

The Interaction of Pension System and  
Unemployment Insurance - Evidence from two  
Reforms

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## **Abstract**

Unemployment benefits are one important option to bridge time between employment exit and claiming retirement benefits for older workers. Therefore it is important to account for the interdependencies of these two systems when analyzing retirement behavior. In this paper we develop an option value model that explicitly accounts for the pension system and unemployment insurance in Germany. We use administrative panel data and implement the model for female birth cohorts of 1940 to 1949, exploiting exogenous variation in social security wealth by the pension reform 1992 and the reform of unemployment benefits in 2004. More specifically we use the option value model to simulate the employment and retirement effects of different reforms, changing (1) the maximum duration of unemployment benefits and (2) the level of benefit reductions for early retirement. Our results suggest that a shortening of the entitlement period of unemployment benefits is an effective instrument to reduce complementarity of pension and unemployment benefits whereas permanent deductions for early retirement leads to substitution between these programs.

**Keywords:** Old Age, Pension, Labor Force Participation, Retirement, Unemployment, Option value model

**JEL:** H55, J14, J22, J26, J65.

# 1 Introduction

Many countries around the world face an aging population. This demographic change increases the financial requirements of social security programs, especially of the pension system. In response, a lot of countries implemented fundamental reforms. For instance, the United States increased the normal retirement age from 65 to 67, allowing early retirement at the cost of benefit deductions. Such a decrease of pensions benefits encourages individuals to prolong their working years and postpone entry into retirement. In a pay-as-you-go system this can have two beneficial effects. A longer working life increases contributions while a shorter entitlement period lowers benefits. The effectiveness of this policy depends on interrelationship between the pension system and other social security and transfer programs. Thus, for the design of such reform, it is important to understand what factors play a role in making the decision to retire and to account for potential substitution effects, for instance into unemployment.

In this paper we develop an option value model that explicitly accounts for the pension system and unemployment insurance in Germany. We use administrative panel data and implement the model for female birth cohorts of 1940 to 1949 which are affected by two reforms. First, an introduction of permanent benefit reductions for early retirement and second, a shortening of the entitlement period of unemployment benefits. This creates exogenous variation in the net present value of social security benefits for different birth cohorts and allows us to separately identify the employment and retirement effects induced by changes in the pension and in the unemployment system. More specifically we use the option value model to simulate the employment and retirement effects of different reforms, changing (1) the duration of unemployment benefits and (2) the height of benefit reductions for early retirement. Our results suggest that a shortening of the entitlement period of unemployment benefits is an effective instrument to reduce complementarity of pension and unemployment benefits whereas permanent deductions for early retirement leads to substitution between these programs.

This study is related to two strands of the literature. Various papers have

focused on how pension wealth affect retirement. Mitchell and Fields (1981) give a thorough overview of early research, which analyzes the retirement decision dependent on pension and Social Security benefits in a life-cycle framework. One drawback of early research is mentioned by Moffitt (1987), criticizing studies using cross-sectional data. It remains unclear if labor supply and retirement decisions can be identified by variation in social security benefits in a cross-section since differences in Social Security benefits only reflect variance in other variables e.g. earnings, marital status etc. Those variables might have a direct effect on labor supply and thus on retirement timing. To get around this identification problem, Krueger and Pischke (1992) analyze the natural experiment of the so called notch babies. Amendments enacted in 1977 lowered Social Security benefits of individuals born 1917 onward, whereas individuals born before 1917 were not affected by these changes. Krueger and Pischke (1992) use the resulting exogenous variation in benefits to examine its effect on labor supply. They only found a modest impact of Social Security benefits.

There are two main approaches on how to implement the dynamic structure of Social Security benefits in the literature. The first is a dynamic programming approach and the second is the use of an option value model. Rust (1989) shows how to apply a dynamic programming model to examine the retirement behavior of older male workers and estimates the model in a subsequent study (Rust, 1990). Other studies that apply dynamic programming are Berkovec and Stern (1991), Rust and Phelan (1997), Karlstrom et al. (2004) and Heyma (2004) among others. Instead of using a dynamic programming approach, Stock and Wise (1990) develop a model, called the option value model. They calculate individual utility when retiring now or at any later point of time. The option value measures the difference between retiring now and when utility is maximized. A similar analysis is completed by Samwick (1998) using a broader data set of American workers. Instead of comparing utility levels, Coile and Gruber (2001) take the difference between present value of Social Security wealth when it would be maximized and today's present value of Social Security wealth. This incentive measure, called peak value, do not need any assumptions on preferences for leisure.

The concepts of option value and peak value are used by several researchers to analyze how Social Security affects retirement in 12 countries (Gruber and Wise, 2004). Although, the effects varies in magnitude, they find large responses of workers labor supply to incentives of Social Security program in all countries. For the German case, Börsch-Supan et al. (2004) expects an increase in retirement age of 8 months due to 1992 pension reform. Using data, capturing entries into retirement of some affected cohorts, Hanel (2010) finds a causal delay of entry into retirement of 14 months.

A comparison of both approaches, dynamic programming and option value, is done by Lumsdaine et al. (1992) and Burkhauser et al. (2004). Lumsdaine et al. (1992) mention, that the option value approach might underestimate future values as it is based on the maximum of the expected values of utility whereas the dynamic programming approach is based on the expected value of maximum utility. For the same reason, the dynamic programming approach is theoretically preferred (Burkhauser et al., 2004). However, Lumsdaine et al. (1992) and Burkhauser et al. (2004) find quite similar estimation results for the option value and the dynamic programming approach. Taking the complexity and computation intensity of the dynamic programming model into account, the option value model is often favored. Therefore, we rely on a modified version of the option value model, namely the peak value and adapt it explicitly to the German pension system and unemployment insurance. Thus, we also contribute to the strand of literature analyzing program substitution. For the United States, Autor and Duggan (2003) find that an unforeseen increase in the earnings replacement rate of disability insurance program increased the labor force exit propensity. Exploiting a cohort discontinuity in the Netherlands, Borghans et al. (2014) show that an income loss due to more stringent disability insurance rules is substituted by other social assistance programs, which replaces 30% of lost disability insurance income. Kyyrä and Ollikainen (2008) analyzes in a quasi-experimental framework how extended unemployment benefits affects the transition out of unemployment of older unemployed. Their findings suggest that unemployment benefits are used as a pathway into retirement prior to old-age pension. A similar finding is proposed by Inderbitzin et al. (2016) for Austria. They

use a difference-in-difference approach to study how extended unemployment benefits affect early retirement. The results show that unemployment benefits serve as a substitute for disability insurance benefits and as a pathway into retirement. In addition to the existing literature we use a structural approach and focus on the interplay of unemployment insurance and pension system.

The paper is organized as follows: In the next section, we give an overview of the German Pension Scheme, the German unemployment insurance and the analyzed reforms of the pension as well as the labor market. The data are presented in section 3 and the method we use in the analysis is introduced in section 4. In Section 5, we present and discuss the results of the analysis, followed by a summary and conclusion in section 6.

## 2 Institutional background

### 2.1 The German public pension system

The German pension scheme is based on three pillars: The public pension system, occupational pension schemes, and private pension investments. The most important pillar is the public pension insurance that is mandatory for employees. At retirement about two thirds of old-age income in Germany stems from public pension system (Frommert and Himmelreicher, 2013). Civil servants have a separate tax-financed insurance system and the self-employed are not obliged to participate, but they can voluntarily choose to participate. Civil servants and the self-employed who do not participate in the public pension insurance are not considered in this study. The public pension insurance is organized as a pay-as-you-go system, where employees and employers equally share the mandatory pension contributions of 18.7% (in February 2016), levied on gross wages up to a cap. This monthly contribution ceiling is €6,350 (€76,200 p.a.) in West Germany and €5,700 (€68,400 p.a.) in East Germany<sup>1</sup> or about twice the average remuneration

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<sup>1</sup>Laid down in the German Social Code (*Sozialgesetzbuch, SGB*), SGB VI, supplement 2 and 2b.

(*Durchschnittsentgelt*). The annual pension contributions are measured in so-called 'pension points'. Pension contributions equivalent to those levied on the average remuneration value one pension point. If individual gross income, which is subject to social security contributions, is larger (smaller) than average gross income the amount of pension points increase (decrease) proportionally. On the verge of retirement, pension payments are calculated based on the sum of accumulated pension points over the life course. In 2015, one pension point increases monthly old-age pensions - not being subject to deductions - by about €29 in West Germany (€27 in East Germany).

Among the different types of old-age pensions, the 'regular old-age pension' is the most common one, which can be claimed after reaching the pension eligibility age of 65 years and four months (in 2015) with at least five years of contributions.<sup>2</sup> Among all women who retired in 2014, 45% claimed the regular old-age pension (Deutsche Rentenversicherung Bund, 2015, p.67).

Retirement prior to the pension eligibility age is only possible if an insured person qualifies for an early old-age retirement pension: 'Especially long-term insured' (*besonders langjährig Versicherte*) and 'long-term insured' (*langjährig Versicherte*), having at least 45 or 35, respectively, years of contributions (*Wartezeit*), can retire at the age of 63. The 'early retirement pension for invalids' (*Altersrente für Schwerbehinderte*) allows to retire before reaching the pension eligibility age if certain invalidity requirements are met and if an insured person has at least 35 years of contributions.

Insured persons who were born before 1952, can claim the 'women's old-age pension' (*Altersrente für Frauen*) or the 'old-age pension for the unemployed' (*Altersrente bei Arbeitslosigkeit oder Altersteilzeit*), if they meet the requirements, between the ages of 60 to 65. Qualifying for the pension for the unemployed requires at least 15 contribution years, including eight contribution years in the last ten years before retirement. In addition, it requires

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<sup>2</sup>The pension eligibility age is being gradually raised from 65 years in 2011 to 67 years in 2031. It increases by one month per birth cohort, for those born before 1959: Those born in 1947 reach the pension eligibility age at 65 and one month, the subsequent birth cohort of 1948 at 65 and two months, etc. For birth cohorts from 1959, it increases by two months until it reaches 67 years for insured born in 1964 or later (SGB VI §235 and SGB VI §35).

being unemployment at retirement entry and having been unemployed for at least 52 weeks after turning 58 years and six months or having being 'partially retired' for at least 24 months.<sup>3</sup> A woman can claim women's old-age pension if she had at least 15 years of contributions, with ten years of compulsory pension contributions from work made after turning 40 years old and further she must be born before 1952. If a woman is eligible for both types of old-age pensions – the women's old-age pension and the pension for the unemployed – then it will always be beneficial to choose the women's old-age pension since it allows for an earlier retirement.<sup>4</sup> The women's old-age pension is of particular interest, since the empirical analysis focuses on women who are eligible for the women's old-age pension.

Until 2000, women who could take advantage of the women's old-age pension had a strong incentive for an early retirement at age 60 since they did not face any deductions on their pensions (Hanel, 2010). To make early retirement less attractive, the Pension Reform Act 1992 (*Rentenreformgesetz 1992*) implemented a gradual increase in the eligibility age for early retirement without deductions. The Growth- and Employment Promotion Act 1996 (*Wachstums- und Beschäftigungsförderungsgesetz*) accelerated the implementation of the increase in eligibility age.<sup>5</sup> Figure 1 shows the increase in eligibility age for the women's old-age pension. Women who are born in January 1940 or later are affected by the increase in eligibility age, at which the pension can be claimed without deductions. Each subsequent month of birth raises the eligibility age for the women's old-age pension without deduction by a month. While a woman, born in January 1940, can claim full benefits at the age of 60 years and one month, a woman born a year later, in January 1941, can only claim the full pension at the age of 61 years and one month. For each month a woman claims the women's old-age pension before the deduction-free eligibility age, her pension payment is permanently re-

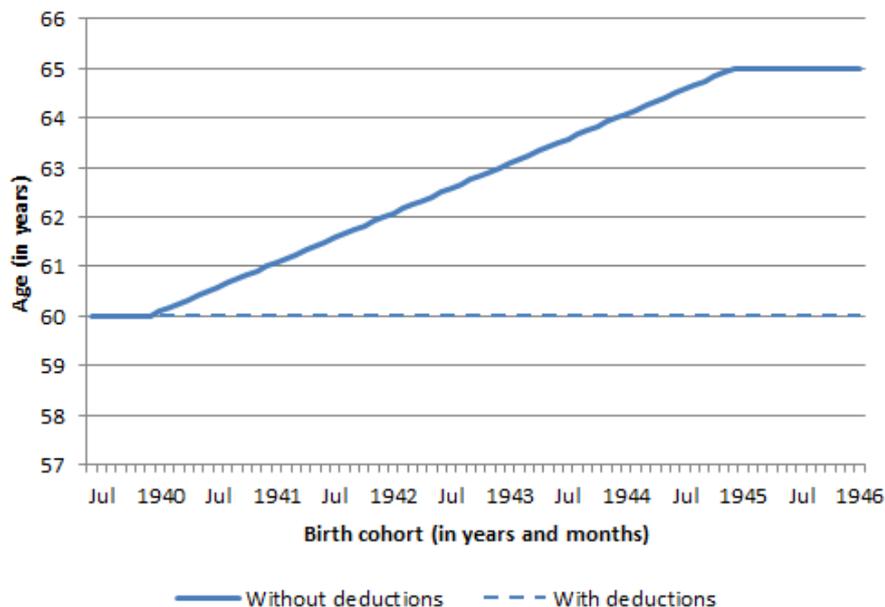
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<sup>3</sup>Berg et al. (2015) describe in detail the institutional background of partial retirement in Germany.

<sup>4</sup>Based on the pension statistics, more than ten times more women retire through the women's old-age pension than the pension for the unemployed (Deutsche Rentenversicherung Bund, 2015).

<sup>5</sup>Haan and Prowse (2014) quantify deduction factors, for Germany, that ensure fiscal stability in the face of increasing life expectancy.

Figure 1: Eligibility age for the women’s old-age pension by birth cohorts



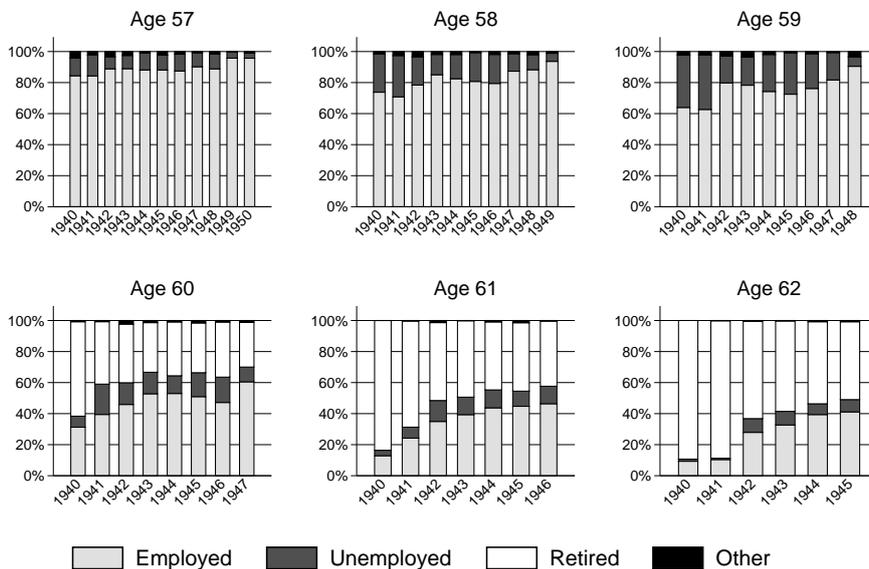
Source: Growth- and Employment Promotion Act 1996 (*supplement 20*); adapted from Hanel (2010), own illustration.

duced by 0.3 percentage points. The deductions are the strongest for women born in 1946 or later who enter retirement after turning 60: their monthly pensions are cut by 18 percentage points. Figure 2 indicates that women react to this reform with a delay of benefit claiming. We precisely exploit this exogenous variation in pension wealth that stems from differences in the birth cohorts, when we analyze how pension wealth affects the retirement decision of mothers.

## 2.2 Unemployment benefits

The unemployment insurance provides income replacement in case of job-loss. The entitlement period and the amount of unemployment benefits depends on the duration and earnings of former employment. The unemployment insurance, as part of the German social security system, is mandatory

Figure 2: Labor market status of women by age and birth cohorts



Source: BASiD 2007, own calculation.

for employees. Under certain conditions self-employed can voluntary insure against unemployment. The unemployment insurance is mainly financed by mandatory contributions. Those are equally shared by employees and employers and sum up to 3% (in January 2017), levied on gross wages up to a cap. As for the public pension insurance this monthly contribution ceiling is €6,350 (€76,200 p.a.) in West Germany and €5,700 (€68,400 p.a.) in East Germany<sup>6</sup> or about twice the average remuneration (*Durchschnittsentgelt*). Several criteria have to be fulfilled to be eligible for unemployment benefits. An individual has to be unemployed, registered as unemployed at the Labor Office and has to fulfill the qualification period. This requires at least 12 months of contributions during the last 24 months.

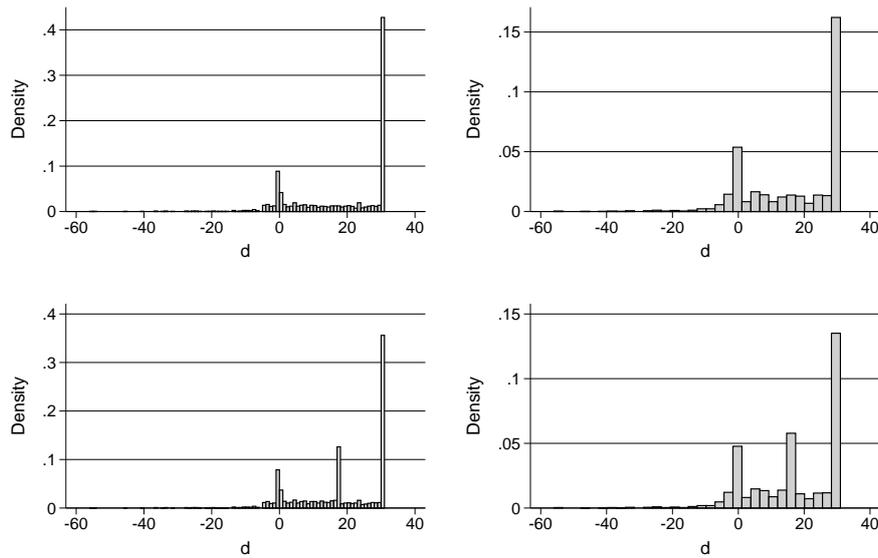
To qualify for unemployment benefits an individual needs to contribute to the unemployment insurance for a certain period of time before job-loss. Figure 5 shows the eligibility for unemployment benefits in the month when

<sup>6</sup>Laid down in the German Social Code (*Sozialgesetzbuch, SGB*), SGB VI, supplement 2 and 2b.

individuals claim their pension benefits. The upper panels excludes individuals leaving the labor market in 2006 or later as they are affected by the reduction of the entitlement period from 32 to 18 months. They are included in the lower panels. The left panels have a bandwidths of 1 month, whereas the bandwidths in the right panels is 2 months.

The large spike at 32 indicates, that around 40% of the individuals in the sample are eligible for 32 months of unemployment benefits but move directly from employment into retirement. The spikes around 0 indicates, that around 15 % of the individuals in the sample retire after receiving unemployment benefits according to their eligibility when ending employment.

Figure 3: Eligibility for unemployment benefits at pension claiming



Source: BASiD 2007, own calculation.

### 3 Data

The empirical analysis is based on the Scientific Use File of the Biographical Data of Social Insurance Agencies in Germany (*Biographiedaten aus-*

*gewählter Sozialversicherungsträger in Deutschland (BASiD)*, version 1951 - 2009), which is provided by the Research Data Center of the German Statutory Pension Insurance. The data is constructed by linking different administrative data sets via the unique social security number. First, a random sample is drawn among insured individuals in the Statutory Pension Insurance who are at least 15 years old but not older than 67 on the cut off date December 31, 2007. This sample is then combined with individual information from different data sources of the Federal Employment Agency. BASiD (SUF) provides information for about 60,000 individuals. It covers the entire employment biography of all individuals since the age of 14 until December 2007. In addition, it provides information on education, number and birth dates of children as well as employment-specific characteristics (Hochfellner et al., 2012).<sup>7</sup> In contrast to studies that rely on survey data, we do not have to approximate pension wealth but we can use the precise administrative information about individual monthly pension entitlements. In addition, BASiD does not suffer from panel attrition nor recall bias.

We select women who are born between 1940 and 1949, which leaves us with 5,870 women. In addition to observing actual retirement entries for these birth cohorts, we choose them because they are affected by the pension reform 1992, the pension reform 1996 and the reform of unemployment benefits in 2006. We exploit this exogenous variation in pension wealth and entitlement period of unemployment benefits, when estimating the impact of social security wealth on retirement. Otherwise, we would have to assume that social security entitlements are uncorrelated with other factors that determine the retirement decision, e.g. tastes for work. By using only 'validated' pension accounts, we make sure that self-declared information was cross-checked by the German Pension Insurance to ensure accuracy. This drops 67 individuals from the sample. Further, we exclude all women who claim disability pensions, which lowers the sample to 5,498 women. Next, we select women who in principle are entitled to the women's old-age pension (*Altersrente für*

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<sup>7</sup>The education variable lacks information for several persons and spells. To improve the individual education information, we apply the imputation procedure by Fitzenberger et al. (2005).

*Frauen*), resulting in a sample size of 3,474 women.<sup>8</sup>

Women who are entitled to the women's old-age pension have a stronger labor market attachment than women who are not entitled, which shows their pension wealth: Measured at age 60, it amounts to about € 140,000, whereas non-entitled women possess on average a pension wealth of about € 50,000. Nevertheless, about 63% of all women can claim the women's old-age pension. Hence, they represent a large share of the population. Women can claim the women's old-age pension at the age of 60. Since, we estimate the impact of pension wealth on (early) retirement, we need to observe women who can retire through the women's old-age pension prior to the official pension eligibility age. Finally, 312 mothers are removed from the sample since the data set does not contain educational information for them. The final sample size is 3,130 mothers, who are included from age 60 onward until retirement entry or December 2007 if retirement is not observed. This results in 212,046 person-month-observations, with 2,509 retirement entries are observed. We count a mother as retired upon the first month she claims her pension.

To capture the incentives of the public pension system we rely *inter alia* on a forward looking measure of public pension wealth. The calculation is based on individual pension points which are only observed before retirement<sup>9</sup>. At later months, we impute individual pension points by the average of the last 12 months until age 65<sup>10</sup>.

In addition, we include factors that potentially are correlated with pension entitlements and the retirement decision in our analysis. We control for individual factors, such as education, 'East' and 'health problems'. We differentiate three levels of education. A mothers' education is low if she has no completed vocational training, education is medium if she has completed a vocational training and high if she holds a university (of applied sciences) degree. The East indicator is one if a mother accumulated pension entitlements

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<sup>8</sup>In line with the law, we classify a women as being entitled to the women's pension in the following way: We consider months for the calculation of the qualifying period (*Wartezeit*) if pension points were accumulated in that month (*'gmeptan' > 0*). A women qualifies for the women's pension if her qualifying period sums up to at least 15 years, while at least 10 years had to be accrued after the 40th birthday.

<sup>9</sup>See section ?? for details.

<sup>10</sup>Thus, we assume the retirement decision to be voluntary.

in October 1989 or earlier in former East Germany and zero else. A mother with potential health problems, but who does not qualify for disability pensions might choose an early retirement entry. Following Hanel (2010), we measure health problems as reporting at least two months of sickness leave in the last three years.

Table 1: Sample characteristics by birth cohort

| Year of birth | 1940 | 1941 | 1942 | 1943 | 1944 | 1945 | 1946 | 1947 |
|---------------|------|------|------|------|------|------|------|------|
| Education     |      |      |      |      |      |      |      |      |
| Low           | 0.25 | 0.22 | 0.19 | 0.19 | 0.17 | 0.19 | 0.16 | 0.15 |
| Medium        | 0.70 | 0.70 | 0.75 | 0.76 | 0.76 | 0.74 | 0.80 | 0.79 |
| High          | 0.05 | 0.08 | 0.06 | 0.05 | 0.07 | 0.06 | 0.04 | 0.06 |
| # of children | 2.23 | 2.14 | 2.12 | 2.07 | 2.05 | 1.94 | 2.04 | 1.93 |
| East          | 0.41 | 0.42 | 0.42 | 0.42 | 0.41 | 0.34 | 0.35 | 0.42 |
| Bad Health    | 0.11 | 0.09 | 0.08 | 0.06 | 0.07 | 0.05 | 0.06 | 0.05 |
| N             | 435  | 439  | 459  | 412  | 401  | 345  | 309  | 330  |

Notes: The comparison refers to the month a mother turns 60. Education is low if a mother has no completed vocational training, medium if she has completed a vocational training and high if she holds a university (of applied sciences) degree. East refers to contributions in October 1989 or earlier. Bad health is defined as being sick or unable to work for at least two months in the last three years.

Data source: BASiD (Scientific Use File 2007), own calculations.

To illustrate the characteristics of mothers in the sample, Table 1 shows their descriptive statistics by birth cohort. In all cohorts the majority has completed a vocational training. The share of mothers with a low level of education decreases in later birth years. On average the number of children varies between 1.94 and 2.23. Further, the share of East German mothers differs between 0.34 and 0.42 over the birth cohorts. Finally, only a small share of mothers faces health problems.

## 4 Methodology

### 4.1 Estimation Strategy

To analyze the impact of pension system and unemployment insurance on labor supply and retirement we estimate a competing risk model. Individuals are observed monthly and can decide between (1) retirement and (2) unemployment or (3) to remain in the labor force. Retirement and unemployment are absorbing states. An individual is treated to choose (1) retirement when she leaves the labor market<sup>11</sup> and do not take up unemployment benefits for more than two months. When an individual take up unemployment benefits for more than two months after leaving the labor market, she is treated as choosing (2) unemployment. We estimate an alternative specific conditional logit model to allow for different characteristics of alternatives, of individuals and to deal with the discrete time of the data. The incentives to choose between the two options to leave the labor market (retirement & unemployment) or to remain in the labor force are given by the pension system and unemployment insurance.

### 4.2 Incentive measures

To capture the financial incentives to choose between the three states, we calculate the net present value for the first and second alternative, retirement and unemployment, in each month. Moreover we use the peak value concept as an incentive measure to choose the third alternative and to remain in the labor force. The calculation of the three incentive measures is explained in detail in the following paragraph.

When an individual chooses (1) retirement, she will receive pension benefits (PB) for the rest of her life (until  $S$ ). First eligibility is at age 60. Therefor

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<sup>11</sup>Exit of the labor market is defined as the month after the last employment is observed.

the net present value of retirement, called  $NPV_{it}^R$ , for individual  $i$  when retiring in month  $t$  follows equation 1:

$$NPV_{it}^R = (1 - rr_{it}) \cdot \sum_{s=\max(t, age_{60})}^S \Pi_t(s) \cdot \frac{PP_{it}}{(1 + \delta)^{s-t}} \quad (1)$$

The deduction rate of individual  $i$  when retiring in month  $t$  is denoted  $rr_{it}$ .  $PP_{it}$  describes the sum of personal premium points, which is discounted by  $(1 + \delta)$  and multiplied by the probability to be alive at month  $s$ ,  $\Pi_t(s)$ .

When an individual chooses (2) unemployment, she will receive unemployment benefits (UB) according to eligibility  $UBD$  (or until age 65) and PB for the rest of her life. Therefore the net present value of unemployment, called  $NPV_{it}^U$ , for individual  $i$  in month  $t$  follows equation 2:

$$NPV_{it}^U = \sum_{s=t}^{\min(t+UBD_{it}, age_{65})} \Pi_t(s) \cdot \frac{UB_t}{(1 + \delta)^{s-t}} + (1 - R_{i(t+UBD_{it})}) \cdot \sum_{s=\max(t+UBD_{it}+1, age_{60})}^S \Pi_t(s) \cdot \frac{PP_{i(t+UBD_{it})}}{(1 + \delta)^{s-t}} \quad (2)$$

When an individual neither chooses (1) retirement nor (2) unemployment in month  $t$ , she remains in the labor force and holds the option to leave the labor market at a later month. This could be beneficial if she expects a higher net present value of either retirement or unemployment in the future. To capture these option value we follow Coile and Gruber and calculate the so-called Peak Value as a forward-looking incentive measure. The peak value of retirement (unemployment) measures the difference between the net present value of retirement - based on immediate (1) retirement ((2) unemployment) - and the net present value of retirement at its maximum in the future. After the maximum net present value has passed, the peak value measures the difference of the net present value between (1) retirement ((2) unemployment) now or in the next month.

Let  $NPV_{max}^R$  be the net present value of retirement at its maximum in the future:

$$NPV_{max}^R = \max \{NPV_{it+1}^R, \dots, NPV_{it=65}^R\} \quad (3)$$

Then, the calculation of the peak value of retirement  $PV_{it}^R$  of individual  $i$  in month  $t$  follows equation 4:

$$PV_{it}^R = \begin{cases} NPV_{max}^R - NPV_{it}^R & \text{if } NPV_{it}^r < NPV_{max}^R \\ NPV_{it+1}^r - NPV_{it}^R & \text{if } NPV_{it}^R \geq NPV_{max}^R \end{cases} \quad (4)$$

The calculation of the peak value of unemployment is analogous, c.f. equation 5 and 6:

$$NPV_{max}^U = \max \{NPV_{it+1}^U, \dots, NPV_{it=65}^U\} \quad (5)$$

$$PV_{it}^U = \begin{cases} NPV_{max}^U - NPV_{it}^U & \text{if } NPV_{it}^r < NPV_{max}^U \\ NPV_{it+1}^r - NPV_{it}^U & \text{if } NPV_{it}^U \geq NPV_{max}^U \end{cases} \quad (6)$$

The maximum of  $PV_{it}^R$  and  $PV_{it}^U$  is denoted as the Peak Value  $PV_{it}$ :

$$PV_{it} = \max(PV_{it}^R, PV_{it}^U) \quad (7)$$

Thus the Peak Value  $PV_{it}$  reflects changes in Social Security wealth over time. The larger the Peak Value, the larger is the increase in benefits when leaving the labor market at a later point of time. When there is no increase in the net present value in the future, the Peak Value becomes negative and reflects a disincentive to remain in the labor force.

## 5 Results

### 5.1 Model estimation

### 5.2 Policy scenario

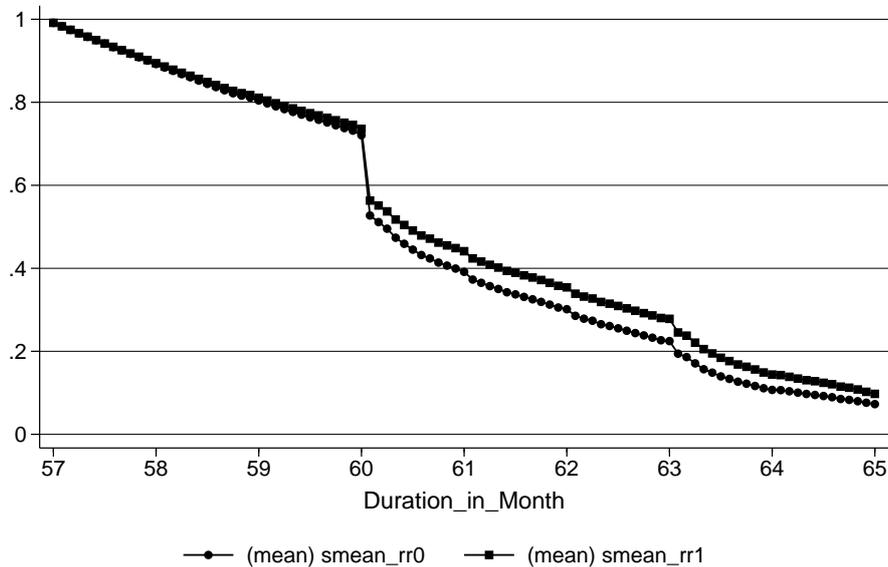
Based on the estimated coefficients we perform two policy simulations. First, we analyze the effect of an introduction of permanent benefit reduction for

early retirement on labor supply. Second, we study how a change in the maximum entitlement period of unemployment benefits affects labor supply.

### **5.2.1 Benefit reductions for early retirement**

In the first policy scenario we simulate an introduction of permanent benefit deductions of 0.3% per month when retiring prior age 65. To evaluate how labor supply changes due to the reform we impose in a first step, that no one is affected by the reform, that means that no one faces any deductions due to early retirement (scenario 1). Moreover the maximum entitlement period for unemployment benefits is 32 months for all individuals, so that everybody faces the same regimes of pension system and unemployment insurance. In a second step we then presume that everybody is affected by the reform so that pension benefits would be reduced by 18% when retiring at age 60 (scenario 2). For both scenarios we calculate the hazard of retirement and unemployment and the resulting survival in the labor market. The difference in these hazards and survival can be interpreted as the causal effect of the policy reform.

Figure 4: Effect of early retirement penalty on survival in labor market

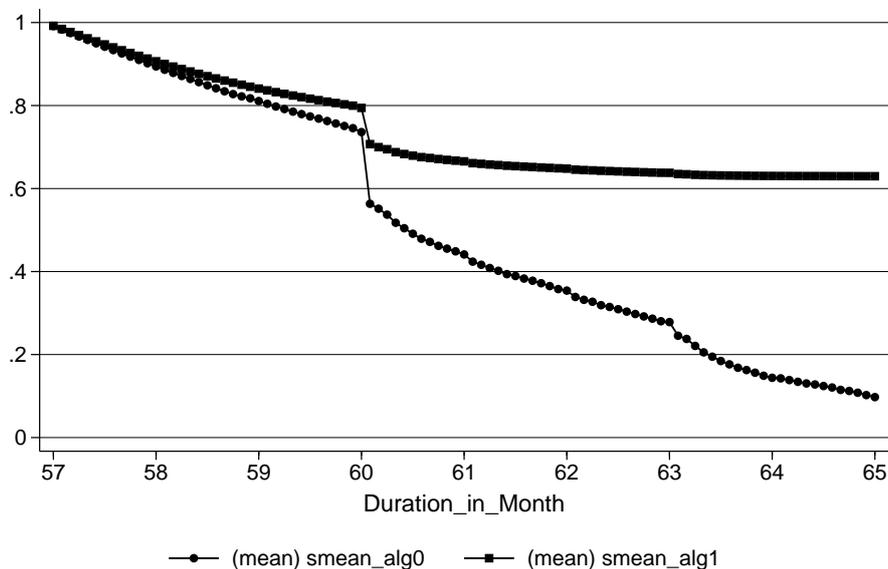


Source: BASiD 2007, own calculation.

### 5.2.2 Reduction of entitlement period of unemployment benefits

In the second policy scenario a reduction in the length of unemployment benefits is analyzed. The procedure is the same as in the first policy simulation. In scenario 1 all individuals face a maximum entitlement period of unemployment benefits of 32 months. Deductions for early retirement are fully introduced. In scenario 2 the maximum entitlement period of unemployment is reduced to 18 months. The comparison of the predicted hazards and survival in scenario 1 and scenario 2 shows the effect of the policy reform.

Figure 5: Effect of a shortening of the entitlement period of unemployment benefits on survival in labor market



Source: BASiD 2007, own calculation.

## 6 Discussion and conclusion

Many countries around the world face an aging population. This demographic change increases the financial requirements of social security programs, especially of the pension system. In response, a lot of countries implemented reforms which reduce pension benefits for early retirement. However, unemployment benefits are one important option to bridge time between employment exit and claiming retirement benefits for older workers. Therefore it is important to account for the interdependencies of these two systems when analyzing retirement behavior. In this paper we develop an option value model that explicitly accounts for the pension system and unemployment insurance in Germany. We use administrative panel data and implement the model for female birth cohorts of 1940 to 1949 which are affected by two reforms. First, an introduction of permanent benefit reductions for early retirement and second, a shortening of the entitlement period of unemployment-

ment benefits. This creates exogenous variation in the net present value of social security benefits for different birth cohorts and allows us to separately identify the employment and retirement effects induced by changes in the pension and in the unemployment system. More specifically we use the option value model to simulate the employment and retirement effects of different reforms, changing (1) the duration of unemployment benefits and (2) the height of benefit reductions for early retirement. Our results suggest that a shortening of the entitlement period of unemployment benefits is an effective instrument to reduce complementarity of pension and unemployment benefits whereas permanent deductions for early retirement leads to substitution between these programs.

## References

- Autor, D. H. and M. G. Duggan (2003). The rise in the disability rolls and the decline in unemployment\*. *The Quarterly Journal of Economics* 118(1), 157.
- Berg, P., M. K. Hamman, M. Piszczek, and C. J. Ruhm (2015, August). Can Policy Facilitate Partial Retirement? Evidence from Germany. IZA Discussion Paper 9266.
- Berkovec, J. and S. Stern (1991). Job exit behavior of older men. *Econometrica* 59(1), 189–210.
- Borghans, L., A. C. Gielen, and E. F. P. Luttmer (2014, November). Social support substitution and the earnings rebound: Evidence from a regression discontinuity in disability insurance reform. *American Economic Journal: Economic Policy* 6(4), 34–70.
- Börsch-Supan, A., R. Schnabel, S. Kohnz, and G. Mastrobuoni (2004, December). Micro-Modeling of Retirement Decisions in Germany. In *Social Security Programs and Retirement around the World: Micro-Estimation*, NBER Chapters, pp. 285–344. National Bureau of Economic Research, Inc.
- Burkhauser, R. V., J. S. Butler, and G. Gumus (2004). Dynamic programming model estimates of Social Security Disability Insurance application timing. *Journal of Applied Econometrics* 19(6), 671–685.
- Coile, C. and J. Gruber (2001, september). Social Security Incentives for Retirement. In *Themes in the Economics of Aging*, NBER Chapters, pp. 311–354. National Bureau of Economic Research, Inc.
- Deutsche Rentenversicherung Bund (2015). *Rentenversicherung in Zeitreihen. DRV-Schriften. Band 22*.
- Fitzenberger, B., A. Osikominu, and R. Völter (2005). Imputation Rules to Improve the Education Variable in the IAB Employment Subsample. Technical report, Bundesagentur für Arbeit.

- Frommert, D. and R. K. Himmelreicher (2013). Entwicklung und Zusammensetzung von Alterseinkünften in Deutschland. In *Altern im sozialen Wandel: Die Rückkehr der Altersarmut? Alter(n) und Gesellschaft*. Springer Fachmedien Wiesbaden.
- Gruber, J. and D. A. Wise (Eds.) (2004). *Social Security Programs and Retirement around the World*. The University of Chicago Press.
- Haan, P. and V. Prowse (2014). Longevity, life-cycle behavior and pension reform. *Journal of Econometrics* 178, Part 3, 582–601.
- Hanel, B. (2010). Financial incentives to postpone retirement and further effects on employment - Evidence from a natural experiment. *Labour Economics* 17(3), 474 – 486.
- Heyma, A. (2004). A structural dynamic analysis of retirement behaviour in the Netherlands. *Journal of Applied Econometrics* 19(6), 739–759.
- Hochfellner, D., D. Müller, and A. Wurdack (2012). Biographical Data of Social Insurance Agencies in Germany – Improving the Content of Administrative Data. *Schmollers Jahrbuch: Journal of Applied Social Science Studies/Zeitschrift für Wirtschafts-und Sozialwissenschaften* 132(3), 443–451.
- Inderbitzin, L., S. Staubli, and J. Zweimüller (2016, February). Extended unemployment benefits and early retirement: Program complementarity and program substitution. *American Economic Journal: Economic Policy* 8(1), 253–88.
- Karlstrom, A., M. Palme, and I. Svensson (2004). A dynamic programming approach to model the retirement behaviour of blue-collar workers in sweden. *Journal of Applied Econometrics* 19(6), 795–807.
- Krueger, A. B. and J.-S. Pischke (1992). The effect of social security on labor supply: A cohort analysis of the notch generation. *Journal of Labor Economics* 10(4), 412–437.

- Kyyrä, T. and V. Ollikainen (2008). To search or not to search? the effects of {UI} benefit extension for the older unemployed. *Journal of Public Economics* 92(10-11), 2048 – 2070.
- Lumsdaine, R. L., J. H. Stock, and D. A. Wise (1992). *Topics in the Economics of Aging*, Chapter Three Models of Retirement: Computational Complexity versus Predictive Validity, pp. 21–60. University of Chicago Press.
- Mitchell, O. S. and G. S. Fields (1981, September). The Effects of Pensions and Earnings on Retirement: A Review Essay. NBER Working Papers 0772, National Bureau of Economic Research, Inc.
- Moffitt, R. (1987). *Life-Cycle Labor Supply and Social Security: A Time Series Analysis*. The Brookings Institution, Washington, DC.
- Rust, J. and C. Phelan (1997). How social security and medicare affect retirement behavior in a world of incomplete markets. *Econometrica* 65(4), 781–832.
- Rust, J. P. (1989, December). A Dynamic Programming Model of Retirement Behavior. In *The Economics of Aging*, NBER Chapters, pp. 359–404. National Bureau of Economic Research, Inc.
- Rust, J. P. (1990, December). Behavior of Male Workers at the End of the Life Cycle: An Empirical Analysis of States and Controls. In *Issues in the Economics of Aging*, NBER Chapters, pp. 317–382. National Bureau of Economic Research, Inc.
- Samwick, A. (1998). New evidence on pensions, social security, and the timing of retirement. *Journal of Public Economics* 70(2), 207–236.
- Stock, J. H. and D. A. Wise (1990). Pensions, the option value of work, and retirement. *Econometrica* 58(5), 1151–1180.