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The Effect of Partial Retirement on Labor Supply, Public Balances and the Income Distribution

Evidence from a Structural Analysis

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Abstract

This paper develops a structural dynamic retirement model to investigate effects and corresponding underlying mechanisms of a partial retirement program in Germany on labor supply, fiscal balances and the pension income distribution. The structural approach allows to disentangle the two counteracting mechanisms that drive the employment effects of partial retirement: 1) the crowd-out from full-time employment, and 2) the movement from early retirement or unemployment to partial retirement. It also allows to investigate the isolated role of financial compensations in a partial retirement program. The analysis is based on a unique administrative dataset that collects biographical information on full employment histories and combines information on partial retirement take-up with information on individual pension levels. I perform counterfactual policy simulations that analyse the role of partial retirement combined with financial subsidies and an increased normal retirement age. The results show negative employment effects but potentially positive fiscal consequences as well as a reduction in pension income inequality when partial retirement is introduced. Wage and pension compensations in partial retirement do not substantially affect employment behavior but play a substantial role in the fiscal consequences and distributional effects of partial retirement. An increased normal retirement age decreases negative employment effects and improves the effect on fiscal balances from partial retirement.

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1 Introduction

Population aging increases the financial burden on pay-as-you go funded public pension systems in many countries around the world. The sustainability of such pension systems is challenged when the group of elderly recipients increases while the group of those that contribute to the system decreases. A promising way to counteract this imbalance is to increase the labor force participation of the elderly by extending working lives (Maestas and Zissimopoulos, 2010). Consequently, increasing attention is being paid to measures that motivate elderly employees to remain longer in the workforce and thus on the contributing side of the social security equation.

Most recently, many European countries introduce partial retirement programs that aim at motivating elderly employees to stay longer in employment (Eurofound, 2001). Since the term "partial retirement" comprises many different retirement schemes (Bloemen et al., 2016), this study defines it as a reduction in working hours in the last job that is held prior to entering retirement. The idea behind increasing labor supply through partial retirement is that a gradual phasing out of work instead of abrupt full retirement encourages workers to stay longer in employment. However, the employment effects of partial retirement programs are ambiguous. Partial retirement may increase labor supply if people opt for partial retirement instead of full early retirement. On the other hand, if people opt for partial retirement instead of full-time employment they would have to spend more years in employment than they would have had in full-time employment in order to actually increase labor supply. That is, partial retirement might also generate negative effects on total labor supply if it crowds out years that would have been spent in full-time employment. Supporting evidence on underlying mechanisms that drive the effects of partial retirement is still scarce.

This paper contributes to the literature with a structural dynamic retirement model to investigate the effects and corresponding underlying mechanisms of partial retirement. The central question of this paper is how different aspects of a partial retirement policy affect employment and retirement behavior, fiscal balances and the pension income distribution. For this purpose I develop a structural dynamic model of individual retirement decisions. The basic model consists of an individual's annual choice to continue working or exit employment through one of three possible retirement paths: 1) regular retirement, 2) retirement via bridge unemployment, or 3) retirement via partial retirement. The choice is subject to individual employment and mortality risks. In addition, access to partial retirement is restricted. The incorporation of a tax and transfer system as well as the specification of the pension system in the model further enables an analysis of the fiscal consequences as well as effects of partial retirement on the distribution in pension income. Particularly the latter effect is so far overlooked by the literature.

There are some advantages to using a structural approach to this research question. It enables the modeling of idiosyncratic aspects of the program, such as financial subsidies and special age thresholds. In particular, wages as well as pension accrual can be subsidized in partial retirement and entry requirements can differ across different retirement paths. By explicitly implementing these aspects in the present structural retirement model, I am able to disentangle and determine the effects of the different channels that affect overall labor supply through a partial retirement policy. Furthermore, with the revealed preference approach I can identify partial retirement preferences directly at the relevant decision margin.

Based on the estimation of structural parameters of individual employment behavior, I am able to subsequently perform different policy simulations that investigate different aspects of a partial retirement policy. First, in order to understand the effect of just introducing partial retirement in the present system, I simulate unrestricted access to partial retirement. Secondly, I investigate the effect of partial retirement in the context of an increase of the normal retirement age (NRA) from 65 to 67 since the role of partial retirement as an option to extend working lives through a lower immediate amount of work may be increasing in the face of increasing retirement ages (Eurofound, 2016). Finally, I investigate the role of compensating wage and pension accrual subsidies for partial retirees by performing policy simulations with and without wage and pension compensations.

I make use of unique administrative Biographical Data of Social Insurance Agencies in Germany (BASiD) which combines information on employment history, wages and partial retirement take-up with the information on corresponding public pension accrual. No other administrative German dataset contains the information on the date of partial retirement take-up which is collected by the Federal Employment Agency and pension point accrual which is collected by the Statutory Pension Insurance. The combination of these attributes is essential to the present research question as this study not only looks at the ad-hoc effects of retirement decisions but also considers a trade-off between current and future income streams of forward-looking individuals. In addition, compared to survey data this dataset contains personal information, e.g. on wages or education, that does not suffer from non-response or reporting bias. The focus of this study lies on West German men which constitutes the largest group of workers in partial retirement.

Determining the sign of the labor supply effect of partial retirement is difficult because it is the result of two counteracting labor market movements: 1) the movement from full-time employment to partial retirement, and 2) the movement from unemployment or early retirement to partial retirement. Which movement dominates the other depends on the way partial retirement is used. It may be seen as a way to remain in the labor force and maintain positive work relations even if full-time employment is not wanted or not possible due to health reasons. Longer working lives, even in part-time, could curtail cognitive decline in higher ages (Rohwedder and Willis, 2010; Bonsang et al., 2012), and create synergies between experienced and new employees when longer firm presence of elderly employees overlaps with the hiring of new employees (Ghent et al., 2001; Munzenmaier and Paciero, 2002). This could potentially increase average normal retirement age. However, the reduction in full-time employment may be stronger if partial retirement is used to enter retirement as early as possible (Machado and Portela, 2012). Financial incentives for partial retirement may also limit positive labour supply effects if it increases its attractiveness relative to full-time employment (Kantarci and Van Soest, 2008; Börsch-Supan et al., 2015; Bloemen et al., 2016).

Therefore, empirical findings on the effect of partial retirement on labor supply are sparse and ambiguous. For instance, Ghent et al. (2001) find that a phased retirement program of the University of North Carolina tends to crowd out full-time employment which led to an overall reduction in labor supply whereas Wadensjö (2006) finds exactly the opposite for a Swedish partial retirement program. Albanese et al. (2016) find negative effects of partial retirement on the probability to remain employed in Belgium in the context of a competing risk model. Graf et al. (2011) analyze the Austrian old age part-time scheme which is institutionally very similar to the German partial retirement policy *'Altersteilzeit'* (ATZ) and find a cumulative negative effect on employment over the five year duration of the program. For Germany, Börsch-Supan et al. (2015) support the hypothesis that allowing for early access to partial retirement would decrease overall labor supply due to the large share of full-time employed that could potentially reduce their labor supply by entering partial retirement. The effects of the German ATZ policy were studied by Berg et al. (2015) and Huber et al. (2016). Both studies distinguish between labor market exit and retirement entry since factual retirement can start earlier in Germany if individuals bridge the transition to retirement with unemployment insurance (UI) take-up. While Berg et al. (2015) find an overall positive effect of ATZ on the average labor market exit age, the results by Huber et al. (2016) are more modest. Moreover, Huber et al. (2016) estimate heterogenous effects for East and West Germany and only find a significant positive effect for East Germany and no effect for West Germany which they contribute to differences in labor market conditions between the regions.

Most structural research approaches implement retirement only as a binary decision with no intermediate step (e.g. Rust, 1989; Stock and Wise, 1990; Rust and Phelan, 1997; Benitez-Silva, 2000; Heyma, 2004; Karlstrom et al., 2004; French, 2005; Blau, 2008). However, Gustman and Steinmeier (2008) present a noteworthy difference. They analyze the effect of partial retirement on the employment behavior of married men in the context of a dynamic structural retirement model using data form the US Health and Retirement Study. They find that removing restrictions for partial retirement generates an overall positive effect of partial retirement on total labor supply. Besides this, stated-preference approaches identify partial retirement preferences by individual ranking of hypothetical retirement schemes (Van Soest et al., 2007; Elsayed et al., 2015).

Finally, given the simulated policies, this paper contributes to the literature on alternative paths into retirement (e.g. Staubli, 2011; Inderbitzin et al., 2016) and to studies that analyze the effect of an increase in retirement age on actual retirement age (e.g. Duggan et al., 2007; Li and Maestas, 2008; Staubli and Zweimüller, 2013; Atalay and Barrett, 2015). The increase of the NRA from 65 to 67 is still in a transitional process in Germany and was only studied in a structural context with an ex-ante analysis by Etgeton (2017).

The analysis yields the following results: introducing the option to retire via partial retirement extends working lives by about one year by reducing the number of individuals exiting employment early via unemployment. However, overall employment volume still decreases by on average 7.35 % if the NRA is at 65 and by on average

4.48 % if the NRA is at 67 due to a large share of individuals that opt for partial retirement prior to full retirement instead of remaining in full-time employment. Thus, the option for partial retirement reduces full-time employment less in the context of an increasing NRA.

Subsidies in wages or pension accrual during partial retirement do not substantially affect employment behavior. However, they play an important role in the fiscal and distributional evaluation of partial retirement. More precisely, introducing partial retirement has a negative effect on net public balances in almost all simulations. Yet, this effect reverts when partial retirement is not subsidized and the NRA is at 67. More importantly, I find that income inequality in pensions reduces with the introduction of partial retirement. However, not compensating pension accumulation in partial retirement leads to a decrease in pensions across all income deciles. The results show that partial retirement becomes more important and fiscally viable as the NRA increases but improvements in net balances due to partial retirement come at the expense of overall lower pensions.

The rest of this paper is structured as follows. Section 2 introduces the dynamic decision model and the estimation strategy, section 3 presents the data and descriptive analysis, section 4 presents the estimation results, section 5 discusses counterfactual policy simulations and section 6 concludes.

2 Model

This section introduces a dynamic structural life-cycle model of individuals' retirement decisions at pensionable age. The institutional background is incorporated in this model as closely as necessary.[1]. The core of this model is based on the standard dynamic retirement model by Rust (1989). A forward-looking individual i derives utility at time t from consumption (C_{it}) and has leisure preferences that vary over employment states Γ^k_{it}. He[2] maximizes his expected remaining lifetime utility through annual decisions between continuing to work or employment exit via regular retirement, retirement via bridge unemployment, or partial retirement. The individual's horizon ranges from age 55 to $T = 100$ but decisions can only be made from age 55 to age 65, where everyone is in retirement at age 65. Moreover, there are two sources of uncertainty: job loss and mortality.

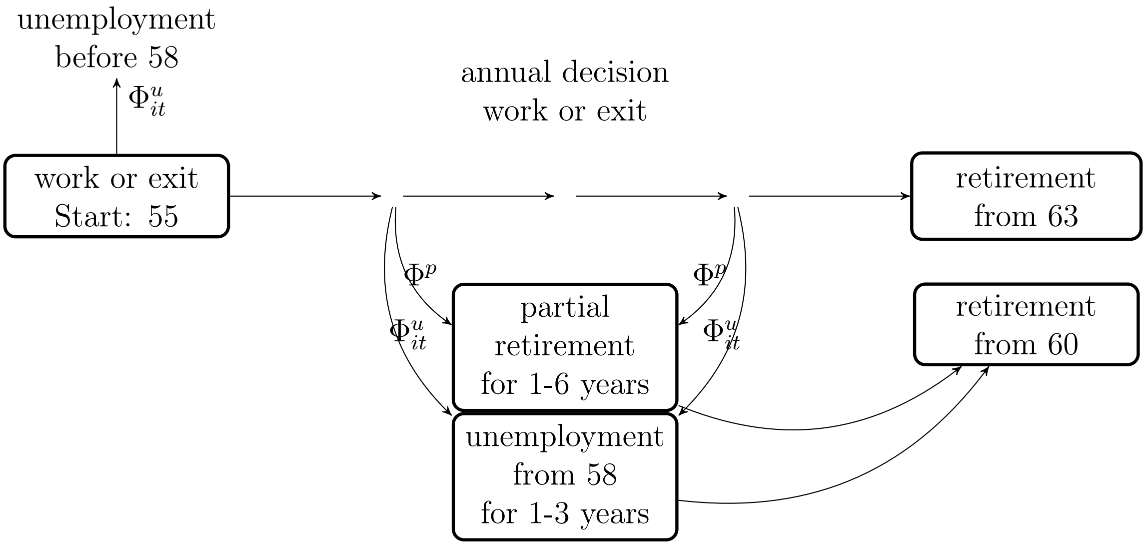
Figure 1 illustrates the structure of the decision problem. The model is conditioned on being employed at age 54.[3]

[1]The institutional background is described in a bit more detail in Appendix A

[2]I use the male form for the decision maker because the present study focuses on retirement decisions of West German men.

[3]This assumption introduces favorable selection in terms of labor market history and income. However, it also conditions on the eligibility criteria for partial retirement. The decisions of individuals not eligible for partial retirement yield no information on the preferences for partial retirement.

Figure 1: Structure of the decision problem



Own illustration

Every period, the individual faces the risk of job loss with probability Φ^u_{it}. Individuals that lose their jobs cannot return to the labor market. The expected value of job loss is divided into three different phases: before age 58, between 58 and 62, and between 63 and 65. Individuals that loose their job before age 58 receive at least one year of UI, then minimum social security contributions until they enter regular retirement.[4] Individuals that lose their job at age 58 -with at least two years of UI eligibility- will enter retirement after at least two years of UI-receipt.[5] If job loss occurs after age 63, the individual can either decide between immediate regular old-age pension or retirement after unemployment.

If job loss does not occur, with probability Φ^p_i the individual can decide between the following options:

1. continue to work in full-time (f)
2. exit work through 1 to 6 years of partial retirement and eventual full retirement (p_a), where $a \in \{1, \cdots, 6\}$[6]
3. exit work through bridge UI or minimum social security receipt and eventually retirement (ru)
4. from age 63: exit work either through regular old-age retirement (re) or the other two retirement paths

[4] I include this group in the model due to their eligibility for partial retirement prior to job loss.

[5] I assume that individuals use the full duration of their UI-eligibility. Due to sample restrictions discussed in section 3, every individual is eligible to at least one year of UI.

[6] Note that opting for partial retirement has the additional value of job security. This is due to the fact that take-up and duration of partial retirement is predefined in an employer-employee arrangement. Thus, partial retirement take-up inherits the additional decision over the duration in partial retirement.

However, with a probability $(1 - \Phi_i^p)$ the individual has no access to partial retirement. This produces two potential choice sets sets $D^p = \{f, p_a, ru, re\}$ and $D^{np} = \{f, ru, re\}$. To continue working is the only option with a continuation value. All other options are exit paths into retirement. Thus, the basic structure is a classic optimal stopping problem but with more than one exit option.

Assuming additive separability of utility over time, the decision problem can be written as

$$\max_{d_{it}} E_{t_0}[\sum_{t=t_0}^{\tilde{t}} \pi_t \delta^{t-t_0} U(C_{it}, \Gamma_{it}^k | d_{it}) + \sum_{t=\tilde{t}+1}^{T} \pi_t \delta^{t-t_0} U(C_{it}, \Gamma_{it}^k | d_{i\tilde{t}})] \tag{1}$$

where π_t[7] denotes the probability of living until age t conditioned on being alive at age $t-1$ and the cohort of the individual, δ denotes the discount factor and the maximum attainable age is denoted T which is set to 100.
In the individual's decision horizon, we distinguish between two phases: the decision phase (the first term of Equation 1) and the retirement phase (the second term of Equation 1). The decision phase ranges from $t = 55$ until $\tilde{t}$, where $\tilde{t}$ is either age 65 or the age at which one of the exit options was chosen. After $\tilde{t}$ utility evolves deterministically and choices can no longer be made.
The individual controls his consumption (C_{it}) and employment-state-specific utility (Γ_{it}^k) through decisions that affect his employment status (k), where k can either be full time employment (f), partial retirement (p), unemployment (u) or full retirement (r). In this study consumption equals income ($C_{it} = y_{i,t}^k$) which is explained in more detail in section 2.4.
In the following chapters I subsequently describe (i) the utility function (ii) partial retirement (iii) pension accumulation (iv) the budget constraint (v) the tax and transfer system (vi) job loss probabilities and finally combine these components in the dynamic programming framework.

2.1 Utility function

With regard to consumption, all individuals exhibit constant relative risk aversion (*CRRA*) in their within-period utility flows. Furthermore, individuals have preferences for each employment state k. The within-period utility function for individual i at period t in employment state k can be written as

$$U_{it}^k = \gamma \cdot \frac{(C_{it}^k)^{(1-\rho)} - 1}{1-\rho} + \Gamma_{it}^k + \epsilon_{it}(d_{it}) \tag{2}$$

where ρ denotes the coefficient of relative risk aversion, γ represents the weight for consumption in utility and ϵ_{it} is a choice-specific random shock which follows a type-one extreme value distribution. C_{it}^k denotes consumption of individual i in period t in employment state k and is elaborated in detail in section 2.4. Similar to Heyma

[7]Survival probabilities are obtained from the mortality database of the German Statistical Office and conditioned on gender and cohort (Statistisches Bundesamt).

(2004), individuals exhibit leisure preferences relative to their employment state k, Γ_{it}^{k} which is defined as follows.

$$\Gamma_{it} = \begin{cases} 0 & \text{if } k = f \\ \lambda & \text{if } k = r \\ \theta & \text{if } k = p \\ \upsilon_0 + \upsilon_1 \cdot \mathbf{1}[age >= 60] \cdot (age_{it} - 59) & \text{if } k = u \end{cases} \tag{3}$$

where λ denotes preferences for full retirement and θ indicates how individuals value leisure in partial retirement as opposed to full-time employment. I let leisure preferences when individuals opt for unemployment be different before individuals can enter retirement (age 60) and after. Before retirement entry is possible, υ_0 mainly represents preferences for full-time leisure, since this is the only option for full leisure prior to retirement. $\upsilon_0 + \upsilon_1$ represent leisure preferences when individuals opt for unemployment after retirement entry is possible and linearly develops with age from age 60. Generally, it is financially more attractive to take up UI before entering retirement. However, the data shows that many individuals directly opt for regular retirement without UI take-up. One reason for this is a stigmatizing effect of UI receipt (Moffitt, 1983). That is, individuals experience disutility merely from being unemployed due to the social stigma that accompanies unemployment. Thus, I expect $\upsilon_1 < 0$. Naturally, the unemployment rate is decreasing as more people enter retirement. Due to the social norm effect of the unemployment stigma that implies a stronger individual stigma with a lower unemployment rate (Clark, 2003), I let the stigma to be increasing with age from the earliest possible retirement entry age.

2.2 Partial retirement

I identify preferences for partial retirement through take-up of *part-time work for elderly employees* (known in Germany as *Altersteilzeit*).[8] Employees can take up partial retirement from the age of 55 by reducing their work hours prior to retirement by 50%. Wage and pension accumulation losses during the partial retirement period are compensated either by the respective employers or the Federal Employment Agency where the law sets a minimum for both compensations. I model subsidies for partial retirement according to these settings. That is, wage compensations in partial retirement amount to 20% of equivalent full-time employment wages ($sub^w = 0.2$) and pension accrual compensations amount to 40% ($sub^r = 0.4$).

Moreover, the model has to account for the fact that access to partial retirement is not a legally binding right but a collective agreement between employer and employees. That is, not every employee who would decide to enter partial retirement can eventually do so. Therefore, with a probability $(1 - \Phi^p)$, the individual's choice set does not contain the option to enter partial retirement. Whether or not an individual has access to partial retirement, cannot be observed in the data. Since the model is estimated by Maximum Likelihood, there is a way to adjust estimation by the access restriction for partial retirement. I construct a likelihood that is conditioned by access to partial retirement and weighted by Φ^p depending on actual

[8] Details on introduction, conditions and take-up of the policy are described in Appendix A.1

partial retirement-take-up. I set $\Phi^p = 35\%$ which is based on information obtained from Wanger (2009).[9]

2.3 Pension accumulation

The German Statutory Pension Insurance, is a pay-as-you-go funded system. Contributions to the system are collected in a payroll tax throughout the working life in the form of annual pension points (pp_{it}) which are based on a ratio of the individual gross wage (w_{it}) to the annual specific average wage of all insured ($\bar{w}_t$), i.e. $pp_{it} = w_{it}/\bar{w}_t$. That is, an employee receives one pension point if his wage is equal to the annual average wage. Annual contributions are capped by a ceiling which varies at around two pension points.

The model incorporates the fact that the individual's pension points are changing throughout the decision process according to the respective employment state as follows

$$P_{it} = \begin{cases} P_{it-1} + pp_{it}(w_{it}) & \text{if } k_t = f \\ P_{it-1} + (\frac{1}{2} + sub^r) \cdot pp_{it}(w_{it}) & \text{if } k_t = p \\ P_{it-1} + 0.8 \cdot pp_{it}(w_{it}) & \text{if } k_t = u \end{cases} \tag{4}$$

Thus, regular pension points from full-time employment are adjusted in partial retirement or unemployment. Here, I follow the institutional settings closely and set $sub^r = 0.4$, which denotes the pension points replacements provided by the partial retirement program. Pension points during unemployment insurance receipt equal the pension points from full-time wages adjusted by 0.8.

2.4 Budget constraint

In this model consumption equals net income, i.e. $C^k_{it} = y^k_{i,t}$.[10] This is in line with Rust and Phelan (1997) who mainly motivate this with problems of imputing missing wealth information. Dynamic consumption choice in a life cycle model that starts relatively late in working life would require information on the initial distribution on wealth. Then, consumption choice could be incorporated using the method by Low et al. (2010). Yet, the BASiD dataset does not provide information on wealth. Moreover, matching a wealth distribution from another dataset is not feasible due to lack of household information. This further implies the indirect assumption of a rather institutionalized than individual process of consumption smoothing. This is ensured by

[9] In particular, Wanger (2009) states that 15% of employees in small firms, where 40 % of the agewise eligible for partial retirement work, take up partial retirement. The partial retirement take-up rate in the remaining firms is 36% to 44%. Due to its financial incentives, partial retirement is taken up by most employees who have access to it.

[10] While this may sound like a fairly restrictive assumption, it is not in the context of the German public pension system. Workers in Germany rely as main source of income during retirement on the pensions from the Statutory Pension Insurance. Other sources of income, such as returns to capital only play a role of distant second order. For instance, Frick et al. (2010) show that the majority of all German households store the largest share of their wealth in pension entitlements.

the idea of the Statutory Pension Insurance that aims at pension annuities with high replacement rates proportional to the living standards prior to retirement. Clearly, I cannot assume that variation in individual retirement decisions is not driven by differences in wealth. However, I assume that most of this source of variation is already captured by income differences relying on a strong correlation between income and wealth (Piketty and Zucman, 2014).

Despite the lack of a savings process, the model still features decisions that affect intertemporal income due to its underlying institutional setting. The German Statutory Pension Insurance covers the majority of the working population. A pensioner's pension level is determined by his entire earnings and employment history. More specifically, an additional year of labor increases the individual's pension in the future. Furthermore, the system incorporates financial penalties and rewards on pension annuities for earlier or later retirement, respectively. The institutional background is described in more detail in Appendix A. In the following, I will elaborate on the income differences across employment states.

An individual's net-income at period t in employment state k ($y^k_{i,t}$) depends on his gross wages for his last observed state in full employment up to period t[11] and is subject to the tax and transfer system as well as social security contributions.[12]

Income in full-time employment The administrative dataset provides information about gross daily wages for working individuals. The net annual income for a working individual (y^f_{it}) equals gross annual labor market earnings minus social security contribution and income tax. Similar to Manoli et al. (2014), who estimate a structural retirement model using Austrian data, we observe little intertemporal variation in wages for elderly working individuals. Therefore, I apply the same approach to modeling future earnings by assuming that earnings w^f_{it} increase linearly by a growth rate g, such that

$$y^f_{it+1} = G^1((1+g)w^f_{it}) \tag{5}$$

where $G^1(.)$ denotes the model of the tax and transfer system and social security contributions which is explained in more detail in Section 2.5.

Income in partial retirement In order to differentiate between leisure preferences in partial retirement and the effects of financial incentives for partial retirement, it is important to consider the financial compensations of wages and pension point accrual that is provided to partial retirees according to the underlying institutional setting.[13] More precisely, according to the institutional setting, income in partial retirement includes a compensation of full-time employment wages of at least 20% which is paid as a wage subsidy $sub^w = 0.2$. Furthermore, the institutional

[11] The sample is conditioned on individuals in full-time employment at age 54. Therefore, I observe gross labor earnings from full-time employment in at least one period per individual.

[12] All monetary values in this analysis are price adjusted to 2005.

[13] See Appendix A.1 For details on the institutional setting of partial retirement.

background ensures that part-time wage penalties are not an issue. This yields the following specification for income in partial retirement.

$$y_{it}^{p} = G^{1}((\frac{1}{2} + sub^{w})w_{it}^{f}) \tag{6}$$

The individual obtains partial retirement income for the number of years that he has chosen to remain in partial retirement. The time in partial retirement is automatically followed by retirement.

Income in unemployment On average, UI amounts to 60% of the net-income that the individual received in the employment period prior to unemployment (Haan and Prowse, 2015). Thus, income in unemployment is specified as follows.

$$y_{it}^{u} = 0.6 \cdot (G^{1}(w_{it}^{f})) \tag{7}$$

Individuals receive unemployment insurance according to their entitlement between one and three years. I assume that the decision maker takes up the maximum of his entitlement at UI receipt. After that, the individual either receives the social security minimum or his pension depending on the respective employment status.

Income in retirement An individual in retirement receives an annual pension in period t (y_{it}^{r}) that is fixed from the moment of retirement entry up to the final period T. At retirement entry in period $\tilde{t}$, annual pension income is calculated as follows.

$$y_{it}^{r} = 12 \cdot P_{i\tilde{t}} \cdot raf(ra, rp, cohort) \cdot pv_{t} \tag{8}$$

where y_{it}^{r} represents the annual pension income of individual i at period t, $P_{i\tilde{t}}$ equals the individuals total sum of pension points collected up to period $\tilde{t}$, raf represents the retirement access factor and $pv_{\tilde{t}}$ represents the institutional pension value in year $\tilde{t}$. The raf is equal to one if the individual opts for regular retirement at the NRA. Then, there are deductions of 3.6 % for every year that the individual enters retirement below the regular retirement age and rewards of 6% for every year that the individual enters retirement later than the regular retirement age. In addition, there is further variation in the raf through cohort-based reforms for different retirement paths rp which are illustrated in Table 11 in Appendix B. Thus, the pension level is proportional to the length of the working life and the average position in the earnings distribution.

Note that pensions do not only depend on the collected pension points but also on the retirement age as well as the cohort of the individual. This is due to a reform in 1996 that introduced a step-wise increase of deductions for early retirement after unemployment or partial retirement across cohorts. This introduces a cohort-based exogenous variation in pension levels that supports the identification of leisure preferences in the structural model. The differences in pension deductions across cohorts, retirement path and age can be seen in Table 11 in Appendix B

2.5 Tax and transfer system

Taxes as well as social security contributions (SSC) differ substantially across employment states. They therefore affect retirement decisions through their effect on income. To control for this, I include a model of the tax and transfer system that incorporates the key differences across employment states. The base year for these institutional settings is 2005. This includes the legislative settings for taxation in different employment states and price adjustments.

Due to lack of demographic information, I model taxes and transfers for a single earner household. The model considers a progressive income tax and differences in SSC across employment states. The wage compensations for partial retirees are not taxed but are still subject to the progression clause. This implicitly provides further financial incentives for partial retirement. Pensions are only taxed by 50 % and exempt from pension contributions. Net income in UI roughly equals 60 % of previous net labor earnings. Furthermore, the model considers compensations in earnings and pension point accumulation for partial retirement and UI receipt. Finally, the lowest possible income is capped to the social security minimum. Overall, this model incorporates the key differences in financial incentives across employment states.

2.6 Job loss risk

The individual's employment decision is subject to labor demand frictions. Similar to Haan and Prowse (2014) and Merkurieva (2016), the risk of involuntary job loss (Φ^u_{it}) is estimated in a first stage random effects logit regression based on the German Socio-Economic Panel (SOEP)[14]. The dataset contains information on employment status and self-reported reasons for job termination. Job loss is defined as involuntary if the respondent has one of the following reasons for job termination: 1) Company shut down, 2) Dismissal, and 3) Temporary contract expired. I let the risk of job loss depend on personal characteristics that are contained in both datasets to be able to match the computed risk to the sample that is used for the structural analysis. The associated risk of job loss depends on age, education, past year's log years of tenure and log monthly wages. Thus, the probability of job loss Φ^u_{it} follows a logistic distribution distribution $\Lambda(.)$ with the following specification.

$$\begin{aligned}\Phi^u_{it} = \Lambda(&\alpha_i + \phi_0 + \phi_1 age_{it} + \phi_2 \mathbf{1}[educ_i = 2] + \phi_3 \mathbf{1}[educ_i = 3] \\ &+ \phi_4 log(tenure_{it-1}) + \phi_5 ln(wage_{it-1}))\end{aligned} \quad (9)$$

where $\alpha_i \sim N(0, \sigma^2_\alpha)$ is an individual-specific random error. The variable $educ$ is defined as 1 if years of education are lower than 12, 2 if years of education are 12 or more and lower than 16 years and 3 if years of education are 16 or more. The variable $yearsofeducation$ is defined as in Couch (1994). That is, the baseline is low education.

[14] This is an annual survey that, since 1984, collects individual- and household-level information from about 12,000 households (Wagner et al., 2007).

2.7 Value functions

The maximization of the decision problem in Equation 1 requires the choice of an optimal sequence of d_t from t to T. Drawing on dynamic programming techniques (Bellman, 1957), the dynamic optimization problem can be broken down to a two-period problem by recursively defining it as a function of state-specific conditional value functions $V_{it}(C_{it}, \Gamma_{it}|d_{it}, \Omega_{it})$ which define the maximum present discounted value of the individual's future life-cycle utility, conditioned on the individual's choice (d_{it}) and state variables (Ω_{it}). For the purpose of readability, I define: $V_{it}^{d}(k) = V_{it}(C_{it}, \Gamma_{it}|d_{it} = d, \Omega_{it} = \Omega)$ as the value function with choice d in employment state k (if one choice inherits different employment states) conditioned on other state variables. Furthermore, the method to condition on access to partial retirement produces two sets of value functions with different choice sets D^p and D^{np}. The choice-specific value functions are written as follows.

$$V_{it}^{f}(d_{it} \in D^p) = U_{it}^{f}(f) + \delta\pi_{t+1}[\Phi_{it}^{u} \operatorname{E}\max\{V_{it+1}^{re}, V_{it+1}^{ru}\} + (1 - \Phi_{it}^{u}) \operatorname{E}\max\{ \operatorname{E}\max\{V_{it+1}^{re}, V_{it+1}^{ru}\}, \operatorname{E}\max\{V_{it+1}^{p_1}, \cdots, V_{it+1}^{p_6}\}, V_{it+1}^{f}\}] \quad (10)$$

$$V_{it}^{p_a} = \sum_{j=t}^{t+a} \delta^{j-t}\pi_j^{\mathbf{1}(j\neq t)} U_{ij}^{p_a}(p) + \sum_{j=t+a+1}^{T} \delta^{j-t}\pi_j U_{ij}^{p_a}(r), \text{where } a \in \{1, \cdots, 6\} \quad (11)$$

$$V_{it}^{ru} = \sum_{j=t}^{t+a} \delta^{j-t}\pi_j^{\mathbf{1}(j\neq t)} U_{ij}^{ru_a}(u) + \sum_{j=t+a+1}^{T} \delta^{j-t}\pi_j U_{ij}^{ru_a}(r), \text{where } a \in \{1, \cdots, 3\} \quad (12)$$

$$V_{it}^{re} = \sum_{j=t}^{T} \delta^{j-t}\pi_j^{\mathbf{1}(j\neq t)} U_{ij}^{re_a}(r) \quad (13)$$

The value function for full-time employment when there is no access to partial retirement is written as:

$$V_{it}^{f}(d_{it} \in D^{np}) = U_{it}^{f}(f) + \delta\pi_{t+1}[\Phi_{it}^{u} \operatorname{E}\max\{V_{it+1}^{re}, V_{it+1}^{ru}\} + (1 - \Phi_{it}^{u}) \operatorname{E}\max\{ \operatorname{E}\max\{V_{it+1}^{re}, V_{it+1}^{ru}\}, V_{it+1}^{f}\}] \quad (14)$$

Furthermore, there is no value function for the partial retirement choice when there is no access to partial retirement and the remaining value functions do not differ under both conditions.

2.8 Solution and estimation

Due to the finite horizon of the choice problem, the solution can be derived by backwards induction starting from the utility flow in the final decision period. Within the model's framework, the individual will eventually have to retire. After choosing one of the potential exit options, the individual receives (depending on the choice either immediately, after a period of partial retirement or after a period of unemployment insurance claiming) an annual pension according to Equation 8 up to the final period. It follows from the type I extreme value distribution of $\epsilon_{it}(d_{it})$ in the utility function that we can derive a closed form solution for the expected maximum of choice-specific value functions (Rust, 1987) such that for any value function specific to the choices $l \neq m$

$$E\max\{V^l, V^m\} = ln(\exp(V^l) + \exp(V^m)) + \gamma \tag{15}$$

where γ represents the Euler-Mascharoni constant with $\gamma \approx 0.5772$. Moreover, with the assumption of additive separability over time and conditional independence (Rust, 1987), the model produces choice probabilities equal to

$$P(max(V_{it}^d) = V_{it}^{\bar{d}}) = \frac{exp(V_{it}^{\bar{d}})}{\sum_{j\in D^p} exp(V_{it}^j)} \tag{16}$$

and

$$P(max(V_{it}^d) = V_{it}^{\bar{d}}) = \frac{exp(V_{it}^{\bar{d}})}{\sum_{j\in D^{np}} exp(V_{it}^j)} \tag{17}$$

The probability to observe a choice needs to be adjusted by the unemployment probability Φ_{it}^u which yields

$$P(d_{it} = f) = (1 - \Phi_{it}^u) \cdot P(V^f > V^r \wedge V^f > V^p) \tag{18}$$

$$P(d_{it} = p_{\bar{a}}) = (1 - \Phi_{it}^u) \cdot P(V^p > V^r \wedge V^p > V^f) \cdot P(max(V_{it}^{p_a}) = V_{it}^{p_{\bar{a}}}) \tag{19}$$

$$P(d_{it} = ru) = (\Phi_{it}^u + (1 - \Phi_{it}^u) \cdot P(V^r > V^p \wedge V^r > V^f)) \cdot P(V^{ru} > V^{re}) \tag{20}$$

$$P(d_{it} = re) = (\Phi_{it}^u + (1 - \Phi_{it}^u) \cdot P(V^r > V^p \wedge V^r > V^f)) \cdot P(V^{re} > V^{ru}) \tag{21}$$

where $V^r = E\max\{V^{ru}, V^{re}\}$. The choice probabilities with the choice set D^{np} are computed analogously. Taking the product of the model's choice probabilities over observed choices produces the conditional individual likelihoods $L_i(D^p) = \prod_{t=1}^{\tilde{t}-1} P(d_{it} = f) \cdot P(d_{i\tilde{t}} \neq f)$ and $L_i(D^{np})$, analogously, where $\tilde{t}$ represents the period in which the exit decision is made. The final log-likelihood is written as

$$LL = \sum_{i=1}^{N^p} \log(\Phi_i^p \cdot L_i(D^p)) + \sum_{i=1}^{N^{np}} \log(\Phi_i^p \cdot L_i(D^p) + (1 - \Phi_{it}^p) \cdot L_{it}(D^{np}) \tag{22}$$

where N^p and N^{np} represent the number of individuals where the partial retirement decision is observed and where it is not observed, respectively. Parameters $(sub^w, sub^r, \pi_t, \delta, g, \Phi_i^p)$ are set in advance, Φ_{it}^u is estimated in a first step using a logit model, and the parameters $(\rho, \gamma, \lambda, \theta, \upsilon)$ are estimated with the structural model using maximum-likelihood estimation.

3 Data and descriptive analysis

This paper relies on administrative Biographical Data of Social Insurance Agencies in Germany (BASiD). The data is a combination of two administrative datasets from the Statutory Pension Insurance and the Federal Employment Agency through the identical social security number that serves as the unique individual identifier (Hochfellner et al., 2012). The basis of this dataset is a random selection from the Sample of Insured Persons and their Insurance Accounts (VSKT) 2007 of the Statutory Pension Insurance which was enriched with individual information from the Federal Employment Agency. The joint data set provides spell information about the employment history for each individual on a daily level from the first entry until 2007. The cohorts in the sample range from 1940 to 1947 to observe at least the earliest retirement entries of one cohort. In addition, BASiD contains information about education and several individual and work-related characteristics. To avoid a heavy reduction of the sample due to a high degree of missings in the education variable, I impute lacking educational information using a method suggested by Fitzenberger et al. (2005).

What distinguishes BASiD from other administrative datasources is the combination of full individual employment histories and information on pension take-up from the Statutory Pension Insurance with the information on partial retirement take-up from the Federal Employment Agency. The administrative reporting of all contributors earnings biographies ensures a high reliability on earnings information. This constitutes a clear advantage over survey data since reported data on earnings and employment histories or education usually suffers from non-response or reporting bias.

Earnings information in German administrative records are top-coded since contributions to social security and pension are deducted as a share of earnings up to an annually specified wage ceiling. Since earnings beyond that wage ceiling are recorded as exactly equal to that limit, wage information in the present dataset are right-censored. In order to obtain a better approximation of the true distribution of earnings, individual earnings that are affected by top-coding are imputed based on a Pareto rule for each year with the censoring limit set to the respective annual wage ceiling. A more detailed description of the imputation is given in section C.

I focus on West German men which constitutes the largest group of workers in partial retirement. The number of women in the studied cohorts eligible to partial retirement take-up is comparatively small and earnings- and employment histories are considerably different between East and West Germans in the studied time interval (Huber et al., 2016). Furthermore, I set the panel level of the dataset to annual observations. However, the loss in information compared to the drastic reduction in the computational burden, as we move from daily to annual intervals, is small, since most individuals make retirement decisions exactly on their birthdays as can be seen in Figure 2 and partial retirement take-up mostly occurs in full years, as seen in Figure 7. Moreover, due to lacking information on health, I exempt individuals that are eligible to the two available types of disability pensions. The missing health information makes it difficult to account for the effect of health shocks on the studied retirement decisions, which is why individuals subject to particularly strong health shocks are excluded. Furthermore, I restrict to a minimum of five contribution years to the pension fund due to the institutional restriction on pension eligibility. Finally, individuals need to be in full-time employment subject to social security contributions at age 54 with at least two years of tenure. This is done in order to correct for the selection of workers into firms that offer partial retirement only to be able to enter partial retirement very soon after firm entry. Refraining from this restriction could potentially yield an over-representation of individuals with strong partial retirement preferences which could result in an upwards biased estimation of partial retirement preferences (Huber et al., 2016). Besides, this restriction further ensures eligibility for UI receipt prior to retirement, such that the retirement path via unemployment is a viable alternative to partial retirement. Thus, these restrictions produce a homogeneous group of people that all fulfill the eligibility criteria for the studied retirement options.

Table 1: Descriptive statistics by retirement path

	Regular		Unemployment		Partial	
	Mean	**Std.Dev.**	**Mean**	**Std.Dev.**	**Mean**	**Std.Dev**
Retirement age	64.123	0.872	60.995	1.228	61.316	1.308
Pension (mon)	1365.597	363.975	1128.939	265.997	1254.981	247.331
Pension points	54.426	14.431	51.851	11.302	56.315	10.083
Contribution years	44.791	6.759	43.533	4.980	44.281	4.197
German	0.812	0.391	0.843	0.364	0.872	0.334
Education low	0.091	0.288	0.108	0.310	0.078	0.269
Education interm.	0.697	0.516	0.760	0.480	0.775	0.473
Education high	0.211	0.434	0.132	0.351	0.146	0.368
$\mathbf{U}_p r$	0.009	0.015	0.022	0.033	0.015	0.024
N	1246		910		1032	

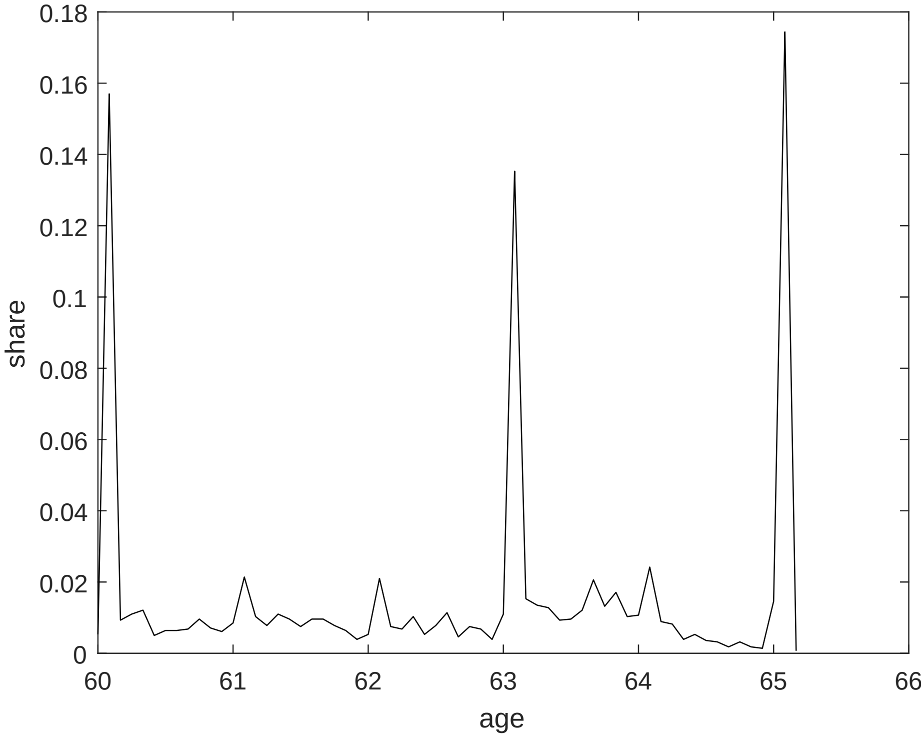
Source: Own calculations based on BASiD. "Partial" stands for partial retirement.

The final sample consists of 3,188 individuals with observed retirement entries. Of those, about 39 % (1,246) enter old-age retirement directly after work, 29 % (910) after unemployment and 32% (1032) after partial retirement. Since the estimation strategy allows the inclusion of right-censored observations in a panel data setting, the sample on which the analysis is based further includes employment decisions of

2,238 additional individuals of which the retirement decision is not observed.

Table 1 shows the group means and standard deviations for relevant variables by retirement paths. It can be seen that institutional retirement age thresholds are binding since regular retirees enter retirement much later than those that retire via unemployment or partial retirement given the early retirement option for non-regular retirement paths. Despite this earlier retirement age for partial retirement retirees, they collect on average more pension points than the other two groups suggesting that the share of partial retirement retirees is higher in higher paying jobs. This is in line with Chen and Scott (2006), who show that individuals with the option for partial retirement generally have a higher socio-economic background. This is further supported by the slightly higher education, share of German citizenship pension and contribution years for partial retirement retirees compared to unemployment retirees. However, despite the higher average pension points for partial retirement retirees, regular retirees receive on average a slightly higher monthly pension. This can be explained by the early retirement age and the corresponding penalties for earlier retirement for partial retirement retirees.

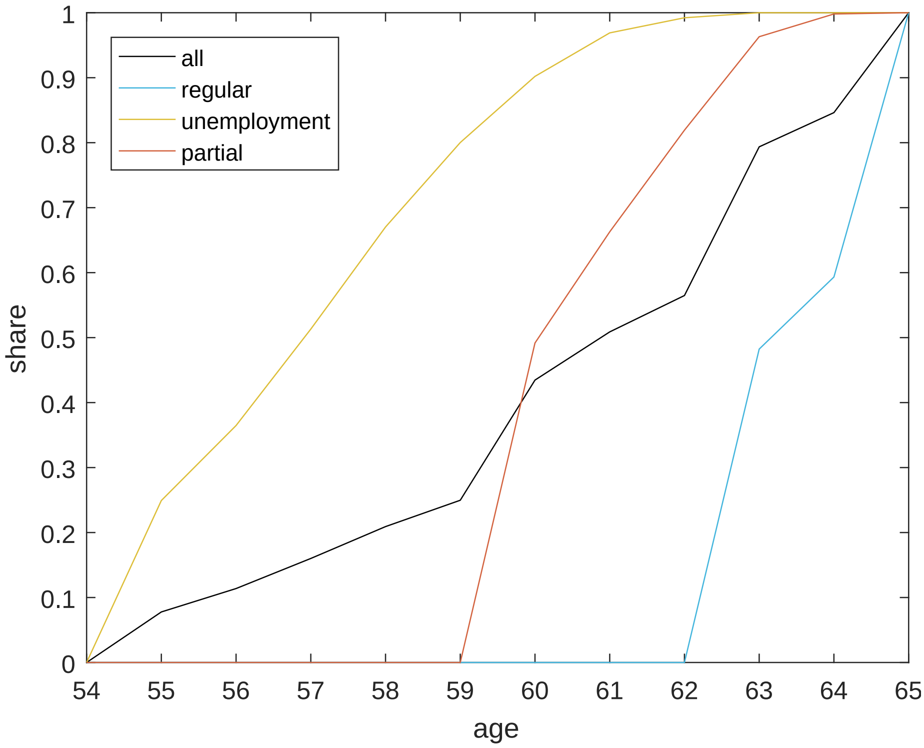
Figure 2: Retirement entry by age



Source: Own calculations based on BASiD sample with monthly observations. Sample restrictions: Only validated accounts, no disability insurance receipt, at least five pension contribution years, at least two years tenure at age 54.

The fact that retirement decisions are -to a large extend- driven by institutional age thresholds is supported by Figure 2 since the peak values for retirement entry occur at ages 60, the earliest possible retirement age for partial or unemployment retirees, 63, the early retirement age for regular retirees and 65, the normal retirement age.

Figure 3: Relative shares in non-employment by age and retirement path



Source: Own calculations based on BASiD. Shares are relative to the retirement path group size.

Finally, Figure 3 shows the share of individuals in non-employment relative to the number of people in the respective retirement paths. Generally, the status *"non-employed"* is defined as being unemployed or in retirement. The figure shows that partial retirees leave the employment status earlier than regular retirees but later than unemployment retirees. Thus, this suggests that a shift from regular retirement to partial retirement would generate negative employment effects while a shift from retirement via unemployment to retirement via partial retirement would generate positive employment effects.

4 Results

In this section I subsequently discuss the results from the estimation of the job loss risk, the structural estimation and the goodness of fit of the structural model.

4.1 Job loss risk

Table 2 shows the marginal effects on the probability of becoming involuntarily unemployed from the logit model that is described in Equation 9.

Table 2: Logit, marginal effects, job loss risk

	Value	Std.Err
age	-0.0146***	0.0017
educ2	-0.4375***	0.0487
educ3	-0.3337***	0.0758
lntenure	-0.3268***	0.0126
lnmonwage	-0.0914**	0.0395
constant	-1.7658***	0.2852
σ_α	0.9951	
N	90,723	
ll	-16,636	

*,** and *** denote significance level of 10%, 5% and 1%, respectively.

The estimation is based on a sample of all West German men in the SOEP excluding civil servants, self-employed and pensioners and the results are matched to the equivalent sample in BASiD. As expected, the risk of involuntary job-loss decreases with age. One reason for this could be that higher job-protection for people with higher tenure reduces the probability of job-loss due to the expiration of a temporary contract or firing as people get older. As expected, the job-loss risk also decreases with wage, education and tenure since better educated individuals in higher paid jobs with more tenure are less likely to risk involuntary job loss. Overall, the unemployment risk ranges between virtually 0 and 10 %.

4.2 Model estimates

Table 3 shows the results from the structural estimation of the model. Due to the separate identification problem between time and risk preferences (Rust, 1994), I set the discount factor δ to 0.96, as identified by Gourinchas and Parker (2002) in a consumption life-cycle model. I obtain an estimate of about 2.13 for ρ, the coefficient of relative risk aversion. This is slightly above the 1.81 as found in the retirement model by Blau and Gilleskie (2006) but far below 5 as estimated in the model by French and Jones (2011). Moreover, I obtain an estimate of 0.44 for the income weight. Overall, I find reasonable and precise estimates of the structural parameters that are consistent with the present literature. Since the baseline employment status in the model is full-time employment, the overall preference for retirement is positive which is in line with the idea of leisure preferences.

Table 3: Structural parameters

	Value	Std.Err
Utility function		
β	0.96	-
ρ	2.1274***	0.0905
γ	0.4370***	0.0345
Retirement		
λ	0.3703***	0.0110
Partial retirement		
θ	0.8469***	0.0299
Unemployment		
υ_0	0.6405***	0.0220
υ_1	-0.2888***	0.0194
ll	-16211	

*,** and *** denote significance level of 10%, 5% and 1%, respectively.

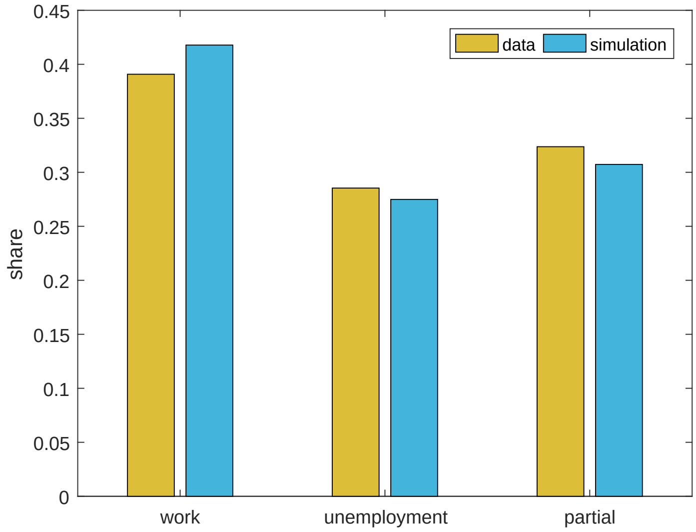
Another representation of leisure preferences lies in υ_0, the intercept in the unemployment-specific utility function. As mentioned before, I allow preferences for unemployment to be different before and after age 60 when retirement entry becomes an option in order to account for the so-called stigma effect of social security benefit receipt. Therefore, the linear effect at the age of retirement entry is negative and overall preferences for unemployment become negative at age 62.

Finally, the model identifies positive preferences for partial retirement compared to full-time employment which suggests that individuals are likely to forego higher earnings in full-time employment for the benefits of part-time employment in the given partial retirement program. Moreover, with an estimated coefficient of 0.85, preferences for partial retirement are higher than for full retirement ($\lambda = 0.37$). This suggests that individuals prefer entering retirement gradually via partial retirement as opposed to abruptly via the regular retirement path. This can also be explained by other positive factors that correspond to general labor market participation, such as higher social integration and the benefit of a regular time schedule. This finding is also in line with studies that measure preferences for partial retirement using stated-preference data (Van Soest et al., 2007).

4.3 Model fit

Based on the estimation of structural parameters and random draws from the income distribution within the data, I am able to simulate a dataset with 100,000 observations. Figure 4 and Figure 5 show how well the simulated dataset fits the real dataset by comparing different moments of the present and the simulated dataset.

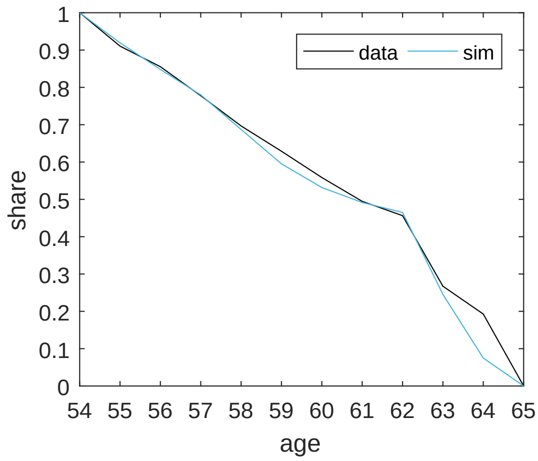
Figure 4: Share of Retirement Paths



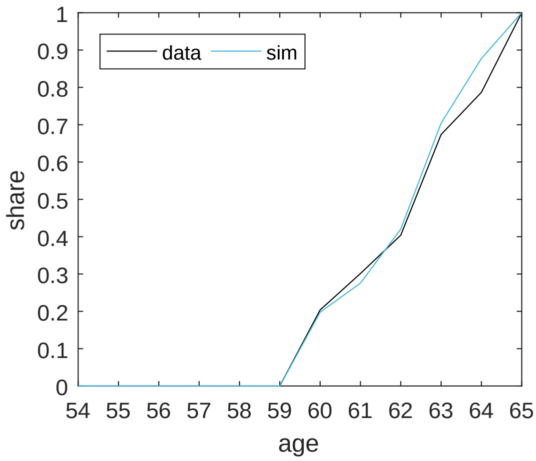
Source: Own calculations based on BASiD. Simulation is based on 100,000 draws.

Figure 4 shows the shares of each retirement path within the respective sample. The simulated share of regular retirees (41.78%) is slightly above the share of observed regular retirees (39.08%), the estimated share of decision makers that retire via unemployment (27.49%) is slightly under-estimated. The estimated share of partial retirees (30.73%) is slightly below the observed share of 32.37%. Overall, the distribution across different retirement paths seems to be reasonably well fitted.

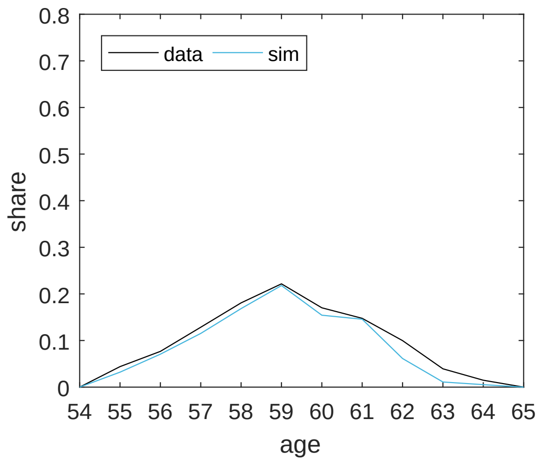
Figure 5: Model fit



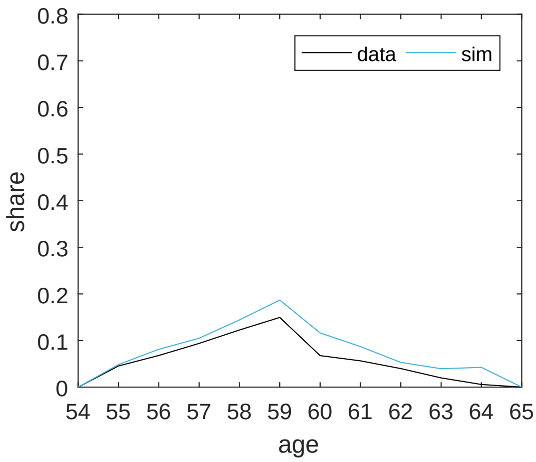
(a) Full-time



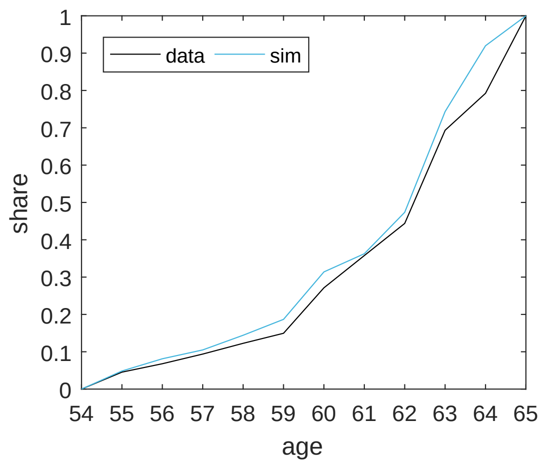
(b) Retirement



(c) Partial Retirement



(d) Unemployment



(e) Non-employment

Source: Own calculations based on BASiD. Based on 100,000 simulated observations. Figure depicts shares in each employment state by age. Sample is conditioned to 100% full-time employment at age 54 and 100% retirement at age 65

Figure 5 shows the share of individuals in each employment state by age.[15] Again, the overall pattern of individuals in each employment state is fitted reasonably well. The model overpredicts the decrease in full-time employment at age 64 and correspondingly overpredicts the increase in retirement or non-employment at age 64. This is because the model does account for the institutionally driven increase in retirement rates from age 63 but not for the observed differences in retirement entries between age 63 and 64 as seen in Figure 2. One easy way to account for this, would be to incorporate a dummy variable for age 63 for leisure-preferences in retirement in the utility function. However, I refrain from this due to an economically difficult justification for this method and subsequently difficult interpretation of the corresponding parameter. Similarly, the decrease in partial retirement at age 63 is a bit over-predicted. Again, this corresponds to the retirement entry behavior specifically for age 63 that is not explicitly modeled. Finally, the model slightly overpredicts unemployment shares overall although the shape of the distribution across ages appears to be fitted relatively well. Overall, the simulated sample provides a reliable basis for further policy analysis.

5 Policy simulations

In this section I present the results of counterfactual policy simulations that are performed based on the estimated parameters. The purpose of this exercise is to understand the effect of offering partial retirement, the role of financial incentives for partial retirement and the effect of partial retirement in the context of an increasing normal retirement age. Note that the institutional settings in the present data comprise different early retirement age thresholds for the studied retirement paths, an intermediate degree of access to partial retirement and some specified financial incentives for partial retirement. Using this as a benchmark in the planned policy simulations would make it difficult to reveal the effects that derive purely from partial retirement. For instance, in the underlying institutional setting people become eligible for full retirement after partial retirement at the age of 60, while eligibility for regular retirement only starts at age 63. Keeping these settings would leave unclear whether the effects that result from simulating partial retirement derive from people's preferences for early retirement or, in fact, for partial retirement. Therefore, for the baseline scenario, I adjust the early retirement age threshold for retirees after unemployment and partial retirement (60) to the early retirement age threshold of regular retirees (63). Moreover, the baseline scenario has no partial retirement option and no financial incentives for partial retirement. This is done in order to understand the isolated effect of each policy simulation. Then, I subsequently analyze the effects of the following policy scenarios: (1) full access to partial retirement, (2) an increase in the NRA from 65 to 67, and (3) subsidies for wages and pension accrual for partial retirement. Note that in order to understand the combined effects from these policies, some analysis also covers the interaction of these policies

[15] For full-time employment it is equal to one at age 54 and for retirement it is equal to one at age 65 because of the model conditions on everyone being in full-time employment at the beginning of the decision period and everyone being retired at age 65. Therefore, the share of full-time employees is always decreasing while the share of individuals in retirement or non-employment is always increasing.

I simulate partial retirement in the context on an increased NRA because OECD countries respond to an aging society by gradually raising early and normal retirement age thresholds. The role of partial retirement is also expected to change in this context which is why this analysis is particularly interesting from a long-term perspective. Another important aspect to consider in the context of retirement policies is their impact on the pension income distribution. Particularly in a publicly organized pension system where trust in the system plays a major stabilizing role, it is important to ensure that participants experience a fairness between their payments into the system and the annuities they receive afterwards. Therefore, this evaluation contains an analysis of the distributional effects.

In the following sections I start with a discussion of the employment effects. For this purpose, I compute the effect of partial retirement on working life duration as well as employment volume. In order to measure the effects on employment volume, I compute the full-time equivalent (FTE) at every age where one year in partial retirement is counted as $\frac{1}{2} * FTE$. This is followed by a discussion of the fiscal consequences and distributional effects of each policy simulation.

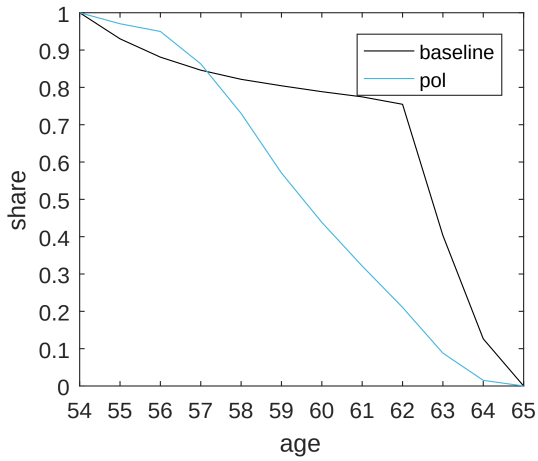
5.1 Employment effects

5.1.1 Introducing partial retirement

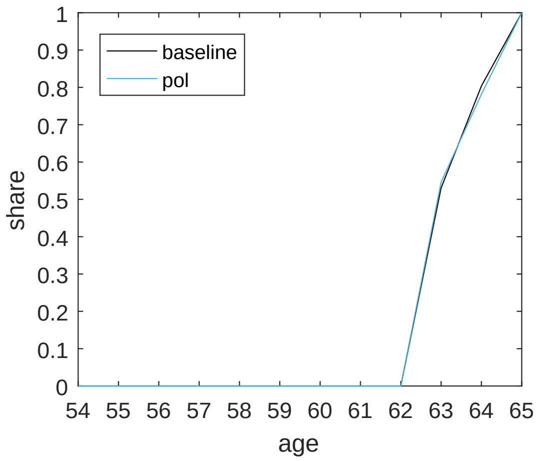
Figure 6 shows the effects on each employment status by age from simulating full access to partial retirement compared to the baseline with no access to partial retirement. As expected, this leads to a significant increase in partial retirees at each age (6(c)) which corresponds to a decrease in unemployment shares (6(d)) as well as individuals in full-time employment (6(a)). Thus, upon the introduction of partial retirement we observe both, a shift to partial retirement from full-time employment as well as unemployment in old age (which is practically early retirement). We derive the net effect on labor supply from both movements when comparing FTE employment in both states further below.

Furthermore, it can be seen in Figure 6(b) that the official retirement entry behavior remains practically unaffected. That is, individuals might be choosing the partial retirement path over other retirement paths upon introduction of this option but this does not affect their timing of full retirement. At first glance, this might seem surprising considering that the preference parameter for partial retirement (θ) is greater than the preference parameter for full retirement (λ). However, note that if income is equal in full retirement as well as partial retirement, immediate utility is higher if he chooses the partial retirement path. Yet, in both cases he will eventually end up in full retirement. Besides, in this case the individual can opt for partial retirement from age 55, i.e. long before he can enter regular retirement (from age 63). This and the partial retirement limit of six years yields that the actual choice between partial retirement and regular retirement only occurs in very few cases. Thus, the additional time spent in partial retirement does not seem to postpone the timing of full retirement.

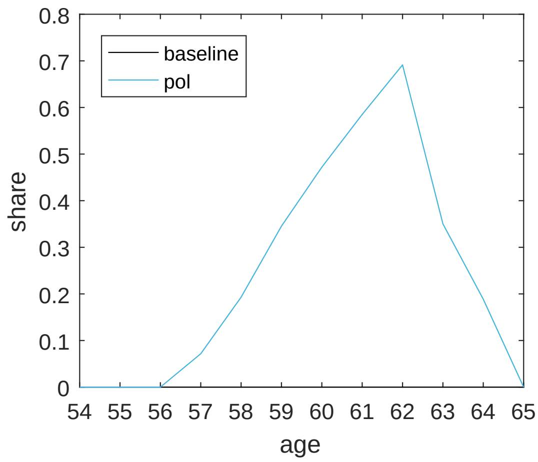
Figure 6: Policy Simulation: 100% access to partial retirement



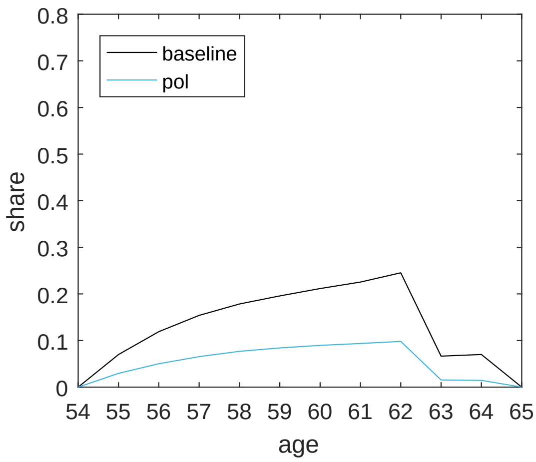
(a) Full-time



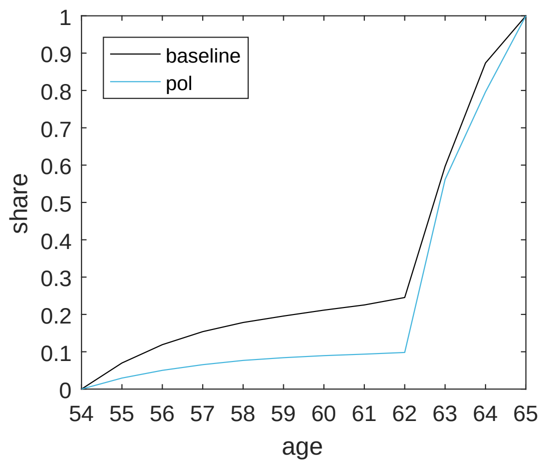
(b) Retirement



(c) Partial retirement



(d) Unemployment



(e) Non-employment

Source: Own calculations based on BASiD. Based on 100,000 simulated observations. Figure depicts shares in each employment state by age. Sample is conditioned to 100% full-time employment at age 54 and 100% retirement at age 65

In contrast, Figure 6(d) shows that employment exit behavior changes visibly with less people exiting employment at every age. This effect is stronger before age 63 than after when people become eligible for regular retirement. This suggests that partial retirement reduces the number of people that exit the labor market at younger ages through unemployment before they become eligible for regular retirement.

Table 4: Employment effects, partial retirement

	No part. ret.	**Part. ret.**	**Diff**	**Diff (%)**
Avg. retirement age	63.67	63.67	0.00	0.00
Avg. employment exit age	62.13	63.05	0.92	1.49
FTE avg.	71.30	66.06	-5.24	-7.35
Retirement path shares				
Regular	69.71	11.39	-58.32	-83.66
Unemployment	30.29	10.87	-19.42	-64.11
Partial	0.00	77.75	77.75	-
Average share in employment state				
Full-time	71.30	51.58	-19.73	-27.67
Partial	0.00	28.97	28.97	-
Unemployment	15.36	6.17	-9.18	-59.81
Retirement	13.34	13.28	-0.06	-0.45

Source: Own calculations based on BASiD. Based on 100,000 simulated observations. FTE represents Full-time employment equivalent. Shares are represented in %. Column 3 depicts absolute changes. Column 4 depicts relative changes.

Whether or not this policy yields a positive employment effect depends on the size of each movement from unemployment/early retirement to partial retirement or full-time employment to partial retirement. Table 4 shows a summary of average statistics describing the employment effect of the present policy simulation. Differences in statistics between the policies are reported in absolute as well as relative changes. The lower panel of Table 4 supports what is discussed before. The share of full-time employees as well as unemployed reduces drastically by 28% as well as 60% respectively and the middle panel shows that with this policy the share of partial retirees takes up about 78% of all retirees. While the increase in the partial retirement path seems drastic, it is reasonable when considering that partial retirement take-up with 35% access, as in the policy scenario underlying the original data, is more than 30%.

Moreover, the upper panel shows, while average retirement age remains unchanged, the average age at labor market exit increases by about 11 months from 62.13 to 63.05 which is mostly driven by fewer people leaving the labor market earlier through unemployment. That is, partial retirement leads to an extension of working lives. However, Table 4 shows that FTE employment decreases on average by 7.35 %. Thus, although partial retirement leads to an extension of working lives the overall effect of partial retirement on employment volume is negative.

5.1.2 Increasing normal retirement age to 67

Here I analyze the role of partial retirement with an NRA at 67. The simulation further incorporates a corresponding adjustment of the early retirement age (ERA) from 63 to 65. The changes in employment states between no and full access to partial retirement are similar to the previous policy simulation. That is, a large spike in partial retirement corresponds to reductions in unemployment and full-time employment. Moreover, retirement entry does not change while the share of employment exits reduces significantly prior to age 65. Figure in Appendix D corresponds to this.

Table 5: Employment effects, partial retirement, NRA: 67

	No part. ret.	**Part. ret.**	**Diff**	**Diff (%)**
Avg. retirement age	65.62	65.66	0.04	0.06
Avg. employment exit age	63.82	64.89	1.07	1.67
FTE avg.	73.53	70.24	-3.29	-4.48
Retirement path shares				
Regular	66.12	10.58	-55.54	-84.00
Unemployment	33.88	12.50	-21.38	-63.11
Partial	0.00	76.91	76.91	-
Average share in employment state				
Full-time	73.53	58.09	-15.45	-21.01
Partial	0.00	24.31	24.31	-
Unemployment	14.97	6.44	-8.53	-56.97
Retirement	11.50	11.16	-0.33	-2.91

Source: Own calculations based on BASiD. Based on 100,000 simulated observations. FTE represents Full-time employment equivalent. Shares are represented in %

The shifts in employment states are further supported by the results for average retirement paths and average shares in employment states in Table 5. The average retirement age without partial retirement (65.62) and with partial retirement (65.66) is higher than in the previous policy simulation which is due to the simulated increase in early and normal retirement age. Still, as in the policy simulation before, the average retirement age does not change substantially when allowing for partial retirement. Yet, the average age at employment exit increases from 63.82 to 64.89, i.e. by about 12.6 months which is a slightly higher effect than in the earlier scenario. The change in FTE employment when introducing partial retirement is still negative but with a 4.48 % reduction less than before. Thus, as before partial retirement leads to an extension of working lives but a reduction in the overall employment volume but in the context of an increasing normal retirement age, people have more time to "make up" for the reduction in full-time employment by staying longer in partial retirement.

5.1.3 Financial subsidies for partial retirement

Since the model incorporates the tax and transfer system and distinguishes between financial and non-financial preferences, I am able to isolate the effect of financial incentives in a partial retirement program. The simulation considers changes in immediate income in partial retirement through a wage subsidy as well as changes in long-run income through changes in the pension point accrual during partial retirement. The long-run differences in income affect the decision makers utility through the forward-looking feature in the model. I employ the wage and pension accrual subsidies that are used in the underlying German partial retirement policy (20% for wages as well 40% for pension point accrual). Moreover, note that the model further considers tax exemptions for the wage subsidy in partial retirement.

Table 6: Employment effects partial retirement, NRA: 67, subsidies for partial retirement

	No part. ret.	Part. ret.	Diff	Diff (%)
Avg. retirement age	65.62	65.70	0.08	0.12
Avg. employment exit age	63.82	64.93	1.11	1.74
FTE avg.	73.53	70.31	-3.23	-4.39
Retirement path shares				
Regular	66.12	10.26	-55.86	-84.48
Unemployment	33.88	12.34	-21.54	-63.58
Partial	0.00	77.41	77.41	-
Average share in employment state				
Full-time	73.53	57.84	-15.69	-21.34
Partial	0.00	24.93	24.93	-
Unemployment	14.97	6.38	-8.60	-57.41
Retirement	11.50	10.85	-0.64	-5.60

Source: Own calculations based on BASiD. Based on 100,000 simulated observations. FTE represents Full-time employment equivalent. Shares are represented in percentages.

Figure 11 in Appendix D compares the policy with financial subsidies to the corresponding policy without financial subsidies. The figure shows almost no difference between both policies which suggests that financial incentives only play a minor role in employment behavior as a response to partial retirement.

Table 6, which compares summary statistics between scenarios with and without partial retirement supports this finding. The effects are very small but it can be seen that wage and pension compensations incentivize partial retirement. That is, the share of retirement through partial retirement (77.41%) is slightly higher than in the previous scenario without subsidies (76.91%) and similarly the average share in the partial retirement state (24.93%) is slightly higher than the previous 24.31%. Correspondingly, with subsidized partial retirement the average age at employment exit increases by 13.3 months compared to 12.6 months in the case without partial retirement and the reduction in FTE employment is with a 4.49 % reduction slightly lower than the previous 4.57 %. Thus, the employment effects from partial retirement with subsidies are slightly higher than the effects from partial retirement without subsidies.

Summing up, I find that partial retirement leads to an extension of working lives by about one year. However, the effect of partial retirement on labor supply is still negative although less so at a higher normal retirement age. Nevertheless, it should be noted that this study only looks at employment behavior of the elderly working population from age 55. Partial retirement might be used by firms to generate new employment opportunities for younger age group. That is, what might be negative employment effects in the studied age group could still lead to positive employment effects for younger generations.

5.2 Fiscal consequences

With the consideration of the underlying tax and transfer system as well as the simulation of counterfactual income streams for every policy simulation, I am able to analyze the fiscal consequences of each policy scenario. In this analysis, costs comprise UI benefits, subsidies for partial retirement (P sub) from the federal employment agency as well as pension benefits (Pension). On the other side, the government's benefits comprise income tax (IT) and SSC. Since these costs and benefits from each individual vary across the respective employment states, the government's budget varies with changes of the employment state distribution across different policy regimes. That is, each individual in the sample produces public costs and benefits in every period. Since it cannot be observed whose partial retirement compensations are subsidized by the federal employment agencies, I assume an average subsidy rate of 18.5% of all partial retirement subsidies based on descriptive findings by Wanger (2009). All other changes in costs and benefits due to changes in employment states following a policy simulation are recorded within the model.

Table 12 in Appendix B summarizes the effects of a change in the employment state for each cost and benefit unit. The previous chapter shows that introducing partial retirement mostly induces a change in the employment state shares from full-time employment or unemployment to partial retirement while retirement entry behavior remains practically unchanged. Clearly, the change from full-time employment to partial retirement yields negative fiscal effects since an individual in full-time employment produces its potentially highest benefits and no public costs. The movement from unemployment to partial retirement produces a slightly more ambiguous public effect. On the one hand, the partial retirement state produces higher public benefits due to taxes and contributions that are gained from part-time wages. Clearly, it also reduces costs of UI. However, if partial retirement is publicly subsidized, this switch would produce public costs due to paid subsidies. Thus, the sign of the fiscal effect depends on the amount of paid subsidies as well as the size of the change in shares from full-time employment relative to the change from unemployment.

To illustrate the substantial difference in fiscal consequences for partial retirement with and without subsidies, I first start with an analysis of the effects with subsidies and then move to analyzing scenarios without subsidies. I collect costs and benefits in each period for each individual during its respective decision horizon. After labor market exit occurs, I take the present discounted sum of all future projected income streams that depend on the respective labor market exit and retirement age, chosen retirement paths, income levels, and collected pension points until the final period $T = 100$. Survival probabilities apply as before. Since this analysis considers the government's perspective, I replace the individual discount factor with the interest rate $r = 0.02$ which yields a government's discount factor of $\frac{1}{1+r} \approx 0.98$. This produces a lifetime balance for each individual for the simulated policy. Note that the decision period as well as cost-benefit calculations start at age 54 for every individual. Naturally, most government benefits of an individuals labor market life already occurred, i.e. SSC and IT. On the other hand, the large share of the costs, i.e. pensions, are about to be paid out. Therefore, net balances in this analysis are always negative. However, the focus is on the differences of net balances across different policy simulations.

Table 7: Fiscal consequences of partial retirement with partial retirement subsidies

	Costs			Benefits		
	Pension	**UI**	**P sub**	**SSC**	**IT**	**Net balance**
			ERA 63, NRA 65			
No part. ret.	344,460	13,746	0	101,960	5,4576	-201,670
Part. ret.	350,100	5,318	3,363	96,121	49,527	-213,133
diff	5,640	-8,428	3,363	-5,839	-5,049	-11,463
			ERA 65, NRA 67			
No part. ret.	357,950	14,310	0	117,290	65,946	-189,024
Part. ret.	363,550	6,018	3,372	112,640	61,875	-198,425
diff	5,600	-8,292	3,372	-4,650	-4,071	-9,401

Average cost and benefit units per person. Based on 100,000 simulated observations

Table 7 compares the average costs and benefits per unit per person between policy regimes without partial retirement access and regimes with full access to partial retirement. This is done for the cases with NRA set to 65 and to 67. In addition, partial retirement is subsidized in this case according to the previously performed policy simulation. That is, wages in partial retirement are subsidized by 20 % and pension point accrual during partial retirement by 40 %. Clearly, partial retirement with subsidies leads to a reduction in net public balances.

In both scenarios partial retirement leads to a reduction in SSC and IT which is mostly driven by the reduction in full-time employment when allowing for partial retirement. Moreover, subsidies in pension accrual and wages during partial retirement lead to an average increase in pensions by about 5,600 € and wage subsidies by about 3,360 € in both cases. In contrast, the introduction of partial retirement leads to a substantial decrease in average UI payments per person, by 8,428 € in case of the NRA at 65 and 8,292 € in case of the NRA at 67 which can be explained by the reduction in the share of unemployed in favor of partial retirement.

Overall, introducing partial retirement in case of the NRA at 65 reduces net public balances on average per person by 11,463 € while this policy reduces net public balances by 9,401 € on average per person in case of the NRA at 67. The lower reduction in the latter case is due to the fact that the reduction in average individual SSC and IT is lower than in the former scenario when allowing for partial retirement (10,888 € when NRA is at 65 and 8,721 € when NRA is at 67). Since most benefits are generated by individuals in full-time employment, this can be explained by the relatively lower reduction in full-time employment when the NRA is set to 67 (21.01% (see Table 5)) as opposed to the reduction in full-time employment when the NRA is set to 65 (27.67 % (see Table 4)) as seen in Section 5.1.

Table 8: Fiscal consequences of partial retirement, no subsidies for partial retirement

	Costs			Benefits		
	Pension	**UI**	**P sub**	**SSC**	**IT**	**Net balance**
			ERA 63, NRA 65			
No part. ret.	344,460	13,746	0	101,960	54,576	-201,670
Part. ret.	339,530	5,440	0	95,058	47,099	-202,813
diff	-4,930	-8,306	0	-6,902	-7,477	-1,143
			ERA 65, NRA 67			
No part. ret.	357,950	14,310	0	117,290	65,946	-189,024
Part. ret.	352,640	6,084	0	111,540	59,355	-187,829
diff	-5,310	-8,226	0	-5,750	-6,591	1,195

Average cost and benefit units per person. Based on 100,000 simulated observations.

Table 8 shows the same analysis of fiscal consequences as before but without subsidies for partial retirement. Without subsidies, the negative effect on net balances from allowing for partial retirement reduces substantially to 1,143 € in case of the NRA at 65 and reverts as net balances even increase by 1,195 € on average per person in case of the NRA at 67.

As before, the introduction of partial retirement leads to an average decrease per person in SSC and IT by 6,902 € and 7,477 € on average per person in case of the NRA at 65 and 5,750 € and 6,591 € in case of the NRA at 67 which is explained by the reduction in full-time employment in favor of partial retirement. At the same time, UI payments decrease in both cases by about 8,300 €. However, removing partial retirement subsidies naturally cancels out any costs for wage subsidies and reverts the effect of partial retirement on pensions. That is, pensions reduce on average per person by about 5,000 € independent of the normal retirement age. This is due to the large share of pensioners that switch from regular retirement to partial retirement and opt to collect only half of the pension points that they could have collected had they remained in full-time employment longer rather than switching to partial retirement earlier. Thus, most of the benefits from partial retirement is due to savings in UI receipt and overall pension reductions.

Finally, as in the case with subsidies, partial retirement is more beneficial from a public perspective in the context of a NRA at 67 which is again explained by a less substantial decrease in full-time employment with the introduction of partial retirement. To sum up, in most cases partial retirement has a negative effect on public balances due to reductions in IT ans SSC. However, without subsidies, these negative effects reduce substantially and in the case with no subsidies and the NRA set to 67 the effect of partial retirement on public balances even becomes positive.

5.3 Distributional effects

I base the analysis of distributional effects on pension payments since the underlying institutional settings yield pensions that reflect lifetime income better than employment earnings at any one point in time. Thus, I present distributional effects through deciles of realized annual pension payments and corresponding Gini coefficients for each policy simulation. As before, I start with analyzing the effects for policies with partial retirement subsidies and then move to policy scenarios without subsidies for partial retirement.

Table 9: Distributional effects in pensions, with subsidies for partial retirement

	Decile							
	1	**2**	**3**	**5**	**7**	**8**	**9**	**Gini coefficient**
				ERA 63, NRA 65				
No part. ret.	10,179	11,905	13,073	15,038	17,051	18,067	19,258	26.20
Part. ret.	10,445	12,210	13,378	15,305	17,263	18,279	19,399	25.44
diff	266	305	305	267	212	212	141	-0.76
				ERA 65, NRA 67				
No Part. ret.	10,709	12,432	13,605	15,702	17,815	18,848	20,055	26.10
Part. ret.	10,966	12,737	13,906	15,922	17,986	19,026	20,241	25.52
diff	257	305	301	220	171	178	186	-0.58

Annual pension deciles. Based on 100,000 simulated observations. Gini coefficient is represented in percent

Table 9 shows the distributional effects of partial retirement with the NRA at 65 in the upper panel and the NRA at 67 in the lower panel. As in the fiscal analysis, I start with the analysis of the effects of subsidized partial retirement. The reduction in the Gini coefficient, by 0.76 percentage points with the NRA at 65 and by 0.58 percentage point with the NRA at 67 shows that introducing partial retirement reduces inequality in pension incomes. This result is independent of the normal retirement age. Furthermore, we can see that partial retirement with subsidies also leads to an increase in annual pensions for every decile. When the NRA is set to 65, the effect is highest for the second and third deciles where it increases annual pensions by 305 € per year and lower for higher deciles. For the ninth decile, annual pensions increase by 141 € per person which is about half of the increase for the second decile.

The differences in the increase in annual pensions with partial retirement across deciles are slightly lower when the NRA is set to 67. In this scenario the effect is highest again for the second decile where it increases annual pensions by 305 € per person. Again, the effect size decreases for higher income deciles and is lowest for the seventh decile with an increase of 171 € per person per year.

Table 10: Distributional effects in pensions, no subsidies for partial retirement

	Decile							
	1	**2**	**3**	**5**	**7**	**8**	**9**	**Gini coefficient**
ERA 63, NRA 65								
No part. ret.	10,179	11,905	13,073	15,038	17,051	18,067	19,258	26.20
Part. ret.	10,110	11,812	12,952	14,833	16,784	17,782	18,872	25.54
diff	-69	-93	-121	-205	-267	-285	-386	-0.66
ERA 65, NRA 67								
No part. ret.	10,709	12,432	13,605	15,702	17,815	18,848	20,055	26.10
Part. ret.	10,609	12,308	13,463	15,446	17,500	18,512	19,675	25.66
diff	-100	-124	-142	-256	-315	-336	-380	-0.44

Annual pension deciles. Based on 100,000 simulated observations. Gini coefficient if presented in percent.

Table 10 shows the distributional effects for the simulated policies without subsidies for partial retirement. As in the case with subsidies, inequality in pensions decreases with the introduction of partial retirement independent of the NRA. The Gini coefficient reduces by 0.66 percentage points when the NRA is set to 65 and by 0.44 percentage points when the NRA is set to 67. Thus, the result that unrestricted access to partial retirement leads to a reduction in pension inequality is robust to retirement entry age thresholds and financial subsidies for partial retirement.

However, without subsidies for partial retirement annual pensions decrease across all deciles with the introduction of partial retirement. With the NRA at 65, annual pensions reduce at the lowest point for the first decile by 69 € per year. The effects are higher for higher deciles. For the ninth decile annual pensions reduce by 386 € per year which is more than five times higher than the reduction for the lowest decile. As before, the results are similar but the differences across deciles are slightly lower for the case with the NRA at 67. In this case annual pensions for the lowest decile decrease by 100 € while they decrease by 380 € for the ninth decile.

This result supports the evidence found on employment effects. That is, decision makers are willing to accept long term reductions in income in favor of reducing working hours prior to retirement since they do not adjust their employment behavior to a change in financial subsidies for partial retirement. To conclude, partial retirement clearly reduces income inequality in pensions. This finding is robust to different retirement entry age thresholds as well as financial incentives for partial retirement. However, without subsidies for partial retirement at least in pension accrual, partial retirement leads to a reduction in annual pensions across all income deciles.

6 Conclusion

In this paper I develop a dynamic retirement model in order to analyze the effect of partial retirement on labor supply, public balances and the pension income distribution. The basic model consists of an individual's annual choice to continue working or exit employment through one of three possible retirement paths: 1) regular retirement, 2) retirement via unemployment, or 3) retirement via partial retirement. The choice is subject to individual employment and mortality risks. Access to partial retirement is restricted.

Based on the model, I investigate three different counterfactual scenarios that explore different aspects in the effect of partial retirement on employment behavior, public balances and pension income distributions: (1) introducing partial retirement as a potential retirement path, (2) partial retirement in the context of an increased normal retirement age from 65 to 67 and (3) financial subsidies for partial retirement.

Independent of changes in any policy parameter, I find that partial retirement has no effect on retirement entry behavior. People still enter full retirement at the same time as in the baseline scenario with no partial retirement. Nevertheless, partial retirement yields an extension of working lives through a reduction of early employment exits via unemployment. However, in all cases partial retirement reduces the overall employment volume by 7.35 % per year when the NRA is at 65 and about 4.4 % per year when the NRA is at 67. Hence, the employment effects of partial retirement are negative but less so at a higher normal retirement age.

Moreover, I find that financial incentives for partial retirement do not substantially affect employment behavior. In contrast, subsidies play a larger role in the analysis of fiscal consequences as well as distributional effects of partial retirement. More precisely, with subsidies the fiscal consequences of partial retirement are always negative while these negative effects are reduced substantially when subsidies are withdrawn and even reverted when the NRA is at 67. Partial retirement increases net public balances on average per person by 1,195 € when it is not subsidized and the NRA is at 67. The fiscal consequences are mostly driven by differences in payed pensions which are positive when pension accrual is subsidized and negative when pension accrual in partial retirement is not subsidized.

Finally, I find that partial retirement reduces pension income inequality in all policy scenarios. This also holds, when financial subsidies for partial retirement are removed. This result is particularly important when considering that labor supply effects from partial retirement are realized through incentives and individual choice while other policy types impose restrictions on individual choice. This adds another dimension to the discussion on the value of partial retirement to a demographically challenged labor market.

From this analysis it is possible to draw the conclusion that partial retirement is beneficial from a public perspective when the normal retirement age is at 67 and partial retirement is not subsidized. That is, the importance of partial retirement as an additional retirement path is increasing in the face of an increasing normal retirement age. However, improvements in fiscal consequences are realized through reductions in pensions across all income deciles. It appears that subsidies for wages in partial retirement play a minor role in the fiscal consequences and distributional effects of partial retirement.

Whether or not potential costs for partial retirement are worth the benefit of less inequality in pensions remains a normative question which is subject to public discussion. The discussion should also consider the fact that partial retirement differs characteristically from policies that raise statutory age thresholds. While statutory age thresholds impose specific barriers on individual choice, allowing for partial retirement extends individual choice. However, the extension of working lives for elderly employees could lead to negative employment effects for younger workers if these elderly employees “sit on" jobs that could be given to younger workers. On the other hand, the overall negative employment effect of partial retirement for the studied population could lead to positive employment effects for younger generations if employers offer partial retirement to elderly employees to generate new employment opportunities for younger job seekers. In addition, there are other positive effects that might be derived from an overall introduction of partial retirement, such as an additional alternative for an individual to smooth out health shocks or potential synergetic effects when employees remain in their firms longer to potentially train new workers. These points are subject to further research.

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A Institutional background

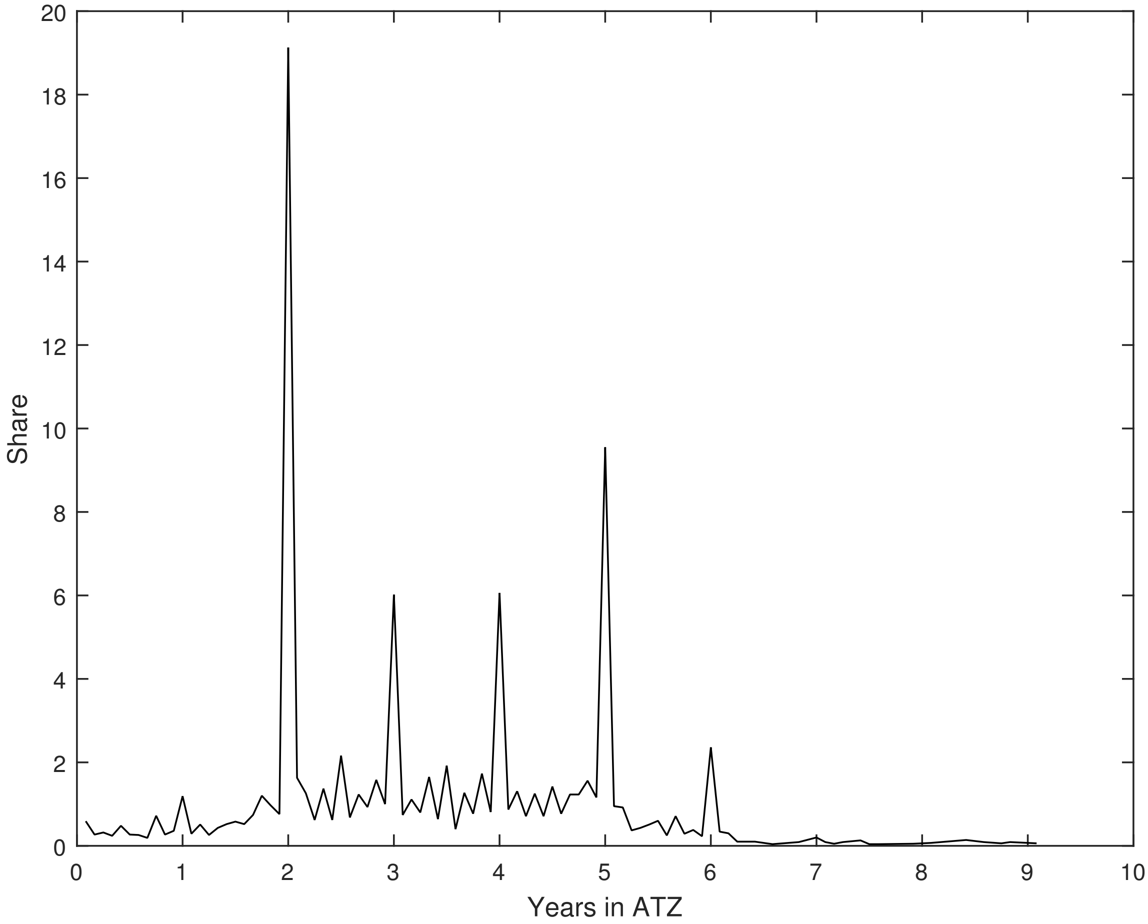
The German Statutory Pension Insurance, is a pay-as-you-go funded system. It covers the majority of the working population and is the main source of income after retirement entry. The focus of this study is on public and private sector dependent employees that are formally eligible for partial retirement take-up, excluding civil servants and self-employed. The Pension Fund is mainly financed by contributions through a payroll tax, evenly split between employee and employer.

A.1 The Altersteilzeit policy

In 1996, Germany introduced the Altersteilzeit (ATZ) policy with the aim to provide elderly employees with the option to gradually transition from work to retirement.[16] It was also intended to extend working lives by offering an alternative to abrupt early retirement. This policy sets legal standards for requirements as well as compensation and pension contributions for gradual retirement options in firms. More precisely, every employee aged 55 or older who has worked at least 1080 days in the past five years can reduce their work hours by 50%. Furthermore, employees in ATZ have to be paid at least 50% of their previous full-time wages. Employers are not legally required to provide ATZ such that further standards were set in agreements within firms or collective wage agreements (Brussig et al., 2009). Among ATZ providing firms, these agreements contained compensation floors of at least 20% of previous wages and 40% of previous pension points. The average compensation for wages among ATZ firms was 23% (Wanger, 2009) while pension point compensations ranged from 30-45% (Berg et al., 2015).

[16]The law governing ATZ (Altersteilzeitgesetz): $https : //www.gesetze - im - internet.de/bundesrecht/alttzg_1996/gesamt.pdf$

Figure 7: Distribution of time spent in ATZ



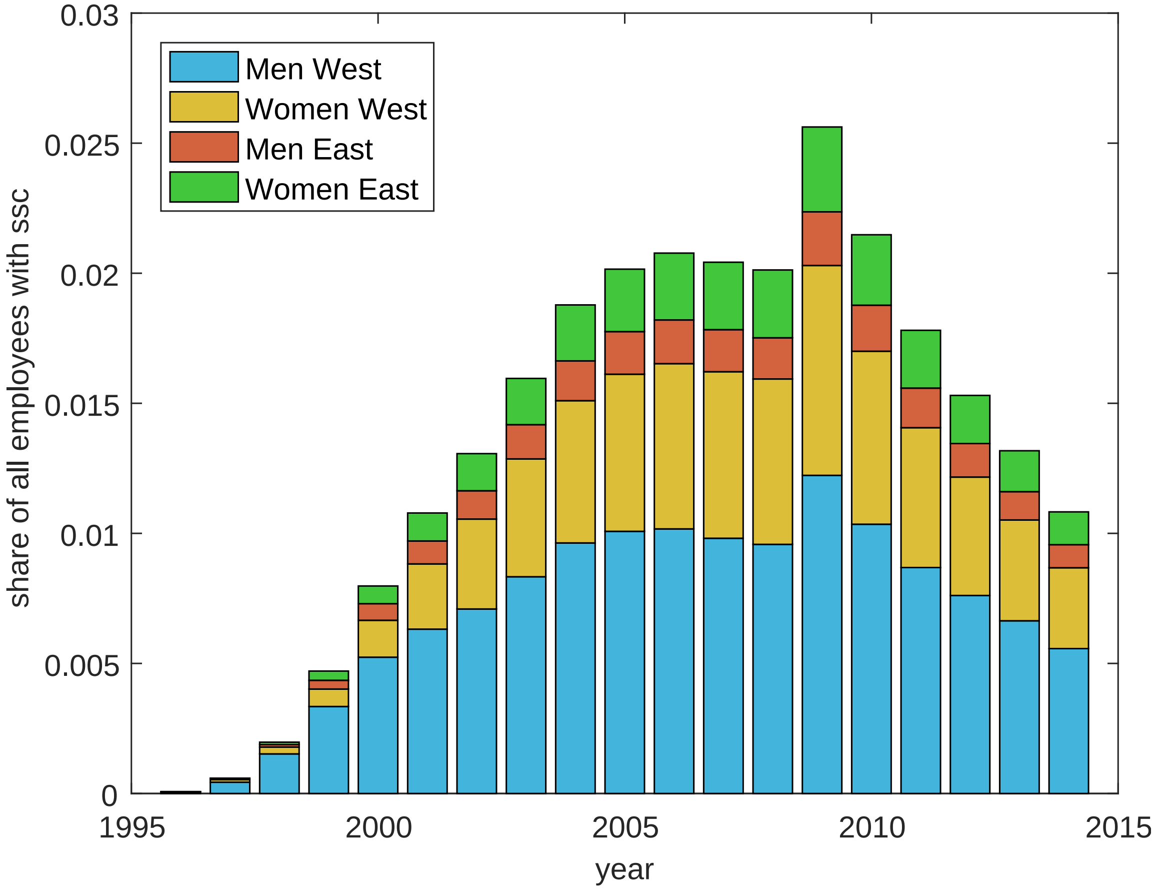
Source: Own calculations based on BASiD. Based on 258,296 monthly observations. Sample restrictions: Only validated accounts, all German men, no disability insurance receipt, at least five pension contribution years, at least two years tenure at age 54.

There are two options to realize the reduction in working time: The employee can either work part-time for the entire ATZ-period or opt for the so-called block model that consists of full-time work in the first half of the ATZ period and a leave of absence in the second half. With a take-up rate of 88 % in 2007 (Wanger, 2009), the block model is the more popular variant among ATZ-takers. While ATZ could be extended over a period of ten years, Figure 7 shows that virtually noone remains in ATZ for more than six years since this was the maximum number of years, the FEA would pay supplements to employers. These FEA subsidies stopped in 2009, while the minimum standards remained. However, due to the limitation to observations up to 2007, this is not relevant to the current study.

Note that for the studied cohorts, workers in ATZ and unemployed can enter full retirement up to three years earlier than regular retirees. That is, ATZ-take-up could also indicate preferences for early retirement.

Figure 8 shows that ATZ-take-up rose steadily since its introduction in 1996. From 2004 on ATZ-take-up reached about 18% of all employees subject to social security contributions aged 55 to 64 (Wanger, 2009), making it a relevant pathway into retirement.

Figure 8: Share of ATZ employees among all employees



Source: Own calculations based on Deutsche Rentenversicherung 2011, 2016

We can also see that ATZ was significantly more relevant to West Germans. In addition to this, East Germans exhibited different employment effects than West Germans with the introduction of ATZ which could be contributed to differences in the respective economies (Huber et al., 2016). The extraordinary peek in ATZ-take-up in 2009 further indicates that employment effects due to ATZ are different in economic busts (Huber et al., 2016). 2009 marks the year of the European Economic Crisis. However, the periods in the present sample only extend to 2007. Although the share of women in ATZ seems non-negligible, it only rose when eligibility was extended to part-time employees (Brussig et al., 2009), making it an economically less relevant group of ATZ employees.

A.2 Retirement after unemployment

Besides the presented retirement paths, workers from the studied cohorts have the additional option to retire at the early retirement age of 60 if they spent at least 12 months in UI receipt after turning 58.5. Depending on their previous employment history, workers are eligible to 18-32 months of unemployment insurance and they can use these months to bridge the time between labor market exit and official retirement entry three years prior to the normal old-age early retirement age of 63. This means that individuals that retire via unemployment are factually retired from the point they enter unemployment.

Retirees after ATZ have the same early retirement options and face the same pension deductions for early retirement (see Table 11). Periods spent in UI yield about 80% of the contributions from previous full-time employment. That is, relative to full-time employment, pension contribution replacements are higher in ATZ than in unemployment. Moreover, the replacement rate of labor earnings is lower in UI than in ATZ. To sum up the differences between these two retirement paths: Retirement via ATZ has higher financial incentives and ATZ employees have to work 50% of the bridge period while the unemployed have fully stopped working. Thus, when studying partial retirement-take-up through ATZ-take-up, retirement via unemployment should be considered as a voluntary alternative retirement option.

B Auxiliary tables

Table 11: Retirement access factors by cohorts and retirement type

	ATZ/Unemployment					Regular Retirement
age	**1940**	**1941**	**1942-1945**	**1946**	**1947**	**1940-1947**
60	0.892	0.856	0.820	0.000	0.000	0.000
61	0.928	0.892	0.856	0.856	0.000	0.000
62	0.964	0.928	0.892	0.892	0.892	0.000
63	1.000	0.964	0.928	0.928	0.928	0.928
64	1.000	1.000	0.964	0.964	0.964	0.964
65	1.000	1.000	1.000	1.000	1.000	1.000
66	1.060	1.060	1.060	1.060	1.060	1.060
67	1.120	1.120	1.120	1.120	1.120	1.120

Retirement access factors for retirement after ATZ/unemployment and regular retirement. Access factors of 0.000 indicate that access is not possible for that cohort-type combination Retirement entry for cohort 1946 can only be observed, if occurrence is at age 61. Retirement entry for cohort 1947 is outside the observed sample. Own Illustration

Table 12: Summary of changes in costs and benefits by state transitions

	Costs			Benefits
State change	**Pension**	**UI**	**ATZ sub**	**SSC/IT**
FT → **P**	0	0	+	-
FT → **U**	0	+	0	-
FT → **R**	+	0	0	-
P → **FT**	0	0	-	+
P → **U**	0	+	-	-
P → **R**	+	0	-	-
U → **FT**	0	-	0	+
U → **P**	0	-	+	+
U → **R**	+	-	0	0
R → **FT**	-	0	0	+
R → **P**	-	0	+	+
R → **U**	-	+	0	0

Own illustration. *ATZ sub* represents subsidies for partial retirement take-up. *UI* represents unemployment insurance payments. *SSC* represents employees' social security contributions. *IT* represents employees' payed income tax.

C Imputation of top-coded earnings

Since wage information in German administrative dataset are right-censored, earnings reported as equal to the annual-specific contribution ceiling z_t are imputed. The imputation of top coded earnings is based on the assumption that earnings w_i^f exceeding a minimum earnings threshold $\tilde{w}$ are distributed according to the Pareto law. Then, the probability to observe an income $w_i^f \geq \tilde{w}$ is given by

$$1 - F(w_i) = (\frac{\tilde{w}}{w_i})^\alpha$$

where $F(w_i)$ denotes the cumulative distribution function (cdf) on the interval $[\tilde{w}, \inf]$ and α is the pareto-coefficient that will be estimated for the imputation. Moreover, let n be the number of earners with $w_i^f \geq \tilde{w}$. In addition, earners with observed wages are ranked in ascending order of their income and accordingly assigned a rank r_i. Zipf's law establishes a relation between the rank r_i and the cdf according to

$$\frac{r_i}{n} \cong (\frac{\tilde{w}}{w_i})^\alpha$$

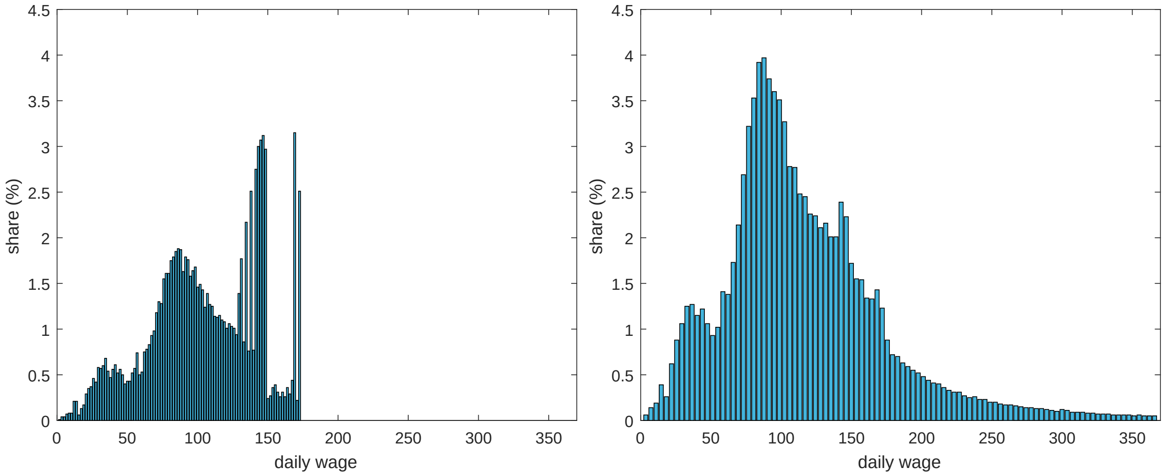
Taking the logarithm yields

$$ln(\frac{r_i}{n}) = -\alpha \quad ln(\frac{w_i}{\tilde{w}})$$

This equation enables the estimation of the pareto-coefficient α by OLS. After this, missing earnings $w_i \geq z_t$ are imputed by putting random draws into the inverse cdf. Since z_t is annual-specific, the estimation of α and the subsequent imputation is performed for each year separately. For each imputation, I set $\tilde{w}$ equal to the 90^{th} percentile of all observations below the respective contribution ceiling. Thus, I assume that at least 10 % of the top earnings on the interval $[0, z_t]$ follow a Pareto distribution.

Figure 9 shows the coarsened distribution of daily wages before and after the imputation. It can be seen that the imputation works well to smooth out the mass points at the wage-ceiling.

Figure 9: Distribution of daily wages before and after imputation of top-coded earnings



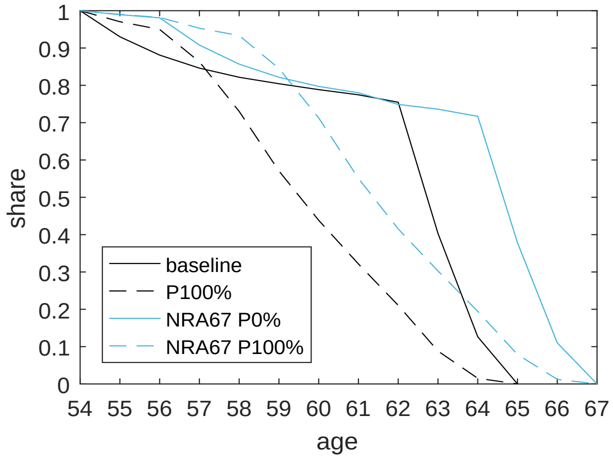
(a) Pre imputation

(b) Retirement

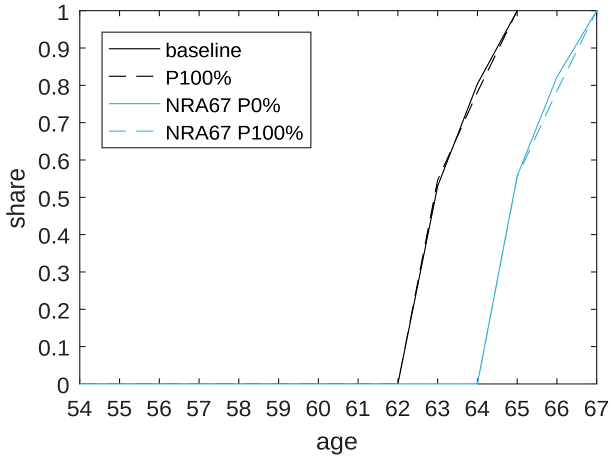
Source: Own calculations based on BASiD. Due to confidentiality law, the distribution is coarsened to a minimum of 20 observations per X value and wages in the 99th percentile are cut off in the plot with imputed earnings. Differences between the figures in the distribution below the wage ceiling occur due to the coarsening. The true distribution does not have differences between right-censored and imputed wages in the distribution below the wage ceiling.

D Further results

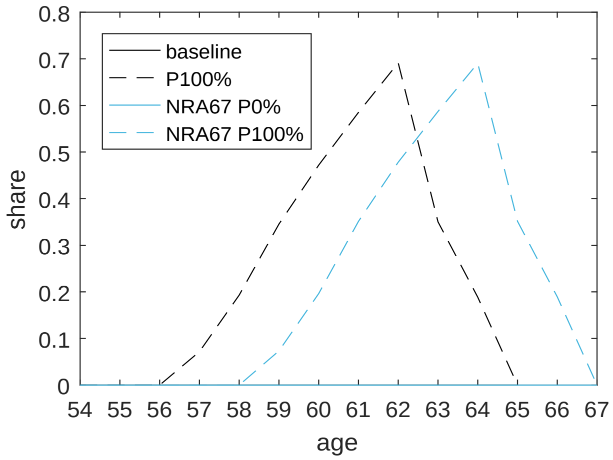
Figure 10: Policy Simulation: Normal retirement age set to 67, no early retirement for retirement after unemployment/partial retirement



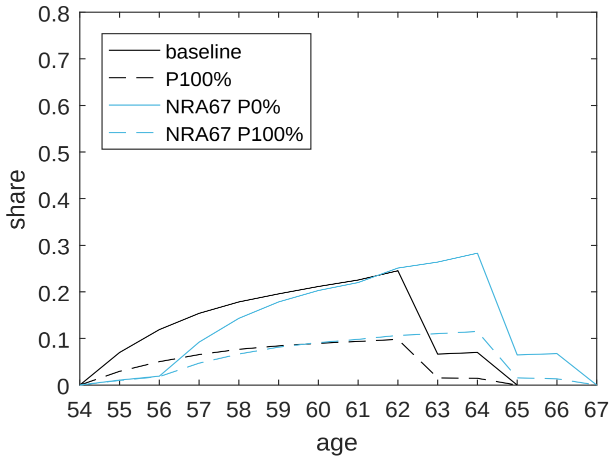
(a) Full-time



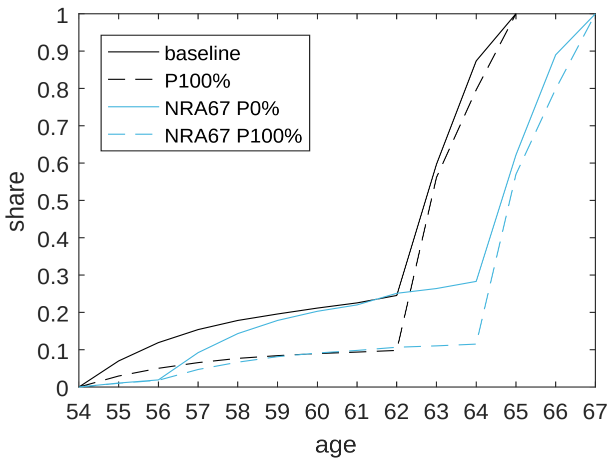
(b) Retirement



(c) Partial retirement



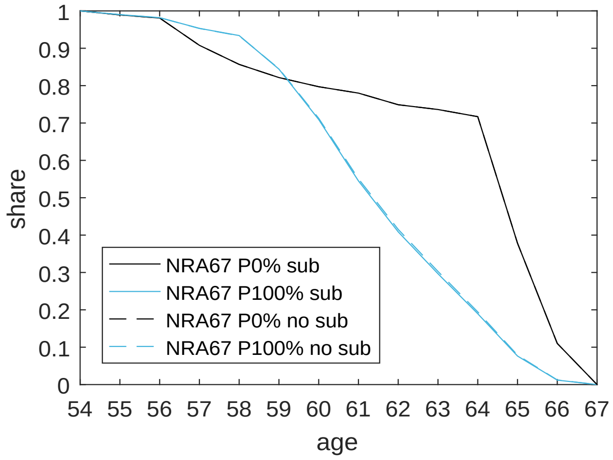
(d) Unemployment



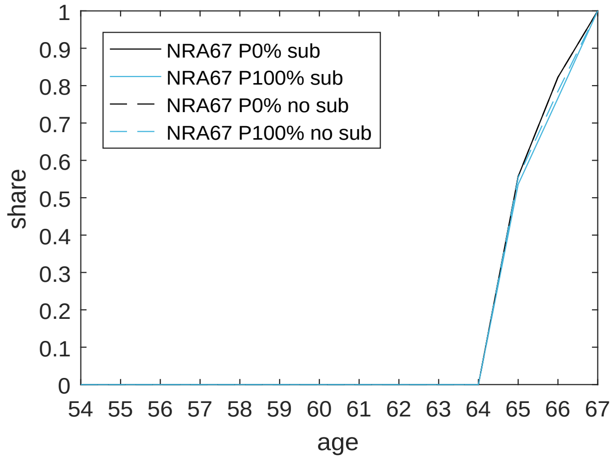
(e) Non-employment

Source: Own calculations based on BASiD. Based on 100,000 simulated observations. Figure depicts shares in each employment state by age. Sample is conditioned to 100% full-time employment at age 54 and 100% retirement at age 67

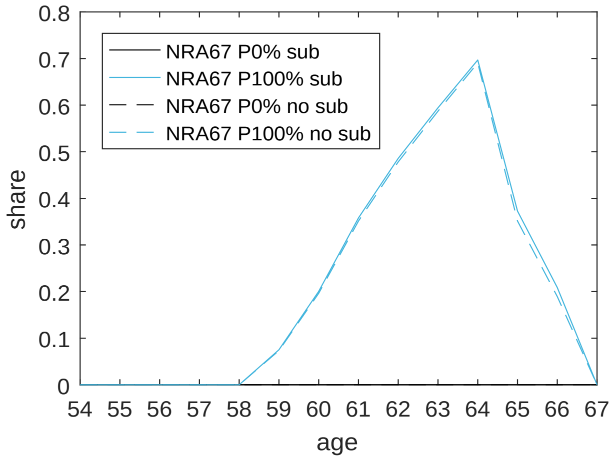
Figure 11: Policy Simulation: Subsidies for partial retirement. NRA set to 67



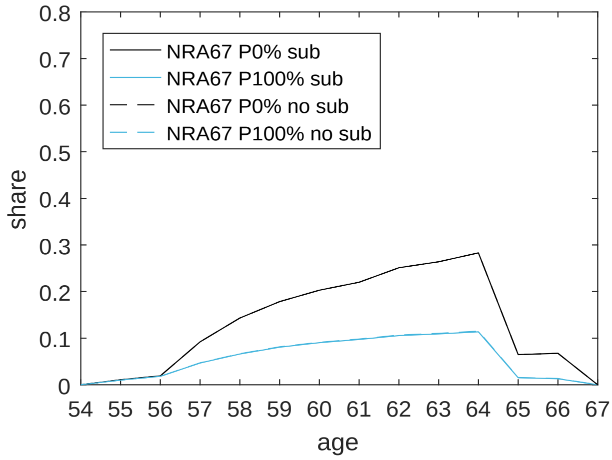
(a) Full-time



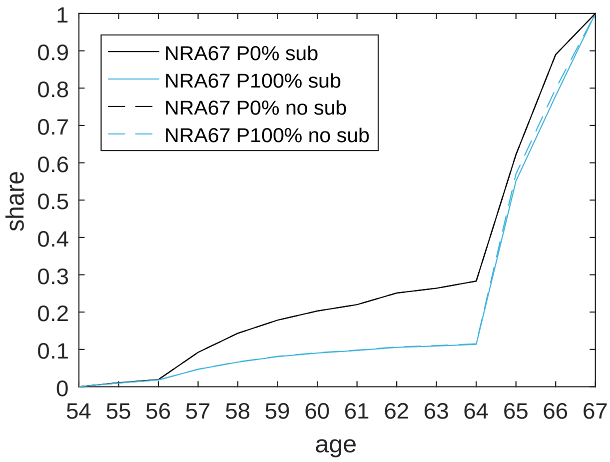
(b) Retirement



(c) Partial retirement



(d) Unemployment



(e) Non-employment

Source: Own calculations based on BASiD. Based on 100,000 simulated observations. Figure depicts shares in each employment state by age. Sample is conditioned to 100% full-time employment at age 54 and 100% retirement at age 65