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Determinants of Entry into Retirement Econometric Analyses for Germany

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Contents

List of Tables

List of Figures

Preface

> *"We are already hard put to establish a relationship between such an obvious effect as a charred tree and the lightning bolt that set fire to it, so to trace sometimes endless chains of causes and effects seems to me as foolish as trying to build a tower that will touch the sky."*
>
> *William of Baskerville, The Name of the Rose by Umberto Eco.*

This quote from the book "The Name of the Rose" by Umberto Eco highlights valuable insights in the analysis of causal inferences within the area of social sciences. First, it underlines that analyses and methods for detecting *causal relationships* depend on the individual perspective. Therefore, the researcher has to argue and define within his research what is meant by the term *causality*. The quote shows that the lightning has an effect on the outcome, i.e. the integrity of the tree. If one actually can see the lightning strike there is no doubt what is the root cause and the actual effect. In the field of social sciences the outcome of certain factors, politics, or determinants are a priori unclear. Vice versa, if the outcome can be quantified, the reasons for the development of the outcome are in most cases unknown or at least disputable. If the researcher constructs a model to analyse the influence of one variable on the other, e.g. the effect of lightning on the integrity of trees, the researcher chooses and therefore pretends the channel which is the root cause in his framework. This becomes even more challenging if one is interested in the effects for a population or subgroup rather than a unique observation. Thus, a reliable model is based on theoretical thoughts of how one variable affects the other. Second, the quote emphasises the simplicity of the explanation when arguing in a causal way. This also applies one to one to research in social sciences.

This dissertation analyses various determinants of entry into retirement in Germany using econometric methods. The first paper investigates how various ages of entry into retirement affect the mortality using administrative data of the German Pension Fund. The second paper takes a closer look at how the additional earning ceiling (*Hinzuverdienstgrenze*) for early old-age pensioners influences the growth of labour force participation and the amount of supplied labour. The source of this analysis is a merged data set of the German subsample of the Survey of Health, Ageing and Retirement in Europe (SHARE) and pensions in payments (*Rentenbestand*) of the German Pension Fund. The third paper analyses the relationship of pension income, age at retirement, and employment during retirement using data from the German Socio-Economic Panel (SOEP). Here, the focus lies on differences of retirement age and pension income over time. In addition, the influence of pension income in predicting the probability of employment during retirement has been analysed. In all papers statistical methods are used to achieve empirical-based evidences in non-experimental setups.

Throughout the process of writing and completing this dissertation I have received a great deal of support. First, I would like to thank my supervisor, Prof. Dr. Thusnelda Tivig, for her guidance and for giving me plenty of rope during my research. In addition, I would like to thank my family and friends who supported me in so many aspects that every explanation would be insufficient. *Thank you so much.*

Summary

This thesis analyses topics related to the determination of entry into retirement in Germany. The focus lies on administrative guidelines and how they interact with the individual's will to retire at a certain moment in time. Due to demographic ageing of the German population, adjustments had to be undertaken to guarantee the financial stability of the predominantly pay-as-you-go financed German Pension Fund. This includes for example the increase of pension eligibility ages, the termination of certain types of early old-age retirement, and a decrease of the replace rate (*Rentenniveau*). By doing so, average age at entry into retirement is on average increasing (Deutsche Rentenversicherung Bund 2018). Moreover, the share of pensioners being employed is increasing, too (Brenke 2011).

The first paper examines if different ages at entry into retirement affect mortality. Descriptive analyses of retirement age and mortality imply that there is a positive relationship between both variables (Kühntopf and Tivig 2012). As overall health is unequally distributed over the range of possible ages of entry into retirement, i.e. individuals with a bad health status tend to retire at younger ages, correlation-based analysis cannot be easily transferred to a causal inference. Therefore, the first paper identifies potential differences of mortality which can be attributed to differences in age of entry into retirement. If differences of mortality caused by variation of retirement age are significant, evaluations concerning the financial stability of the Pension Fund have to be re-evaluated irrespective of the direction of the effects. To identify potential mortality differences associated with age of entry into retirement, retirement age is instrumented via actual pension eligibility age. In addition, further control variables are used to overcome non-randomness of the instrument. Moreover, the models include a dummy which captures the heterogeneity of mortality over analysed birth cohorts. Using different sensitivity analyses, it shows that the independent relationship of age at entry into retirement and mortality cannot be rejected. By reviewing related literature it can be found that differences to previous results can mainly be attributed to heterogeneity with regard to the relationship of mortality and age at retirement along different birth cohorts. The outcomes of the analysis imply that there are no additional budgeting effects of an increase of legal retirement age as suggested by previous authors.

The second paper is based on an evaluation of an instrument to restrict the earnings out of employment during retirement when individuals retire before the relevant regular pension eligibility age. The additional earnings ceiling (*Hinzuverdienstgrenze*) was introduced in the 1970s in combination with several early old-age pension types to ensure that respective pensioners cannot profit from both, pension income and earnings from continuing labour. As the share of workers to pensioners is declining (Borsch-Supan and Schnabel 1998), recent reforms try to increase the share of employment of older people in Germany (Bundesgesetzblatt 2016). The trade-off of not giving an incentive to several incomes versus the wish to increase the fraction of older people working makes it interesting to analyse the influence of the additional earnings ceiling on labour force participation. Focusing on early old-age pensioners the analysis is based on an identification strategy by finding an adequate control group for the determination of the influence of the additional earnings ceiling. Results show that the additional earnings ceiling from 1986 to 2013 does not have a statistical significant effect on the growth of labour force participation in Germany. Unfortunately, there is no suitable variable capturing the amount of supplied labour during retirement within the proposed strategy of identification. By using different measures of activity during retirement which can be interpreted as activities of substitution of labour, one can indirectly control for the amount of labour supplied. Results give some support that the additional earnings ceiling has a negative effect on the amount of supplied labour. Results imply that the additional earnings ceiling during retirement does not affect the range of the population of pensioners working during retirement, but there is empirical indication that the size of supplied labour is negatively affected by the additional earnings ceiling. Although recent reforms ease the burden of supplying labour during retirement (Bundesgesetzblatt 2016), divergent actions in the regulatory framework are still in effect.

Besides the increase of pension eligibility ages the termination of certain types of early old-age pension lead to an overall increase of the average age at entry into retirement in Germany. The third paper analyses the association of age at entry into retirement and pension income over time while focusing on distributional differences in the relationship of both variables. In addition, reasons for employment during retirement are analysed to answer the question if working after entry into retirement is based on preferences or is motivated by a low pension income. Moreover, an empirical univariate overview of pension income, age at retirement, and employment during retirement are presented in this paper. Within the period of analysis of 1995 until 2015 the distribution of total pension income becomes more unequal. Results imply that the association of own pension income with age at retirement changed fundamentally. In previous years age at retirement is not associated with pension income. In contrast, it can be seen a statistical positive relationship in 2015. Moreover, the magnitude of this positive effect is higher for lower parts of the distribution of pension income and flattens out for upper parts. While this development can be interpreted as an additional incentive of shifting entry into retirement to higher ages, this result cannot be confirmed by using total pension income which also includes pension income from non-own source, i.e. widow's or widower's pension as well as orphan's pension. As the inclusion of those pension income from non-own source leads to a more equal distribution of pension income, the legislative authority faces a classical trade-off. Regarding the influence of pension income on probability of employment, results imply that working after retirement is more a preference of will rather than a necessity, at least on an aggregated level of analysis.

Using three different sources, covering administrative and survey data, it is shown that the regulatory framework of entering retirement has a large impact on the individual retirement behaviour. Moreover, the analysis points out that objectives within the system of retirement can be revised on an administrative level due to changing demographic structure of the population. This change can induce additional costs when previous guidelines counteract instruments which are used to implement these newer objectives. This dissertation gives empirical evidence of this multidimensional duality and quantifies additional costs.

Chapter 1

Statistical Artefact or Mortality Risk Factor? The Influence of Age at Retirement on Mortality Using German Pension Fund Data

Abstract

The paper analyses the effect of age of retirement on mortality for old-age pensioners using administrative data of the German Pension Insurance. Reviewing related literature, it shows that problems of sample selection and omitted-variables bias (OVB) influence previous results for Germany. To overcome these problems, the model accounts for heterogeneity of birth cohorts while actual retirement age is instrumented via age of pension eligibility. The results indicate that the independent relationship of age of retirement on mortality cannot be rejected. They are robust over various types of old-age pensions and further sensitivity checks.

JEL codes: I00, J14

1.1 Introduction

The entry into retirement constitutes an important cut in individual life, as it is combined with several economic and social changes. Although entry into retirement can be the result of decreasing health (Quaade et al. 2002), it in itself might be a health relevant factor (Bloemen, Hochguertel, and Zweerink 2013, Stolzenberg 2011 or Coe and Zamarro 2011).

This paper analyses the effects of age at retirement on mortality using data from the German statutory pension scheme. The determination of the effect is relevant for different reasons. First, the pensioner must find a solution to the trade-off between time in retirement and pension income, as they are are negatively correlated. If the effect of age at retirement on time in retirement is disproportional, as previous studies from Germany imply, a solution to the trade-off is even more difficult to achieve. Second, the German statutory pension scheme is mainly constructed as a pay-as-you-go system with age limits for entering retirement. As age limits increase within the statutory pension system[1], time in retirement should decrease proportionally. But if the choice of age at retirement in itself has an effect on mortality, considerations regarding the financing of the pension fund have to be re-evaluated.

As there are confounding factors affecting the point of retirement, a strategy using different eligibility ages is established to identify the influence of age at retirement on different ages of survival. By doing so, one circumvents the problem of endogeneity due to omitted-variables bias (OVB).

The study is structured as follows. In section 1.2 literature dealing with the relationship of age at retirement and mortality is reviewed. Here, I will focus on German studies and those studies which identify the actual effect of age at retirement on mortality. Section 1.3 presents data. In this section, properties of the underlying data set is presented and previous results for Germany are re-analysed while also giving an overview of old-age retirement in Germany. Section 1.4 explains the strategy of identification and discusses the model and the estimation methods. In section 1.5 results are presented. Section 1.6 concludes.

1.2 Literature Review

The review reports findings of the relationship of age at retirement and mortality. Results are separated into studies focusing on Germany and studies focusing on other countries. Within this review, the focus lies on old-age pensions. Therefore,

1. The age limit for regular old-age pension increases gradually to 67 years (§§ 35, 235 SGB VI). Other types of old-age pension are also affected by an increase of the age limit, for example §§ 236 II, 236a II, 236b II or 237 IV, 237a III SGB VI.

other retirement options and their influence on mortality will not be reviewed.[2]

Studies can be classified into two categories. The first category analyses the relationship between age at retirement and mortality from a descriptive viewpoint. It focuses on the question of how mortality differs between different ages of retirement. The second category analyses the actual influence of age at retirement on mortality. Therefore, the second category of papers deals with the question of how a potential change in age at retirement effects mortality. By doing so, studies construct a strategy to identify the causal link of age at retirement on mortality. The step from the first category to the second can be seen as a gradual development from a general examination of the relationship of age at retirement and mortality to a causal interpretation.

Table 1.1 reports key results of analysed studies. Furthermore, the overview presents information about the data set, strategies and estimation methods.

Literature Review – Germany

Giesecke (2015) uses a data set of the German Pension Fund, registering the cessation of pension payment, which is equivalent to individuals' death.[3] The origin of the data set is similar to the ones used in this study.[4] Focusing on redistribution issues Giesecke regresses time in retirement, a measure of the life expectancy after retirement, on age at retirement. Based on descriptive and regression results, Giesecke concludes that for "male individuals, the average remaining years to live increase in age at retirement towards age 63".

Kühntopf and Tivig (2012) also analyse data from the general German statutory pension insurance. Separating by the age at retirement, Kühntopf and Tivig calculate the probability of dying at the age of 72 for all old-age pensioners reaching the age of 65. Therefore the authors use the life expectancy in the range of 7 years as a proxy for mortality. The authors also control for health and income by using aggregated proxies over the working live span. The authors find a positive correlation between the life expectancy and age at retirement for men. For women retiring after 60 years[5], Kühntopf and Tivig cannot find substantial differences with regard to mortality.

Brockmann, Müller, and Helmert (2009) analyse individuals' mortality rate by age at retirement for old-age pensioners and individuals with an invalidity pension.

2. For a comparison of mortality and life expectancy with regard to various retirement options, i.e. individuals with old-age pensions versus individuals with invalidity pensions, see e.g. Rehfeld and Scheitl (1986), (1991) or Kruse (2000).

3. Other reasons of cessation of pension payment as for example change of type of old-age pension or changes of part-pensions is not included.

4. The data set used in this study utilises another population and includes additional information regarding the type of old age pension and additional variables on a monthly basis. For further details, see 1.3.

5. The earliest possibility receiving an old-age pension in the analysed cohorts is 60.

The authors use data of a German health fund, Gmündner Ersatzkasse[6]. Since not all individuals in their data died at the end of the study, Brockmann et al. use as dependent variable the survival time after retirement to proxy for life expectancy. Here, that can be the end of life or the studies' end, respectively. To deal with the problem of right-censoring of this kind of data the authors use a Cox proportional-hazards estimation method, separately for men and women, to analyse the risk of mortality for different ages of retirement. In their analysis, ages of retirement of old-age pensioners are combined within a 5 year scale; 56-60 years and 61-65 years. Whereas their descriptive results are similar to the analyses of Kühntopf and Tivig (2012), i.e. higher mortality risks for early old-age male pensioners and lower mortality differences with regard to age at retirement for women, the results of the model estimated via Cox proportional-hazards show no significant mortality differences between different retirement ages for men. For women on the other hand hazard ratios show considerably lower mortality risks when retiring at earlier ages. Moreover, Brockmann et al. control for marital and socio-economic status and include calendar year of retirement as well as age variables in their models. In an additional regression, the authors also include the days in hospital two years prior to retirement. But since old-age and disability pensions are not identifiable in this model no conclusions for old-age pensioners can be obtained.

Rohwer (2003) analyses data, similar to Brockmann, Müller, and Helmert (2009), from the German health fund Gmündner Ersatzkasse. The period of observation for old-age pensioners covers 27 years form 1975 until 2001. In comparison to Brockmann et al. Rohwer analyses male old-age pensioners from the age of 59 until 66. Rohwer uses survival functions of individuals' age at death or age at studies' end, respectively. For old-age pensioners, the author finds a positive correlation between life expectancy and age at retirement.

In summary, German studies analyse the relationship between retirement age and mortality from a descriptive point of view. In most cases those studies find a positive relationship between age at retirement and mortality for men whereas there is no clear tendency for women. Literature dealing with the influence of age at retirement on mortality (second category) regarding Germany are rare. So far, studies about Germany did not take the characteristics of the German statutory pension scheme into account, i.e. the individual requirements for entering into specific types of old-age retirement. Moreover, only some studies factor in particularities within the German pension scheme.[7] Incorporating those particularities and accounting for non-equal distribution of age at retirement across birth cohorts, studies concerning

6. Nowadays, the fund is called Barmer GEK.

7. An example might be the fact that pensioners with an invalidity pension automatically become old-age pensioners at the age of 65.

Germany are re-analysed in subsection 1.3 by using similar methods.

Literature Review – Other Countries

Hernaes et al. (2013) analyse administrative data from Norway. The authors use exogenous variation of eligibility age and build their model around a Difference-in-Differences (DiD) specification. By using DiD they can control for non-random assignment of the eligibility status. This is an advantage to studies where the data set does not offer the possibility to control before and after the introduction of early retirement. Using a dummy as a dependent variable indicating whether the respective individual lives beyond a given age limit (up to age 77), Hernaes et al. do not find any effects of age at retirement on life expectancy.

Kuhn, Wuellrich, and Zweimüller (2010) analyse the effect of early retirement on mortality for blue collar workers in Austria. Eligible workers can withdraw from employment up to 3.5 years earlier compared to non-eligible individuals. Eligibility varies by region. The dependent variable is a dummy indicating whether the individual died by the age of 67. Kuhn, Wuellrich, and Zweimüller instrument the difference between the statutory and actual age at retirement by an eligibility dummy. Results indicate that early retirement increases mortality significantly for men, but does not have any effect on women. The size of the effect is large, implying that early retirement increases the probability of dying by 13%. Further evidence of the relationship between age at retirement and mortality in other countries (first category) are summarised in Table 1.1.

In summary, evidence from other countries regarding the correlation between age at retirement and mortality differ by magnitude and direction. Studies using an instrumental variables approach (IV) have a high internal, but low external validity. The reason for low external validity are differences in the composition of the group of compliers across data sets. Compliers[8] are individuals whose treatment status change due to the assignment to the instrument. So, different data sets and setups, i.e. different retirement systems or different instruments, affect different groups of complying individuals. Thus, results obtained via IV can vary across different studies. Therefore, previous empirical findings achieved by an instrumental variables approach cannot easily be applied to Germany. The broad coverage of the statutory pension scheme[9] and its relevance as an important source of income during retirement is an additional motive for analysing the influence of age at retirement on mortality in Germany.

8. See Angrist and Pischke (2008) for details.

9. Scholz (2005) estimates that for 2003 on average 92% of men and 95% of women between the age of 65 and 99 are covered by the German statutory pension scheme.

Table 1.1: Age at Retirement Effects and Mortality – Overview of Empirical Results for Germany and Worldwide*

Author(s) / Title	Data Set	Strategy & Method	Results
Germany			
Giesecke (2015) *Redistribution in a Pay-As-You-Go Pension System***	• period: 2006-2008 (only death people) • German statutory pension insurance • 116,991 individuals (48% men)	• OLS regression of duration of retirement till death	• significant differences between different ages of retirement for men and women on mortality
Kühntopf and Tivig (2012) *Early retirement and mortality in Germany*	• period: 2002-2005 • German statutory pension insurance	• period life tables	• positive correlation of life expectancy and age at retirement for men • no differences for women
Brockmann, Müller, and Helmert (2009) *Time to retire – Time to die?***	• period: 1990-2004 • German health insurance fund (GEK) • 104,914 individuals (65% men)	• Cox proportional hazard model of survival time after retirement	• no effect on life expectancy for men • lower mortality risk for early retired women
Rohwer (2003) *Rentenzugangsalter und Lebensdauer***	• period: 1975-2001 • German health insurance fund (GEK) • 77,144 individuals (men only)	• period life tables • survival functions	• positive correlation of life expectancy and age at retirement for men
Other Countries			
Hernaes et al. (2013) *Does retirement age impact mortality?*	• period: 1992-2010 • administrative registers of Statistics Norway • 148,643 individuals (52,5% men)	• IV and DiD using exogenous variation in retirement eligibility	• no causal effect of age at retirement on mortality using survival probability up to age 77
Carlsson et al. (2012) *Late retirement is not associated***	• period: 1991-2008 • Swedish population registries	• probability model (logit)	• early retirement is associated with increased mortality comparing mortality between 69 and 78 for men • no effect for women
Kuhn, Wuellrich, and Zweimüller (2010) *Fatal Attraction?***	• period: 2006-2008 • Austrian Social Security Database • 20,873 blue-collar workers (84% men)	• IV using exogenous variation in retirement eligibility	• early retirement increase mortality for men using survival probability to age 67 • no effect for women
Skirbekk et al. (2010) *Retirement and mortality in Norway***	• period: 1970-2007 • administrative registers of Statistics Norway • 352,315 individuals	• Cox proportional hazard model	• early retirement is associated with increased mortality using survival probability up to age of 70 for men and women
Bamia, Trichopoulou, and Trichopoulos (2008) *Age at Retirement and Mortality***	• period: 1994-2006 • EPIC study (Greek participants only) • 16,827 individuals (53% men)	• Cox proportional hazard model	• lower mortality risk for individuals with higher age at retirement for men and women
Other findings***			

*Findings and characteristics rely on old-age pensioners only. Results for disability pensions are not further displayed. **For the sake of clarity, titles are abbreviated. The complete title can be found in the bibliography. ***Litwin (2007) (±); Tsai et al. (2005) (+); Waldron (2002) (+); Baker et al. (1982) (+); Tyhurst, Salk, and Kennedy (1957) (±); where (+) means positive effect of higher age at retirement on life expectancy, (−) negative effect of higher age at retirement on life expectancy and (±) no effect of age at retirement on life expectancy. Those methods are reported which are predominantly important for the respective results. Obs. - observations. GEK - Gmündner Ersatzkasse. IV - Instrumental Variables. DiD - Differences-in-Differences. EPIC - European Prospective Investigation into Cancer and Nutrition.

1.3 Data

The chapter's results are based on data from the research data centre of the German Pension Insurance (FDZ-RV). Two independent data sources, pensions in payment (*Rentenbestand*) and cessation of pension payment due to death (*Rentenwegfall durch Tod*), are used to analyse the influence of age at retirement on mortality. The data set is a pooled cross-section and covers observations from 2004 until 2012 in a two year interval. In addition, data for 2013 is available and used, too. Therefore, the whole data set covers a time span of 10 years. Individuals who receive two pensions are recorded only once per year. Data of pensions in payment covers all pensioners who are alive at least until November of the year under review. In comparison, the data of cessation of pension payment enlists all deceased pensioners from January until November of the given year.

As both data sets exhibit similar sets of variables the data sources can be easily merged. From each of the six reporting years (2004, 2006, 2008, 2010, 2012 and 2013) a 10% random sample of the population of each reporting year was drawn and used for analysis.[10] The merged data set contains the year and month of birth, year and month of entry into retirement, and year at death (for deceased pensioners). Using the information available in the data, I construct the age at entry into retirement and current age for living pensioners and age at death of deceased pensioners on a monthly basis respectively. In addition to these variables the data set contains demographic indicators like sex, citizenship[11], number of children, and family status indicating if the respective individual is re,-married or unwed. The data set also includes variables which are connected to the calculation of the actual pension. It includes: the type of old-age pension; the contribution periods (fully fledged); the creditable periods due to illness and unemployment; the personal earnings points[12]; whether the individual has pension entitlements from foreign countries; and if so, how many years are accounted for in the data for the calculation of the pension.

Those individuals whose entry into retirement do not require a poor health status were selected for the analysis. Therefore, I exclude individuals receiving an invalidity pension and concentrate on old-age pensioners only. Thereby, I manually exclude a large source of bias affecting the influence of age at retirement on mortal-

10. Due to reasons of data protection the analysis was executed via remote computing. Although I have access to the complete population data, results are based on the restricted sample due to limit of available server capacity.

11. The original data set contains foreign citizenship for different regions and countries in more detail. Due to non-coverage of former West and newly formed German states a dichotomous variable indicating German or foreign citizenship was constructed.

12. One earning point in a given year corresponds to the average pay. The respective annual pay of an individual is divided through the average pay to determine the earnings points. The variable psegpt contains the sum earning points adjusted for the access factor within pension calculation and other determinants.

ity, as invalidity pensioners retire at earlier ages and tend to have higher mortality rates at lower ages. Nonetheless, since individual's health is a relevant factor among old-age pensioners, it can potentially affect the influence of different ages of retirement on mortality. That means omitted-variables bias in the form of different health outcomes at varying ages of retirement can still be relevant.

Due to the fact that invalidity pensions will be assigned to old-age pensions after the respective individual turns 65 years, the sample was further restricted to individuals whose type of pension have not changed, i.e. start of current entry into retirement is similar to the first beginning of retirement. This method identifies old-age pensioners only, but has some drawbacks. Pensioners with former GDR pension, whose pension is revalued after the German reunification, were mostly excluded by construction. Moreover, recipients of part-pensions whose portion of pensions change or pensioners whose first receipt of pension is missing are excluded, too.

As the data source contains information on the specific age at entry into retirement and type of old-age pension, it was possible to calculate[13] the actual age at pension eligibility without deductions.[14] After examination of the data some observations were excluded with regard to problems of plausibility. This refers to people whose age at retirement is higher than their respective actual age or age at death. In addition, observations were excluded when the age at pension eligibility is higher than the actual age at retirement. The whole sample consists of 6,742,180 observations. A detailed overview of the data set can be found in the appendix on Table 1.13.

Sample Selection and Omitted-Variables Bias

As I use administrative data, one has to account for the non-experimental design of the given data source when analysing the influence of age at retirement on mortality. This section will focus on the properties of the data and their consequences when analysing the research question. Due to changes in the legal frameworks concerning retirement across the analysed period (Deppe and Foerster, 2014) and the construction of the data set biases arise when analysing data without further adjustments.

Potential biases can be generalised into two categories. The first category, *sample selection*, deals with the choice of individuals within the data set. With respect to the data source of cessation of pension payment due to death, individuals were selected by death during the period of observation. By construction, pensioners of earlier birth cohorts die at older ages in comparison to pensioners of later birth cohorts within the respective year under review. This can cause biases when individuals'

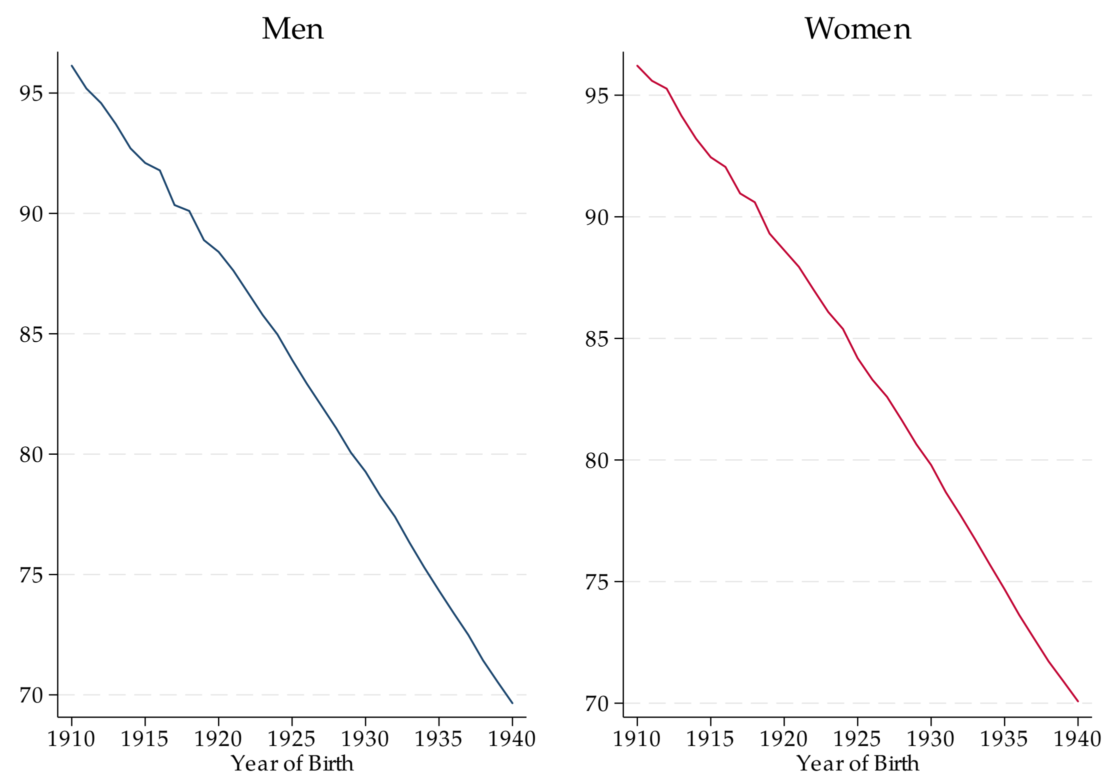
13. For the determination of age at pension eligibility I used the Federal Law Gazettes (*Bundesgesetzblätter*).

14. This step is important when it comes to the identification strategy explained in section 1.4.

age at retirement diverge over birth cohorts, as it the case for Germany, see Deppe and Foerster (2014).

The second category is *omitted-variables*. Here, omitted-variables can be seen as a divergence between experimental setup and observational data regarding potential comparisons when analysing individuals with different age at retirement. To be precise, within an experiment, treatment and control group diverge in only one aspect; here that would be age at retirement. Within administrative data individuals might also differ not only in age at retirement, but in determinants regarding health, wealth or social background. If this is true, a simple comparison of mortality with respect to retirement age would be misleading as those determinants are correlated with mortality. Therefore, one has to clarify if a potential statistical effect is the result of differences of characteristics of analysed groups or attributed to different age at retirement.

Figure 1.1: Age at Death and Year of Birth

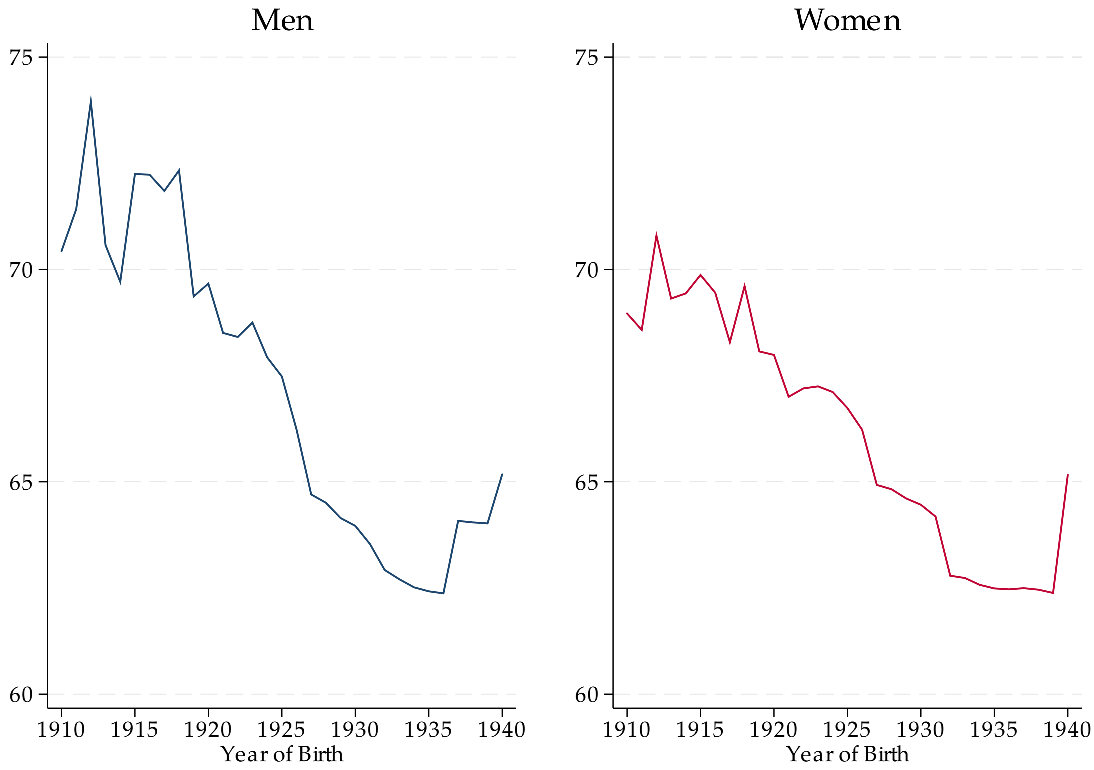


Notes: Average age at death by year of birth from 1910-1940. Data: FDZ-RV – SUFRTWF04-13; own calculations.

Figure 1.1 displays the distribution of the average age at death by year of birth. Within the data set the trend of age at death is decreasing for later birth cohorts. This is in contrast to average life expectancy where individuals tend to be older for later birth cohorts. This result is based on the fact that the draw of the sample is built upon the year of cessation of pension payment due to death. This is also true for pensions in payment, the other data source. Therefore, individuals from earlier birth cohorts are systematically older than individuals from later cohorts. Thus the method of sampling does not allow for the equal probability of ageing between birth cohorts.

Remark 1. *Within sample data, early birth cohorts die on average at older ages than individuals from later birth cohorts. This is in contrast to normal age trends in Germany.*

Figure 1.2: Age at Retirement and Year of Birth – 2012



Notes: Average age at entry into retirement by year of birth between 1910-1940. FDZ-RV – SUFRTBNRTWF12; own calculations.

If the distribution of age at retirement is identical over birth cohorts, a diverging age structure for birth cohorts does not per se have to be a source of bias. But, Figure 1.2 shows that age at retirement for pensions is decreasing for later birth cohorts. As Deppe and Foerster describe, there was a far-ranging introduction of early retirement options within the German Pension Fund during the analysed time. This introduction offered the possibility to retire at earlier ages for later birth cohorts[15].

Remark 2. *Within data, the trend of average age at retirement is decreasing for later birth cohorts.*

15. Nowadays, some of the early old-age retirement options are closed and pension eligibility age has increased. This explains to some extent the rise of the graph at the end of the scale.

Within data, individuals from earlier birth cohorts die systematically at older ages and have, on average, a higher age at retirement; analogously, individuals of later birth cohorts tend to retire at earlier ages and die on average at lower ages. When estimating the effect of retirement age on mortality without further adjustments there would be a systematic spurious relationship implying that higher ages of retirement increase the age at death or lowers mortality. A priori, it is unclear if the heterogeneity of mortality over birth cohorts with respect to age at retirement is the result of sample selection or can be attributed to age at retirement.[16] To face this source of bias one has to account for systematic differences of age at retirement over birth cohorts. This can be achieved by controlling the year of birth within the regression framework. Doing so, one can control for legal differences which can influence entry into retirement.

Even when controlling for birth year, omitted-variables can still bias the influence of age at retirement on mortality. Here, one source of confounding the influence of age at retirement on mortality is health. That means, that individuals with poor health condition tend to retire at earlier ages. This is also known as the healthy-worker-effect.[17] Besides health, other determinants like economic or social factors can be also potential unobserved components which influence the effect of age at retirement on mortality within the same age cohort. Ideally, omitted-variables bias is solved by finding a variable which extracts the part of age at retirement which is unrelated to those unobserved components.[18]

In summary, sample selection and omitted-variables tend to affect the impact of age at retirement on mortality within the given data set. Both biases go in the same direction, i.e. implying that later retirement is associated with better health. Thus, a convincing analysis identifying the influence of age at retirement on mortality should account for both biases.

Analysis of Previous Results for Germany

In this section, literature dealing with the relationship of age at retirement and mortality in Germany is analysed in detail. Similar methods used by the authors are estimated with the given data set of the German Pension Fund. While reported studies capture different retirement schemes, the focus in this article lies upon old-age pensioners only. As section 1.3 implies, aggregating individuals over different birth cohorts while distribution of age at retirement is not constant may lead to mis-

16. As different birth cohorts face different probability of ageing (due to construction of the data) and distribution of age at retirement is not equal over birth cohorts (due to administrative changes) the origin for the positive effect of higher age at retirement on mortality is unclear.

17. As individuals with invalidity pension are excluded one controls indirectly for health. Nevertheless, health differences may also arise between old-age pensioners.

18. The identification strategy to circumvent omitted-variables bias is presented in section 1.4.

leading conclusions. With regard to omitted-variables bias, methods and data are evaluated by the possibility of controlling for confounding variables. Since this paper focuses on the influence of age at retirement on mortality, one has to control for both types of biases. But, since previous studies deviate on the research question, omitted-variables bias can be of minor importance in descriptive analysis of mortality differences with regard to retirement age. In contrast, sample selection affects results irrespectively of the underlying research question. As presented, studies in Germany do not or only indirectly control for birth cohort heterogeneity. Therefore, this section tests the sensitivity of the results presented in section 1.2 when birth cohort heterogeneity is accounted for.

Giesecke (2015) identifies mortality differences by analysing time in retirement across ages of retirement. Giesecke focuses solely on cessation of pension due to death. Therefore it is possible to generate time in retirement.[19] Using descriptive analysis and regression models using cessation of pension payment between the years 2006 and 2008 Giesecke concludes that men retiring at the age of 63 receive pensions for longer periods than individuals retiring at lower ages. Giesecke uses data, like this analysis, from the German Pension Fund. But using only deceased pensioners when analysing mortality differences with regard to age at retirement is misleading, since pensioners who are not dead may have a large impact on estimation results. Imagine that a potential large fraction of pensioners retired before age of 63 survived the period of observation of Giesecke's analysis. This would imply that the main result of the author, i.e. men retiring at the age of 63 receive pensions for more periods than individuals retiring at lower ages is just the consequence of sampling solely deceased pensioners. Therefore the choice of data by Giesecke is problematic. Using only deceased pensioners creates sample selection which goes beyond the selection effect of using pensioners of different birth cohorts at once without controlling for birth cohort's heterogeneity. The way Giesecke analyses mortality by different ages of retirement is not reasonable as using only deceased pensioners is only valid if there is no connection between age at retirement and mortality at all.

Interestingly, Giesecke controls in a second step of his analysis for birth cohorts within regression analysis. By doing so, the remaining life expectancy is decreasing with higher ages of retirement. Giesecke does not discuss sampling bias and assigns the importance of birth cohorts to retirement rules and social security incentives.

Due to data problems, concerns dealing with redistribution in a pay-as-you-go pension system, as Giesecke claims, cannot be affirmed. Therefore, the results were not re-estimated.[20]

19. Whereas the time span of time in retirement for deceased pensioners is fully known, the actual time span of pensioners alive is unknown.

20. Table 1.9 estimates the influence of age at retirement on mortality via OLS, similar to Giesecke, but incorporates both, deceased pensioners and pensioners alive. Results show no clear tendency of

Kühntopf and Tivig use period life tables separating by age at retirement and sex to estimate the influence of retirement age on life expectancy at the age of 65. Moreover, within their descriptive analysis they control for creditable periods of disease and separate their analysis of age at retirement and life expectancy by income quintiles. By doing so, they control indirectly for health and income differences between the groups of different ages of retirement. But, those proxies used for health and income are in themselves determined by the entry in retirement. Therefore, selection regarding health and income may still be present.[21] Results of the study of Kühntopf and Tivig (2012) indicate that later retirement is associated with an increase in remaining life expectancy for men. For women, Kühntopf and Tivig find no overall differences with regards to life expectancy of old-age female pensioners. Kühntopf and Tivig use data of pension stock and cessation of pension payment between 2003 and 2005. As there are no adjustments regarding birth cohort heterogeneity, the sampling design of the data may bias the achieved results. From a technical side it is not clear if invalidity pensions are to a minor extent part of the analysis of old-age pensioners. This would explain the somewhat lower life expectancy of individuals retiring at age 65 in comparison to individuals retiring at 63 or 64 in their article.

Figure 1.3 plots mortality differences by age at retirement while accounting for birth cohorts heterogeneity. In comparison to remaining life expectancy as in the analysis of Kühntopf and Tivig, I used a dummy variable which indicates whether the respective individual survives the age of 75 or not. Birth cohorts are analysed individually. By doing so, one circumvents the problem of non-equal distribution of age at retirement and mortality differences over birth cohorts. The share of individuals surviving the age of 75 is plotted for different ages of retirement from 60 to 68 for birth cohorts 1930, 1932, 1935 and 1937.[22] Analysis is separated by sex.[23] Due to data properties probability of ageing is decreasing for later birth cohorts. Therefore the share of individuals living past the age of 75 is decreasing for later birth cohorts, too. Figure 1.3 highlights three points. First, differences in surviving the age of 75 by different ages of retirement are small. Those differences are much smaller in comparison to the results of Kühntopf and Tivig.[24] Second, there are no differences with respect to the relationship between age at retirement and surviving the age of 75 between women and men. And third, there is no clear tendency that higher retirement age is associated with higher probability of surviving the age of 75. Differences of mortality regarding age at retirement, implied by Kühntopf and Tivig, are not sen-

age at retirement affecting mortality. A discussion can be found in section 1.5.

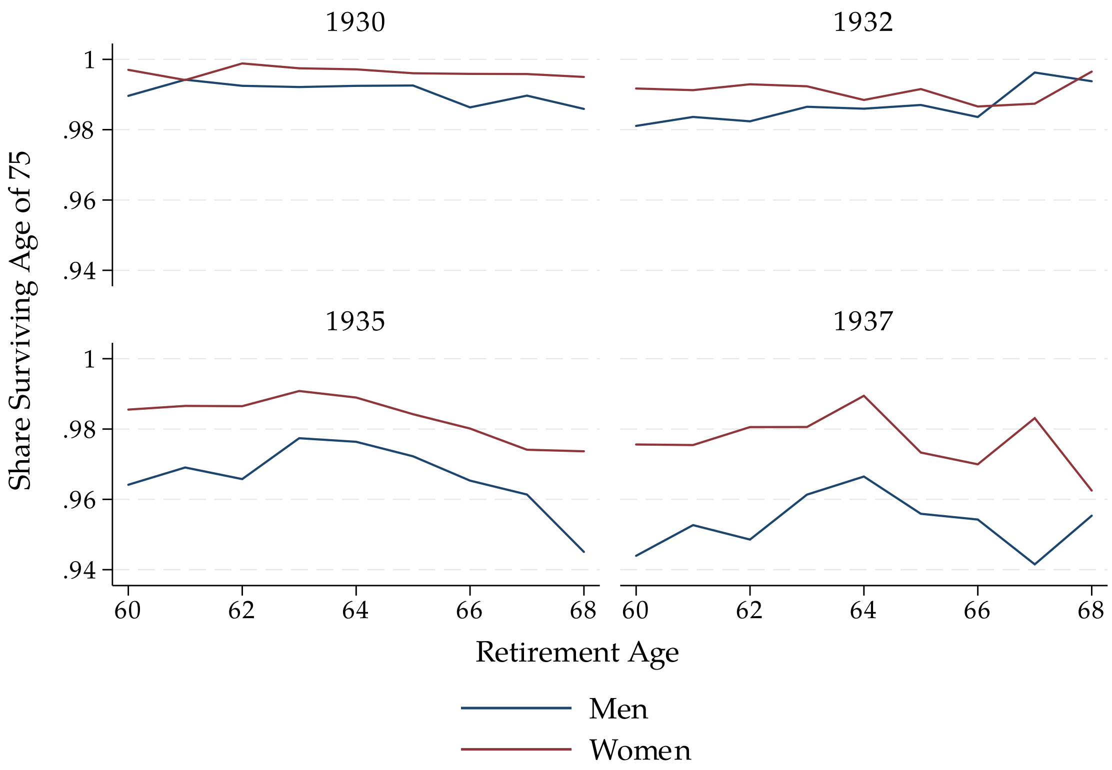
21. If an individual delays retirement the period of aggregating pension income increases.

22. Retirement age is rounded to full integer.

23. Descriptive analysis shows that mortality is higher for men than for women. There are only some divergences at the boundaries of analysed birth cohorts.

24. Resulst of Kühntopf and Tivig show differences up to several years between ages at retirement between 60 and 65.

Figure 1.3: Survival at Age 75 by Age at Retirement



Notes: Share of individuals surviving the age of 75 for different birth cohorts. Data: FDZ-RV – SUFRTWF04-13; own calculations. Number of individuals (n): $n_{1930} = 163,450$; $n_{1932} = 180,318$; $n_{1935} = 192,934$; $n_{1937} = 141,275$. Results for individuals retiring after the age of 65 is based on few observations. This may explain their volatile process.

sitive if one controls for birth cohorts individually. Therefore, results indicate that sample selection bias is relevant when comparing age at retirement without controlling for birth cohort heterogeneity.

Brockmann et al. analyse mortality differences with regard to different ages at retirement by estimating their model via Cox proportional-hazards. Time in retirement is used as survival time. The death of the respective pensioner or the end of study in case of surviving the period of analysis marks the end of survival. This strategy is based on a control strategy similar to OLS, but offers the possibility to control for the right-censored data. Brockmann et al. analyse data of individuals who retired between 1990 and 2004. This means year of retirement does not vary as much as in the data set analysed here. Therefore potential sample selection due to birth cohort heterogeneity might be of minor relevance.[25] Since Brockmann et al. use time in retirement as dependent variable, individuals with earlier retirement entries have by construction larger periods of time in retirement than groups with increasing retirement age. Due to this fact[26], conclusions regarding mortality risk differences are misleading when hazard ratios diverge by construction.

Brockmann et al. find lower mortality risk for women retiring at lower ages and no differences of mortality for men when using the Cox proportional-hazards estimation method.[27] Table 1.2 shows hazard ratios by using Cox proportional hazards estimation strategy. The model controls for socio-cultural differences.

Table 1.2 presents four different models with respect to the dependent variable. The dependent variables sum up the years since the age of 65[28] until the ages of 70, 75, 80, and 85 for the respective individual. For pensioners not surviving the respective age of the dependent variable, the difference between age at dead and 65 is computed. By using different ages of survival as a dependent variable, one analyses potential differences of age at retirement on mortality over the life span.[29]

Hazard ratios for age at retirement are all near to one. Whereas the first two models indicate a statistically significant effect of age at retirement on mortality[30], the last two models show no statistically significant differences of mortality for different ages of retirement. The magnitude of the hazard ratios is close to one, implying that there

25. Moreover Brockmann et al. control for year of retirement and therefore control indirectly for birth cohorts.

26. Individuals with same age at death, but varying age at retirement differ in the survival time after retirement.

27. In contrast, when using Kaplan-Meier estimates results of Brockmann et al. imply that later retirement is associated with higher probability of survival. Brockmann et al. explain those differences with the inclusion of control variables.

28. Only individuals are selected whose age at death is beyond the latest retirement age. Otherwise there would be the chance of individuals dying before the last individual retires.

29. For a detailed overview of controls and estimation procedures, see section 1.4.

30. A hazard ratio of age at retirement significantly lower than one indicates that a higher retirement age is associated with a lower mortality risk.

Table 1.2: Cox Proportional-Hazards

Dependent Variable: duration from 65 to 70,75,80 and 85

	Cox Proportional-Hazards			
	Duration until			
	70	**75**	**80**	**85**
retirement age	0.999	0.998	1.000	0.994
	(0.000)	(0.000)	(0.001)	(0.007)
gbjavs	1.001	1.004	1.012	1.014
	(0.000)	(0.000)	(0.001)	(0.005)
family status				
re-,married	0.997	0.991	0.979	0.980
	(0.000)	(0.000)	(0.002)	(0.023)
sex				
female	0.994	0.982	0.964	0.951
	(0.000)	(0.001)	(0.003)	(0.025)
Number of children				
1	0.999	0.999	0.999	0.981
	(0.000)	(0.001)	(0.003)	(0.029)
2	0.999	0.998	0.996	1.031
	(0.000)	(0.001)	(0.003)	(0.036)
3	0.999	0.999	1.001	0.997
	(0.000)	(0.001)	(0.004)	(0.038)
4	1.001	1.003	1.007	1.049
	(0.000)	(0.001)	(0.005)	(0.059)
5 or more	1.001	1.006	1.012	0.994
	(0.001)	(0.001)	(0.005)	(0.051)
citizenship				
foreign	1.000	0.999	0.998	0.998
	(0.000)	(0.001)	(0.003)	(0.024)
foreign pension time				
GDR	1.000	0.998	0.998	0.948
	(0.000)	(0.001)	(0.005)	(0.053)
other	1.000	0.999	1.006	0.979
	(0.000)	(0.001)	(0.003)	(0.033)
Observations	1,271,437	639,708	91,753	1,324

Notes: The model is estimated using robust standard errors. Standard errors are displayed in parentheses. Estimates are rounded to three digits after the comma. The table reports hazard ratios. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations. Analysis includes individuals who survived at least until the age of 65 and whose type of retirement is not pension for invalids. Age at retirement is limited to ages equal or under 65 years. In addition, first type of retirement equals current retirement status.

is no economical relevant divergence of mortality for different ages of retirement for all four models.[31]

Without using an identification strategy for the effect of age at retirement on mortality, omitted-variables bias may be still present. By using a control strategy, like Cox proportional-hazards, one cannot control with certainty for all unobserved components influencing the effect of age at retirement on mortality. In comparison to Brockmann et al., the inclusion of birth cohort as a control variable leads to a different conclusion of the effect of age at retirement on mortality, at least for women. The results for men are similar although the approach of Brockmann et al. are based on non-equal hazard ratios by construction.

Rohwer uses survival graphs to display mortality differences with regard to age at retirement. Since Rohwer uses a long time period for his analysis[32], potential bias as noted in section 1.3 may be relevant. The author finds that men retiring at later ages die on average at higher ages. Thus, they have a lower mortality risk. Figure 1.4 shows the re-estimated survival functions at the most frequent entry ages into retirement for birth cohort 1932.[33]

Results using Kaplan-Meier estimates are mixed. For some birth cohorts (Figure 1.8 and 1.9) descriptive analysis implies a positive relationship of age at retirement and survival. For other birth cohorts (Figure 1.4, 1.10, and 1.11) the differences between the most frequent ages of retirement are low or even non-existent.[34]

After analysis of the four studies one can conclude that previous results for Germany do not incorporate changes of the institutional settings of the pension system in Germany and do not or only indirectly account for the difference of probability of survival over birth cohorts. By controlling for birth cohorts, it shows that a large fraction of mortality differences with respect to age at retirement can be accounted for. Section 1.4 establishes an identification strategy to verify if remaining differences can be attributed to differences in age at retirement. As identification requires specific knowledge over the legal framework of retirement options the next subsection summarises necessary information and gives a descriptive overview over types of old-age retirement in Germany.

31. Due to large sample size, especially for the first two models, it is not surprising that estimation results are statistically significant on common levels of significance.

32. Retirement entry from year 1975 until 2001.

33. Results for other birth cohorts can be found in the appendix.

34. Although, figures show that differences of age at retirement are more relevant for older birth cohorts, this conclusion cannot be verified. This is due to sampling. That means that distribution of birth cohorts with regard to mortality is not equal nor distribution of retirement age over birth cohorts. Therefore general conclusions of birth cohort differences are misleading.

Figure 1.4: Kaplan Meier Survival Estimates by Age at Retirement

Notes: Kaplan Meier Estimates of survival after 65. Contains male individuals retiring at the age of 60, 63 and 65. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations.

Old-Age Retirement in Germany

Type of Old-Age Pension

In Germany, old-age pensioners can choose between different paths into retirement. The eligibility age varies between the different types of old-age retirement. To take advantage of early retirement, prerequisites have to be fulfilled. The following section provides information on the various types of old-age pensions. This information is only valid for the underlying data set as prerequisites with regard to pension eligibility change over time.[35]

Individuals can enter regular old-age pension, with respect to the analysed birth cohorts, at the age of 65 (§ 235 SGB VI, including previous versions). There is no possibility of earlier entry. Therefore, this type of old-age pension exhibits the latest pension eligibility age within the German Statutory Pension Insurance. Normally[36], the qualifying period is five years for applying for this type of pension. The qualifying period[37] can consist of contribution periods or credited substitute periods. Since conditions are rather low compared to other pensions, a majority of individuals (44,70% pensioners within data of reporting year 2012) receive this type of old-age pension.

Entry at retirement for longtime insured persons is normally[38] possible at the age of 63 (§ 236 SGB VI, including previous versions). Individuals have at least 35 years of qualifying periods. As the name of the pension suggests, people with a long earnings history can apply for this type of pension. 8,41% of analysed individuals in 2012 apply for this type of pension.

Pension for women is generally possible at the age of 60 (§ 237a SGB VI, including previous versions). As the name suggest for this type of pension only women can apply. In addition, female pensioners need 10 years of compulsory contribution periods after the age of 40 and in total 15 years of qualifying periods. Thus, for this type of pension women with persistent earnings histories can apply. 21.74% of old-age pensioners in the data set of 2012 chose this type of old-age pension.

Individuals with pension due to unemployment or part-time work can enter retirement at the age of 60 years earliest (§ 237 SGB VI, including previous versions). One possibility is to be unemployed for 52 weeks in the last one and a half years before retirement. Another possibility is to apply for part-time work for at least 24 months. In addition, both possibilities require 8 years of compulsory contribution

35. Some of the presented types are no longer available to potential pensioners with later birth cohorts.

36. If the respective individual had a pension due to reduced earning capacity or a child-raising pension qualifying period is seen as fulfilled.

37. Qualifying period indicates the required insurance period.

38. For a certain group of people entry into retirement was possible at the age of 62. But, this pertains only to a small fraction of people with protection of legitimate expectation.

periods in the last 10 years and 15 years of qualifying periods. Since the law for applying for part-time work was introduced in 1996, the majority of individuals should use the first path via unemployment to enter retirement in the analysed sample.[39] The share of this type of retirement is 14.95%.

The earliest eligibility age for individuals who enter retirement via a pension for disabled persons is 60 years (§ 236a SGB VI, including previous versions). Individuals have to fulfil 35 years of qualifying periods and have to be accepted as severely disabled, unfit for work or invalid. Due to special health related requirements of applying for this type of pension, individuals with pension for disabled persons are mostly excluded from the analysis. They represent 10.21% of old-age pensioners in 2012 data.

Table 1.3: Distribution of Age Retirement by Type of Pension – 2012

	Age at Retirement in %						
	60	**61**	**62**	**63**	**64**	**65**	**66+**
Total							
♂	24.22	6.79	6.18	17.02	4.82	38.89	2.08
♀	33.61	4.94	3.83	4.81	1.92	48.02	2.87
Regular old-age pension							
♂						94.71	5.29
♀						94.25	5.75
Pension for longtime insured persons							
♂				71.52	19.23	9.16	0.09
♀				67.87	17.02	14.97	0.24
Pension for women							
♀	70.83	9.95	7.89	5.93	3.18	2.20	0.02
Pension because of unemployment or part-time work for employees over 55							
♂	54.46	15.02	14.19	10.89	3.74	1.71	
♀	80.88	6.90	5.12	3.32	1.71	2.07	
Pension for disabled persons							
♂	51.27	14.88	12.48	15.93	4.28	1.16	0.00
♀	59.65	13.26	9.28	12.84	3.58	1.38	0.00

Notes: Sample: 1,169,740 observations (45% men). Data: FDZ-RV – SUFRTBNRTWF12; own calculations. Rounded off to the second decimal place.

Table 1.3 shows the distribution of age at retirement by type of old-age pension. The first two rows present the distribution of age at retirement for all old-age pensions, separated for women (♀) and men (♂). The table presents only individuals for whom first and current retirement is the same, that have no non-logical values, and can be assigned to one type of old-age pension. Retirement age is rounded to full year. The distribution for men is concentrated on three retirement years, 60, 63 and 65. Women retired primarily within the analysed period at the age of 60 and 65. Those peaks are directly attributed to pension eligibility age, i.e. a large fraction of

39. There is no possibility to distinguish between the two types.

people tend to retire when they are allowed to do so.[40] More than 94% of regular old age pensioners retired in the first year of being eligible. For individuals with pension for longtime insured, the majority retires at the age of 63. Noteworthy is that the share of individuals retiring within the first year is smaller compared to regular old-age pensions. This may be the result of eligibility age differences, which are up to several years between both types of pension. Another explanation refers to immanent eligibility differences within the pension for longtime insured persons. This means that some individuals fulfil prerequisites for entering into pension for longtime insured persons at ages later than 63. A similar pattern of retiring is also valid for pension for women and due to unemployment or part-time work. The pattern of retirement age for individuals with pension for disabled persons is more equally distributed than for other types of old-age pension. This may be due to health-related conditions which have to be fulfilled when the individual enters retirement.

Distributional Aspects of Retirement

As pensions from the German Pension Fund are predominantly financed by a pay-as-you-go scheme, subgroup differences with regard to variation of time in retirement have a redistributional relevance. Disproportional differences of mortality, caused by different age at retirement, may have an unexpected influence of redistribution within the pension fund.

Table 1.4: Distribution of Survival by Type of Old-Age Pension

	Survival at Age							
	70		75		80		85	
	1942	1935	1937	1930	1932	1925	1927	1920
Regular old-age pension								
♂	0.983	0.996	0.955	0.992	0.920	0.984	0.830	0.979
♀	0.989	0.998	0.974	0.996	0.949	0.989	0.897	0.978
Pension for longtime insured persons								
♂	0.986	0.997	0.964	0.992	0.923	-	0.822	-
♀	-	0.999	0.980	0.997	0.950	-	0.879	-
Pension for women								
♀	0.989	0.998	0.977	0.997	0.950	-	0.892	
Pension because of unemployment or part-time work for employees over 55								
♂	0.974	0.995	0.949	0.992	0.900	-	0.790	-
♀	0.990	0.998	0.975	0.996	0.946	-	-	-
Pension for disabled persons								
♂	0.956	0.995	0.932	0.989	0.892	-	0.782	-
♀	0.978	0.994	0.958	0.993	0.926	-	-	-

Notes: Sample: observations. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations. Rounded off to the third decimal place. Items with - do not have enough observations.

40. For a detailed view of entry into retirement by eligibility age see Table 1.7.

Table 1.4 lists the survival at different ages separated by type of old-age pension.[41] For each age at survival two relevant birth cohorts are chosen. Table 1.4 shows that the share of survival is decreasing by age at survival for all types of old-age pension. As already noted in section 1.3, due to sampling of the data source earlier birth cohorts face lower mortality rate for each age at survival. Moreover, as commonly assumed, women's share of survival is higher for almost each category. Interestingly, the share of survival differs in terms of type of old-age pension. For example male longtime insured pensioners face higher survival at age of 80 than other types of old-age pension. This is generally also true for other ages of survival. For women one finds a similar pattern implying that female pensioners having a pension for women or being longtime insured face higher rates of survival at different ages. This result can be seen as a sign for subgroup heterogeneity of different types of old-age retirement with regard to mortality. As types of old-age pension differ with respect to distribution of age at retirement this subgroup heterogeneity may bias the influence of retirement age on mortality. This bias can be seen as the classical form of omitted-variables bias.

Table 1.5: Retirement-Relevant Information – 2012

		byvl	psegpt	auaz	ajaz
retirement age					
60	♂	37.81	46.84	1.56	6.67
	♀	32.01	30.07	1.18	7.96
61	♂	39.70	47.47	1.28	3.35
	♀	31.69	29.38	0.83	4.11
62	♂	40.60	49.16	1.21	3.00
	♀	31.30	29.59	0.80	3.92
63	♂	41.10	48.73	0.93	2.65
	♀	29.66	27.09	0.66	5.87
64	♂	40.77	49.45	0.95	2.81
	♀	30.40	28.62	0.69	4.35
65	♂	27.47	27.69	0.69	3.05
	♀	14.00	12.07	0.51	2.98
66+	♂	17.33	12.44	0.31	1.27
	♀	9.90	8.80	0.20	0.73

Notes: byvl – contribution period full-valued. psegpt – sum of personal earnings points. auaz – creditable periods due to illness. ajaz – creditable periods due to unemployment. Data: FDZ-RV – SUFRTBNRTWF12; own calculations. Rounded off to the second decimal place.

As prerequisites for applying to a specific type of old-age pension differ, Table 1.5 lists the contribution period (byvl) in years[42], sum of personal earnings points[43] (psegpt) and creditable periods due to illness (auaz) and due to unemployment (ajaz) in months separated by age at retirement and sex.[44] When analysing Table 1.5, dif-

41. If one multiplies the decimal value by 100, one will get the percentage of pensioners surviving the respective age.

42. byvl covers the sum of contribution periods full valued including periods of reduced contribution.

43. psegpt is the sum of earning points reflecting the individual working life including allowances and deductions and multiplied by the access factor in pension calculation.

44. As byvl, auaz and ajaz are top-coded from above the amount can be biased. The extent should

ferences of the distribution of byvl with respect to age at retirement and sex are predominant. While for men the contribution period has a bell-shape, for women it is a decreasing function with higher age at retirement. This result is also true for the sum of personal income points. Values of auaz are mostly decreasing with age at retirement for both sexes, but the time span of absence from work due to illness is larger for men. In comparison, values of ajaz are higher for women up to age at retirement of 65 (not included).

As presented, variables can be seen as proxies for duration of employment, income, time of unemployment, and time of sick leave. Thus, they are potentially health relevant factors in the long run. Therefore, differences of those proxies with regard to age at retirement can confound the identification of age at retirement on mortality.

Table 1.6 shows survival at age of 70 and 80 using proxies of individual years of contribution and pension income. Individuals are separated if their individual amount is below or above the median value. By doing so, distributional effects with regard survival can be identified. As individuals' insurance period varies, the ratio of both measures, psegpt/byvl, is constructed to highlight the influence of individual's income position.

Table 1.6: Share of Survival by byvl and psegpt – 2012

		byvl		psegpt		psegpt/byvl	
		Below Mdn	**Above Mdn**	**Below Mdn**	**Above Mdn**	**Below Mdn**	**Above Mdn**
survived 70	♂	0.994	0.995	0.993	0.997	0.992	0.996
	♀	0.997	0.997	0.998	0.997	0.997	0.998
survived 80	♂	0.817	0.834	0.875	0.888	0.818	0.833
	♀	0.939	0.864	0.962	0.916	0.921	0.882

Notes: Share of individuals surviving the respective age is displayed. Median - Mdn. Quantiles are computed for each sex; old-age pensioners only. Data: FDZ-RV – SUFRTBNRTWF12; own calculations. Rounded off to the third decimal place.

Analysing the survival at age 70, differences between individuals below and above the median of the respective variables are low. This is especially true for women. For men, survival rates are higher for individuals above the median of psegpt and psegpt/byvl. This can be interpreted that higher relative income has a positive effect on survival at age 70. Taking a look on survival at age of 80, differences between individuals below and above the median are larger. Interestingly, survival rates are higher for men above the median when comparing contribution periods while for women contribution periods above the median lead to lower survival. For men relative income position has a positive effect on survival, while for women this effect is

be relatively small. For byvl values are top-coded if the respective individual have more than 48 years of contribution periods full-valued. For auaz values are top-coded after 60 months and for ajaz from 120 months.

negative.[45]

This section shows that individuals' mortality varies across types of old-age pension with different distribution of age at retirement. Moreover, variables which are important for applying the specific type of old-age pension have an influence on survival at different ages. Therefore, an identification strategy is necessary to measure the actual influence of age at retirement on mortality. This is presented in the following section.

1.4 Strategy

Identification

This section focuses on retirement age and its influence on mortality. The decisions to retire are varied and depend on personal constitution, institutional aspects, and social and economical conditions. All parts of this multidimensional decision may be relevant when someone is willing to retire and are weighted by individual importance. Therefore, the point of retirement, i.e. age at retirement, is the result of an individual's own decision. Regarding the influence of age at retirement on mortality, the age at retirement covers the point in time where life-changing habits occur. Those changes may concern activities, socialisation, status, time budget etc. In summary, by comparing different ages of retirement, one identifies the influence of a shift of age at retirement on mortality. Although one controls for heterogeneity of birth cohorts, one is confronted with omitted-variables bias when using non-experimental data. The problem is illustrated in Figure 1.5.

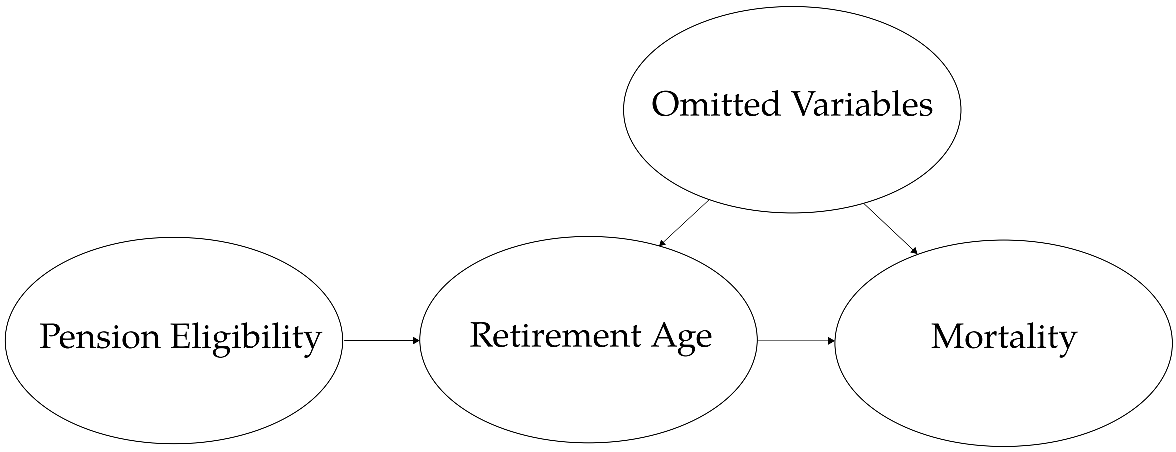
Figure 1.5 visualises the difficulty of identifying the actual influence of retirement age. As one is interested in finding the influence of age at retirement on mortality, highlighted by the arrow from *retirement age* to *mortality*, one is confronted with *omitted variables*. Those omitted variables are the result of the non-experimental data source. That means, individuals differ by more than just age at retirement when analysing mortality differences. One can think of overall health, as individuals with better health may tend to retire later and face lower mortality risk.[46] Another source of omitted variables may be income, as income affects both the point of retirement and mortality. Therefore, omitted variables affect age at retirement as well as mortality. This is illustrated by the two arrows going to retirement age and mortality,

45. As results are based on individual analyses, household data would offer a better view on income during retirement. Moreover, pension income from the German Pension Fund is just one possible source of income during retirement.

46. Analogously, if early retired individuals show systematically poor health outcomes, which is not the result of the difference between the age at retirement, estimated results would be a proxy for health-related components and would not display the influence of age at retirement on mortality in itself.

respectively. It is important to note that only those variables are relevant which affect both variables, retirement age and mortality.

Figure 1.5: Graphical Illustration of the Empirical Model



Notes: Pension eligibility is not related to the unobserved component and affects mortality only through the treatment variable, i.e. age at retirement.

In a perfect experiment, avoiding omitted-variables bias, one would assign individuals randomly to retire at different ages and compare their survival after several years. If individuals are willing to follow this assignment concordantly, potential differences with respect to mortality are only the result of different ages of retirement. Since both, treatment and control group, exhibit similar properties, i.e. do not differ in health or other important variables[47], identification of the influence of age at retirement on mortality is possible. Unfortunately, there is no randomisation within ages of retirement per se. Therefore, omitted variables are always a source of bias and may influence the results. To overcome this bias, one can use the second-best alternative and establish a quasi-experiment design by using different pension eligibility ages to instrument the actual age at retirement.

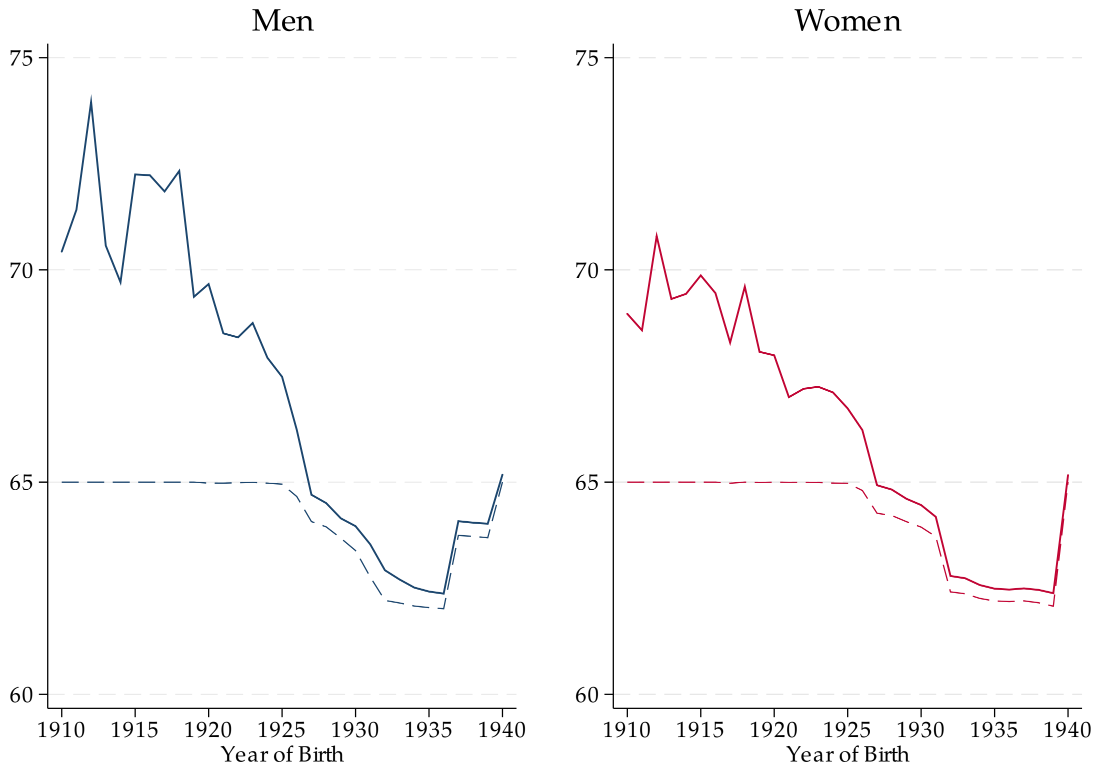
For a valid instrumental variables (IV) approach necessary assumptions have to be fulfilled. Here, the age at retirement should be sufficiently correlated with pension eligibility age, also called existence of a first-stage. Analysing Table 1.7, one can see that a major part of individuals retire when they are institutionally able to do so.[48] In addition, Figure 1.6 shows that average age at retirement is decreasing along with the introduction of early retirement options.

Secondly, the instrument works only through the channel of the endogenous variable, i.e. age of retirement. This means that pension eligibility age has no direct effect on mortality, but indirectly through retirement age. This assumption is known as

47. Confounding variables would otherwise bias our results, i.e. overestimate or underestimate the actual influence.

48. In addition, the older the individuals the higher the fraction of entry into retirement at date of eligibility.

Figure 1.6: Age at Retirement and Year of Birth and Pension Eligibility – 2012



Notes: Average age at entry into retirement by year of birth between 1910-1940. FDZ-RV – SUFRTBNRTWF12; own calculations.

the exclusion restriction and not testable by construction. The possibilities to retire at earlier ages for old-age pensioners introduced in Germany during the 1950s until 1970s were mainly the result of labour market considerations to provide an incentive for the demand for labour of younger individuals. With regard to the requirements of early old-age pensions, the possibility to retire is mainly the result of contribution periods within the retirement system. Therefore, access to pension eligibility does not favour potential pensioners with poor health. Moreover, being eligible does not affect mortality. It can only affect mortality if the individual decides to retire.

The idea of an instrument within the setup of age at retirement and mortality is simple. If pension eligibility is randomly assigned, one identifies those individuals who change treatment status because of the assignment of earlier or later pension eligibility. This means one shows the effect on those individuals who retire at a different age due to individual pension eligibility status. In Figure 1.5, it is visible that pension eligibility works only through age at retirement and has no direct effect on mortality. If this is true, no omitted variables affect the assignment of pension eligibility. Within the ideal standard, there are no arrows from omitted variables to the instrument, i.e. age at pension eligibility. Therefore, the effect of age at retirement

Table 1.7: Retirement Entry in Percent by Age at Eligibility – 2012

		Age at Retirement						
		60	**61**	**62**	**63**	**64**	**65**	**66+**
	60	77.56	9.33	7.11	4.00	1.46	0.53	0.01
Eligibility	**63**				79.25	15.19	5.51	0.05
	65						94.21	5.79

Notes: $n = 773,006$, without pension for disabled persons. Data: FDZ-RV – SUFRTBNRTWF12; own calculations. Year of pension eligibility within chosen type of old-age pension, no earlier retirement entry with deductions possible.

on mortality is identified by instrumenting age at retirement via pension eligibility. Thus, one overcomes omitted variables by using shifts of the age at retirement which are not the result of a change in habits or needs of the affected individual, but rather an exogenous event like age at pension eligibility.

The administrative data has the advantage of detailed information concerning the time and age at which the respective individual enters retirement. In combination with the type of pension, one can use the heterogeneity of eligibility into retirement to construct a quasi-experiment. For that reason, eligibility ages are constructed using information provided in the data set in combination with Federal Law Gazettes. The critical assumption of a comparison of treatment and control group is the assignment into one of those two groups. If the assignment is randomly chosen, this method would be valid to measure the actual effect of age at retirement on mortality. Although pension eligibility is not random per se, one can identify the true effect if one controls for those factors that influence the assignment into the respective eligibility status. Formally, this would imply that $u \perp \textit{retirement age}|X_2$, where X_2 describes those variables influencing the assignment into eligibility status. This is known as the independence assumption. Individuals' eligibility status depends mainly on age at birth and type of old-age pension. The type of old-age pension depends on personal properties like sex and different aspects of employment history for which proxies are available in the data; see section 1.3 for details.

The potential drawback is that those variables affecting the pension eligibility status, i.e. contribution periods' full value or proxies for health and employment might also be outcome variables of the endogenous age at retirement. If this is true, using those variables can generate a bad control problem; for details see Angrist and Pischke (2008). Therefore, one is confronted with the trade-off to include variables for the sake of randomness while the actual inclusion can result in a different form of bias. Sensitivity of results concerning this problem is analysed in section 1.5. Moreover, the pension eligibility age of an individual represents the earliest entry into retirement within the chosen type of retirement. Technically, an earlier entry would be possible if the individual was able to choose another old-age type of retirement. But, this seems implausible since age limits between different types of old-age pensions are relatively high within the analysed period. Another concern is that individuals with poor health are earlier eligible to entering pension than healthier individuals. Since the focus lies on old-age pensions, invalidity pensions are not included. In addition, individuals with pensions for disabled persons are not included in the regression analysis either. Therefore, one can, to some extent, control for anticipatory behaviour. Furthermore, as already noted, laws of early old-age retirement options in Germany focus on participation, i.e. contribution periods rather than health issues.

As a result, identification is based on two means. First, one accounts for potentially omitted variables by using eligibility age as an instrument for actual retirement. Using retirement-relevant variables which determine the assignment into respective types of old-age retirement one controls for subgroup heterogeneity over different types of old-age pension. Second, the approach controls for birth cohort differences to account for the sample design of the underlying data set and changing ages of retirement over the analysed period. If assumptions are fulfilled, this strategy identifies potential differences of mortality which can be attributed to different ages of retirement.

Model & Estimation

To highlight potential differences over the life span after retirement, four different dummies of ages of survival (70, 75, 80 and 85) are regressed separately on age at retirement and other variables indicated by X. As each variable on the left-hand side is a dummy, a linear probability model is estimated.

$$Survived_{age} = \gamma \; RetirementAge + X'\beta + u \tag{1.1}$$

Baseline estimation is done via Ordinary Least Squares (OLS) using robust standard errors. Control variables consist of a constant and socio-demographic variables like family status, sex, number of children, citizenship, and foreign pension time.[49] To account for birth cohort heterogeneity with respect to age at retirement and survival, the model controls for the respective year of birth of the pensioner.

49. Family status controls whether the pensioner is re,-married or unwed during pension claim. Sex is a dummy variable indicating whether the pensioner is female or male. Number of children is a ordinal variable indicating whether the pensioner has zero, one, two, three, four, or five more children. The identification on number of children depends on two conditions. First, only children before 1st of January 1992 are recorded and second, only those children are recorded for whom the pensioner received benefits or periods of child raising within the pension insurance system. Citizenship is a dummy variable highlighting whether the pensioner has a German or different citizenship. Foreign pension time is a categorical variable indicating whether the pensioner has foreign pension time from the German Democratic Republic (GDR), other countries (other) or none (baseline category in the regression framework).

While sex is an important determinant for longtime health differences the influence of other variables, except for birth year[50], is a priori unclear. The OLS estimator is $\widehat{\gamma}_{OLS} = \frac{Cov(RetirementAge,\ Survived_{age})}{Var(RetirementAge)}$. While zero conditional mean assumption remains critical, $Cov(RetirementAge, u) = 0$, identification of γ, the coefficient of age at retirement, is done via instrumental variable approach using pension eligibility age to instrument actual retirement age. Estimation is executed via Two-Stages-Least-Squares (2SLS) using robust standard errors.[51] Since types of old-age retirement differ by requirements of eligibility vector X_2, a subset vector of X, includes proxies of prerequisites of eligibility status. To be precise, vector X_2 includes the contribution periods full-valued, personal income points and creditable periods due to illness and unemployment.[52] In addition, exogenous covariates include socio-demographic variables, too. The 2SLS estimator has the following form, $\widehat{\gamma}_{2SLS} = \frac{Cov(Surivived_{age},\ PensionEligibilityAge)}{Cov(RetirementAge,\ PensionEligibilityAge)}$.[53]

As the data set is a pooled cross section of six years between 2004 and 2013 individuals can potentially occur in the regression framework several times. Unfortunately, the personal identifier of pensioners is not fix over the years. Therefore sample size of regression outputs display the number of observations, since the actual number of individuals is unknown by construction.

The analysis focuses on specific birth cohorts. The selection of birth cohorts for the regression analysis is based on the idea that each chosen birth cohort faces a non-zero probability of surviving or not surviving the respective age of the dependent variable. Table 1.8 lists the relevant birth years for each age at survival.

Taking individuals surviving age 75 as an example: pensioners in the birth cohort 1930 include on the one hand individuals dying before the age of 75, i.e. dying at 74 years at reporting year 2004, and on the other hand this method includes pensioners surviving the age of 75 of subsequent reporting years 2006 until 2013, i.e. pensioners being alive and older than 75 and pensioners dying at ages before the age of 75. By

50. Due to construction of data, see section 1.3, birth year has an negative effect on survival.

51. As type of old-age pension is chosen by the individual standard errors are not clustered by type of old-age pension.

52. Available proxies could be unsatisfactory controls. Take for example the variable auaz, which contains the creditable periods due to illness or rehabilitation in the social security system. One can think of a proxy for health, but one has to keep in mind that requirements of those creditable periods change over time. Moreover, the variable is censored from above and is directly connected to the age at retirement. In this context that means, the longer you work, the longer you are eligible for such periods. This could mean that auaz can be in itself an outcome variable of age at retirement. This may cause problems when using such variables as control variables, e.g. a bad control problem. This problem is addressed in the sensitivity section. In summary, auaz may be an indicator for health, but does not cover all the aspects of health-influencing factors affecting the relationship of age at retirement on health.

53. Multiplying the expression by the empirical variance of the instrument, the ratio of the 2SLS estimator is the ratio of regression coefficients of the reduced form (regression of survived age on the instrument and controls) and first-stage regression of age at retirement on pension eligibility age, $RetirementAge = \beta_1 PensionEligibilityAge + X'\beta_2 + u_1$.

Table 1.8: Survival and Relevant Birth Cohorts

Dependent Variable	Relevant Birth Cohorts
survived age of 70	1935-1942
survived age of 75	1930-1937
survived age of 80	1925-1932
survived age of 85	1920-1927

Notes: The choice of birth cohorts depends on the assumption of non-zero probability of surviving or not-surviving the respective age for given reporting years 2004, 2006, 2008, 2010, 2012, and 2013.

construction, later birth cohorts face lower a probability of survival.[54][55]

The model analyses potential differences of age at retirement on mortality. If γ is significantly different from zero, it implies that a shift in the age at retirement has a mortality-relevant influence (positive or negative). In fact, one tests if $\gamma = 0$ and draws conclusions on mortality at different ages of survival.[56]

Due to the construction of the model and the fact that highest pension eligibility within the data is at the age of 65, only those individuals were analysed in the regression framework who survived at least the age of 65 years. The analysis recognises old-age pensioners only. Thus, individuals with invalidity pensions or pensions for disabled persons are excluded from the analysis. Moreover, analysed individuals have no possibility of earlier access to retirement with deductions.

1.5 Results

The following section presents and discusses the results of the estimation strategies of model 1.1. At first, results were presented for OLS and 2SLS using all types of old-age retirement at once. For 2SLS, regression results are shown with and without proxies for prerequisites of eligibility. Within sensitivity analysis, different types of early old-age retirement are analysed individually by comparing them to pensioners with regular old-age pension. Afterwards, pensions due to unemployment or part-time work are excluded and regression results are also separated by sex. Moreover, nearest neighbour matching is used to overcome the trade-off of using proxies of prerequisites to fulfil the assumption of randomness of the instrument and the potential emerging bad control problem.

Table 1.9: Overall Baseline Regression Results – OLS

Dependent variables: survived the age of 70, 75, 80 and 85

	OLS			
	survived 70	**survived 75**	**survived 80**	**survived 85**
retirement age	0.007	0.019	-0.016	0.333
	(0.003)	(0.007)	(0.035)	(0.579)
Socio-Demographic Variables				
birth year	-0.145	-0.428	-0.881	-1.401
	(0.003)	(0.006)	(0.023)	(0.118)
family status				
re-,married	0.353	0.724	1.197	0.572
	(0.016)	(0.034)	(0.095)	(0.560)
sex				
female	0.460	1.219	2.621	6.102
	(0.021)	(0.043)	(0.122)	(0.720)
number of children				
1	0.087	0.143	0.060	1.175
	(0.023)	(0.049)	(0.142)	(0.765)
2	0.142	0.235	0.600	0.854
	(0.022)	(0.045)	(0.131)	(0.769)
3	0.076	0.161	0.400	1.603
	(0.024)	(0.049)	(0.145)	(0.907)
4	-0.015	-0.077	-0.039	1.672
	(0.032)	(0.062)	(0.179)	(1.127)
5 or more	-0.202	-0.535	-0.582	-0.599
	(0.040)	(0.072)	(0.197)	(1.436)
citizenship				
foreign	0.099	0.221	0.619	3.070
	(0.023)	(0.047)	(0.131)	(0.633)
foreign pension time				
GDR	0.041	0.206	0.549	-3.574
	(0.046)	(0.079)	(0.266)	(2.280)
other	0.028	0.090	-0.275	-1.667
	(0.032)	(0.066)	(0.193)	(1.197)
constant	379.722	923.935	1794.641	2761.104
	(5.754)	(12.276)	(45.542)	(229.860)
$\gamma = 0$	0.014	0.004	0.637	0.565
R^2	0.003	0.008	0.010	0.022
Observations	1,961,510	1,151,175	320,073	16,652

Notes: All point estimates and standard errors are multiplied by 100. Therefore, reported results show the magnitude of the effect in percentage points. The model is estimated using robust standard errors. Standard errors are displayed in parentheses. The row $\gamma = 0$ reports the p-value of testing if the coefficient of age at retirement is equal to 0. Relevant birth cohorts, see Table 1.8. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations. Rounded off to the third decimal place. Analysis includes individuals who survived at least the age of 65 and whose type of retirement is not pension for invalids. Retirement age is limited to ages 65 and under. In addition, first type of retirement equals current retirement status.

OLS

When comparing coefficients of retirement age over different ages of survival one has to keep in mind that subsets of relevant individuals differ because of the choice of relevant birth cohorts. Due to the construction of the underlying data set, comparisons correspond only for respective years under report and cannot be easily transferred to universally valid conclusions. In general, magnitude of estimates of age at retirement on mortality are rather low. In contrast to previous results from Germany[57] the influence of age at retirement on mortality is non-existent for higher ages of survival.[58] Although estimates of age at retirement are significantly positive using survival at age 70 and 75, implying that individuals with higher age at retirement face lower mortality risk, the actual size of the effect is negligible. For example, looking at the effect of age at retirement on survival at age of 75, reveals that for pensioners retiring one year later the mortality risk decreases between 0.062 and 0.0330 percentage points within 95% confidence interval (point estimate of 0.007). The effect using age at retirement on survival at age 70 is even lower. The effect of age at retirement on mortality using measures of survival at age of 80 and 85 are not significant at all, implying that there is no sufficient statistical evidence that different age at retirement affects mortality at higher ages. As heterogeneity increases with ages beyond the retirement age standard errors increase, too. But, the increase in standard errors with higher survival can be also attributed to decreasing number of observations when using survival dummies for higher ages.

Analysing other coefficients of the model using OLS shows that the coefficient of birth year has the expected negative and significant sign. This can be attributed to the construction of the underlying data set. The actual influence of birth year is increasing using higher ages of survival. One reason for this result may be the different frequencies of relevant birth cohorts for each regression.[59] An overview for the frequencies of birth years for each reporting year can be found in the appendix, see Figure 1.7. The effect of being married or remarried during entry into retirement lowers mortality risk significantly for the first three models. Although the effect of being re,-married using survival at age of 85 has a positive sign, it is not significant.

54. Doing analysis for reporting years separately offers the possibility to identify the actual number of individuals. However, there is no heterogeneity of survival for each birth year. Therefore, the following analysis is based on a pooled cross section.

55. Regression results for each relevant birth year separately are available upon request.

56. Due to test construction it is statistically not possible to conclude that γ is automatically zero. It is just possible not to reject the null hypothesis of $\gamma = 0$.

57. Previous results did not take into account birth cohort heterogeneity with respect to age at retirement. For details see section 1.3.

58. For an actual comparison of the relative magnitude of the coefficients, one has to use standardised coefficients. As the cited literature does not provide this information an actual comparison of the magnitude of the coefficients on survival is difficult.

59. See Table 1.8 for the relevant birth cohorts.

Since the variable indicates whether the respective individual is married during entry into retirement the probability of a change of the family status due to death or divorce of the husband or wife is increasing when using higher ages of survival. This may explain the increasing standard errors for family status. In general, there is some support that being married has a protective mechanism with respect to mortality. Women face higher survival rate at any analysed age. The magnitude of the effect is increasing with age at survival. The effect of having children on mortality using survival at age of 70 until the age of 80 has a bell shape. That means that having up to three children lowers mortality; the maximum of the effect is at two children. The magnitude of the effect of having children becomes negative when having more children, but differences with respect to the baseline category on having no children is significant only for 5 and more children. When using survival at age of 85 as dependent variable there are no significant differences at all. Foreign citizenship is a mortality decreasing factor. As migration is a selective process, i.e. those who migrate are on average healthy, this subsample of the population exhibits higher survival probability in comparison to individuals with German citizenship. The effect is increasing with age at survival and always significant. There is no clear tendency that having foreign pension time affects mortality in a certain way. Most estimates are insignificant and magnitude is volatile.

The fraction of explained variation of the dependent variable is rather low and is increasing slightly for older birth cohorts and higher ages of survival, respectively. Moreover, the number of observation is decreasing with higher age at survival. This pattern is not surprising since the chance of survival is decreasing with higher ages, i.e. mortality increases. As OLS lacks an adequate identification strategy achieved results report correlations only.

2SLS

In this section the strategy proposed in section 1.4 is estimated via 2SLS. Age at retirement is instrumented by individual pension eligibility age. Estimation is based on the same set of socio-demographic variables. In addition, the model is estimated with and without retirement-relevant variables, which represents the prerequisites of eligibility status.

The effect of age at retirement on mortality using the identification strategy of instrumenting retirement age by pension eligibility age reveals that the influence is, similar to OLS results, low and insignificant. The only significant estimate without the inclusion of retirement-relevant variables can be found using survival at age 70 as a measure of mortality. The magnitude of the effect is even reversed compared to previous findings, implying that higher age at retirement is associated with lower

Table 1.10: Overall Regression Results – 2SLS

Dependent variables: survived the age of 70, 75, 80 and 85

	2SLS							
	survived 70		**survived 75**		**survived 80**		**survived 85**	
Socio-Demographic								
retirement age	-0.011	0.003	-0.001	0.064	0.061	0.312	-0.210	-0.593
	(0.003)	(0.004)	(0.007)	(0.010)	(0.039)	(0.063)	(0.662)	(2.078)
gjavs	-0.148	-0.147	-0.416	-0.405	-0.858	-0.880	-1.406	-1.458
	(0.004)	(0.004)	(0.006)	(0.007)	(0.024)	(0.034)	(0.118)	(0.193)
family status								
re-,married	0.281	0.276	0.661	0.649	1.193	1.202	0.591	1.260
	(0.017)	(0.017)	(0.033)	(0.035)	(0.095)	(0.113)	(0.560)	(1.137)
sex								
female	0.351	0.399	1.142	1.398	2.619	3.422	6.089	7.406
	(0.024)	(0.026)	(0.043)	(0.051)	(0.122)	(0.167)	(0.720)	(1.651)
number of children								
1	0.080	0.104	0.131	0.255	0.039	0.411	1.196	2.316
	(0.025)	(0.026)	(0.048)	(0.052)	(0.142)	(0.179)	(0.765)	(1.588)
2	0.139	0.167	0.229	0.351	0.571	0.873	0.875	2.456
	(0.023)	(0.024)	(0.045)	(0.049)	(0.131)	(0.166)	(0.769)	(1.643)
3	0.101	0.135	0.165	0.296	0.363	0.724	1.627	2.357
	(0.025)	(0.027)	(0.049)	(0.053)	(0.145)	(0.181)	(0.907)	(2.075)
4	0.022	0.059	-0.068	0.096	-0.081	0.176	1.699	2.209
	(0.033)	(0.034)	(0.062)	(0.066)	(0.179)	(0.219)	(1.128)	(2.692)
5 or more	-1.72	-0.119	-0.527	-0.360	-0.628	-0.542	-0.570	-0.350
	(0.042)	(0.044)	(0.073)	(0.077)	(0.197)	(0.236)	(1.436)	(3.130)
citizenship								
foreign	0.128	0.200	0.221	0.507	0.593	1.502	3.038	2.547
	(0.025)	(0.028)	(0.047)	(0.055)	(0.131)	(0.172)	(0.634)	(1.256)
foreign pension time								
GDR	0.014	-0.012	0.177	0.061	0.548	0.582	-3.586	-12.673
	(0.045)	(0.046)	(0.078)	(0.078)	(0.266)	(0.281)	(2.278)	(5.078)
other	0.035	-0.037	0.071	-0.234	-0.234	-1.038	-1.730	-4.457
	(0.033)	(0.042)	(0.065)	(0.081)	(0.193)	(0.267)	(1.197)	(2.532)
Retirement-Relevant								
byvl		0.000		0.008		-0.007		0.008
		(0.001)		(0.002)		(0.007)		(0.006)
psegpt		0.004		0.014		0.044		0.099
		(0.001)		(0.001)		(0.005)		(0.040)
auaz		-0.026		-0.056		-0.178		-0.246
		(0.003)		(0.005)		(0.017)		(0.136)
ajaz		-0.003		-0.010		-0.036		-0.001
		(0.001)		(0.001)		(0.006)		(0.057)
constant	386.489	383.133	902.135	874.967	1744.416	1769.201	2806.283	2928.480
	(7.703)	(7.912)	(12.713)	(13.847)	(46.706)	(66.859)	(232.620)	(381.064)
Partial R^2	0.940	0.899	0.901	0.825	0.799	0.713	0.647	0.527
F-value	$1.7x10^7$	$7.0x10^6$	$6.0x10^6$	$2.4x10^6$	242,005	119,515	716	101
Robust regression-based test	0.000	0.000	0.002	0.970	0.000	0.000	0.145	0.573
Observations	1,375,716	1,298,067	1,103,366	1,003,373	320,057	244,405	16,652	5039

Notes: All point estimates and standard errors are multiplied by 100. Therefore, reported results show the magnitude of the effect in percentage points. The model is estimated using robust standard errors. Standard errors are displayed in parentheses. F statistic of instruments is rounded as integer. P-values for regression-based test are displayed; null hypothesis: variables are exogenous. Relevant birth cohorts, see Table 1.8. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations. Rounded off to the third decimal place. Analysis includes individuals who survived at least the age of 65 and whose type of retirement is not pension for invalids. Retirement age is limited to ages equal or under 65 years. In addition, first type of retirement equals current retirement status.

long term health. This can be interpreted as implying that estimates using OLS are confounded by unobserved variables. But, the actual effect is, similar to OLS, very small. Using survival at age of 70, results indicate that a delay of one year of entry into retirement decreases the survival rate on average by 0.011 percentage points.

As discussed in section 1.4 pension eligibility is not randomly distributed and depends on individual circumstances. To overcome a potential bias due to non-randomness of pension eligibility age retirement-relevant variables which proxy for the prerequisites of entering retirement are used. Estimates show significant positive results of age at retirement on survival at age 75 and 80, respectively. The effect on survival at age of 80 is rather large implying that a delay of age at retirement is associated on average with an increase in probability of survival by 0.312 percentage points. However, estimates of the coefficients of age at retirement are volatile since survival at age 70 and age 85 are not significant when including the subset of retirement-relevant variables. Even more problematic is the potential bad control problem, since measures used to overcome non-randomness of the instrument depend on actual age at retirement. That means that exogenous covariates are in fact endogenous.

Estimates of the control variables are in line with OLS estimates. The birth year has the assumed negative effect on survival. Results for the control variables are not affected by the inclusion of retirement-relevant variables, either. Being re,-married has a positive effect on survival up to age 80. Afterwards estimates are too heterogeneous for significant effects. The effect of being female lowers mortality at every age of survival. The effect of having children has, similar to OLS estimates, a bell shape. Having up to three children lowers mortality whereas the biggest effect is at two children. Having four children makes no difference with respect to mortality to individuals having no children at all. The effect of having five and more children lowers chances of surviving up to age of 80 years. There are no significant results when analysing the effect of having children on survival at age of 85. Individuals with non-German citizenship exhibit lower mortality at every age of survival in comparison to individuals with German citizenship. Similar to OLS results foreign pension time has no clear direction of affecting mortality.

Analysing proxies for prerequisites of being eligible of entering retirement shows that psegpt, a measure of pension income during retirement, has a positive effect on survival. The effect is increasing with age of survival. The proxy of length of work before retirement is mostly insignificant and time of being unemployed or ill have a negative effect on survival until age of 80.

The partial R^2 and F-value are summary statistics for the first-stage regression, i.e. they show if pension eligibility is sufficiently correlated with the age at retirement. Both measures show the significance of the instrument, but in different ways.

The partial R^2 represents the proportion of variation of age at retirement which is explained by pension eligibility and which is not explained by other variables included in the model. Here, the instrument is more important for later birth cohorts or lower ages of survival. The F-value reports the test statistic of testing if the effect of pension eligibility age on age at retirement is different from zero. As a rule of thumb an F-value of at least 10 is regarded as sufficient. The F-value implies high significance. In summary, this analysis finds a strong statistical evidence for a sufficient first-stage of the instrument.

Moreover, a robust regression-based test is performed to test the endogeneity of age at retirement. The test is based on an auxiliary regression of the endogenous variable on all exogenous variables. The residuals, the part which is not explained by the auxiliary regression, are used in a second regression as an additional regressor of (1.1). Afterwards, one tests the null hypothesis of the significance of the residuals with a t-test. The row "Robust regression-based test" reports the corresponding p-values.[60] The null hypothesis of exogeneity of age at retirement is rejected in most cases. The inclusion of retirement-relevant variables leads to a non-rejection of the null hypothesis of exogeneity using survival at age of 75. Estimates of survival at 85 imply that one cannot reject the null hypothesis of exogeneity irrespective of the inclusion of retirement-relevant variables. In this case results of the robust regression-based test imply that using OLS is the more efficient way of estimating the influence of age at retirement on survival at age of 85. OLS results, similar to 2SLS estimates, imply that age at retirement does not affect survival at age 85 at all.

In general, results using 2SLS imply that age at retirement does not affect mortality. But, when using additional measures of retirement-relevant variables results are more volatile. To check the sensitivity of estimates using retirement-relevant variables types of old-age pension are analysed individually and matching is used to overcome the bad control problem while also accounting for non-randomness of the instrument.

Sensitivity Analysis

In the following, different types of old-age pensions are examined individually. The analysed data for regressions consists out of four types of old-age pension. There are three types which allow an early entry into retirement, namely the pension for longtime insured persons, the pension for women and the pension because of unemployment or part-time work for employees over 55. In contrast, individuals of the regular old-age pension do not have any possibilities of early retirement. The pensions differ from each other with respect to requirements for entry into retire-

60. For further details of the test, see Wooldridge (2001).

ment and diverge regarding the age at pension eligibility. The control group are individuals with regular old-age pensions. The separation of types of early old-age pensions increases the comparability between the groups. All models include socio-demographic as well as retirement-relevant variables. For the sake of simplicity only point estimates and standard errors of γ are presented along with observations and first-stage summary statistics.

Table 1.11: Regression Results by Type of Old-Age Pension – 2SLS

Dependent variables: survived the age of 70, 75, 80 and 85

	2SLS			
	survived 70	**survived 75**	**survived 80**	**survived 85**
Longtime Insured				
retirement age	-0.026	-0.134	0.124	-2.911
	(0.017)	(0.028)	(0.101)	(4.057)
Socio-Demographic Variables	✓	✓	✓	✓
Retirement-Relevant Information	✓	✓	✓	✓
$\gamma = 0$	0.131	0.000	0.220	0.473
Partial R^2	0.901	0.852	0.820	0.493
F-value	$1.1x10^6$	$1.2x10^6$	227,629	205
Robust regression-based test	0.066	0.348	0.355	0.594
Observations	760,323	639,650	220,351	5004
Women				
retirement age	-0.019	-0.022	-0.063	0.764
	(0.006)	(0.014)	(0.073)	(2.600)
Socio-Demographic Variables	✓	✓	✓	✓
Retirement-Relevant Information	✓	✓	✓	✓
$\gamma = 0$	0.001	0.111	0.391	0.769
Partial R^2	0.859	0.815	0.742	0.516
F-value	$2.4x10^6$	890,090	44,583	35
Robust regression-based test	0.000	0.024	0.755	0.388
Observations	821,199	539,792	127771	2278
Unemployed or Part-Time Work				
retirement age	0.017	0.134	0.761	1.210
	(0.007)	(0.015)	(0.102)	(4.467)
Socio-Demographic Variables	✓	✓	✓	✓
Retirement-Relevant Information	✓	✓	✓	✓
$\gamma = 0$	0.015	0.000	0.000	0.786
Partial R^2	0.941	0.842	0.818	0.752
F-value	$4.2x10^6$	$1,6x10^6$	84,602	25
Robust regression-based test	0.309	0.092	0.202	0.520
Observations	822,071	648,699	198,140	4839

Notes: All point estimates and standard errors are multiplied by 100. Therefore, reported results show the magnitude of the effect in percentage points. The model is estimated using robust standard errors. Standard errors are displayed in parentheses. F statistic of instruments is rounded as integer. P-values for regression-based test are displayed; null hypothesis: variables are exogenous. Relevant birth cohorts, see Table 1.8. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations. Rounded off to the third decimal place. Analysis includes individuals who survived at least the age of 65 and whose type of retirement is not pension for invalids. Retirement age is limited to ages 65 and under. In addition, first type of retirement equals current retirement status.

Pensions for Longtime Insured Persons

Entry into retirement of pensioners for longtime insured persons is possible at the earliest at age of 63. Therefore differences with regard to pension eligibility age are up to two years in comparison to regular old-age pensioners.

The coefficient of age at retirement is not significant from zero in three cases implying that retirement age does not have any influence on mortality using survival at age 70, 80 and 85. The effect on survival at age 75 is significant and negative. As other measures of survival and general results using 2SLS imply that there is no differences with regard to mortality and age at retirement, these results can be explained by subgroup heterogeneity which cannot be accounted for by the identification strategy proposed in section 1.4.

Pensions for Women

The difference of pension eligibility age between individuals with pension for women and regular old-age pension is 5 years. As the title suggest only women can apply for this pension. Therefore the control group is restricted to female old-age pensioners only.

Coefficients of age at retirement are mostly insignificant implying that there is an independent relationship between retirement age and mortality for women. The only significant coefficient is negative when using survival at age of 70. But, similar to previous results the magnitude of the coefficient is low.

Pensions because of Unemployment or Part-Time Work

Early retiring is possible at the age of 60 for individuals with pension because of unemployment or part-time work for employees over 55.

In comparison to other types of early old-age retirement estimates using pensioners eligible due to unemployment or part-time work show only positive coefficients of age at retirement on mortality. Except for survival at age 85 all coefficients of age at retirement are significant. Taking a closer look at the coefficient of age at retirement on survival at age 80, the actual size of the estimate is considerable. Comparing the significance and size of other estimates using pension for women or pensions for longtime insured persons reveals that the general effect of age at retirement on survival at age 80 (see Table 1.10, survival 80 including retirement-relevant variables) using all types of old-age pensions at once is mainly driven by higher mortality of pensioners because of unemployment or part-time work. As individuals with pension due to unemployment or part-time work consist mainly of formerly unemployed individuals rather than part-time workers[61] one can reasonably assume that part of the variation of mortality attributed to unemployment is responsible for the significant positive estimates of age at retirement on mortality. Therefore, the identification strategy fails to account for consequences related to unemployment when analysing

61. For details, see section 1.3.

mortality differences by age at retirement.[62] To account for that, in the next section the model will be re-estimated without pensioners because of unemployment or part-time work. By doing so, one checks if previous results implying that age at retirement does not affect mortality can be confirmed and may also determine the source of variation of previous estimates.

Analysis without Pensions due to Unemployment or Part-Time Work

In this part of the sensitivity analysis all types of early and regular old-age pension are added to the model except pensioners with pensions due to unemployment or part-time work. At first, an estimation using OLS is presented. Afterwards, the identification strategy from section 1.4 is used and estimated via 2SLS. In the following, retirement-relevant variables are added. Moreover, matching is used to overcome the trade-off between bad control problem and random assignment of the instrument (for details of the trade-off see section 1.4). In the end, the effect of age at retirement on different mortality measures separated by female and male retirees is presented.

The effect of age at retirement on survival at age 70, 75, and 80 is significantly smaller than zero using OLS. The results imply that retirement at a younger age is associated with lower mortality risk. This is in contrast to regression results using OLS and all types of old-age pension (see Table 1.9) where estimates are significantly positive or not significant at all. Therefore, subgroup heterogeneity is responsible for the variation of estimates. Similar to previous results the effect of retirement age on survival at age 85 is not significant.

Applying the identification strategy proposed in section 1.4 and estimating the influence of age at retirement on mortality without retirees who receive pension due to unemployment and part-time work the effect of retirement age on survival at 70, 75 and 80 is still significantly smaller than zero. In addition, the size of the effect of retirement age on survival at age 85 becomes negative, but is not significant. The actual size of the effect is relatively small, i.e. results imply that the probability of surviving the age of 80 is on average 0.188 percentage points lower when entry into retirement is delayed by one year. But, one has to keep in mind that pension eligibility age has to be randomly distributed over affected individuals for actual identification of the influence of age at retirement on mortality.

Results including proxies for prerequisites, *2SLS add'l controls*, show that point estimates are still negative but are only statistically different from zero in one of four cases. There are only survival differences for survival at 75. Even more, the effect is

62. Although the model contains the variable ajaz, creditable periods due to unemployment, results imply that identification strategy accounts only for a part of all mortality differences due to unemployment of the respective pensioners.

Table 1.12: Overall Regression Results without Pensions due to Unemployment or Part-Time Work – 2SLS

Dependent variables: survived the age of 70, 75, 80 and 85

		survived 70	**survived 75**	**survived 80**	**survived 85**
OLS	retirement age	-0.023	-0.067	-0.173	0.268
		(0.003)	(0.007)	(0.036)	(0.605)
	$\gamma = 0$	0.000	0.000	0.000	0.658
	R^2	0.002	0.006	0.009	0.022
	Observations	1,503,945	951,182	303,305	16,620
2SLS	retirement age	-0.015	-0.074	-0.188	-0.448
		(0.003)	(0.007)	(0.038)	(0.692)
	$\gamma = 0$	0.000	0.000	0.000	0.517
	F-value	$1.4x10^7$	$6.0x10^6$	207,770	630
	Robust regression-based test	0.000	0.000	0.322	0.064
	Observations	1,225,041	935,102	303,289	16620
2SLS add'l controls	retirement age	-0.003	-0.044	-0.064	-0.913
		(0.005)	(0.011)	(0.060)	(2.320)
	$\gamma = 0$	0.515	0.000	0.282	0.694
	F-value	$6.0x10^6$	$2.1x10^6$	87,787	91
	Robust regression-based test	0.000	0.015	0.798	0.719
	Observations	1,156,788	849,839	231,000	5034
2SLS matching	retirement age	-0.042	0.003	-0.066	-4.672
		(0.003)	(0.007)	(0.058)	(3.115)
	$\gamma = 0$	0.000	0.644	0.256	0.134
	Observations	951,992	709,348	92,530	400
2SLS Men	retirement age	0.057	-0.115	0.002	
		(0.023)	(0.036)	(0.123)	
	$\gamma = 0$	0.012	0.001	0.989	
	F-value	859,314	$1.1x10^6$	193,135	
	Robust regression-based test	0.785	0.702	0.632	
	Observations	323,447	286,631	97,255	
2SLS Women	retirement age	-0.018	-0.016	-0.040	3.585
		(0.006)	(0.013)	(0.072)	(3.316)
	$\gamma = 0$	0.001	0.212	0.573	0.280
	F-value	$2.5x10^6$	954,863	47,952	30
	Robust regression-based test	0.000	0.028	0.517	0.565
	Observations	833,341	563,208	133,745	126

Notes: All point estimates and standard errors are multiplied by 100. Therefore, reported results show the magnitude of the effect in percentage points. The model is estimated using robust standard errors. Standard errors are displayed in parentheses. Relevant birth cohorts, see Table 1.8. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations. Analysis includes individuals who survived at least the age of 65 and whose type of retirement is not pension for invalids. Retirement age is limited to ages 65 and under. In addition, first type of retirement equals current retirement status. Matching algorithm: Nearest neighbour matching without replacement. All regressions include socio-demographic variables. Regressions for *2SLS add'l controls*, *2SLS Men*, *2SLS Women* and *2SLS matching* include retirement-relevant information.

negligible. In comparison to general estimation results including retirement-relevant variables, see Table 1.10, the extraction of pensioners due to unemployment and part-time work leads to less variation of the coefficient of age at retirement. Although the inclusion of proxies of prerequisites may satisfy the randomness of the instrument, it can lead to a bad control problem as proxies of prerequisites are in themselves outcomes of the variable of interest, i.e. retirement age.

To account for the bad control problem, the respective sample is restricted to pensioners who exhibit similar or identical properties of socio-demographic and retirement-relevant variables but differ in their age at retirement. That means, pensioners were separated into groups depending on whether they are early (treatment group) or regular old-age pensioners (control group). Afterwards, the treatment indicator is regressed on all available socio-demographic and retirement-relevant variables using Probit estimation method. After regression, the respective propensity score for each individual is projected. To chose the best possible control item for each treatment nearest neighbour matching without replacement is used. Afterwards, the restricted sample is estimated via 2SLS, while age at retirement is instrumented by pension eligibility age.

By doing so, one reduces the chance that control variables can be in itself endogenous. On the other side, one loses observations due to the underlying matching process. In addition, the propensity score is actually estimated and 2SLS is applied on a restricted sample which is based on a previous estimation procedure. But, the 2SLS estimator does not account for that fact. Moreover, matching is a control strategy and depends on the actual available subset of control variables. Although, this procedure can identify identical companions based on matched variables, they can differ in important ways not accessible to the researcher. This potential bias is not quantifiable by construction. An overview of propensity score matching, overlap and common support and matching quality can be found in the appendix, tables 1.15, 1.16 and 1.17.[63]

Estimates based on matching confirms the non-significance of the influence of retirement age on survival. A statistically significant effect exists only for survival at age 70 implying that later retirement lowers survival probability. The actual size is however negligible, i.e. a delay of entry into retirement leads to lower survival probability of 0.042 percentage points.

Comparing estimates separated by female and male pensioners reveals that estimates for male pensioners show a higher volatility, but they are also fluctuating around zero. For women, the results are more homogeneous.

In summary, estimates confirm the independent relationship between age at re-

63. Definitions of standardised bias and further details of relevant matching terms, see for example Caliendo and Kopeinig (2005).

tirement and mortality. Although some estimates are significantly different from zero there is no clear tendency of the direction of the estimated effect. Moreover, the actual sizes of the effects are relatively small and economically insignificant.

1.6 Conclusion

Results are based on an identification strategy by instrumenting retirement age via age at pension eligibility while also controlling for the prerequisites of eligibility status. In addition, birth cohort heterogeneity is accounted for in contrast to previous studies for Germany. As pension eligibility age is an important factor for entry into retirement compliance is high.

Results show that age at retirement does not influence mortality in a specific way. Divergences with respect to the size of the estimates can mostly be attributed to subgroup heterogeneity which is not accounted for by the underlying identification strategy. As survival at different ages depends on different birth cohorts conclusions with regard to the temporal development of the effect are not possible. As one cannot change data properties results are based on the given individuals in the relevant birth cohorts and cannot be extrapolated to all individuals within the analysed birth cohorts.

It is also important to note, that age at retirement cannot be a causal determinant of mortality in itself. Rather, age at retirement is a proxy of potential determinants affecting mortality which are influenced by a shift of age at retirement. However, results imply that potential determinants are not affected or level themselves out.

As the results show that a shift of age at retirement does not influence survival, there are no additional budgeting effects of an increase of legal retirement age as suggested by previous authors. The results imply that an increase of age at retirement leads to proportional decrease of time in retirement.

Although work after retirement for analysed birth cohorts are of minor importance for the majority of pensioners, it is important to note that retirement using the definition from the pension scheme is not equivalent to end of work. Even more, the entry into retirement can happen out of a situation of unemployment. For these individuals, entry into retirement just means the beginning of pension payment. Nonetheless, for a large fraction of individuals retirement is associated with end of work even though there is no possibility to extract this part out of the existing data set.

With regard to the gradual increase of age limits within the German statutory pension scheme, it remains an open question whether potential unemployment of older workers due to higher age limits outweighs the positive budgeting effects of decreasing time in retirement.

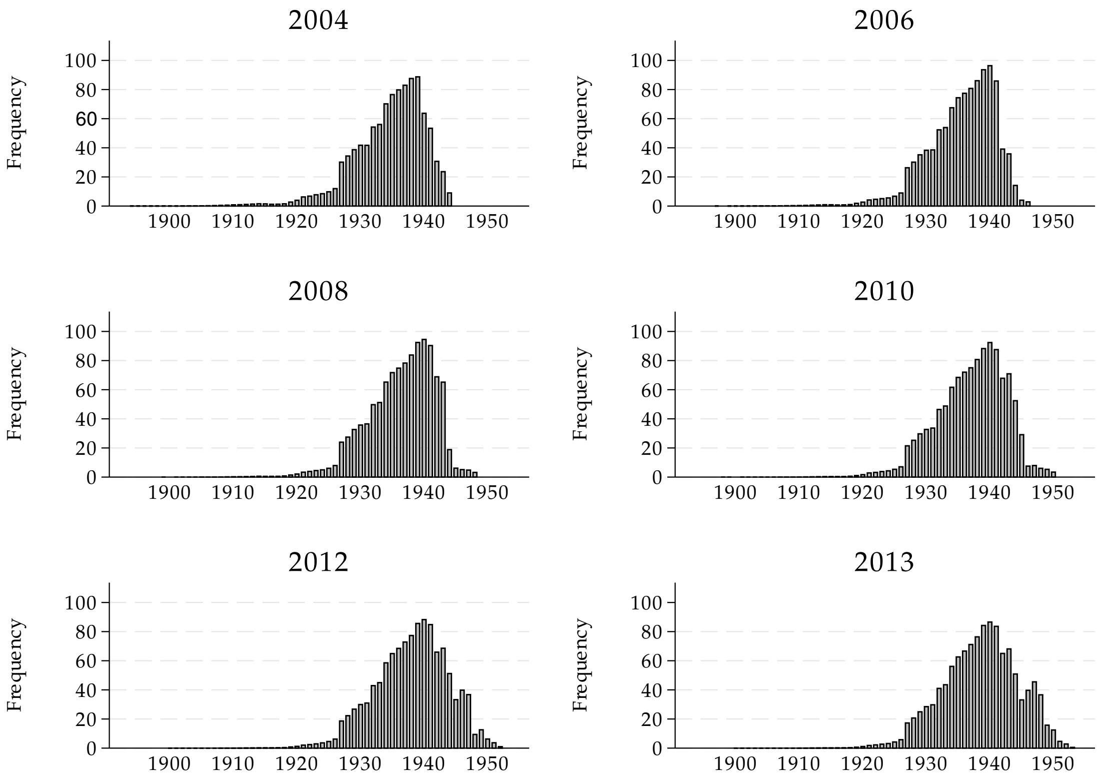
1.7 Appendix

Table 1.13: Overview Variables – Original Data Set and Constructed Variables

Name	Description	Type of Variable	Observations
	From Original Data Set		
ja	year under review	metric	6,742,180
fmsd	family status	nominal	6,180,901
gbjavs	year of birth	metric	6,742,180
gbmovs	month of birth	metric	6,742,107
gevs	sex	nominal	6,742,180
zlki12	number of children	ordinal	6,742,180
rtbe1	year of first pension	metric	6,742,180
rtbe2	month of first pension	metric	6,742,180
ztptr1	year of current pension	metric	6,742,180
ztptr2	month of current pension	metric	6,742,180
rtwf1	year of cessation of pension payment	metric	145,197
rtwf2	month of cessation of pension payment	metric	145,197
frgld	foreign pensions	nominal	6,719,607
frgmo	years of foreign pensions	metric	6,742,180
byvl	contribution period full-valued	ordinal	5,871,205
auaz	creditable periods due to illness	ordinal	5,871,205
ajaz	creditable periods due to unemployment	ordinal	5,871,205
psegpt	sum of personal earnings points	ordinal	6,742,180
rtat	type of pension	nominal	6,742,180
leat	type of old-age pension	nominal	6,736,980
ausland	citizenship	nominal	6,725,579
	Constructed Variables		
geburtsdatum	year and month of birth	nominal	217,308
survived70	Individual survived the age of 70	nominal	4,302,228
survived75	Individual survived the age of 75	nominal	2,184,335
survived80	Individual survived the age of 80	nominal	836,310
survived85	Individual survived the age of 85	nominal	302,771
erstrente	first corresponds current retirement	nominal	6,742,180
rentenalter	age at retirement	metric	6,742,107
age	age of individual	metric	6,742,107
atg	pension eligibility age without deductions	metric	4,763,548
mogab	possibility of retirement with deductions	nominal	5,673,247

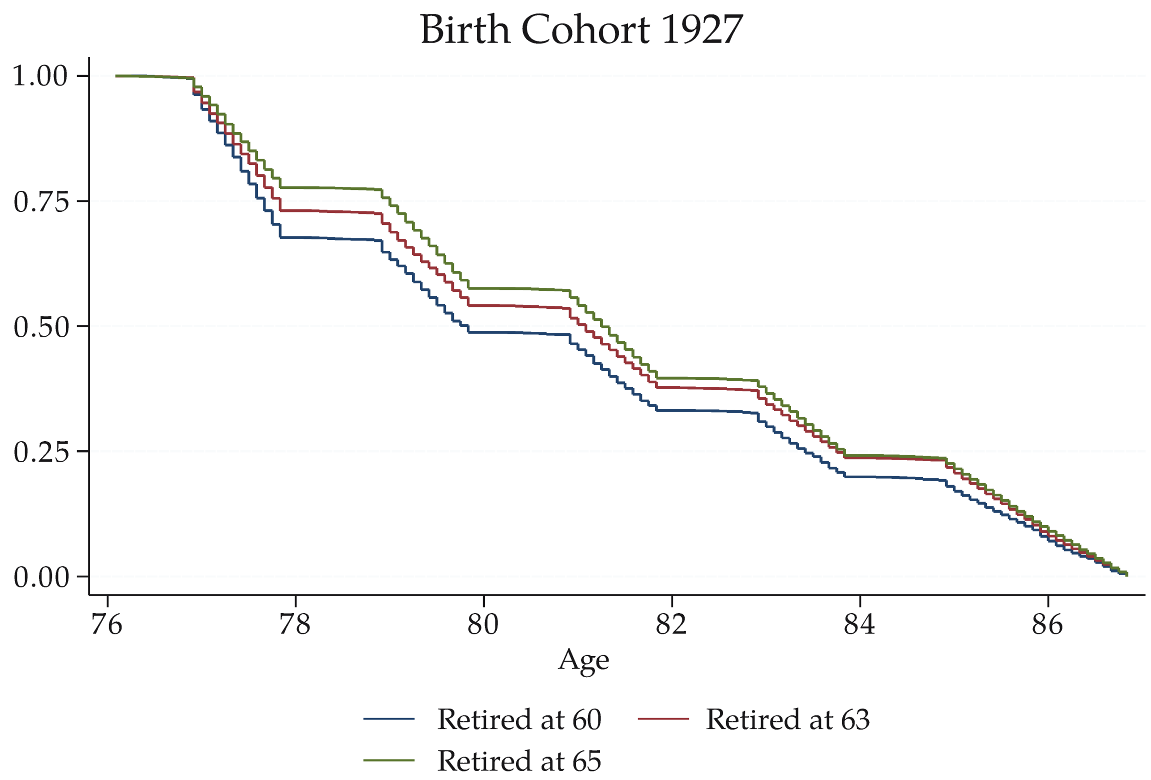
Notes: frgmo, byvl, auaz, ajaz and psegpt are censored from above. Observations with implausible values are removed from the data set.

Figure 1.7: Histograms Year of Birth by Reporting Year



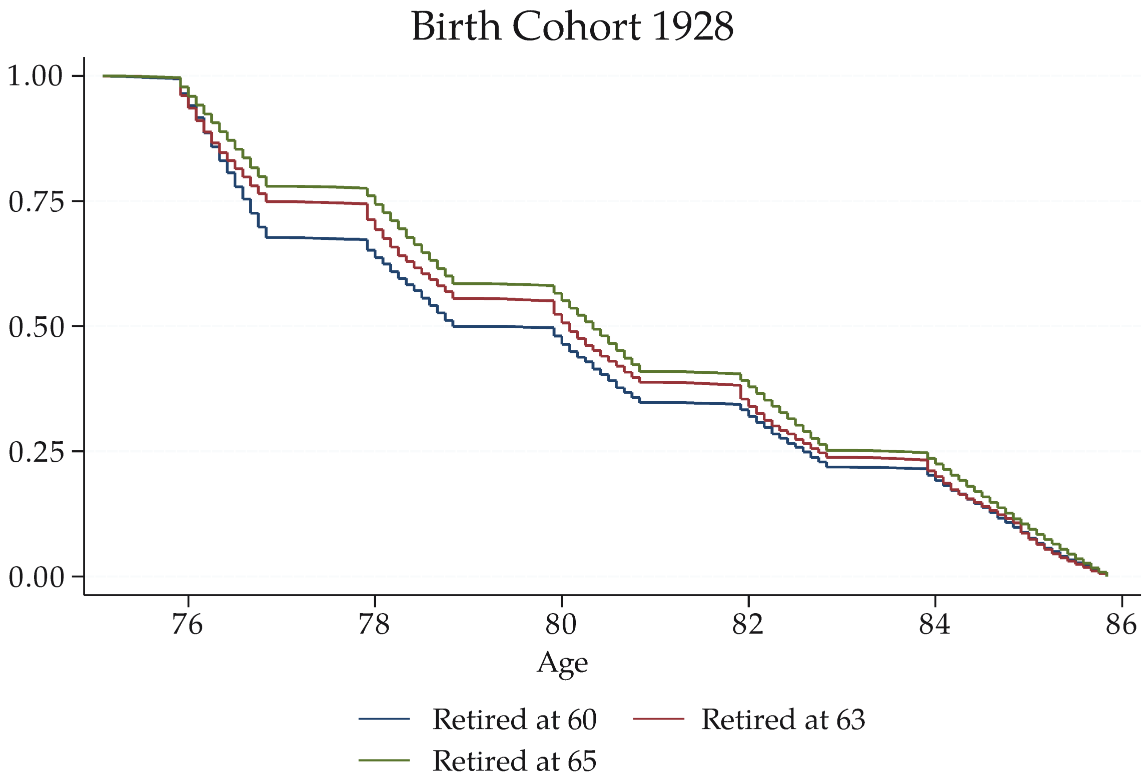
Notes: Frequency of year of birth times 1000 by reporting years; Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations.

Figure 1.8: Kaplan Meier Survival Estimates – Birth Cohort 1927



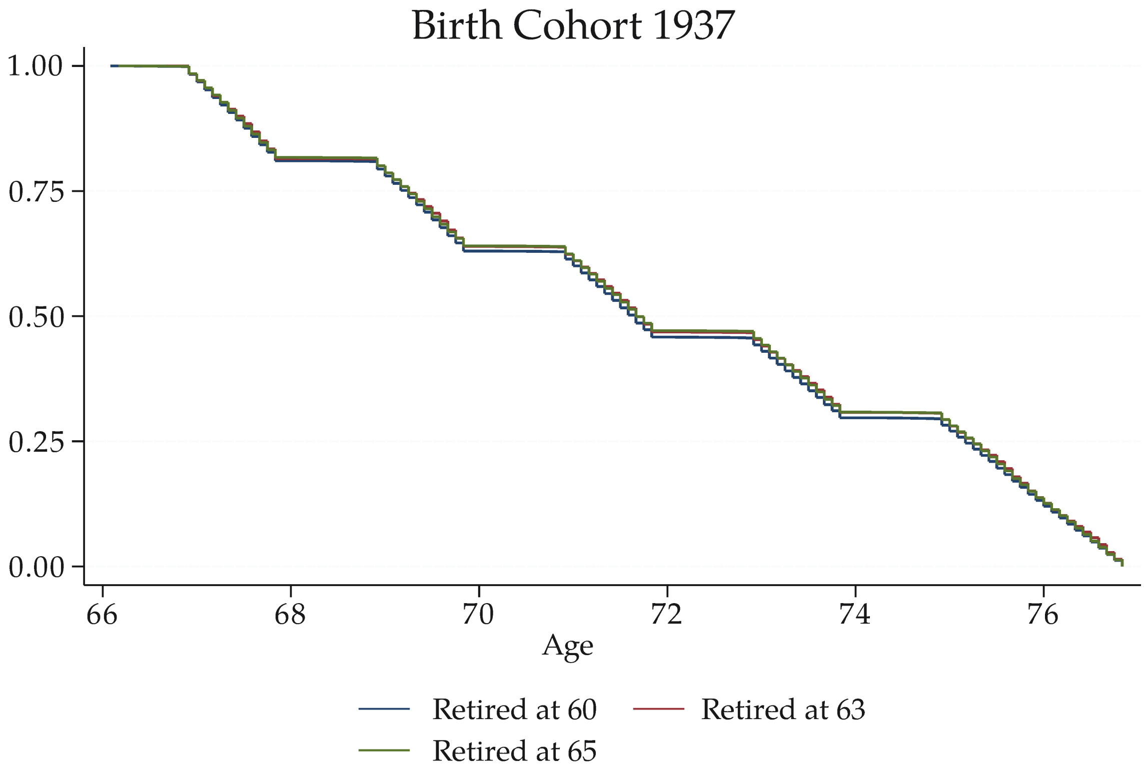
Notes: Kaplan Meier Estimates of survival after 65. Contains male individuals retiring at the age of 60, 63 and 65. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations.

Figure 1.9: Kaplan Meier Survival Estimates – Birth Cohort 1928



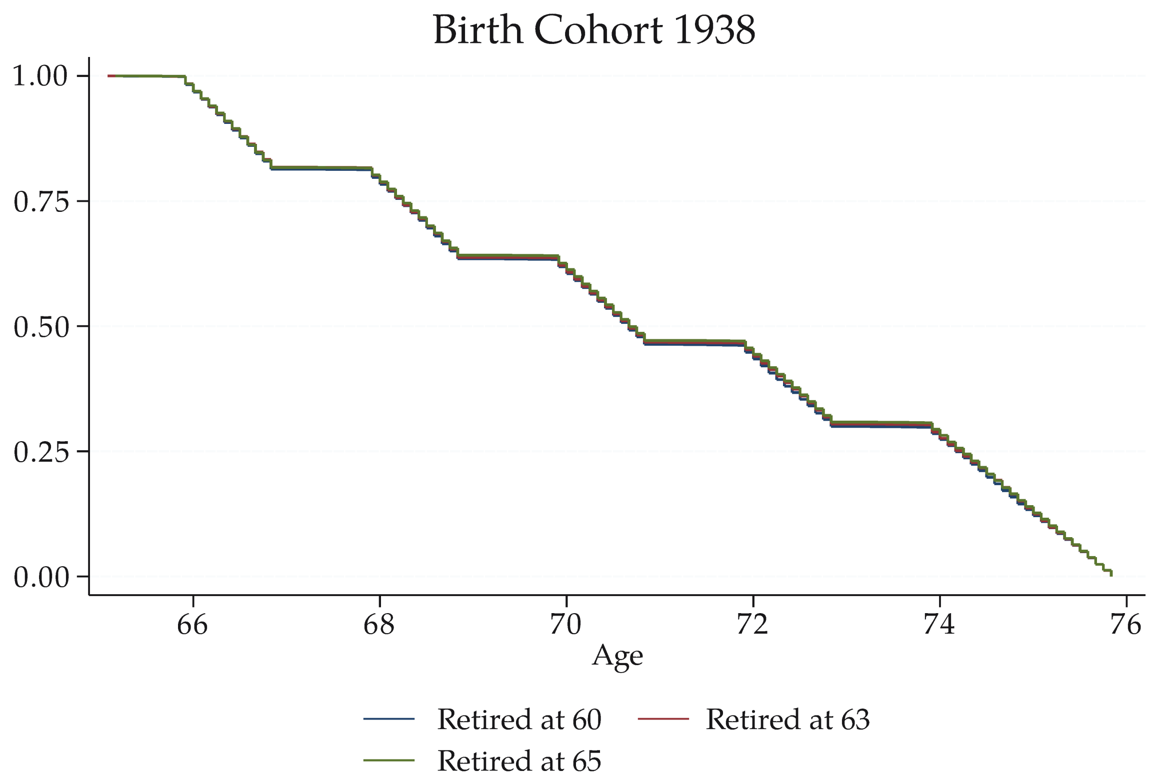
Notes: Kaplan Meier Estimates of survival after 65. Contains male individuals retiring at the age of 60, 63 and 65. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations.

Figure 1.10: Kaplan Meier Survival Estimates – Birth Cohort 1937



Notes: Kaplan Meier Estimates of survival after 65. Contains male individuals retiring at the age of 60, 63 and 65. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations.

Figure 1.11: Kaplan Meier Survival Estimates – Birth Cohort 1938



Notes: Kaplan Meier Estimates of survival after 65. Contains male individuals retiring at the age of 60, 63 and 65. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations.

Table 1.14: Regression Results by Type of Old-Age Pension – OLS

Dependent variables: survived the age of 70, 75, 80 and 85

	OLS			
	survived 70	**survived 75**	**survived 80**	**survived 85**
Longtime Insured				
retirement age	-0.079	-0.204	-0.199	-0.619
	(0.014)	(0.022)	(0.071)	(1.410)
Socio-Demographic Variables	✓	✓	✓	✓
Retirement-Relevant Information	✗	✗	✗	✗
$\gamma = 0$	0.000	0.000	0.005	0.661
R^2	0.003	0.007	0.009	0.022
Observations	798,817	690,331	284,742	16,431
Women				
retirement age	-0.013	-0.038	-0.099	0.613
	(0.003)	(0.007)	(0.040)	(0.661)
Socio-Demographic Variables	✓	✓	✓	✓
Retirement-Relevant Information	✗	✗	✗	✗
$\gamma = 0$	0.000	0.000	0.014	0.354
R^2	0.002	0.004	0.005	0.011
Observations	870,391	598,558	171,611	10,239
Unemployed or Part-Time Work				
retirement age	0.001	0.109	0.466	0.415
	(0.005)	(0.012)	(0.072)	(1.727)
Socio-Demographic Variables	✓	✓	✓	✓
Retirement-Relevant Information	✗	✗	✗	✗
$\gamma = 0$	0.851	0.000	0.000	0.810
R^2	0.003	0.009	0.011	0.023
Observations	865,500	698,632	253,372	15,957

Notes: All point estimates and standard errors are multiplied by 100. Therefore, reported results show the magnitude of the effect in percentage points. The model is estimated using robust standard errors. Standard errors are displayed in parentheses. Relevant birth cohorts, see Table 1.8. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations. Rounded off to the third decimal place. Analysis includes individuals who survived at least the age of 65 and whose type of retirement is not pension for invalids. Retirement age is limited to ages 65 and under. In addition, first type of retirement equals current retirement status.

Table 1.15: Propensity Score Matching – Probit

Dependent variables: Dummies indicating treatment of early old-age pension, zero otherwise

	Probit			
	survived 70	**survived 75**	**survived 80**	**survived 85**
Socio-Demographic Variables				
birth year	-0.306	0.119	0.415	0.080
	(0.001)	(0.001)	(0.003)	(0.032)
family status				
re-,married	0.124	0.097	0.044	0.039
	(0.004)	(0.005)	(0.010)	(0.096)
sex				
female	2.309	1.287	0.557	0.201
	(0.007)	(0.007)	(0.015)	(0.125)
number of children				
1	0.264	0.217	0.108	0.355
	(0.007)	(0.008)	(0.018)	(0.147)
2	0.422	0.364	0.255	0.281
	(0.006)	(0.007)	(0.017)	(0.155)
3	0.472	0.440	0.342	0.355
	(0.007)	(0.008)	(0.019)	(0.187)
4	0.507	0.507	0.430	0.319
	(0.009)	(0.010)	(0.023)	(0.265)
5 or more	0.513	0.606	0.612	0.020
	(0.010)	(0.011)	(0.023)	(0.330)
citizenship				
foreign	0.666	0.948	0.998	0.613
	(0.007)	(0.007)	(0.015)	(0.119)
foreign pension time				
GDR	2.490	0.107	-0.308	-0.396
	(0.241)	(0.013)	(0.023)	(0.312)
other	0.311	0.356	0.539	0.294
	(0.012)	(0.011)	(0.019)	(0.140)
Retirement-Relevant				
byvl	0.100	0.088	0.066	0.042
	(0.000)	(0.000)	(0.001)	(0.004)
psegpt	0.018	0.020	0.017	-0.003
	(0.000)	(0.000)	(0.000)	(0.003)
auaz	0.003	0.015	0.003	0.011
	(0.001)	(0.001)	(0.001)	(0.007)
ajaz	0.014	0.012	0.011	0.004
	(0.000)	(0.000)	(0.000)	(0.004)
constant	586.457	-234.621	-805.175	-157.902
	(2.038)	(1.675)	(5.887)	(61.394)
Pseudo R^2	0.580	0.502	0.418	0.105
Observations	1,156,788	849,839	231,000	5034

Notes: The model is estimated using robust standard errors. Standard errors are displayed in parentheses. Relevant birth cohorts, see Table 1.8. Data: FDZ-RV – SUFRTBNRTWF04-13; own calculations. Rounded off to the third decimal place.

Table 1.16: Propensity Score Matching – Overlap and Common Support

	Overlap and Common Support					
	Minimum			**Maximum**		
	Before	**After**	**Treatement**	**Before**	**After**	**Treatment**
Survived 70						
propensity score	$3.41x10^{-12}$	$2.50x10^{-7}$	$2.50x10^{-7}$	0.9999924	0.9999924	1
Survived 75						
propensity score	$2.42X10^{-6}$	$4.74x10^{-6}$	$4.89x10^{-6}$	0.9999098	0.9999098	0.9999003
Survived 80						
propensity score	$5.57x10^{-9}$	0.0000241	0.0000241	0.9951046	0.9951046	0.9983278
Survived 85						
propensity score	0.0003381	0.004852	0.0048577	0.3905379	0.3465074	0.3404922

Notes: Nearest neighbour matching without replacement. Before and after refers to the use before and after matching algorithm. Estimation without individuals with pension due to unemployment or part-time work. Treatment group are individuals with pension for longtime insured or women. Adjusted group (control group) are individuals with regular old-age pension.

Table 1.17: Propensity Score Matching – Matching Quality

Matching Quality

	Achieved Percentage Reduction in Standardised Bias			
	survived 70	**survived 75**	**survived 80**	**survived 85**
Socio-Demographic				
birth year	35.7	25.9	36.4	90.8
family status				
re-, married	5.3	-2.3	89.1	59.0
sex				
female	52.2	-965.0	97.9	80.8
number of children				
1	25.6	27.4	88.8	18.2
2	61.7	-227.2	88.4	70.8
3	-88.6	-33.0	95.3	-104.4
4	-622.0	32.9	99.2	51.0
5 or more	-519.3	-67.2	89.2	67.6
citizenship				
foreign	18.8	-6.1	-238.2	-83.9
foreign pension time				
GDR	0.0	7.1	89.2	-52.7
other	12.3	14.9	51.3	39.3
Retirement-Relevant				
byvl	15.9	15.6	79.9	89.9
psegpt	14.1	12.5	77.9	84.4
auaz	12.4	18.0	83.4	54.9
ajaz	15.8	23.0	90.4	73.3

Notes: Nearest neighbour matching without replacement. Estimation without individuals with pension due to unemployment or part-time work. Treatment group are individuals with pension for longtime insured or women. Adjusted group (control group) are individuals with regular old-age pension. The percentage reduction of the standardised bias is rounded off to the first decimal place.

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Chapter 2

Additional Earnings Ceiling During Retirement – Analysis of the Effects on Labour Force Participation in Germany

Abstract

Pensioners in Germany who enter early old-age retirement scheme face an additional earnings ceiling until they reach the regular pension eligibility age. In comparison, regular old-age pensioners do not have any earning limits at all. Using administrative data of the German Pension Insurance in combination with panel data of the German subsample of the SHARE data source, a model is constructed which considers the heterogeneity of labour force participation over different types of old-age retirement. It also accounts for age differences of early and regular old-age pensioners when entering retirement. Assuming a common growth of early and regular old-age pensioners, results using Difference-in-Differences (DiD) indicate that the additional earnings ceiling does not have any effect on the growth of labour force participation for pensioners in Germany between 1986 and 2013. In addition, there are signs that the additional earnings ceiling in Germany negatively affects the amount of work during retirement.

JEL codes: J32, J26

2.1 Introduction

Early old-age retirement options within the German Pension Fund were largely introduced in the 1970s (Deppe and Foerster 2014) to stimulate the employment of younger workers. To restrict the entry into early old-age pension, potential retirees face an additional earnings ceiling (*Hinzuverdienstgrenze*) when entering retirement. The additional earnings ceiling prevents the possibility of two incomes, i.e. out of labour and pension payment, to certain extent (§ 34 SGB VI, 2019). Earning restrictions are lifted once the regular legal retirement age is reached (§ 34 II SGB VI, 2019).

Due to demographic ageing of the German workforce (Borsch-Supan and Schnabel 1998), the continued employment of older people becomes more relevant and is additionally supported by recent political reforms (Bundesgesetzblatt 2016). The idea of these reforms is to ease the transition from working into retirement and to increase the fraction of older people in the workforce. However, the general framework preventing excess earnings when entering early retirement has not changed over past reforms.[1]

From a theoretical standpoint, an earnings ceiling limits the amount of supplied labour if the chosen limit is binding. If restrictions on supplementary income are too high, it can lead to the total termination of supplied work. This paper answers the question of how the additional earnings ceiling during early retirement affected labour force participation of early old-age pensioners in Germany between 1986 and 2013.[2]

The paper is organised as follows. Section 2.2 presents the regulatory framework of the additional earnings ceiling when entering retirement in Germany. Section 2.3 provides information on the underlying data sets and the construction of relevant variables. Section 2.4 shows empirical findings of labour force participation of older people by comparing pensioners who are affected by additional earnings ceiling (early old-age pensioners) with pensioners who are not affected (regular old-age pensioners). Section 2.5 describes the strategy of identification of the effect of additional earnings ceiling on labour force participation while section 2.6 presents the results. Section 2.7 concludes.

1. Although working during retirement has become more flexible due to past reforms (*Flexirentengesetz*) an upper limit of additional earnings during retirement, the so-called *Hinzuverdienstdeckel*, is still in effect.

2. The additional earnings ceiling is relevant for all own pensions which start before the regular pension eligibility age. Although invalidity pensions face an additional earning ceiling too, this type of pension is not analysed in the following.

2.2 Additional Earnings Ceiling in Germany

Regulatory Framework

When entering early retirement pensioners face an additional earnings ceiling up to the effective regular pension eligibility age (§§ 34, 96a SGB VI). Therefore, the additional earnings ceiling is valid for any type of pension[3] that offers the possibility of an entry into retirement before regular pension eligibility age.[4] In contrast, regular old-age pensioners who enter retirement after they reach the regular pension eligibility age have no earnings limit at all. Pension entitlements before the regular pension eligibility age are only valid if the effective limit of additional earnings is not exceeded. If the individual amount of additional earnings are too high, it can lead to the complete loss of pension entitlement by the German Pension Fund.

In the analysed period, early old-age pensioners are allowed to increase the individual amount of earnings by resigning one-third, half or two-thirds of the pension income. By doing so, the additional earnings ceiling is increased on an individual amount.[5] But, due to difficult administrative guidelines and potential losses of earnings[6] general acceptance was low. In the analysed sample of pensions in payment only three out of 1948 individuals, which is about 0.15 percent, used this kind of pension.[7]

The introduction of new guidelines with respect to the additional earnings ceiling in 2017 (*Flexirentengesetz*) simplified additional earnings above the exemption amount of 6300€ annually.[8] But, additional earnings limits are still in effect.

The additional earnings ceiling for individuals entering retirement before the regular pension eligibility age was introduced in 1972 (Bundesgesetzblatt 1972). According to the first guidelines, pensioners faced an additional earnings ceiling of one eighth of the individual contribution assessment ceiling (*Beitragsbemessunsgrenze*) in a year. These individual limits were replaced in 2008 by a fixed amount. Table 2.1

3. Pensions which are not paid out of an own assurance entitlement, e.g. survivors' pensions do not exhibit an additional earnings ceiling at all.

4. The regular pension eligibility age is 65. For birth cohorts after 1946 the pension eligibility age is increased gradually up age of 67. For exemptions to these guidelines, see § 235 II SGB VI.

5. The amount of additional earnings with part-pensions is computed individually and depends on the last three calendar years. Even more, the place of work, i.e. former East (excluding Berlin) or former West German states, has an influence on the amount of the additional earning ceiling.

6. An excess of the individual additional earnings ceiling is combined with a step backwards to the next lower part-pension. That means that just one Euro of earnings above the individual additional earnings ceiling leads to a disproportional loss as pensioners fall to the lower limit of the part-pension, e.g. from one third part-pension to zero.

7. Evaluating the Scientific Use File of pensions in payment by the German Pension Fund in 2015 (*Versicherungsrentenbestand*) the share of pensioners using part-pensions is even lower, approximately 0.08 percent.

8. Although the level of 6300€ is identical to previous earning limits, the level of the additional earnings ceiling shifted from a monthly to annual determination. This step makes it easier for pensioners with seasonal work or self-employed persons to work during retirement.

Table 2.1: Earnings Ceiling per Month in Euro – 1992-2013

	Earnings			
	General (§ 34 SGB VI)	**Care (§ 37 SGB XI)**		
		Level of Care		
Relevant since		I	II	III
1st January 1992	$\frac{1}{7}$ of monthly reference value			
1st April 1995		205	410	665
1st January 2008	400			
1st July 2008		215	420	675
1st January 2010		225	430	685
1st January 2012		235	440	700
1st January 2013	450			

Notes: Earnings out of care are not relevant for the additional earnings ceiling according to § 34 SGB VI. Exceeding general earnings twice in a year by its actual amount is allowed. In 2002 earnings were revalued from Deutsche Mark into Euro; no change with respect to the amount. Source: Federal Law Gazette (Bundesgesetzblatt), General Earnings: BGBl. I p.2261 (1989), BGBl. I p.1824 (1995), BGBl. I p.2167 (2002), BGBl. I p.554 (2007), BGBl. I p.681 (2008), BGBl. I p.2474 (2012), Care: BGBl. I p.1014 (1994), BGBl. I p.830 (1996), BGBl. I p.2702 (2001), BGBl. p.874 (2008).

lists the additional earnings limits from 1992 to 2013. In contrast to the first guidelines introduced in 1972, the analysed additional earnings limits were calculated on a monthly basis. Exceeding general earnings twice in a year by its actual amount is allowed. The monthly determination of the additional earnings ceiling is replaced by a yearly determination in 2017.[9]

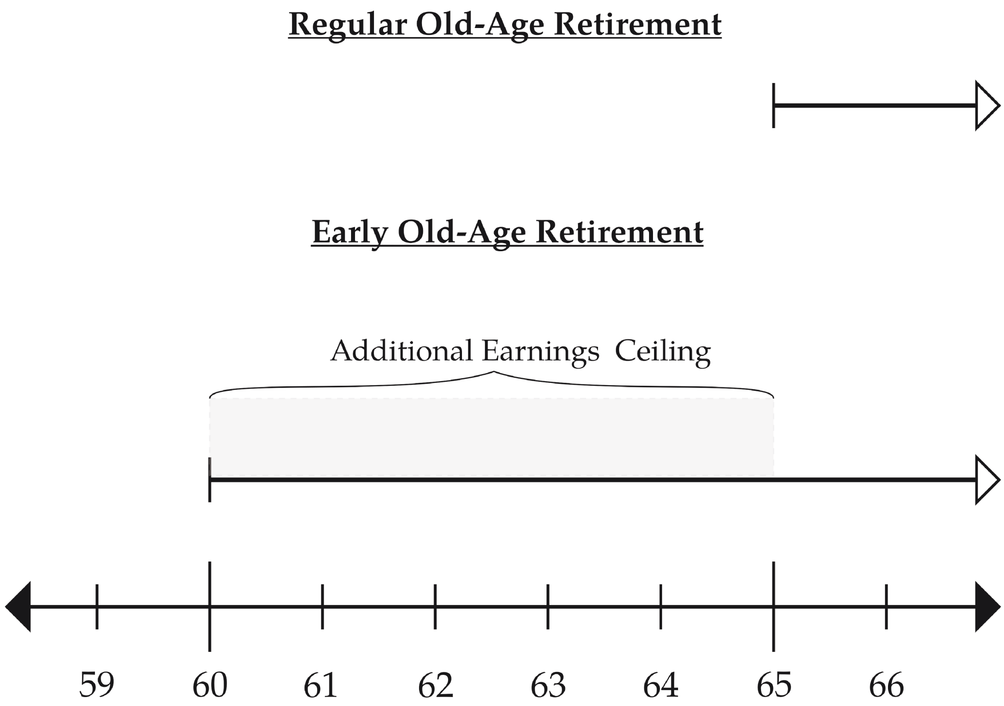
These earnings are relevant for the additional earnings ceiling which originate from being self-employed or employee during retirement. In addition, in 2003 comparable earnings, e.g. earnings from a representative function or early retirement benefits are relevant for the additional earnings ceiling, too (Bundesgesetzblatt 2002). However, income from rent and leasing or other capital income is irrelevant for the additional earnings ceiling. Moreover, allowances for nursing care in terms of § 37 SGB XI do not count towards the additional earnings ceiling. These guidelines refer to pensioners who nurse needy people. The level of care depends on the needs of the person in care.[10] Table 2.1 gives an overview of exempted earnings depending on the level of care and year. The exempted earnings increase with severity of the needy individual. Handicapped persons who work in special institutions according to § 1 SGB VI are also exempted from the additional earnings ceiling.

The length of the period of the additional earnings ceiling depends on the entry into retirement and the effective regular pension eligibility age. Figure 2.1 illustrates the period of the additional earnings ceiling assuming an entry into retirement at the age of 60. The regular pension eligibility age in the figure is 65, which is the valid one for the majority of individuals in the analysed data set, i.e. for over 95 percent. Within the figure, the illustrated period of the additional earnings ceiling covers five

9. From the first of July 2017 the monthly earnings ceiling of 450€ is removed. The tax-free amount of 6300€ per year stays the same. Earnings above this amount are taxed with a tax-rate of 40%.

10. With the begin of 2017 the level of care changed to a system of five grades of care, see *Zweites Pflegestärkungsgesetz - PSG II* for details.

Figure 2.1: Illustration of the Additional Earnings Ceiling in Germany



Notes: Illustration of the additional earnings ceiling during retirement. The illustration assumes a regular pension eligibility age of 65.

years. The particular period of the additional earnings ceiling depends on the type of early old-age pension and on the time during which the individual fulfils the requirements of the respective type of pension and enters into retirement. There are five types of early old-age pension recorded in the data. There is the pension for women, pension due to unemployment and part-time work, pension for disabled persons, pension for longtime insured persons, and the pension for really longtime insured persons. Whereas the first three types of pensions offer the possibility of entering retirement at age of 60 at the earliest, pensioners having one of the last two types of pensions are allowed to enter retirement at 63 at the earliest. As the pension type of really longtime insured persons was introduced recently the fraction of pensioners having this type of pension is marginal. In contrast, the majority of analysed individuals receive the regular old-age pension. This type of pension starts at the age 65 and increases step-wise for later birth cohorts. The majority of pensioners obtaining this type of pension have an eligibility age of 65. As regular old-age pensioners enter retirement only after they having reached the regular pension eligibility age, none of them exhibit an additional earnings ceiling.

Economic Evaluation

On the one hand, restricting the labour force participation of pensioners in a mainly pay-as-you-go financed pension scheme[11] may be reasonable from a sociopolitical standpoint as current workers pay the pensions for current pensioners. If pensioners would not suffer from an additional wage ceiling, they could otherwise compete with those individuals who finance an important part of their monthly earnings. Moreover, an additional earnings ceiling leads to a backward shift of entry into retirement for potential pensioners as it is less attractive to enter retirement at earlier ages. Therefore, the additional earnings ceiling indirectly stabilises the budgeting of the German Pension Fund.

On the other hand, the German Pension Fund is based on the principle of merit. In this context, it means that entry into retirement itself is based on individual requirements, for example years of contribution to the pension scheme.[12] According to that, it is debatable to restrict retirement earnings for those who contributed more while pensioners with less contribution periods face no additional earnings ceiling when entering the regular old-age pension type.[13] From an economical point of view, any restriction of the potential labour force is inefficient, especially if one is interested in an increase of the fraction of a particular group, as is the case for Germany. This is even more true for old-age pensioners who offer above average work experience.

Due to asymmetric information the individual amount of participation in the labour market is a priori not clearly visible to the social planner. Therefore, early retirement options can be an incentive to reduce labour force of older people.[14] Therefore, assuming that individuals' knowledge is the best source for their respective willingness to participate in the labour market, individuals should determine the entry into retirement themselves. To some extent, this flexibility is achieved by deductions and additions when shifting entry into retirement. But, these cuts and benefits are too small in size (Börsch-Supan 2004) so that a majority of pensioners tend to retire as soon as they reach pension eligibility age (Just 2019). Therefore, if the official

11. Pay-as-you-go refers to a system where you have to pay before you actually use the particular service. Here, the current workforce pays the majority of present costs of the pension payments. By doing so, workers qualify for future pension payments.

12. Although contribution periods are a main factor for pension eligibility of early old-age pensions, higher contribution periods do not automatically lead to earlier entry into retirement. Whereas pension eligibility age was at the earliest 60 for pensioners with a pension for women these pensioners do not need to have as many contribution periods as longtime insured persons who can enter retirement at the earliest of 63 in the analysed time interval. Therefore, other requirements are also relevant for entry into retirement.

13. On average, regular old-age pensioners exhibit fewer fully valued contribution periods than early old-age pensioners. This is true for every type of early old-age pension in the data set.

14. If early retirement options are too generous, individuals tend to retire earlier than they would without those options in effect. If early retirement options are too restrictive, people work longer or terminate their participation in the labour market before they enter retirement.

age of entry into retirement is too generous, the labour force shrinks as the additional earnings ceiling prevents the full participation of the respective work force.

All early retirement options, i.e. invalidity and early old-age pensions, face an additional earnings ceiling. Therefore, anticipatory behaviour of shifting the type of pension to circumvent the additional earnings ceiling is only possible if the individual enters retirement after the legal pension eligibility age.

The size of the additional earnings ceiling was standardised in 2008 by 400€ and increased over time to 450€ per month in the analysed period, see Table 2.1. The presented limits of the additional earnings ceiling over time are comparable to earnings of employees with a minor employment (*Minijob*). It is worth noting that due to given limits of the additional earnings ceiling, pensioners compete with those employees who already have a lower probability of finding an adequate employment. In addition, the change from yearly limits to monthly limits of the additional earnings ceiling complicates irregular employment as is the case for seasonal employees and self-employed pensioners. This problem was fixed by recent reforms which came into effect in 2017.

Exceptions for additional earnings ceiling are possible with regard to type of earnings and group of people. Whereas earnings out of labour are affected by additional earnings ceiling, earnings out of capital are not affected by the additional earnings ceiling at all. As the main source of pension payments is out of labour, this is a reasonable measure. However, as the fraction of expenses of tax-funded pension payment is increasing, the separation of earnings sources with regard to the additional earnings ceiling does not have to be fixed over time. The group of retirees with an additional earnings ceiling does not cover disabled persons in certain facilities. Moreover, pensioners' earnings out of care of high-maintenance individuals at home are exempted from the additional earnings ceiling, too. The amount of the exemption depends on the individual level of care. For details, see the right part of Figure 2.1. Although given limits orientate on the needs of the high-maintenance individual who is often in a close relationship with the caring pensioner, any exemptions of the additional earnings ceiling in one sector penalise those pensioners who exhibit earnings in other sectors. Moreover, those exemptions of the additional earnings ceiling lead to higher competition on the market of nursing and increases the pressure of labour costs for regular employees.

2.3 Data

The data set consists of two independent data sources. On the one hand, administrative data of pensions in payment (*Rentenbestand*) from the Research Data Centre of the German Pension Fund (FDZ-RV 2015) between 2009 and 2013 is used. This data source gives access to detailed information regarding entry into retirement on an individual level. On the other hand, survey data from wave 1, 2, 4, and 5 (2004-2013) of the German subsample of the SHARE panel data (Börsch-Supan et al. 2013) is the basis for the identification of labour force participation and other relevant variables. Both data sources can be matched by social security number if respective participants of the SHARE agreed to this action (Korbmacher and Czaplicki 2015).[15]

Labour force participation in a given year is constructed out of five different indicators which are available in each wave. Participants of the SHARE were asked if they did any paid work in the last four weeks before the interview and if they had any earnings from (self-) employment in the previous year. In addition, retrospective questions of the beginning of the current employment and end of last job were used for the generation of labour force participation in a given year. Due to that, detailed information on labour force participation of each individual before and after entry into retirement can be obtained. Data of labour force participation before entry into retirement is important for two reasons. First, it is an indication if differences of labour force participation during retirement can be explained by previous employment before retirement. Second, employment history before entering retirement is necessary when it comes to the identification of the effect of the additional earnings ceiling on labour force participation during retirement.[16]

As this analysis focuses on old-age pensioners only[17], those pensioners who exhibit any time of invalidity pension are excluded. This is achieved by choosing only those old-age pensioners whose current pension is equal to first pension. By doing so, one can identify old-age pensioners only, but pensioners whose pension is revalued or changed by a switch to part-time pension are automatically excluded from the analysis.[18]

Age at entry into retirement can be determined exactly on a monthly basis[19]. The determination of the age of the individual for any year of given information on labour force participation is achieved by the difference of the reporting year and the date of birth.[20] The regular pension eligibility age is based on data of the German Pen-

15. The linkage rate in wave 3 and 4 was about 50%.

16. For details see subsection 2.5.

17. As the entry into an invalidity pension requires a poor health status, which is directly related to labour force participation during retirement, pensioners with this type of pension are not part of the analysis – although they face additional earnings ceiling, too. In contrast, entry into early old-age pensions does not require a poor health status.

18. As already the fraction of part-pensions is low, due to this step the chance of having pensioners with an individual size of an additional earnings ceiling in the data set is close to zero.

19. Those observations whose age at entry into retirement is below 60 – which is the lowest age of entry into retirement for old-age pensioners – are deleted in the given sample.

20. For retrospective information on labour force participation no monthly accuracy is available in the data. Therefore, the calculated difference of reporting year and date of birth is lowered by one year for individuals with month of birth later than June, in contrast to individuals with month of birth between January and June. Potential effects of this step on the achieved results is tested in the

sion Fund, namely type of old-age pension, year of birth and possible time working in mining industry (knbt) and is determined by Federal Law Gazettes (*Bundesgesetzblätter*). Within the analysed sample, the regular pension eligibility age for the majority of pensioners is 65 years. Based on the raw data, 95.4% exhibit this regular pension eligibility age.[21] Early old-age pensioners are those individuals which enter retirement before the actual legal regular pension eligibility age.[22] Regular old-age pensioners are therefore individuals whose age of entry into retirement is equal or higher than the corresponding regular pension eligibility age. The assignment of having an additional earnings ceiling for early old-age pensioners is based on the respective age in the reporting year, i.e. if the age is lower than the regular pension eligibility age.

For the analysis a set of control variables is used which are time invariant[23] in the analysed period. This applies to sex of the individual, a variable, region, which identifies inhabitants of former GDR and BRD, the school leaving certificate, a variable indicating the graduation of the pensioner, and the amount of children.

To measure the influence of the additional earnings ceiling on the size of supplied labour during retirement[24], potential actions of avoidance of employment restriction due to the additional earnings ceiling can be analysed. Therefore, different activities which can be executed otherwise indicate potential effects on the quantity of supplied labour. For this reason, dummy variables indicating whether the respective individual does weekly voluntary or charity work, attended educational or training course, club meetings, or is taking part in religious organisations are added to the data set. Moreover, "given help to someone outside the household" and "individual looks after grandchildren" are activity dummies which give information about the last twelve months.

This data set offers the possibility of studying labour force participation and possible side effects which arise out of the additional earnings ceiling for early old-age pensioners. For descriptive analysis, given weights of the SHARE data set are used to calculate representative estimates of the underlying population of older people in Germany (Börsch-Supan et al. 2013). An overview of given and constructed variables

sensitivity part of the paper, 2.6.

21. The regular pension eligibility age is increased step-wise to 67 years. In the given sample the highest regular pension eligibility age is 65.5 for individuals born at birth year 1952.

22. A small fraction, 0.98 percent, of regular old age pensioners are attributed to early old-age pensioners. As it is a priori unknown whether there is a specification error in the assignment of type of old-age pension or in the construction of age of entry into retirement, observations were not excluded from the sample. Excluding them does not change results, either. Estimates are available upon request. Moreover, a model using type of old-age pension instead of early and regular old-age pension can be found in the sensitivity section, 2.6.

23. As the identification strategy requires data on retrospective labour force participation time varying variables cannot be used for the analysis

24. Although the SHARE survey asks for the amount of work, the actual response rate is rather low. Therefore actual data of the amount of employment in hours cannot be used.

used for the analysis can be found in the appendix, Table 2.8.

2.4 Labour Force Participation and Retirement in Germany

In this section an overview of empirical findings of employment during retirement based on the created data set is presented. The analyses focus on a comparison of early and regular old-age pensioners' labour force participation. By doing so, different motives and incentives of entering retirement and employment before and after retirement of both groups will be discussed. Socio-demographic differences of pensioners employment behaviour are analysed, too.

Table 2.2: Share of Pensioners Working by Type of Old-Age Pension – 2013

		Paid Work Last 4 Weeks	Worked Last Year (2012)
		in %	
Early Old-Age Retirement	**Yes**	10.93	15.29
	No	89.07	84.71
Regular Old-Age Retirement	**Yes**	10.32	15.86
	No	89.68	84.14
Individuals	**n**	1278	1363
Equality of Means	**t-test**	-0.32	-0.32

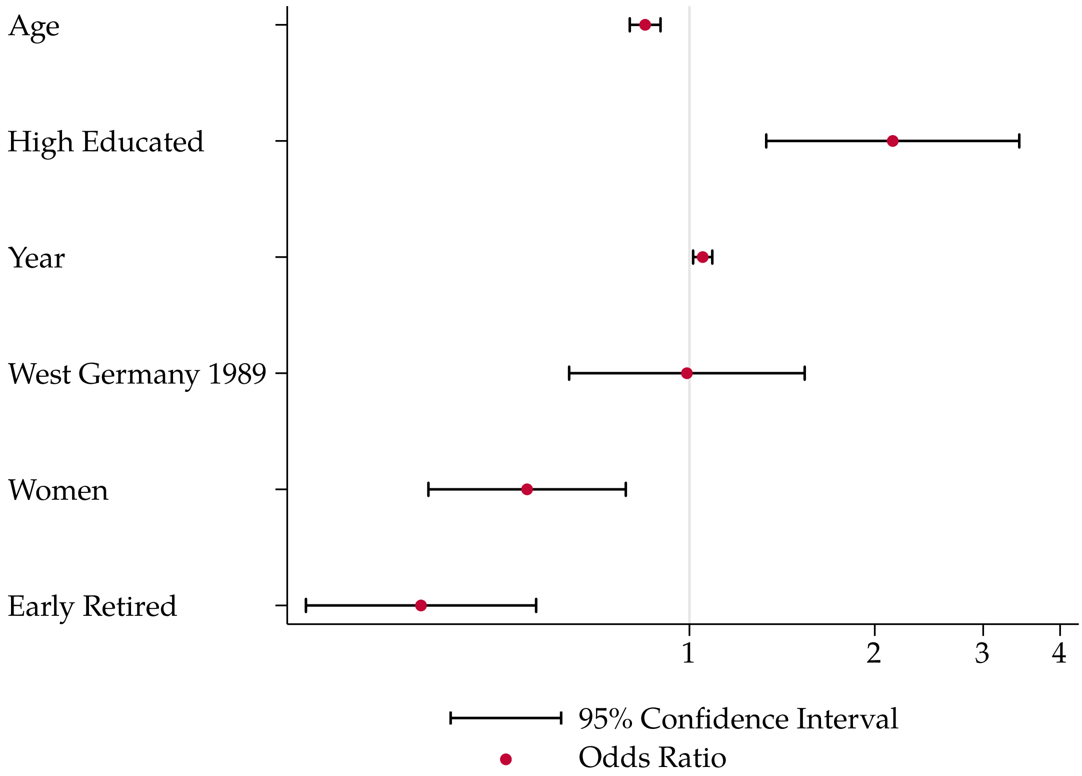
Notes: Data: SHARE-RV, SHARE: Wave 5 (Release 5-0-0), RV: pensions in payment (Release 3-0-0). Own calculations. Only old-age retired individuals with current retirement status identical to earliest retirement entry are used. Weighted using calibrated cross-sectional weights for Wave 5 on individual level. Calibration reflects the size of targeted population (50+) across 8 gender-age groups and across NUTS1 regional areas (states). For "Worked Last Year" only individuals were used who did not enter retirement the year before interview. The values of t-test display the corresponding t-value of equality of means of both groups, i.e. early and regular old-age pensioners. The t-value neglects stratification and the multi-staging process of the underlying sample.

The share of old-age pensioners working during retirement depends on the chosen proxy of Table 2.2 and varies between approximately 10 and 16%. Table 2.2 shows the results separated by type of old-age pension. The two indicators of labour force participation, paid work in the last four weeks since the interview and whether the pensioner worked the last year at any time, show no significant differences between both groups of old-age pensioners. The difference of both indicators can be attributed to the lower time span of a potential employment in the first case. In addition, more than 50% of the amount of interviews were performed in February and March, were seasonal conditions of the weather led to lower demand of labour. This may be especially relevant as for the majority of pensioners the type of employment is a minor employment (Hochfellner and Burkert 2013). Due to different scope of the variables general time trends are not identifiable.[25]

25. For changes in employment behaviour during retirement, see for example results of the logistic model in Figure 2.2.

The chance of take up employment for old-age pensioners is not equal over the population. Therefore, a model is constructed which explains the probability of employment during retirement by socio-demographic variables. This model is estimated via a logistic function. The model includes all old-age pensioners without any invalidity pension. As individuals can potentially appear several times in the data, standard errors allow for intragroup correlation of the particular individual. The model includes 8569 observations from 1107 individuals.

Figure 2.2: Probability of Employment during Retirement by Socio-Demographic Determinants – Logit



Notes: Data: SHARE-RV. 8569 observations; 1107 individuals; own calculations. Only old-age retired individuals with current retirement status identical to earliest retirement entry are used. Results are based on logit estimation including a constant. Standard errors allow for correlation within groups (individual). Odds ratio is plotted on logarithmic scale. 92.34% correctly classified. McFadden's R^2 is approximately 0.073.

Figure 2.2 shows the odds ratio[26] and corresponding confidence intervals of relevant control variables on a log scale of the estimated model.[27] The presented model includes the age of the pensioner, the school leaving certificate, the reported year, if the pensioner lived before the Fall of the Berlin Wall in West Germany or the German

26. Odds ratio is the probability of success, i.e. being employed, over the probability of failure, i.e. not employed.

27. For detailed coefficients and standard errors, as same as measures of goodness of fit, see Table 2.9.

Democratic Republic (GDR)[28], sex and type of old-age pension.[29]

The interpretation of the direction and significance of estimates presented on Figure 2.2 is straightforward. Odds ratios which are located on the right from the value 1 displayed on the abscissa imply that an increase by one unit is associated with a higher probability of an employment during retirement.[30] Analogously for odds ratios on the left. Using given confidence intervals allows conclusion of statistical significance on a five percent significance level. Confidence intervals which overlap the vertical line of the value one imply the non-significance of the underlying odds ratio.

The age of the pensioner does have a significant influence on the probability of employment. Estimates of the model imply that an increase in age is associated with a lower probability of labour force participation. This is in line with descriptive analysis of employment trends with increasing age, see Figure 2.8 in the appendix. The level of education, i.e. finished specialised secondary school (*Fachhochschulreife*) or qualification for university entry, is significantly positively correlated with employment probability. General year effects are identifiable in this model. All other variables being constant, employment probability is increasing with reporting years. In contrast, lived in West Germany or former GDR before Fall of Berlin Wall does not have any influence on the probability of employment during retirement. Figure 2.2 implies that women exhibit a lower probability of employment during retirement.[31] Former results of Table 2.2 imply that there are no differences between the share of employment of early and regular old-age pensioners. Controlling for the given age one can conclude that early old-age pensioners, all other variables fixed, exhibit a lower probability of employment. The reason for differences in Table 2.2 and Figure 2.2 between early and regular old-age pensioners' amount of labour force participation is the control for the variable age. Whereas Table 2.2 does not control for the effect that early old-age pensioners retire at a lower age, the presented model accounts for age differences. Bringing both results together – no differences between the share of work of both groups of pensioners and lower labour force participation of early old-age pensioners when controlling for age differences – it is implied that the length of being retired, rather than actual age, determines the level of aggregated labour force participation during retirement. This is tested in the next subsections.

28. Individuals living outside German territory in 1989 are excluded from the model.

29. Different models with regard to the inclusion of a control variable of having children or not and different specifications of the level of graduation can be found in the appendix on Table 2.9.

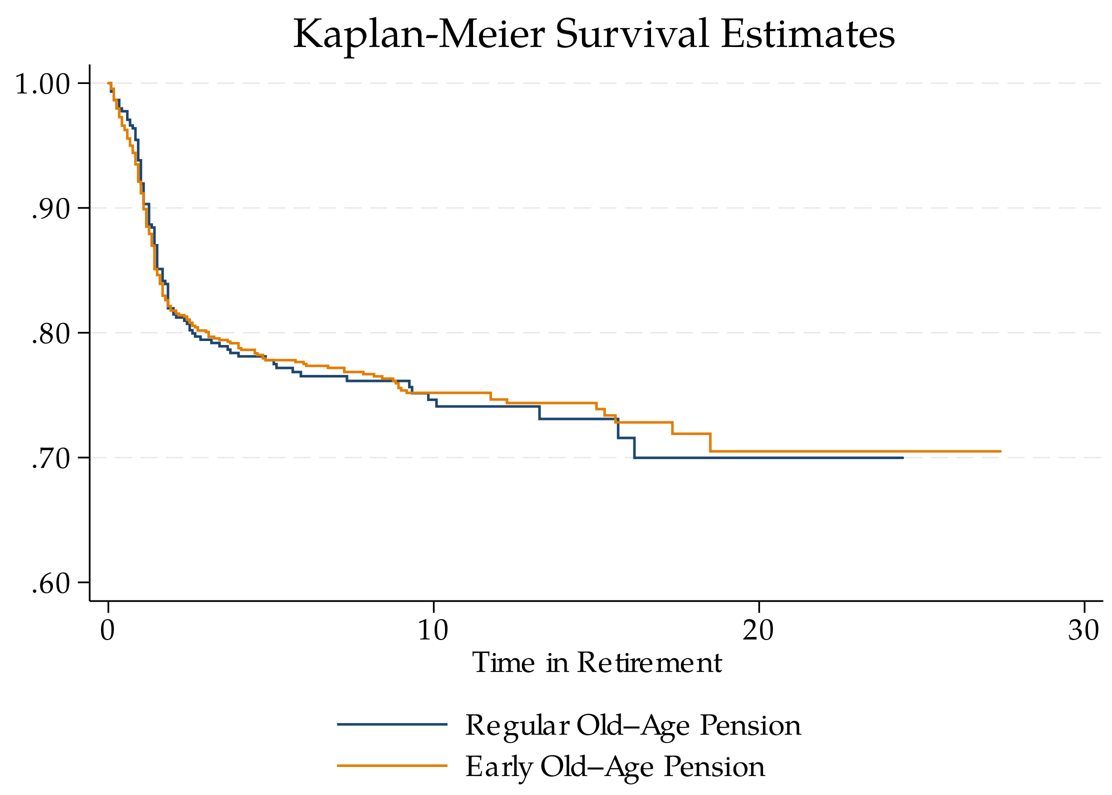
30. If the variable of the figure is a dummy odds ratios on the right side of value one imply higher chance of employment if the dummy is one. Analogously for values on the left side of value 1.

31. Regression results which can be found in the appendix show that the negative and significant effect of being female on labour force participation during retirement vanishes if one controls for children. But, due to definition of the variable children the variable can be seen as a proxy for sex itself. The underlying variable zlki12 records children if they are necessary for the computation of the amount of the pension payment. This is mostly the case for women.

Employment During Retirement – Begin and Duration

To test the relevance of the length of being retired on labour force participation, both groups of old-age pensioners are compared along the time interval of being retired. By doing so, one disregards the fact that early old-age pensioners exhibit by definition a lower age when entering retirement. If results show no significant differences between both groups of old-age pensioners, this would imply that the length of being retired determines the amount of aggregated labour force participation. If that is the case, the actual age of the pensioner is of minor relevance for the labour force participation.

Figure 2.3: Time Until First Employment During Retirement by Type Old-Age Pension



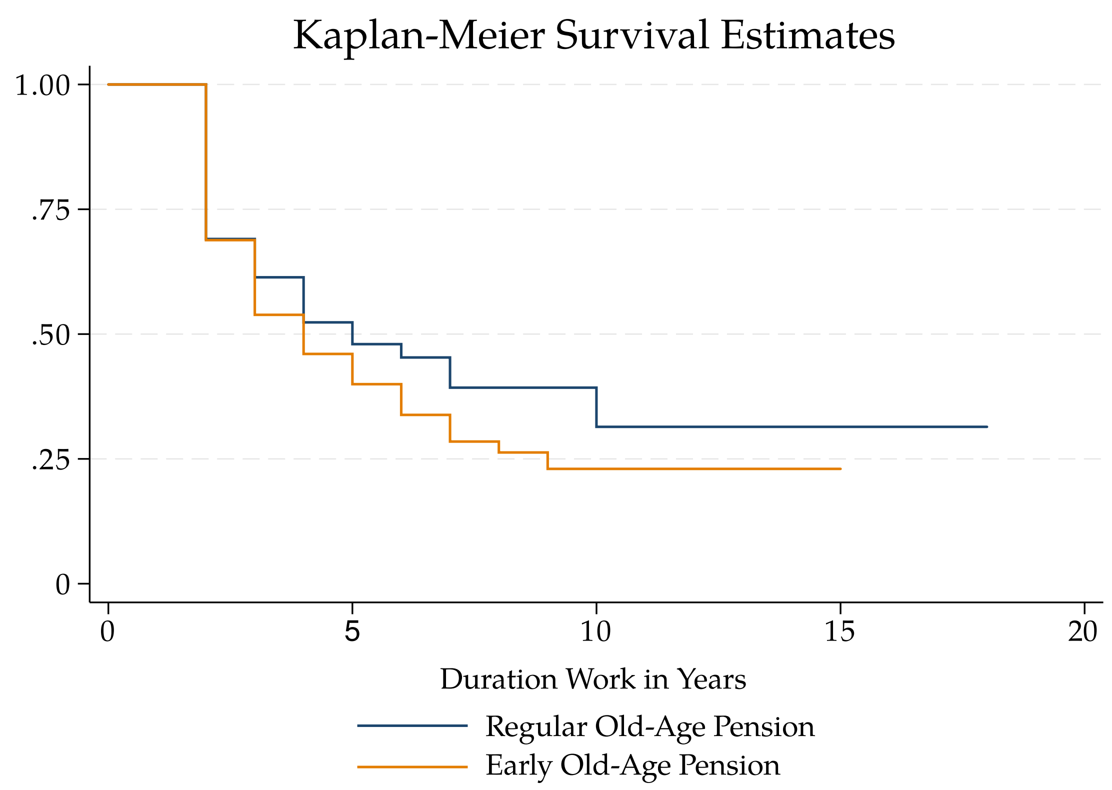
Data: SHARE-RV. 9295 observations; 1330 individuals, 316 not censored; own calculations. Only old-age retired individuals with current retirement status identical to earliest retirement entry are used.

For that purpose Kaplan-Meier survival estimates are used to analyse potential differences of early and regular old-age pensioners with respect to beginning and duration of work when entering retirement. To evaluate the significance of potential differences, models[32] are estimated via Cox proportional-hazards.

32. Can be found in the appendix, see tables 2.10 and 2.11.

Figure 2.3 analyses how much time it takes to begin the first employment separated by type of old-age pension. At first around 70 percent of all pensioners in the given data set do not start an employment during retirement. Second, the slope of survival graphs is decreasing with increasing time of being retired. That means, approximately two-thirds of pensioners who work during retirement begin their employment within the first two and a half years of retirement. Third, there are no differences[33] for early and regular old-age pensioners although early old-age pensioners exhibit a lower age of entry into retirement. This supports the hypothesis that the length of being retired determines the aggregate level of labour force participation rather than actual age of the pensioner.

Figure 2.4: Length of Employment During Retirement by Type Old-Age Pension



Data: SHARE-RV. 1027 observations; 322 individuals, 137 not censored; own calculations. Only old-age retired individuals with current retirement status identical to earliest retirement entry are used.

Figure 2.4 presents the duration of employment of those who actually start their employment during retirement.[34] Approximately 25 percent of pensioners in employment do not end their employment even after 15 years and beyond. Around

33. Table 2.10 shows no significant differences of hazard ratios between early and regular old-age pensioners.

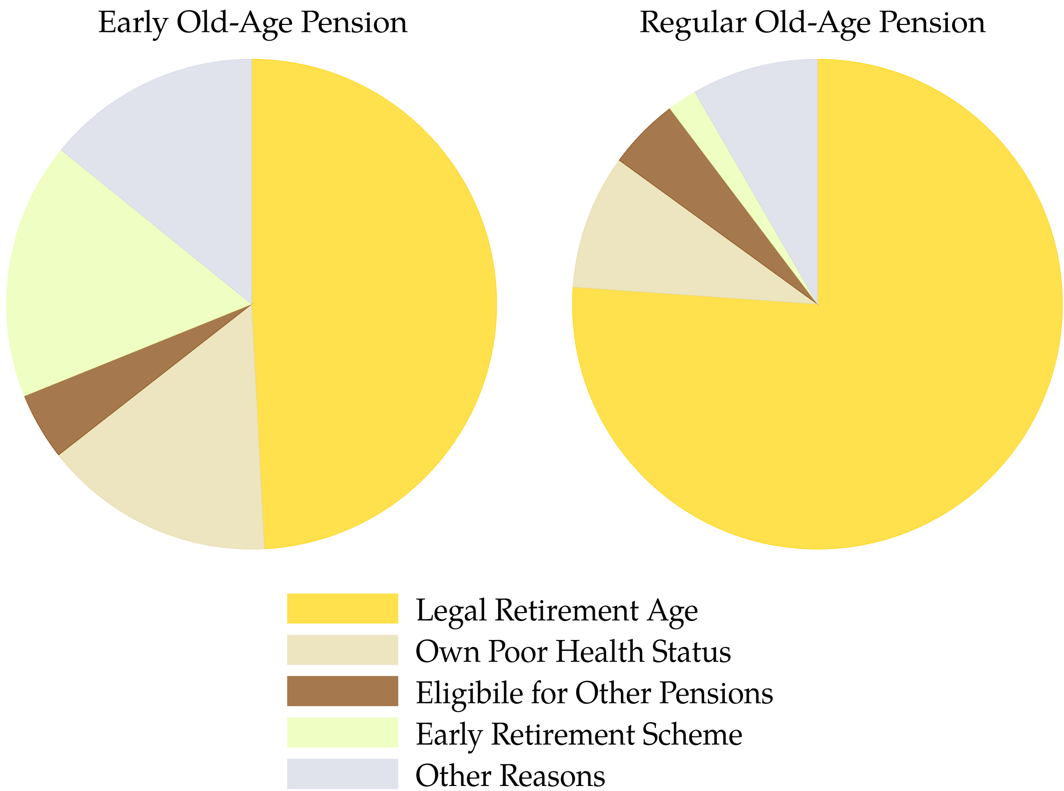
34. Therefore, individuals starting retirement without quitting the previous employment are not analysed.

50 percent of all pensioners working quit their employment within the first three or four years. There are some differences in survival rates between early and regular old-age pensioners implying that the duration of employment is longer for regular old-age pensioners. But, results of Table 2.11 show no statistical differences in hazard ratios. Because of that, results imply that the duration of employment does not differ by type of old-age pension.

Reasons for Entering Retirement

Although having an age advantage, early old-age pensioners do not exhibit a higher duration of employment. Therefore, they must differ in certain characteristics which are relevant for labour force participation during retirement. For that purpose pie charts in Figure 2.5 compare the reasons for entering retirement of early and regular old-age pensioners in 2013.

Figure 2.5: Reasons for Entry into Retirement by Type of Old-Age Pension – 2013



Data: SHARE-RV, SHARE: Wave 5 (Release 5-0-0), RV: pensions in payment (Release 3-0-0). 802 individuals; own calculations. Only old-age retired individuals with current retirement status identical to earliest retirement entry are used. Weighted using calibrated cross-sectional weights for Wave 5 on individual level. Calibration reflects the size of targeted population (50+) across 8 gender-age groups and across NUTS1 regional areas (states).

Figure 2.5 shows the shares of relevant reasons for entry into retirement. The label "Other Reasons" includes the following reasons: being terminated from job, poor health status of a family member, synchronise entry into retirement with spouse, having more time for the family, and enjoy the life. The fractions of respective reasons differ by type of old-age pension. Two-thirds of all regular old-age pensioners declare that the legal age at retirement is the primary reason for entering retirement. As intrinsic circumstances are of minor relevance for those pensioners, results imply that pensioners tend to retire when they are actually allowed to do so. Around 50 percent of early old-age pensioners specify the legal age at retirement as the relevant reason for entering retirement. Therefore, administrative guidelines are the major determinant for the point of retirement of old-age pensioners.

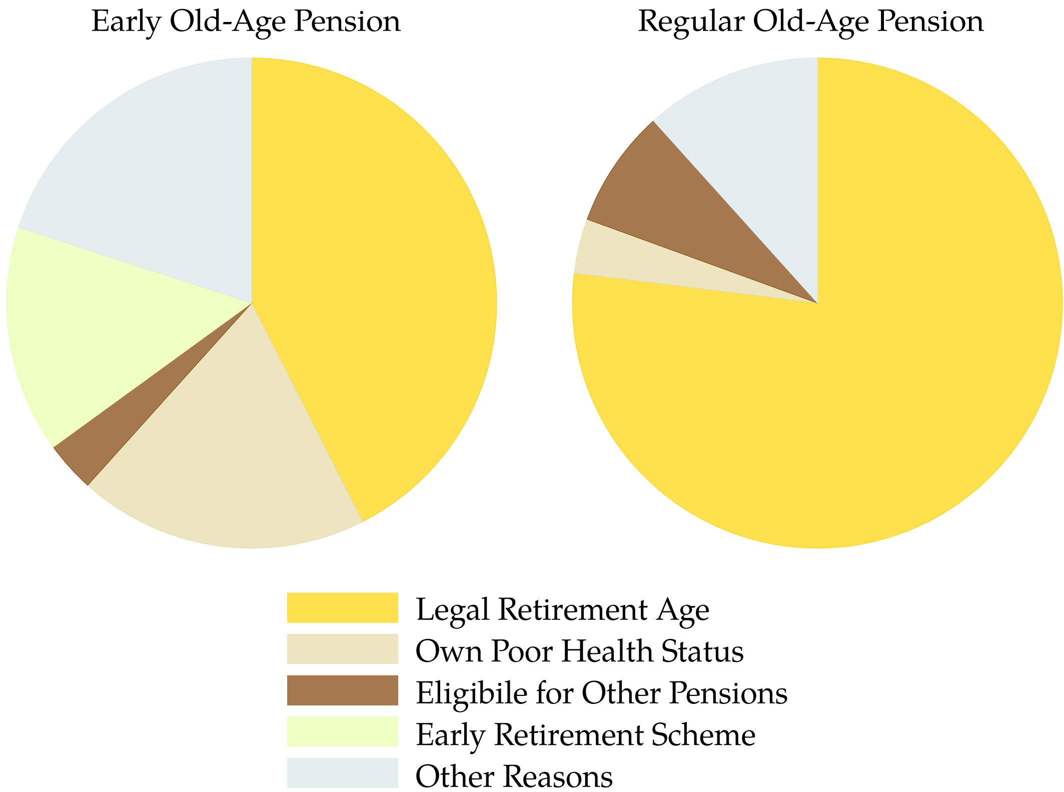
The share of pensioners who retire due to poor personal health status varies between types of old-age pension. This share is nearly twice as high for regular old-age pensioners. Although overall health is not a mandatory requirement for early old-age pensioners, particular requirements indirectly affect the composition of the group of early old-age pensioners. In most cases, early old-age pensioners need a certain amount of contribution periods. For those pensioners who achieve these periods after physically hard labour, this requirement can correlate with a poor health status. For pensions due to unemployment or part-time work, the decision to not or to partially work can be the result of an overall bad health status. As this measure is subjective and does not depend on measurable indicators, it can also be the result of a subjective feeling of bad health. As pensions due to part-time work require an early retirement scheme, differences regarding the size of the share of the early retirement scheme between early and regular old-age pensioners are in line with administrative guidelines.

Analysing only pensioners who work in the last year, the distribution of shares of the given reasons does not change fundamentally for either group. Figure 2.6 shows the respective pie charts. As the distribution of reasons remain nearly unaffected by choosing only pensioners who work in the last year, one can assume that the decision to work does not influence the distribution of reasons for entry into retirement for either group of old-age pensioners. This implies that given reasons for entry into retirement do not influence the decision of labour force participation during retirement, at least on an aggregated level.

Employment Before and After Retirement

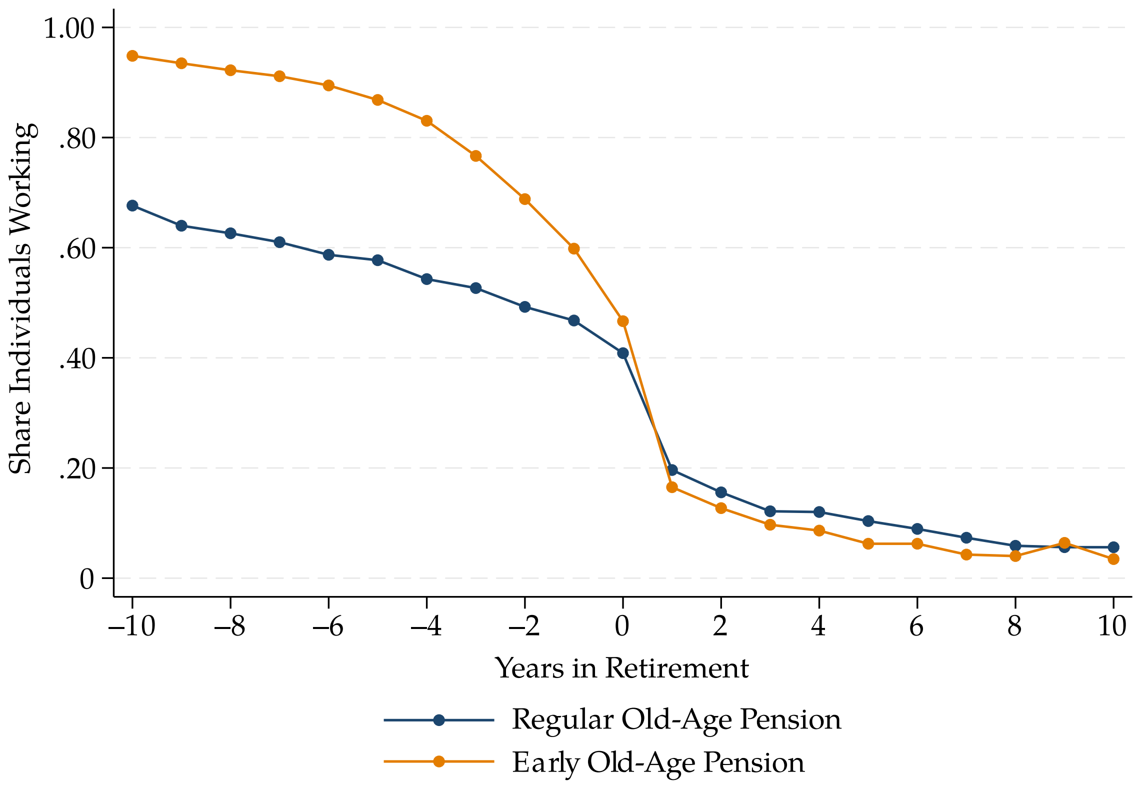
Results of a comparison of Figure 2.5 and 2.6 imply that reasons for entry into retirement cannot explain labour force participation during retirement. A comparison of labour force participation before and after the entry into retirement for early and old-age pensioners is presented in Figure 2.7.

Figure 2.6: Reason for Entry into Retirement by Type of Old-Age Pension – Worked Last Year



Data: SHARE-RV, SHARE: Wave 5 (Release 5-0-0), RV: pensions in payment (Release 3-0-0). 79 individuals who worked last year (2012); own calculations. Only old-age retired individuals with current retirement status identical to earliest retirement entry are used. Weighted using calibrated cross-sectional weights for Wave 5 on individual level. Calibration reflects the size of targeted population (50+) across 8 gender-age groups and across NUTS1 regional areas (states).

Figure 2.7: Labour Force Participation Before and After Entry into Retirement by Type of Old-Age Pension



Data: SHARE-RV 3-0-0. 21,542 observations; 1435 individuals; own calculations. Only old-age retired individuals with current retirement status identical to earliest retirement entry are used. Separated by type of old-age pension. Early old-age pensions includes the following pension types: pension due to unemployment or part-time work for employees, pension for women, pension for invalids, pension for longtime insured persons and pension for really longtime insured persons.

The share of individuals working *before* entry into retirement differs in several aspects between early and regular old-age pensioners. First, the overall share of individuals working is higher for early old-age pensioners. Second, the slope of labour force participation is decreasing towards entry into retirement whereas the trend is predominantly linear for regular old-age pensioners. In contrast to regular old-age pensioners, the negative slope is increasing towards entry into retirement for early old-age pensioners and approaches the level of regular old-age pensioners. This can be explained by requirements being valid for some types of early old-age retirement. For example, pensioners due to unemployment or part-time work need to have some time of unemployment or time of being away from employment. Third, less than 50 percent of old-age pensioners are employed when entering retirement.

The retirement effect on labour force participation, i.e. the drop in labour force participation upon entering retirement, is steeper for early old-age pensioners. This indicates that the fraction of individuals continuing their employment after retirement is higher for regular old-age pensioners. *After* retirement the labour force participation is at a lower level and is decreasing with increasing years of retirement. This is true for both groups of old-age pensioners. Comparing the actual size, regular old-age pensioners exhibit a higher share of labour force participation at nearly every year in retirement. Using years in retirement as time indicator, the difference of share of labour force participation is relatively small between both groups. The result is remarkable as regular old-age pensioner exhibit a higher age when comparing both groups of old-age pensioners.

Summarising the descriptive results reveals that the share of pensioners in employment does not vary between early and regular old-age pensioners. Although early old-age pensioners have an age advantage as they retire at earlier ages, this advantage does not lead to a higher employment share or increased length of employment. Moreover, it shows that the entry into retirement rather than actual age is the relevant determinant for labour force participation during retirement. Due to heterogeneous motives for participation in the labour market, reasons for entry into retirement do not predict labour force participation during retirement. For regular old-age pensioners employment before and after retirement is almost linear and only interrupted by the retirement effect. In addition, graphical analysis implies that the regular old-age pensioners' share of individuals with continuous employment over retirement is larger than for early old-age pensioners. In contrast, early old-age pensioners' labour force participation shows an anticipatory behaviour towards retirement entry which can mainly be attributed to administrative requirements of underlying types of early old-age pensions.

2.5 Strategy and Model

The descriptive analysis from the previous section gives an overview of the behaviour with regard to labour force participation during retirement. Although early and regular old-age pensioners differ in age at entry into retirement and employment behaviour before retirement, they actually face similar patterns of employment during retirement when comparing them via time in retirement. As both groups differ by entry into retirement and since age of the pensioner is negatively correlated with labour force participation during retirement, see for example Figure 2.8, one cannot deduce an effect of the additional earnings ceiling on labour force participation when using descriptive analysis. Therefore, one has to use a strategy of identification to extract the effect of the additional earnings ceiling from all other confounding influences when analysing its effect on labour force participation during retirement.

From theoretical considerations an additional earnings ceiling during retirement could have a negative effect on labour force participation if the given restrictions lead to an unwillingness of supply of labour of affected pensioners. If restrictions of additional earnings ceiling are not binding, estimates of the coefficient of the additional earnings ceiling should not be different from zero. A positive estimate of the effect of the additional earnings ceiling seems unlikely as given restriction should not induce an additional stimulus on participation in the labour market.

To quantify the effect of the additional earnings ceiling in Germany, one needs to compare individuals which are affected by the additional earnings ceiling with those individuals who exhibit no earning limits. This can be achieved by different means. As additional earnings ceilings are temporal and last only until respective pensioners exhibit regular old-age pension eligibility age, one could use early old-age pensioners only. By doing so, one compares early old-age pensioners when entering retirement and their labour force participation after they reach regular pension eligibility age. But, as duration of being retired and effective age of the pensioners correlate with individuals' labour force participation, the obtained estimate of the effect of the additional earnings ceiling would be confounded by age differences by analysed groups. Analogously, that would also apply when comparing early old-age pensioners with regular old-age pensioners when entering retirement. Although regular old-age pensioners exhibit no additional earnings ceiling at all, they have by definition an older age when entering retirement. Therefore, by comparing both groups of old-age pensioners at their point of retirement, one faces a bias, too. As labour force participation during retirement decreases with corresponding age of the pensioners, see Figure 2.8 for a graphical illustration, the obtained estimate of the effect of the additional earnings ceiling would be biased.

To circumvent age differences of analysed groups one can compare groups at similar ages. But, while early old-age pensioners enter retirement, future old-age pensioners exhibit higher shares of labour force participation as they retire at older ages and are still working. Therefore, one is confronted by a retirement effect which leads to an abrupt decrease in labour force participation of the underlying group, see Figure 2.7 for an aggregated empirical illustration of the retirement effect on labour force participation. As a result, when comparing early and regular old-age pensioners' labour force participation using levels of employment one is confronted with a classical trade-off, to either compare groups at different ages to circumvent the retirement effect or to compare individuals at similar ages while one group has not yet retired. Both strategies make it impossible to identify the actual influence of the additional earnings ceiling on labour force participation during retirement.

A possible solution to this problem is the use of changes from one age to another rather than a comparison of levels of labour force participation at each age. Using changes in labour force participation erases differences with regard to the participation of labour before and after retirement and eliminates the negative effect of retirement entry. The application of this approach offers the possibility to compare early and regular old-age pensioners at similar ages without a confounding retirement effect. But when analysing changes instead of levels, the model cannot explain differences regarding the level of labour force participation between both groups. Rather, it detects differences regarding the growth of labour force participation.

When using changes the trade-off which prevents an identification of additional earnings ceiling is no longer relevant. But, this strategy is based on certain assumptions. First, the effect of the additional earnings ceiling has to be separated from general age-specific employment changes. The assumption can be seen as fulfilled since additional earnings ceiling are an additive restriction which does not interact in a multiplicative way with age changes. By using potential outcomes notation in the equations (2.1) and (2.2), one assumes an additive structure in the growth of labour force participation. This structure includes a time variant component (β_t), which captures the diminishing probability of being employed at higher ages, a time invariant component (α_s)[35], which is allowed to differ over type of old-age pension and the additional earnings ceiling (γ).[36] Moreover, this strategy requires that changes in employment trends, i.e. growth of labour force participation during retirement, would be the same for early and regular old-age pensioners without the treatment of an additional earnings ceiling. That means that the effect of age changes during the

35. While subscript s describes the type of old-age pension and subscript i identifies the corresponding individual, subscript t highlights age differences.

36. Assuming an additive structure for the change of work proposed in (2.1) and (2.2) leads to an unspecified representation of the underlying variable work. Moreover one assumes that differences of the variable work eliminates differences of labour force participation before and after retirement.

period of observation ($\beta_{\Delta Age_{[63,65)}} - \beta_{\Delta Age_{[66,68)}}$)[37] has to be the same for both groups of pensioners. This assumption can be described as the parallel growth assumption, as both groups need to have identical employment changes in the absence of an additional earnings ceiling. As this situation cannot be observed with observational data, a test of falsification of this assumption is not possible. Rather than testing, one has to argue by visual inspection of relevant employment behaviour of both groups. Therefore, Figure 2.7 is used to check the parallel growth assumption. As the period of identification should begin in a close range of a change in the treatment (Bertrand et al. 2004) of the additional earnings ceiling and regular old-age pensioners have not been retired in the given age range, one needs data of employment behaviour before regular old-age pensioners start entering retirement.

Analysing the employment behaviour of regular old-age pensioners shows that intended regular old-age pensioners have a nearly linear decrease towards entry into retirement. In comparison to early old-age pensioners, they show no anticipatory behaviour which would otherwise lead to a disproportional drop of labour force participation several years before affected groups enter retirement. This difference can be explained by requirements of entering certain types of early old-age pensions, e.g. pension due to part-time work for employees over 55 and pensions due to unemployment.[38] When analysing the effect of the additional earnings ceiling during retirement, the composition of affected and not affected groups should not be biased by anticipatory behaviour of individuals who circumvent the additional earnings ceiling. As all pensioners who enter retirement before the regular legal age of retirement face an additional earnings ceiling, it is not possible to bypass this earnings restriction. On the other hand, it could be the case that especially motivated individuals shift their entry into retirement backwards to circumvent the additional earnings ceiling. If that would be the case, the effect of the additional earnings ceiling would be biased. The impact of this potential anticipatory behaviour is checked, see section 2.6 for results and further details. As given age ranges of identification are to some extent arbitrarily, a shift of age ranges will also be checked in the sensitivity subsection of 2.6.

37. The lower bound of each age range is included in the age range. In contrast, the upper bound of each age is not included. By doing so, one circumvents potential duplication. By definition $t = 1$ describes the age effect on labour force participation from the age range 63 until 64 to the age range 64 until 65. Analogously, $t = 2$, describes the age effect on labour force participation from age range 66 until 67 to the age range 67 until 68.

38. The pension due to unemployment requires having a certain time of unemployment prior to entry into retirement. For pensioners due to part-time work for employees over 55 the chosen time horizon and quantity of being part-time employed can lead to periods of non-employment prior to entry into retirement.

$$E[\Delta Work_{0_{ist}}|s,t] = \alpha_s + \beta_t \tag{2.1}$$

$$E[\Delta Work_{1_{ist}}|s,t] = \alpha_s + \beta_t + \gamma \tag{2.2}$$

To extract the component γ and identify the effect of the additional earnings ceiling, one can use a strategy which is known as Difference-in-Differences (DiD). The idea of DiD is to use the fact that the treatment, in this example the additional earnings ceiling, is only temporal within the treatment group, i.e. early old-age pensioners. By finding an adequate control group which is not affected by the treatment, one can identify the actual treatment effect by using differences *within* and *between* both groups of treatment and control. While the difference within each group is used to erase time invariant aspects in which treatment and control group differ, the difference between both groups clears the treatment effect from confounding variables which are time-depending and by assumption identical over both groups. By applying both, i.e. the difference in differences , the average effect of the treatment indicator, in this application γ, on the variable of interest, $\Delta Work$, can be achieved.

Equations (2.3) and (2.4) show the results of differences (within) for regular and early old-age pensioners in a potential outcome setup. As regular old-age pensioners do not face any additional earnings ceiling, the average effect depends on a time invariant component, α, which is allowed to differ between regular and early old-age pensioners[39] and a time changing component, β. The time invariant component, α_{RR}, disappears and the average effect of a change in labour force participation for regular old-age pensioners can be solely attributed to changing age of underlying individuals. As age during retirement is negatively correlated with labour force participation, obtained estimates of equation (2.3) should be positive.

$$\begin{aligned} & E[\Delta Work_{ist}|s = RR, t = \Delta Age_{[63,65)}] - E[\Delta Work_{ist}|s = RR, t = \Delta Age_{[66,68)}] = \\ & = (\alpha_{RR} + \beta_{\Delta Age_{[63,65)}}) - (\alpha_{RR} + \beta_{\Delta Age_{[66,68)}}) \\ & = (\beta_{\Delta Age_{[63,65)}} - \beta_{\Delta Age_{[66,68)}}) \end{aligned} \tag{2.3}$$

Early old-age pensioners face an additional ceiling when entering retirement until they reach the regular pension eligibility age. Therefore, the component γ, the effect of additional earnings ceiling, is only displayed in the first bracket of equation (2.4).

39. The subscript *RR* refers to regular old-age pensioners whereas the subscript *ER* refers to early old-age pensioners.

$$
\begin{aligned}
&E[\Delta Work_{ist}|s = ER, t = \Delta Age_{[63,65)}] - E[\Delta Work_{ist}|s = ER, t = \Delta Age_{[66,68)}] = \\
&= (\alpha_{ER} + \beta_{\Delta Age_{[63,65)}} + \gamma) - (\alpha_{ER} + \beta_{\Delta Age_{[66,68)}}) \\
&= (\beta_{\Delta Age_{[63,65)}} + \gamma - \beta_{\Delta Age_{[66,68)}})
\end{aligned}
\tag{2.4}
$$

The difference of the differences of treatment and control groups leads to γ, as shown in equation (2.5). These results are based on the assumption that there are no adaption effects of the additional earnings ceiling, i.e. that the burden of any earnings restrictions have ended with the end of the additional earnings ceiling. Applying DiD by sample means is illustrated in equation (2.6). The estimate of γ, $\hat{\gamma}$, is achieved by differentiating between the respective sample means during and after the additional earnings ceiling. A disadvantage of using sample means rather than an econometric model is that standard errors and therefore statements regarding significance are not directly accessible. Therefore, an equivalent econometric model is constructed, see equation (2.7).

$$
\begin{aligned}
&E[\Delta Work_{ist}|s = ER, t = \Delta Age_{[63,65)}] - E[\Delta Work_{ist}|s = ER, t = \Delta Age_{[66,68)}] - \\
&E[\Delta Work_{ist}|s = RR, t = \Delta Age_{[63,65)}] - E[\Delta Work_{ist}|s = RR, t = \Delta Age_{[66,68)}] \\
&= (\beta_{\Delta Age_{[63,65)}} + \gamma - \beta_{\Delta Age_{[66,68)}}) - (\beta_{\Delta Age_{[63,65)}} - \beta_{\Delta Age_{[66,68)}}) \\
&= \gamma
\end{aligned}
\tag{2.5}
$$

$$
\begin{aligned}
\hat{\gamma} = &(\overline{\Delta work_{\mathrm{ER},\, t\, =\, \Delta Age_{[63,65)}}} - \overline{\Delta work_{\mathrm{ER},\, t\, =\, \Delta Age_{[66,68)}}}) \\
&- (\overline{\Delta work_{\mathrm{RR},\, t\, =\, \Delta Age_{[63,65)}}} - \overline{\Delta work_{\mathrm{RR},\, t\, =\, \Delta Age_{[66,68)}}})
\end{aligned}
\tag{2.6}
$$

The econometric model is based on the DiD approach. The point estimate of the effect of additional earnings ceiling on change in labour force participation is identical if using sample means or baseline econometric approach without further control variables X. But the model which is proposed in (2.7) offers more flexibility regarding the specification. This flexibility is used to test some of the underlying assumptions and the sensitivity of baseline results.

$$
\Delta Work_{ist} = \alpha EarlyRetired_s + \beta Time_t + \gamma EarningsCeiling_{st} + X'_{ist}\delta + u_{ist} \tag{2.7}
$$

The variable on the left-hand side of (2.7), $\Delta Work$, is the difference of labour force participation, which is allowed to vary on individual i with type of old age pension

s over relevant years of living t. As labour force participation is a dummy variable, the difference of this dummy variable can be defined as the growth in labour force participation.[40]

On the right-hand side of (2.7) the baseline model controls for type of old age pension, *EarlyRetired*, the respective time in terms of age of the pensioner, $Time$, and the additional earnings ceiling with coefficient γ. In addition, the baseline model includes an error term. The model is estimated with heteroscedasticity robust standard errors.

Due to the panel data structure, the model detects changes in labour force participation which can be the result of a change of the additional earnings ceiling for each pensioner. As individual's outcome is analysed over more than one period, the error term in (2.7) might be affected by serial correlation. As the variable of interest, *EarningsCeiling*, varies around t and s cluster robust standard errors (over type of old-age pension) cannot be used due to low number of groups. To account for serial correlation, the time series dimension is focusing only at the end of the additional earnings ceiling. By using only two periods, at the close end of the additional earnings ceiling and directly after the treatment, the model accounts indirectly – to some extent – for serial correlation. In addition, the variable of interest differs only at the group level s, the type of old-age pension, while the outcome variable, $\Delta Work$, can change on the individual level. This situation can lead to lower standard errors. Therefore, a parametric Moulton correction[41] is used if conventional standard errors imply any ambiguity regarding the significance.

The analysis builds on individuals with regular pension eligibility age of 65 only. Although groups of type of old-age pension are formed at the beginning of entry into retirement, previous information on labour force participation is used to identify the effect of the additional earnings ceiling. The formalisation of treatment and control groups might be affected by the situation of labour at older ages, i.e. shift of entry into retirement to circumvent the additional earnings ceiling. Therefore, potential anticipatory behaviour will be tested.

The model captures the average effect of the additional earnings ceiling on the change of labour force participation for old-age pensioners in Germany. By doing so, the analysis shows whether given restrictions of the additional earnings ceiling affected the growth of labour force participation between 1986 and 2013. As the variable on the left-hand side can be interpreted as the change in probability of having

40. As pensioners who work are assigned a value of one, respectively non-working pensioners exhibit a value of zero, the difference, $\Delta Work$, is allowed to vary between three values, i.e. minus one (decline of labour force participation), zero (no change, either continuing working or continuing non-working pensioner) and one (increase of labour force participation).

41. The Moulton factor corrects for the intraclass correlation as $\Delta Work$ varies over i and the additional earnings ceiling varies over s, i.e. type of old-age pension. The formula can be found in (Angrist and Pischke 2008) on page 311.

employment, a multiplication of coefficients by hundred leads to an interpretation in percentage points.

Besides anticipatory behaviour, the model is also extended by using additional control variables, allowance for different trends of treatment and control group across time and gender specific analysis of additional earnings ceiling and other sensitivity checks. In addition, when using indicators which imply a lower activity on the labour market, e.g. voluntary or charity work, educational or training course etc., conclusions regarding the size of labour during retirement can be made by using the same identification strategy proposed in this section. This is done in subsection 2.6.

2.6 Results

Table 2.3 lists the sample averages for relevant age groups and their differences separated by type of old-age pension. While the upper part of the table presents the means of each age group, the lower part of the table uses the difference of each individual during and after the potential treatment. The identification of the effect of the additional earnings ceiling is based on individual differences in labour force participation of relevant years. Analyses of size of supplied labour use the sample averages for the computation of respective differences. This is due to data availability.

Comparing the results of the upper part between types of old-age pension and over time, one can see that the labour force participation before retirement for regular old-age pensioners is significantly higher, specifically by a factor of four, than for similar age groups of already retired early old-age pensioners. After entry into retirement the labour force participation changes to a lower level; for a graphical illustration of the effect of retirement on labour force participation see Figure 2.7. Comparing both types of retirees, labour force participation in retirement is higher for regular old-age pensioners. However, for either group a decrease of labour force participation over time can be observed.[42] The differences of the lower part are negative or not significantly different from zero when evaluating the provided standard errors of the mean. That means that labour force participation is on average decreasing (negative) or stable (not different from zero) over time. Using the lower part of Table 2.3 to determine the point estimate of the additional earnings ceiling, $\hat{\gamma}$, one has to subtract for each type of old-age pension row I from row II. Afterwards the difference of both differences is calculated, i.e. the difference of early old-age pensioners and regular old-age pensioners ($-0.019 - 0.006 + 0.023 - 0.028$) which is around

42. Although technically possible, the age range of pensioners after the treatment of the additional earnings ceiling is not beginning at the age of 65. The first reason is that the computation of the actual age is based on a month year level. The second reason is the low number of observations for this starting point.

Table 2.3: Difference in 1st Differences by Sample Averages

		Early Old-Age Pension	Regular Old-Age Pension
		ER	**RR**
	$\sum_{i=1}^{n} \frac{Work_{i[63,64)}}{n}$	0.099	0.451
		(0.014)	(0.026)
	$\sum_{i=1}^{n} \frac{Work_{i[64,65)}}{n}$	0.096	0.431
		(0.012)	(0.026)
	$\sum_{i=1}^{n} \frac{Work_{i[66,67)}}{n}$	0.067	0.173
		(0.010)	(0.020)
	$\sum_{i=1}^{n} \frac{Work_{i[67,68)}}{n}$	0.065	0.146
		(0.010)	(0.019)
I	$\sum_{i=1}^{n} \frac{Work_{i[64,65)} - Work_{i[63,64)}}{n}$	-0.019	-0.023
		(0.009)	(0.009)
II	$\sum_{i=1}^{n} \frac{Work_{i[67,68)} - Work_{i[66,67)}}{n}$	0.006	-0.028
		(0.006)	(0.011)

Notes: Multiplied by 100 gives the probability of labour force participation of respective age groups. Rounded off to the third decimal place. Standard errors of means in parentheses.

-0.03.[43] The effect of -0.03 would imply that individuals with additional earnings ceiling exhibit a lower labour force participation which is around three percentage points lower than for pensioners without an earnings ceiling. But, as standard errors are not directly accessible, conclusions of the significance of the effect are not possible.

Therefore, the model in (2.7) is estimated via Ordinary Least Squares (OLS) with robust standard errors. General results of this model are displayed in Table 2.4. Table 2.4 lists five different specifications of the model in (2.7). The baseline model without further control variables is estimated in (1). Adding further control variables which differ over index i increase precision of the estimates. This model can be found in (2). Allowing for different trends of treatment (early old-age pensioners) and control group (regular old-age pensioners) offers the possibility of accounting for different developments of labour force participation over time which is not attributed to the additional earnings ceiling. This procedure requires more data to determine the trend. Therefore labour force participation up to the age of 80 is used. This is done in (3) while also controlling for further variables. To circumvent the additional earnings ceiling, an individual can shift its entry into retirement after regular pension eligibility age. Although descriptive analysis (Figure 2.6) implies that the extent of this behaviour is relatively low, it can affect the estimates. Therefore in (4) only individuals who enter retirement due to the achievement of individual legal age of retirement are used to estimate the effect of the additional earnings ceiling on labour force participation. From another perspective it may be possible to enter early old-age pension by allowing deductions of the pensions income. Because of this, the model in (5) uses only those individuals who enter retirement without any deductions.

43. When using estimates which are not rounded off to third decimal place one would calculate an effect of 0.0297; $(-0.0188679 - 0.0057692) - (-0.0234604 + 0.028481) = 0.0297$.

Table 2.4: Regression Results – Difference in 1st Differences

Dependent variable: $\Delta Work$

	Difference-in-1stDifferences				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
constant	-0.023	-3.804	-1.993	-1.763	-3.342
	(0.009)	(1.583)	(0.974)	(1.905)	(1.815)
early retired	0.034	0.018	0.020	0.000	0.019
	(0.013)	(0.012)	(0.009)	(0.014)	(0.012)
time	-0.005	-0.005	0.001	0.012	-0.004
	(0.015)	(0.013)	(0.001)	(0.014)	(0.014)
earnings ceiling	-0.030	-0.020	-0.015	-0.011	-0.022
	(0.018)	(0.017)	(0.010)	(0.023)	(0.019)
Control Variables					
Sex					
women		0.002	0.004	0.013	0.012
		(0.008)	(0.011)	(0.009)	(0.006)
year		0.002	0.001	0.001	0.002
		(0.001)	(0.000)	(0.001)	(0.001)
region lived before Fall of Berlin Wall					
West Germany		-0.016	-0.006	-0.013	-0.019
		(0.010)	(0.006)	(0.017)	(0.011)
somewhere else		-0.002	0.001	0.020	0.017
		(0.019)	(0.010)	(0.016)	(0.010)
school leaving certificate					
finished primary school		0.003	0.002	0.025	0.007
		(0.012)	(0.006)	(0.013)	(0.010)
secondary school – low		0.001	-0.001	0.017	0.012
		(0.014)	(0.008)	(0.014)	(0.012)
secondary school – middle		0.007	0.007	0.030	0.014
		(0.016)	(0.009)	(0.016)	(0.015)
specialised secondary school		0.017	0.003	0.003	0.013
		(0.024)	(0.014)	(0.037)	(0.022)
qualification for university entrance		-0.019	-0.011	0.007	-0.005
		(0.018)	(0.009)	(0.017)	(0.017)
other education		0.191	0.070	0.033	0.022
		(0.153)	(0.058)	(0.017)	(0.014)
Number of children					
1		-0.009	-0.005	-0.032	-0.018
		(0.015)	(0.011)	(0.021)	(0.018)
2		0.009	0.003	-0.004	0.008
		(0.009)	(0.011)	(0.012)	(0.009)
3		-0.023	-0.017	-0.042	-0.024
		(0.015)	(0.013)	(0.022)	(0.016)
4		-0.001	0.001	0.002	-0.010
		(0.019)	(0.013)	(0.005)	(0.020)
5 or more		0.020	0.010	0.005	0.012
		(0.008)	(0.010)	(0.007)	(0.006)
Trend					
early retired ∗ time			-0.001		
			(0.001)		
control variables		✓	✓	✓	✓
trend			✓		
potential anticipatory behaviour				✓	✓
R^2	0.007	0.020	0.013	0.015	0.014
N	1601	1527	3445	822	1277
n	947	887	899	470	727

Notes: Estimated via OLS. Heterosecedasticity robust standard errors in parentheses. Only individuals included with pension eligibility age of 65. Rounded off to the third decimal place. Models including additional variables control for year, sex, region, highest education and number of children. Model (4) and (5) test for anticipatory behaviour. While (4) restrict the sample by using only individuals who enter retirement due to the achievement of individual legal age of retirement, model (5) uses only those individuals who enter retirement without deductions due to early entry into retirement.

The point estimate of the additional earnings ceiling on the change in labour force participation in the baseline model (1) is equal to using sample averages as in Table 2.3. The standard error of the estimated coefficient, $\hat{\gamma}$, is around 0.018. That means that on a conventional significance level of five percent, one cannot reject the null hypothesis that the actual influence of the effect of additional earnings ceiling during retirement on the change of labour force participation is zero. Therefore, the result of the baseline model implies that the additional earnings ceiling does not have any influence on the growth of labour force participation in Germany.[44]

Model (2) includes additional control variables. The set includes the sex of the pensioner, the reporting year, a proxy of assigning the pensioners to Former GDR, West Germany or somewhere else, a variable of measuring the level of education, and the number of children. Whereas the first three variables are socioeconomic variables which account for differences of specific subgroups, the latter two can be interpreted as labour market proxies. First, the level of education may influence the level of labour demand and therefore increase the probability of finding an employment during retirement. But it may also be the case that the level of education reduces the labour force participation during retirement as it is positively correlated with different wealth measures. Second, the amount of children can be seen as a proxy of higher opportunity costs as the probability of having grandchildren to care for is increasing with more children. When controlling for these additional control variables the effect of the additional earnings ceiling approaches zero and is still not significantly different from zero. Potential labour market differences by using control variables cannot be stated for specific subgroups.

When adding a trend to the model it does not change the result of a non-significance of the additional earnings ceiling on the change of labour force participation either. This is also true for different anticipatory behaviour in model (4) and (5). All estimates of $\hat{\gamma}$ are close to zero and show no significance at all.

Sensitivity

The next section uses several sensitivity checks to validate the result of a non-significance of the effect of the additional earnings ceiling on the change of labour force participation in Germany. Model (6) uses a restricted sample of individuals who exhibits information at every point in time of the analysis. The balanced panel in (6) does not contain any outliers that are only recorded once. But, on the other hand the probability of attrition is higher. Instead of using an aggregated measure of early and regular retired persons to assign group of treatment and control, one can also

44. As pointed out in section 2.5 conventional standard errors are lower and should be inflated by the Moulton factor. As given standard errors show no ambiguity of the results, respective Moulton factors are available upon request.

use the specific type of old-age retirement pension which is done in model (7). That means that the group of early old-age pensioners can be separated into retirees having a pension due to unemployment or part-time work, a pension for women, for disabled persons, or a pension for longtime insured persons. The reference group is the pension for regular old-age retirees. The separation of the early old-age retirement group allows flexibility regarding the group specific importance of each type of pension which can effect the influence of the additional earnings ceiling.

As the definition of the range of age after the additional earnings ceiling is arbitrary, model (8) uses the age range from 67 to 69 instead of 66 to 68 to evaluate the influence of a shift of age range on the effect of the additional earnings ceiling. The trade-off of shifting the age range at times which are far away from one another is that the non-testable assumption of having a parallel growth assumption is extended to longer periods. Even more, the longer the periods of analysis, the higher the probability of measuring something else than the pure effect of the additional earnings ceiling. The sensitivity of the generation of age with regard to the effect of the additional earnings ceiling is tested in model (9) and (10). The generation of age depends on the month of birth. Therefore, the respective age of an individual is only specific on a monthly basis. That means that variations of generated age and actual age can be possible if executed rounding is misleading, see section 2.3 for details of the generation of age. Thus, model (9) uses information from individuals born from July until December, whereas model (10) uses only individuals born between January and June. The sensitivity of the construction of $\Delta Work$ is checked in model (11), which excludes the short term indicator of having "any paid work in the last four weeks".

In model (12), the additional earnings ceiling is interacted with a year dummy indicating whether observations are from 2008 or higher (dummy is one) or from previous years (dummy is zero). By doing so, the effect of the additional earnings ceiling is allowed to vary between periods in time. This is especially meaningful as the amount of the additional earnings ceiling is not stable within the period of analysis. Moreover, the definition of restricted income changes between the years, too. Consequentially, an interaction with year is meaningful. For the sake of a clear visual presentation a year dummy is used instead of interacting the additional earning ceiling with all years.[45]

The effect of the additional earnings vary around zero for each model and show no significance at all. This is also true for the interaction with year which means that there are no differences regarding the effect of the additional earnings ceiling over the period of analysis. Thus, the sensitivity analysis validates previous results

45. The detailed regression results using an interaction with all years are available upon request. The implication of using a year dummy or the whole set of years is the same in both models.

Table 2.5: Sensitivity Results – Difference in 1st Differences

Dependent variable: $\Delta Work$

	Difference-in-1stDifferences						
	(6)	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
constant	-0.030	-0.024	-0.023	-0.020	-0.026	-0.024	-0.025
	(0.010)	(0.009)	(0.009)	(0.012)	(0.014)	(0.009)	(0.009)
early retired	0.014		-0.009	0.033	0.035	0.027	0.034
	(0.012)		(0.011)	(0.021)	(0.016)	(0.012)	(0.013)
pension due to unemployment or part-time work		0.025					
		(0.014)					
pension for women		0.031					
		(0.014)					
pension for disabled persons		0.047					
		(0.018)					
pension for longtime insured persons		0.049					
		(0.018)					
time	0.010	-0.005	0.020	-0.009	-0.002	0.004	-0.008
	(0.014)	(0.014)	(0.013)	(0.023)	(0.018)	(0.014)	(0.015)
year >= 2008							0.013
							(0.011)
year >= 2008 * earnings ceiling							0.008
							(0.015)
earnings ceiling	-0.013	-0.026	0.013	-0.040	-0.022	-0.025	-0.030
	(0.018)	(0.018)	(0.017)	(0.027)	(0.024)	(0.017)	(0.018)
$\overline{T} = 2$	✓						
individual type of retirement		✓					
shift of age range			✓				
potential measurement error in generation of age				✓	✓		
variation with respect to labour force participation						✓	
Interaction with year dummy							✓
R^2	0.004	0.008	0.002	0.008	0.007	0.007	0.008
N	1308	1601	1550	699	902	1575	1601
n	654	947	950	418	530	927	947

Notes: Estimated via OLS. Heterosecedasticity robust standard errors in parentheses. Only individuals included with pension eligibility age of 65. (6) Only those individuals were selected with no missing during analysed time span. (7) Instead of differentiating between early and regular old-age pension the particular type of old-age pension is being used. (8) Shift of age range from 66-68 to 67-69. (9) Sensitivity of variable age, i.e. only individuals born from July until December. (10) Sensitivity of variable age, i.e only individuals born from January until June. (11) Without labour force indicator: "any paid work in the last four weeks". (12) Interaction of earnings ceiling with year dummy before and after 2008.

of non-significance of the effect of the additional earnings ceiling on the growth of labour force participation in Germany.

Gender Differences

Although some of the previous models control for the sex of the pensioner, i.e. models (2) to (5), the inclusion of sex as a control variable does not affect the size of the effect or the level of significance of the additional earnings ceiling. In this section the sample is divided into women and men. This offers the possibility to analyse the effect of the additional earnings ceiling by each sex individually. Another possibility is to use the whole sample and to interact the additional earnings ceiling with sex. This step has the advantage to test if potential differences between both sexes with regard to the additional earnings ceiling are statistically significant. But, as this is of minor importance here, the separation of both sexes is presented in the following.

Table 2.6: Gender Differences – Difference in 1st Differences

Dependent variable: $\Delta Work$

	Difference-in-1stDifferences			
	Men		**Women**	
	(13)	**(14)**	**(15)**	**(16)**
constant	-0.014	-8.719	-0.031	1.416
	(0.014)	(2.610)	(0.012)	(1.926)
early retired	0.051	0.036	0.017	0.004
	(0.024)	(0.022)	(0.013)	(0.014)
time	-0.024	-0.029	0.009	0.016
	(0.027)	(0.024)	(0.016)	(0.015)
earnings ceiling	-0.067	-0.058	0.005	0.014
	(0.031)	(0.028)	(0.021)	(0.021)
Control Variables		✓		✓
Moulton Factor	1.663	1.753	1.830	1.427
R^2	0.013	0.059	0.005	0.014
N	785	750	816	777
n	480	450	467	437

Notes: Estimated via OLS. Heteroscedasticity robust standard errors in parentheses. Only individuals included with pension eligibility age of 65. The set of control variables includes year, region, school leaving certificate, and the number of children.

Interestingly, there are large differences in the additional earnings ceiling between women and men. Whereas for women the size of the effect of the additional earnings ceiling on the growth of labour force participation is not different from zero, for men conventional standard errors show a significantly negative effect of the additional earnings ceiling on the growth of labour force participation. This is true for the baseline model as well as for a model which includes additional control variables.

The results imply that the additional earnings ceiling has a negative effect on labour force participation only for male pensioners. But, conventional standard errors do not account for the difference in variation of the variable on the left side,

$\Delta Work$, which varies by each individual i and the variable of interest, the additional earnings ceiling, which varies by s the type of old-age pension as described in section 2.5. To account for that the Moulton factor is displayed. Multiplying the conventional standard errors with the Moulton factor gives a more reliable measure of variation of the estimated effect of the additional earnings ceiling.[46] Thus, for the male baseline model the standard error of the additional earnings ceiling is around 0.031 which is multiplied with a Moulton factor of 1.663. This gives a standard error of around 0.052. Based on the 95% confidence interval, the point estimate of -0.067 various around $[-0.168, 0.034]$. The confidence interval using additional control variables with adjusted standard errors are $[-1.556, 0.040]$. So, in both cases the estimated coefficient of the additional earnings ceiling is not different from zero. Therefore, it can be concluded that the additional earnings ceiling does not have any effect on the change of labour force participation even when sexes are analysed separately.

Effects of Additional Earnings Ceiling on Other Activities

Although general results and sensitivity checks imply that the additional earnings ceiling does not affect the growth of labour force participation of pensioners, it can suppress the size of supplied labour. That means while the composition of targeted groups of working pensioners is not changed by the additional earnings ceiling, it can be the case that these pensioners decrease their amount of work due to earnings restrictions when entering retirement.

A straightforward way to test this assumption would be the use of a variable indicating the hours of supplied labour. Although available in the SHARE data, the response rate of supplied hours during retirement is rather low and thus not suitable for the proposed identification strategy. Therefore, an indirect approach of analysing activities during retirement is used to draw conclusions regarding the influence of the additional earnings ceiling on the size of supplied labour. The idea is that an increase in the analysed activity is combined with a reduction of supplied labour. This is achieved by using the strategy of Difference-in-Differences which compares individuals' activity behaviour during and after the additional earnings ceiling and compares the outcome with the one of regular old-age pensioners. If the common growth assumption holds, reported differences can be directly attributed to the additional earnings ceiling.[47]

To evaluate the influence of the additional earnings ceiling on the growth of anal-

46. As the effect of the additional earnings ceiling is not different from zero with conventional standard errors the Moulton factor is not displayed in these tables. The reason is that standard errors can only inflate conventional standard errors if the model is specified like (2.7.)

47. As already noted the assumption of a common growth is not testable. Therefore it can be the case, that a change of preferences is responsible for the change in activities and not the additional earnings ceiling.

Table 2.7: Influence on Other Activities

	Δ Treatment $t=0$	Δ Treatment $t=1$	Δ Control $t=0$	Δ Control $t=1$	**Δ 1st Differences**
Δ *Voluntary or Charity Work*	0.034	-0.011	-0.119	0.050	0.214
Δ *Educational or Training Course*	-0.024	0.023	0.000	-0.100	-0.148
Δ *Club Meeting (sport, social, etc.)*	0.001	0.029	-0.057	-0.025	0.003
Δ *Taking Part in Religious Organisation*	-0.001	0.007	-0.091	0.023	0.105
Δ *Given Help*	-0.091	0.013	0.012	0.063	-0.054
Δ *Looked After Grandchildren*	0.286	-0.244	0.233	0.110	0.406

Notes: The last column lists the estimated effect of each indicator. Positive values show an increase in the respective activity due to the additional earnings ceiling, while a negative values show a decrease. Treatment in $t = 1$ (Without Earnings Ceiling) and $t = 0$ (with Earnings Ceiling). Age range $[63, 64)$, $N = 304$; age range $[64, 65)$, $N = 351$; age range $[66, 67)$, $N = 572$ and age range $[67, 68)$, $N = 700$.

ysed activities, sample means of each age range are calculated. This is in contrast to the executed strategy in section 2.5 where the individual difference during and after the additional earnings ceiling is used to calculate the respective sample means. The reason is that overall data quality of activities is not as good as for the information of labour force participation. The calculation of sample means of each age range is not a problem if the distribution of included and excluded individuals is as good as random.

For the proposed strategy the SHARE data source offers six activities. All of them are dummy variables indicating whether the respective individual takes part in the given activity. Four of them ask if the the individual attends on a weekly basis; voluntary or charity work, educational or training course, club meeting, or takes part in a religious organisation. The other two, given help and looked after grandchildren, ask for the last twelve months. As the probability of exercising the respective activity is increasing with a broader time horizon, the latter two indicators are less informative with regard to the effect of the additional earnings ceiling on the size of supplied labour.

Positive values of the last column in Table 2.7 can be attributed to a higher growth of the probability of exercising the respective activity. If the assumption holds that both groups of treatment and control do not differ except for the additional earnings ceiling, positive values are a sign for the reduction of supplied labour. Standard errors are not available so far, so that conclusion regarding the statistical significance cannot be stated.

The effect of the additional earnings ceiling on the growth of voluntary and charity work is relatively strong and positive. This is also true for the effect of looking after grandchildren. Both effects can be interpreted as a sign for a decrease of the size of supplied labour of pensioners who face an additional earnings ceiling. Both effects are combined with a decrease of the growth of each activity after the end of the treatment of the additional earning ceiling. For the control groups the growth of voluntary work is increasing with age while the growth of probability is decreasing for looking after grandchildren. The effect on the growth of taking part in a religious organisation is positive and mostly driven by an increase in the growth of probability of the control group. The effects of given help and club meeting are close to zero. Interestingly, the effect of educational or training course is negative. That would imply that the additional earnings ceiling would have a negative effect on this activity. This effect is largely driven by a drop in the control group in $t = 1$, whereas the treatment group exhibit an increase in growth at the same period. Therefore, results imply that potential labour market effects counteract the influence of the additional earnings ceiling on the change of participation with regard to educational or training courses. Summing up all effects there is some support that the additional earnings ceiling have a negative effect on the size of supplied labour.

2.7 Conclusion

By using a Difference-in-Differences approach this paper shows that the additional earnings ceiling in Germany does not affect the growth of labour force participation during retirement. The result is robust over various sensitivity checks including anticipatory behaviour. Moreover, the analysis of potential activities of substitution of labour gives some support to a decrease of the size of supplied labour due to the additional earnings ceiling. However, this indirect approach has to be validated if data sources allow an analysis of the actual quantity of supplied labour. It is important to note that as identification strategy makes it necessary to use the change of labour force participation, reported differences which can be attributed to the additional earnings ceiling can only be assigned to the growth of labour force participation. That means that potential differences in the level of labour force participation between both types of old-age pension cannot be explained by the proposed approach with regard to the additional earnings ceiling.

Descriptive analysis shows little differences in labour force participation between early and regular old-age pensioners when comparing both groups via time in retirement. But, this approach neglects the different age structures as regular old-age pensioners exhibit an higher age when entering retirement. As age is negatively correlated with labour force participation during retirement, differences with regard to employment increase when comparing both groups of old-age pensioners via age.

The strategy compares early and regular old-age pensioners during and after the additional earnings ceiling. Another possibility is to use data before the additional earnings ceiling. Moreover, a combination of using data before, during and after the additional earnings ceiling could be implemented in a model. But, this step needs careful handling of the anticipatory behaviour of labour force participation towards entry into retirement for early old-age pensioners.

In this context it seems also reasonable to analyse the influence of the duration of the additional earnings ceiling on labour force participation. This step, similar to the previous extension, requires a larger time interval of analysis. Therefore the proposed extensions need to address serial correlation in a potential setup. In addition, future analysis should incorporate the increasing regular pension eligibility age as well as consequences of recent reforms of the so-called *Flexirente*, which try to increase the flexibility of additional earnings during retirement.

From an economical perspective the prevailing additional earnings ceiling in Germany increase the costs of supplying labour during retirement while other sources, i.e. earnings out of capital, remain unaffected. Therefore, it seems interesting to analyse whether the additional earnings ceiling does have a positive influence on the participation rate in the capital market of affected pensioners. Moreover, it seems also promising to analyse the influence of the additional earnings ceiling on the participation of care as earnings out of care are exempted from the additional earnings ceiling.

2.8 Appendix

Table 2.8: Overview Variables – Original Data Sets and Constructed Variables

Name	Description	Type of Variable	Origin	Observations
	From Original Data Sets			
mergeid	personal identifier	nominal	SHARE-RV	64,530
rtbe	year and month of first pension	metric	FDZ-RV	60,135
ztptr	year and month of current pension	metric	FDZ-RV	64,530
gevs	sex of individual	nominal	FDZ-RV	64,530
fmsd	family status	nominal	FDZ-RV	64,530
gbjavs	year of birth	metric	FDZ-RV	64,478
leat	type of old-age pension	nominal	FDZ-RV	64,530
psegpt	sum of personal earnings points	ordinal	FDZ-RV	64,530
byvl	contribution period full-valued	ordinal	FDZ-RV	55,884
zlki12	number of children	ordinal	FDZ-RV	64,530
knbt	share of miners' pension on the amount of pension	metric	FDZ-RV	64,507
moab	number of months of deductions	metric	FDZ-RV	64,530
	Constructed Variables			
work	dummy indicating working during retirement	nominal	SHARE	64,530
year	reporting year	metric	SHARE	64,530
intyearmonth	year and month of interview	metric	SHARE-RV	3,288
age	age of pensioner	metric	SHARE-RV	64,470
origin work	origin of value of variable work	nominal	SHARE	64,530
region	location pensioner lived before Fall of Berlin Wall	nominal	SHARE	61,072
wave	corresponding wave in SHARE data	nominal	SHARE	3,288
school leaving cert.	type of graduation	nominal	SHARE	61,072
reason retirement	reason of entering retirement	nominal	SHARE	52,244
early retired	type of old-age retirement	nominal	FDZ-RV	58,540
earnings ceiling	additional earnings ceiling during retirement	nominal	FDZ-RV	58540
tinr	time in retirement	metric	SHARE-RV	60,075
retired	individual retired or not	nominal	SHARE-RV	60,075
regelaltersgrenze	legal age of retirement	metric	FDZ-RV	62,943
erstrente	first corresponds current retirement	nominal	FDZ-RV	60,135
rentenalter	age at retirement	metric	SHARE-RV	60,075
geburtsdatum	year and month of birth	metric	SHARE-RV	64,418
activity1w	voluntary or charity work; weekly	nominal	SHARE	3,280
activity2w	attended educational or training course; weekly	nominal	SHARE	3,280
activity3w	club meeting (sport, social, etc); weekly	nominal	SHARE	3,280
activity4w	taking part in religious organisation; weekly	nominal	SHARE	1,707
sp008	given help last 12 months (outside household)	nominal	SHARE	2,547
sp014	looked after grandchildren	nominal	SHARE	1,868

Notes: SHARE-RV: can be found in both data sets. SHARE: only in SHARE data source. FDZ-RV: variable can only be found in the administrative data source of the German Pension Fund. Rounded variables as same as weights are not displayed. Furthermore, the time indicator for treatment and control group in model 2.7, variable time, is not displayed.

Table 2.9: Probability of Working During Retirement – Logit

Dependent variable: Dummy indicating working during retirement, zero otherwise

	Odds Ratio via Logit			
	I	**II**	**III**	**IV**
age	0.847	0.847	0.849	0.848
	(0.025)	(0.025)	(0.025)	(0.026)
year	1.051	1.053	1.051	1.053
	(0.019)	(0.019)	(0.020)	(0.020)
Sex				
female	0.545	0.180	0.497	0.182
	(0.103)	(0.144)	(0.094)	(0.139)
Lived Before Fall of Berlin Wall				
West Germany	0.991	0.981	0.944	0.932
	(0.223)	(0.220)	(0.212)	(0.209)
Education				
high educated	2.139	2.209		
	(0.516)	(0.532)		
high educated (incl. secondary education)			1.427	1.444
			(0.278)	(0.279)
Type of Old-Age Pension				
early retired	0.366	0.378	0.351	0.360
	(0.080)	(0.084)	(0.079)	(0.083)
Children				
yes		3.326		2.961
		(2.706)		(2.296)
constant	✓	✓	✓	✓
McFadden's R^2	0.073	0.079	0.065	0.070
McFadden's Adjusted R^2	0.069	0.074	0.061	0.065
n	1107	1107	1107	1107
N	8569	8569	8569	8569

Notes: Only old-age retired individuals with current retirement status identical to earliest retirement entry are used. Results is based on Logit estimation. The variable `high educated` aggregates pensioners with *Abitur* or similar education. The base category includes pensioners with lower education level. Only pensioners included who lived in West or East Germany before the Fall of Berlin Wall. Standard errors allow for intragroup correlation within clusters (individual). Odds ratios are displayed. Data: SHARE-RV; own calculations. Rounded off to the third decimal place.

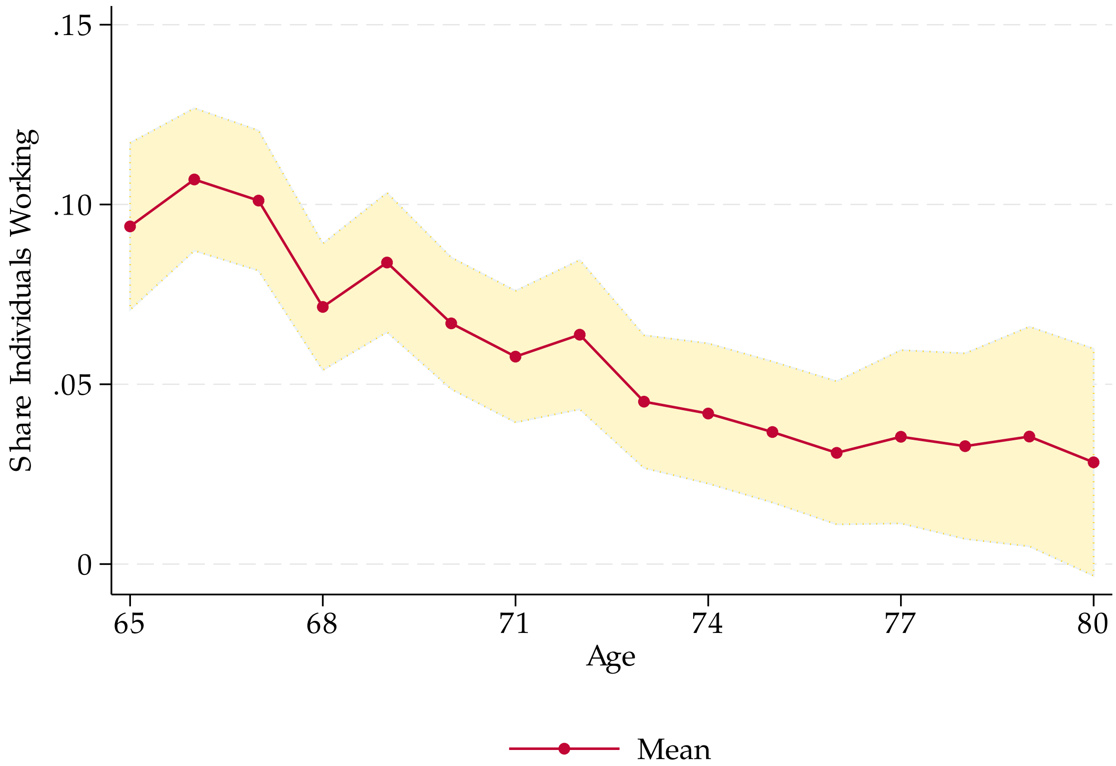
Table 2.10: Time Until First Employment After Retirement – Cox Proportional-Hazards

Dependent variable: Time in retirement

	Hazard Ratio	
	I	**II**
Type of Old-Age Pension		
early retired	0.984	1.134
	(0.117)	(0.184)
Sex		
female		0.591
		(0.223)
Education		
high educated		1.534
		(0.261)
Lived Before Fall of Berlin Wall		
West Germany		1.086
		(0.184)
Children		
yes		1.297
		(0.490)
n	1330	1100
N	9295	7386
Not censored	316	211

Notes: Only old-age retired individuals with current retirement status identical to earliest retirement entry are used. Results are based on Cox Proportional-Hazards estimation. The variable `high educated` aggregates pensioners with *Abitur* or similar education. The base category includes pensioners with lower education level. Only pensioners included who lived in West or East Germany before the Fall of Berlin Wall. Standard errors allow for intragroup correlation within clusters (individual). Hazard ratios are displayed. Data: SHARE-RV; own calculations. Rounded off to the third decimal place.

Figure 2.8: Labour Force Participation of Pensioners by Age



Data: SHARE-RV. 8421 observations; 1128 individuals; own calculations. Only old-age retired individuals with pension eligibilty age 65 are used. 95% confidence interval for proportion p: $\hat{p} \pm z_{1-\frac{\alpha}{2}} \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ with z the inverse cumulative standard normal distribution, α level of significance and n observations.

Table 2.11: Duration of Employment in Retirement – Cox Proportional-Hazards

Dependent variable: Duration of work

	Hazard Ratio	
	I	**II**
Type of Old-Age Pension		
early retired	1.202	1.416
	(0.199)	(0.301)
Sex		
female		1.358
		(0.552)
Education		
high educated		0.761
		(0.190)
Lived Before Fall of Berlin Wall		
West Germany		1.189
		(0.247)
Children		
yes		0.708
		(0.293)
n	322	216
N	1027	771
Not censored	137	106

Notes: Only old-age retired individuals with current retirement status identical to earliest retirement entry are used. Results are based on Cox Proportional-Hazards estimation. The variable high educated aggregates pensioners with *Abitur* or similar education. The base category includes pensioners with lower education level. Only pensioners included who lived in West or East Germany before the Fall of Berlin Wall. Standard errors allow for intragroup correlation within clusters (individual). Hazard ratios are displayed. Anaylsis includes only the first employment during retirement. Data: SHARE-RV; own calculations. Rounded off to the third decimal place.

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Chapter 3

Pension Income, Age at Retirement, and Employment During Retirement: Correlation-Based Evidence for Germany

Abstract

Based upon univariate and multivariate analyses, this paper examines the relationship between pension income, age at retirement, and employment during retirement using data from the Socio-Economic Panel (SOEP) between 1995 and 2015. Results show that the distribution of total pension income becomes more unequal. Referring to the increase of inequality, this paper examines the association of age of entry into retirement with pension income while focusing on distributional differences in the relationship of both variables. In a second step, the influence of pension income on employment probability during retirement is analysed. Regression outcomes imply that the association of own pension income and age at retirement have changed fundamentally. In previous years, age at retirement is not associated with pension income. In contrast, a statistical positive relationship can be seen in 2015. Moreover, the magnitude of this positive effect is higher for lower parts of the distribution of pension income and flattens out for upper parts. While this development can be interpreted as an additional incentive of shifting entry into retirement to higher ages, this result cannot be confirmed by using total pension income, which also includes pension income from non-own source, i.e. widow's or widower's pension as well as orphan's pension. Therefore, the legislative authority faces a classical trade-off as the inclusion of pension income from non-own source leads to a more equal distribution of pension income. Regarding the influence of pension income on probability of employment, findings show that working after retirement is rather a preference than a necessity, at least on an aggregated level of analysis.

JEL codes: J26, D63

3.1 Introduction

The association of pension income, age at retirement, and employment during retirement is multidimensional. It is obvious that an early entry into retirement of otherwise identical individuals is associated with lower pension income. But this simple relationship becomes vague whenever accounting for the different history of earnings over the working life and different health outcomes. Moreover, as entry into retirement is not any longer connected to end of work (Brenke 2011), it is unclear if employment during retirement is based on economical needs or can be attributed to a preference. Whereas the former can be the result of an early entry into retirement which is connected to lower pension income, the latter could imply that pension income is not a relevant factor for predicting employment probability during retirement. This becomes even more complicated as the German Pension Fund privileges different subgroups with an earlier entry into retirement.[1]

Due to demographic ageing, the distribution of the population in Germany changes (Birg and Flöthmann 2002), e.g. the share of workers to pensioners is decreasing (Borsch-Supan and Schnabel 1998). This puts pressure on the German Pension Fund which is mainly financed by a pay-as-you-go system (Borsch-Supan and Schnabel 1998). As a result, pension eligibility ages were increased (Bundesgesetzblatt 2007) or certain types of old-age pension were terminated for later birth cohorts (§ 237, § 237a SGB VI). In addition, other reforms (Bundesgesetzblatt 2016) try to increase the labour force participation of older people. Based upon a general increase of average age at retirement within the period of analysis (Deutsche Rentenversicherung Bund 2018), this paper investigates if the relationship of age of entry into retirement and pension income gives further incentives to retire at later ages or not. Moreover, estimation methods are used to determine if the effect is equal over the distribution of pension income.

As the share of individuals who exhibit employment during retirement is increasing (Brenke 2011), this paper gives evidence for the reasons of an employment during retirement. This is done by analysing the influence of pension income at the beginning of entry into retirement on employment probability in 2015. The paper is structured as follows: section 3.2 presents data and gives an overview of univariate analyses of *age at entry into retirement* (3.2), *pension income* (3.2), and *employment during retirement* (3.2). Section 3.3 analyses the association of age of entry into retirement and pension income, whereas section 3.4 identifies potential differences of probability of employment during retirement which can be attributed to the size of pension income at the beginning of entry into retirement. Section 3.5 concludes.

1. Individuals with a bad health status can enter retirement before regular pension eligibility age via invalidity pension. Old-age pensioners with a long and continuous history of earnings can apply for an early old-age retirement.

3.2 Data

The analysis is based on the German Socio-Economic Panel (SOEP). The SOEP is a household panel study which contains representative information of the life course of the underlying German population (Wagner, Frick, and Schupp 2007). Within this paper, individual level data is used from 2000 up to 2015. The focus of the analysis lies on three specific individual questionnaires (1995, 2005, and 2015) which cover a period of more than 20 years.[2]

The advantage of the SOEP when analysing the relationship of pension income, age at retirement, and employment during retirement is the panel survey design and the wide range of different proxies of employment during retirement and pension income. That means, the data source on the one hand includes information about the size and source of pension income while on the other hand, it also covers information about employment during retirement and age at entry into retirement. In combination with socio-demographic information provided by each respondent, the association of these variables can be analysed and compared for different subpopulations. On the downside, available information, especially concerning income and other sensitive information, is based on individual willingness to report. Therefore, given information lacks precision in comparison to administrative data. But, as administrative data does not cover a wide range of sources of pension income, the SOEP constitutes a basis of analysing the interaction of total pension income, age at retirement, and employment during retirement.

The targeted population are pensioners with usable information for the respective purpose of univariate and multivariate analysis. While univariate analysis of pensioner's income uses all information of any pension income, analyses of employment during retirement and the distribution of age at entry into retirement restrict the sample of pensioners whose age at entry into retirement is known by certainty and equal or higher than age of 55. For multivariate analyses the focus refers to individuals with known entry into retirement, whose age at retirement is not earlier than age of 55. To account for sample design of the SOEP (Spiess and Kroh 2007) cross sectional weights are used to give a representative view on the targeted population (Solon, Haider, and Wooldridge 2013).

Information regarding age at entry into retirement is extracted from spell data source ARTKALEN (activity status over the life course combined with information from biography questionnaire) from the SOEP (Goebel 2017). This data source offers the possibility of extracting the year and month of the entry into retirement. Moreover, the data set contains a variable which identifies a possible censoring of

2. While the time horizon of the questionnaires cover 20 years, included retrospective information in the given personal questionnaires enlarge the period of analysis.

the information of entry into retirement. In combination with year and month of birth provided by PPFAD (SOEP Group 2017), a basic data set of the SOEP, age at retirement can be determined on a monthly basis.

Pension income is surveyed two times in each analysed questionnaire; first for the given year of the questionnaire and second for the previous year. All values are pre-tax income. As income from different sources is taxed differently, e.g. different tax exemption limits, net incomes may diverge disproportionally. In addition, retrospective pension income in questionnaires can be split into different sources. The values of monthly pension income from own insurance are asked separately from pension income of non-own insurance, i.e. widow's or widower's pension, and orphan's pension. Total pension income includes pension income from own and non-own income sources. Capital income is not included. If necessary, income is revalued from Deutsche Mark (DM) into Euro using the official exchange rate of 1€ = 1.95583DM. If income is compared over several years, values are expressed in same prices using Consumer Price Index of the Federal Office of Statistics (Destatis).

Employment during retirement in 2015 is analysed using two different measures, i.e. "paid work last seven days" and "current employment status". The current employment status can be separated into full-, part-time, and minor employment. The variable "paid last seven days" is a dummy which is one if the respective individual exhibits any employment and zero if otherwise. For later purposes current employment status is aggregated to a dummy of having an employment or not.

In the following analyses additional control variables are used. The set of control variables includes: sex; current age of the pensioner; a regional variable indicating if the pensioner lives in East or West Germany; the year of entry into retirement; and a potential invalidity status.

Age at Entry into Retirement

The general step-wise increase of the pension eligibility age within the German Pension Fund leads to a higher average age at entry into retirement (Deutsche Rentenversicherung Bund, 2018). This increase is displayed in Figure 3.1 which compares the distribution of age at entry into retirement over the period of 1995 until 2015 using SOEP data.[3] The average age of entry into retirement in the year 1995 was 61.24 years while in the year 2015 the average age at entry into retirement rose to 62 years. The variation, specified as standard deviation (SD), is nearly unchanged over time. The sample includes all pensioners who enter retirement between age 55 and age 70, irrespective of type or source of the pension. Moreover, the average retirement age

3. The graphical illustration of age at retirement over the period of analysis restrict entry into retirement to age of 70 for visual purposes.

Figure 3.1: Distribution of Age at Entry into Retirement – 1994, 2004, 2014

	Age of Retirement	
	Mean	**SD**
1995	61.24	2.92
2005	61.61	2.82
2015	62.02	2.85

Notes: Only individuals whose entry into retirement is uncensored or right censored are used. Illustration displays pensioners whose entry into retirement is equal or higher 55 years and lower or equal age of 70. Respective cross sectional weights are used. Individuals equals observations in the samples. 2015: $n = 2891$, 2005: $n = 4084$, and 1995: $n = 2551$.Data: Socio-Economic Panel (SOEP) 1995, 2005, and 2015.

does not account for a potential invalidity status of the pensioner. When differentiating by potential invalidity, pensioners without invalidity status exhibit a higher age of entry into retirement compared to pensioners with an invalidity status.[4] The difference between pensioners with invalidity status is about one and a half years and statistically significant.[5] Average age at retirement in West Germany is significantly higher than in East Germany (average age of retirement in West Germany 62.26 years in the sample in comparison to 60.95 in East Germany), while differences of age at retirement via sex are small (for women: 62.06, for men: 61.98) and not statistically different from each other.[6]

Figure 3.1 shows that there are three relevant ages (60, 63, and 65) of entry into

4. An invalidity status does not mean that the respective pensioner have an invalidity pension.

5. According to the definition, the average age at retirement of pensioners with invalidity status is about 60.98, the average retirement age is 62.41 in 2015. A Wald test (Wooldridge 2001) rejects the null hypothesis of the equality of the means. The F-value is 62.95. The test accounts for stratification and primary sample units and uses cross sectional weights of 2015.

6. The exact test statistic and p-values are available upon request.

retirement over the period of analysis. When evaluating the change of age at entry into retirement over time, it is evident that the share of individuals retiring at age 60 is decreasing over time while the share of pensioners retiring at age 65 is increasing. In 1995, the share of pensioners retiring at 60 was the highest while in 2015 the share of pensioners retiring at age 65 marks the peak. The share of people retiring at age 63 is increasing too, but, on a smaller scale. These affects can be mainly attributed to the termination of specific types of pensions for later birth cohorts – pension for women and pension due to unemployment and part-time work for employees over 55 – and increasing pension eligibility ages for other pension types.

Pension Income

The source and distribution of pre-tax pension income over time is evaluated in this subsection. Pension income covers all sources from previous own insurance of any private or official source. Pension income from non-own insurance, i.e. widow's or widower's, and orphan's pension are only to a minor extent part of this section. Capital income or transfer payment are not part of the analysis.

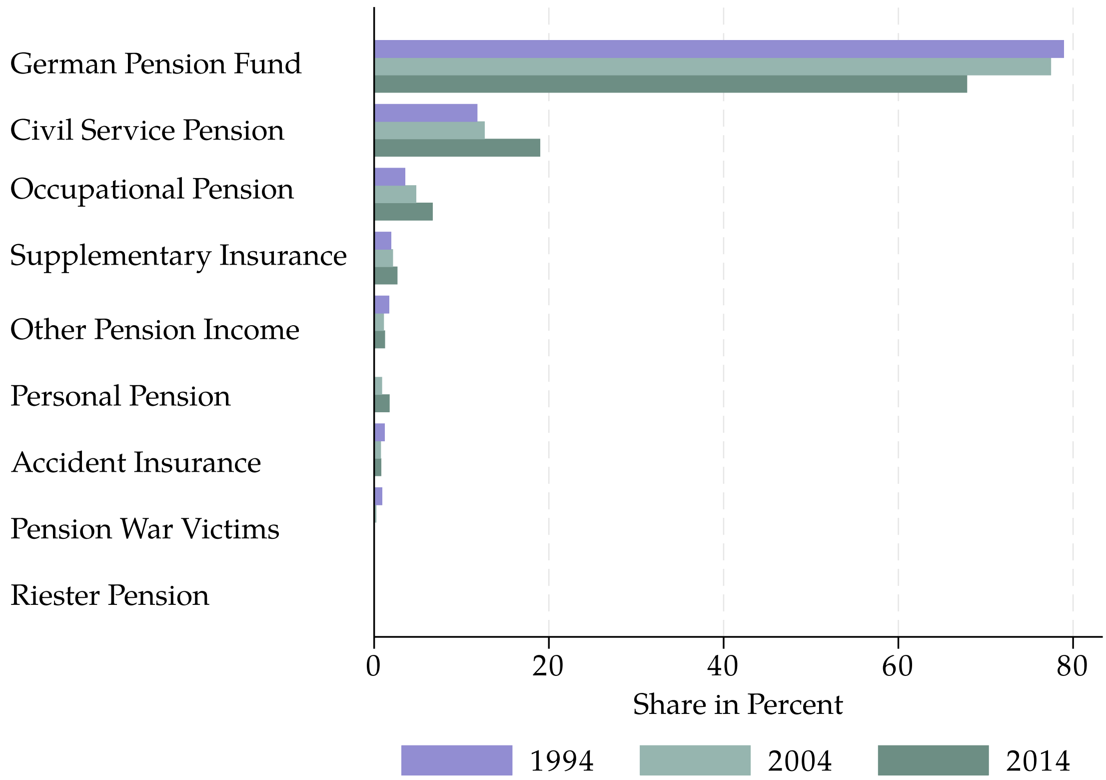
The SOEP asks for several sources of pension income. The choice of categories changed over the analysed questionnaires. Pension income from the German Pension Fund was separated in 1995, i.e. the questionnaire includes separate categories for miner's, farmer's, salaried employees' and wage earners' pension. These values were added to the source of German Pension Fund to ensure comparability of income source over time. Personal pensions were not included in the questionnaire of 1995. This is also true for Riester pensions which only appear in the 2015 questionnaire.[7] The Riester pension is a privately financed, but publicly subsidised insurance which was introduced to account for the decrease of the net replacement rate when entering retirement (Börsch-Supan, Coppola, and Reil-Held 2012). As the name suggests, the civil service pension (*Beamtenversorgung*) covers individuals who work in a official field of administration and exhibit a civil servant status. Occupational pensions are based on an employer-employee relationship. Supplementary insurance (*Zusatzversorgung des öffenlichen Dienstes*) is relevant for public sector employees. The pension for war victims[8] (*Kriegsopferversorgung*) compensates and assists war victims. It can include civilian as well as soldiers which were directly affected by the Second World War and have bad health. In addition, the questionnaires include pensions from an accident insurance and personal pension scheme, e.g. pensions for members of professions and other private insurances.

Figure 3.2 plots the share of each source of the own total pension income of all

7. Each analysed questionnaire includes the category "other pension income" in which pensioners can enter pension income from not mentioned income sources.

8. See Bundesversorgungsgesetz for details.

Figure 3.2: Share of Own Total Pension Income (Pre-Tax) by Source – 1994, 2004, 2014



Notes: Monthly own pension income. In 1995, income from the German Pension Fund was asked separately for miners', famers' pension insurance as well as salaried employees' and wage earners' pension insurance. Personal Pension is not included in individual questionnaire of 1995. Riester Pension is only included in the 2015 questionnaire. Ordered by size. Respective cross sectional weights are used. Individuals equals observations in the samples. 2014: n = 5780, 2004: n = 4882, and 1994: n = 2118. Data: Socio-Economic Panel (SOEP) 1995, 2005, and 2015.

pensioners. Therefore, Figure 3.2 lists the economic magnitude of each source for every year within the analysis. For each year the shares sum up to one. Pension income from the German Pension fund exhibits by far the highest share; up to nearly 80% in 1994. But, this share is decreasing over time. In 2014, the share is about 68%. Civil service pension's share is the second most important pension income source in the economy and its influence is increasing over time. The actual share in 2014 is about 19%. Occupational pensions cover about 6-7% of total pension income in 2014. Other sources of pension income have in total about 6.5% of the total pension income in 2014.[9] Although several income sources profit from the loss of relevance of the German Pension Fund over time, the largest increase can be attributed to the civil service pension.[10]

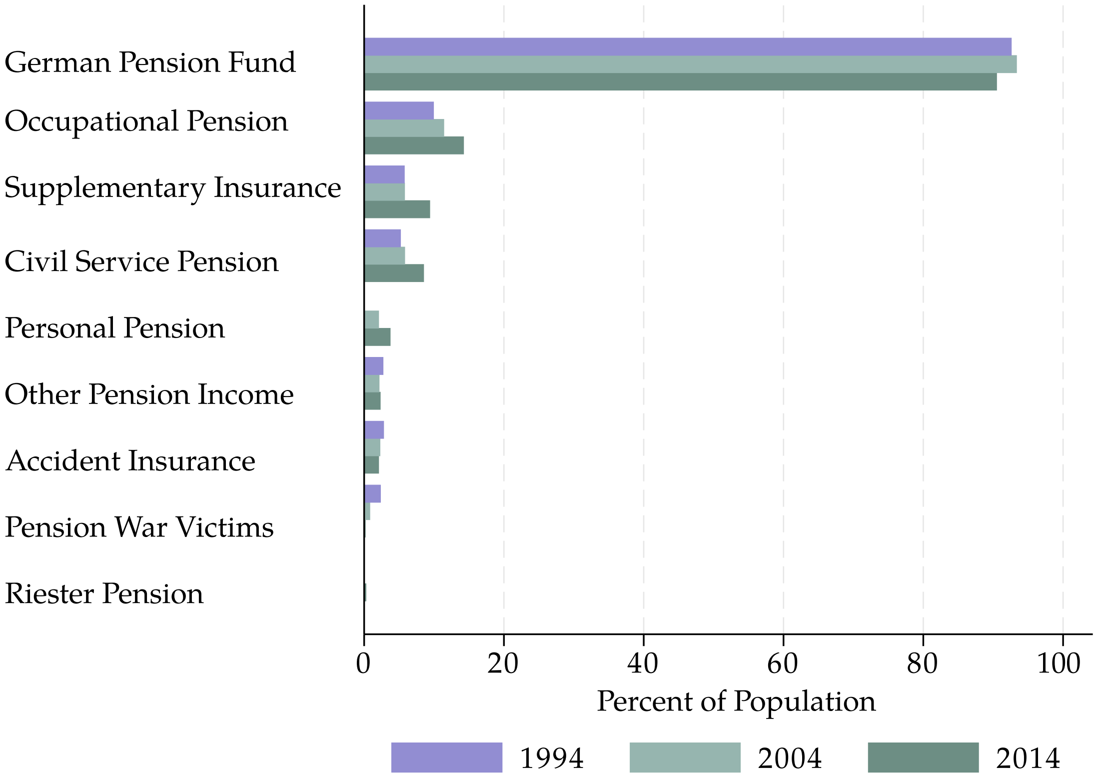
The distribution of the size of each source of pension income and therefore its relevance across the population of pensioners in Germany is displayed in Figure 3.3. The figure plots the share of pensioners having the respective source of pension income. As pensioners can have pension income from several sources, the sum of shares is larger than one. The spread of pension income from the German Pension Fund across the population is large. Results indicate that about nine of ten pensioners have any earnings from the German Pension Fund in 2014. However, the fraction is decreasing over time, but not as much as its magnitude with regard to overall pension income. In contrast, the fraction of pensioners with earnings from civil service pension is increasing over time, implying that a part of the increase of the economic relevance in Figure 3.2 can be attributed to an increasing fraction of reception. In comparison, its overall share of distribution within the population is relatively small, about 8.5% in 2014. Moreover, the shares of occupational pension and pension from supplementary insurance for public sector employees, and personal pension are increasing over time, too. The share of the Riester pension is relatively small. Since most of the individuals having a Riester pension have not yet retired and benefits of having a Riester pension are rather low for analysed birth cohorts, this result is not out of ordinary.

Combining both Figures, 3.2 and 3.3, conclusions with regard to the average magnitude of each pension type can be drawn. Results imply that the decrease of the share of total pension income from the German Pension Fund is disproportionally high and cannot solely be attributed to the decrease of pensions in payment (*Rentenbestand*). Moreover, the average value of civil service pensions is in comparison to other pension income sources relatively high and increasing over time. A

9. Supplementary insurance for public sector employees exhibit the highest share with 2.6%.

10. As the survival of directly affected individuals of the Second World War is decreasing over time, the actual share of pension for war victims is decreasing for recent years, too. The share of other pension income is increasing from 2004 to 2014, while the highest share is in 1994. This effect may be the result of the non-existence of personal pensions in the 1995 questionnaire.

Figure 3.3: Distribution of Pension Income (Pre-Tax) by Source within Population – 1994, 2004, 2014



Notes: Share of all pensioners having respective type of pension income. In 1995, income from the German Pension Fund was asked separately for miners', famers' pension insurance as well as salaried employees' and wage earners' pension insurance. Personal Pension is not included in individual questionnaire of 1995. Riester Pension is only included in 2015 questionnaire. Respective cross sectional weights is used. Ordered by size. Individuals equals observations in the samples. 2014: n = 5780, 2004: n = 4882, and 1994: n = 2118. Data: Socio-Economic Panel (SOEP) 1995, 2005, and 2015.

detailed overview of average pension income by source over the analysed period can be found on Table 3.1.

Table 3.1 lists the mean and the standard deviation (SD) of each income source for the years 1994, 2004, and 2014. The respective values are expressed in 2014 Euro using Consumer Price Index of the Federal Office of Statistics (Destatis) and the official exchange rate of 1€ = 1.95583DM for values in the questionnaire of 1995. Cross sectional weights have been used to guarantee that the sample is representative with regard to the German population of pensioners. The average total value of pre-tax pension income is increasing over the analysed period. The largest increase happend in the first decade while in the second decade, from 2004 to 2014, the difference between the average total pension income is relatively small. Analysing total pension in 2014 by subgroups; men face higher average own pension income than women (for men: 1720.44€, for women: 910.35€). The pension income is higher in West Germany (West: 1335.59€, East: 1058.27€), while an invalidity status is associated with a slight decrease of average pension income in the weighted sample (with invalidity status: 1232.95€, without 1307.87€).

Evaluating the development for each pension income source separately, large differences can be quantified. The average pension income from the German pension income has not been changed fundamentally between the ends of the analysed period while in 2004 there is a substantial increase to previous and prospective values. This pattern can also be observed for the supplementary pension income insurance of public sector employees. In contrast, average values of civil service pensions, occupational pensions, and personal pensions are increasing continuously over time. Pension income from accident insurance is stable at the ends of the period under surveillance, but with a minimum value in 2004. The size of pensions for compensation and assistance of war victims is decreasing over time.[11]

Although analysing pre-tax income, conclusions with regard to net pension income for each source can be drawn when using growth rates of the respective sources. However, one has to assume that there are no major differences over time with regard to taxation of pensions. Moreover, the distribution within each pension source has to be relatively stable over time. If so, individuals having a civil service pension, occupational pension, or personal pension face an increase in net pension income. In contrast, the size of pension income from the German Pension Fund is relatively stable over time. Even when incorporating the Riester pension, which was introduced to compensate for subsequent income losses from the German Pension Fund, the value of the sum of earnings from the German Pension Fund and Riester pension leads to only a minor increase to 960.03€ in 2014 in comparison to 959.86€ without

11. A general pattern of the category "Other Pension Income" cannot be stated as the categories are not stable over the questionnaires.

Table 3.1: Mean and Standard Deviation of Own Pension Income (Pre-Tax) by Source – 1994, 2004, 2014

	1994		**2004**		**2014**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
			in 2014 €			
German Pension Fund	956.33	571.45	1033.55	734.71	959.86	518.06
Civil Service Pension	2535.63	908.37	2702.88	1157.79	2851.66	1230.80
Occupational Pension	398.76	546.31	523.43	979.62	600.38	1256.90
Supplementary Insurance	377.07	307.83	459.28	743.72	360.47	309.20
Other Pension Income	702.27	740.84	633.08	946.44	677.12	1195.77
Personal Pension	-	-	531.20	629.71	598.78	688.22
Accident Insurance	479.66	377.76	415.02	273.87	489.68	355.97
Pension War Victims	434.12	369.25	352.87	305.85	343.58	167.97
Riester Pension	-	-	-	-	71.50	157.78
Total	1122.08	802.37	1245.64	1082.77	1280.29	1030.97

Notes: Values in 1994 are revalued in Euro using the official exchange rate of 1€ = 1.95583DM. Own Pension income is expressed in 2014 Euro using Consumer Price Index of the Federal Office of Statistics (Destatis). Respective cross sectional weights for 1995, 2005, and 2015 (year of questionnaire) are used. Individuals equals observations in the samples. 2014: $n = 5780$, 2004: $n = 4882$, and 1994: $n = 2118$. Data: Socio-Economic Panel (SOEP) 1995, 2005, and 2015.

Table 3.2: Distribution of Monthly Retirement Income (Pre-Tax) – Inequality Measures

	Total			**Own Insurance**			**Non-Own Insurance**		
	1995	**2005**	**2015**	**1995**	**2005**	**2015**	**1995**	**2005**	**2015**
Relative Mean Deviation	0.216	0.225	0.242	0.265	0.257	0.265	0.219	0.223	0.229
Coefficient of Variation	0.592	0.660	0.695	0.700	0.744	0.763	0.589	0.627	0.630
Gini Coefficient	0.311	0.323	0.345	0.369	0.363	0.373	0.309	0.320	0.329
Theil's Index	0.164	0.183	0.204	0.226	0.226	0.237	0.162	0.175	0.183
Observations	2302	5165	5374	2030	4853	5123	661	1099	1006

Notes: Total monthly retirement income includes own and non-own pension payments. Respective cross sectional weights for 1995, 2005, and 2015 are used. The *Relative Mean Deviation* computes the average absolute difference from the mean divided by the mean (Cowell, 2011). The *Coefficient of Variation* is the square root of the sample variance of monthly retirement income, standardised by the respective mean (Cowell, 2011). The *Gini Coefficient* is based on the ratio filled by the Lorenz curve and the area of total equality. *Theil's Index* is $\frac{1}{N}\sum_{i=1}^{N}\frac{y_i}{\bar{y}}log(\frac{y_i}{\bar{y}})$, where y is the monthly pension income and index i refers to the individual i of N individuals in total. Further definitions, details ,and additional information of the inequality measures can be found in Cowell (2011). Individuals equals observations. Data: Socio-Economic Panel (SOEP) 1995, 2005, and 2015.

including the Riester pension. This is remarkable from a distributional standpoint, as shares within the population of each increasing source are also increasing over time. When comparing the ratio of means of pre-tax income from civil service pensions and the German Pension Fund, the ratio is increasing from 2,65 in 1994 to a factor of almost three in 2014.

The overall variation of pension income is evaluated by using different measures of inequality. Table 3.2 lists four different inequality measures: the relative mean deviation, the coefficient of variation, the Gini coefficient, and Theil's index. A definition of each measure can be found in the notes under Table 3.2. The table also lists the variation of own pension income, pension income from non-own insurance including widow's or widower's, and orphan's pension, and the sum of own and non-own pension income (described as "Total"). The analysis uses cross sectional weights for each year of the analysis. The total pension income is increasing on all measures over time. That implies, that pension income is distributed more unequally over time. By evaluating own and non-own pension income separately, the increase of inequality cannot be confirmed with certainty for own pension income. In contrast, inequality of non-own pension income is increasing over time. With regard to own pension income, the relative mean deviation is stable while the coefficient of variation is increasing substantially. The Gini coefficient as well as Theil's index is only increasing marginally. A comparison of the actual magnitude of the variation of pension income shows that pension income from own insurance is more unequally distributed than pension income from non-own insurance. Therefore, the sizes of measures of inequality using total pension income lie between both incomes of own and non-own insurance. This implies that widow's or widower's, and orphan's pension income have a positive effect with regard to an equal distribution of total pension income in Germany.

Employment During Retirement

In this subsection the probability employment in 2015 are evaluated while focusing on subgroup differences. The share of employment during retirement is increasing over time (Just 2019). Based on the SOEP data source, the share of pensioners with employment whose age of entry into retirement is equal or higher age of 55 is around 9-11% and depends on the measure used to proxy actual employment status.[12]

Table 3.3: Employment during Retirement in Percent – 2015

	Paid Work Last 7 Days	**Current Employment Status**		
		full-time	**part-time**	**minor**
Germany	10.81	1.17	2.02	5.96
West Germany	11.74	1.30	2.24	6.55
East Germany	6.65	0.59	1.09	3.35
Germany – Only Men	12.72	2.07	1.85	7.35
Germany – Only Women	9.13	0.39	2.18	4.75
Germany – Pensioners with Invalidity	9.78	0.73	0.61	7.49
	T-tests for "Paid Work Last 7 Days"			
	F-value	**p-value**		
Difference West and East Germany	10.89	0.00		
Difference Men and Women	5.41	0.02		
Difference Invalidity – Yes and No	0.67	0.41		

Notes: Employment during retirement for pensioners older than 55 whose age at entry into retirement is known. The table reports shares of pensioners with employment. Cross sectional weights for 2015 are used. T-tests accounts for survey design, i.e. accounts for stratification and primary sampling units. Singleton primary sample units do not contribute to standard errors. Individuals equals observations in the samples. Paid work last seven days: $n = 2913$; current employment status: $n = 2921$. Socio-Economic Panel (SOEP) 1995, 2005, and 2015.

The majority of pensioners who have an employment during retirement exhibit a minor employment. By evaluating the current employment status, it becomes evident that the share of pensioners with full-time employment is low in comparison to

12. Using the proxy of employment "Paid Work Last 7 Days", the share is about 11%. In contrast, using the ordinal measure of current employment status the share is about 9%.

other types of employment. Differences between East and West Germany are large, implying that the share of East German pensioners being employed is about 56% of the share in West Germany. The difference is statistically significant on conventional levels of significance. However, the differences of the relative shares of the attributes of the current employment do not differ between East and West Germany.

Gender differences affect the share of employment, too. Women have a significantly lower share of employment than men. Even more, differences between gender are also relevant when it comes to shares of type of employment. The share of male pensioners with fulltime employment is about 18% whereas the share of female fulltime employment is about 5%. With regard to invalidity status, which has to be officially determined according to the respective question in the questionnaire, there are no overall differences in the share of employment between pensioners with and without an invalidity status.

Based upon the univariate results of this section, the next two sections analyse the relationship of pension income, age at retirement, and employment during retirement in a multivariate setup. As increasing pension eligibility ages lead to higher average retirement age, the next section analyse the association of age at retirement and pension income. Here, heterogeneous effects along the distribution of pension income will be presented in detail. Afterwards, the relationship of pension income at the beginning of retirement and employment probability is evaluated. By doing so, this analysis gives support of actual reasons for supplying labour during retirement, i.e. out of a personal preference versus necessity.

3.3 Age at Entry into Retirement and Pension Income

A continuous and rewarding employment during life time is associated with higher pension income during retirement. Moreover, early old-age retirement options are granted within the German Pension Fund for individuals who exhibit longer periods of employment. However, early entry into retirement is also motivated by a bad health status and as a result attributed to lower income, e.g. invalidity pensions due to reduced earning capacity. The association of age at retirement and pension income in Germany is analysed in this section. Moreover, corresponding distributional differences with regard to the relative income position at different ages of entry into retirement will also be evaluated. The analysis covers a period of 20 years from 1995 until 2015 and focuses on pensioners with age at retirement of 55 years or later. For each year under review (1995, 2005, and 2015) respective cross sectional weights are used. The analysis uses monthly pension income from own insurance and the total pension income which also incorporates pension income from non-own insurance, i.e. widow's or widower's, and orphan's pension.

Table 3.4: Age at Entry into Retirement and Own Pension Income (Pre-Tax) – QRE and OLS

		Log(Own Pension Income)		QRE			OLS	
Year	Obs.	Mean	SD	0.25	0.50	0.75	Coefficient	Root MSE
1995	598	6.500	0.809	-0.016	0.051	0.078	-0.031	0.631
				(0.110)	(0.065)	(0.081)	(0.081)	
2005	2245	6.743	0.810	0.046	0.028	0.105	0.015	0.636
				(0.109)	(0.054)	(0.059)	(0.037)	
2015	2321	6.968	0.822	0.171	0.121	0.051	0.134	0.692
				(0.056)	(0.034)	(0.053)	(0.050)	

Notes: QRE – Quantile Regression Estimates. Models control for year of entry into retirement, current age, sex, region, and family status. Respective cross sectional weights for 1995, 2005, and 2015 are used. In 1995, pension income is revalued from DM in Euro using the official exchange rate of 1€ = 1.95583DM to ensure comparability of Mean and standard deviation (SD) over the years. Standard errors in parentheses. Only pensioners whose age at entry into retirement is equal or higher 55 years are chosen. Cross sectional weights are used. Data: Socio-Economic Panel (SOEP) 1995, 2005, and 2015.

The model explains the association of age at retirement and the logarithmised pension income while also controlling for year of entry into retirement, current age, sex, region (East or West Germany), and family status. The former two variables control for the heterogeneity of paid pension over different years and different ages. The last three variables control for socio-demographic differences of pensioners. The analysis is executed on the individual level.

To evaluate the average effect of age at entry into retirement on pension income, Ordinary Least Squares (OLS) with heteroscedasticity robust standard errors is used. To analyse distributional differences with regard to the relative pension income position, Quantile Regression Estimates (QRE) are computed and displayed for the 0.25, 0.50, and 0.75 quantiles.

Table 3.4 reports the association of age at entry into retirement and own pension income. For the first two years, 1995 and 2005, there is no clear tendency of age at retirement and own pension income. This is true for the average effect using OLS and for respective quantiles using QRE. Only in 2005, there is little support[13] of a positive relationship of retirement age and own pension income for the upper quartile (0.75). However, in 2015 the relationship of age at entry into retirement and own pension income changes fundamentally. Evaluating the average effect, there is a clear tendency that a higher age at entry into retirement is associated with higher own pension income. The effect is significant on conventional levels of significance. Evaluating the point estimate, regression results imply that an increase of age at retirement of one year is associated with an increase of own pension income of 13.4 percent on average. The effect varies over the distribution of pension income. This is illustrated by the QRE estimates. While the effect is positive on all displayed quartiles, the magnitude is decreasing with higher quartiles and only significant for the lower quartile and

13. The effect is statistical significant on the ten percent significance level. In contrast, evaluating significance at the five percent level, the null hypothesis implying that the relationship of retirement age and own pension income is independent cannot be rejected.

Table 3.5: Age at Entry into Retirement and Total Pension Income (Pre-Tax) – QRE and OLS

		Log(Total Pension Income)		QRE			OLS	
Year	**Obs.**	**Mean**	**SD**	**0.25**	**0.50**	**0.75**	**Coefficient**	**Root MSE**
1995	636	6.584	0.762	-0.156	0.012	0.073	-0.058	0.640
				(0.098)	(0.080)	(0.061)	(0.078)	
2005	2307	6.822	0.772	-0.011	0.049	0.051	0.058	0.618
				(0.101)	(0.070)	(0.213)	(0.044)	
2015	2347	7.061	0.784	0.017	0.049	0.015	0.072	0.660
				(0.048)	(0.032)	(0.039)	(0.047)	

Notes: QRE – Quantile Regression Estimates. Models control for year of entry into retirement, current age, sex, region, and family status. Respective cross sectional weights for 1995, 2005, and 2015 are used. In 1995, pension income is revalued from DM in Euro using the official exchange rate of 1€ = 1.95583DM to ensure comparability of Mean and standard deviation (SD) over the years. Standard errors in parentheses. Only pensioners whose age at entry into retirement is equal or higher 55 years are chosen. Cross sectional weights are used. Data: Socio-Economic Panel (SOEP) 1995, 2005, and 2015.

the median. This implies that the positive association of age at entry into retirement and pension income is relevant for individuals at the lower parts of the distribution of own pension income.[14]

Table 3.5 reports the regression estimates of age at entry into retirement on total pension income. In contrast to Table 3.4, there are no statistical significant changes in the association of retirement age and total pension income over the period under review. This is true for OLS and QRE estimates which implies that the inclusion of non-own pension income prevents a positive relationship of age at entry into retirement and total pension income.

3.4 Pension Income and Employment

Within life cycle theory, the entry into retirement describes the point in time during which individuals achieve a stable path of consumption over the life course. This result is based on a trade-off between consumption which has to be financed mainly out of employment and leisure. The idea is that individuals seek for continuity of consumption levels over different ages (Deaton 2005). For Germany Beznoska and Steiner (2012) show that there is, on average, no consumption drop when entering retirement. But in contrast to basic theory, entering retirement is not associated with the end of work. Additionally, an increasing part of the population of pensioners in Germany exhibit an employment after entering retirement (Brenke 2011). In this section, the relationship of pension income and employment during retirement is analysed. In detail, this section gives answers of how total pre-tax pension income at the very beginning of entering retirement affects the probability of employment

14. When evaluating the sign and the magnitude of the average effect of retirement age on pension income over the period of observation, one can see that there is change in the development of the distribution of own pension income with regard to age at retirement. Although not significant in 1995 the association was negatively related and shifts to a statistical significant positive relationship in 2015.

during retirement. Employment during retirement is represented by two different variables, i.e. having a *paid work in the last seven days* and a dummy variable of the *current employment status*.

A potential negative association of pension income and employment can be interpreted as a sign of necessity of supplying labour during retirement, as pension income is to low to finance individual consumption levels. According to classical life cycle theory which assumes a clear cut between work and retirement, it is also implied that a potential shift of entry into retirement, i.e. a higher age at retirement, is more reasonable. On the other hand, an independent relationship or even positive association of pension income and employment during retirement gives support for the theory that employment during retirement is a preference of will rather than a necessity. As the analysis covers average effects, potential individual needs of employment during retirement are only relevant if those needs are important for a larger part of the underlying population of pensioners.

The model explains the employment status in 2015 by total monthly pension income at the beginning of entering retirement. The total pension income includes pension income from own and non-own source from 2000 up to 2014. Therefore, the model controls directly for a potential endogeneity bias from simultaneous causality, i.e. an employment can increase the amount of pension income. See for example recent changes within the German Pension Fund (Bundesgesetzblatt 2016). The variable of interest, the *total pension income*, is logarithmised. In addition, the model adds respective year dummies to account for the nominal property of the pension income variable (Wooldridge 2015).[15] Furthermore, further specifications of the model are added to control for the age of the pensioner, the age at retirement, the region (East or West Germany), the sex, and the family status of the pensioner. In a second step, logarithmised pension income is interacted with sex, region, a dummy indicating if the pensioner has an invalidity status, and pension income quartiles. These sensitivity checks allow flexibility with regard to the determination of the influence of pension income on employment probability. Results can be found in Table 3.7.

The model is estimated via logistic link function which insures that predictions of employment probability are always between zero and one. By using the logistic function, the cumulative density function is strictly increasing (Wooldridge 2015), which means that the sign of reported coefficients are in line with the direction of underlying partial effects (Wooldridge 2015).

Table 3.6 reports the regression results using the logistic function for two different proxies of employment during retirement. The first three columns, (1)-(3),

15. Assuming that inflation is constant over respective subpopulations in different regions in Germany, the addition of an intercept for each year of entry into retirement (except for the base category) absorbs the price level of the respective year when the variable of interest is logarithmised.

Table 3.6: Total Pension Income (Pre-Tax) and Employment During Retirement – Logit

	Dependent Variable					
	Paid Work Last 7 Days			**Current Employment Yes/No**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Log(pension income)	-0.013	-0.057	-0.179	0.025	-0.018	-0.168
	(0.131)	(0.132)	(0.147)	(0.142)	(0.143)	(0.153)
Age at Entry into Retirement		-0.237	-0.124		-0.272	-0.197
		(0.336)	(0.356)		(0.343)	(0.371)
Age		0.257	0.146		0.264	0.178
		(0.334)	(0.356)		(0.341)	(0.370)
Sex			-0.635			-0.732
Female			(0.289)			(0.307)
Region						
East Germany			-0.005			-0.261
			(0.328)			(0.364)
Family Status						
Married, Living Separately			-0.345			-0.194
			(1.387)			(1.389)
Unmarried			-0.567			0.291
			(1.044)			(0.921)
Divorced			-0.358			-0.737
			(0.501)			(0.606)
Widowed			-0.413			-0.471
			(0.347)			(0.370)
Year of Entry into Retirement	✓	✓	✓	✓	✓	✓
Constant	✓	✓	✓	✓	✓	✓
Log-likelihood value	-205	-202	-192	-189	-185	-174
McFadden's R^2	0.066	0.070	0.096	0.056	0.060	0.097
Percentage correctly classified	84	84	84	84	84	84
n	500	494	487	454	447	440

Notes: Total log(pension income) at the beginning of entry into retirement is used. Only pensioners are chosen who exhibit an age at entry into retirement equal or higher than 55 years and whose begin of retirement is not later than year 2000. Estimated via logistic regression. Standard errors in parentheses. Dummy of current employment status is constructed out of raw ordinal employment status. Number of individuals n is equal to the number of observations. The value of Log-liklehood is rounded to full integer. Data: Socio-Economic Panel (SOEP) 2000-2015.

Table 3.7: Sensitivity Checks of Total Pension Income (Pre-Tax) and Employment During Retirement – Logit

	Dependent Variable							
	Paid Work Last 7 Days				**Current Employment Yes/No**			
	(7)	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
Log(pension income)	-0.214	-0.233	-0.155	0.221	-0.165	-0.231	-0.108	0.173
	(0.193)	(0.156)	(0.261)	(0.413)	(0.197)	(0.161)	(0.252)	(0.430)
Interaction Terms								
Female*Log(pension income)	0.079				-0.006			
	(0.286)				(0.294)			
East Germany*Log(pension income)		0.447				0.669		
		(0.381)				(0.448)		
No Invalidity*Log(pension income)			-0.036				-0.086	
			(0.298)				(0.298)	
Pension Income Quartile								
2*Log(pension income)				-2.464				-1.553
				(1.599)				(1.587)
3*Log(pension income)				-1.803				-1.267
				(1.805)				(2.019)
4*Log(pension income)				-0.858				-0.383
				(0.990)				(1.187)
Year of Entry into Retirement	✓	✓	✓	✓	✓	✓	✓	✓
Control Variables	✓	✓	✓	✓	✓	✓	✓	✓
Log-likelihood value	-192	-192	-192	-188	-174	-173	-173	-172
McFadden's R^2	0.096	0.099	0.095	0.116	0.097	0.103	0.098	0.110
Percentage correctly specified	84	84	84	84	84	84	84	84
n	487	487	483	487	440	440	437	440

Notes: Total log(pension income) at the beginning of entry into retirement is used. Only pensioners are chosen who exhibit an age at entry into retirement equal or higher than 55 years and whose begin of retirement is not later than year 2000. Estimated via logistic regression. Standard errors in parentheses. Dummy of current employment status is constructed out of raw ordinal employment status. Number of individuals n is equal to the number of observations. The value of Log-liklehood is rounded to full integer. Data: Socio-Economic Panel (SOEP) 2000-2015.

report regression results using the proxy of *paid work in the last seven days*. The last three columns, (4)-(6), display the results using a dummy of *current employment status*. All models include a constant and intercepts for the respective year of entry into retirement.

Evaluating all specifications, the coefficients of log(pension income) is not different from zero using conventional levels of significance. As signs of coefficients are in the majority negative, except for model (4), point estimates show a negative association of pension income and employment probability which is also valid in terms of partial effects. Nevertheless, effects are not statistical different from zero, implying that the independent relationship of pension income and employment probability during retirement cannot be rejected.

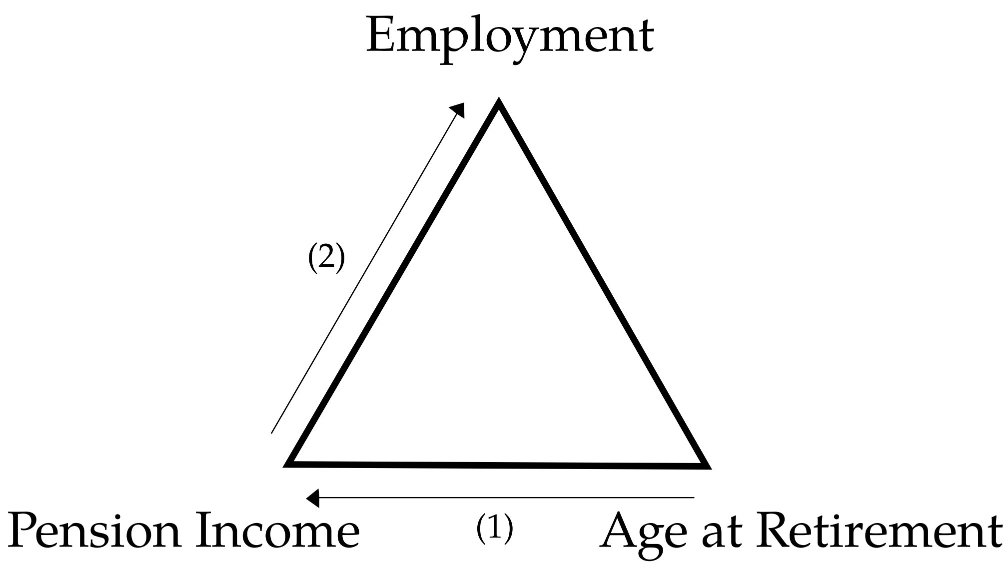
Table 3.7 uses interactions terms with log(pension income) to check the sensitivity of achieved results. Similar to Table 3.6 results have been computed for both proxies, *paid work in the last seven days* and *current employment status*. Models (7) and (11) interact log(pension income) with sex to allow different coefficients for the variable of interest, separated by sex. Models (8) and (12) combine log(pension income) with a dummy indicating if the respective pensioner is located in East or West Germany. Models (9) and (13) interact the logarithmised pension income with a dummy showing a potential invalidity status. In models (10) and (14) pension income quartiles have been generated and interacted with log(pension income) to identify potential differences of coefficients of log(pension income) over the distribution of pension income.

All sensitivity checks show that log(pension income) in itself and the respective interaction terms are not different from zero using conventional levels of significance. Therefore, sensitivity checks confirm the independent relationship of pension income and employment probability during retirement.

3.5 Conclusion

In this paper the relationship of pension income, age at retirement, and employment during retirement is analysed using univariate and multivariate procedures. Figure 3.4 visualises the interaction and shows the executed correlation-based analyses by using arrows. The arrow marked with (1) refers to the analysis of pension income by different ages of entry into retirement. Here, the focus lies on distributional differences in the association of pension income and retirement age and changes over time. The second arrow, (2), marks the model in section 3.4. The model tests the influence of pension income at the beginning of entry into retirement on employment probability in 2015.

Figure 3.4: Pension Income, Employment, and Age at Retirement – Illustration



Notes: Trinity of age at retirement, pension income, and employment. In this paper, (1) gives descriptive evidence of the association of age at retirement and pension income, (2) reports potential differences of employment behaviour during retirement by pension income.

The univariate analyses show that average age of entry into retirement is increasing which can be mainly attributed to increases of pension eligibility ages and the termination of respective types of pension within the German Pension Fund. After quantifying the actual share of pensioners with an employment during retirement, the univariate analysis shows that the majority of pensioners exhibit a minor employment. Moreover, men show significantly higher employment shares and pensioners in West Germany exhibit higher shares of employment during retirement in comparison to pensioners from East Germany. Differences of employment probability with regard to a potential invalidity status are not statistical significant. Descriptive analysis of total pension income shows that overall inequality using different measures is increasing within the period of analysis from 1995 to 2015. Separating total pension income by own and non-own source, it is evident, that non-own pension income's variation is increasing over time while inequality measures using own pension income show no congruent results. This is interesting as the inclusion from non-own pension income leads to a more equal distribution of the underlying pension income. The German Pension Fund is the major source regarding the share of total pension income, but it's influence is decreasing with time. However, the shares of civil service pensions, occupational pensions and income from supplementary insurance for public sector employees increased within the period of analysis. As the use of the German Pension Fund within the population is relatively stable over time, it is obvious that the importance of the German Pension Fund is, in comparison to other sources of pension income, decreasing. The analysis shows that the average pension income from the German Pension Fund was increasing, but at the end of the analysis decreases to its originally value. In contrast, civil service pensions and occupational pensions are increasing within the same period.

The analysis of the association of age of entry into retirement and own pension income shows that only recently a positive relationship of both variables can be determined. That implies that higher age of entry into retirement is associated with higher pension income. This conclusion can be not drawn for previous years for 1995 and 2005. Moreover, this new development is especially important for lower parts of the distribution of pension income. In contrast, using total pension income which includes pension income from own and non-own source, the positive association of retirement age and pension income cannot be confirmed. As pension eligibility ages are increasing (Bundesgesetzblatt 2007) and recent reforms (Bundesgesetzblatt 2016) try to increase the fraction of older people working, this new development can be seen as an incentive for increasing labour force participation at higher ages. But when incorporating pension income from non-own source, which is independent of individual merit, this positive incentive cannot be achieved. As the inclusion of non-own pension income leads to a more equal distribution of pension income and is especially relevant for female pensioners with a non-continuous earnings history, the pension system in Germany faces a trade-off which has to be analysed in subsequent analyses.

Analysing the influence of pension income at the beginning of entry into retirement on probability of employment during retirement using data of 2015, it shows that pension income cannot predict the individual decision of labour force participation during retirement. Therefore, the decision of employment during retirement is more related to an individual preference than a necessity, at least on an aggregated level.

As taxation varies over sources, an analysis using after tax pension income is desirable, but cannot be executed as after tax pension income is not available so far within the SOEP data. In addition, it seems reasonable to include other forms of income, i.e. transfer payments and capital income when analysing the influence of income on employment probability during retirement. In this context, an analysis on the aggregated household level could be done in further research.

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