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Nicolas Goll, Felizia Hanemann

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Financial Incentives and Heterogeneity in Retirement Behavior

An Empirical Analysis Based on SHARE-RV Data

Nicolas Goll* and Felizia Hanemann

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Abstract: Over the past few decades, different reforms have come into force, which aim at keeping older workers in the labor market longer. Broad literature to date has investigated reform effects for the average worker. Evidence on the heterogeneous reform effects on different groups is to date however relatively sparse. We therefore evaluate the 1992 pension reform in Germany, which gradually introduced actuarial deductions for early retirement between 1997 and 2004. We investigate whether individuals with physically demanding jobs at the end of their working career responded differently to the introduction of actuarial deductions in comparison to individuals with physically non-demanding jobs later in life. The gradual introduction of actuarial adjustments offers exogenous cohort-specific variation for the identification of the causal effect of financial incentives on the retirement decision. We estimate Cox proportional hazard models using SHARE-RV data, which offer a direct linkage of administrative data from the German public insurance with the survey data from the Survey of Health, Ageing and Retirement in Europe (SHARE). Results show that the introduction of actuarial deductions in Germany led to a postponed pension benefit claiming date. Individuals working in physically demanding jobs at the end of their working career postponed benefit claiming less than workers in non-physically demanding jobs did.

Zusammenfassung: In den vergangenen Jahrzehnten wurden verschiedene Reformen umgesetzt, die auf eine Verlängerung der Erwerbsleben älterer Arbeitnehmer abzielten. In der Literatur wurden bislang überwiegend die durchschnittlichen Effekte dieser Reformen untersucht. Evidenz zu den Auswirkungen auf heterogene Personengruppen ist bislang jedoch relativ begrenzt. Wir untersuchen daher die Auswirkungen der Einführung versicherungsmathematischer Abschläge für den vorzeitigen Renteneintritt, die in der deutschen Gesetzlichen Rentenversicherung (GRV) mit der Rentenreform 1992 eingeführt wurden. Im Speziellen analysieren wir, ob Personen in körperlich anstrengenden Berufen am Ende ihrer beruflichen Laufbahn anders auf die Einführung der Abschläge reagierten als Personen in nicht-anstrengenden Jobs. Die kohortenspezifische Einführung der Abschläge bietet exogene Variation zur Ermittlung des kausalen Reformeffekts auf die Renteneintrittsentscheidung. Wir schätzen Cox-Proportional-Hazard-Modelle unter Verwendung von SHARE-RV-Daten, der direkten Verknüpfung aus administrativen Daten der GRV und Umfragedaten des Surveys of Health, Ageing and Retirement in Europe (SHARE). Die Ergebnisse zeigen, dass Individuen durch die Einführung der Abschläge ihren Renteneintritt aufgeschoben haben, Personen in körperlich anstrengenden Berufen ihren Renteneintritt allerdings weniger stark aufschoben als die Gruppe der Personen in nicht-anstrengenden Berufen.

Keywords: Demographic change, retirement policies, retirement behavior, heterogeneity

JEL Classifications: H55, J26

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* *Corresponding author*: Nicolas Goll, Munich Center for the Economics of Ageing (MEA) at the Max-Planck-Institute for Social Law and Social Policy, Amalienstr. 33, 80799 Munich. Email: goll@mea.mpisoc.mpg.de.

1. INTRODUCTION

Increasing life expectancy and low fertility rates have caused demographic change and population aging in many countries around the world and in particular in Germany. Ageing populations put enormous pressure on pension systems and especially on Pay-As-You-Go (PAYG) funded pension systems. In the light of ongoing demographic developments, many governments have enacted various pension reforms over the past decades aiming at later retirement and longer working lives (see, e.g., OECD 2017a and Börsch-Supan and Coile 2020). A prolongation of individual working careers is supposed to increase contribution payments and to weaken the financial burden of demographic change on pension systems. The reforms often encompassed an increase of eligibility ages for pension receipt or the introduction of actuarial adjustments for early or late retirement. While Germany changed eligibility ages for pension receipt with different reforms, actuarial deductions for early retirement were introduced with the major 1992 reform (see Börsch-Supan et al. 2019 for an overview on the reform process in Germany).

This paper contributes to the literature studying older individuals' labor market behavior responding to reforms of the public pension system by evaluating the introduction of actuarial deduction rates with the 1992 reform in Germany. Besides average pension benefit claiming reactions, we also aim to investigate heterogeneity since evidence on heterogeneous reform effects is to date relatively sparse. We investigate whether individuals with physically demanding jobs at the end of their working career responded differently to the introduction of actuarial deductions in comparison to individuals with physically non-demanding jobs. Workers in physically demanding jobs may lose their work capacity earlier compared to individuals working in non-physically demanding occupations. These physical constraints may cause differences in the abilities to postpone retirement entry as intended by the reforms gearing towards longer working careers. Eventually, the heterogeneity may lead to lower pension benefits for individuals suffering from physically demanding jobs if they are not able to compensate the actuarial deductions with the benefits from longer working lives. So far, there is only little literature that takes this heterogeneity of constraints into account.

Recent empirical literature has shown that specific reform mechanisms have changed individual labor force behavior of older workers (see, e.g., Hanel 2012, Hanel and Riphahn 2012, Riphahn and Schrader 2020, Börsch-Supan et al. 2020, Geyer et al. 2020, Geyer and Welteke 2021). Hanel (2010), Engels et al. (2017) and Giesecke (2018) evaluated the introduction of actuarial deductions with the 1992 reform (as we do). All these studies found that the reforms have led to substantial reactions of older individuals' labor market behavior, although at different magnitudes.

The central research question in this paper is whether individuals postpone benefit claiming as a reaction to the introduction of the actuarial deductions. To investigate the heterogeneity of reform effects, we analyze the claiming responses for individuals working in physically demanding jobs compared to individuals in non-manual occupations. Finally, we examine whether the two groups differ in terms of pension wealth. In more detail, we analyze the retirement timing in response to the gradual introduction of actuarial deductions that became effective between 1997 and 2004. Since then, early retirement leads to a permanent pension benefit reduction of 3.6% for each year (0.3% per month) pension benefits are claimed before the official eligibility age for full pension benefits. The intensity of actuarial deductions is a function of the month of birth only. Therefore, the reform provides exogenous variation to identify the reform effect on retirement timing which is a critical issue in analyses of retirement behavior (see Gruber and Wise 2004).[1]

We estimate retirement hazard rates between age 60 and 66 for the birth cohorts 1935 to 1947. We calculate the duration until pension benefit claiming by estimating hazard rates using Cox proportional hazard regressions using the dataset SHARE-RV. SHARE-RV stands for the record linkage of survey data of the Survey of Health, Ageing and Retirement in Europe (SHARE) with administrative data from the German Pension Insurance (*Deutsche Rentenversicherung Bund*, see Börsch-Supan et al. 2018). Due to the linkage, SHARE-RV contains accurate administrative data and profound information about different aspects of the respondents' lives in one single data source. The administrative data part includes very precise monthly information on employment, contribution histories and the date and type of pension claims. This enables us to identify the retirement pathways individuals chose and to precisely compute pension benefits. The survey data part from SHARE offers information on socio-demographics and job characteristics, such as whether individuals were working in physically demanding jobs. The resulting record-linked dataset thus combines the best of both data worlds.

The remainder of the paper is structured as follows. Section 2 provides an overview of related literature and contains our hypotheses. Section 3 thoroughly describes the reform we are investigating and shows how it is embedded in the reform process over the past decades. While Section 4 includes more information about the data, Section 5 shows the empirical approach and presents our results. In Section 6 we conclude.

[1] Some studies name this approach a „natural experiment", see e.g. Hanel (2010) and Giesecke (2018).

2. LITERATURE AND HYPOTHESES

The paper contributes to two main streams of the literature. The first stream contains studies analyzing the influence of pension benefits and institutional changes on the labor force participation and retirement decision in old age, respectively. The second stream examines the role of working conditions in the retirement decision. In the following, we present relevant studies of the respective literature streams we are contributing to; first separately and linked to each other afterwards.

Pension benefits, financial incentives and the retirement decision

There is extensive literature on the influence of pension benefits and institutional changes for the retirement decision. Seminal work was done by Gruber and Wise (1999, 2004), who investigated the effect of retirement incentives on the downturn of labor force participation of older individuals by the end of last century. The research group around Gruber and Wise (1999, 2004) found that varying retirement incentives had a strong effect on retirement decisions (see, e.g, the study by Börsch-Supan and Schnabel 1999 for Germany). More recent empirical literature has shown that specific reform devices have changed individual labor force behavior of older workers by evaluating for instance the reform effect of the introduction of actuarial adjustments for early retirement (Hanel 2010, Engels et al. 2017, Giesecke 2018), the increase of the statutory eligibility age (Hanel and Riphahn 2012), the increase of the earliest eligibility age for early retirement (Geyer and Welteke 2021 and Geyer et al. 2020), as well as reforms on disability insurance (Hanel 2012) and unemployment insurance (Riphahn and Schrader 2020). These studies found that the reforms have led to substantial reactions of older individuals' labor market behavior, albeit at varying magnitudes. Ye (2018) analyzes a reform that implemented supplemental pension benefits and shows that additional monthly pension benefits induced female recipients to claim pension benefits earlier. Börsch-Supan and Coile (eds., in progress) investigate the striking trend reversal of employment rates among older individuals between 1970 and 2015. They find that a substantial proportion of the trend reversal is caused by the reform-driven change of the implicit tax on working longer (see, e.g., Börsch-Supan et al. 2020 for evidence on Germany). Beside financial incentives, Seibold (2019) found that reference point effects are a potential explanation of retirement patterns as well.

Since we use the introduction of actuarial adjustments as a source of identification, our study comes closest to the following other studies that examine the same reform: Börsch-Supan and Schnabel (1998) evaluate the reform effect based on *ex ante* simulations. The authors predict a six month increase of the average claiming age. Börsch-Supan et al. (2004) apply the option-value framework and simulate the 1992 reform. The resulting increase of the retirement age amounts to six months for the introduction of adjustment factors. Hanel (2010) confirms this qualitative finding by showing that the reduction of pension benefits causes a postponement of claiming benefits by about 14 months and a delay of employment exit by about 10 months on average. Engels et al. (2017) find that an increase in the actuarial deduction rate by one percentage point reduces the average retirement rate by about 1.9 percentage points, increases the employment rate around one percentage point and increases the unemployment rate about 0.9 percentage points. Giesecke (2018) finds that, on average, individuals postpone retirement by 13.2 months if pension benefits are reduced by 3.6% for each year of early retirement.

Based on the empirical evidence of varying financial incentives, we derive the first hypothesis (H1).

H1: The introduction of adjustment factors leads to a postponed pension benefit claiming date.

Working conditions and the retirement decision

Based on SHARE data, Siegrist et al. (2006) study the relationship between the quality of work and the intension to retire early. They find that indicators of a poor psychosocial quality of work, which includes a measure of physical demand, is significantly associated with intended early retirement. A follow-up study confirms these results and in addition uses measures of occupational positions to show that the lower the occupational status, the higher the intention to retire (Wahrendorf et al. 2012). Moreira et al. (2017) claim to rely on a more accurate measure of the early retirement intentions by accounting for the planned retirement age in relation to the country-specific official retirement age. They find a smaller, but still positive effect of poor working conditions on the intention to retire early. Robroek et al. (2013) complement these studies by investigating the influence of work characteristics on the effective exit from paid employment by using Cox proportional hazard models with SHARE data. They find that a lack of job control is a risk factor for early retirement. Similar evidence is found based on the US dataset from the “Health and Retirement Study” (HRS, Angrisani et al. 2013).

Working conditions, financial incentives and the retirement decision

Considered separately, the impact of financial incentives and the impact of working conditions on the decision to retire have been well established in the literature. However, there is only little research on the interacting role of working conditions and financial incentives on the retirement decision. Different mechanisms could explain the association between physically demanding jobs and the impact of financial incentives on early retirement behavior.

On the one hand, despite the economic theory of compensation that predicts a positive relation between wages and job characteristics (Smith 1976, Thaler and Rosen 1976), empirical evidence shows that in most countries low-paid employment is concentrated in industries that typically offer blue-collar jobs with physically demanding job requirements (OECD 2017b). In particular, unskilled blue-collar workers are not awarded a wage premium as compensation of the hazardous work and in turn often experience both intense physically demanding working conditions and a low-wage compensation scheme. Euwals and Trevisan (2014) show that low-wage earners are more sensitive to financial incentives, as predicted by a stylized life-cycle model. Therefore, workers in physically demanding jobs are predicted to be more financially impaired by the introduction of adjustments. Thus, they have to postpone retirement more than high-wage earners in order to minimize the reductions in the pension payments.

On the other hand, physically demanding jobs are shown to be negatively related to health outcomes (Borg and Kristensen 2000, Rodriguez 2002, Cottini 2012). Poor health in turn is predicted to make older workers less responsive to financial incentives because their labor supply is less elastic, as has been shown by the aforementioned literature on the role of working conditions in the retirement decision. Based on these mechanisms, workers in physically demanding jobs are predicted to postpone retirement less than workers in non-physically demanding jobs.

Building on these opposing mechanisms, it is an empirical question to predict how workers in physically demanding jobs react to the introduction of actuarial adjustments. Workers in physically demanding jobs could either be forced to continue working as they are in need of income or they could be forced to stop working because their health does not allow the continuation of the job. In both scenarios, workers in physically demanding jobs are limited in their decision of the retirement timing due to outer circumstances, which may seem unfair compared to workers in non-physically demanding jobs who are not faced with these restrictions in their decision. In order to countervail such effects through specific policy interventions, it must be assessed which mechanisms are more prevalent and how the working conditions impact effects of the financial incentives within the retirement decision.

To the best of our knowledge, there is only one empirical study so far which considers this interplay between working conditions, financial incentives and the retirement decision. Giesecke (2018) takes worker heterogeneity into account and finds that male manual workers postpone retirement on average by 9.7 months if actuarial deductions in the amount of 3.6% per year of early retirement apply. Thus, their response is about 50 percent lower compared to male non-manual workers, who postpone by 19.6 months. Overall average is 13.2 months.

Based on Giesecke's finding and the fact that the relationship between physically demanding jobs and health problems is more evidenced in the literature than the correlation between physically demanding jobs and financial incentives, our hypothesis regarding the role of working conditions is as follows:

H2: Workers in physically demanding jobs are more likely to retire early for health reasons. Therefore, these workers respond less to the introduction of adjustments and we expect less postponement than for workers in non-physically demanding jobs.

In the following section we present how the reform we evaluate is embedded in the past reform process of the public pension system in Germany.

3. INSTITUTIONAL SETTING

The German public pension system was the first formal pension system in the world. It was originally designed as a funded disability insurance scheme in 1889 with "old age" being a subcategory of disability. However, within few years after its introduction, the system was broadened into a general old-age security system with both disability pensions and old-age pensions on the same level (DRV 2020). After two world wars and a period of hyperinflation, about half of the capital stock was lost and the system was transformed into a PAYG system in 1957. The PAYG scheme included a single eligibility age for old-age pensions which was age 65 for men and 60 for women. Early retirement was not possible unless individuals could prove disability. Disability was the main early retirement pathway after World War II for both men and women (Börsch-Supan and Jürges 2012).

Several pension reforms in the 1960s and 1970s led to one of the world's most generous pension systems.[2] In particular, the 1972 reform was a major change in policy and a reform towards more generosity. The reform introduced new early retirement pathways without any adjustment for early claiming and induced a decrease of the average retirement age by more than two years between 1972 and 1982 (Börsch-Supan 2000).

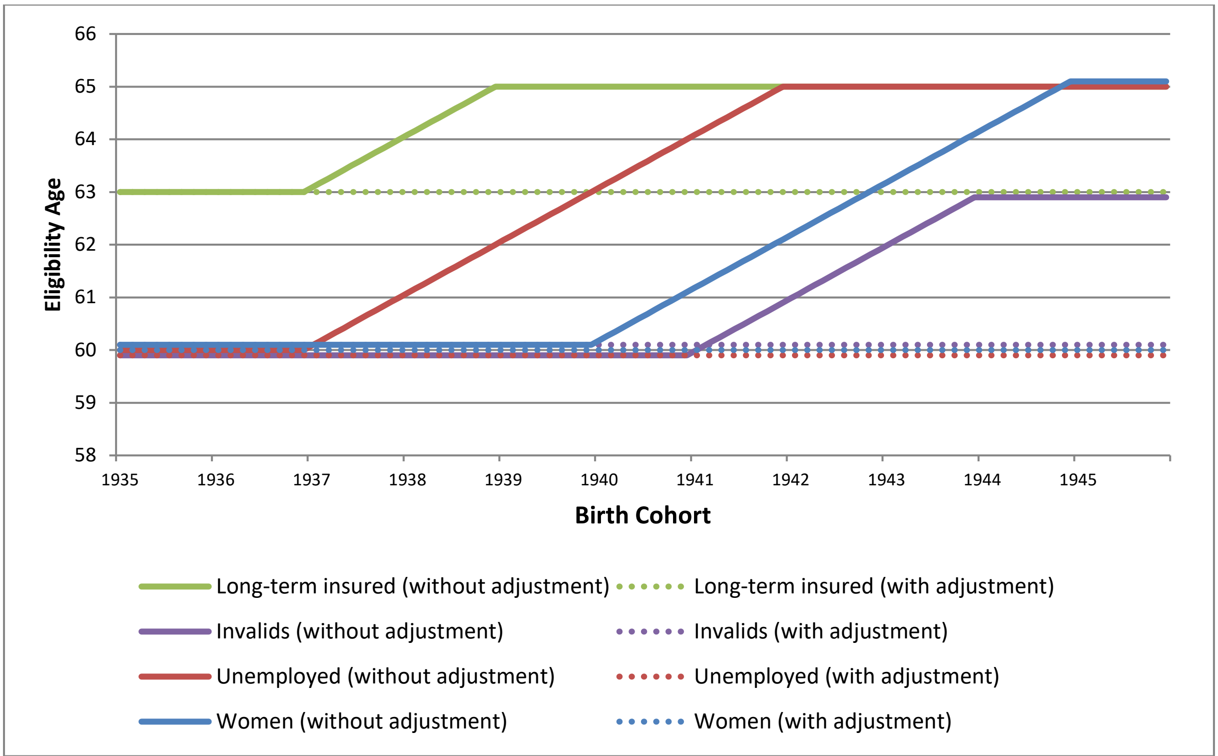
In the light of the decreasing retirement age, pension politics led to a paradigm shift at the end of the 1980s. Consequently, a fifteen-year pension reform process began and the German government enacted different reforms aiming at increasing retirement ages and longer working lives. One of the

[2] Börsch-Supan and Schnabel (1999) state that, e.g., the U.S. net replacement rate at that time was with about 53% substantially lower compared to the corresponding net replacement rate in Germany around 70%.

most important reforms has been the introduction of actuarial deductions for early retirement into the public pension system with the 1992 pension reform. The purpose of actuarial deductions is to adjust individual benefits for a comparably longer pension claiming period.[3]

In addition to full benefit claiming at the statutory eligibility age, the introduction of actuarial adjustments has resulted in a system with different eligibility ages for the specific early retirement pathways affected by the reform. The difference mainly lies in the availability of either full pension benefits without adjustment factors or reduced benefits with adjustments factors. The reform has led to gradually increasing full rate ages (solid lines in Figure 1), at which full benefits are available and has kept earliest eligibility ages constant (dotted lines), at which reduced benefits are available.

Figure 1: Gradual Increasing Full Rate Age (solid, adjustment-free) and Earliest Eligibility Age (dotted, with adjustments) for Early Retirement Pathways Affected by 1992 Reform



Source: Own table based on German legal text. For detailed sources see Section 4.1.

Figure 1 depicts the gradually increasing full rate ages from 1997 to 2004 for the cohorts born from 1937 to 1944. The figure shows the introduction for the early retirement pathways that were affected by the reform: the (1) old-age pension for individual with long-term insurance careers, (2)

[3] In 1992, actuarial supplements for late retirement have already been in place and were slightly adjusted with the 1992 reform. A detailed description of the German pension system until 1980 and the reform process since 1980 is given in Börsch-Supan et al. (2019).

old-age pension for invalids, (3) old-age pension due to unemployment, and (4) the gender-specific old-age pension for women. The relevant reform was implemented with a slightly different timing for the different pathways.

The gradual increase of the full rate age has brought about steadily increasing actuarial deductions with every birth cohort. However, the degree of the actuarial deductions at a specific claiming age does not only depend on the year of birth, but also on the month of birth. Table 1 shows exemplarily the within-cohort variation. For instance, the pension benefits of an individual born in May 1941 are reduced by 15.9% while the pension benefits of an insurant born one month later is reduced by 16.2% when claiming old-age pension benefits due to unemployment at age 60.[4] The main advantage of SHARE-RV is the monthly character that enables us to exploit this within-cohort variation in the empirical analysis (Section 5).

Table 1: Example for Gradual Introduction of Adjustment Factors

	Birth Cohort 1941 – Old-Age Pension due to Unemployment											
Claiming Age	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
60	14.7	15	15.3	15.6	15.9	16.2	16.5	16.8	17.1	17.4	17.7	18
60 + 6 months	12.9	13.2	13.5	13.8	14.1	14.4	14.7	15	15.3	15.6	15.9	16.2
61	11.1	11.4	11.7	12	12.3	12.6	12.9	13.2	13.5	13.8	14.1	14.4
62	7.5	7.8	8.1	8.4	8.7	9	9.3	9.6	9.9	10.2	10.5	10.8
63	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6	6.3	6.6	6.9	7.2
64	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3	3.3	3.6
65	0	0	0	0	0	0	0	0	0	0	0	0

Source: Own table based on German legal text. For detailed sources see Section 4.1.

[4] Technically, the adjustment factors are incorporated in the pension formula which is the base for individual pension benefit calculation. Pension benefits are computed as the product of two universal components (1, 2) and two individual components (3, 4) and are related to the individual earnings history. The universal components are (1) the current pension value *(aktueller Rentenwert)* and a (2) pension type factor (*Rentenartfaktor).* The individual components are (3) the sum of earnings points an individual has accumulated over the working career (*Entgeltpunkte)* and (4) an access factor which captures actuarial adjustments for early or late retirement *(Zugangsfaktor).* The access factor equals one if pension benefits are claimed at the statutory eligibility age or at the full rate age. The access factor is reduced by 0.003 for each month (0.036 for each year) of early retirement. Since the 1992 reform, postponing pension claiming beyond the statutory eligibility age leads to supplements of 6% per year of late retirement. That means that the access factor is increased by 0.005 for each month or 0.06 for each year of late retirement. This regulation took effect in 1992 while the adjustment factors for early retirement came into operation only in 1997.

4. DATA

4.1. SHARE-RV and other Data

Our dataset contains baseline interviews from SHARE (see Börsch-Supan et al. 2013). The survey includes wide-ranging information of microdata on socio-economic status, social and family networks as well as health for individuals aged 50+ across European countries. SHARE is a multidisciplinary and cross-national survey and was conducted for the first time for eleven European countries in 2004. Since then, the scope of the representative survey has expanded in biennial survey waves; it now covers more than 140,000 individuals in 28 countries. Our study concentrates on the German subsample of the study though (more details on the sample selection in Section 4.3).

For our research purpose, we link data from SHARE waves' 1, 2, 3, 4, 5, 6 and 7 with information from the official employment history records of the German public pension system (*Gesetzliche Rentenversicherung*). SHARE-RV combines data of the German sample of SHARE with high-quality administrative data about exact pension claiming dates and pension entitlements. Linking the SHARE data with the administrative SHARE-RV data is especially advantageous for our research purpose because the data is very accurate, reliable and on a monthly basis. We need monthly data because the introduction of adjustment factors varies not only between two cohorts but also within cohorts.

Information about how actuarial adjustments were introduced are taken from the German legal text (see Wachstums- und Beschäftigungsförderungsgesetz 1996; Rentenreformgesetz 1999; Korrektur des Rentenreformgesetzes 1999). To capture the individual earnings history in the empirical analysis we calculate the individual pension wealth (PW) as a covariate. The calculation incorporates official survival rates from the Federal Office of Statistics (*Statistisches Bundesamt*). The German Pension Insurance provides necessary historical values for the current pension value (Deutsche Rentenversicherung Bund 2017). Projected future values we obtain from the pension simulation program MEA-PENSIM (see Holthausen et al. 2012, Gasche and Rausch 2016).

4.2. Calculation of Pension Wealth[5]

Individual pension wealth is computed as the discounted stream of future pension benefits. For the calculation of the pension wealth (PW) we take into account individual earnings points $\mathrm{EP_{is}(R)}$ and the current pension value PV_t set by social policy, survival rates $\pi(s)$ and the discount factor δ, with t is time measured in months, s is the planning age and R the benefit claiming age. The adjusted pension wealth (APW) takes into account the financial incentives, namely the actuarial deductions $\left(\tau_{is}(\mathrm{R})\right)$, ranging from 0% for zero years of early retirement to 18% for five years of early retirement.

$$APW_{ist}(R) = \left(1 - \tau_{is}(R)\right) \underbrace{\sum_{s=R}^{T} \pi(s)\delta^{(s-t)}\, EP_{is}(R) * PV_t}_{PW_{ist}(R)}$$

We calculate the (adjusted) pension wealth on the individual level for each month of observation.[6]

4.3. Sample Selection and Descriptive Statistics

Our initial sample consists of the 4,356 German SHARE respondents that can be linked to the administrative dataset of SHARE-RV. We restrict the sample to those individuals born between 1935 and 1947, resulting in 1,046 individuals. We limit the sample to those individuals for which we observe a retirement spell in the data, amounting to 961 individuals. Further, we concentrate on those individuals with pension types that are relevant in the context of the introduction of actuarial deductions ((1) old-age pension due to unemployment, (2) old-age pension for women, (3) old-age pension for invalids and (4) old-age pension for long-term insured)[7], leading to a reduction of the

[5] Our pension wealth variable is very similar to the commonly known variable named “social security wealth”. However, we focus on entitlements from the public pension scheme only. Therefore, the label pension wealth seems to be more intuitive. The focus on entitlements from the public pension scheme is reasonable since benefits from this scheme were (and still are) the by far most important source of income in old age in Germany. This holds in particular for the cohorts and the time period under investigation. Social security wealth – as often used in the international literature – usually encompasses benefits from different sources, such as old-age pension (OA), disability insurance (DI), unemployment insurance (UI) and other public transfer programs available at older ages.

[6] Footnote 4 gives more details on how monthly pension benefits are calculated according to the pension formula.

[7] Each pension type requires fulfilling specific eligibility criteria (see Börsch-Supan et al. 2019, Table 1). Eligibility depends, e.g, on a minimum contribution period which is at least 35 service years in the case of the OAP for long-term insured and the OAP for invalids, 15 for the old-age pension due to unemployment (with at least 8 in last 10 years) and the OAP for women (with at least 10 after age 40). Therefore, individuals in our sample have been part of the German public pension system for a substantial proportion of their employment history. Individuals who entered the labour force only at later ages are thus not part of the sample.

sample to 582 persons and 363,168 person-month observations. In the administrative data, individual social insurance contributions are reported starting at age fourteen of all German citizens. In order to capture the transition phase from working to benefit claiming we keep all person-month spells in the relevant age group from 60 up to the first benefit claiming spell. Our final sample consists of 544 individuals and 5,160 person-month observations.

Table 2: Summary Statistics

Variables	**(1) N**	**(2) Mean**	**(3) Std.Dev.**	**(4) Min.**	**(5) Max.**
Retirement Variables					
Monthly Spells since Age 60	544	14.71	17.32	0	60
Average Retirement Age	544	61.23	1.44	60	65
Components of Pension Wealth					
Earnings Points	544	40.32	15.00	5.79	75.06
Current Pension Value	544	24.46	1.93	19.39	27.04
Pension Wealth	544	213,760	73,836	31,785	412,036
Adjusted Pension Wealth	544	199,554	68,437	29,878	383,605
Incentive	544	0.06	0.06	0	0.18
Personal Characteristics					
Age	544	60.71	1.14	60	63.50
Male	544	0.53	0.50	0	1
Married	544	0.84	0.37	0	1
West Germany	544	0.70	0.46	0	1
Years of Education	544	11.81	2.92	2	24
Physically Demanding Job	418	0.48	0.50	0	1

Note: N refers to number of individuals in the sample. Variables that are variant across time within person (e.g. components of pension wealth) are reported as average per individual. Information on the physical strain of the occupation is only available for SHARELIFE respondents. Therefore, the number of observations drops.

Source: Own calculations.

Table 2 presents basic summary statistics. On average, we observe around 15 monthly spells per person after the age of 60 until the first month of retirement. This equals an average retirement age of 61.23. Our dataset is truncated at the age of 65. Therefore, a maximum of 60 monthly spells can be observed after the age of 60. Regarding the components of the pension wealth, our sample reveals the following characteristics: On average around 40 individual earnings points have been collected until the first retirement spell and the pension wealth accumulates to 213,760 on average. Taking into account the actuarial deductions varying between 0% and 18%, the adjusted pension wealth accumulates to 199,554 on average. The personal characteristics refer to the typical demographic information. The average age in our sample is around 61 years, 53% of the sample are male, 84% are married and 70% live in West Germany. On average, individuals in our sample spent almost twelve years in full-time education. A proportion of around 48% worked under physically demanding conditions in their last main career job.

Table 3 shows the sample distribution of old-age pension types individuals have chosen to access their pension benefits. The OAP due to unemployment and the OAP for women account for around one third each. Almost 13% of the sample proved invalidity. A fifth of the sample claim pension benefits after a long-term insurance career. The majority of males in our sample accesses pension benefits after a period of unemployment. Around 27% of males claim benefits after a long-term insurance history. The corresponding proportion of females is much less with only 7%. This is most likely due to the fact that for the cohorts in our sample the male breadwinner model was widely prevalent. Moreover, females often did not accumulate enough insurance years to fulfill the requirements for the specific pension type for long-term insured individuals. For women, the gender-specific pension type is by far the most widely used pathway to retirement because the reduced number of required insurance years is easier to reach. In addition, we check whether there is an education gradient. We built three categories referring to the International Standard Classification of Education (ISCED) coding.[8] The proportions for individuals with medium education level altogether reflect the proportions over the whole sample (see "All"). While the OAP for women is more prevalent in the group of low-educated individuals, those with high education are more likely to claim benefits after a period of unemployment. High-educated individuals may be more easily able to afford a period of unemployment and therefore choose unemployment on purpose. Besides, this pathway is connected with more formalities. High-educated individuals may be more capable to overcome these requirements.

[8] The categories base on the ISCED-1997-classification. Low education corresponds to ISCED 0-2, medium education to ISCED 3-4 and high education to ISCED 5-6.

Table 3: Distribution of Old-Age Pension Types

Type of OAP	All N	All %	Males %	Females %	Low Education %	Medium Education %	High Education %
OAP due to Unemployment	182	33.46	59.44	4.65	13.79	31.10	48.53
OAP for Women	199	36.58		77.13	62.07	37.21	24.26
OAP for Invalids	69	12.68	13.99	11.24	13.79	13.95	9.56
OAP for Long-Term Insured	94	17.28	26.57	6.98	10.34	17.73	17.65
Total	544	100.00	100.00	100.00	100.00	100.00	100.00

Note: N refers to number of individuals in the sample.

Source: Own calculations.

5. RESULTS

In the following two sections we present our results. In Section 5.1 we show the results from the empirical analysis on whether the introduction of actuarial deductions lead to postponed pension claims. We take the heterogeneity of physically demanding jobs into account. In Section 5.2 we examine whether the potential health constraints of these individuals coincide with lower pension entitlements compared to individuals in non-manual occupations who were able to adjust with later pension claims.

5.1 Pension Claiming Behavior

We calculate the duration until pension benefit claiming by using Cox proportional hazard regressions (Cox 1972). Cox regression is a form of survival analysis that models rates of event occurrence (here: retirement) as a log-linear function of multiple independent variables. It allows us to examine the effect of actuarial deductions on the hazard of retiring while controlling for confounding factors. To verify our first hypothesis, we apply the following empirical model:

$$h(t) = h_0(t) \exp(\beta_1(incentive) + \beta_j X_j + \varepsilon) \quad (1)$$

where $h_0(t)$ is the baseline hazard and X_j is a vector of covariates consisting of gender, marital status, years of education, region (East/West Germany), number of children and the adjusted pension wealth[9]. For the second hypothesis we additionally consider whether someone has been working in physically demanding conditions by estimating the following model:

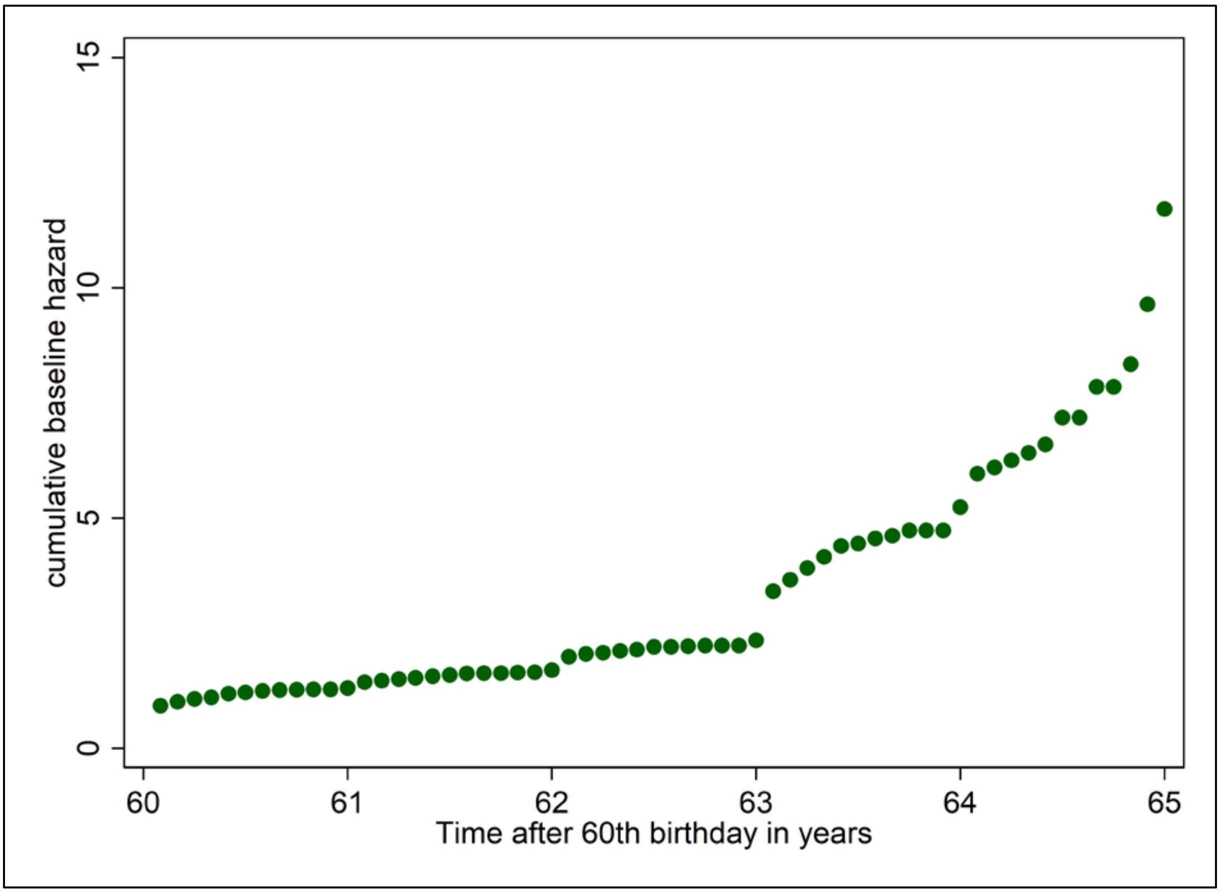
$$h(t) = h_0(t) \exp(\beta_1(Incentive) + \beta_2(Job.Phys.Dem.) + \beta_3(Incentive * Job.Phys.Dem.) + \beta_j X_j + \varepsilon) \quad (2)$$

Cox regression models base on the assumption that the ratio of time-specific event risks of two groups is constant over time. For example, the hazard ratio between those working in physically demanding jobs and those not working in physically demanding jobs should remain the same over time. In our case, the proportional hazard assumption is fulfilled, which can be shown graphically and numerically by testing the null hypothesis of zero slope, which is equivalent to testing that the log hazard-ratio function is constant over time (see Appendix A). Figure 2 displays the baseline hazard. At age 63 there is a jump in the hazard rate, reflecting the uptake of pension benefits at the earliest eligibility age for the old-age pension for long-term insured individuals (see Figure 1). After age 63, the hazard rate increases slowly with another jump at the age of 64. Starting from age 64, the hazard rate increases strongly up to the peak hazard at the age of 65. In our study period, age 65 is the statutory eligibility age where full pension benefits become available (see Section 3).[10]

[9] As a robustness test, we use another measure for lifetime earnings (i.e. "Earnings points/year") as an alternative to the adjusted pension wealth. The alternative variable is the sum of earnings points individuals have accumulated over their working life, divided by the number of insurance years. The number of insurance years is defined following the distinction in Börsch-Supan et al. (2021, Table 6) and comprises different pensionable periods such as periods of employment, child raising, and education, among others. Results from the robustness test are shown in Appendix B, see Table B.1 and Table B.2. Overall, the results remain stable in size and sign.

[10] Note that only in 2007 the German government legislated the gradual increase of the statutory eligibility age from age 65 to 67 between 2012 and 2030.

Figure 2: Cumulative Baseline Hazard for Retirement After 60th Birthday



Source: Own calculations.

Based on the full sample of 544 individuals, we estimate the empirical model (1) to verify our first hypothesis claiming that the introduction of adjustment factors leads to a postponed pension benefit claiming date. Results are presented in Table 4 in hazard ratios (HR) and their confidence intervals (95%), indicating the change of risk for a one-point change in the independent variable. A hazard ratio greater than one means that an individual is more likely to retire, with higher values of that explanatory variable. Conversely, a ratio less than one implies a smaller risk. A hazard ratio of exactly 1.0 means that a variable provides neither an increased nor a reduced risk of retirement.

In more detail, the hazard rate of 0.985 for the incentive variable is interpreted as follows: An increase in the incentive variable by one unit decreases the hazard to claim benefits in month t significantly by about 1.5%. Thus, the results show that the actuarial deductions lead to a postponement in pension claiming, which confirms the first hypothesis. The other covariates show the expected effect on the retirement decision. Men face a hazard 37% lower than women do, thus males are significantly less at risk to retire in month t than females. This can be explained by the fact that females have a gender-specific retirement pathway with an eligibility age of 60 (see

Figure 1). As has been shown in the descriptive part, around a third of our sample and almost four out of five females draw benefits from the old-age pension for women. For males, early benefit receipt at the age 60 is only available if they prove invalidity in a medical test, or have been unemployed right before retirement. Indeed, the majority of males in our sample claims benefits after a period of unemployment (see Table 4). However, the old-age pension due to unemployment has been one of the pathways for which the adjustment-free eligibility age has been increased rather early within our observation period (starting from the 1937 cohort, see Figure 1). The full rate age for the gender-specific old-age pension for women has been gradually increasing only starting from the 1940 cohort. Overall, this constitutes a higher risk to retire in month t for females than for males. Being married and the number of children do not significantly influence the retirement decision. Yet, the hazard significantly decreases with the number of years of education. Higher-educated individuals are thus less likely to retire compared to lower-educated individuals. Different occupational types may explain this pattern. Jobs in the high-education sector may more likely allow a later retirement due to a more pleasant work environment and less physically demanding work conditions. In addition, a large proportion of high-educated individuals claims pension benefits after a period of unemployment (see Table 3). As the adjustment-free full rate age has been gradually increasing already for the 1937 cohort, the preferred early retirement option among high-educated individuals got less generous rather early within our time window of observation.

Summing up the first part of our analysis, we claim that the significant effect of the incentive variable on the retirement decision shows that the introduction of actuarial deductions leads to a postponed pension benefit claiming date. In other words, from the governments' perspective the financial incentives to claim benefits before the statutory eligibility age seem to work adequately and individuals respond by claiming pension benefits later. This finding is in line with the results from previous literature.

Table 4: Effect of Incentive on Retirement Decision

Variables	(1) HR	(2) 95% CI	(3) p value
Incentive	0.985*	0.970 - 1.002	0.078
Pension Wealth (Adj.)	1.000	1.000 - 1.000	0.278
Male	0.624***	0.471 - 0.825	0.001
West Germany	0.921	0.761 - 1.115	0.399
Married	1.036	0.820 - 1.308	0.768
Years of Education	0.961**	0.932 - 0.992	0.014
Number of Children	0.951	0.853 - 1.060	0.365
Observations	4,710		

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Source: Own calculations.

Our second hypothesis claims that workers in physically demanding jobs are more likely to retire early for health reasons and, therefore, respond less to the introduction of actuarial deductions. To prove this hypothesis, we include a dummy variable indicating whether the last job of the main career was physically demanding. We further include an interaction term with the incentive variable to interpret the effect of the financial incentive on the retirement variable in dependency of the degree of physical demand in the last job of the main career (Job.Phys.Dem.*Incentive). When taking into account the job characteristics, our sample size drops to 3,689 observations since this information is only available for respondents that took part in the retrospective life history interview. The results of the Cox regression are presented in Table 5. We find that working in a physically demanding job increases the hazard by 22%. This statistically significant positive effect shows that individuals with physically demanding jobs at the end of their working careers tend to claim pension benefits earlier. Moreover, an increase in the incentive variable leads to an increase in the hazard rate significantly by almost 4% for persons working in physically demanding jobs, indicating that the flexibility in the reaction to the actuarial deductions is limited. We conclude that the results show the expected pattern indicating that individuals with physically demanding jobs later in life postponed benefit claiming less than workers in non-physically demanding jobs did.

Table 5: Effect of Incentive on Retirement Decision

Variables	(1) HR	(2) 95% CI	(3) p value
Incentive	0.970**	0.945 - 0.996	0.022
Pension Wealth (Adj.)	1.000	1.000 - 1.000	0.624
Male	0.619***	0.447 - 0.857	0.004
West Germany	0.971	0.779 - 1.209	0.790
Married	1.042	0.799 - 1.360	0.762
Years of Education	0.969*	0.935 - 1.005	0.091
Number of Children	0.995	0.875 - 1.131	0.935
Final Job of Main Career Physically Demanding	1.221*	0.986 - 1.512	0.067
Job.Phys.Dem.*Incentive	1.032*	0.996 - 1.070	0.079
Observations	3,689		

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Source: Own calculations.

5.2 Pension Wealth

We finally examine whether the two groups – individuals working in physically demanding or non-demanding jobs at the end of the working career – differ in terms of pension wealth. The numbers are displayed in Table 6. Both pension wealth and adjusted pension wealth are lower for individuals working in physically demanding jobs. This reflects the finding from the literature review that individuals in physically demanding jobs are more represented in the group of low earners and, therefore, accumulate less pension wealth until retirement. Health may be an explanation for the earlier exit from the labor market for the individuals in physically demanding jobs. There is a significant difference in the percentage of individuals subjectively reporting that their health suffered due to their job. While only 2% on average report that their health suffered in the group of persons with non-demanding jobs, this fraction amounts to 23% for the individuals in physically demanding jobs. This descriptive evidence supports our second hypothesis that workers in physically demanding jobs are more likely to retire early for health reasons and therefore respond less to the introduction of adjustments.

People in physically demanding jobs seem to have significantly lower pension values than people in non-physically demanding jobs. This is surprising because the pension values are not affected by individual circumstances but set by law. They vary only between East and West Germany and over time. One explanation the reader may accordingly think of could be the retirement year for the two subgroups. Comparably higher pension values for one group could be associated with later retirement years. By comparing the mean year of retirement we do not find significant differences though. Time effects therefore should not be the reason for the lower pension values for people in physically demanding jobs. However, the data show a significant difference in the proportions of East and West Germans within the two groups. The group with a physically demanding job comprises more individuals from East Germany. One result of the German reunification has been that pension values are lower in East Germany to account for the former different earning capacities in East and West Germany[11]. This different group composition by region should explain the differences in the pension values between the groups of physically and non-physically demanding jobs.[12]

Table 6: Group Characteristics by Physical Demand of the Job

	(1) physically demanding job		**(2) no physically demanding job**		**(3) difference**	
	mean	sd	mean	sd	b	t
Age at Retirement	61.11	1.38	61.35	1.48	0.24	(1.71)
Earnings Points	39.82	13.23	42.35	15.99	2.53	(1.77)
Current Pension Value	24.10	2.09	24.72	1.72	0.61**	(3.26)
Pension Wealth	206,361	64,770	227,436	77,454	21,074**	(3.03)
Adj. Pension Wealth	192,486	60,091	212,383	71,468	19,897**	(3.09)
Left Job due Disability	0.13	0.34	0.10	0.31	-0.03	(-0.55)
Health Suffered due Job	0.23	0.43	0.02	0.15	-0.21**	(-3.38)
Year of Retirement	2002.01	3.78	2002.79	3.79	0.78*	(2.11)
West Germany	0.63	0.48	0.74	0.44	0.11*	(2.46)
Observations	199		219		418	

Source: Own calculations.

[11] A time series comparison of current pension values for East and West Germany can be found in Deutsche Rentenversicherung Bund (2017).

[12] As a robustness test, we exclude the observations for East Germany from the analysis (see Appendix C). The repetition of the group characteristics by physical demand of job shows that the significant differences for the (adjusted) pension wealth and for the variable “health suffered due to job” remain (see Table C.1). Moreover, we repeat the survival analysis as well: The results are robust in size. However, the effects are less significant due to the smaller sample size (see Table C.2 and Table C.3).

6. CONCLUSION

The aim of this paper is to investigate the individual response in pension claiming behavior with respect to varying financial incentives in the German public pension system with a special focus on reform effect heterogeneity. The specific research question is whether individuals postponed benefit claiming as a reaction to the introduction of actuarial deductions with the 1992 pension reform and whether there are differences in the claiming responses for individuals working in physically demanding jobs compared to individuals in non-physically demanding occupations.

We calculate the duration after age 60 until pension benefit claiming by estimating hazard rates using Cox proportional hazard regressions on the base of the dataset SHARE-RV and find that the introduction of actuarial deductions leads to a postponed pension benefit claiming date. More specifically, an increase in the incentive variable by one unit decreases the hazard to claim benefits in month t significantly by about 3%. This result is in line with former research findings. Our second hypothesis states that workers in physically demanding jobs respond less to the introduction of adjustments leading to less postponement than for workers in non-physically demanding jobs. The data support the second hypothesis: We find that individuals working in physically demanding jobs actually postponed benefit claiming less than workers in non-physically demanding jobs did.

The database of this project forms both the strength and the weakness of the paper. On the one hand, the combination of monthly administrative data and information from the regular SHARE waves build a rich data source, perfectly suited for our research purpose. On the other hand, the small sample size limits the scope for deeper analyses and additional robustness checks. The restriction on West Germany, for instance, yields similar results but loses precision of the estimates. Another limitation is the external validity of the analysis. While the reform of 1992 provides a quasi-experimental setting for the identification of the causal effect of financial incentives on the retirement decision, it has limited informative value for other cohorts and other circumstances. We can conclude that the introduction of actuarial deductions with the 1992 reform led to a postponement of retirement as intended by the reform. Further, we find that workers in physically demanding jobs respond less to the introduction of adjustments, most likely for health reasons. This can help policymakers to design effective future reforms and interventions taking into account the heterogeneous effects for different occupational groups.

REFERENCES

Angrisani, M., Hurd, M. D., Meijer, E., Parker, A. M., and S. Rohwedder (2013). 'Labor Force Transitions at Older Ages: The Roles of Work Environment and Personality', *Ann Arbor MI: University of Michigan Retirement Research Center (MRRC) Working Paper*, 2013-295.

Borg, V. and T. S. Kristensen (2000). 'Social class and self-rated health: can the gradient be explained by differences in life style or work environment?', *Social Science & Medicine*, 51(7), 1019-1030.

Börsch-Supan, A. and R. Schnabel (1998). 'Social Security and Declining Labor-Force Participation in Germany', *American Economic Review*, 88(2), 173-178.

Börsch-Supan, A. and R. Schnabel (1999). 'Social security and retirement in Germany', In: Gruber, J. and D. Wise (eds), *Social Security and Retirement Around the World*, The University of Chicago Press: Chicago, 135–180.

Börsch-Supan, A. (2000). 'Incentive effects of social security on labor force participation: evidence in Germany and across Europe', *Journal of Public Economics*, 78(1-2), 25-49.

Börsch-Supan, A. and H. Jürges (2012). 'Disability, Pension Reform, and Early Retirement in Germany, NBER Chapters, in: *Social Security Programs and Retirement around the World: Historical Trends in Mortality and Health, Employment, and Disability Insurance Participation,* National Bureau of Economic Research, Inc., 277-300.

Börsch-Supan, A., Brandt, M., Hunkler, C., Kneip, T., Korbmacher, J., Malter, F., Schaan, B., Stuck, S., and S. Zuber (2013). 'Data Resource Profile: the Survey of Health, Ageing and Retirement in Europe (SHARE)', *International Journal of Epidemiology*, 42(4), 992-1001.

Börsch-Supan, A., Czaplicki, C., Friedel, S., Herold, I., Korbmacher, J. and T. Mika (2018). 'SHARE-RV: Linked Data to Study Aging in Germany', in: Winker, P. (ed.-in-chief), v. Büttner, T., Riphahn, R., Smolny, W. and J. Wagner (eds.), *Jahrbücher für Nationalökonomie und Statistik*, Berlin: De Gruyter.

Börsch-Supan, A. and C. Coile (2020). '*Social Security Programs and Retirement around the World: Reforms and Retirement Incentives*', NBER book series – International Social Security, University of Chicago Press: Chicago.

Börsch-Supan, A. and C. Coile (eds, in progress). '*Social Security Programs and Retirement around the World: Phase Ten (title TBD)*', NBER book series – International Social Security, University of Chicago Press: Chicago.

Börsch-Supan, A., Rausch, J. and N. Goll (2019). 'Social security reforms and the changing retirement behavior in Germany', in: Börsch-Supan, A. and C. Coile (eds, 2020), preliminary draft available online at: *https://www.nber.org/chapters/c14195.pdf* (Accessed 14 January 2020).

Börsch-Supan, A., Ferrari, I., Goll, N. and J. Rausch (2020). 'Retirement decisions in Germany: micro-modelling', mimeo, in progress for: Börsch-Supan, A. and C. Coile (eds, in progress), *NBER book series – International Social Security*, University of Chicago Press: Chicago.

Börsch-Supan, A., Bucher-Koenen, T., Goll, N. and F. Hanemann (2021). 'Targets Missed: Three case studies exploiting the linked SHARE-RV data', *Journal of Pension Economics & Finance*, (Published online before print: DOI: https://doi.org/10.1017/S1474747220000359).

Coile, C. and J. Gruber (2001). 'Social Security Incentives for Retirement', in Wise, D. A. (ed.), *Themes in the Economics of Aging*, University of Chicago Press: Chicago.

Cottini, E. (2012). 'Is your job bad for your health? Explaining differences in health at work across gender', *International Journal of Manpower*, 33(3), 301-321.

Cox, D. R. (1972). 'Regression Models and Life-Tables', *Journal of the Royal Statistical Society: Series B (Methodological)*, 34(2), 187-202.

Deutsche Rentenversicherung Bund (DRV) (2017). 'Rentenversicherung in Zeitreihen', *DRV-Schriften*, Band 22: Berlin.

Deutsche Rentenversicherung Bund (DRV) (2020). 'Chronik' available online at: *http://forschung.deutsche-rentenversicherung.de/ForschPortalWeb/ressource?key=chronik* (Accessed 3 July 2020).

Engels, B., Geyer, J. and P. Haan (2017). 'Pension Incentives and early retirement', *Labour Economics*, 47(C), 216-231.

Euwals, R. and E. Trevisan (2014). ‘Early retirement and financial incentives: differences between high and low wage earners’, *Netspar Discussion Paper*, 12/2011-105.

Forschungsdatenzentrum der Rentenversicherung, Max-Planck-Institut für Sozialrecht und Sozialpolitik (2019). *SHARE-RV. Release version: 7.0.0. SHARE-ERIC. Dataset.* DOI: 10.6103/SHARE.SHARE-RV.700.

Gasche, M. and J. Rausch (2016). ‘Beitragsentwicklung in der Gesetzlichen Krankenversicherung und der Sozialen Pflegeversicherung – Projektionen und Determinanten’, *Zeitschrift für Wirtschaftspolitik*, 65(3), 195-238.

Geyer, J., Haan, P., Hammerschmid, A. and M. Peters (2020). ‘Labor Market and Distributional Effects of an Increase in the Retirement Age’, *Labour Economics*, 65(C), Article 101817.

Geyer, J. and C. Welteke (2021). ‘Closing routes to retirement for women: how do they respond?’, *Journal of Human Resources*, 56(1), 311-341 (Published online before print: DOI:10.3368/jhr.56.1.0717-8947R2).

Giesecke, M. (2018). ‘The Effect of Benefit Reductions on the Retirement Age: The Heterogeneous Response of Manual and Non-Manual Workers’, *Review of Income and Wealth*, 64(1), 213-238.

Gruber, J. and D. A. Wise (eds, 1999). ‘Social Security Programs and Retirement Around the World’, University of Chicago Press: Chicago.

Gruber, J. and D. A. Wise (eds, 2004). ‘Social Security Programs and Retirement Around the World: Micro Estimation’, University of Chicago Press: Chicago.

Hanel, B. (2010). ‘Financial incentives to postpone retirement and further effects on employment – Evidence from a natural experiment’, *Labour Economics*, 17(3), 474-486.

Hanel, B. (2012). ‘The Effect of Disability Pension Incentives on Early Retirement Decisions’. *Labour Economics*, 19(4), 595-607.

Hanel, B. and R.T. Riphahn, (2012). ‘The timing of retirement – New evidence from Swiss female workers’. *Labour Economics*, 19(5), 718-728.

Holthausen, A., Rausch, J., and C.B. Wilke (2012). ‘MEA-PENSIM 2.0: „Weiterentwicklung eines Rentensimulationsmodells, Konzeption und ausgewählte Anwendungen“’, *MEA-Discussion Paper*, 3-2012, Munich.

Hurd, M. D. (1990). ‘Research on the Elderly: Economic Status, Retirement, and Consumption and Saving’, *Journal of Economic Literature*, American Economic Association, 28(2), 565-637.

Korrektur des Rentenreformgesetzes (1999). ‘Gesetz zu Korrekturen in der Sozialversicherung und zur Sicherung der Arbeitnehmerrechte’, Vom 19. Dezember 1998, *Bundesgesetzblatt (BGBl) Teil I*, No. 85, 3843–3852, Bonn.

Moreira, A., Azevedo, A.B. and L.P. Manso (2018). ‘Reducing early retirement in Europe: Do working conditions matter?’ *Journal of Population Ageing*, 11(3), 265–284.

OECD (2017a). ‘Pensions at a Glance 2017: OECD and G20 indicators’, *OECD Publishing:* Paris.

OECD (2017b). ‘OECD Employment Outlook 2017’, *OECD Publishing*: Paris.

Rentenreformgesetz (1999). ‘Gesetz zur Reform der gesetzlichen Rentenversicherung’, Vom 16. Dezember 1997, *Bundesgesetzblatt (BGBl) Teil I*, No. 85, 2998–3038, Bonn.

Riphahn, R. T. and R. Schrader (2020). ‘Institutional reforms of 2006 and the dramatic rise in old-age employment’, *Industrial & Labor Relations Review*, 73(5), 1185-1225.

Robroek, S.J.W., Schuring, M., Croezen, S., Stattin, M. and A. Burdorf (2013). ‘Poor health, unhealthy behaviors, and unfavorable work characteristics influence pathways of exit from paid employment among older workers in Europe: a four year follow-up study’, *Scandinavian Journal of Work, Environment & Health*, 39(2), 125-133.

Rodriguez, E. (2002). ‘Marginal employment and health in Britain and Germany: Does unstable employment predict health?’, *Social Science & Medicine*, 55(6), 963-979.

Seibold, A. (2019). ‘Reference Points for Retirement Behavior: Evidence from German Pension Discontinuities’, *CESifo Working Paper No. 7799*, CESifo: Munich; forthcoming, *American Economic Review*.

Siegrist, J., Wahrendorf, M., von dem Knesebeck, O., Jürges, H. and A. Börsch-Supan (2006). ‘Quality of work, well-being, and intended early retirement of older employees – baseline results from the SHARE Study’, *European Journal of Public Health*, 17(1), 62-68.

Smith, R. (1976). ‘The Occupational Safety and Health Act’ Washington, D.C.: American Enterprise Institute.

Thaler, R. and S. Rosen (1976). ‘The value of saving a life: evidence from the labor market, NBER Chapters, in: *Household Production and Consumption*, National Bureau of Economic Research, Inc., 265-302, Wachstums- und Beschäftigungsförderungsgesetz (1996). ‘Gesetz zur Umsetzung des Programms für mehr Wachstum und Beschäftigung in den Bereichen der Rentenversicherung und Arbeitsförderung’, Vom 25. September 1996, *Bundesgesetzblatt (BGBl) Teil I*, No. 48, 1461–70, Bonn.

Wahrendorf, M., Sembajwe, G., Zins, M., Berkman, L., Goldberg, M., and J. Siegrist, (2012). ‘Long-term effects of psychosocial work stress in midlife on health functioning after labor market exit — results from the GAZEL study’, *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences,* 67(4), 471-480.

Ye, H. (2018). ‘The effect of pension subsidies on retirement timing of older women: evidence from a regression kink design’, *IZA Discussion Paper,* No. 11831, IZA - Institute of Labor Economics: Bonn.

APPENDIX

A. Test of Proportional Hazard Assumption

Table A.1: Test using Schoenfeld Residuals

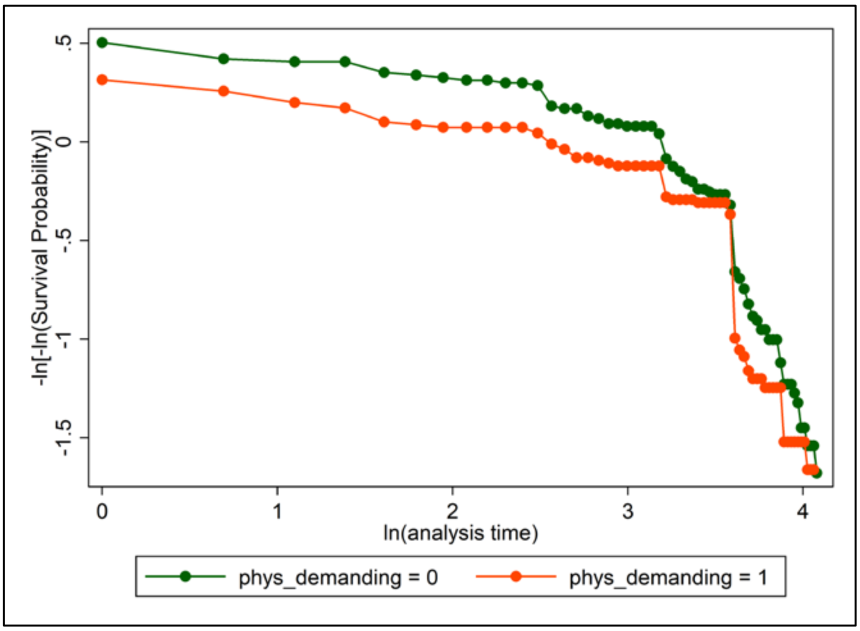
	roh	chi2	Prob>chi2
Incentive	-0.03796	0.75	0.3857
Pension Wealth	-0.03113	0.37	0.5423
Male	0.06841	1.95	0.1630
West Germany	0.05083	1.11	0.2928
Married	0.02996	0.37	0.5451
Years of Education	0.06618	1.76	0.1848
Number of Children	0.03831	0.66	0.4174
Job Physically Demanding	0.00572	0.01	0.9078
Incentive*Job Physically Demanding	0.00330	0.01	0.9413
Global test		6.69	0.6696

Source: Own calculations.

We use Schoenfeld residuals to test the proportional hazard assumption and produce both covariate-specific and global tests. We can see that there is no evidence that the proportional-hazards assumption has been violated.

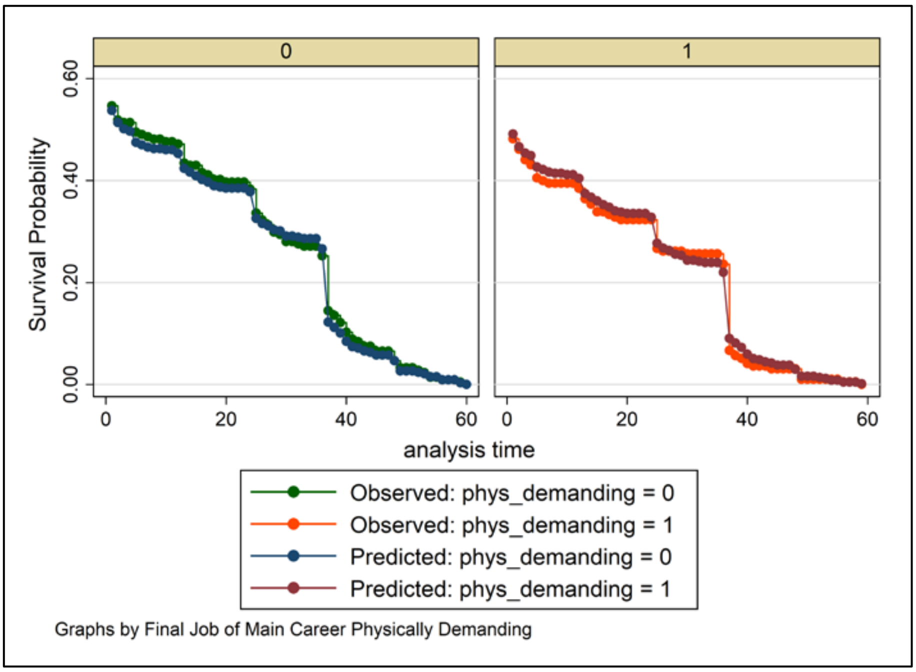
In addition, Figure A.1 displays lines that are parallel, implying that the proportional-hazards assumption for treatment has not been violated. This is confirmed in Figure A.2, where the observed values and predicted values are close together.

Figure A.1: Log-log Plot of Survival



Source: Own calculations.

Figure A.2: Kaplan–Meier and Predicted Survival Plot



Source: Own calculations.

B. Robustness Test with Alternative Measure of Individual Earnings History

Table B.1: Effect of Incentive on Retirement Decision

VARIABLES	(1) HR	(2) 95% CI	(3) p value
Incentive	0.985*	0.969 - 1.001	0.061
Earnings Points/Year	0.940	0.024 - 36.661	0.974
Male	0.642***	0.480 - 0.860	0.003
West Germany	0.915	0.756 - 1.107	0.359
Married	1.031	0.817 - 1.302	0.795
Years of Education	0.962**	0.932 - 0.993	0.015
Number of Children	0.944	0.846 - 1.053	0.299
Observations	4,710		

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Source: Own calculations.

Table B.2: Effect of Incentive on Retirement Decision Including Job Variable

VARIABLES	(1) HR	(2) 95% CI	(3) p value
Incentive	0.969**	0.944 - 0.995	0.020
Earnings Points/Year	0.462	0.006 - 33.48	0.724
Male	0.641***	0.457 - 0.898	0.010
West Germany	0.967	0.777 - 1.205	0.767
Married	1.038	0.796 - 1.355	0.783
Years of Education	0.970*	0.935 - 1.006	0.099
Number of Children	0.991	0.871 - 1.127	0.888
Final Job of Main Career Physically Demanding	1.196	0.965 - 1.482	0.101
Job.Phys.Dem.*Incentive	1.032*	0.996 - 1.070	0.079
Observations	3,689		

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Source: Own calculations.

C. Robustness Test with West Germany only

Table C.1: Group Characteristics by Physical Demand of the Job

	(1) physically demanding job		(2) no physically demanding job		(3) difference	
	mean	sd	mean	sd	b	t
Age at Retirement	61.29	1.47	61.33	1.44	0.05	(0.26)
Earnings Points	39.03	15.54	42.90	17.56	3.87*	(1.97)
Current Pension Value	25.48	0.95	25.54	0.95	0.06	(0.55)
Pension Wealth	208,802	76,379	232,901	84,100	24,100*	(2.54)
Adj. Pension Wealth	194,627	70,831	216,476	76,837	21,848*	(2.50)
Left job due Disability	0.13	0.34	0.07	0.25	-0.07	(-1.17)
Health Suffered due Job	0.25	0.44	0.02	0.13	-0.23**	(-2.93)
Year of Retirement	2002.43	3.77	2002.63	3.69	0.20	(0.44)
Observations	125		162		287	

Source: Own calculations.

Table C.2: Effect of Incentive on Retirement Decision

VARIABLES	(1) HR	(2) 95% CI	(3) p value
Incentive	0.990	0.971 - 1.010	0.339
Pension Wealth (Adj.)	1.000***	1.000 - 1.000	0.006
Male	0.472***	0.335 - 0.663	0.000
Married	1.155	0.865 - 1.543	0.330
Years of Education	0.963*	0.926 - 1.001	0.055
Number of Children	0.952	0.835 - 1.085	0.460
Observations	3,386		

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Source: Own calculations.

Table C.3: Effect of Incentive on Retirement Decision Including Job Variable

VARIABLES	(1) HR	(2) 95% CI	(3) p value
Incentive	0.983	0.955 - 1.012	0.252
Pension Wealth (Adj.)	1.000	1.000 - 1.000	0.157
Male	0.509***	0.341 - 0.761	0.001
Married	1.165	0.829 - 1.637	0.378
Years of Education	0.981	0.938 - 1.026	0.402
Number of Children	1.037	0.882 - 1.219	0.663
Final Job of Main Career Physically Demanding	1.102	0.848 - 1.432	0.467
Job.Phys.Dem.*Incentive	1.019	0.976 - 1.063	0.402
Observations	2,533		

Note: Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Source: Own calculations.