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The Effects of Early Retirement Incentives on Retirement Decisions*

Abstract

This paper analyzes behavioral responses to a reform in the German public pension system that allowed individuals with a long contribution history to retire without deductions before reaching the regular retirement age. Following the 2014 reform, individuals with 45 contribution years could retire without deductions as early as age 63 instead of age 65. Using high-quality administrative data from public pension insurance accounts, we first conduct an event study to quantify responses to becoming eligible for the early retirement scheme. Our results indicate that the probability of retiring immediately increases by more than 10 percentage points upon becoming eligible, relative to the counterfactual probability of retiring at the same age with deductions. Second, we employ a coarsened exact matching procedure to compare retirement entry decisions of eligible and non-eligible individuals. Results are in line with the event study and show that individuals who are eligible for the early retirement scheme retire on average 5.4 months earlier than non-eligible individuals with identical characteristics. With additional pension insurance expenditures of 3.4 billion euro and aggregate fiscal costs of 6.5 billion euro in 2016, our subsequent fiscal cost projections are at the upper end of the range of previous back-of-the-envelope estimates.

JEL code: H55, J14, J18, J26

Keywords: Retirement age, early retirement, pension reform

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1 Introduction

Pension systems around the world face aging populations and demographic change, putting increased pressure on fiscal sustainability. Against this background, many countries have conducted pension reforms aimed at extending the working lives of the elderly population [OECD, 2017]. These reforms encompass increases in the normal or the early retirement ages, tightening qualifying conditions and the introduction of actuarial deductions for early retirement. While Germany also increased the normal retirement age and closed specific pathways to retirement, a major reform in 2014, quite on the contrary, sharply increased early retirement incentives for individuals with a long contribution history.

This paper analyzes behavioral responses to this public pension reform that allowed individuals with a long contribution history to retire without deductions before reaching the regular retirement age. From July 2014 onwards, individuals with at least 45 contributory years could retire without deductions at age 63. In the years before the reform, retiring without deductions was only possible at age 65, i.e. the reform implied a significant shift in the retirement age at which the long-term insured can retire without deductions.

The paper thereby contributes to the literature studying how individuals respond to incentives in the retirement system. A large empirical literature addresses the effects of pension reforms which increase the regular retirement age [Atalay and Barrett, 2015, Mastrobuoni, 2009, Hanel and Riphahn, 2012] or the early retirement age [Staubli and Zweimüller, 2013, Cribb et al., 2016, Manoli and Weber, 2018, Geyer and Welteke, 2017, Geyer et al., 2018]. Mainly employing difference-in-difference or regression discontinuity designs, these studies find substantial labor market effects, albeit at varying magnitudes. In addition to increasing employment and an upward shift in retirement claiming ages, some of the papers also find evidence for program substitution towards unemployment insurance. In contrast to these studies, this paper assesses a very salient reform that increased incentives to retire early, which is of particular interest as responses to changing incentives may be asymmetric. Evidence on such reforms is much more scarce. For once, Börsch-Supan and Schnabel [1998] show that the possibility of retiring at an earlier age than 65 leads to a substantial reduction in the average retirement age. Similarly, a reduction in the early retirement age results in earlier labor market exits [Vestad, 2013]. The reform we investigate has a substantially different approach though, as rather than enabling

retirement at earlier ages than before, it drastically alters financial incentives for early retirement for a subgroup of the population.

Evidence on responses to financial retirement incentives that do not entail changing retirement ages is mixed. Analyzing the introduction of deductions, Engels et al. [2017] find sizable behavioral responses. Likewise, Ye [2018] shows that an increase in retirement benefits due to a pension subsidy program reduces the retirement claiming age. In contrast, results by Manoli and Weber [2016] point to only a limited responsiveness of retirement choices to financial incentives. Responsiveness to financial incentives also relates to the recent literature on reference dependence in retirement behavior: Using bunching analysis, Seibold [2017] finds that retirement patterns cannot be explained by financial incentives alone. Rather, framing statutory ages as reference ages results in increased retirement probabilities at these thresholds. In a similar spirit, Cribb et al. [2016] find that a change in the UK's statutory early retirement age affected retirement behavior despite limited financial incentives. We also contribute to this literature. In our sample, all individuals are able to retire at the early retirement reference age 63, with the difference that financial incentives differ considerably between those who are eligible for early retirement with deductions and those who are not. While the early retirement age potentially serves as a more salient focal point for those eligible for the reform, our results nevertheless show that large financial incentives affect retirement behavior.

Our analysis is based on high-quality administrative data on pension claimants from public pension insurance accounts for the years 2013-2016. We make use of two identification strategies to estimate the causal effect of the reform on retirement entry decisions. First, we employ an event study design which exploits that individuals become eligible to claim early retirement without deductions at different ages. Second, we use matching techniques and compare retirement entry decisions of eligible and non-eligible individuals.

Our main results are as follows. The event study analysis shows that the probability of retiring immediately upon becoming eligible for early retirement without deductions increases by more than 10 percentage points relative to the counterfactual probability of retiring at the same age with deductions. Looking at specific subgroups in our sample, we find stronger responses for men compared to women and for voluntarily and socially insured individuals compared to those in marginal employment. Results from the matching analysis are in line with those from the event study analysis. In 2015 and 2016, the two years after the reform had been

introduced, eligible individuals retire on average 5.4 months earlier than non-eligible individuals with identical characteristics. Fiscal cost projections indicate additional pension insurance expenditures of 3.4 billion euro and aggregate fiscal costs of 6.5 billion euro in 2016. These projections are at the upper end of the range of previous back-of-the-envelope estimates.

2 Institutional Background

2.1 The German Public Pension System

Covering almost all private and public sector employees¹, the German statutory pension system provides old-age pensions as well as invalidity and survivors' benefits. Financed as a pay-as-you-go scheme, the calculation of pension benefits is based on a person's contribution history. Entitlements are calculated according to a point system, where the number of pension points is determined by the ratio of individual annual earnings to average earnings across contributors in the same year. The system also features certain redistributive properties, such as pension points for child raising.

In recent years, the system has seen numerous reforms, affecting both the retirement age and the choice of pathways towards retirement. In light of demographic tensions, most of these reforms focused on increasing the retirement age or restricting pathways for accessing retirement. Most notably, recent years have seen a stepwise increase in the statutory retirement age from 65 to 67. Retiring earlier is possible through several early retirement schemes, but usually requires deductions of 0.3% per month of retiring early. The accessibility of schemes depends on the insurance record, notably on the number of contributory years. Retiring as early as age 63 with deductions is possible for those with at least 35 contributory years. In addition to periods spent in employment, these also include periods spent raising children, voluntarily contributing or, under certain conditions, receiving unemployment benefits. Severely disabled individuals face both a lower regular and a lower early retirement age. For those born prior to 1952, two additional pathways were possible. Women with at least 15 contributory years, 10 of which have been spent actively contribut-

¹Civil servants are exempt from the statutory pension system. While self-employed individuals in certain vocations, such as craftspeople, are covered by compulsory insurance, other self-employed individuals have the option to opt into public pension insurance.

ing after age 40, may retire as early as age 60, but face deductions for each month of early retirement. Likewise, retiring earlier is also possible after unemployment or partial retirement. Table 1 shows the respective retirement ages by cohort. As the reference age for deductions, which also varies across cohorts, differs from the regular retirement age for some birth cohorts, it is also depicted here. We also list the deductions a person faces when retiring at 63 through the ‘regular’ early retirement scheme.

Table 1: Retirement ages by birth cohort

	1948	1949	1950	1951	1952	1953	1954	1955
Regular retirement	65+2	65+3	65+4	65+5	65+6	65+7	65+8	65+9
Early retirement (reference age)	65	65+1...3	65+4	65+5	65+6	65+7	65+8	65+9
Early retirement (with deductions)	63	63	63	63	63	63	63	63
Deductions at 63 ^a	7.2%	8%	8.4%	8.7%	9.0%	9.3%	9.6%	9.9%
Retirement at 63 (without deductions)	63	63	63	63	63	63+2	63+4	63+6
Retirement for severely disabled (ref.)	63	63	63	63	63+1...6	63+7	63+8	63+9
Retirement for severely disabled	60	60	60	60	60+1...6	60+7	60+8	60+9
Retirement for women	60	60	60	60	-	-	-	-
Retirement after unemployment	62+1...12	63	63	63	-	-	-	-

The table shows the earliest possible retirement ages for regular and early retirement schemes in years + months. For example, ‘65+2’ refers to 65 years and two months. Early retirement schemes other than ‘retirement at 63’ require deductions of 0.3% per month, for which reference ages are shown. Severely disabled individuals face a lower reference age. Retirement ages continue to increase up to the 1964 birth cohort. To limit table size, we restrict this table to a selection of relevant birth cohorts.

a: Deductions when retiring at 63 with less than 45 contributory years. Not considering foregone benefits due to the shorter contribution period.

2.2 The 2014 Early Retirement Reform

As opposed to the other reforms, the 2014 reform (*retirement at 63*) decreased the early retirement age for individuals with long contribution histories. From July 2014 onwards, the so-called *old-age pension for the especially long-term insured* permitted individuals with at least 45 contributory years to draw a pension without deductions as early as at age 63. Between 2012 and 2014, the same was possible only at age 65. Prior to the reform, individuals who are now eligible for the ‘retirement at 63’ scheme and who retired at 63 would have faced deductions for a period of 24 months, amounting to 7.2%. Yet, while retirees do not face deductions anymore, monthly retirement benefits at 63 would still be lower than when working till 65 as possible contributions between age 63 and 65 are foregone when retiring early. As a person retiring through the retirement at 63 scheme faces no deductions, the change in incentives upon becoming eligible for the scheme is very large. For example, a person born in 1950 with 44 years and 11 contributory months at age 63 could either

retire at age 63 and face deductions of 8.4%, or keep on working for one more month and not face deductions at all. If the person earned an average income, delaying retirement by one month would thus increase retirement benefits by roughly 9.4% relative to pre-eligibility benefits.² This is much larger than the aforementioned deductions of 8.4% since deductions are generally framed relative to benefits without deductions. In turn, the 9.4% are set in relation to the comparatively lower pre-eligibility benefits with deductions. If retirement was delayed one further month, benefits would only increase by a further 0.19% due to accumulating more pension points during this month. Similar to the regular retirement age, the minimum retirement age for the retirement at 63 scheme increases across cohorts. From the birth cohort 1953 onwards, it increases stepwise until reaching the age of 65 for the 1964 birth cohort.

The retirement reform was part of a substantial and very salient retirement reform, which also increased pensions for mothers of children born before 1992 and increased invalidity benefits.³ Being the first large project by the new grand coalition government that had formed at the end of 2013, it was widely discussed in the media. The reform was first announced in the new government's coalition agreement in mid-December 2013, a first legislative draft was passed in January 2014 and the final law was passed in May. The ministry of labor dedicated a publicity campaign (*'not a gift, but well-deserved'*) to the retirement reform in January 2014, claiming that hard-working individuals benefited from the reform as a reward for having contributed to society throughout their lives. Hence, the reform could hardly be anticipated in 2013, but was very salient from the beginning of 2014 onwards. The reform was also subject to much public discussion, with critics stating that the reform would increase benefits for those who already receive large retirement benefits at the expense of younger generations, whose contributions fund the reform. In this spirit, a pre-reform analysis indicated that eligible individuals are entitled to above-average retirement benefits and do not have worse health than non-eligible

²This calculation assumes the person has contributed for 45 years at an average income, and has thus earned 45 pension points. In this setting, working one further month at an average income increases pension benefits by 0.19%. Actual incentives differ across individuals due to heterogeneous earnings histories.

³These other aspects of the reform should not confound our analysis. For once, invalidity benefits are commonly drawn at a much earlier age and with much fewer contributory years than required by the 'retirement at 63' scheme. While invalidity benefits thus play a very small role in our sample, we nevertheless exclude all individuals drawing invalidity benefits. Also, our analysis accounts for group demographics. Any potential income effect of mothers' increased pensions should thus not exert a differential effect on control and treatment groups.

individuals [Börsch-Supan et al., 2015].

We intend to evaluate the incentive effects and behavioral responses to as well as the fiscal costs of the 2014 retirement reform. To what extent does the reform increase the propensity to retire early? How do responses differ by demographic groups? What fiscal costs did the reform entail?

3 Data and Descriptive Evidence

3.1 Public Pension Insurance Accounts

We employ high-quality administrative data on pension claimants from public pension insurance accounts (*Versichertenrentenzugang 2013-2016*). The scientific use file contains a 10% random sample of all individuals entering retirement between 2013 and 2016. As the dataset is process-produced, it mainly contains variables needed for calculating pension entitlements. Amongst others, we observe personal characteristics such as gender, marital status, education level and region of residence, as well as variables on the contribution history and retirement. These include the exact retirement age in months, the chosen retirement scheme, pension points, i.e. accumulated pension contributions, and pension-relevant periods, which enable us to determine the eligibility for the early retirement scheme. The dataset provides further details on the three years preceding retirement, such as the respective socio-economic status and the annual salary.

3.2 Sample

Our analysis focuses on individuals with a long contribution history of 41 to 47 contribution years at age 63. While all individuals in this group are able to retire with deductions at age 63, their eligibility for early retirement without deductions differs. This allows us to identify a treatment (control) group of individuals who are affected (unaffected) by the reform. We exclude individuals who retired in prior years and are included in the dataset for administrative reasons, individuals with previous retirement spells, and individuals entering invalidity benefits (*Erwerbsminderungsrente*). Individuals who spent part of their career abroad, receive pensions according to the Foreign Pension Law or are subject to transitory regulations are likewise dropped from the sample. The overall sample contains roughly 80,000 individuals retiring

between 2013 and 2016.

The calculation of relevant pension periods slightly differs from the calculation of contributory periods in other retirement schemes. In particular, the retirement at 63 scheme does not consider periods spent in education or periods of long-term unemployment. Short-term unemployment counts towards the relevant pension period as long as it does not occur in the two years leading up to retirement. We thus subtract periods of education, unemployment extending 12 months, and unemployment occurring in the two years prior to retiring from the overall contributory period.

Table 2: Summary statistics

	Event study	Matched sample
Female	46.2%	47.0%
Married	74.7	73.2%
East German	31.5%	41.9%
Education		
None	6.1%	4.9%
Vocational degree	61.8%	55.6%
Advanced occupational degree	5.0%	5.1%
University degree	2.4%	2.1%
Unknown	24.8%	32.3%
Labor market status before turning 63		
Employed	75.1%	67.7%
Marginally employed	3.7%	4.4%
Voluntarily insured	4.1%	4.7%
Short-term unemployed	7.2%	7.7%
Receiving other social benefits	4.4%	5.1%
Credit period (sickness leave etc.)	1.9%	5.3%
Employer-sponsored early retirement ^a	0.6%	0.6%
None/ unknown	3.0%	4.4%
Pension points at 63	43.6	42.3
Number of observations ^b	45,834	48,998

Event study: 2015-2016. Matched sample: summary stats after weighting, 2013-2016.

a: Does not include partial retirement (Altersteilzeit). *b*: Unweighted sample size.

Table 2 shows summary statistics across (i) the sample used in the event study and (ii) the weighted sample used in the coarsened exact matching procedure (cf. section 4). Both samples differ: Sample (i) corresponds to those who become eligible for the ‘retirement at 63’ scheme at some point prior to reaching the regular retirement age. Sample (ii) encompasses individuals with 41-43 and 45-47 contributory years at age 63, i.e. individuals who are immediately eligible for the ‘retirement at

63' scheme as well as a control group of individuals who are ineligible for the scheme. Individuals who become eligible between age 63 and age 65 are included in sample (i) but not in sample (ii). A majority of those in the sample are employed prior to retirement and have earned a vocational degree. Compared to the universe of retirees, East German retirees, in particular East German women, are overrepresented due to their on average longer and more continuous labor market biographies.

3.3 Descriptive Evidence

Prior to the estimations, we present descriptive evidence showcasing retirement behavior and underlining the scope of the reform. Table 3 shows the fraction of retirees retiring through each retirement scheme in the full sample, regardless of contributory years. In the years following the reform, about 40 percent of all retirees retire at the regular retirement age, while about 30 percent exit the labor market through the 'retirement at 63' scheme. Hence, the 'retirement at 63' scheme constitutes one of the most important pathways towards retirement. The remainder retires early through another retirement scheme, in most cases facing deductions. The share choosing to retire through one of the alternative retirement schemes declines over time as two of these schemes were only accessible to pre-1952 birth cohorts, and possibly due to substitution towards the 'retirement at 63' scheme. We investigate this channel in subsequent sections.

Table 3: Retirement choices by year in the full sample

	2013	2014	2015	2016
Regular retirement	41.79%	44.78%	39.33%	39.44%
Early retirement with deductions	17.82%	10.38%	16.03%	19.51%
Retirement at 63 ^a	2.60%	18.40%	30.88%	28.89%
Retirement for severely disabled	12.30%	9.71%	6.39%	7.15%
Retirement for women	15.11%	9.59%	4.84%	3.72%
Retirement after unemployment	10.37%	7.14%	2.52%	1.30%

The sample includes retirees regardless of their contributory periods, excluding invalidity benefit recipients.

a: Prior to July 2014, a precursor of the 'retirement at 63' scheme allowed for early retirement without deductions for individuals with 45 contributory years at age 65. The group of individuals claiming an old-age pension for the especially long term insured after age 65 are assigned to the same retirement pathway in the data as those entering early retirement without deductions at age 63 following the reform. For this reason, a small percentage of retirees enters retirement through this scheme prior to the reform.

To showcase the distribution of retirement ages, Figure 1 depicts the frequency of retirement decisions by retirement types and ages in the pre-reform benchmark 2013 as well as in the post-reform years 2015 and 2016. While we observe the month of retirement in the most recent years, the retirement age is only available on a quarterly basis prior to 2014. For this reason, the 2013 retirement ages can only be depicted in 3-month age intervals, while more precise monthly retirement ages are available in the years that follow. Retirees retiring between age 60 and age 66 are included in the graphs regardless of their accumulated pension points.⁴

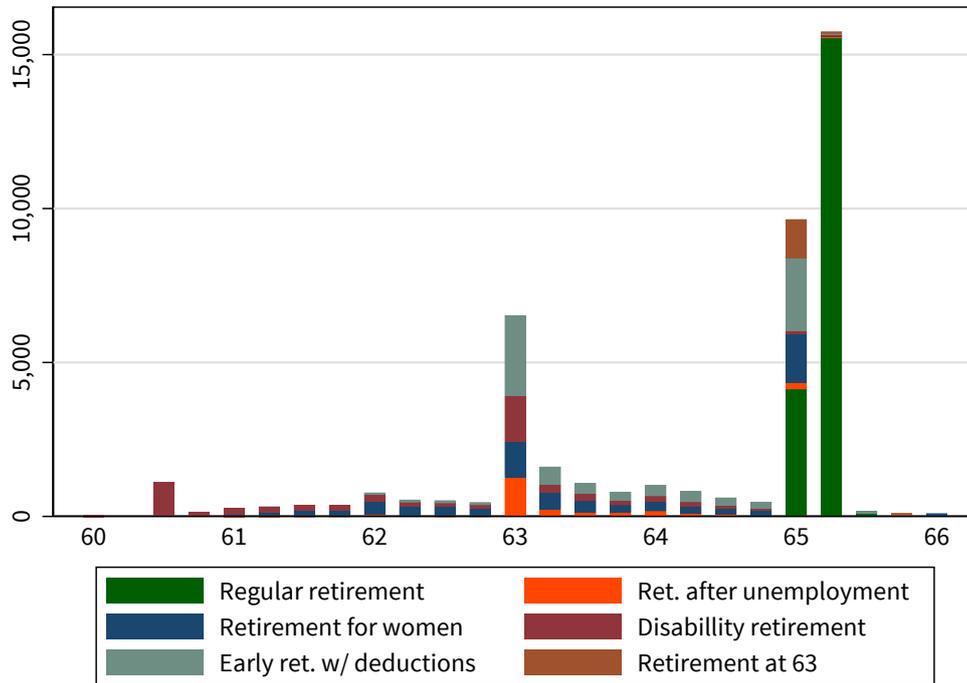
The large frequency of early retirement via the retirement at 63 scheme in panel (b) indicates that the shift towards early retirement in 2015/2016 is substantially driven by the retirement reform. A large fraction of those who retire early enter retirement immediately at age 63, or at $63 + 2$ months. Overall, one third of all retirees chooses to retire within three months of turning 63. Not all of this second spike seems to be due to younger birth cohorts facing a higher early retirement age without deductions: while retirement with deductions is possible at 63 for all birth cohorts, a notable share of individuals retiring through this pathway chooses to retire at $63 + 2$ months. This could potentially be due to some individuals only starting the early retirement application process and handing in their notice when they turn 63, which might delay the age at which they actually retire. Most of those who retire regularly do so immediately at their regular retirement age, which differs by birth cohort.

Figures 2 and 3 plot the Kaplan-Meier failure function, i.e. the empirical cumulative distribution function of retirement ages of those who are eligible for early retirement immediately once they reach the early retirement age (45-47 contributory years at age 63), those that will not reach 45 contributory years prior to age 65 and hence will not become eligible (41-43 contributory years at age 63), and those in between that could potentially become eligible after age 63 (between 43-45 contributory years at age 63). As opposed to section 5.2, where we use coarsened exact matching to ensure comparable characteristics of those with 45-47 and 41-43 contributory years, no weighting procedure is used here. Hence, some of the differences may be due to differing characteristics across groups. In all years, the Kaplan-Meier function displays a jump at age 63. While the size of the jump is roughly equal across different contributory year brackets in 2013, the jump is much

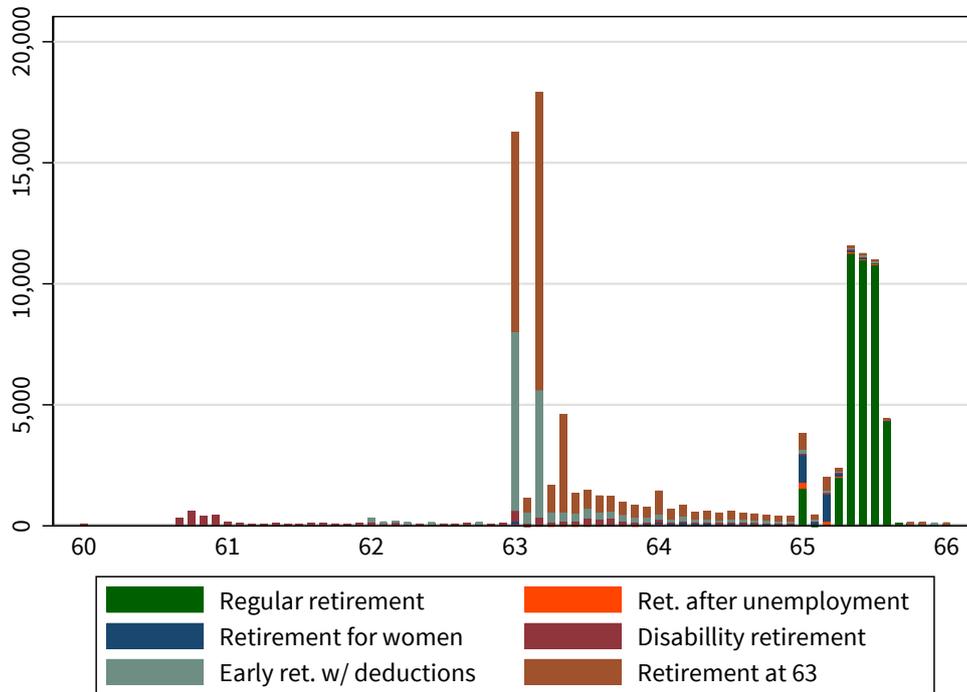
⁴All other sample restrictions, such as the exclusion of individuals with previous retirement spells, do apply.

Figure 1: Frequency of retirement decisions by age and retirement type

(a) 2013

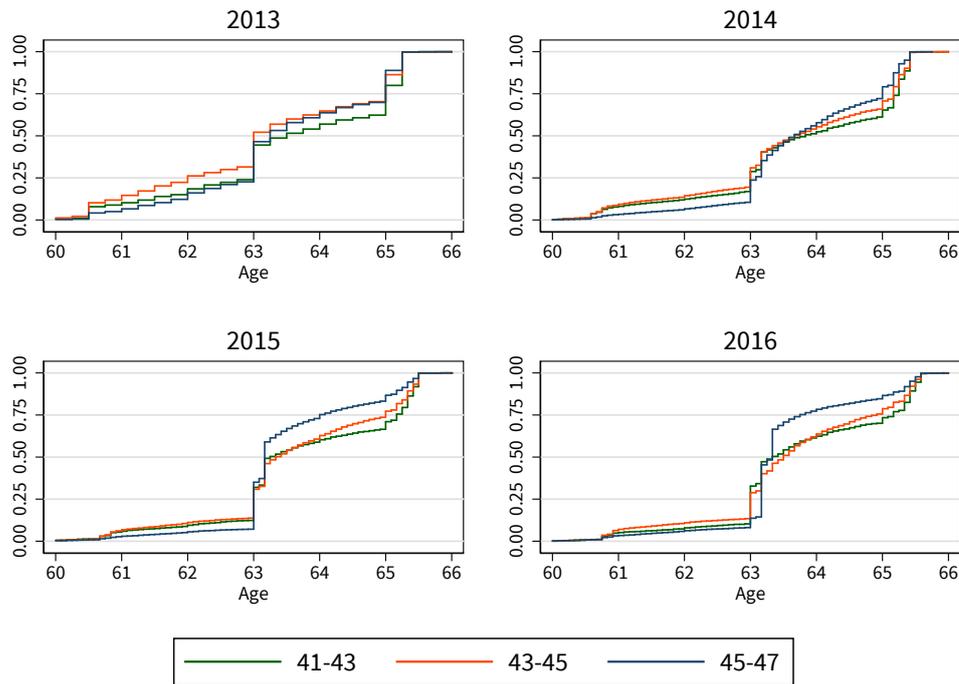


(b) 2015-2016



Notes: Only quarterly retirement age variable available in 2013.

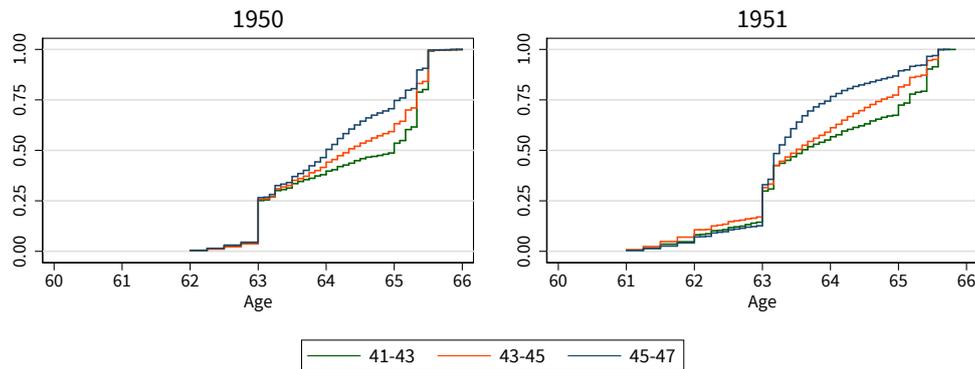
Figure 2: Kaplan-Meier failure estimates: ECDF of retirement ages by year



larger for those with 45-47 than for those with fewer contributory years in 2015 and 2016. That is, retiring at age 63 occurs much more frequently for those eligible for the retirement at 63 scheme than for those who are not eligible. Note also that the Kaplan-Meier function of those with 43-45 contributory years is close to the distribution function of those who are ineligible at age 63, but then rises more steeply than the comparison groups' cumulative distribution function as more and more individuals with 43-45 contribution years at age 63 become eligible over time.

In a similar spirit, figure 3 shows the Kaplan-Meier functions by birth cohort and contribution years at 63. For both cohorts 1950 and 1951, a larger fraction of eligible than of ineligible individuals retire early. As opposed to Figure 2, the jump does not immediately occur at 63, but the distribution function increases faster at later ages. This is due to the reform being passed in mid-2014, when those born in 1950 and many of those born in 1951 were already older than 63.

Figure 3: Kaplan-Meier failure estimates: ECDF of retirement ages by birth cohort



4 Empirical Strategy

We employ two different approaches to quantify responses to the pension reform. On the one hand, we conduct an event study to exploit that individuals become eligible at different ages. In this setting, the variation stems from individuals who reach 45 contributory years in differing months of their lives.

On the other hand, we contrast the retirement behavior of individuals who are immediately eligible with the behavior of comparable individuals who are not eligible for this preferential retirement scheme. To ensure the similarity of the control vis-a-vis the treatment group, we employ a coarsened exact matching procedure.

4.1 Event Study

Using an event study design, we analyze the pathway towards retirement upon becoming eligible for the early retirement scheme. Pooling the data years 2015 and 2016, the event study encompasses the cohorts 1950 to 1953. The sample includes individuals becoming eligible for the early retirement scheme prior to reaching the regular retirement age. In addition to those who reach at least 45 contributory years, we also consider those who would have reached 45 contributory years if they had not retired earlier through a different retirement scheme. Thereby, we are able to contrast those who choose to retire early through another scheme with those who postpone their retirement in order to be eligible for the retirement at 63 scheme.

We estimate the following equation, where t corresponds to the age in months between age 62 and age 66.

$$Ret_{i,t} = \sum_{j=-12}^{24} \beta_j \delta Elig_{i,t-j} + \mu_i + \varsigma_{i,t} + \epsilon_{i,t} \quad (1)$$

where $Ret_{i,t}$ is a dummy whether person i is retiring at time t . $\delta Elig_{i,t-j}$ indicates a change in eligibility at time $t - j$. I.e. it is a dummy for the double condition of reaching 45 contributory years while also having reached age 63 (or age 63 + 2 months for birth cohort 1953). β_j indicates the event window running from 12 months prior to 24 months after reaching eligibility. We include individual fixed effects μ_i as well as monthly age x birth year fixed effects $\varsigma_{i,t}$. The year of birth interaction term is included in the time fixed effects to control for differing retirement conditions across birth cohorts (see Table 1). Notably, those born in 1953 can only claim early retirement benefits without deductions at age 63 + 2 months, and should thus have different time fixed effects than individuals born in earlier cohorts. The error term $\epsilon_{i,t}$ is clustered at the individual level.

We estimate the equation across the event window and use β_{-12} as a benchmark set to zero in order to identify the other coefficients. This is a matter of scaling. For the ease of interpretability and as opposed to many other event studies, we do not use β_{-1} , i.e. the period prior to becoming eligible, as a benchmark as this period may reflect anticipation effects. In the months preceding eligibility, individuals might be less likely to retire as waiting until they become eligible drastically increases their retirement benefits. Setting β_{-1} to zero would thus depict all coefficients in relation to a period in which soon-to-be eligible individuals have a lower propensity to retire than others.⁵ Overall, the event study contrasts an individual's propensity to retire at a certain point in time prior to or after becoming eligible with a counterfactual probability of retiring with deductions at the same age. A positive coefficient β_j indicates that j periods after becoming eligible, a person is β_j percentage points more likely to retire than if they still had to wait 12 months until becoming eligible. As long as anticipation effects 12 months prior to becoming eligible are low, this approximates the increase in the propensity to retire j periods after becoming eligible due to the retirement at 63 scheme. Another way of interpreting the coefficient is that j periods after becoming eligible, individuals are more likely to retire than other, non-eligible individuals at the same age.

⁵Results for an event study in which β_{-1} is set to zero, resulting in all coefficients shifted upwards, are available upon request.

4.2 Matching

Subsequently, we contrast the behavior of those who are immediately eligible for retirement at 63 to those who are not eligible: The treatment group is composed of individuals with 45 to 47 contributory years at age 63, whereas individuals in the control group have accumulated 41 to 43 contributory years. Other than that, the definition of treatment and control group is analogous to the event study. As characteristics, preferences and expected retirement benefits might differ between groups, we employ a coarsened exact matching procedure [Iacus et al., 2012] to ensure the comparability of control and treatment groups. The following variables are used in the matching procedure: year, gender, marital status, education level, a dummy for East Germany, socio-economic status at age 63⁶, and the pension points an individual has earned at age 63 as a proxy for the earnings history and for expected retirement benefits. While all other variables require exact matching, the latter variable matches on coarsened intervals, where cutpoints are defined according to Sturges' rule [Scott, 2015].

In a second step, the retirement age in years is regressed on the eligibility dummy, with matching weights accounting for group differences. The analysis is conducted separately for each year between 2013 and 2016, where the year 2013 constitutes a placebo test. The treatment and control groups only differ by their eligibility for the retirement at 63 scheme.⁷ Any other variable affecting retirement preferences across groups should be controlled for by the matching procedure. As the reform was neither passed nor announced at this point, the behavior of individuals in the treatment and control group should not be affected by the reform.

⁶This variable differentiates socially insured employees, marginally employed employees, voluntarily insured individuals including self-employed individuals who have opted into the retirement insurance scheme, unemployment benefit recipients (*Arbeitslosengeld I*), recipients of other benefits, individuals with credit periods (*Anrechnungszeitversicherte*), e.g. due to sickness, and individuals who are neither working nor otherwise contributing towards retirement insurance, such as housewives.

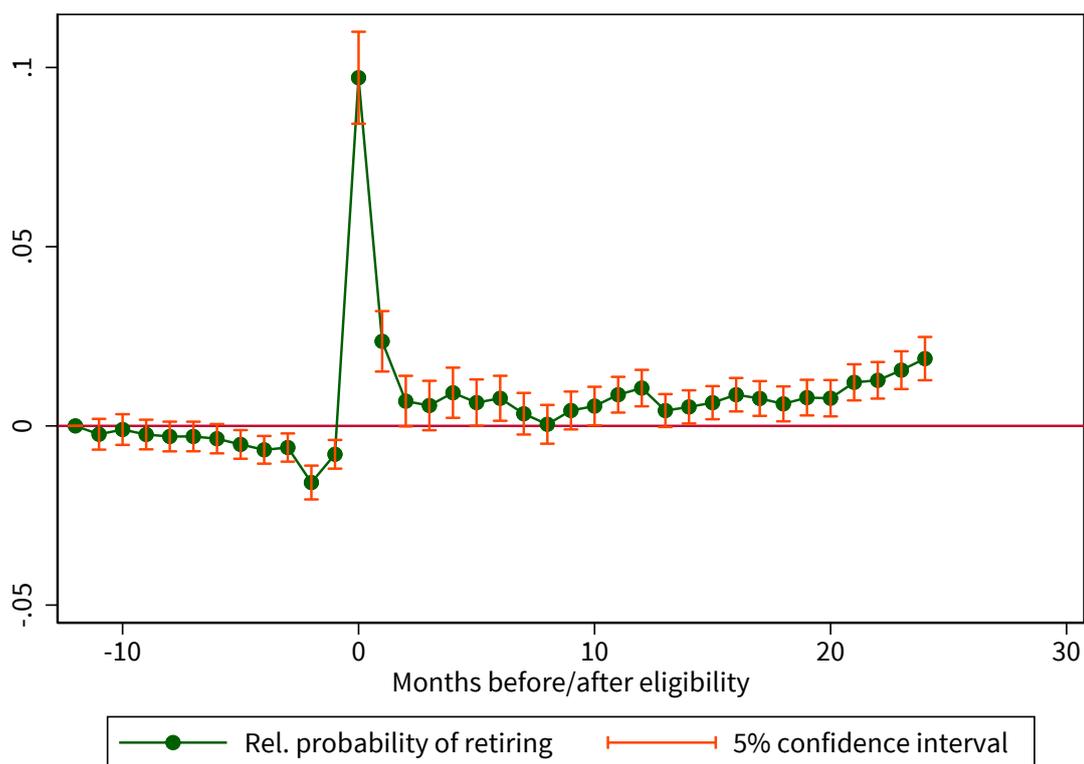
⁷In the year 2013, retiring without deductions was possible from age 65 onwards (instead of e.g. at age 65 + 2 months for the birth cohort 1948). This also required 45 contributory years. Hence, one could possibly expect a small negative coefficient in 2013.

5 Results

5.1 Event Study

Figure 4 displays the results of the baseline event study. The large spike at $t = 0$ shows that a substantial fraction of prospective retirees exit the labor force immediately once they are able to retire without deductions. The probability of retiring immediately upon becoming eligible exceeds the counterfactual probability of retiring at the same age with deductions by more than 10 percentage points. Note that many of those who become eligible do so immediately at age 63, which also serves as a focal point for retiring early with deductions [Seibold, 2017]. A smaller positive effect remains for the year after becoming eligible, indicating comparatively higher retirement probabilities in the months that follow eligibility. This is also driven by a fraction of employed people not immediately exiting the labor force, but remaining in their job for a few more months.

Figure 4: Event study: Baseline



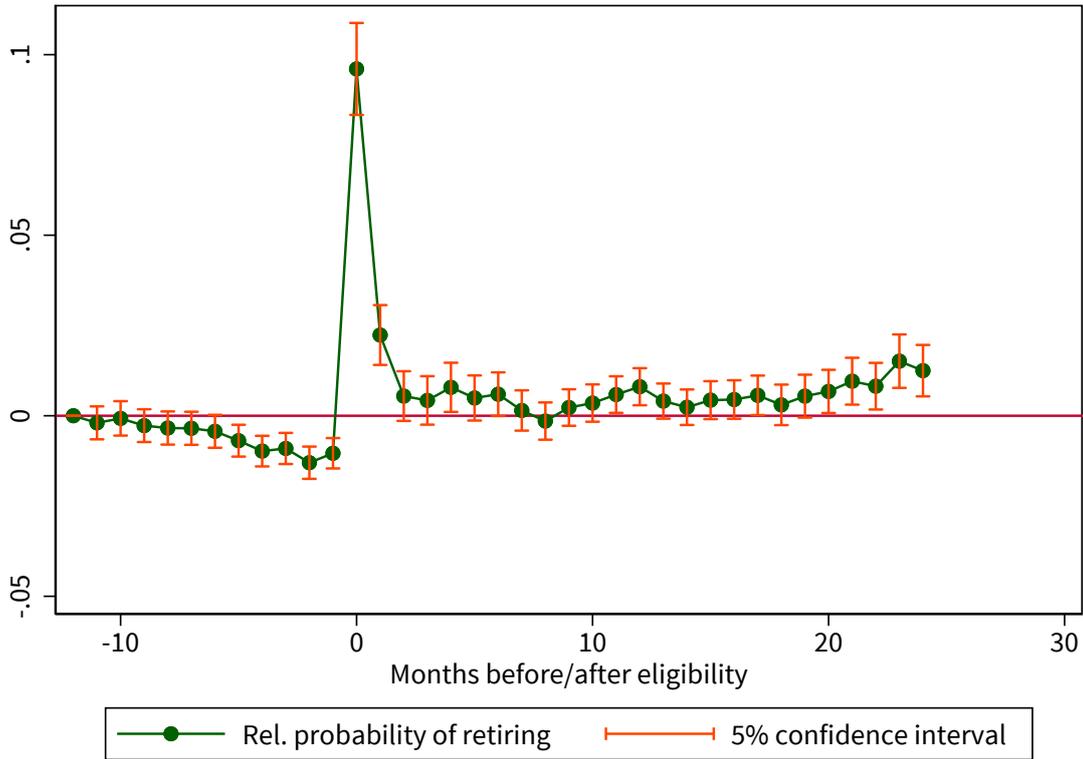
Specification: t ranging from -12 to +24 months, β_{-12} set to zero, age x birth year fixed effects.

In the months preceding the eligibility date, a slightly negative effect arises. This indicates that some individuals postpone their retirement by a few months in order to benefit from the retirement at 63 scheme. The fact that many individuals in the sample become eligible right away when turning 63 contributes to the rather small size of the anticipation effect. While many of those individuals could retire prior to becoming eligible, for example through the retirement for women scheme, overall retirement probabilities between age 62 and age 63 are low (cf. Figure 1). Hence, retirement probabilities of those soon-to-be eligible and those who are still one year short of eligibility do not differ by a large magnitude in this age group. The comparatively larger effect in $t - 2$ is mainly attributable to the 1953 cohort, for whom the early retirement age without deductions differs across retirement schemes. While retiring with deductions is feasible at age 63, retiring through the retirement at 63 scheme is only possible two months after turning 63 for this cohort (see Table 1). As individuals in this cohort would face deductions of 8.7% when retiring at 63, but no deductions when retiring two months later, there are strong incentives to retire at $63 + 2$ months. Hence, comparatively less of those eligible for the retirement at 63 scheme at age $63 + 2$ opt into early retirement with deductions at 63, leading to the larger negative effect at $t - 2$. A positive effect can also be observed at the end of the 24 months interval. That is, the probability of retiring two years after becoming eligible exceeds the retirement probability of other individuals at the same age, albeit at a low level. Reference dependence [Seibold, 2017] may play a role here: many of the individuals in the sample become eligible immediately at age 63 and hence turn 65 at $t + 24$ (or $t + 22$).⁸

As the previous results may be substantially driven by the large fraction of immediately eligible individuals, we also analyze the subset of individuals who reach 45 contributory years at least one month after turning 63 (or $63 + 2$ months for the 1953 birth cohort) or later. In this group, retiring early with deductions is not connected to the reference age 63. However, the overall trajectory of the event study in Figure 5 resembles that of Figure 4. A large spike at $t = 0$ indicates that individuals becoming eligible at non-focal retirement ages have a much larger propensity to retire than other individuals at the same age. Anticipation effects are however slightly larger than in the overall sample.

⁸Note however that all coefficients are relative to $t - 12$, a period in which small anticipation effects might still be present.

Figure 5: Event study: Not immediately eligible individuals



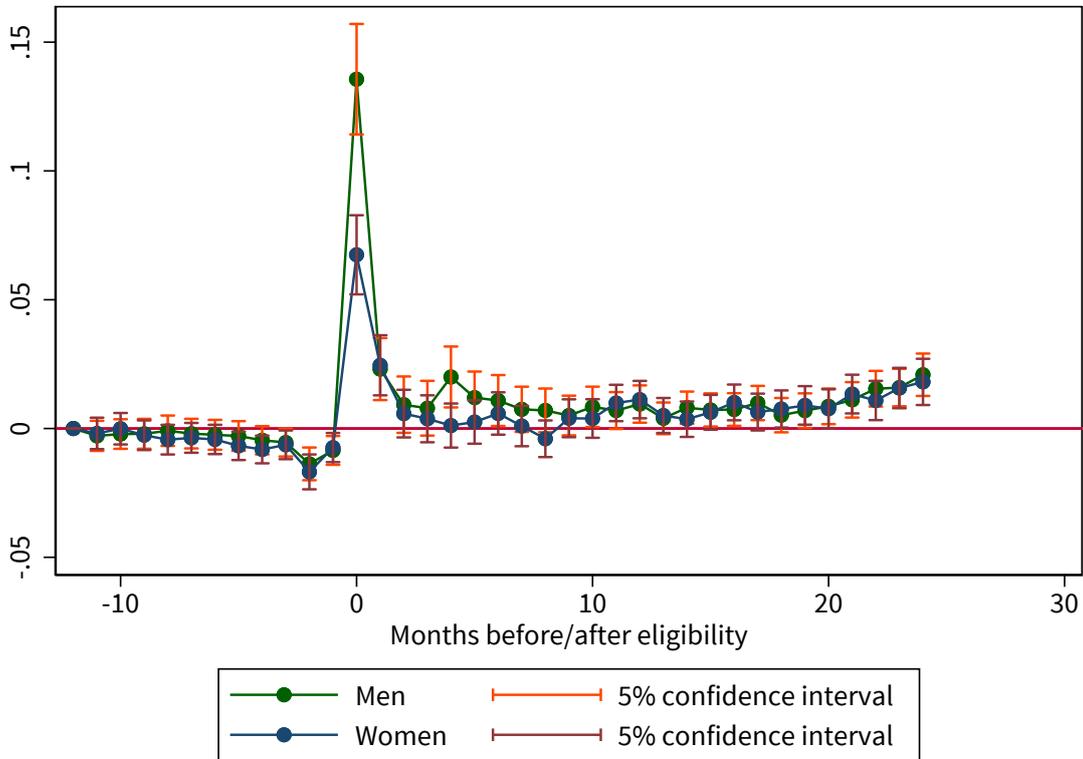
Specification: t ranging from -12 to +24 months, β_{-12} set to zero, age x birth year fixed effects, only individuals becoming eligible after age 63 or, for birth cohort 1953, after age 63 + 2 months.

5.1.1 Analysis Across Subgroups

We subsequently assess whether responses differ by gender. As shown by Figure 6, immediate effects are much stronger for men than for women. One possible explanation are cross-effects between spouses. Using Swiss data, Lalive and Parrotta [2017] show that women reduce their labor force participation once their partner reaches pension eligibility, whereas spousal retirement does not significantly affect male retirement behavior. A similar effect might play a role here. As on average, men tend to be older than their spouses, many 63 year old women will have spouses that become eligible for retirement schemes prior to them. Some of these women may choose to retire at the early retirement age regardless of incentives, resulting in a lower average responsiveness to becoming eligible for the retirement at 63 scheme.⁹

⁹While the data contains marital status, we cannot match spouses and are hence unable to adequately assess the cross-effect of spousal retirement behavior.

Figure 6: Event study: Results by gender

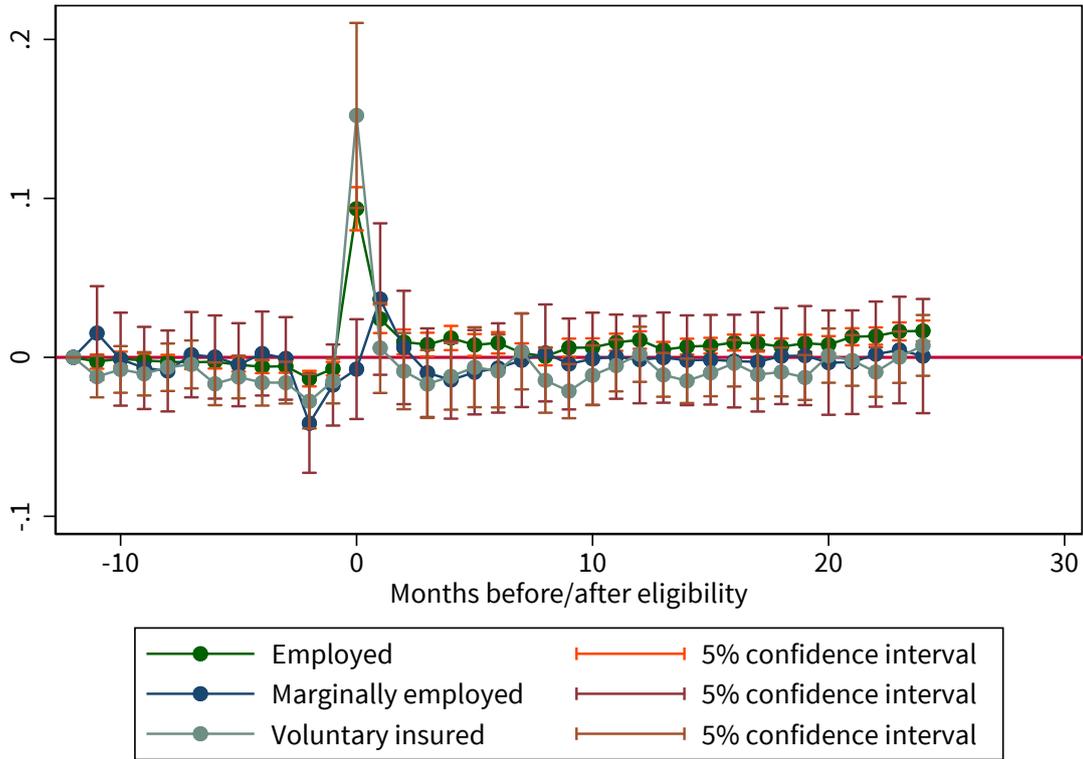


Specification: t ranging from -12 to +24 months, β_{-12} set to zero, age \times birth year fixed effects.

We also conduct the analysis by pre-retirement employment status. As the event study design requires variation in the age at which individuals become eligible, this subgroup analysis is only possible for employed, marginally employed¹⁰ or voluntarily contributing individuals. Unemployment benefit receipt in the years prior to retirement, for example, does not increase contributory years. Hence, unemployed people are either eligible for the early retirement scheme right away, or will not become eligible at all. Figure 7 depicts the event study for socially insured employees, marginally employed employees and voluntary contributors. The trajectory of socially insured employees looks rather similar to the baseline in Figure 4. There is a substantial spike of roughly 10 percentage points at $t = 0$, followed by smaller

¹⁰Marginally employed individuals only earn monthly wages of up to 450 euro and are exempt from social security contributions, but can opt into retirement insurance. This analysis is limited to marginally employed individuals who choose to contribute to retirement insurance and hence acquire further contributory periods.

Figure 7: Event study: Results by socio-economic status



Specification: t ranging from -12 to +24 months, β_{-12} set to zero, age x birth year fixed effects.

positive effects in subsequent periods. In contrast, voluntarily insured individuals exhibit a much larger propensity to retire immediately, but no effect is observable in the follow-up periods. This could be expected since voluntary contributions increase retirement benefits only by very little once eligibility is reached. As opposed to socially insured employees, who may have to observe a certain period of notice when quitting their job or who may adjust the month of their exit to the requirements of their employer, voluntarily insured individuals, many of them self-employed, are more flexible. The picture looks different for those in marginal employment. Whilst a negative effect can be observed at $t - 2$, again due to the 1953 cohort, no significant effect ensues in the periods that follow. This indicates that those who are only marginally employed retire as early as possible, regardless of deductions. For this group, the retirement at 63 scheme does not seem to affect behavior, but mainly results in windfall gains. Only when incentives are very strong – i.e. postponing retirement by two months and in turn avoiding deductions – retirement behavior is

adjusted.

5.2 Matching

5.2.1 Coarsened Exact Matching

Table 4 highlights the results of the baseline specification. The first specification (upper panel) shows OLS results without any matching. Specification 2 (lower panel) employs coarsened exact matching and matches on demographics and on characteristics related to the earnings history. The retirement age in years is used as dependent variable. After matching, eligibility for the scheme does not exert an effect on the retirement age in the placebo test (first column, lower panel), adding credibility to the matching procedure. In 2015 and 2016, coefficients are large and significant, indicating a substantial behavioral response to the reform. Those who are eligible retire on average 5.4 months (0.45×12) earlier than those in the control group. In 2014, those who are eligible retire on average 2.2 months earlier. As the scheme only became effective in the second half of the year, a coefficient of roughly half the size of 2015/2016 fits in nicely with the other results. Two factors might have further reduced the 2014 coefficient. First, the reform's announcement in the beginning of 2014 could have led to anticipation effects as some individuals may have postponed their retirement to the second half of the year in order to benefit from the reform. Second, many of those becoming eligible once the scheme was passed were already older than 63, leaving less room for antedating retirement.

Table 4: CEM: Baseline specification

Retirement age				
	2013	2014	2015	2016
Treat (no matching)	-0.105***	-0.066**	-0.278***	-0.257***
se	(0.034)	(0.029)	(0.023)	(0.022)
t	-3.08	-2.23	-11.66	-11.64
N	8692	11386	14749	14171
Treat (CEM, all observations)	-0.008	-0.185***	-0.460***	-0.437***
se	(0.060)	(0.058)	(0.044)	(0.040)
t	-0.13	-3.18	-10.39	-10.94
N	7387	9648	12754	12357

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Treatment: 45-47 contribution years at 63. Control: 41-43 contribution years. Heteroskedasticity-robust standard errors. Specification 1: no matching. Specification 2: matching via demographics and total pension points at 63.

Table 5 depicts the results by gender, showing much larger coefficients for men than for women. While men retire on average 7 months earlier following the reform, women only retire 3.7 months earlier. This is in line with women’s lower responsiveness to the reform in the event study setting, shown in Figure 6.

Table 5: CEM: By gender and pathways towards retirement

Retirement age				
	2013	2014	2015	2016
Treat (CEM, all men)	-0.058	-0.331***	-0.582***	-0.601***
se	(0.084)	(0.077)	(0.067)	(0.063)
t	-0.69	-4.32	-8.75	-9.60
N	4106	5745	6312	5816
Treat (CEM, non-unemployed men)	-0.109	-0.529***	-0.700***	-0.772***
se	(0.111)	(0.084)	(0.079)	(0.075)
t	-0.98	-6.32	-8.82	-10.26
N	2377	3824	4728	4347
Treat (CEM, all women)	0.058	0.040	-0.333***	-0.285***
se	(0.083)	(0.079)	(0.058)	(0.050)
t	0.69	-0.50	-5.77	-5.65
N	3281	3903	6442	6541

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Treatment: 45-47 contribution years at 63. Control: 41-43 contribution years. Heteroskedasticity-robust standard errors.

Specification 1: All men, matching via demographics and total pension points at 63. Specification 2: Men ineligible for early retirement through the early retirement after unemployment and partial retirement scheme. This specification dropped all men that could potentially be eligible, i.e. benefit recipients and men without a known labor market status. As opposed to the other specifications, this specification considers the direct pre-retirement labor market status as well as the labor market status. Specification 3: All women.

Several reasons may play a role here: for once, due to the early retirement for women scheme, women born before 1952 may already retire as early as age 60, albeit with deductions. Hence, some women may postpone retirement to age 63 in order to avoid deductions. This may compensate part of the counteracting effect of those antedating their retirement. Also, labor market affinity and selection effects due to gender roles may play a role here. In the cohorts born in the late 1940s and early 1950s, female labor market participation was much lower than male participation. For this reason, those who accumulated 45 contributory years may constitute a selection of particularly labor market affine women, on average deriving a lower utility from retiring early. On the other hand, some women may adjust their retirement behavior to their spouse’s retirement choices, reducing the responsiveness

to own financial incentives [Lalive and Parrotta, 2017].¹¹

While the above analysis matches on a variety of individual characteristics, it cannot match on both the retirement year and the birth cohort at the same time. This would restrict the possible difference in retirement age between control and treatment groups and bias the coefficient towards zero. However, the large discrepancies between the retirement schemes across cohorts may also have an impact on results. Those born prior to 1952 could enter the retirement for women scheme as well as retirement after unemployment and partial retirement. Younger cohorts did not have this option. As a side effect of those in the control group retiring later, those in the control group are born earlier, on average, and thus had more retirement options. We hence include a specification considering only those that could not exit via one of the pre-1952 retirement schemes, i.e. men that were neither unemployed or in a part-time retirement (*Altersteilzeit*) scheme in the years leading up to retirement. Men whose labor market status might be related to unemployment (i.e. not only those receiving benefits, but also those without any contributions or known labor market status) are dropped from the sample here. While the overall picture that emerges is similar, the effect is a little larger. Note, however, that this may also be due to unemployed individuals being less responsive to the reform, possibly as many of them retire early regardless of deductions.

In line with this, Table 6 separates effects by socio-economic status. The table focuses on the status with a sufficiently large number of observations and comparability across years. Results are in line with the event study in Figure 7. Socially insured employees in control and treatment group do not exhibit significantly different retirement behavior in 2013.¹² In 2015 and 2016, those who are eligible retire on average 6.7 months earlier than those who are ineligible. Rather comparable effects are observed for voluntarily insured individuals. In turn, effects for marginally employed individuals are slightly positive, but only significant in 2014, where those who become eligible retire 4 months later on average. This could be due to anticipation effects. As previously discussed, marginally employed individuals predominately retire immediately at age 63, even if this leads to deductions. In 2014, the reform only became effective in the second half of the year. This resulted in strong incentives

¹¹However, coefficients do not significantly differ between married and unmarried women.

¹²The negative but insignificant coefficient possibly stems from the possibility to retire at age 65 without deductions if 45 contributory years have been reached. Contributory years were defined slightly differently in 2013 and e.g. did not account for unemployment. Hence, this effect should not be as strong as for other socio-economic status.

Table 6: CEM: By socio-economic status at age 63

Retirement age				
	2013	2014	2015	2016
Treat (CEM, employed)	-0.093	-0.352***	-0.582***	-0.540***
se	(0.085)	(0.069)	(0.055)	(0.048)
t	-1.09	-5.09	-10.56	-11.17
N	4318	6509	8922	8842
Treat (CEM, marginally employed)	0.026	0.358**	0.086	0.121
se	(0.162)	(0.179)	(0.091)	(0.074)
t	0.16	2.00	0.94	1.63
N	324	369	593	574
Treat (CEM, unemployed (ALGI))	-0.032	-0.092	-0.153*	-0.072
se	(0.147)	(0.164)	(0.090)	(0.117)
t	-0.22	-0.56	-1.69	-0.62
N	739	428	592	570
Treat (CEM, voluntarily insured)	-0.100	-0.229	-0.603***	-0.430***
se	(0.35)	(0.153)	(0.123)	(0.137)
t	-0.74	-1.49	-4.91	-3.13
N	373	469	548	459

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Treatment: 45-47 contribution years at 63. Control: 41-43 contribution years. Heteroskedasticity-robust standard errors.

to postpone early retirement to after July 2014. For other socio-economic status, a similar effect is offset by comparatively earlier retirement in the second half of the year. In contrast, individuals receiving unemployment benefits display a rather low level of responsiveness to the reform. Coefficients are negative and borderline significant only in the year 2015, where unemployed individuals retire on average 1.8 months earlier if they can benefit from the reform.

Table 7 addresses possible cohort effects in previous estimations. Instead of separate results by year, it shows the results for respectively birth cohorts 1950 and 1951. The estimation is restricted to the reform years 2014-2016 as including the placebo year 2013, where the reform had zero effect, would bias the coefficient downwards. Results are again in line with previous findings: those in the 1950 cohort retire on average 4.4 months earlier, while those born in 1951 retire 6.8 months earlier. The smaller coefficient in 1950 is due to the cohort's rather advanced age when the reform was passed.

Table 7: CEM: By birth cohorts, years 2014-2016

Retirement age		
	1950	1951
Treat (CEM, all observations)	-0.365***	-0.563***
se	(0.032)	(0.052)
t	-11.23	-10.73
N	5334	7323

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Treatment: 45-47 contribution years at 63. Control: 41-43 contribution years. Heteroskedasticity-robust standard errors.

5.2.2 Robustness Check: Propensity Score Matching

As a further robustness check, we employ propensity score matching [Dehejia and Wahba, 2002]. Instead of directly matching on observables, this methodology first predicts the probability of belonging to the treatment group using a logistic regression, and then matches observations in control and treatment group with a similar propensity score. We use Mahalanobis matching, matching on the same variables as with CEM.¹³ As opposed to the CEM methodology, individuals with different characteristics, but a similar propensity score can be matched here. This results in an overall larger sample size than in the CEM procedure. With CEM, treated individuals are dropped from the estimation if no individual in the control group shares their characteristics.

Table 8: Propensity score matching

Retirement age				
	2013	2014	2015	2016
ATT (propensity score matching)	-0.101	-0.148**	-0.351***	-0.479***
se	(0.076)	(0.075)	(0.049)	(0.045)
t	-1.34	-1.97	-7.15	-10.61
N	8683	11375	14737	14161

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Treatment: 45-47 contribution years at 63. Control: 41-43 contribution years. Propensity score matching via demographics and polynomial of total retirement points at 63.

The results in Table 8 are in line with our previous findings using coarsened

¹³We use dummies for gender, marital status, being East German, education level, and labor market status before turning 63 to determine a person's propensity score. Pension points at age 63 enter the estimation as a third degree polynomial.

exact matching. While no significant effect can be found in the 2013 placebo test, strongly significant negative coefficients arise in the years 2015 and 2016. This again confirms that those affected by the reform retire on average about 5 months earlier than those unaffected by the reform.

6 Fiscal Costs

In the German public debate, the fiscal costs of the reform are controversially discussed. Current fiscal cost estimates vary substantially. At the lower end, the draft bill of the retirement reform estimated additional retirement insurance expenditures amounting to EUR 0.9 billion in 2014, 1.9 billion in 2015 and 2.2 billion in 2017, with costs slightly declining in subsequent years and then again increasing to 3.1 billion in 2030 [Deutscher Bundestag, 2014]. Pimpertz [2017] provides a lower bound estimate of the reform’s cost, assuming unchanged retirement behavior and focusing on foregone deductions only. This approach yields cost estimates ranging between 0.14 billion in 2014 and 1.2 billion in 2017. Using a simulation model, Werdning [2014] projects somewhat higher costs of EUR 0.5 billion in 2014, rising to 2.6 billion in 2015 and 3.2 billion in 2016 and 2017. Schnabel [2015] estimates that annual fiscal costs might rise to EUR 6 billion if 125,000 individuals retire via the scheme per year – a figure which the number of actual claimants exceeds by far.¹⁴ At the upper end, monthly costs of 1.3 billion were frequently circulated in the media¹⁵ – an overestimation based on all retirement benefits paid under the ‘retirement at 63’ scheme, neglecting that many of those claiming early retirement benefits would otherwise have retired early through another scheme.

Against this background of widely varying cost estimates, we strive to provide a more precise estimate of fiscal costs. Using our detailed microdata and the coarsened exact matching methodology described above, we are able to account for behavioral responses as well as for foregone deductions and contributions. To obtain counterfactual retirement choices, we match those retiring via the ‘retirement at 63’ scheme to the same control group as in section 5.2. Within each strata, we then compute the counterfactual retirement age, also accounting for specific retirement rules for women and individuals with disabilities. Overall, the reform’s costs entail changing

¹⁴In 2016, 225,290 individuals retired via the ‘retirement at 63’ scheme [Deutsche Rentenversicherung Bund, 2018].

¹⁵See e.g. <https://www.tagesschau.de/inland/rente-253.html>.

pension insurance expenditures as well as foregone social insurance contributions and tax revenues. For each of these dimensions, we calculate actual and counterfactual expenditures and revenues for each individual retiring via the ‘retirement at 63’ scheme and for each year under consideration. Individual fiscal costs, i.e. the difference between actual and counterfactual costs, are then aggregated and upweighted to match the total number of those retiring through the retirement scheme, taken from official statistics [Deutsche Rentenversicherung Bund, 2018]. Our calculations encompass the following aspects:

Pension insurance expenditures. The retirement reform affects pension insurance expenditures along three dimensions: deductions, retirement timing, and accumulated pension points. Costs are assigned to the relevant fiscal year, assuming that retirement under the reform takes place in the middle of the year.¹⁶ While retirement benefits under the reform are provided in the data, we impute counterfactual retirement benefits, accounting for changes in retirement timing, the ensuing change in pension points, as well as deductions. The abolition of deductions under the ‘retirement at 63’ scheme increases benefits of those retiring early, even absent any behavioral response to the reform. In addition, retiring earlier due to the reform results in less accumulated pension points, which reduces retirement benefits. At the same time, claiming benefits early raises fiscal costs in the year of retirement. Naturally, these effects reverse for individuals postponing their retirement in order to become eligible under the reform.

Income tax revenues. The timing of entering retirement and the amount of benefits affect taxable income and have direct implications on tax revenues. Furthermore, retirement benefits are only partially taxable, with only 72% of pension benefits of those retiring in 2016 included in taxable income. Similar to the changes in pension insurance expenditures, we calculate each individual’s actual and counterfactual tax base, which is composed of wages and retirement benefits. Individuals postponing their retirement in the counterfactual scenario are assumed to extend their pre-retirement employment status at their previous wage. Taxes are simulated by applying the German individual income tax schedule to taxable income. As we lack comprehensive data on partners’ taxable income as well as on other income sources such as investment or rental income, we are nevertheless only able to provide a rough approximation of the reform’s impact on tax revenues.

¹⁶While we observe the retirement age in months, we do not observe the calendar month of retirement.

Social insurance contributions. Entering retirement likewise affects social security contributions. While employed individuals’ employer and employee social insurance contributions amount to about 40%¹⁷, contributions of retirees only correspond to roughly 18% of their retirement benefits. Considering that pension insurance covers about half of retirees’ health insurance fees, retirees are only liable to contributing the remainder of about 10.5%. These low rates are due to retirees not contributing to retirement and unemployment insurance. At the same time, if retirement benefits increase due to foregone deductions, a small percentage of these costs is compensated by rising health insurance and nursing care insurance contributions. As before, calculations assess actual and counterfactual social insurance contributions in each year.

Our calculations do not account for second round effects, such as possible increases in social insurance contribution rates to compensate for lost revenues following the reform. Table 9 presents the ensuing fiscal cost estimates. With estimated pension insurance expenditures of 3.41 billion and total fiscal costs of 6.46 billion in 2016, our fiscal cost projections are at the upper end of the range of cost estimates. This is also due to the high number of claimants, which had been underestimated when the reform was announced. Yet, costs per claimant lie between projections that assumed unchanged retirement behavior and projections assuming that all claimants would have otherwise have retired at the regular retirement age.

Table 9: Fiscal costs

Costs in billion euro			
	2014	2015	2016
Pension insurance expenditures	0.79	2.34	3.41
Total costs	1.47	4.52	6.46

Annual fiscal cost estimates in billion euro. Total costs encompass pension insurance expenditures, income taxes and social insurance contributions.

7 Conclusion

This paper assesses the responses to a recent German pension reform that introduced incentives for retiring early. While the retirement age has been gradually

¹⁷Contribution rates slightly differ across years, between those with and those without children, for those with lower wages and by health insurance provider.

increasing over time for most prospective retirees, the reform enabled individuals with 45 or more contribution years to retire early at 63 instead of 65 without incurring a financial penalty. We both employ an event study design, and estimate the effect of becoming eligible for the early retirement scheme in a coarsened exact matching scheme. Our results indicate that the probability of retiring early increases by more than 10 percentage points in the month of becoming eligible relative to the counterfactual probability of retiring at the same age with deductions. Individuals eligible for the reform retire on average 5.4 months earlier than non-eligible individuals with identical characteristics. The effect is larger for men than for women and particularly large for individuals who have been working or voluntarily contributing to retirement insurance prior to becoming eligible.

We subsequently use our matching methodology to quantify fiscal costs. With additional pension insurance expenditures of 3.4 billion euro and aggregate fiscal costs of 6.5 billion euro in 2016, our cost estimates exceed most previous back-of-the-envelope cost estimates.

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