincentives give individuals the choice to retire within a certain time period at the cost of actuarial adjustments. When modeling retirement behavior, dynamic incentives are particularly relevant because individuals account for the entire future stream of pension benefits (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. This enables us to disentangle other changes in the tax and pension system from the introduction of the disincentives, which induce cohort specific dynamic incentives. The inter-cohort variation in dynamic incentives helps identifying the structural parameters of our retirement model (e.g. Manoli et al., 2014). Then, based on the estimated parameters, we simulate a variety of economic outcomes for a number of counterfactual scenarios with changing levels of retirement disincentives.

For working males and the disincentive level of the 1992 reform, we find a retirement entry delay of 4.1 months. Increasing the disincentives causes further delay; a tripling of the 1992 disincentive level encourages most individuals to abandon early retirement. We also find disincentives to increase inequality in expected earnings and pensions, to cause individual welfare losses, and to lead to positive net public returns. All three outcomes increase with the disincentive level, although with diminishing marginal effects. The welfare losses are heterogeneously spread across the earnings distribution and greatest for medium income earners. Still, at each disincentive level, the net public returns are about three times as high as monetarized individual welfare losses. Further, depending on disincentive level, net public returns account for up to 16% of total pension expenditure per individual. It follows that early retirement disincentives are able to substantially increase the pension system's financial stability. When comparing disincentives to indiscriminating pension cuts, we find that at similar levels of net public returns, pension cuts result in individual welfare losses that are

more than twice as high.

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 present 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 great majority of employees is mandatorily insured and contributes a percentage of their gross earnings up to a contribution ceiling. For their contributions, the insurants acquire pension entitlements in form of earnings (or remuneration) points. The number of points is based on the ratio of individual wage to average wage. An individual earns exactly one point (per year) if its yearly wage corresponds to the average yearly wage. Employees accumulate earnings points over their working life 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 life 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:[1]

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

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 1 below). RA represents the pension type, which is 1 for old-age pensions. The factor Z is introduced by the 1992 reform and accounts for the actual retirement age and corresponding early retirement deductions: $Z = (1 - deduction)$.

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, therefore abstracting from previously unemployed or disabled individuals. The individuals considered are able to claim the *normal old-age pension* at age 65 or the *pension for long-term*

[1] Appendix A1 provides an overview on key institutional figures. For further details on the calculation of pensions in Germany see Lüthen (2016).

insured after age 63, which is conditioned on having spent at least 35 years in the pension system.[2] Retiring before age 65 is considered as early retirement. Women are excluded due to their diverging pension prospects and the low number of cases when conditioning on similar early retirement eligibility. In sum, we concentrate on men with a strong labor market attachment who 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 different retirement ages monetarily. The aim was to balance the pension wealth of early retirees and normal retirees. However, the budget relief was also needed to ensure financial stability (e.g. Schmähl, 2011). Since early retirees have a prolonged benefit period, reducing their pension wealth simultaneously serves both goals. 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 normal retirement age of 65.[3] The deductions were gradually phased in for the 1937 and 1938 cohorts, then fully affecting those born thereafter (see Appendix A.2 for details). Still, all cohorts were allowed to retire at 63.

2.3 Data

To calculate pension entitlements as described above, the pension insurance collects information on all contributors' earnings biographies. The data we use, the Insurance Account Sample (*Versicherungskontenstichprobe*, VSKT), is a stratified random sample of these records. Each wave contains information on individuals aged between 30 and 67 in the reference year.[4] From age 14 through age 65, the VSKT provides a monthly history of employment, unemployment, sickness, and earnings points. The latter are used to compute monthly gross earnings and their total sum provides the foundation for calculating gross pensions. To obtain net incomes from earnings, pensions, and social transfers, we subtract taxes and social security contributions according to the current legal

[2] We disregard individuals claiming old-age pensions for previously unemployed or disabled persons. 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 (2016).

[3] See Lüthen (2016) 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. Due to dominance of collective bargaining for cohorts considered, most contracts force workers to retire at 65.

[4] 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 A for further information).

status. Hereby, we account for all regulations and changes affecting monthly disposable income and pensions. Further, this allows us to compute real net lifetime incomes until age 63.

To ensure early retirement eligibility, we restrict the sample to those who have 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 the German Democratic Republic (GDR; the former East Germany). For the cohorts considered, neither labor market situation nor working life is comparable to the West German context.[5] The final sample contains 945 individuals (Table 1).

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.[6] Further, the VSKT lacks information on other income sources, wealth or household context. Comparing the considered population to survey data shows that other income sources account on average for less than 10% of total household (Table A5). We use the model to predict a wealth distribution and validate this distribution with survey data. Concerning the household context, nearly 80% are married, but spouses only contribute a small share of household income (Table A5). Accordingly, we assume a married single-earner household and joint taxation. For robustness, we also calculate a scenario assuming single households (Tables B1 and B2). The results do not suggest a qualitative difference.

Table 1 provides key descriptives of the sample. Column 1 shows that the observed average retirement entry age increases by about 8 months across cohorts. Column 2 reveals declining average pensions in 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.[7] The column “disincentives” gives the average deduction on

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

[6] 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.

[7] Note that all changes affecting the net income stream from earnings and pension influence the retirement behavior. In Appendix C.3, we show stand-alone effects of alterations in the tax code and pension regulations since 1998.

the monthly pension realized by each cohort. For fully affected cohorts, average deductions fluctuate between 2.6% and 4.3%.

Table 1: Sample descriptives

Cohort	Entry age	Monthly pension	Earnings points	Pension value at 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: Average pensions and pension values are in 2010 Euro real values. The numbers of observations represent the final sample. Source: SUFVSKT2002, 2004-12, Deutsche Rentenversicherung (2014), own calculations.

3 Model and estimation

3.1 Dynamic retirement model

The model aims to explain retirement behavior in a time frame of 24 months, namely between age 63 and age 65. Individuals are assumed to be forward-looking and have rational expectations about the consequences of their choices. We rely on a theoretical framework where agents' utility in period t depends on consumption c and disutility of labor l. There are N individuals indexed by n. Individual age is measured discretely in months t, where $t = 0$ corresponds to the month an agent turns 63. Age 100 corresponds to period T. Consumption in t for individual n equals the net income flow minus savings. Agent n's utility in month t can be expressed as:

$$u(c_{nt}, l_{nt}) \tag{1}$$

Further, we allow for concavity of the agent's utility function. Current and future consumption possibilities in month t depend on earnings biography and choices until the current period, whereas disutility of labor is allowed to vary in age t. Equation (1) becomes:

$$u(c(\boldsymbol{s}_{nt}, d_{nt}, srate_n), l(d_{nt}, t_n)) \quad (2)$$

where $\boldsymbol{s}_{nt}$ denotes a vector of state variables (age, birth cohort, accumulated pension points, gross wage, lifetime income until age 63, wealth, and previous period's choice). The dummy $d_{nt} \in \{0,1\}$ indicates the retirement choice and $srate_n$ represents the individual specific life-cycle savings rate until retirement. The rate is assumed to be stable over the life-cycle. When choosing the rate, individuals anticipate both the rules of the pension system and their future retirement choice. In this way, individuals can adjust their behavior according to the respective disincentive level. This may matter as we vary the level to assess the full impact of disincentives. The rate, combined with the observed lifetime net income, yields a wealth accumulation profile and wealth at the beginning of retirement (for specification details see Appendix B). Upon retirement, the individuals spend their accumulated wealth to purchase a fair life annuity. The life annuity is based on cohort-specific survival probabilities and an annual net real interest rate of $i = 2\%$. Therefore, $c(\boldsymbol{s}_{nt}, d_{nt}, srate_n)$ denotes the level of consumption associated with state $\boldsymbol{s}_{nt}$, retirement choice d_{nt}, and savings rate $srate_n$. Taken together, the equations for consumption, wealth accumulation and annuity constitute the individual budget constraint:

$$c(\boldsymbol{s}_{nt}, d_{nt}, srate_n) = wage_{nt} + pension_{nt} + annuity_{nt} - tax_{nt} - savings_{nt}$$

$$wealth_{nt+1} = (wealth_{nt} + savings_{nt}) \cdot (1 + i)$$

$$annuity_{nt} = [t \geq R] \sum_{j=1}^{T-R} \theta_{bR+j} \left[\frac{wealth_{nR}}{\left(\frac{1-(1+i)^{-j}}{i}\right) \cdot (1+i)} \right]$$

where R marks the period (age) of retirement and θ_{bR+j} indicates individual's probability of being alive in period $R + j$, conditional on survival until retirement and belonging to cohort b. Cohort specific mortality rates ensure a realistic setup and also help identifying parameters in the estimation procedure by inducing cohort-specific heterogeneity in dynamic incentives.[8] tax_{nt} comprises all deductions from gross wage and pension income (i.e. income tax and social security contributions).

Since individuals need to consider all current and future wages when making a decision, wage information until age 65 needs to be complete. 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

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

wage observed in the respective month of the previous year. This corresponds to the wage observed 12 or 24 month before the imputation and accounts for monthly wage volatility.

Disutility of labor $l(d_{nt}, t)$ is both a function of age t and d_{nt} (since there is no more disutility of labor after retirement). For the explicit form, we assume a time separable random utility model representing individual preferences that satisfy our assumptions on consumption and disutility of labor:

(3) $$u(c_{nt}, l_{nt}) = \alpha \frac{c(\boldsymbol{s}_{nt}, d_{nt}, srate_n)^{(1-\rho)} - 1}{(1-\rho)} + l(d_{nt}, t_n) + \epsilon_{nt}(d_{nt})$$

We assume the random component $\epsilon_{nt}(d_{nt})$ to be type 1 extreme value distributed. The random component represents unobserved individual utility shocks. ρ is the coefficient of relative risk aversion and α a consumption weight. To allow the disutility of labor to vary in age, age enters $l(d_{nt}, t)$ as a linear spline function. The function is allowed to change the slope every three months of age to ensure a flexible specification (see Appendix B.1).

When timing retirement, agents are forward looking and maximize their expected lifetime utility according to their preferences constrained by the institutional setting. For each month between ages 63 and 65, agents decide between continuing to work or retirement. When continuing to work, utility stems from consumption and individuals experience disutility of labor. After retirement, agents receive utility from consumption only. In line with the rules and regulations of the pension system, working individuals accumulate pension claims proportional to real wages. This creates dynamic incentives for individuals taken into account by the dynamic choice framework. Retirement is an absorbing state and agents are not allowed to return to work, making utility maximization an optimal stopping problem. Earliest possible retirement choice is at $t = 1$ in the month following the 63rd birthday, latest possible early retirement decision is in the month they turn 65 ($t = 24$). Each month t, individual n observes state variables $\boldsymbol{s}_{nt}$ and makes retirement choice d_{nt} to maximize expected lifetime utility. We define $D(\boldsymbol{s}_{nt})$ to be the choice set available to individual n in period t:

(4) $$\max_{d_{nt} \in D(\boldsymbol{s}_{nt})} E\left[\sum_{j=0}^{T-t} \theta_{bt+j}\, \beta^j u\left(c_{nt+j}, l_{nt+j}\right)\right]$$

with β denoting a monthly subjective time discount factor, which we derive from a yearly discount factor of 0.97. To accommodate our monthly setting, we implement $\beta = \sqrt[12]{0.97}$. θ_{bt+j} indicates individual probabilities of being alive in period $t + j$, conditional on survival until period t and belonging to cohort b.

We further define a Markov transition function $q(\boldsymbol{s}_{nt+1}|\boldsymbol{s}_{nt}, d_{nt})$ to capture individual beliefs about future states. Given the model setup, this is a deterministic function. Only the utility shock $\epsilon_{nt}(d_{nt})$ evolves stochastically. Then, the agents' maximization problem can be described by the following value function $v(\boldsymbol{s}_{nt})$:

$$v_t(\boldsymbol{s}_{nt}) = \max_{d_{nt} \in D(\boldsymbol{s}_{nt})} \Bigg\{ u(c_{nt}, l_{nt}) + \theta_{bt+1}\beta \int_{\epsilon} \left[\sum_{S(\boldsymbol{s}_{nt})} v(\boldsymbol{s}_{nt+1}) q(\boldsymbol{s}_{nt+1}|\boldsymbol{s}_{nt}, d_{nt}) \right] g(\boldsymbol{\epsilon}_{nt+1}) \Bigg\} \tag{5}$$

where $g(\cdot)$ represents a multivariate probability density function of the random components. $S(\boldsymbol{s}_{nt})$ contains all possible different states in $t+1$ given state $\boldsymbol{s}_{nt}$. The difference in the expected discounted future utility between working and not working reflects option values of respective choices.

3.2 Choice probabilities and estimation

Given the finite horizon of the individuals' optimization problem, it can be solved recursively. Starting point is the expected value function $V(\cdot)$ for particular choice options in the last period T. $V(\cdot)$ needs to be computed for all possible choices. In the last period T, this corresponds to

$$V(\boldsymbol{s}_{nT}, d_{nT}) = E[u(c_{nT}, l_{nT})]. \tag{6}$$

By Bellman's principle of optimality, the individual's optimization problem can be written as a two-period problem for all other time periods t, which take into account the optimal decision for $t+1$. Due to the type 1 extreme value distribution of the utility shock $\epsilon_{nt}(d_{nt})$, the expected value function has a closed form solution (Rust, 1987):

$$V(\boldsymbol{s}_{nt}, d_{nt}) = E[u(c_{nt}, l_{nt})] + \theta_{bt+1}\beta \sum_{\boldsymbol{s}_{nt+1}} \log \left\{ \sum_{d_{nt+1} \in D(\boldsymbol{s}_{nt+1})} exp\big(V(\boldsymbol{s}_{nt+1}, d_{nt+1})\big) \right\} q(\boldsymbol{s}_{nt+1}|\boldsymbol{s}_{nt}, d_{nt}) \tag{7}$$

Computation of expected value functions between mandatory retirement (age 65) and T is comparatively simple as individual choices are limited until age 65. Thereafter, consumption streams remain constant. Rust (1987) shows that when assuming additive separability and conditional independence of utility shocks, conditional choice probabilities have a closed form solution:

(8) $$Prob(d_{nt}|\boldsymbol{s}_{nt}) = \frac{exp\big(V(\boldsymbol{s}_{nt}, d_{nt})\big)}{\sum_{j \in D(\boldsymbol{s}_{nt})} exp\big(V(\boldsymbol{s}_{nt}, j)\big)}$$

The model is estimated by maximum likelihood. The log-likelihood function of the sample is given by

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

with $I(d_{nt})$ indicating the individual choice observed in period t and the vector $\boldsymbol{\lambda} = (\alpha, \rho, \delta_1, .., \delta_9)$ containing all parameters of the utility function. The likelihood contributions then correspond to the respective conditional choice probabilities. For robustness, we also estimate a model allowing for unobserved heterogeneity in δ_1 (Heckman and Singer, 1984). We do not find any significant unobserved heterogeneity in the disutility of work. This likely follows from explicitly accounting for heterogeneous wealth accumulation in the model, which is associated with observed lifetime net income until age 63.

3.3 Parameter estimates and model fit

An overview on parameter estimates is displayed in Table C.3 in the Appendix. Our estimate of the relative risk aversion, $\rho = 1.12$, is in line with previous studies (see e.g. Chetty, 2006). The consumption weight α equals 0.21. The estimates of the age-specific spline function $l(\cdot)$ indicate the results typically found in the literate: a spiking retirement hazard at early eligibility and normal retirement age that cannot be explained entirely by incentives but rather mirrors institutional constraints (e.g. Coile and Gruber, 2007). All estimates are independent of their starting values and 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.

Panel (a) of Figure 1 demonstrates the internal validity of our model by comparing predicted and observed retirement outcomes by age. It follows from the flexible age specification in the disutility of labor that our predictions match the observed shares very well. Moreover, panel (b) shows that the assumption of optimal life-cycle saving behavior produces a wealth distribution at age 63 that comes fairly close to what we observe in the SOEP when considering the corresponding population.[9]

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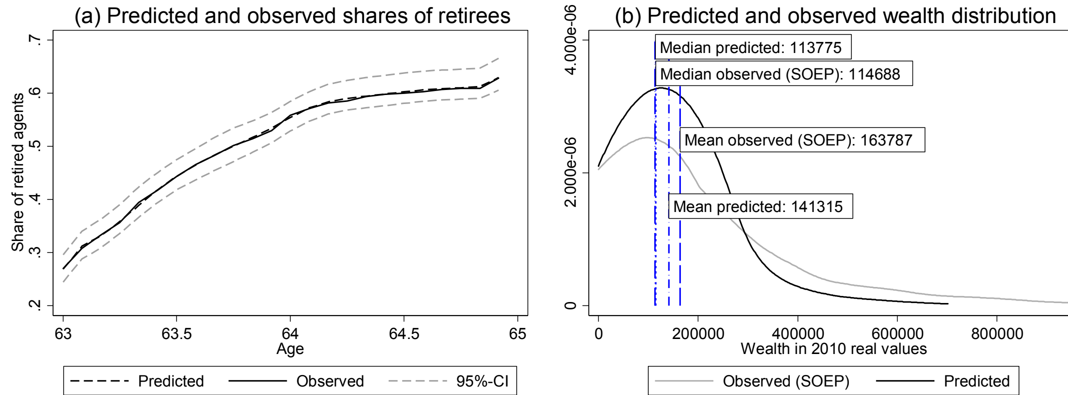
[9] To ensure a high degree of similarity, we construct a sample from the SOEP using wealth information in 2007. We restrict the SOEP sample to West German males subject to social security contributions (discarding civil

The predicted and observed medians of wealth at age 63 amount to 113,775 EUR and 114,688 EUR, respectively. This reassures us that our model captures sufficiently well the incentives of wealth on retirement behavior. Both average and median predicted savings rate correspond to about 6%, while the individual rates range from 0 to 10%.

Figure 1: Comparison of model prediction to observed retirement decisions and wealth distributions



Note: Observed wealth distribution in 2007 (in real values of 2010) obtained from a SOEP sample mirroring the considered population: West German males born between 1943 and 1945 in regular insurable employment at age 62. Source: SUFVSKT2002, 2004-12; SOEPv31, own calculations.

4 Results and policy analysis

This section sheds light on the "dose-response" relationship between disincentive level and outcome measure. We simulate scenarios for different disincentive levels from 0% to 1% per month of early retirement. Applying a distance of 0.1%, we obtain 11 different scenarios. This range of levels includes the actually implemented level of 0.3% and therefore a full analysis of the 1992 reform. We present predominantly graphical results and mark the 0.3% level with a vertical dashed line. For consistency, the results are based on cohorts 1939 to 1945 which are fully affected by the 1992 reform.

A. Behavioral effects

Here we look at the effects of disincentives on labor market exit timing and wealth accumulation. Figure 2 displays a slightly concave relationship between average retirement age and disincentive level. This suggests that disincentives can be used to steer retirement behavior. While low disincentive levels lead to small postponements in retirement, high levels induce most individuals to

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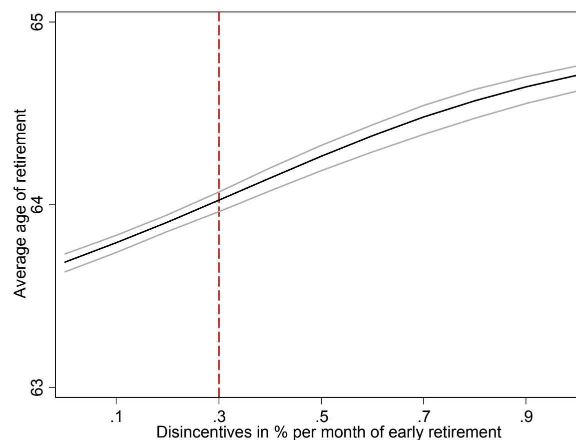
servants, self-employed, and unemployed) and born between 1943 and 1945. Hence their age ranges from 62 to 64 in 2007, mimicking the wealth situation of our VSKT sample at age 63.

retire at age 65 such that hardly any penalties are actually realized ("prohibitive effect"). The actually implemented level causes a postponement of about 4.1 months, whereas the highest considered disincentive level of 1% would have delayed average retirement by about 12 months. Our model is also able to attribute changes in retirement behavior to the actually implemented level during the phase in and other changes in tax code and pension regulations besides the introduction of disincentives (see Appendix B.2). Other behavioral changes concern the impact of disincentives on wealth accumulation and savings rate. These effects are fairly small (see Appendix C.2).

Figure 2: Expected retirement age by disincentive level



Note: Grey lines indicate 95% CI. The vertical dashed line indicates the actually implemented disincentive level of 0.3% per month. Source: SUFVSKT2002, 2004-12.

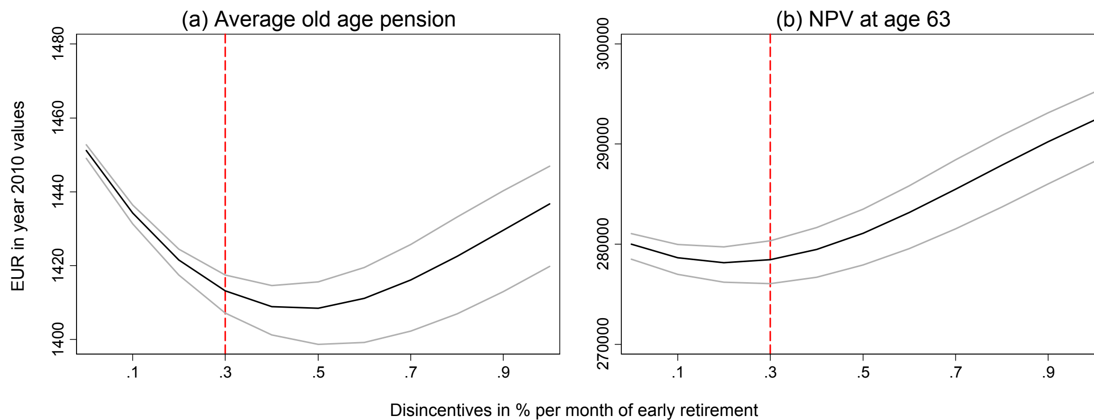
B. Implications for earnings and pensions

This section shows disincentive effects on pension level and NPVs of remaining lifetime earnings and pensions (henceforth: NPV).[10] 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 (as wages exceed pension benefits in most cases). More contributions then translate into higher pension claims. Thus, the behavioral effect of delayed retirement counteracts the disincentive effect at some point. With that in mind, it is not surprising that Figure 3 shows a u-shaped relationship between pension and disincentive level. The actually implemented disincentive level of 0.3% per month yields a comparatively low pension — reducing or strongly 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. For the actually implemented level of the 1992 reform, we find

[10] The NPV constitutes the sum of the discounted expected earnings and pension stream at age 63.

that pensions decrease by €38 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 earnings point). Figure 3 also shows a similar relationship between disincentive level and NPVs. The lowest NPV realized is associated with a disincentive level of 0.2%. At a level of 0.3%, the increases in labor market earnings start to outweigh the decreases in pension level.

Figure 3: Retirement income and NPVs of earnings and pensions by disincentive level



Note: Grey lines indicate 95% CI. Euro in 2010 real values. NPV at age 63 constitutes the remaining sum of the discounted expected earnings and pension stream at age 63. The vertical dashed line indicates the actually implemented disincentive level of 0.3% per month. Source: SUFVSKT2002, 2004-12

C. Individual welfare effects

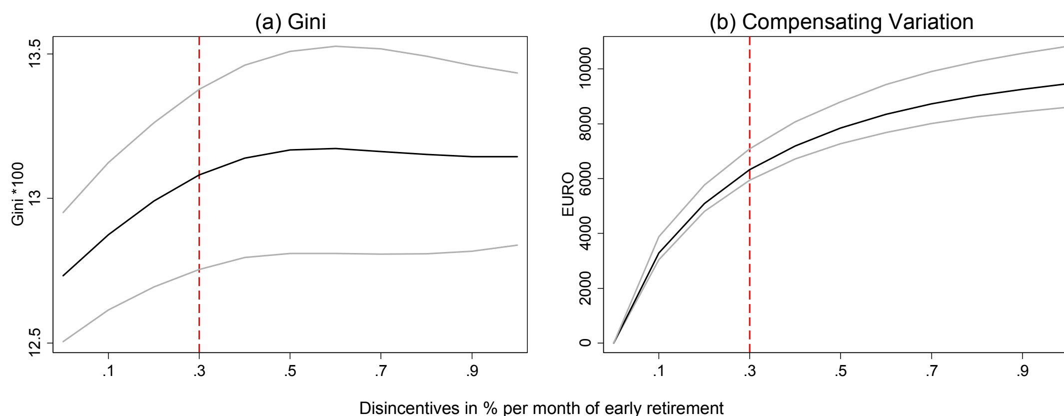
Figures 4 displays potential costs associated with the considered range of disincentive levels. Panel (a) provides estimates on increasing inequality in NPVs (Gini coefficient). Without disincentives, retirement behavior is more heterogeneous, which offsets some initial inequalities in pension claims at age 63. Panel (b) assesses expected individual welfare losses with compensating variations (CV). [11] The variations refer to NPVs at age 63 that are annuitized over the remaining lifetime. 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.

Both Gini and CV show a concave relationship to the level of disincentives. Increases at low disincentives levels cause large increases in Gini and CV. Increases at higher disincentive levels have smaller effects since at high disincentive levels, the average retirement age is close to 65 already

[11] A compensating variation (CV) indicates the amount of money that an individual would have to receive at age 63 to be fully compensated for a particular reform. Here, to compute CVs, we employ an iterative algorithm targeting the expected remaining lifetime utilities at age 63 without retirement disincentives. The algorithm converges when the differences in individuals' expected utilities under both scenarios (disincentives and no disincentives) are very small.

(see Figure 2). For the Gini, the relationship flattens out around a disincentive level of 0.5%, whereas the CV continues to increase with every level.

Figure 4: Gini and CVs by disincetive level

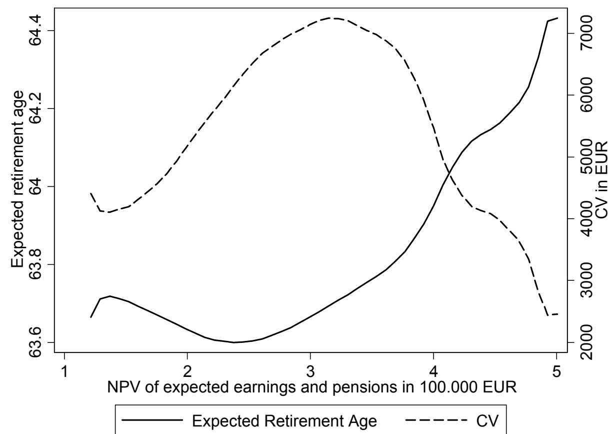


Note: Grey lines indicate 95% CI. Euro in 2010 real values. The vertical dashed line indicates the actually implemented disincentive level of 0.3% per month. Source: SUFVSKT2002, 2004-12

For a detailed analysis, we again focus on the 0.3% disincentive level implemented by the 1992 reform. Figure 5 shows a non-parametric regression of estimated compensating variations on the NPVs. 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 and pension level. Low income earners have relatively low CVs due to their small pension claims. Medium income earners suffer most, as they have average claims but the lowest expected retirement age. High income earners have small CVs because they tend to retire closer to age 65 regardless of disincentives. In general, the individual welfare losses are heterogeneously distributed in the sample population, ranging from negligible amounts up to about €20,000 (see Appendix C.1). This complicates compensation through e.g. saving subsidies because such a scheme may not allow targeting individuals according to their specific losses.[12]

[12] Indeed, in 2002 Germany introduced subsidies for private pension plans 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).

Figure 5: Predicted CVs and expected retirement age by NPVs of earnings and pensions



Note: Euro in 2010 real values. Source: SUFVSKT2002, 2004-12

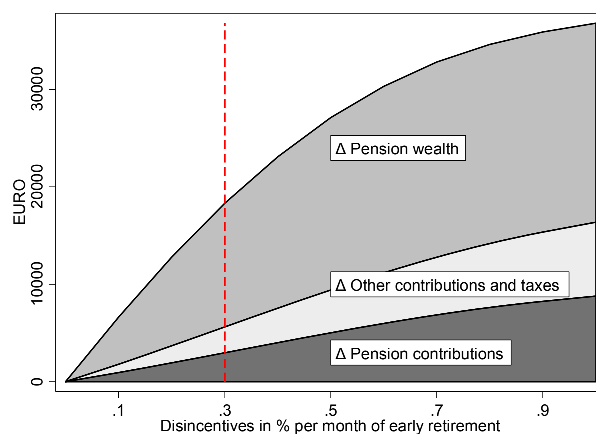
D. Fiscal implications

Figure 6 displays the (fiscal) benefits of introducing disincentives − the net public returns at varying levels. We again find the relationship to be concave. Although the marginal returns are diminishing, increasing disincentives beyond the implemented level (vertical dashed line) would further foster the pension system's financial sustainability. At each disincentive level, about half of the net public returns are generated by reduced pension wealth, while the remainder is divided into increases in pension contributions and increases in tax payments and other contributions.

The net public returns can be linked to pension expenditures under a no disincentive scenario. This reveals that net public returns correspond to about 8% of average pension wealth under the actually implemented 0.3%-scenario (€ 18,309; vertical dashed line) and to 16% at the 1%-disincentive level. These fiscal implications are substantial. Resorting to aggregate data of the German pension insurance, we find that our sample population corresponds to 424,286 individuals for the 1939 to 1945 cohorts affected by the 1992 reform (Deutsche Rentenversicherung, 2014). We assess that the simulated public returns per capita at the 0.3% disincentive level translate into overall public gains of 424,286 $\times$ € 18,309 $\approx$ € 7.768 billion for these cohorts.

Relating costs (Figure 4) and benefits (Figure 6) demonstrates that this increase in financial stability comes at the cost of increasing inequality and non-negligible individual welfare losses within the population of retirees. Still, at each disincentive level, net public returns are about three times as high average individual welfare losses.

Figure 6: Net public returns by disincentive level

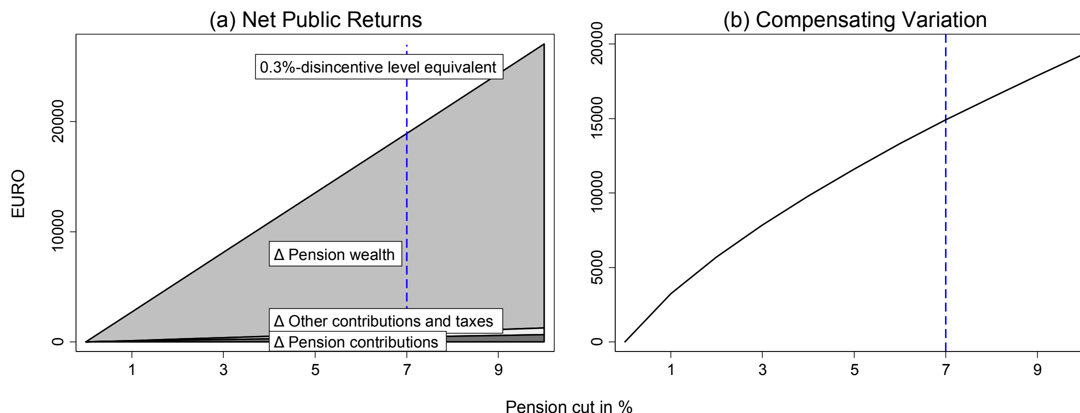


Note: Euro in 2010 real values. The vertical dashed line indicates the actually implemented disincentive level of 0.3% per month. Source: SUFVSKT2002, 2004-12

E. Alternative reforms

To set the welfare losses into perspective, we simulate scenarios where we indiscriminately cut all pensions by a certain amount, ranging from 1% to 10% (Figure 7). It turns out that to yield equal net public returns to introducing a 0.3%-disincentive level, all pensions would have to be lowered by about 7%. However, pension cuts more than double the individual welfare losses. This holds also true for higher levels of net public returns. Since individuals barely adjust their retirement behavior when confronted with a pension cut, nearly all the net public returns stem from decreased pensions: €100 per month instead of €38 under the 0.3% disincentive level. These findings suggest that disincentives realize financial gains at lower individual costs than pension cuts (see Appendix B.2 for more detailed results).

Figure 7: Pension cuts – costs and benefits



Note: Euro in 2010 real values. The vertical dashed line indicates the pension cut that corresponds to the net public return associated with a 0.3%-disincentive level. Source: SUFVSKT2002, 2004-12, own calculations.

5 Conclusion

This study evaluates the effectiveness of early retirement disincentives and its distributional, individual welfare and fiscal implications. We focus on disincentives leading to permanent pension deductions that increase with the distance between actual/early and normal retirement age. We model different disincentive levels and analyze to what extent disincentives are able to steer retirement behavior. Our range of disincentive levels includes the level actually implemented by 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 4.1 months. Further simulations demonstrate that tripling the actually implemented level would essentially induce a prohibitive effect on early retirement choices. Dose-response analysis reveals that disincentives increase inequality in expected remaining earnings and pensions, cause individual welfare losses, and lead to positive net public returns. All three outcomes 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. However, at each disincentive level, the net public returns are more than five times as high as the individual welfare losses.

Contrary to many public claims, disincentives do not correspond to an indiscriminating pension cut. In fact, at equal levels of net public returns, disincentives cause individual welfare losses that are less than half as large as those under a pension cut. Hence, the pension system's financial situation can be improved, ceteris paribus, with lower welfare costs through changes in the incentive scheme. Concerning future implications, Germany introduced various major pension reforms, two of which can be directly related to our results. The first reform increases the normal retirement age from age 65 to 67 while the early retirement age remains at 63. This potentially raises the disincentives for early retirees. Here, our results suggest that average retirement age increases and average pensions adjust slightly for individuals still employed at 62. The second reform introduces an exception to the rule by abolishing disincentives for pensioners with very long employment histories. According to our results, this will cause a substantial decline in average retirement age for eligible individuals. A more detailed analysis is left for future research.

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 is 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. Sample construction is covered in subsection A.3.

A.1 Social security contributions

The calculation of social security contributions is straightforward. Regular employees considered in our sample must 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 that 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 used for calculating statutory social security contributions for the 1998 to 2011 assessment years. 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 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 receiving 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 rate	
			Pension insurance	Unemployment insurance
1998	DM 52925	DM 100800	10.15	3.25
1999	DM 53507	DM 102000	9.85	3.25
2000	DM 54256	DM 103200	9.65	3.25
2001	DM 55216	DM 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. One Euro corresponds to 1.95583 DM. 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 rate		
		Health insurance – employees	Long-term care insurance – employees	Health and long term care insurance – pensioners
1998	DM 75600	6.8	7.575	0.85
1999	DM 76500	6.8	7.6253	0.85
2000	DM 77400	6.8	7.6	0.85
2001	DM 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. One Euro corresponds to 1.95583 DM. Contribution rates are annual averages for employees/pensioners, contribution rates for employers/pensions insurance differ slightly. Source: Deutsche Rentenversicherung (2014) (own calculations).

A.2 Pension reform 1992: Introduction of disincentives

Cohorts born before 1937 are not affected by the reform. For cohorts 1937 and 1938, the pension deductions are phased in. 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 A3 provides an overview and exemplary date of birth examples.

Table A3: Phase-in of disincentives

Date of birth	Retirement age without deductions	Maximal deduction (month)	Maximal deduction (share)
Before 1937	63	0	0%
January 1937	63+1 month	1	0.3%
June 1937	63+6 month	6	1.8%
January 1938	64+1 month	13	3.9%
June 1938	64+6 month	19	5.7%
After 1938	65	24	7.2%

Note: The maximal deduction (share) determines the age factor Z in the pension formula.
Source: Bundesministerium der Justiz (2012)

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 Tables A4 and A5 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 A4 and A5 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. Further, Table A4 shows that roughly three-quarters of the individuals are married. Because the martial status is not recorded in the data, we assume all tax units to be married and eligible for joint assessment.[13] For robustness, we also calculate a scenario where the tax units are assumed to be single. Due to the ages considered, we do not regard the case of tax relevant children.

[13] Married couples profit from a splitting rule (Bönke and Eichfelder, 2010). We assume joint assessment and a single earner/pensioner without spousal income.

Table A4: 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	96	(16)	0	(2)	3	(14)	0	(0)	1	(7)	78	(48)
63	92	(24)	1	(10)	7	(21)	0	(0)	1	(7)	76	(48)
64	83	(32)	1	(9)	16	(31)	0	(3)	0	(4)	70	(47)
65	58	(46)	0	(3)	41	(46)	1	(7)	0	(2)	73	(48)
66	36	(41)	0	(6)	64	(41)	0	(1)	0	(1)	72	(47)
67	10	(22)	1	(8)	89	(23)	0	(0)	0	(0)	72	(44)
68	8	(21)	1	(7)	92	(22)	0	(0)	0	(0)	76	(44)

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

Table A5: Composition of household income

Age	Labor income		PAYG Pensions		Asset income		Share of spousal income	
	Share	(SD)	Share	(SD)	Share	(SD)	Share	(SD)
62	87.81	(18.69)	6.10	(15.83)	4.18	(8.96)	10.23	(7.52)
63	84.65	(22.48)	8.77	(19.01)	3.53	(6.82)	12.73	(3.67)
64	75.71	(28.65)	17.23	(25.31)	3.90	(8.40)	13.87	(7.08)
65	56.69	(38.86)	32.22	(34.73)	5.12	(8.72)	10.99	(9.24)
66	39.22	(35.40)	47.93	(32.81)	4.58	(7.59)	13.37	(4.89)
67	20.24	(25.77)	63.67	(28.14)	6.37	(10.38)	12.91	(8.74)
68	17.54	(26.69)	67.73	(28.65)	5.57	(9.05)	14.79	(9.25)

Note: Income shares of total household income in percent. Standard deviation (Sd) in parentheses. Sample comprised of households with a West German male born between 1935 and 1945 in regular insurable employment at age 62. Share of spousal income is conditional on being married. Source: SOEP waves 1984-2012.

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. All these changes occur regularly between 1998 and 2011, impacting the birth cohorts accordingly and influencing their retirement decisions. To disentangle the impact from changes in the income tax law from changes in the pension system, we simulate a counterfactual assuming the governing law of 1998 (see Appendix

B.2). Concerning the taxation of income from employment and PAYG-pensions, our tax model in particular includes the following regulations:[14]

- 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, the return portion (*Ertragsanteil*) is taxable only 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 is 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 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 the entire employment history (at least 420 month/35 years) of as well as the year and month of birth. Verification checks further confirm 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.

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

Appendix B: Model specification

This section shows some details regarding our model specification. The first subsection shows explicitly how we model the disutility of labor, while the second subsection gives further details on how savings behavior and wealth accumulation are implemented in the model.

B.1 Disutility of labor

(B.1)
$$l(d_{nt}, t_n) = \delta_1[1-d_{nt}] + [1-d_{nt}]\left\{\begin{matrix} & \delta_2\, min(t,3) & if\ t>0 \\ + & \delta_3\, min(t-3,3) & if\ t>3 \\ + & \delta_4\, min(t-6,3) & if\ t>6 \\ \vdots & \vdots & \vdots \\ + & \delta_9\, min(t-21,3) & if\ t>21 \end{matrix}\right\}$$

B.2 Savings rate

We assume that individuals accumulate wealth for retirement between ages 20 and 63. While this is an abstraction, it allows for adjustments in wealth accumulation in response to changes in the pension system.

For the choice of the savings rate, individuals maximize expected remaining lifetime utility at age 20 while anticipating their future retirement choice. This is done by solving a maximization problem analogous to equation (4). The maximization accounts for two things. First, it considers subjectively discounted expected utility flows from consumption between ages 20 and 63. These flows are based on both equation (3) and annuitized observed lifetime net income minus savings (i.e. consumption). All flows are weighted with cohort-specific probabilities of surviving until the respective periods. Second, the problem incorporates the subjectively discounted $v_1(\boldsymbol{s}_{n1})$, which corresponds to expected remaining lifetime utility at age 63 for optimal retirement choices. The vector of state variables at age 63, $\boldsymbol{s}_{n1}$, contains both the savings rate chosen at age 20 and the associated wealth at age 63. We denote expected utility from consumption between ages 20 and 63, measured at age 20, as $EU_{20}^{20-63}(\boldsymbol{s}_{n1})$. This leads to the following optimization problem that determines the individual savings rates:

$$\max_{srate_n} EU_{20}^{20-63}(\boldsymbol{s}_{n1}) + Prob(survival\ until\ age\ 63|age\ 20, cohort)\beta^{(43*12)}v_1(\boldsymbol{s}_{n1})$$

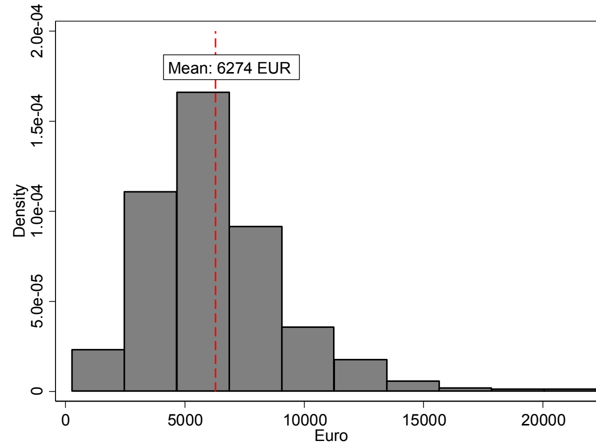
We solve the problem by computing the expected remaining lifetime utility at age 20 for a grid of savings rates between 0% and 15% (31 grid points with uniform intervals of 0.5%).

Appendix C: Additional results and robustness

Here we provide results on the actually implemented reform level (subsection C.1), wealth by disincentive level (subsection C.2), effects of different institutional changes described in Appendix A (subsection C.3) and parameter estimates and robustness for a scenario assuming single households only (subsection C.4).

C.1 Additional result for the actually implemented disincentive level of 0.3%

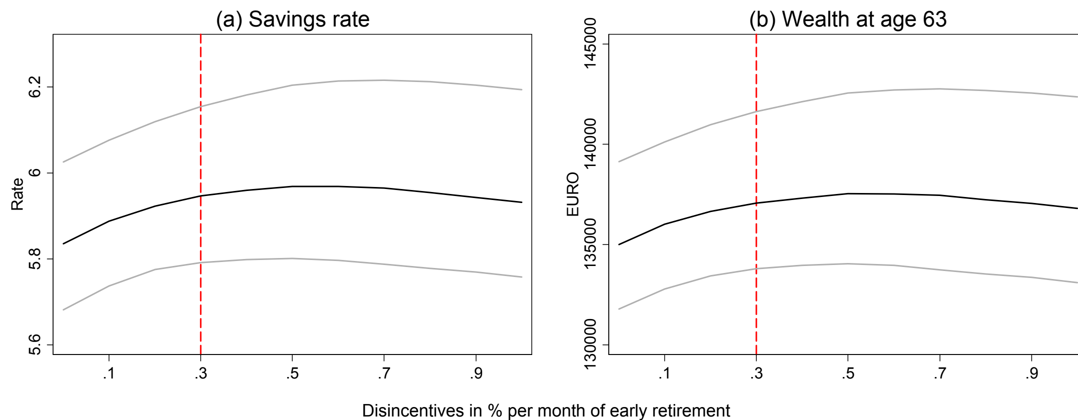
Figure C1: Distribution of compensating variations



Note: Euro in 2010 real values. The vertical dashed line indicates the actually implemented disincentive level of 0.3% per month. Source: SUFVSKT2002, 2004-12

C.2 Additional result for the effects changing disincentive levels on wealth

Figure C2: Average savings rate and wealth at age 63 by disincentive level



Note: Euro in 2010 real values. The vertical dashed line indicates the actually implemented disincentive level of 0.3% per month. Source: SUFVSKT2002, 2004-12

C.3 Effects of different institutional changes

Here we document the effects of various alternative reforms apart from the introduction of disincentives. Table C1 shows the effects of certain tax/pension parameters on retirement age. These effects are measured by assuming the values from 1998 (the first year of this study) for all other years. Table C2 lists the effects of pension cuts.

Table C1: Predicted effects of various reforms

Cohort	Predicted effect on retirement age in month			Total change in month due to institutional reforms
	Disincentives	Change in pension value relative to 1998	Change in tax system relative to 1998	
1935	0	0.0035625	0.5483875	0.55195
1936	0	0.011416	0.519024	0.53044
1937	1.1016	0.0197	0.5593	1.6806
1938	3.7399	-0.022	0.5385	4.2564
1939	4.5348	0.0293	0.5061	5.0702
1940	4.2345	0.1433	0.4582	4.836
1941	4.0678	0.2724	0.4517	4.7919
1942	4.0189	0.4061	0.4984	4.9234
1943	3.8768	0.5092	0.4979	4.8839
1944	4.0593	0.5887	0.5282	5.1762
1945	3.8298	0.5701	0.5325	4.9324

Note: Changes in pension value and tax system refer to scenarios where both are constant at the 1998 level, the first year of this study. Source: SUFVSKT2002, 2004-12, own calculations.

Table C2: Effects of pension cuts

Pension cut	Net public returns	CV	Δ Retirement age (month)	Δ Gini	Δ NPV of expected remaining earnings and pensions	Δ Monthly pension benefits
1%	2704	3232	0.0851	0.17	-2352	-14
2%	5417	5699	0.1738	0.36	-4690	-28
3%	8125	7858	0.2624	0.54	-7029	-43
4%	10832	9814	0.3500	0.73	-9365	-57
5%	13540	11621	0.4407	0.91	-11697	-71
6%	16235	13311	0.5377	1.09	-14038	-85
7%	18934	14909	0.6178	1.26	-16370	-100
8%	21644	16426	0.7113	1.46	-18686	-113
9%	24343	17889	0.8033	1.64	-21010	-128
10%	27047	19297	0.8977	1.82	-23326	-142

Note: Euro in 2010 real values. Source: SUFVSKT2002, 2004-12, own calculations.

C.4 Further estimation results and robustness

Table C3: Parameter estimates and robustness

	Baseline	Single
α (consumption)	0.20962	0.20478
	(0.019313)	(0.030632)
ρ (CRRA)	1.1159	1.1013
	(0.03461)	(0.02537)
δ_1 (disutility, constant)	-3.0507	-3.0356
	(0.24643)	(0.029883)
δ_2 (disutility, spline)	1.0524	1.0553
	(0.11881)	(0.0014775)
δ_3 (disutility, spline)	-0.16212	-0.16526
	(0.07553)	(0.030804)
δ_4 (disutility, spline)	0.027735	0.032837
	(0.07261)	(0.030805)
δ_5 (disutility, spline)	0.072466	0.069636
	(0.081271)	(2.7377E-06)
δ_6 (disutility, spline)	-0.24469	-0.2463
	(0.099273)	(3.5048E-06)
δ_7 (disutility, spline)	0.24947	0.25036
	(0.13286)	(0.016559)
δ_8 (disutility, spline)	-0.24744	-0.24017
	(0.15708)	(0.034778)
δ_9 (disutility, spline)	1.2542	1.2453
	(0.13642)	(0.0121)
Log-likelihood	-1957.01	-1957.05

Source: SUFVSKT2002, 2004-12, own calculations.

Table C4: Exemplary robustness results for a disincentive level of 0.3%

	Baseline	Single
ΔE[retirement age] (months)	4.06	3.84
ΔAverage wealth at age 63	€ 2,060	€ 2,271
ΔE[NPV of remaining earnings and pensions]	€-1,549	€-3,284
ΔE[NPV of remaining earnings and pensions] (%)	-0.67	-1.23
ΔGini coefficient (%)	2.7393	2.2185
ΔMonthly retirement income	€ -38.01	€ -38.7
Average compensating variation	€ 6,322	€ 5,809
NPV of net public returns	€ 18,309	€ 18,989
ΔE[NPV of pension benefits]	€ -12,688	€ -12,351
ΔE[NPV of pension contributions]	€ 2,970	€ 2,788
ΔE[NPV of other contr. & taxes]	€ 2,651	€ 3,850

Note: Euro in 2010 real values.

Source: SUFVSKT2002, 2004-12, own calculations

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