NBER WORKING PAPER SERIES

PENSION REFORMS AND INEQUALITY IN GERMANY: MICRO-MODELLING

Axel H. Börsch-Supan
Johannes Rausch
Luca Salerno

Working Paper 32796
http://www.nber.org/papers/w32796

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2024

This paper uses data from the Socio-Economic Panel (SOEP), data for years 1984-2020, SOEP-Core v37, EU Edition, 2022, doi:10.5684/soep.core.v37eu. This paper is part of the National Bureau of Economic Research's International Social Security (ISS) project. This phase of the ISS Project is supported by the Sloan Foundation (G-2019-12578), the National Institute on Aging (grants P01 AG012810 and P30-AG012810) and by the U.S. Social Security Administration through grant #5-RRC08098400-10 to the National Bureau of Economic Research as part of the SSA Retirement Research Consortium. The findings and conclusions expressed are solely those of the authors and do not represent the views of the Sloan Foundation, SSA, any agency of the Federal Government, or NBER. The authors thank the other members of the ISS Project for important methodological contributions, as well as Nicola Simonetti and Frederik Fetzer for their excellent research assistance. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Pension Reforms and Inequality in Germany: Micro-Modelling
Axel H. Börsch-Supan, Johannes Rausch, and Luca Salerno
NBER Working Paper No. 32796
August 2024
JEL No. H55,J23,J26

ABSTRACT

Germany, like many other countries, has undergone a series of pension reforms since the 1980s which generally decreased benefit generosity and increased the retirement age due to demographic pressures. This paper investigates whether these reforms have increased income and wealth inequality among retirees. In order to answer this question, we employed counterfactual simulations in which we predict how the income and social security wealth distributions would have developed if these reforms had not taken place, compared to the actual development of the income and social security wealth distributions.¸

Our analysis reveals that the pension reforms has led to an increase in inequality in terms of social security wealth between the 1990s and 2000s and decreased inequality thereafter. The decrease in inequality is mainly driven by social assistance as it represents a lower bound for benefit size and thus mitigates the effect of benefit-reducing reforms for lower income groups. We further divided the total effect of the pension reforms into two components. The first component is the mechanical effect, which keeps retirement probabilities constant and only considers changes in benefit calculation. The second component is the behavioral effect, which describes how SSW differs because of altered retirement probabilities. Our findings indicate that in the German context the behavioral effect is statistically significant but economically small.

Axel H. Börsch-Supan
Munich Research Institute for the Economics
of Aging and SHARE Analyses
Max Planck Institute
Leopoldstrasse 139
80804 Munich
Germany
and NBER
boersch-supan@mea.mpisoc.mpg.de

Johannes Rausch
Munich Research Institute for the Economics
of Aging and SHARE Analyses
Leopoldstrasse 139
80804 Munich
Germany
j.rausch@mea-share.eu

Luca Salerno
Munich Research Institute for the Economics
of Aging and SHARE
Leopoldstrasse 139
Munich 80804
Germany
salerno@mea.mpisoc.mpg.de

1. Introduction

Germany, like many other countries, experienced a flurry of pension reforms since the 1980s which generally decreased benefit generosity and increased the retirement age. The main question to be answered by this paper is whether these reforms increased income and wealth inequality for retirees. More subtly posed, the question is whether the inequality for retirees increased stronger than for employees, and if so, whether this was caused by the pension reforms in Germany. Data from the German Socio-Economic Panel (SOEP, see Section 3), which is representative of the German population, show that wealth inequality rose for both employees and retirees but determining whether this increase was larger for retirees than for employees requires more sophisticated methods.

We begin by looking at the development of wealth levels. Table 1 presents data on the value of real and financial assets by individuals in Germany for the years 2002, 2007, 2012, and 2017. To ensure comparability, we adjust the figures for inflation and express them in terms of their 2023 values. Additionally, we consider household size by using the "old" OECD equivalence scale.[1] **Real assets** comprise housing wealth, other real estate, business holdings, vehicles, and loans. In contrast, **financial assets** include various forms of financial wealth, such as stocks and bank accounts.

Table 1: Level of mean and median values of real and financial assets (in 2023€)

	2002	2007	2012	2017
A. Mean Values				
Real Assets	164,210	158,205	154,030	177,601
Financial Assets	24,253	28,939	28,015	28,206
B. Median Values				
Real Assets	87,891	75,414	80,732	100,099
Financial Assets	7,375	5,446	3,741	3,562

Note. Wealth is based on equivalized household values, and all values are adjusted to German prices in 2023. Sample weights used.

Source. Own calculation based on SOEP v37.

We observe that **real assets** constitute the largest portion of total wealth (**Table 1A)**. Throughout the survey years, real assets are consistently higher than financial assets by a factor of 5.5 to 6.8. Over the 15-year period from 2002 to 2017, the average value of real assets increased by approximately 8.2% in real terms. However, while we observe an overall increase in average real assets between 2002 and 2017, they were slightly decreasing between 2002 and 2012, which coincided with the financial crisis

[1] The "old" OECD equivalence scale values the first household member with 1, each additional member of age 14 and above with 0.7 and each member below age 14 with 0.5.

of 2008. Over the 15 years, the average amount of wealth invested in financial assets increased by 16.3%. However, average financial assets only increased between 2002 and 2007 and remained stagnant thereafter.

Examination of median values in **Table 1B** reveals an 13.9% increase in real assets between 2002 and 2017, exceeding the growth rate of the average value. Notably, the median value for real assets demonstrates a more substantial increase. However, it is important to acknowledge that the average value consistently remains approximately 1.8-2.1 times higher than the median value, indicating disparities in wealth distribution. In contrast, for **financial assets**, the differences between average and median values are not only substantially higher (3.3 to 7.9 times), but there is also a strong trend of decreasing median financial assets with each later wave. The decline is substantial: between 2002 and 2017, median values decreased by 51.7%.

The disparity between average and median values suggests the presence of significant financial inequalities within the population. To examine this in more detail, we present Gini coefficients[2] in **Figure 1.** Alongside the two wealth components discussed earlier, we include several additional measures. For individuals in the workforce (shown in the left panel), we consider average lifetime earnings and social security wealth (SSW) at the age of 60. For retirees (right panel), we analyze inequalities in public pension (solely the state pension) and total pension (which includes occupational and private pension as well).

Both, employees and retirees display considerable inequality in the distribution of **financial assets**. The Gini coefficients are comparable in both groups and show a similar increasing trend over time, with retirees experiencing a more pronounced increase between 2002 and 2007. For employees, the Gini coefficient shows a more consistent rate of increase. The values of (almost) 0.7 in 2017 indicate a highly unequal distribution of financial wealth.

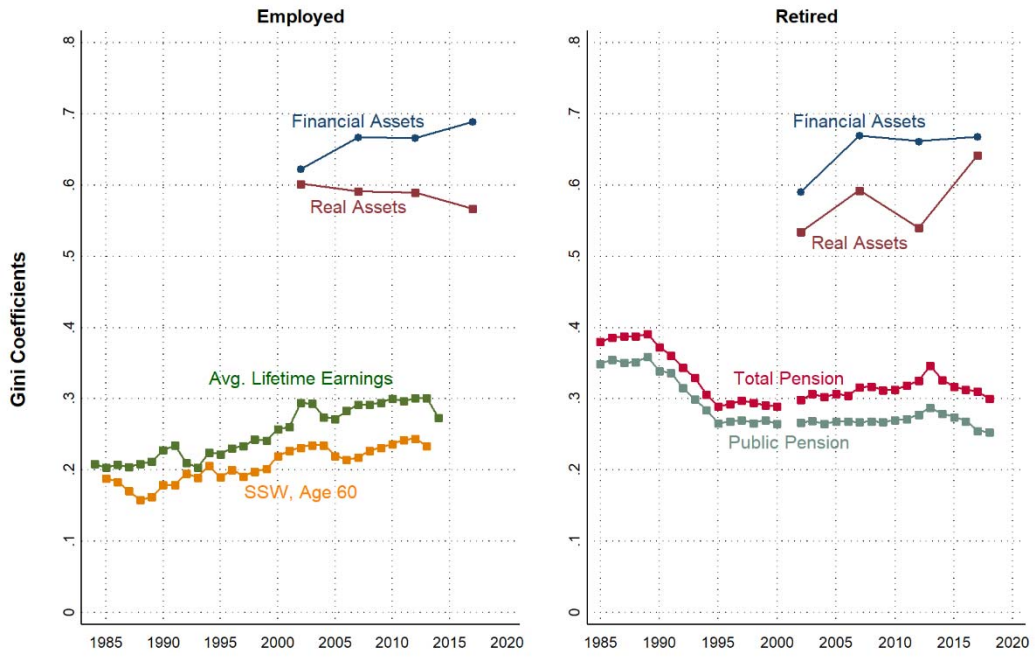
Real assets, which encompass housing wealth, exhibit an interesting pattern. Despite Germany having one of the lowest ownership rates among European countries[3], still approximately every second German owns their home. This not only makes real assets a significant component of total wealth for many individuals, but potentially it is more equally distributed. Initially, the Gini coefficients are larger for employees than for retirees. However, for both groups, Gini coefficients in 2007 are, as expected, lower than those for financial assets. While for employees Gini coefficients stay at a relatively constant level over the years, we observe a substantial overall increase for retirees between 2002 and 2017. The increasing trend may be partially attributed to the impact of rising house prices in Germany between 2012 and 2021. As only half of the population owns a house, their real wealth may have increased due

[2] The Gini coefficient is defined as follows: A value of 0 implies that the wealth is evenly distributed across all individuals, a value of 1 that one individual of the sample owns all financial assets. Hence, the closer the Gini coefficient gets to 1, the more unequal wealth is distributed.

[3] See https://ec.europa.eu/eurostat/cache/digpub/housing/bloc-1a.html.

to the appreciation in property values, while the other half of the population did not benefit from these price-induced changes. Homeownership decreased since 2000, mainly because younger individuals chose rental housing. Hence, the younger employees were less affected by the increase in inequality due to rising house values than the older retirees.

Figure 1: Inequalities in financial variables as measured by the Gini coefficient



Note: Wealth is based on equivalized household values. Sample weights used. For SSW, we smoothed values by taking a moving average that includes the year before and the year after.

Source: Own calculation based on SOEP v37.

For employees, we present **average lifetime earnings (ALTE)**, which we estimate by predicting individual earnings histories (see Section 3.4) and calculating the mean for periods during which individuals contributed to the pension insurance. ALTE provides an average measure of earnings independent of the time spent in the pension system. The Gini coefficient for ALTE varies between 0.2 and 0.3 over the years, consistently lower than the observed coefficients for real or financial assets. There is a steady increase in the Gini coefficients of ALTE since the early 2000s.

In Germany, employees accrue claims against the German Pension Insurance through contributions to the system. These claims are represented by the so-called **social security wealth (SSW)**. SSW is a theoretical construct since it measures the expected sum of benefits from retirement to end of life, properly discounted, not a capital stock. We calculate it based on expected benefits (which depend on ALTE), the probability of retiring at a specific age, and life expectancy. Due to discounting, SSW varies with the age at which the individual computes it. We consider SSW at age 60 for all employees. The Gini coefficients for SSW closely resemble those of ALTE in most years, but slightly shifted

downwards. Importantly, ALTE determine expected pension benefits, which in turn are part of the construction of SSW. Thus, while income inequalities during working life appear to translate into inequalities in old-age income, they are less pronounced because of several features in the German social security system (e.g. income from social assistance or the upgrade of years with low contributions).

Finally, we explore inequalities in **pension income** as observed in our SOEP sample. We distinguish between income from public pensions and total pensions, where the latter includes occupational and private pensions in addition to public pensions. The Gini coefficients for public pensions decrease from their initial level in 1985 of approximately 0.35 to below 0.3 until 1995, remaining relatively stable thereafter. A similar trend is observed for total pensions, albeit with the Gini coefficients being slightly shifted upwards. However, since the early 2000s, the Gini coefficients for total pensions have been increasing, with the gap between public and total pensions widening. This suggests that while income from state pension appears to be relatively evenly distributed, private and occupational pensions exhibit a somewhat greater inequality, which has been accentuated in recent years. Nevertheless, inequality, as measured by the Gini coefficients, remains substantially lower than for real and financial assets.

The remainder of this paper is structured as follows. Section 2 briefly describes the German pension system, and Section 3 our data. Our analysis is split in four sections. The main object of our interest is social security wealth (SSW). It summarizes how large pension benefits are and for how long they are received which depends on the retirement age. The pension reforms in Germany have strongly affected both, and in addition the pathways which were chosen by employees to reach retirement. These pathways and their associated benefits and retirement age are described in Section 4, followed by a prediction model of the age of retirement in Section 5.

The key instrument to detect causal effects of the reforms on income and wealth inequality are counterfactual simulations in which we predict how income and wealth had developed if these reforms had not taken place, compared to the actual development of income and wealth. This is the core of the paper, Section 6.

While Section 6 analyses the German pension reforms as a bundle, Section 7 does additional simulations of single reform elements such as several forms of minimum pensions, variants of the benefit computation formula, the introduction of actuarial adjustments of pension benefits depending on the chosen retirement age, and deferred taxation. Section 8 concludes.

2. The German pension system

In this section, we shortly describe the German pension system with a focus on the most important characteristics (see Börsch-Supan et al., 2023, for a detailed description). In a second step, we describe how the reforms potentially affect inequality.

2.1. Key characteristics of the German pension system

The German pension system is a mandatory insurance for all private sector workers and non-civil servant public sector workers. It is a strictly earnings-related system with means-tested benefits available for those with insufficient income in old-age.

Coverage and Contributions. The system covers 85% of the German workforce and is mandatory for all private and public employees. Civil servants (approximately 5% of the workforce) have their own pension system, and most self-employed individuals (around 10%) also have their own system, with some exceptions. Contributions to the public pension system are financed mainly by insurants' contributions, which are administered like a payroll tax. The contribution rate in 2022 was 18.6% on the first 84,600€[4] of yearly gross income (upper-earnings threshold, *"Beitragsbemessungsgrenze"*) and contributions are split evenly between employees and employers. Contributions cover roughly 77% of the total budget of the system, with the remaining 23% being financed by governmental subsidies.

Eligibility and pathways to retirement. The German public pension scheme provides old-age pensions, disability pensions, and survivor pension. There are seven major types of old-age pensions (OAP) and disability pensions: (1) regular OAP, (2) OAP for long-term insured, (3) OAP for especially long-term insured, (4) OAP for invalids, (5) OAP after unemployment, (6) OAP after part-time employment prior to retirement ("*Altersteilzeit"*), (7) OAP for women, and (8) disability pensions.[5] However, not all OAP were available at the same time as, for instance, (5) to (7) were abolished for cohorts born after 1952. Survivor pension, on the other hand, do not constitute a separate pension pathway but rather transfer a portion of the deceased spouse's pension rights to the surviving partner.[6]

The eligibility criteria for each pension type vary, and individuals must fulfill specific requirements to access their pension entitlements (see Table 2 for a summary). Regular old-age pensions can be claimed after reaching the statutory eligibility age and acquiring at least five years of service. Other pensions offer early retirement with lower eligibility ages than the statutory requirement. However, not all of these pathways are available for everyone. For instance, the eligibility for the old-age pension of invalids and the disability pension depend on the health status of an insurant.

Benefits and taxation. Pension benefits in the public pension system are related to an individual's earnings and contributions history. They are calculated as the product of two individual components (1, 2) and two universal components (3, 4). The individual components are (1) the sum of earnings points an individual has accumulated over his/her working career (*"Entgeltpunkte"*) and (2) an access factor which captures actuarial adjustments for early or late retirement (*"Zugangsfaktor"*). The universal

[4] These values refer to West Germany only.

[5] The public pension system offers other very specific pension types like a separate old-age pension for miners. Measured against the total number of insurants, the number of individuals choosing one of the specific pension types is very low, so we do not consider these retirement pathways in our analysis.

[6] Upon the passing of the spouse, a portion of between 55% and 60% is transferred to the surviving spouse, with the exact amount determined based on the year of marriage and the year of birth. The survivor pension is subject to a fairly generous income test.

components are (3) the current pension value (*"aktueller Rentenwert"*) and a (4) pension type factor (*"Rentenartfaktor"*).

Table 2: Pathways to retirement: Eligibility criteria

Pathway	Earliest eligibility age (EEA)		Years of service		Actuarial deductions*	Earnings Tests	Other
(1) Regular OAP	Until 2012	After 2029	Until 1984	Since 1984	None	None	
	65 (i.e. SEA)	67 (i.e. SEA)	15	5			
(2) OAP for long-term insured	63		35		Yes	Yes	
(3) OAP for especially long-term insured	Increase from 63 to 65 until 2029		45 years of contribution		None	Yes	
(4) OAP for invalids	Until 2011	After 2025	35		Yes	(Yes)	At least 50% disabled
	60	62					
(5) OAP after unemployment	Until 1996	After 2002	15 (8 in last 10 years)		Yes	Yes	At least 52 weeks unemployed; Born before 1952
	60	63					
(6) OAP after part-time employment	Until 1996	After 2002	15 (8 in last 10 years)		Yes	(Yes)	Two years part-time; Born before 1952
	60	63					
(7) OAP for Women	60		15 (10 after age 40)		Yes	Yes	Born before 1952
(8) Disability pension	--		Until 1984	Since 1984	Yes	Yes	Medical exams
			5	5 (3 in last 5)			

(*) Actuarial deductions for early retirement were introduced between 1992 and 2004.

Source: Börsch-Supan et al. (2020).

The sum of earnings points represents the individual earnings history and ensure a relation between earnings and benefits. Additional points are credited for care, unemployment, disability, etc. Earnings points are calculated by dividing the individual gross income by the average gross earnings of all contributors to the public pension system. If the individual's earnings are exactly the average gross earnings of all contributors, then this individual receives one earnings point. Half the average gross income entails 0.5 earnings points, etc.

Actuarial adjustments for early or late retirement are captured by the access factor. For each year of early retirement, pension benefits are reduced by 3.6%. On the other side, for each year of late retirement an actuarial supplement of 6% percent is granted.[7]

[7] Actuarial supplements were already introduced in 1972. Until 1992 they were with 7.2% slightly higher than today. Therefore, they were only granted for two years of late retirement (i.e. until age 66 and 67).

The current pension value indicates the relationship between average earnings and pension benefits. It is a political parameter expressing the replacement rate of pension benefits. The current pension value is the amount of monthly pension benefits related to one earnings point. Each year, the current pension value is adjusted with a new value by law. The adjustment formula mainly considers the wage development plus an adjustment for demographic change.

The pension type factor reflects the type of pension and the percentage of pension entitlements. It, for instance, equals one for old-age pensions and full disability pension benefits, and 0.55 (0.6 until 2001) for full survivor benefits (*"große Witwen-/Witwerrente"*).

Until 2004, pension benefits were only taxed if they surpassed a significant allowance, affecting relatively few cases. However, with the 2004 pension reform that took effect in 2005, deferred taxation of pension was introduced. Contributions to the public pension system became tax-exempt, while pension benefits became taxable. To prevent double taxation, the reform included a generous transition period until 2040.

2.2. Differences between West and East Germany

Following the reunification of Germany, integrating the East German population into the West German pension system became necessary. This integration was facilitated by the pay-as-you-go system, where pension payments were funded directly from current contributions rather than from a capital stock that would have needed to be constructed first.

However, how contribution periods were assessed differed between East and West Germany since the reunification. These differences were justified by the economic gaps between the two regions (especially at the time of the reunification). It was expected that East Germany would quickly catch up economically with the West, which would have led to an automatic decline over time. However, this expectation only partially came true. As a result, a gradual process to eliminate these differences was finally put in place for the period from 2018 to 2025.

In principle, pensions in East Germany were calculated based on the same principles as in West Germany, but with some variation. One difference was the upward revaluation of the contribution assessment bases used to evaluate a year's work. This meant that earnings points earned in a year were adjusted upwards, and this was also done for pre-reunification periods. The highest revaluation took place in 1985 (factor 3.31), but for years after reunification the conversion factor fell rapidly (factor 1.14 in 2017). By 2025, the distinction will be abolished due to the forced abolition of the East-West distinction.

Another difference was the lower monetary valuation of the earnings points earned in East Germany compared to West Germany. The annual current pension value in the East was annually adjusted with

wage growth in the region. While the difference in pension values in 1992 was 40%, it decreased to 18% by 1996 and to only 5% by 2017.[8] By 2025, the difference will be abolished.[9]

2.3. The reform process since 1980 and potential consequences for inequalities

Due to population aging, the generous German public pension system became financially unsustainable. This precipitated a sequence of reform steps starting around 1980, see Figure 2. In this section, we discuss the expected effects of those reforms on inequality. We will focus on reforms which potentially are the main drivers of changes regarding inequality as well as major reforms which fundamentally changed the system. Moreover, we will rather discuss reforms addressing identical or similar aspects of the pension regulation in a bundle than going step by step through the reform process. For a detailed description of the reforms that have taken place throughout the past almost four decades see Figure 2 and Börsch-Supan et al. (2020).

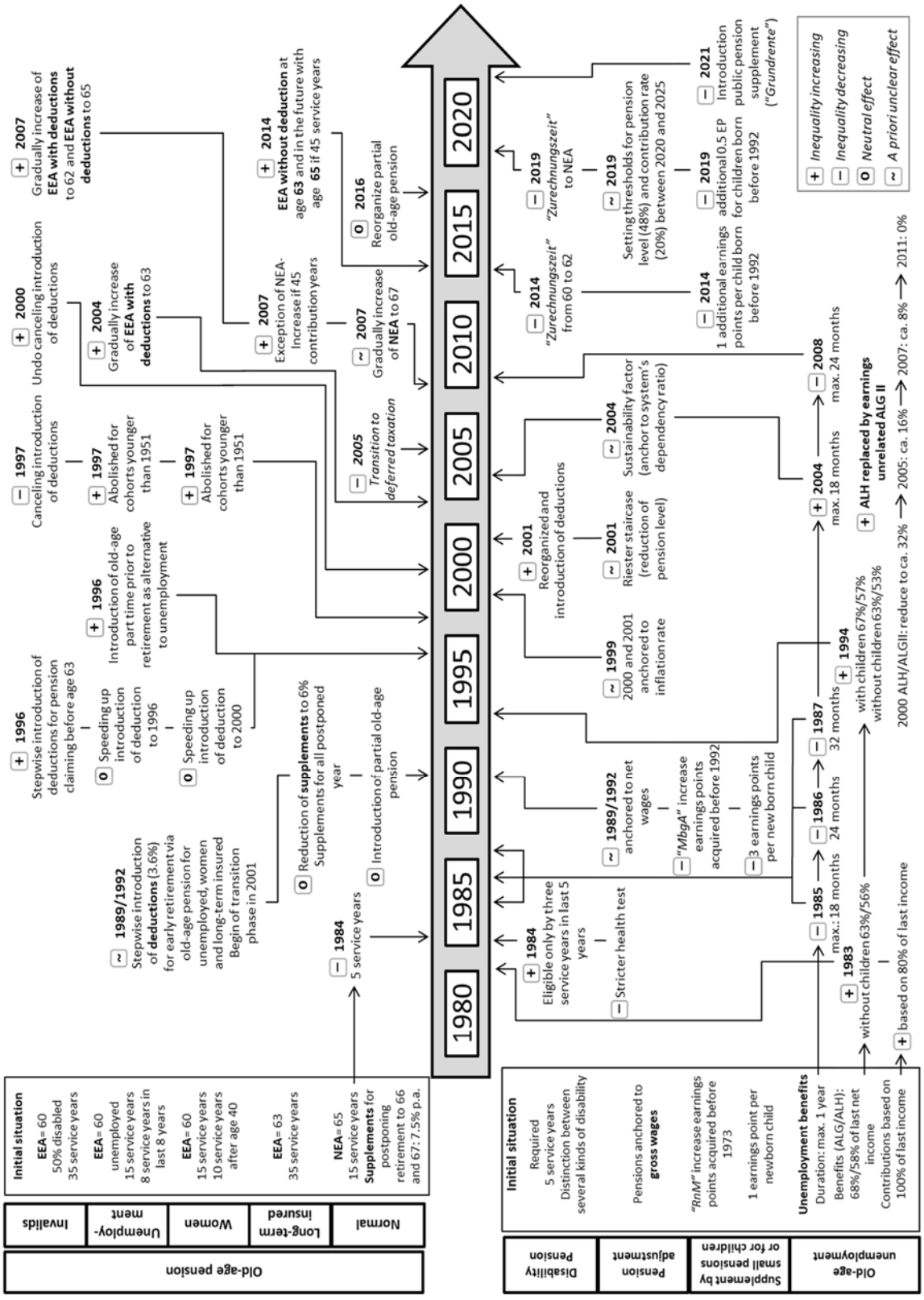
All in all, we discuss the following reforms to the system:

- Introduction of actuarial adjustments and increase of statutory eligibility age,
- Closure of early retirement pathways,
- Changes to the disability pension (e.g. higher/lower benefits, stricter health tests),
- Reduction of benefit generosity,
- Introduction of public pension supplement by small pensions or for bringing up children,
- Pension taxation,
- Changes to unemployment benefits, and
- Abolishment of earnings tests and introduction of partial ("flexible") retirement.

[8] To mitigate the pronounced catch-up effects following reunification, the deviation from the overall current pension value in 1996 is employed to establish the current pension value for the accession area up to that year.

[9] In the course of the unification already retired persons were treated slightly different. As we consider in our calculation only individuals who retire after the reunification we refrain from going into more detail here. For more information see Ruland et al. (2019) pp. 331ff or Ritter (2012) pp. 81ff.

Figure 2: Timeline of pension reforms in Germany



Note: ALG = unemployment benefits I, ALH = unemployment assistance, ALG II = unemployment benefits II

Source: Own presentation, partially based on Börsch-Supan et al. (2020).

Introduction of actuarial adjustments and increase of statutory eligibility age

In **1992**, a phased introduction (by cohorts) of **actuarial adjustments** for an early pension claiming was decided. The actuarial adjustments were set at 3.6% per year of early retirement and were originally planned to be gradually introduced from 2001 onwards. However, in **1996** the timetable for the introduction of the actuarial adjustment was moved up to 1997 for the old-age pension because of unemployment and to 2000 for the old-age pension for women. Moreover, it was decided to phase in actuarial adjustments also for the old-age pension for disabled persons. At last in **2001** actuarial adjustments were introduced for disability pensions. Other than for old-age pensions the actuarial adjustments were, however, limited to 10.8 percent and depended on the distance between the claiming of a disability pension and the age 63 rather than the statutory eligibility age. Due to the connection between adjustments and statutory eligibility age, the increase of the latter by two years until 2029, introduced in **2007**, effectively increased the adjustments for early retirement.[10] However, insured persons with forty-five years with active contribution payments were exempt from this reform. In **2014**, this exemption was extended even further by enlarging the group of workers with forty-five years of contributions by watering down the definition of contribution year and, even more significantly, granting an adjustment free retirement already at the age of 63, called "retirement at 63".[11]

Actuarial adjustments affect initially all income groups equally. Any effect on inequality depends on the extent to which income groups differ in their retirement behavior and their ability and intention to respond to the introduction of the deductions. If the share of lower income groups among early retirees is overly proportional, for example due to health constraints, the introduction of the deductions will primarily affect this group and further reduce their pension benefits. But even if there were no differences in retirement behavior at the time of the reform, lower income groups would still be primarily affected if they adjust their retirement behavior less. This is particularly problematic when the non-response is less the result of a personal decision and more a consequence of external circumstances or health problems. For example, people who work in physically demanding jobs tend to have lower pension wealth (see Goll and Hanemann, 2020) but at the same time may be less able to postpone retirement than workers in non-physically demanding jobs because of the greater physical strain. Overall, the adjustments therefore have the potential to increase inequality rather than reduce it. For similar reasons, the increase of the statutory eligibility age may increase inequality if particular lower income groups are unable to postpone their retirement and instead have to accept higher deductions due to health contains.

In principle, however, it should also be pointed out that inequality can increase or decrease depending on the willingness to change one's behavior. If the higher income groups are willing and able to pay the

[10] The reference year for the disability pension's adjustments increases parallel from 63 to 65.

[11] The claiming age of 63 increased in parallel to the statutory eligibility age, such that the claiming age for this type of pensions was set to two years before the statutory eligibility age.

deductions, this group may not change their behavior for the most part. In this case, even a reduction in inequality would be possible.

The exemptions for individuals with at least forty-five active contribution years has complex effects on inequality. These exemptions were aimed at increasing benefits for workers with arduous job, usually at low incomes. In this case, the exemptions would have decreased inequality. In fact, however, Börsch-Supan et al. (2021) show that the middle- and upper-income groups benefitted more from this regulation while many individuals in the lower-income groups did not fulfil the requirements for the exemption because of their unstable employment histories.

Closure of early retirement pathways

In **1997** it was decided to abolish the **old-age pension because of unemployment and old-age pension for women** for cohorts born after 1952. On inequality this should have a negative effect since women and unemployed belong to lower income groups more often. However, eliminating these retirement options could have also affected individuals to seek new employment instead. If this were to happen successfully, inequality could have been reduced. Moreover, since both pensions were associated with high deductions if taken at the earliest age, the abolishment of the pathways led to higher pensions at later ages.

Disability pensions

The German disability pension faced many changes over the last four decades. It started in **1984** when the requirements for disability pensions were tightened by making a minimum of three contribution years in the last five years a condition. Moreover, stricter medical examinations were introduced. As kind of compensation the vesting period for regular old-age pensions was reduced from 15 to 5 service years. In **2001**, the disability pension's original composition of pensions owing to vocational disability and "real" disability pensions ("*BU and EU-Rente"*) was abolished in favor of a twostep disability pension (partial/full earning incapacity) with strict focus on the maximal working capacity (less than six/three hours per day for a partial/full disability pension). Moreover, the disability pension benefits were enlarged if the act of disability happened before the age of 60, what compensated for a major part of the newly introduced actuarial adjustments. All of these restrictions ultimately led to the fact that a disability pension could only be claimed by a particularly disadvantaged group with low pension entitlements. As a result, their benefits were increased in several steps by gradually raising the age on the basis of which the lost working time ("*Zurechnungszeit*") is determined for which additional pension entitlements are credited. Specifically, in **2014** there was an increase of 2 years from 60 to 62 and in **2019** of more than 3 years when the reference age was linked to the statutory eligibility age.

The effect of the reforms on inequality is at least complex. More stringent restriction on disability pensions should be more likely to affect lower income-groups due to the correlation between health and income (see Section 3.6). It is, therefore, likely that less generous disability pensions increase inequality. On the other side, this is only the case if the medical examinations are not too permeable and there was

only a relatively loose connection between the receipt of a disability pension and health. In fact, this may have been the case before 1984 and especially before 2001 due to the generous pensions owing to vocational disability. Correspondingly, with the stricter health tests and stricter focus on work incapacity, in the best-case scenario, the higher income groups could be prevented from earning a pension early, thereby reducing inequality.

The group excluded by the stricter vesting time regulation in 1984 were most likely women and housewives in particular. Since they also tend to have low pension entitlements and no other income, this increases inequality. On the other hand, the shorter general vesting period has made it easier for women to receive a regular old-age pension. The increase of disability pensions after 2014 should have reduced inequality as disability pensions are in fact below average pension payments, especially since the 2001 reform.

Reduction of benefit generosity

The development of the pension benefits depends on the pension adjustment formula which was changed several times. In **1992** the benefit adjustment switched from gross wage growth to **net wage growth**. With the so called Riester-reforms in **2001** the benefits growth was further reduced in favor of a (not mandatory) subsidized private funded system ("*Riester-Rente"*). This was done by adding an appropriate component into the pension benefit indexation formula (so called "*Riester-Treppe"*).[12] To further increase the sustainability of the system, the pension benefit indexation formula was yet again changed by introducing the so-called **"sustainability factor"** in **2004**. This demographic factor dampens the pension adjustment depending on the increase in the ratio of pensioners to contributors. Recently, however, the pension adjustment formula has become more generous again. A minimum pension level of 48% was set for the period between 2021 and 2025, which may suspend the effect of the sustainability factor. Ultimately, this represents a pension adjustment in respect to the gross wage development corrected for social security contributions. The continuation of this threshold beyond 2025 is moreover an essential part of the current political discussion.

Changes to the pension adjustment formula should generally have no effect on inequality regarding the public pension payments, since the formula is independent from the personal pension claims. Changes to the pension adjustment formula increase or reduce the future annual pensions therefore equally of the income spectrum. However, it will change the balance between pensioners and workers due to the effect on the future pension level and contribution rate. It is also conceivable that the inequality among pensioners will increase if upper income groups are more prepared or able to increase private savings in respond to lower pension adjustments. This of course also applies to the Riester reforms with the private subsidized Riester pension. This is even more the case since the Riester pension was intended to compensate for the weakening of the public pension. In fact, the subsidies for Riester pensions were

[12] The 1989 introduced components in the pension adjustment formula, which anchored benefits to the net wage growth, were, thereby, replaced by a sole consideration of the pension system's contribution rate's growth rate. Due to this, changes in the balance between the fiscal burden of pensions and wages had no longer an influence on the adjustment of the pensions.

designed in such a way that low-income earners and families with children would benefit more than average. However, the non-mandatory design of the Riester pension led to selection effects. As Geyer et al. (2021) show, the Riester pension is underrepresented among lower income groups as a result. Ultimately, the lower savings volume of the lower income groups is likely to increase inequality in old age, provided that the upper income groups adjusted their savings rate upwards as a result to the reduction of the pension adjustment.

Public pension supplement for small pensions or upbringing children

Although redistribution generally played a subordinate role within the statutory pension insurance system, redistribution mechanisms were already in place in the past. Basically, these were aimed at improving the position of women with low incomes, although men could also benefit. In essence, they upgraded a low number of earnings points. The oldest of these systems was the "*Rente nach Mindesteinkommen*" (*"RnM"*), which in particular upgraded pre-1973 pensions.[13] In **1992**, this regulation was replaced by the so-called "*Mindestentgeltpunkte bei geringem Arbeitsentgelt*" (*"MbgA"*). The new system, like the old one, provided for an increase in small pensions, but was less generous and contained stricter conditions. For instance, instead of 25 insurance years 35 were necessary. Moreover, the annual working income over the whole labor history had to be below 75% of the average income. If the requirements are met, the earning points acquired before 1992 are doubled, with an average maximum of 0.75. For a more intuitive understanding, we refer to these two mechanisms as 1973-Low-EP-Upgrade (*"RnM"*) and 1992-Low-EP-Upgrade *("MbgA"*).

In **2021**, a hotly debated reform on a public pension supplement, which can also be seen as the successor to *"MbgA",* came into force ("*Grundrente*" or basic pension). In order to ensure that only disadvantaged households benefit from the revaluation, the design of the reform is more complex than for the old regulations. In particular, it includes a simplified household income test rather than looking only on the individual pension payments. Since the reform lies outside of our subsequent analysis horizon, we refrain from an explicit description of the new regulation.

Another redistribution within the German pension insurance are additional earnings points that parents (mainly the mothers) receive for each child. Before **1992**, those earnings points were set to one. In 1992, those earnings points were then increased to three, however, only for the children born after 1992.[14] Later this difference was reduced by increasing the earnings points received for children born before 1992 from one to two in **2014** and in **2019** from two to 2.5.

The additional earnings points for children should reduce inequality since mainly women will benefit and raising children cost not only money but normally leads to a reduction of working time and therefore income and finally pension claims (see Barišić and Consiglio, 2020). The increase of pension

[13] The "*RnM*" increased all earnings points acquired before 1973 to 0.75 under the requirements of 25 insurance years and an average annual working income below 75% of the average income for the time before 1973.

[14] Note that on the other side the earnings points earned before 1992 were eventually increased due to the 1992-Low-EP-Upgrade.

entitlements acquired before 1992 due to the *1992-Low-EP-Upgrade* also inevitably reduced inequality within the public pension insurance system. However, the reform neglects the household context although it is only possible to infer household income from the state pension to a limited extent, as was shown most recently in the discussion of the reform on supplemental pension benefits that make up the basic pension ("*Grundrente*") (see Börsch-Supan and Goll, 2021). Thus, without considering the household context, such a reform may ultimately also benefit households in the higher income range.

Pension taxation

In **2004**, the pension taxation was reorganized as a consequence to a decision of the Federal Constitutional Court (see Börsch-Supan and Quinn, 2015). Until 2004 public pensions were taxed only if they surpassed a quite large allowance. Actually, this applied only to relative few cases. With the new regulations a **deferred taxation of pension** was introduced. Hence, the contributions to the pension insurance got tax exempted and the pension benefits taxable. To prevent a double taxation the reform included a generous transition period.[15]

Inequality among pensioners should decrease with the taxation of pensions since smaller pensions are not taxed at all or only marginal while taxes rise with the pension value. However, at the same time for the upper income groups, the tax burden in the employment phase will decrease more strongly. Consequently, the extent of the effect depends on the extent to which the tax savings are invested in private pension or saving plans.

Unemployment benefits.

Unemployment benefits are not pension benefits. Nevertheless, they can be used as a bridge to retirement. In addition, social assistance in old age is provided by the unemployment system rather than the pension system and is based on the benefits for long-term unemployed. Moreover, for the development of inequality in old age the pension claims received during unemployment are important. For this reason, we also have to discuss changes to the unemployment benefits when looking at inequality in old age.

The first changes already took place between **1984** and **1987** when the maximal duration time of unemployment benefits for older workers (age 56 and above) was extended from 12 months to 32 months. However, the major reform of the unemployment system happened in **2004**. The Hartz reforms replaced, inter alia, the unemployment assistance by the lower so called "unemployment benefits II" (commonly called "*HARTZ IV*"). Moreover, the pension claims granted while receiving unemployment benefit II were stepwise reduced after 2004 from 16 percent to zero percent of the last income. The duration time of normal unemployment benefits were, furthermore, reduced for older

[15] The transition included, on the one hand side, an implementation of the tax exemption between 2005 and 2025 and, on the other hand, a constant tax allowances on pension claimed before 2040. The tax exemption increases stepwise from 60 percent to 100 percent. For pension claimed before 2005 the tax allowance was set to 50 percent of the gross pension benefits in 2005. For pensions claimed between 2005 and 2040 the allowance is a fraction of the first received gross pension whereby the fraction itself depends on the pension claiming year and decreases from 50 percent to 0 percent.

workers from maximal 32 months to 18 months. In **2008,** the duration of unemployment benefits was, however, yet again increased for older workers (older than 57) to 24 months.

Until 2021, if an individual's pension fell below the basic income support level, it would be completely compensated by basic income support. Consequently, pension reforms that affected the pension level could effectively have no impact on recipients of basic income support, if pension benefits after the reform were still below the social assistance level. In **2021,** an important change was made: An allowance on pension payments was introduced when calculating social assistance benefits. This change aimed to combat increasing poverty among the elderly and encourage low-income earners to extent their working lives, even with the expectation of a pension below the social assistance level. However, this allowance is conditional on having at least 33 years of insurance contributions. The size of the allowance varies, ranging from 100€ to 50% of the basic social assistance level (which was 251€ in 2023), depending on the pension amount.

Overall, more generous unemployment benefits should reduce inequality especially since long term benefits are strongly income tested in Germany. However, this does not have to be the case for short-term unemployment (unemployment benefits I) which does not require an income test and may be used as bridge into retirement by all income groups. In this sense, longer duration times of unemployment benefits I may be problematic. The abolishment of pension claims for times during unemployment benefit II (long-term unemployment) for sure will increase inequality in the future when the cohorts who did not acquire pension claims during those times enter retirement.

Earnings tests and partial ("flexible") retirement,

In **1992**, a **partial old-age pension** was introduced which enabled individuals to compensate an income loss due to a reduction in working hours (part-time work) by drawing a partial pension. However, this pension scheme was not successful as only every few individuals used it. One main reason for this was most likely the rigid earning limits which were therefore substituted by more flexible limits in **2016**, coming into force in July 2017. Within the new system, each additional earned Euro in excess of 6300 € per year is only counted by 40 percent towards the pension. The employee can retain 60 percent. With the new regulation the German government tried to encourage partial pensioners to extend their labor supply. However, as actuarial adjustments are still not actuarially fair it has to be shown whether this new regulation will meet their expectation or not and what will be the effect on inequality. Moreover, it remains to be seen whether or not the changes encourage more people to take up a **partial old-age pension.**

The so far most widely used model of pre-retirement work reduction was the **1996** introduced **part-time work for employees over 55**. The scheme is based on a bilateral agreement between employee and employer and required a reduction of working hours by half in the last five years before the public pension is claimed. The remaining "half" working time could be distributed either consistent over the whole period of five years or could be fulfilled entire in the first two and a half years without a reduction

in working, the so-called "block model". In both cases the employee gets an ongoing payment, composed of his part-time work income and a supplementary income of 20 percent by the employer. Additionally, the employer pays pension contributions for 80 percent of the part-time work income. The scheme is subsidized in the sense that the supplementary compensation by the employer is tax exempted (see Börsch-Supan et al., 2015). However, this subsidizes ended in 2009. The eligibility ages for pension claiming were the same as for the pension because of unemployment.

The **partial old-age pension** could reduce inequality as individuals with small pension claims could combine pension benefits with work income even before the statutory retirement age.[16] With increasing income, on the other hand, the share of the pension that can be drawn decreases, which means that this form of pension does not bring any further advantages for higher earners. This is the case in particular because the deductions are still made on the pension claimed.

The effect of the **part-time work for employees over 55** on inequality depends not only on the preferences of the income groups' individuals, but also on the willingness of the respective employers to agree to an arrangement for this concept. Huber et al. (2013) have examined the use of the German part-time regulation according to individual but also company characteristics. Among other things, they have shown that the employees using the opportunity to work part-time before retiring have a higher income than those who do not use this retirement pathway. Moreover, they have shown that also the companies that agree to part-time employment prior to retirement on average pay higher wages. If part-time employment is therefore a financially worthwhile offer in its form, it is likely to increase inequality.

3. Data

In this section, we introduce our primary data source, the German Socio-Economic Panel (SOEP)[17], and outline the process of constructing income groups. We also present descriptive statistics for our sample categorized by income. Additionally, we describe how we constructed income profiles and how we define the retirement status. Finally, we show how life expectancy differs across income groups.

3.1. The German Socio-Economic Panel (SOEP)

The German Socio-Economic Panel (SOEP) is a representative longitudinal study of private households. It conducts annual interviews, and the sample size has currently reached around 30,000 respondents from around 15,000 households at the beginning. SOEP started in 1984 and we use waves up to 2020 included, therefore we can count on 37 consecutive years of data. This is particularly convenient for the current analysis, as this time span includes several pension reforms which provide variation for the

[16] There are no income tests after the statutory eligibility age.

[17] Fore more information on SOEP, see Goebel et al. (2019).

identification of our empirical analysis. Although available, we do not use data collected in 2021 since retirement behavior might have been affected by the pandemic.

The dataset includes information on all household members and contains a stable set of core demographic and economic questions, such as labor market status, gross and net income, hours worked, education and marital status. As each household member is interviewed, we have corresponding information for both spouses. SOEP comprises various subsamples, each with distinct sampling probabilities to ensure sufficient cases for separate analyses.[18]

Another advantage of the SOEP data is the possibility to construct individuals' labor history from the age of 15. Participants are asked once to provide information on their activity status throughout their life course up to the interview date. The information is provided in the form of activity spells and distinguishes between time spent in education, doing apprenticeship or training, in the military force or community service, in full-time employment, in part-time employment, unemployed, being out of the labor force, or being a pensioner.

This retrospective occupation history can be combined with information on the activity status during the sample period, as SOEP also collects detailed information on occupation in the form of a calendar, with monthly information on labor market status. On the other hand, while information on labor income is available for the sample period, retrospective information is not available. Furthermore, the dataset provides limited or irregular information on health, particularly on objective measures of health, and on household wealth.

3.2. Construction of income groups

In this volume, we focus on the effect of pension reforms on workers, considering the presence of income heterogeneity. To categorize individuals into income groups, we utilize our measure of average lifetime earnings, which depends on the average earnings points individuals have accrued. This approach offers an advantage over using yearly income since it provides a comparable income measure over the years.

Instead of using cumulated, we opt for average earnings points since the former could group individuals with relatively short employment histories but high incomes into lower income groups. Such an assignment would assume similar life expectancies for individuals with contrasting working lives and income levels, which is unlikely. Also, retirement behavior may be very different across these two groups. Hence, we assign income groups based on average earnings, acknowledging that this approach groups individuals with potentially varying pension benefits due to differing working lives.

The division into income groups is done at the household level. We recognize thereby that retirement decisions, life expectancy and other factors are likely influenced by household rather than only by own

[18] The subsamples consist, among others, of West German citizens, East German citizens, immigrants, high income individuals, as well as several refreshment samples.

income. Where partner information is available, we combine both partner's income and divide the total by 1.7, using the OECD equivalence scale. We do not factor in children, as our sample primarily consists of individuals aged 50 and older, and their children typically are independent and no longer reside with them.

Although our preference is to use income deciles for the empirical estimation, our sample size does not permit this due to the need to stratify by multiple dimensions: age (n=15), birth year (n=24), and gender (n=2), resulting in a total of 720 groups. Considering our sample size of 60,401 observations from 5,648 individuals, stratifying income by deciles would lead to 8.4 observations per cell. Instead, we employ income terciles for the empirical analysis, which are derived from the deciles used earlier: deciles 1-4 form tercile 1, deciles 5-7 form tercile 2, and deciles 8-10 form tercile 3. The bottom tercile consists of 2,193 individuals, the middle tercile comprises 1,783 individuals, and the top tercile contains 1,672 individuals. To further reduce dimensions, we group birth years together (see Section 6 for details).

3.3. Sample and summary statistics

Our sample selection primarily relies on two key criteria. Firstly, we focus on individuals aged between 55 and 69, both in East and West Germany. Secondly, only pensioners and employees in the private and public sectors who are either entitled to a public pension because they have paid contributions for at least five years or who receive a public pension are included. Civil servants, who have a separate pension system, are excluded from our analysis.

Our sample comprises 5,648 individuals and 60,401 person-year observations. The average and median observation times are 12.8 and 15 years, respectively. For a comprehensive overview of the primary variables within our sample, we present descriptive statistics across average lifetime income terciles in Table 3.

We observe a slightly higher proportion of men than women in our sample. However, this gender distribution varies across income terciles. The highest proportion of men is found in the top tercile (59%), while the bottom tercile comprises only 45% men. It is important to note that our tercile assignments are based on household income, potentially amplifying this gender discrepancy at an individual level. Regarding retirement age, there is an average difference of 13 months between the bottom and top terciles, suggesting that individuals with lower average lifetime earnings tend to retire earlier.

The proportion of individuals with low education is comparable between the bottom and the middle tercile groups and is lowest in the top tercile. Conversely, the percentage of individuals with high education is highest in the top tercile (31.7%). Homeownership becomes more prevalent as income increases, while there is a slight decrease in the number of children. The share of individuals being married at age 55 does not significantly differ across the income groups.

Table 3 – Sample Summary Statistics

	Total	Tercile 1	Tercile 2	Tercile 3
% Male	52.2	44.6	54.6	59.0
Ret. Age	62.0	61.5	61.9	62.6
% With low educ.	15.3	17.1	17.7	10.5
% With high educ.	20.0	15.5	14.0	31.7
% Owns home	52.6	44.9	51.5	64.0
# Children	1.93	2.1	2.0	1.7
% Married, age 55	84.2	84.8	84.7	82.7
Experience, age 55	31.6	30.8	32.3	31.8
Experience, age 60	35.2	33.8	36.2	36.0
% Full Time, age 55	68.5	55.9	72.1	80.3
% Full Time, age 60	54.8	35.8	59.0	72.6
Health Satisfaction, age 55	6.2	5.9	6.1	6.6
Health Satisfaction, age 60	6.3	6.0	6.1	6.7
Max. Wealth (in €)	292,960	141,844	202,580	515,207
Ret. Inc, Public (in €)	1,322	1,061	1,375	1,651
Ret. Inc, Total (in €)	1,469	1,089	1,469	2,035

Note: Retirement income and wealth are reported in German 2023 Euros. Wealth is household equivalized wealth.

Source: Own calculation based on SOEP v37.

Our longitudinal sample is not balanced, resulting in varying observations for individuals at different ages. Consequently, we assess experience, full-time employment, and health satisfaction at specific ages (55 and 60), with experience measured in terms of years individuals contributed to the public pension insurance. At age 55, individuals in the lowest tercile have contributed roughly 31 insurance years, whereas those in the middle have accumulated the most with 32.3 years, and those in the top tercile accumulated 31.8 years. At age 60, the difference in experience between the bottom and the other terciles widens: over these five years, the bottom tercile increases experience by 3 years, the middle tercile by 3.9 years, and the top tercile by 4.2 years on average. This aligns with our finding of higher retirement ages as income increases. The household-based categorization may influence these findings, as individuals with high-income partners are grouped into the top tercile, even if they themselves have not

worked. The share of individuals engaged in full-time employment rises with income and decreases with age, though the decrease between ages 55 and 60 is less pronounced for the top tercile.

Health satisfaction displays only minor variations among the terciles and remains relatively constant between ages 55 and 60, with individuals in higher income groups tending to express slightly greater satisfaction with their health.

Shifting our focus to wealth and pension income, the average individual-specific maximal observed wealth in the sample shows a monotonically increasing trend with income. The difference between the 2nd and 1st terciles is much smaller compared to the difference between the 3rd and the 2nd terciles. In terms of retirement income, we observe a similar upward trend aligned with income levels. For public pensions, the difference is approximately 300€ between the 2nd and the 1st and the 3rd and the 2nd terciles. Total retirement income (comprising public, private, and occupational pensions) is not very different from public pensions only for the bottom tercile (28€ on average) and the middle tercile (94€). However, in the top tercile, total retirement income is substantially higher than public pensions only (384€).

3.4. Income profiles

While we are able to use SOEP to construct the complete employment history of individuals, information regarding labor income is only available for the sample period. Given that the pension benefits formula hinges on earnings points (EP), derived from an individual's relative income position relation to the "average" earner, we predict the earnings points that individuals accumulated.

We adopt the approach outlined in Börsch-Supan et al. (2023), where we calculate the earnings points for all individuals within the sample who are engaged in full- or part-time employment and receive a positive wage. Subsequently, using income information in years we observe individuals, we proceed to estimate a fixed-effects earnings points model on the sample of individuals:

$$EP_{it} = \alpha + \beta_1 age_{it} + \beta_2 age_{it}^2 + \beta_3 exper_{it} + \beta_4 exper_{it}^2 + \beta_5 exper_{it} * educ_i + \beta_6 parttime_{it} + a_i + u_{it}$$

This model incorporates quadratic terms in both age and experience, an interaction effect between experience and education, as well as a binary variable indicating part-time employment status. The fixed effects comprehensively account for constant, individual-specific attributes. Finally, we predict earnings points of the years preceding the survey.

As elaborated in our previous work, our predictions yield declining EP profiles in the latter stages of individual's working lives. However, given empirical indications of relatively steady income profiles towards the end of the career, we assume flat profiles following the income peak of individuals.

3.5. Retirement and Retirement Pathways

Following our chapter from the last volume, our definition of retirement is based on the self-reported labor market status of respondents. We showed in Börsch-Supan et al. (2023) that flexible retirement (i.e. claiming to be retired while simultaneously working in full- or part-time for at least two consecutive months) as well as working while receiving a pension is not very common in Germany.

3.6. Life Expectancy by Socio-Economic Status

When considering distributional effects, an important aspect of social security wealth are the large differences of life expectancy by socio-economic status (SES). In this section, we describe how life expectancy varies by SES in Germany and which assumptions we draw for our social security wealth calculations.

Like in other welfare states there is a strong correlation between health status and socio-economic status in Germany. This correlation is characterized by a more frequent occurrence of diseases and risk factors among individuals with lower income, education or job status, which then lead to higher mortality and lower life expectancy. Moreover, the health status and life expectancy increase steadily with the socio-economic status. Hence, also the middle and higher society differ in health and life expectancy. While there are several studies that prove this correlation, the number of empirical funded studies for Germany is manageable due to a lack of appropriated data (Kroll, Lampert 2009, Wolf et al. 2012). One disadvantage of the German data situation is that unlike to some other countries no information on the socio-economic situation of the deceased is noted on the official death certificates. German studies therefore have to use either scientific (panel) data or other (official) data which include information on health, mortality and income (e.g. data from the social security agency). In the following we provide a small overview over the most recent studies which analysis this topic for the older German population. For a general overview see (Lampert and Kroll, 2014).

Recently, especially two datasets are used for the income related analyses of mortality among older individuals. First, there is the SOEP, which carries out a systematic follow-up recording of not reachable participants. Based on this dataset, Kroh et al. (2012) found a difference in life expectancy at age 65 in respect to the equivalent income (divided by 60%, 80%, 100% and 150% of median income). The difference amounts to 3.5 year for women and 5.3 year for men. According to the study, these differences can be attributed, at least in part, to increased psychological and physical stress over the life course, especially in working life, and to fewer material, cultural and social resources in the lower income group. Unger and Schulze (2013) used the self-reported health status in the SOEP panel to show that the differences between the healthy life expectancy increases stronger for the higher income groups and higher educated individuals. All in all, they found a 1.7 years larger surplus for the well-situated individuals between 1995 and 2008.

The other used dataset is administrative data of the German Pension Insurance. These data provide information about the date of death of the benefit receiving individuals. It is, therefore, possible to calculate morality rates as soon as the majority of the insured population is retired, which is the case after the statutory retirement age. The SES status can be estimated by the sum of accumulated earnings points. However, the data does not provide information regarding the household context and other income sources. This results in some restrictions. For instance, so far, the data cannot be used to compute income related mortality rates for female pensioners, as for the observed married women the household income is likely to depend mainly on the partner's income due to past family structures. Moreover, the resulting mortality rates for East Germany have to be treated with caution due to the differences before the reunification.

The two most recent studies using those administrative data were published in 2019 and 2020. First, there is Wenau et al. (2019), who compare period life tables by SES status like the SOEP-papers. Wenau et al. divided the population into quintiles in respect to the accumulated earnings points. As the size of the administrative data is larger as for the SOEP they are, moreover, able to compute separate period life tables for each year between 1997 and 2016. They find a general increase of the men's life expectancy at age 65 by 2.72 years. Moreover, they find a gap between the increase among the most advantaged group (3.55 years) and most disadvantaged group (1.8 years) of 1.75 years. The total difference in the life expectancy increases from 1.78 years in 1997 to 3.37 years in 2016. The differences are, therefore, smaller as in the studies using the SOEP.

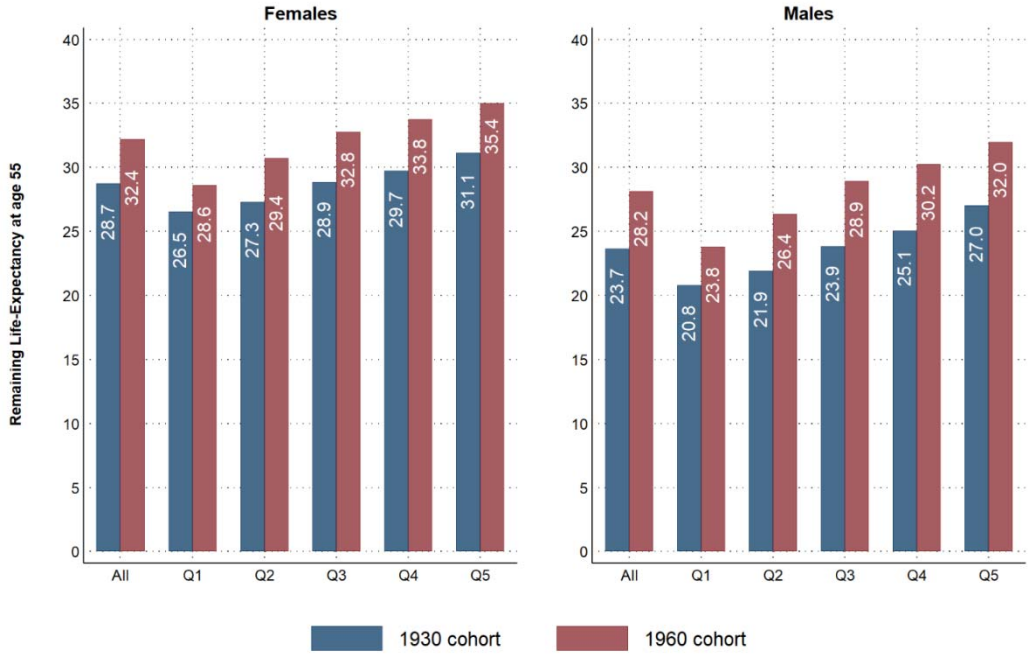
The other study is Haan et.al. (2020), who compute **cohort life tables** for the cohorts 1926 to 1949 after dividing the pensioners into deciles instead of quantiles. Since the administrative data includes individuals who were only mandatorily insured for a short time in the German Pension Insurance and therefore did not acquire pension entitlements over their entire working life (e.g. due to moving to / leaving Germany, self-employment, civil servants). Haan et al. drop all pensioners with less than 30 earnings points. This is problematic as it also includes individuals who belong to the lowest deciles.[19] Robustness checks without dropping those individuals or reducing the threshold to 20 earnings points lead overall to similar results. However, the lowest decile indeed shows higher life expectancies due to the now more heterogeneous composition of this group. The cohort life expectancy itself is calculated for West German men at age 65. The differences between the lowest income group and highest income group increase from 4 years (cohorts 1926-28) to 7 years (cohorts 1947-49). By extending the analysis to widowed pensioners they, moreover, show that life expectancy is also related to the spouse's lifetime income.

For our analyses, we use the results of Haan et al. (2020) and combine them with the model calculations of the German Federal Statistical Office regarding the cohort mortality tables for the years 1896 to 2009

[19] Wenau et al. (2019) use a more direct approach by controlling for the health insurance status and citizenship. Concert, they drop individuals privately insured or voluntarily insured in the statutory health insurance system as proxy for self-employment and civil servant and foreigners and ethnic German repatriates for probably longer periods of employment outside of Germany.

(BMAS, 2015). We use those two data sources for the following reasons. The model calculations of the Federal Statistical Office were already used in the previous papers of this project (see Börsch-Supan et al., 2023). We use for the general development of the mortality the assumptions V2 of these official model calculations. On the other side, we use the results from Haan et al. (2020) since their cohort approach fits our computation approach better and they provide a detailed table of their logistic regression estimates of West German male's mortality including the cohort-decile dependency. However, the observed cohorts (1926 to 1949) do not cover all considered cohorts of our calculations. Consequently, we have to make some assumptions for the missing cohort born before 1926 and after 1949. For the cohorts born before 1926 we simply use the same ratio of decile specific mortality rates to the average mortality rate as computed for the cohort 1926. For the cohorts born after 1949 we instead predict the future cohort-decile dependency using a logistic regression on the provided coefficients. We use a logarithmic approach as it fits best to the decile-related differential development of mortality rates over time. In the end, we first compute the mortality tables accordingly to the thus extended regression tables of Haan et al. (2020). Afterwards, we use the ratio to the average mortality rate on the average mortality rates of the Federal Statistic Office. Since Haan et al. (2020) compute mortality rates only for ages above 65 we use the same ratio between the average mortality and income related mortality for ages younger than 65 as observed for the age 65. For women we use the same approach. However, since we do not have separate calculations for the women's decile-related mortality rate, we have to use the men's ratio.

Figure 3: Life expectancy by income quintile and sex



Source: Own calculations based on the results from Haan et al. (2020).

Figure 3 shows for the cohorts 1930 and 1960 the respective life expectancy at age 55 by income quintile and sex. To no surprise the life expectancy is higher for women. For the cohorts born in 1930 the difference in the life expectancy between the first and fifth quintile accounts to 6.21/4.59 years (man/women). For the cohort 1960 the difference increases to 8.22/6.42 years (men/women). The differences between the quintiles increase, moreover, steadily over the quintiles.

4. Aggregation over multiple pathways to retirement

For the construction of social security wealth, we need to calculate expected pension benefits for all labor market exit ages within our retirement window. The applicable labor market exit age depends on the pathway for which a worker is eligible and for which this worker opts. Among these, the most important are:

- Regular old-age pension (at the statutory eligibility age),
- Early pension claiming via old-age pension for (especially) long-term insured or for women,
- Leaving the labor market via unemployment,
- Part-time employment prior to retirement,
- Early pension claiming via old-age pension for the disabled, and
- Disability pension.

It is important to notice that all of these pathways pay the same basic benefit once a person is eligible.[20] The main differences lie in the income between the labor market exit and first pension claiming. However, in practice there is no free choice, as each of these pathways are subject to eligibility criteria (as outlined in Table 2). These criteria can be categorized as either "strict" or "soft". The former align with objective variables such as age, gender, and previous contribution history, which we all observe in our data.

For our calculation, we assume that an individual will claim their pension as soon as the "strict" criteria for an old-age pension are met. Consequently, distinguishing the retirement paths only in terms of behavior prior to actually drawing a pension is sufficient. We consider the following four cases:

- Labor market exit without further income until the earliest pension claiming age,
- Claiming unemployment benefits or other wage replacement benefits until retirement,[21]
- Part-time employment prior to retirement,
- Claiming a disability pension.

[20] "Basic" is the benefit before the application of actuarial adjustments and access factors, see Section 2.1.

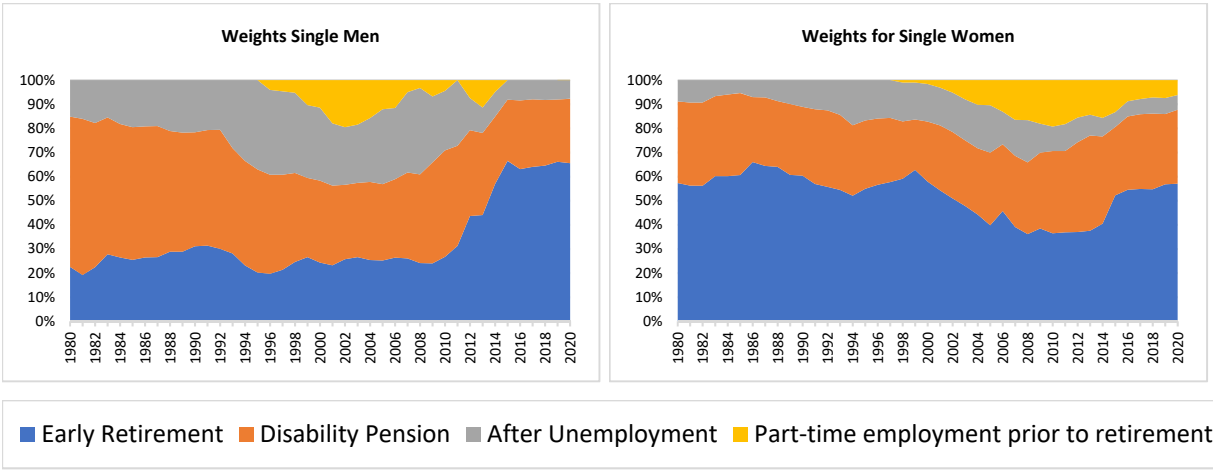
[21] In fact, in this case it is assumed that unemployment benefits 1 will be drawn for as long as possible and only then will the next possible retirement age be selected.

For example, a non-disabled[22] 55-year-old male worker with 35 years of service is eligible to claim an old-age pension for long-term insured beginning from age 63. Choosing the first pathway, he would not receive any payments between ages 55 and 62. Under the second pathway, in the unemployment scenario, he is likely to fulfill the remaining criteria for an old-age pension due to unemployment and could thus claim his pension from age 60. Additionally, during this phase, he would receive unemployment benefits for ages 55 to 59. If an individual does not meet the criteria for any early retirement option, they can claim their pension at the statutory eligibility age. In cases where even the five-year waiting period for a regular old-age pension is not fulfilled, we consider at least the basic old-age support.

The "soft" eligibility rules are subject to discretionary decisions, notably the determination of a workers' disability status or the potential for a pre-retirement part-time agreement with an employer. These "soft" entry restrictions are implicitly factored in when weighing the four pathways against each other. This weighting also accounts for the distribution of observed retirement pathways within the society. For instance, even though retirement through unemployment is theoretically possible for all employees, this route is comparatively rare, possibly due to prevailing social norms.

In order to compute the expected retirement age and pension benefit we aggregate over the relevant pathways and weigh each pathway with the share by which it is actually chosen. These weights changed over time and are depicted in Figure 4.

Figure 4: Weights for Retirement Pathways



Source: Own calculation based on *Deutsche Rentenversicherung Bund, Rentenzugang* (see DRV, 2022).

We utilize official annual statistics (as provided by DRV 2022) on the distribution of pension receipts by pension type (e.g., pension due to unemployment, part-time employment prior to retirement, disability pension) to derive the weights. However, these statistics lack information regarding the

[22] SOEP includes the degree of severe disability of the individuals. We therefore know whether the health restrictions for the old-age pension for disabled are met.

income distribution, resulting in uniform weights for all income groups, which poses certain challenges. Unemployment, or rather involuntary non-self-induced unemployment, is more likely among lower income groups. Similarly, the likelihood of incapacity to work is also higher in these groups. This is especially relevant, if the increasing importance of health-related criteria for disability pension approval tends to exclude higher income groups, thereby altering the distribution of disability pension recipients across the income spectrum. For married couples, we adopt a similar approach to that for singles. This implies that the four retirement pathways are individually calculated for both partners. The calculation of the tax rate, however, requires considering joint assessment.

Furthermore, the inclusion of expected survivor pensions is important when calculating expected pension benefits. We add the survivor pension for the individual's partner to the individual's social security wealth. Survivor pensions are calculated for each pathway and each potential death date of the partner, conditional on survival of the individual, and aggregate over all death dates.

For singles, we compute social security wealth for each observed age, both when exiting the labor market immediately and when delaying exit by one more year. On the other hand, for couples, we consider four scenarios for labor market departure within the household. The first two encompasses the cases where both partners opt to exit in the observed year and where both partners decide to leave a year later. The remaining two involve one partner exiting immediately and the other partner exiting a year later, and vice versa. Finally, we aggregate over these scenarios (unweighted).

5. Retirement probabilities

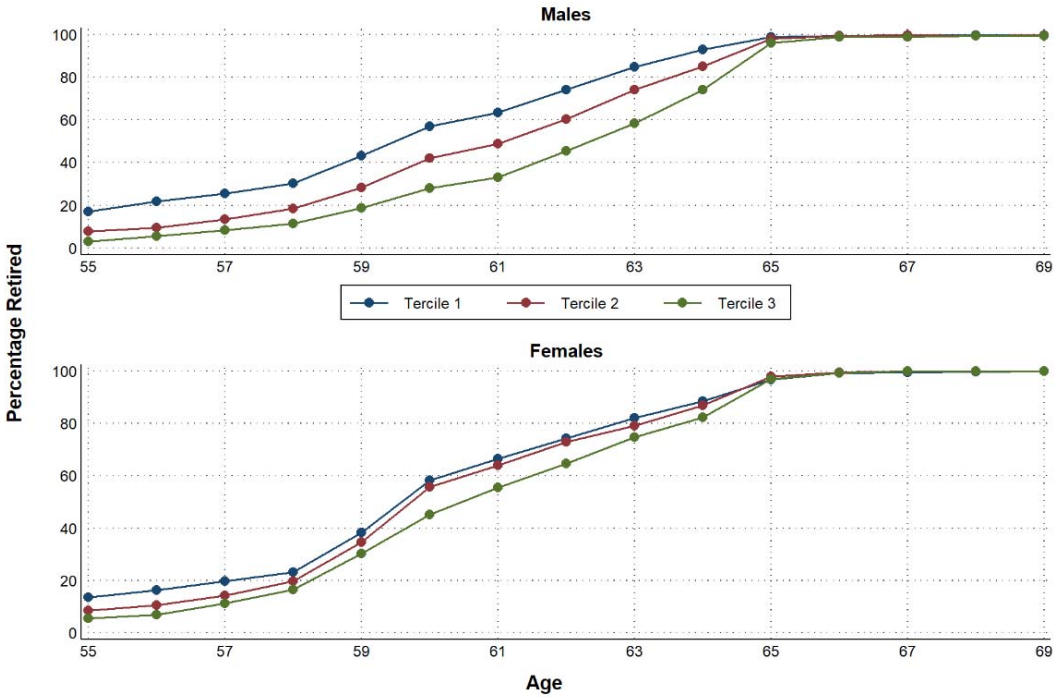
The effects of pension reforms on inequality are likely to depend on their effects on the retirement age, especially in the light of income-dependent life expectancies (Figure 3). An important ingredient of our simulation model is therefore a model to calculate retirement probabilities. While the design and the estimation of this model follows Börsch-Supan et al. (2023), our approach differs by extending beyond the consideration of the average worker only to include probabilities that are calculated for specific income groups.

5.1. Retirement probabilities in the sample

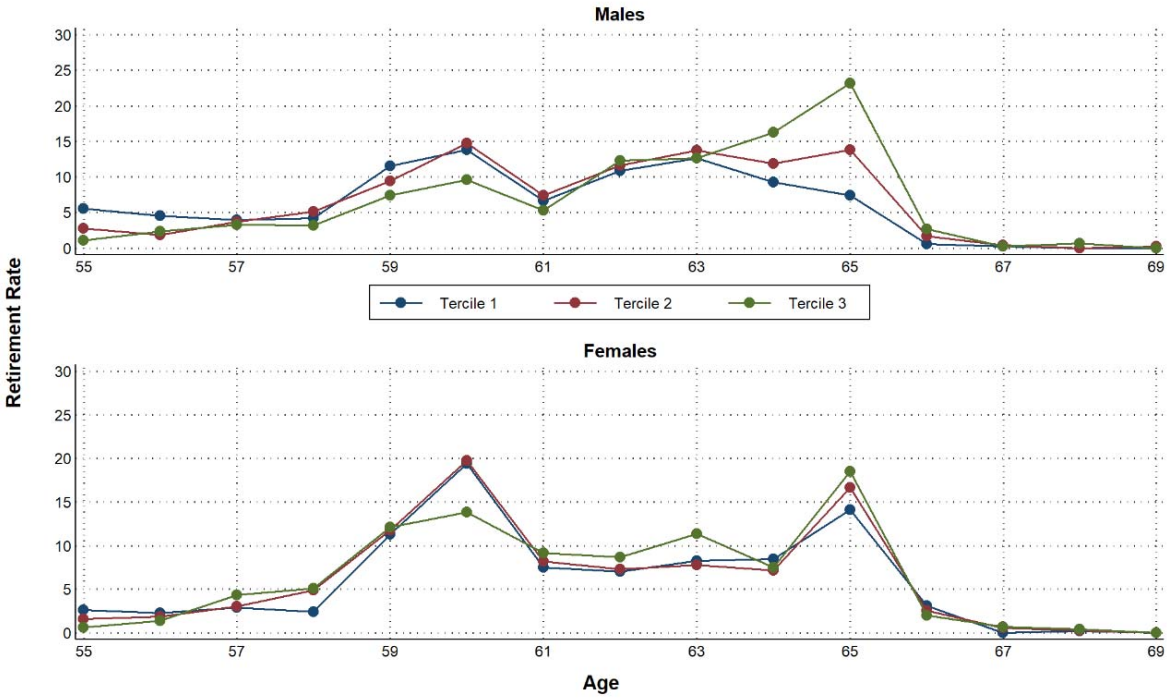
Before turning to our regression model, we first outline individuals' retirement patterns as observed within our SOEP sample. In Figure 5.A, we depict the share of individuals who *are retired* at a specific age. This includes individuals retiring at that precise age as well as those who retired at any earlier point. We show this share separately by gender and income terciles. Throughout the entire age range, the bottom tercile exhibits the highest percentage of individuals who are already retired, followed by the middle tercile, and the highest income tercile retiring the latest. At age 66, almost all individuals are retired. However, the differentiation between income groups is less pronounced for women.

Figure 5: Observed retirement behavior

A. Share being retired



B. Share retiring at a specific age



Note: Panel A shows the share of individuals who are already retired at a specific age, e.g. the point at age 63 shows the share of all individuals who are at most 63 years old and who are already retired. Panel B shows the share of individuals who retire at a specific age, i.e. the point at age 63 shows the share of individuals who are 63 years old and who retire at exactly that age.

Source: Own calculation based on SOEP v37.

Figure 5.B shows the share of individuals *retiring* at specific ages. Two distinct peaks emerge at ages 60, and 65, which correspond to different pension pathways becoming accessible. The spike at age 60 is more pronounced among women, while men tend to retire more evenly between ages 60 and 65. This difference could be attributed to the possibility for women to leave the labor force early at age 60, impacting the spike at that age positively and at subsequent ages negatively. Interestingly, there is no spike at age 63, which is when regular early retirement options become available.

The distinction between income terciles becomes less apparent in Figure 5.B. However, the spike at age 65 is most pronounced for men in the highest income tercile, while they retire substantially less often at age 60 compared to the other two income groups, which is also the case for women. Nonetheless, it is worth noting that even for men with high income we observe a small spike at age 60 and individuals retiring even before age 60.

5.2. The retirement model

Our outcome variable is labor force status in old-age. It takes the value 0 when the individual is in the labor force, and value 1 when she is retired. We consider retirement as an absorbing state, implying that individuals are kept in the regression sample only until their first observation in retirement. Subsequently, they are dropped from the sample.

Our main explanatory variable is the incentive variable *implicit tax on working longer (ITAX)*. ITAX describes how an individual's social security wealth would have changed if they were to retire immediately compared to retiring one year later. In the German context, delaying retirement by one year results in increased contributions to the pension system, thereby augmenting future benefits. This will have a positive effect, while, in contrast, receiving pension benefits for one year less has a negative effect on social security wealth. We divide the difference in individual's social security wealth between the scenario of retiring immediately and continuing to work for an additional year by its last income, which yields the implicit tax on working longer. [23]

Exogeneous variation is needed to causally estimate the retirement probabilities in dependence on financial incentives. Germany represents a particularly well-suited setting for this, as there were numerous reforms and minor changes of the pension system (as outlined in Section 2) that yield us exogenous shocks to the financial incentive variable.

Our analysis is based on a random effects probit model, as in Börsch-Supan et al. (2023). It follows the equation:

$$P(Y = 1|ITAX, \boldsymbol{X}) = \Phi(\beta_0 + \beta_1 * ITAX + \beta_2 * EEA + \beta_3 * SEA + \gamma' \boldsymbol{X})$$

In this equation, ITAX is our financial incentive variable, EEA is a dummy variable indicating whether the individual has reached their earliest eligibility age, and SEA is a dummy variable for reaching the

[23] For more details, see Börsch-Supan et al. (2023) chapter 4 and chapter 7.

statutory eligibility age. **X** is a vector of control variables that includes the independent variables: (1) Sum of earnings points, (2) number of children, (3) dummy for low education, (4) dummy for medium education, (5) ISCO code (1-digit classification of occupation), (6) health satisfaction, (7) a dummy for home ownership, (8) a dummy for working full-time, (9) a dummy whether the individual worked more years in Western than in Eastern Germany, and (10) age dummies. Finally, Φ represents the cumulative distribution function of the standard normal distribution.

Note that we do not differentiate for income groups here. We assume, that the effect of financial incentives on retirement probabilities is the same across the income terciles (i.e. β_1 is the same for the three groups). However, retirement probabilities do differ across income groups, because the financial incentives themselves differ.

5.3. Estimation results

Our main results are summarized in Table 4, where we report marginal effects for the explanatory variables of interest. We anticipate a positive sign for ITAX, as it can be understood as a tax on working – the higher this tax is, the greater we anticipate the probability of retirement to be.

Table 4: Marginal effects on the probability to retire

Regression results for couple & single households combined

	Males			**Females**		
	(1)	(2)	(3)	(1)	(2)	(3)
ITAX	0.069	0.090	0.075	0.077	0.053	0.035
P>|z|	0.000	0.000	0.000	0.000	0.000	0.016
Couple HH	0.039	0.026	0.024	0.007	0.004	0.005
P>|z|	0.095	0.000	0.001	0.231	0.683	0.598
Avg. EP	-0.026	-0.006	-0.006	-0.012	-0.003	-0.001
P>|z|	0.028	0.183	0.187	0.050	0.822	0.939
EEA (0/1)			0.075			0.114
P>|z|			0.000			0.038
SEA (0/1)			-0.012			-0.027
P>|z|			0.720			0.737
Age dummies	X	X	X	X	X	X
Controls		X	X		X	X
N. Observations	17,929	14,150	14,132	15,746	12,294	12,286

Source: Own calculation based on SOEP v37.

We present three models: (1) we include only ITAX, average earnings points, household type and age dummies, (2) we further include the control variables presented in Section 5.2, while adding dummies for reaching the eligibility age only in Model (3).

Our preferred specification is Model (3). Our findings reveal statistically significant effects of ITAX for women and men. For men, we estimate a coefficient of 0.075, implying that a 10 percentage points increase in ITAX would increase the probability of retirement by 0.75 percentage points. For women, we estimate an effect of roughly half the size. For them, such a ten percentage points increase in ITAX would imply an increased probability of retirement of 0.35 percentage points. However, while we find statistically highly significant effects for our financial incentives measure, its impact appears to be limited. This aligns with the findings described by Seibold (2021) for the German context. In contrast to financial incentives, reaching the earliest eligibility age has a substantial effect on the decision to retire. It increases the likelihood of retirement by 7.5 percentage points for men (statistically significant on the 1% level) and 11.4 percentage points for women (significant on the 5% level). Conversely, reaching the statutory eligibility age has no statistically significant effect.

6. Counterfactual analysis

The key instrument to detect causal effects of the reforms on income and wealth inequality are counterfactual simulations in which we predict how income and wealth had developed if these reforms had not taken place, compared to the actual development of income and wealth. We first illustrate how retirement probabilities were influenced by the change in financial incentives over the reform process and then proceed to examine the effect on individual's expected benefits and social security wealth. We present three scenarios that either differ in financial incentives or in retirement probabilities:

1. **With-reforms scenario**: This corresponds to the benefits and financial incentives with their associated retirement probabilities as they actually evolved over time, i.e., including all the reforms that were implemented since 1980 (Figure 2).
2. **Without-reforms scenario 1 (mechanical effect only)**: In this scenario, we compute the pension benefits as if the reforms shown in Figure 2 had never happened but take the observed retirement behavior as given. In other words, we ignore a potentially different retirement behavior that could have occurred in the absence of reforms.
3. **Without-reforms scenario 2 (total effect)**: In this scenario, we compute benefits *and* financial incentives as if the reforms had never happened. In other words, we also calculate counterfactual retirement probabilities that reflect retirement behavior in the absence of reforms.

We call the difference between (1) and (2) the **mechanical effect**. Here we are only interested in how benefits and social security wealth would have been if they were calculated under the old legislation but leave out behavioral responses to reforms. The difference between (1) and (3) is the **total effect**, including these behavioral responses. Considering that our estimates in Table 4 show a significant, but

small effect of ITAX on the probabilities to retire, we anticipate that the total reform effect is dominated by the mechanical effect. Note that only (1) is actually observed while (2) and (3) are counterfactual.

We proceed in three steps. First, we compute the applicable retirement probabilities. Second, we compute expected pension benefits. Finally, we calculate social security wealth.

6.1. Counterfactuals: Retirement probabilities

The first step is to show what the probability of retirement would have been, had there been no policy changes, or in other words, had the incentives to retire remained constant throughout our observation period. While we did this calculation already in Börsch-Supan et al. (2023), we run into cell size problems if we do the same when splitting the sample by three income groups. We therefore group birth years in 7 groups of roughly similar size. The groups are: (1) 1930-35, (2) 1936-38, (3), 1939-41, (4) 1942-44, (5) 1945-47, (6) 1948-50, and (7) 1951-53. Within these groups, retirement probabilities do not differ while they can be different across these groups.

Formally, we compute the average individual retirement probabilities by a labor force probability model of the following form:

$$LFP_{it}^{baseline} = f(ITAX_{it}(age_{it}, covariates_{it}), age_{it}, covariates_{it}) + \mu_{it}.$$

Here, i and t index individuals and year, respectively, LFP_{it} stands for labor force participation and μ_{it} is the error term.

For the without-reforms scenario, we apply the same model but replace ITAX and the statutory eligibility ages by the values that would have prevailed if the rules from t=0 (in our case 1984) remained constant between all years in 1984 and 2019. All other covariates, including the effect of age and other covariates in the incentive variables, are kept at their actual and changing value. This way, we remove the changes due to policy reforms but acknowledge all other changes. This leads to the following equation for the counterfactuals:

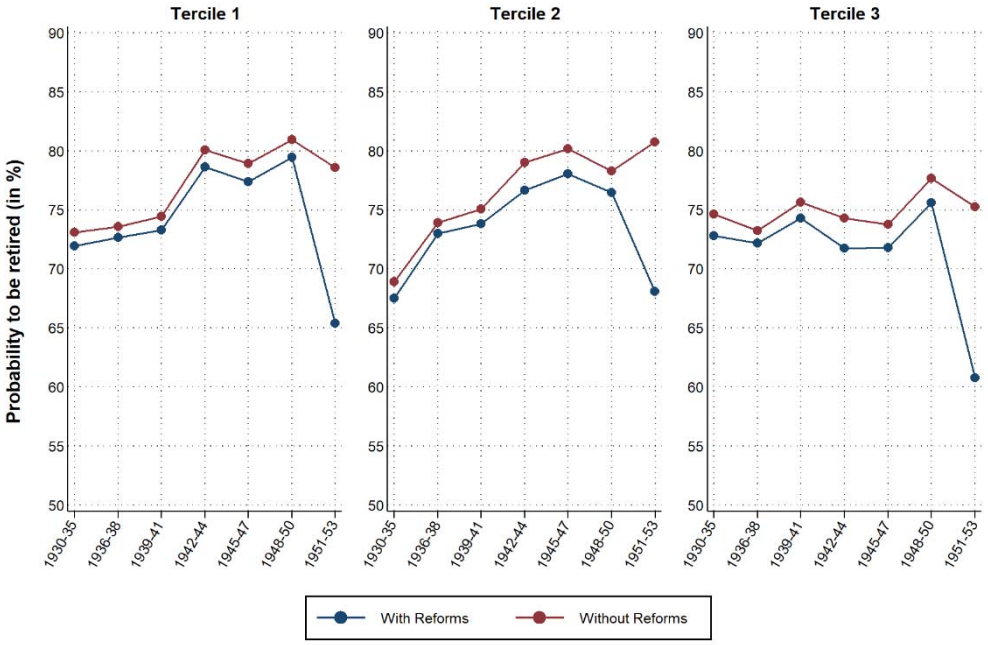
$$LFP_{it}^{counterfactual} = f(ITAX_{i0}(age_{it}, covariates_{it}), age_{it}, covariates_{it}) + \mu_{it}.$$

All calculations are based on our preferred specification which includes both age dummies and a set of control variables. We perform regressions separately for each income tercile.

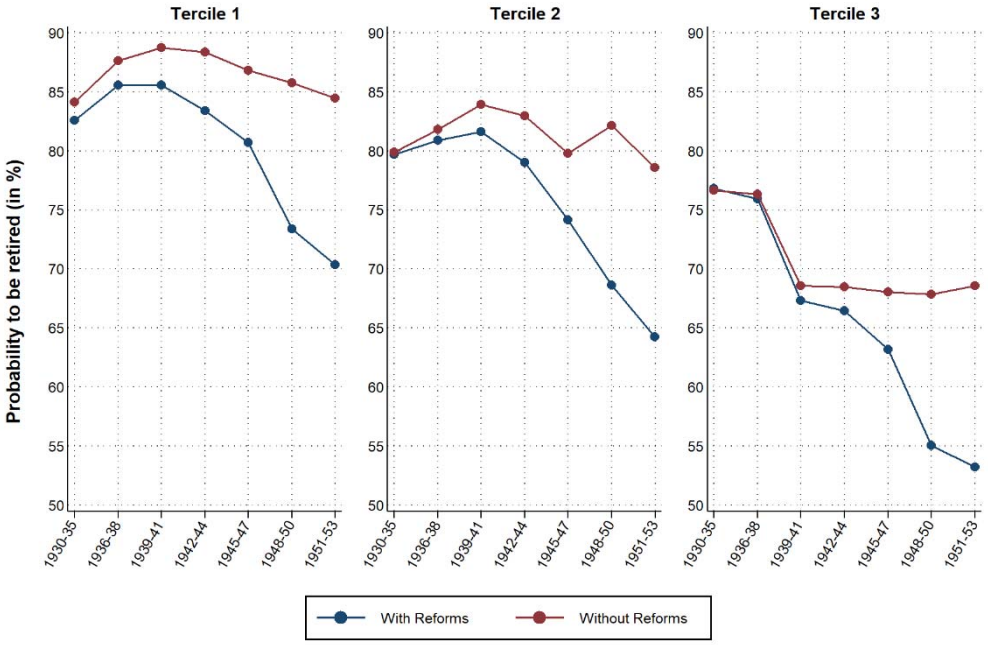
In Figure 6, we present the probability to be retired by age 64 for the three income groups, separately for men and women. We avoid using age 65, as it represents the statutory eligibility age for most individuals in our sample. The graph shows the with-reforms scenario in blue, i.e. the retirement probability predictions with the observed financial incentives and eligibility ages. The without-reforms scenario, i.e. the predictions if financial incentives and eligibility ages remained unchanged, is depicted in red.

Figure 6: Probability to be retired at age 55-64, baseline and counterfactual

A. Women



B. Men



Source: Own calculation based on SOEP v37.

In the without-reforms scenario, we observe that for women, the probability of being retired by age 64 shows an upward trend across birth years. In the lowest tercile, the probability slightly increased from

above 72.5% to 75% until the birth-year group 1939-41. Subsequently, it jumped up to 80% and remained constant at that level. Similarly, for the middle tercile, there is a consistent trend starting from slightly below 70% for the first cohort group (1930-35) up to nearly 80% for the 1942-44 cohort, after which it stabilized. Conversely, for women in the top tercile, retirement probabilities consistently hover around 75%, approximately five percentage points lower than those in the bottom two terciles for younger cohorts.

For men born between 1930 and 1935, the probability of being retired by age 64 is approximately 85% in the bottom tercile and 80% in the middle tercile. Subsequently, the probability increased to around 89%/84% (bottom/middle tercile) up to the 1939-41 cohorts. Then it decreased again to around the starting values. In the top tercile, this probability is around 75% for the two oldest cohorts, but decreases then to around 68% from the 1939-41 cohorts onwards. Hence, individuals in the top tercile are consistently less likely to be retired by age 64, and there appears to be no strong cohort trend in any of the income terciles.

In the with-reforms scenario, the probabilities to be retired by the age of 64 are consistently lower across all terciles for men. Initially, the difference is relatively small for the first tercile and negligible for the middle and upper terciles. However, this gap gradually widens, and especially so starting from the 1945-47 cohorts, where the retirement probabilities are sharply decreasing in the with-reforms scenario. For instance, compared to the cohort group 1939-41, probabilities in the 1951-53 cohort are approximately 15 percentage points lower. The starting point of the strong decrease coincides with the stepwise increase of the eligibility age of the old-age pension because of unemployment from 60 to 63 for the cohorts 1946 to 1948, followed by its complete abolishment for the cohorts born in 1952 and later, as well as the introduction of actuarial adjustments. The most substantial decrease can be found in the middle tercile. In general, differences in the retirement probability can be attributed to the effects from changing financial incentives (for all cohorts) and to increases in the earliest eligibility age (especially for younger cohorts).

For women, we observe consistently lower retirement probabilities of approximately 1-2 percentage points for all cohort groups up to 1948-50. This trend can be explained by the effect of ITAX on the retirement probability. However, the most noticeable difference between the with-reforms and the without-reforms scenarios is observed for the youngest cohort group, born between 1951 and 1953. In this group, retirement probabilities decrease by almost 15 percentage points in the bottom and top terciles and by approximately 10 percentage points in the middle tercile. This sharp drop coincides with the abolishment of the old-age pension for women whose requirements were, compared to other early retirement opportunities, more easily to fulfil and enabled women to retire at the age of 60.

6.2. Counterfactuals: Expected pension benefits

In Step 2, we compute the expected pension benefits of individuals before and after the pension reforms. First, we compute average pension benefits for individuals leaving the labor market at a specific year t, a specific age a, separately by income terciles k and gender s. This follows the equation:

$$\overline{benefits_{a,t}}(k,s) = \frac{\sum_{pid=i}^{I} benefits_{i,a,t}(k,s)}{N_{a,t}(k,s)},$$

with $N_{a,t}(k,s)$ denotes the number of individuals observed at age a in year t.

Subsequently, we use the retirement probabilities derived in Section 5, categorized by age, gender, income, and cohort group. By multiplying the potential benefits at a specific age a by the probability of retiring at that age, we obtain a weighted measure. Summing across all ages of a cohort provides the expected benefits for the income group. This can be represented by the equation:

$$E\left(\overline{benefits_c}(k,s)\right) = \sum_{a=55}^{69} (\overline{benefits_{a,a+c}}(k,s) \times \overline{ret.prob_{a,c}}(k,s)).$$

Here, $\overline{ret.prob_{a,c}}(k,s)$ describes the average retirement probability at a specific age a and cohort c (based on cohorts-groups).

Figure 7 shows the results of these counterfactual analysis graphically, separately for men and women. The blue lines show pension benefits in the with-reforms scenario, i.e. with today's benefit legislation and predicted retirement probabilities, which incorporate the effects of reforms. The without-reforms scenario 1, i.e. if *only* the benefit calculation had remained unchanged, but probabilities would adjust to the financial incentives (just as in the with-reforms scenario), is depicted in red. Lastly, the green line illustrates the without-reforms scenario 2 in which both, benefit calculation and computation of the probabilities are performed as there were no reforms. All lines are presented with their actual values and a smoothing function, as our sample size results in relatively volatile lines. Benefits are reported on an annual basis and are adjusted for inflation, showing 2023 price levels.

In Figure 7.A, when examining women in the lowest income tercile, we observe relatively constant expected benefits in the with-reforms scenario across all birth cohorts of around 7,000€. For those in the middle tercile, expected benefits show an increasing trend with each later birth year. Starting at around 6,000€ for cohorts born shortly after 1930, benefits rise to roughly 10,000€ for cohorts born in the mid-1940s and remain stable thereafter. The initially lower values observed in the middle tercile are likely attributed to women from older cohorts, who often have lower personal entitlements, are nevertheless assigned to higher income groups due to their spouse's entitlements. As we are observing relatively few women in the top tercile, we refrain from interpreting their expected benefits, as the calculated values seem to suffer from the sample size. However, there appears to be a positive relationship with birth year, and the benefits are at least comparable in magnitude to those of the middle tercile.

The disparities across income groups are more pronounced for men (see Figure 7.B. and note the larger scale in that panel). Men in the bottom tercile experienced first an increase in their expected benefits from initially ca. 10,000€ (1930 cohort) to ca. 12,000€ (cohort 1936). Afterwards it decreased gradually to about 9,000€ for those born in the 1950s. For men in the middle tercile, benefits remain on a relatively constant level of approximately 15,000€, with slightly higher expected benefits for older cohorts compared to those born from the 1940s onwards. In the top tercile, expected benefits increase over time for cohorts up to the 1940s, from initially ca. 18,000€ (1930 cohort) to 25,000€ (1935 and later cohorts). However, for individuals born after 1950, expected benefits decrease to around 20,000€.

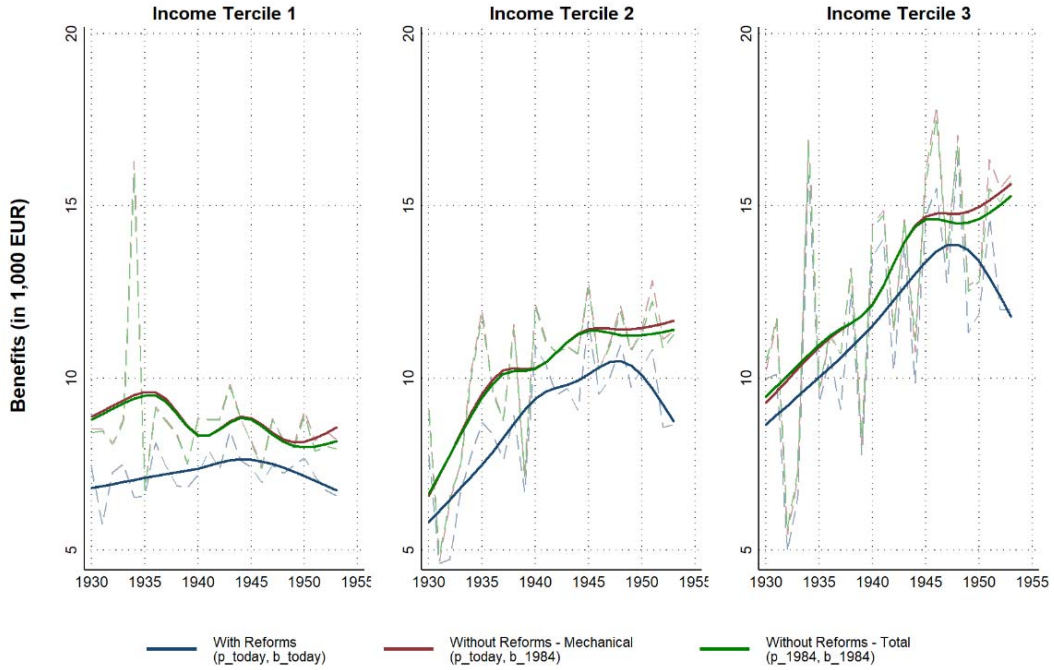
Analyzing the difference between the blue and the green line reveals the **total effect**. For most cohorts, the without-reforms scenario 2 is simply shifted upwards for all terciles and both genders, while the trend itself basically follows the with-reforms scenario. One reason for the upward shift is that in the without-reforms case higher pensions are assumed due to the indexation of the pension value with the gross wage growth while in reality the adjustment was reduced after 1992 (see Section 2.3). Another reason is the replacement of the 1973-Low-EP-Upgrade mechanism by the 1992-Low-EP-Upgrade scheme. In scenarios without reforms, the 1992 regulation is not included such that the 1973-mechanism persists beyond 1992. Due to its eligibility criteria being less stringent and more generous adjustment of earnings points (see Section 2.3), not accounting for its replacement appears to result in higher pensions, particularly for older cohorts. This aspect will be further elaborated in Section 7, where we analyze the isolated impact of some reforms. It is important to note that in our calculations, pensions cannot fall below the social assistance level. Therefore, reforms could have an even more pronounced impact, especially for the bottom tercile, if lower pensions are compensated by increased receipt of social assistance.[24] Calculations excluding social assistance reveal a larger disparity for women in the bottom tercile, while for all other groups, the significance of social assistance appears negligible.

There are, moreover, some differences in the general trend for the youngest cohorts: With exception of the two bottom terciles among men, expected benefits decrease much stronger in the with-reforms scenario than in the two scenarios without reforms. For the two remaining income groups, the gap only slightly widens. The increasing discrepancy between the scenarios could be attributed to the pension reforms described earlier, which had a more pronounced impact on younger cohorts due to their greater exposure to the new legislations.

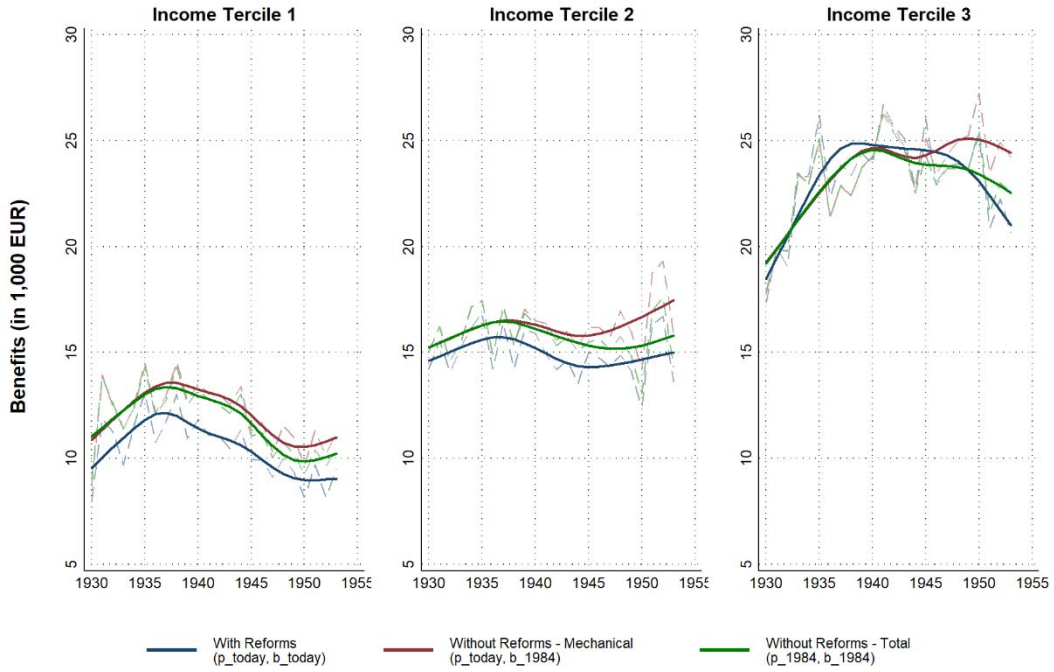
[24] The introduction of pension allowances in the social assistance calculation counteracts this, as the allowance itself depends on the pension amount. However, since the allowance was introduced beyond our observation period, its impact is not factored into our analysis.

Figure 7: Counterfactuals, expected benefits

A. Women



B. Men



Note: In the with-reforms scenario (blue line), we calculate benefits with today's benefit legislation and today's predicted retirement probabilities. In the without-reforms scenario 1 (red line), we use the benefit legislation from 1984 but take retirement probabilities as we predict them in the with-reforms scenario. Finally, in the without-reforms scenario 2 (green line) benefit calculation and computation of the probabilities are performed as there were no reforms.

Source: Own calculation based on SOEP v37.

The difference between the blue and the red line yields the **mechanical effect**. Arguably more interesting is the difference between the red and the green line, which sheds light on the **behavioral responses** to the reforms. These two lines are based on identical benefit calculation legislation but differ only in the retirement probabilities at specific ages and cohorts (based on cohort groups). Hence, it shows how much more benefits individuals would receive under the old legislation if retirement behavior was the same as under today's legislation. We find that for women there is only a rather small effect stemming from behavioral changes. The only difference that can be observed between the red and the green line in Figure 7.A. is for the youngest cohorts, and especially so in the top tercile. By retiring later (as we observed in Figure 6), these women increase their expected benefits.

For men, this effect is stronger. In all three terciles, we observe that there is a positive effect from the behavioral changes on expected benefits, particularly for younger cohorts. The effect is especially strong for men in the two upper terciles, and applies more to cohorts that were affected by increasing eligibility ages.

To provide a clearer view on income group differences, Figure 8 aggregates expected benefits across all cohorts. By reducing this dimension, we can now show expected benefits by income *deciles* instead of only *terciles*. The graph illustrates that for women, expected benefits in the with-reforms scenario are consistently lower than in the without-reforms scenarios across all income deciles. While the absolute difference is slightly increasing over the deciles (from 1,100€ in the 1st to 1,500€ in the 10th decile), the relative impact is stronger on those in the bottom deciles (-14% in the 1st decile, -12.9% in the 5th decile, -9.2% in the 10th decile). For men, we even find that the absolute difference decreases in income, and that in relative terms, the bottom decile loses 15% of expected benefits while the top income groups are unaffected.

Without social assistance income, the absolute and relative difference between the with-reforms scenario and without-reforms scenario is even more pronounced for individuals in the bottom tercile. Additionally, it is noteworthy that there appears to be only a small behavioral effect across all income groups for women, and also for men is the behavioral effect not particularly strong.[25]

6.3. Counterfactuals: Expected social security wealth

Although social security wealth is constructed from benefits[26], there is an additional feature which makes it worthwhile to examine social security wealth separately: It is not only affected by the size of benefits but also by life expectancy. Postponing retirement might have a negative impact on SSW due to a shorter

[25] As shown in Figure 7.A, the behavioral effect only emerges for young cohorts. Since we aggregate over all cohorts here, we average these effects and observe this relatively small effect in Figure 8. The same holds true for the strong drop in expected benefits that we observed among top tercile men in Figure 7.B. Averaging over all other cohorts, lets this trend disappear.

[26] Social security wealth is a product of benefits and years these benefits are received. We discount payments in the future by 3% for each year of distance. SSW values can thus be interpreted in today's values.

duration during which benefits can be claimed. Simultaneously, benefits generally increase by delaying retirement. Which of these two effects on SSW dominates, is a priori unclear.

In Figure 9, we present both the with-reforms and without-reforms scenarios for expected SSW, following the same approach used for expected benefits. In the with-reforms scenario, the pattern of SSW for women (Figure 9.A) resembles what we observed in Figure 7.A for expected benefits. In the bottom income tercile, expected SSW stays relatively constant at around 150,000€ with a slightly increasing trend to 160,000€. For women in the middle tercile, we observe an increasing trend, starting at around 150,000€ for those born in 1930 to ca. 225,000€ for those born in the 1950s. In the highest tercile, calculation of expected SSW is again more imprecise but shows an increasing trend, climbing up to around 280,000€ for the youngest cohorts.

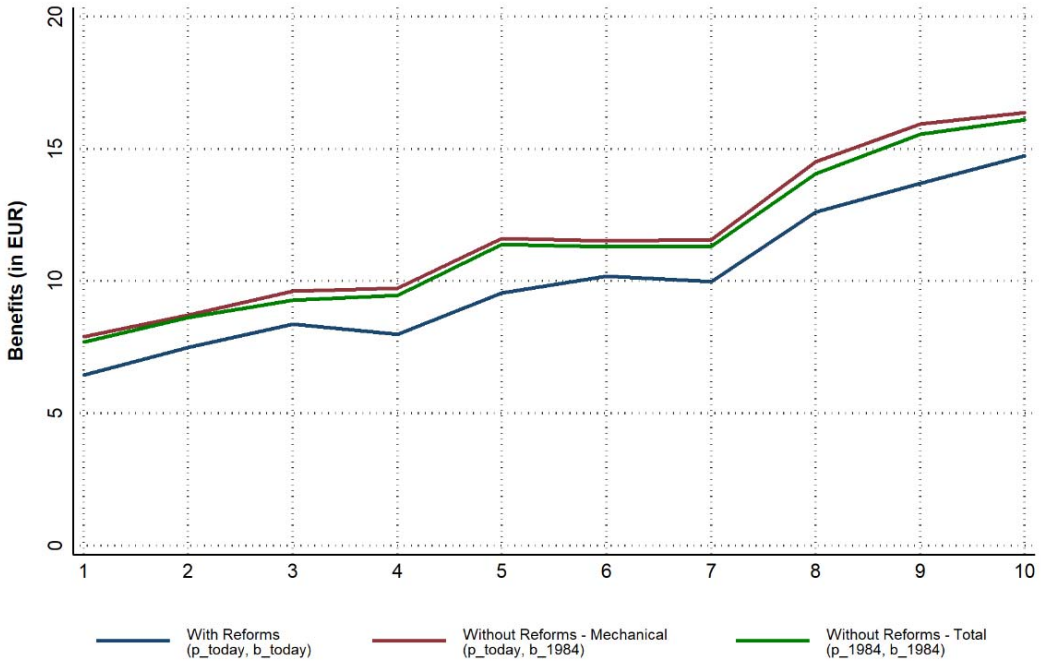
For men (Figure 9.B), the relationship between expected benefits and expected SSW also appears strong. In the bottom income tercile, SSW decreases from roughly 200,000€ (for individuals born in 1935) to 150,000€ (for individuals born in the mid-1940s and later). The pattern closely resembles that in Figure 7.B. Similarly, for men in the middle tercile, we observe a relatively constant SSW of around 250,000€ for almost all cohorts. For men in the top tercile, SSW increases from around 325,000€ to 400,000€ between the 1930 and 1935 cohorts and remains constant thereafter. The substantial drop in benefits that we observed for cohorts born after 1950 is less pronounced for SSW.

Turning to the without-reforms scenarios, it becomes evident that at first sight the behavioral effect does not play a large role for SSW. The behavioral effect was more visible when we analyzed benefits; the reason is that individuals gain benefits by working longer, but they receive this pension for a shorter time. SSW in the absence of reforms remains nearly the same, regardless of whether we use retirement probabilities as we predict them to be today or as we would have predicted them for the pre-reforms time. This is the case across all income terciles and for both genders.

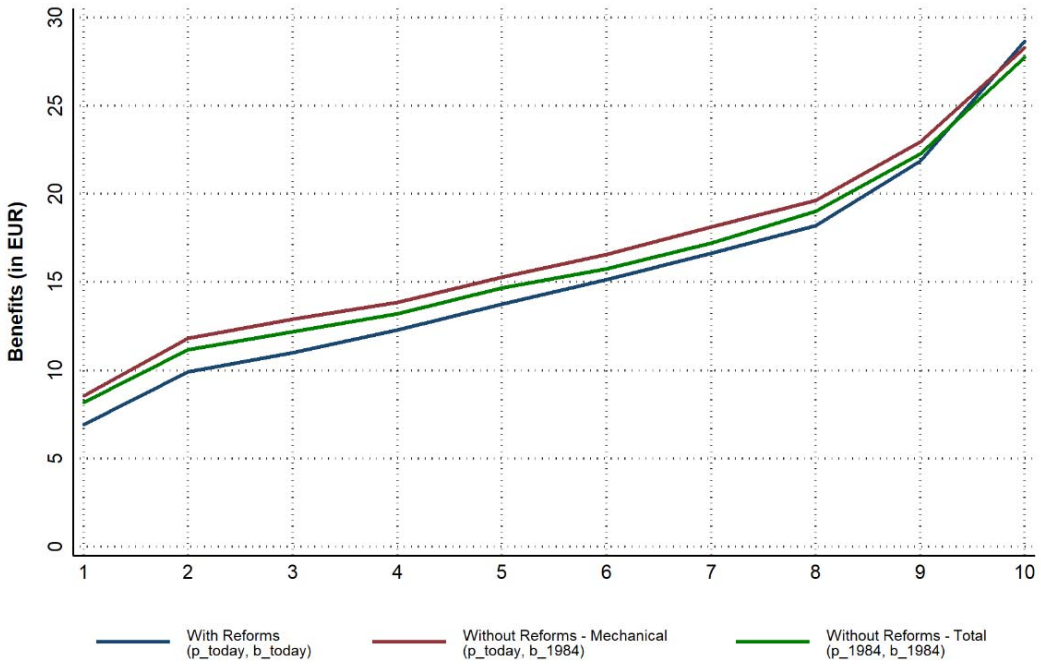
The without-reforms scenario 2 closely aligns with the with-reforms scenario for older cohorts in the upper two terciles, as a greater portion of the working lives was unaffected by the considered reforms if individuals are born earlier. The differences observed are, among other things, attributed to the more generous pension indexation in the without-reforms scenario. In the bottom tercile, the differences in the SSW of the oldest cohorts are even more pronounced between the without-reforms and with-reforms scenarios. These larger deviations can be explained, on the one hand, by differences in the politically motivated changes of the pension indexation rules since 1984 and on the other hand by the implementation of the 1992-Low-EP-Upgrade mechanism, as we will further see in Section 7.

Figure 8: Counterfactuals, expected benefits over ALTE groups

A. Women



B. Men

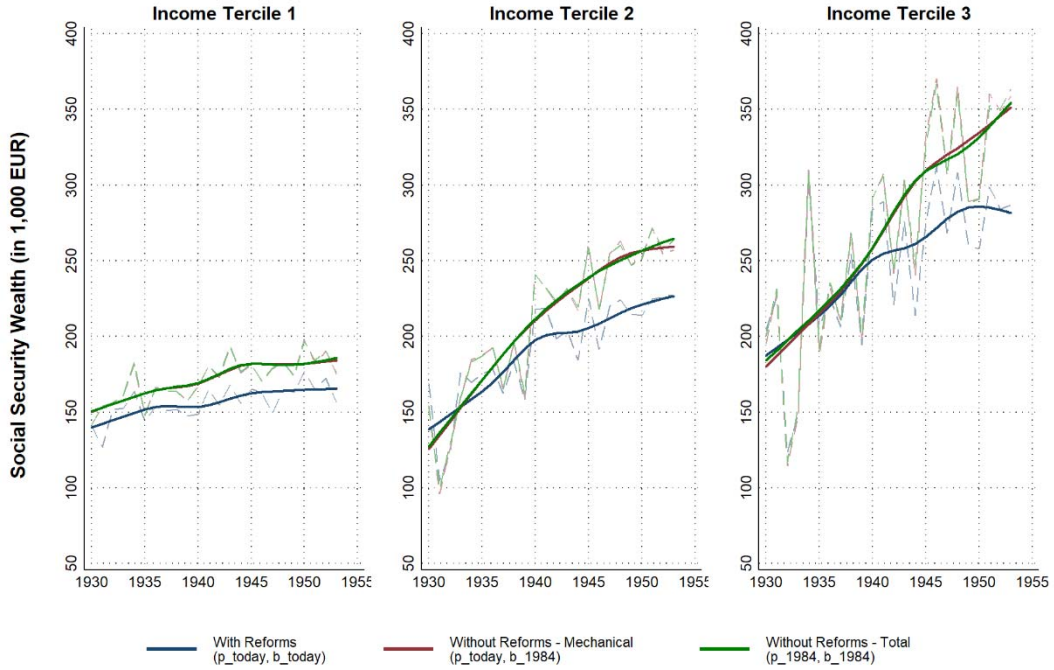


Note: In the with-reforms scenario (blue line), we calculate benefits with today's benefit legislation and today's predicted retirement probabilities. In the without-reforms scenario 1 (red line), we use the benefit legislation from 1984 but take retirement probabilities as we predict them in the with-reforms scenario. Finally, in the without-reforms scenario 2 (green line) benefit calculation and computation of the probabilities are performed as there were no reforms.

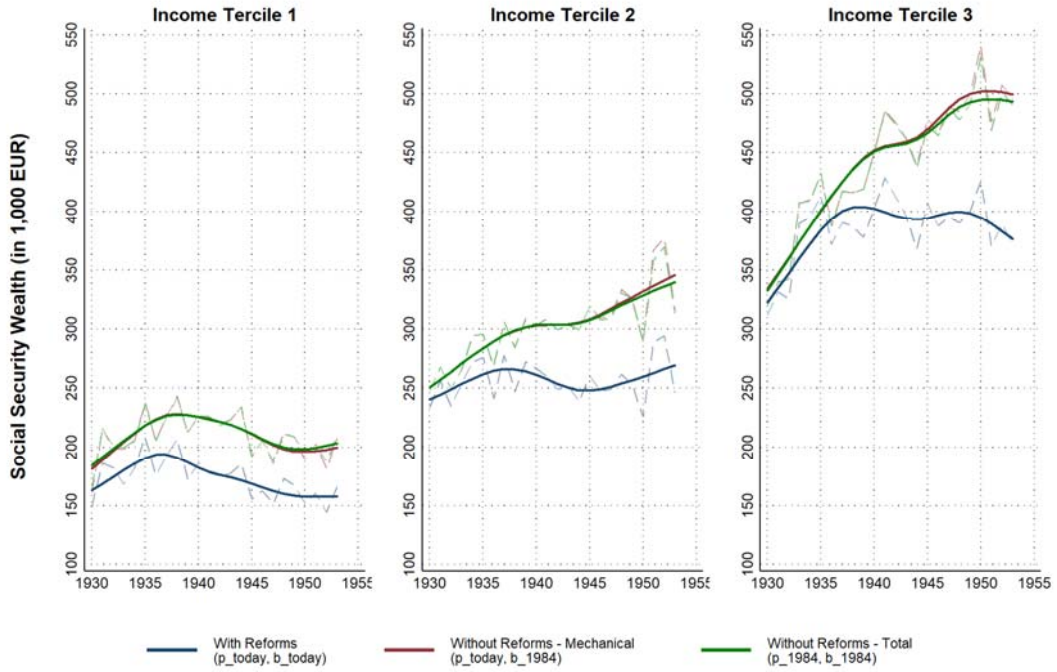
Source: Own calculation based on SOEP v37.

Figure 9: Counterfactuals, expected SSW

A. Women



B. Men



Note: In the with-reforms scenario (blue line), we calculate SSW with today's benefit legislation and today's predicted retirement probabilities. In the without-reforms scenario 1 (red line), we use the benefit legislation from 1984 but take retirement probabilities as we predict them in the with-reforms scenario. Finally, in the without-reforms scenario 2 (green line) benefit calculation and computation of the probabilities are performed as there were no reforms.

Source: Own calculation based on SOEP v37.

While this is consistent with our observations for expected pension benefits, in contrast, we observe a much more pronounced increase in the difference between the without-reforms scenario 2 and the with-reforms scenario for all income terciles as cohorts are born later. For women, this trend begins with the 1940 cohort, while for men already with the 1935 cohort. The increasing divergence between the with-reforms and without-reforms scenarios can be attributed to several factors. One is the introduction of actuarial adjustments for these cohorts, which we will discuss further in Section 7. Yet, the most significant influence stems from variations in pension indexation rules.

In the scenarios absent of reforms, SSW calculations are based on a pension adjustment that mirrors gross wage growth. In contrast, in the scenario with reforms, SSW is based on actual pension adjustments applicable in the year of calculation. These adjustments were altered by some reforms over time, initially by shifting the adjustment basis from gross to net wages and subsequently by introducing a sustainability factor (as described in Section 2.3). These changes made the pension adjustments less generous in response to wage growth, leading to a more pronounced divergence in SSW between the two scenarios, especially for cohorts born later. Expected future pension adjustments were particularly reduced by the sustainability factor, as it was introduced to evenly divide the pressure of the rising life expectancy and the coming retirement entries of individuals from the baby boomer generation on the pension finances between pensioners and contributors. The fact that the pension differences will be greater in the future also explains why differences between the scenarios are smaller when looking at the expected benefits shown in Figure 7, as benefits at retirement entry do not take the future development into account.[27]

To provide an overview of the differences, we display the absolute difference between the without-reforms scenario 2 (old legislation *and* according retirement probabilities) and the with-reforms scenario for the cohort born in 1950 in Table 5. For women (Table 5.A), we observe the smallest relative difference in the bottom tercile, where the reforms reduced social security wealth by approximately 17,250€ (-9.5%), based on the smoothed lines in Figure 9. Females in the middle tercile have around 36,000€ less (-14.1%). Those in the top tercile experienced a in relative terms similar reduction to the middle tercile of about 50,000€ (-14.9%). In the case of men (Table 5.B), reforms affected all terciles roughly the same. All three terciles lost between 20.3% to 20.9% of SSW as a consequence of the reforms.

We further provide numerical insights into the extent to which the total effect is shaped by the mechanical and behavioral effects. Across all three income terciles, and as observed in the figures, the effect is primarily driven by the mechanical effect. For women born in 1950, we observe that for the bottom two terciles the behavioral effect goes in the same direction as the mechanical effect, i.e., it

[27] It is important to note that the pension adjustment rules have also been changed for already retired individuals. Their computed SSW, which was calculated for the legal situation before their retirement, are therefore overestimated as the reforms occurring after their retirement also reduced their pension adjustment. This overestimation represents in the end the reduction in the generosity of the pension system.

decreases expected SSW. However, the magnitude of the behavioral effect for women in these income groups is very small. Conversely, for women in the top tercile, the behavioral effect is the strongest and works in the opposite direction of the total change; it increases SSW by 4.9% of the total effect. For men, we observe that only individuals in the bottom tercile experienced a loss in SSW in response to their adjusted retirement behavior after reforms. The effect amounts to 5.8% of the total effect. In the other two terciles, the behavioral effect is positive: For the top tercile it increases SSW by 6,686€ (reducing the negative total effect by 6.7%). The findings from Table 5 are also summarized in Figure 10.

Table 5: Effect on Social Security Wealth, cohort 1950

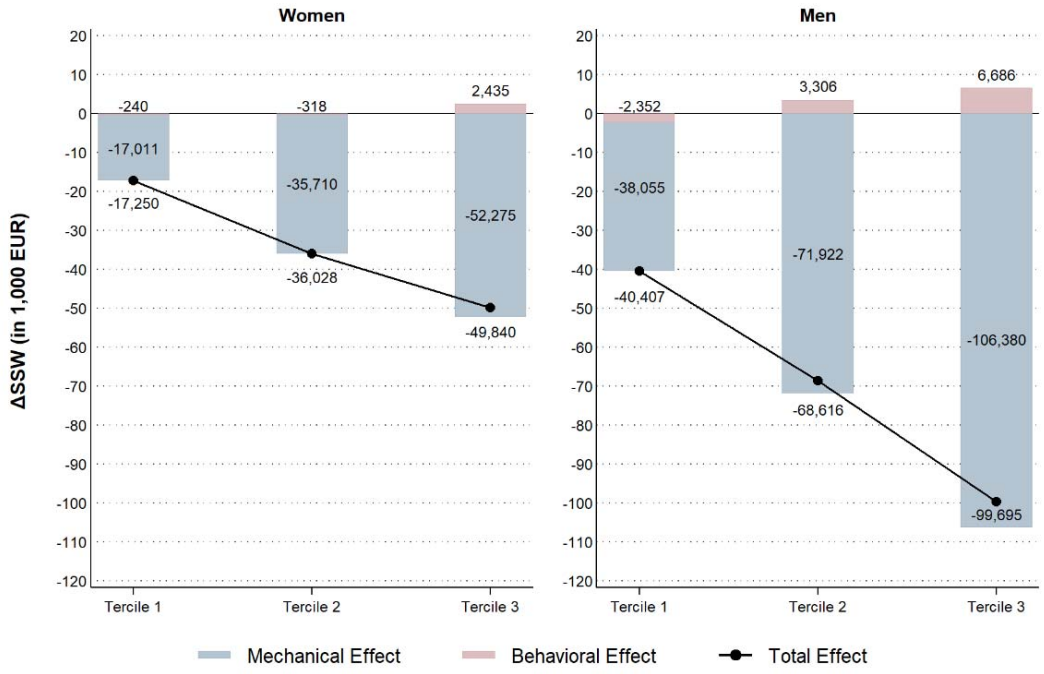
	Before Reforms	After Reforms	Change		Mechanical Effect		Behavioral Effect	
	(A)	(B)	(C)=(B)-(A)	(C)/(A) %	(D)	(D)/(C) %	(E)	(E)/(C) %
A. Women								
All	255,361	221,301	-34,060	[-13.3]	-34,617	[101.6]	557	[-1.6]
1st Tercile	181,301	164,050	-17,250	[-9.5]	-17,011	[98.6]	-240	[1.4]
2nd Tercile	255,106	219,078	-36,028	[-14.1]	-35,710	[99.1]	-318	[0.9]
3rd Tercile	334,568	284,728	-49,840	[-14.9]	-52,275	[104.9]	2,435	[-4.9]
B. Men								
All	347,728	277,127	-70,601	[-20.3]	-74,449	[105.5]	3,848	[-5.5]
1st Tercile	198,519	158,112	-40,407	[-20.4]	-38,055	[94.2]	-2,352	[5.8]
2nd Tercile	328,017	259,401	-68,616	[-20.9]	-71,922	[104.8]	3,306	[-4.8]
3rd Tercile	490,234	390,539	-99,695	[-20.3]	-106,380	[106.7]	6,686	[-6.7]

Source: Own calculation based on SOEP v37.

In Figure 11, we once again divide the sample by income deciles, aggregating all cohorts together. As in the previous analysis, we find that for women in the with-reforms scenario expected SSW is consistently lower than in the without-reforms scenarios across all income groups. In contrast to expected benefits, not only does the absolute difference increase with income, but also the relative difference increases (-8.0% in the 1st decile, -9.9% in the 5th decile, -12.7% in the 10th decile). This difference likely arises from differential life-expectancy: Although benefits decrease less strongly for women in the top tercile, they experience this reduction over a longer period. For the lower deciles, the difference is also smaller as reductions in future pensions benefits are irrelevant for people who are dependent on social assistance and limited for people with a pension slightly above the social assistance

level.[28] That we do not observe the same difference between the deciles in the expected benefits can be attributed to the reforms to the pension adjustment formula, which effectively reduced future rather than current pension benefits.

Figure 10: Effect on Social Security Wealth, cohort 1950



Note: The graph shows absolute changes in SSW due to the reform for the 1950 cohort, as they are also reported in Table 5. The black line reports the total effect of the reforms, while the blue bar shows the effect coming from the mechanical side (i.e. only the benefit legislation changes), and the red bar the effect coming from the behavioral side (i.e., the change in SSW that comes from changed retirement probabilities).

Source: Own calculation based on SOEP v37.

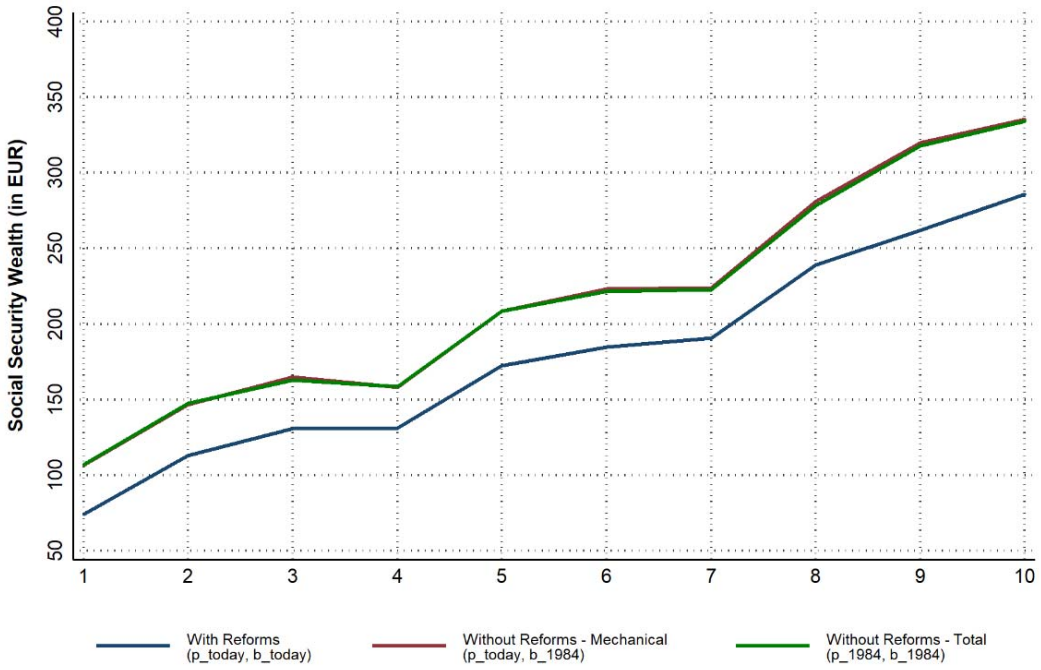
For men, the picture is different. Individuals in the 1st decile lose 17.0%, those in the 5th decile 15.9% and those in the top decile 15.5%. Thus, while women's SSW is particularly affected in higher income groups by the reforms, there is no substantial difference for men, and if anything, lower income groups experience a greater loss in SSW relative to their income level.

The difference between women and men can be attributed to more pronounced differences in expected benefits. This could be due to an effect stemming from social assistance, which is more often claimed by women than by men and might have provided additional support for women in the lowest income groups. However, it is important to note that this also implies that many women in these groups have their SSW reduced to a level where they depend on social assistance income, which is close to the minimum living standard.

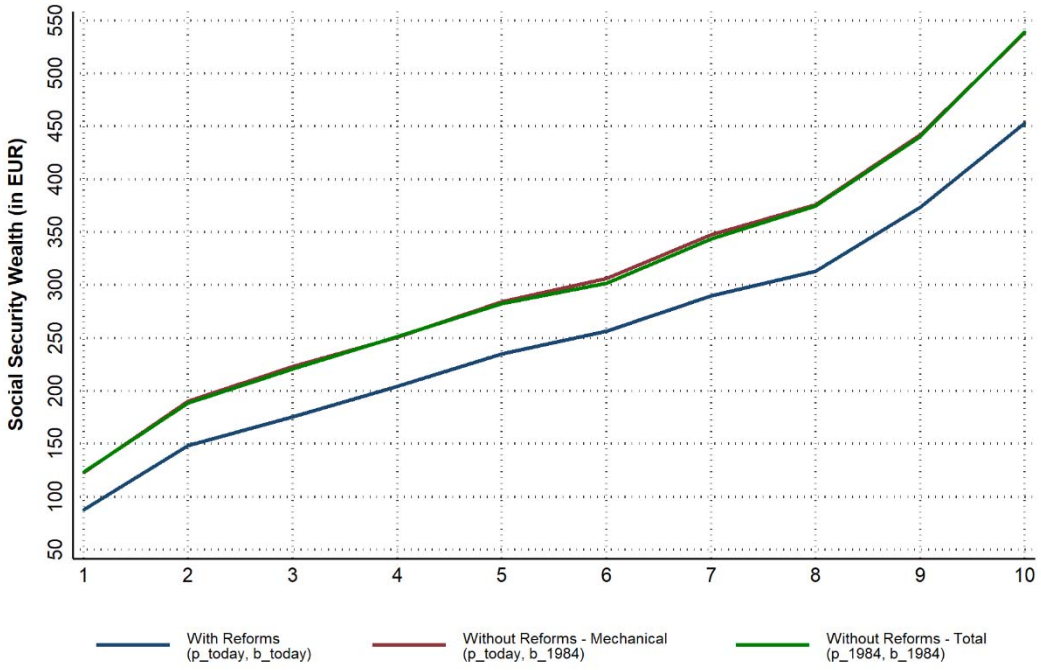
[28] This changed slightly with the introduction of pension allowances on social assistance in 2021.

Figure 11: Counterfactuals, expected SSW over ALTE groups

A. Women



B. Men



Note: In the with-reforms scenario (blue line), we calculate benefits with today's benefit legislation and today's predicted retirement probabilities. In the without-reforms scenario 1 (red line), we use the benefit legislation from 1984 but take retirement probabilities as we predict them in the with-reforms scenario. Finally, in the without-reforms scenario 2 (green line) benefit calculation and computation of the probabilities are performed as there were no reforms.

Source: Own calculation based on SOEP v37.

7. Reform scenarios

In this section, we utilize our model's capability to selectively activate or deactivate specific reform elements or certain assumptions made in the computation to examine the effects coming from these reforms. Additionally, we want to investigate the extent to which the effects on inequality are influenced by allowing for differential life expectancy for income groups.

We argued in Section 3 that there were a couple of reforms that may have affected inequality. To better understand the individual impact of each reform, we isolate their effects. We do this by keeping the baseline case (with reforms, probabilities and benefits how they were observed in a specific year) and compare this to a counterfactual scenario where we retain all other factors from the baseline but deactivate specific reforms. The five scenarios which we consider are:

(1) **Deferred taxation:** This scenario involves the introduction of deferred taxation in 2005. We anticipate an increasing effect on inequality in SSW, as this should affect particularly benefits of individuals in the top tercile.

(2) **1992-Low-EP-Upgrade:** Here we assess the consequences of the mechanism introduced in 1992 to upgrade low earnings points. For this purpose, its introduction is suspended. Instead, the old scheme of 1973 remains in place, which had laxer eligibility requirements, but only revalued pension entitlements acquired before 1973. Consequently, this reform scenario measures the difference between the two mechanism that were designed to upgrade low earnings points.

(3) **1973-Low-EP-Upgrade**: In addition to the previous scenario, we want to analyze the combined effect of both regulations on the revaluation of low pensions. Therefore, we compute pension benefits without both the 1992 and the 1973 revaluation mechanisms.

(4) **The introduction of deductions and changes in retirement ages:** More ambiguous than the previous scenarios is the stepwise introduction of deductions. On the one side, it might have decreased inequality if, relatively to other income groups, individuals with little income retired later. This might be the case because this group tends to retire earlier. On the other hand, it might increase inequality if retirement behavior of the lower-income group was less affected, and the resulting deductions decrease their benefits. However, as the effect of the deductions relies on the distance to the statutory eligibility age, we additionally have to consider changes in that age. This also involves the abolishment of the pension for women and the pension because of unemployment, which increased the earliest eligibility age substantially, which in turn increases the maximum deductions a person could face on their pension.

(5) **Changes to the indexation of pensions benefits:** In our final scenario, we examine the impact of modifications to the pension adjustment formula that indexes benefits to wages. We focus specifically on the change from gross to net wage adjustment and two modifications that introduce elements of demographic change, namely the so-called *"Riester-Treppe"* and the

sustainability factor. To understand these effects, we will maintain the pre-1992 pension adjustment throughout our simulation, assuming pensions grow with gross wages, leading to larger SSW. Given our findings so far, we anticipate these reforms may reduce inequality. This is because individuals in the lower income brackets are only partially affected by the reforms, as a share of these individuals is covered by social assistance income and therefore their old age income cannot be reduced by the adjustment formula.

Figure 12 shows the effects of these five scenarios on SSW by gender. Each line on the graph represents the relative difference in SSWs between the with-reforms scenario and the selected counterfactual scenario, that is the with-reforms scenario but without the respective reform. The difference can then be understood as follows: SSW is by that much lower or higher just through that single reform, given that all the other reforms were still in place.

Deferred taxation

The introduction of deferred taxation, starting in 2005, involved a gradual increase in the share of pension benefits that are subject to taxation. We expect this reform to predominantly impact the highest income tercile due to the progressive nature of the tax system.[29] Because of the gradual increase of the taxable pension income, we would further expect that the effect on SSW is larger in later years and therefore for younger cohorts.

However, the observed results, as depicted in Figure 12 (red line), suggest that the effect of deferred taxation on SSW is rather small across all income groups. In particular, in the first two income terciles we do not observe any significant changes for both, women and men. For the top tercile, deferred taxation leads to a slight decrease in SSW from the 1945 cohort onward. For the 1953 cohort, this difference has increased to about 2%. The effect is somewhat more pronounced when looking at developments over years instead of cohorts (not shown).[30]

Overall, the introduction of deferred taxation was not completed in 2019. For instance, the introduction included generous allowances on pension payments, which were only gradually phased out. Therefore, the differences are likely to increase further and the overall effect is likely to be much higher for even younger cohorts. At the same time, the only group of individuals that we observe to be affected by this reform is the top tercile, indicating that the reform reduces inequality.

1992-Low-EP-Upgrade

The 1992-revaluation regulation replaced the previously applicable mechanism from 1973. A description of both regulations can be found in the Section 2. Shortly summarized, the 1992 reform extended the periods in which insurance years were to be considered for upgrading low earnings points

[29] For instance, there is a basic tax-free amount in Germany. In 2022, it amounts to 9,984 € for single and 19,968 € for married people.

[30] In this context, it is important to note that deferred taxation is only included in the calculation of the SSW if the cohort makes its retirement decision after 2005. However, cohorts who retired before 2005 may still be affected by deferred taxation, albeit to a lesser extent, as their tax-free amount is relatively high.

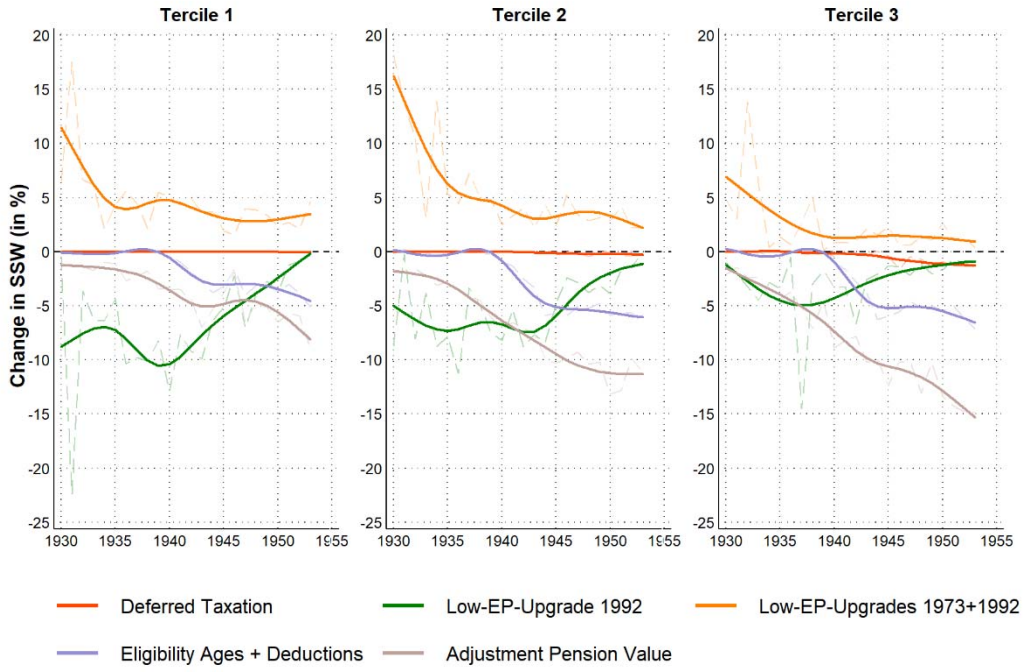
from up to 1973 to up to 1992. Assuming that more periods of individuals from low-income groups were upgraded, this should have an inequality-decreasing effect. On the other hand, the revaluation process is less generous as under the 1973 scheme in which all benefits below 75% of average income were increased to that threshold. Under the new scheme, only the average of the earnings points a person collected were doubled up to the threshold of 75%. This can be disadvantageous in two ways: First, instead of upgrading each individual year with earnings below 75%, the new rule would only upgrade the average of an observation period. This might be disadvantageous if some years with low earnings were offset by years with higher earnings, where the latter would not have been upgraded under the old legislation either. Second, as earnings points were no longer increased to 75% of the average income, individuals who earned less than 37.5% of the average income would be better off with the old regulation. This could even be amplified by the eligibility criteria of the newer mechanism being stricter: The old regulation only considered periods up to 1973 to determine if someone became eligible. In our sample, this means that working periods in relatively younger ages were considered while those at older ages were not, making it more likely to be eligible for revaluation. The new system considers the whole working history, including all years at higher, and therefore potentially better paid, ages. The direction of the effect thus depends on the proportion of those who are excluded under the new regulation to those remaining eligible under the new scheme.

The green line in Figure 12 shows the effect from the 1992-Low-EP-upgrade on SSW. It is important to highlight that the line shows the difference to a scenario in which the old legislation would not have been changed, and not to a scenario where there are no upgrades for low earnings points at all. Hence, a negative effect indicates that the 1992-mechanism is disadvantageous relative to the 1973-mechanism but does not necessarily mean that the mechanism itself decreases SSW. As expected, we see the largest difference in SSW in the first tercile. However, we also find effects in the middle and the upper terciles. These effects are more pronounced for women compared to men.

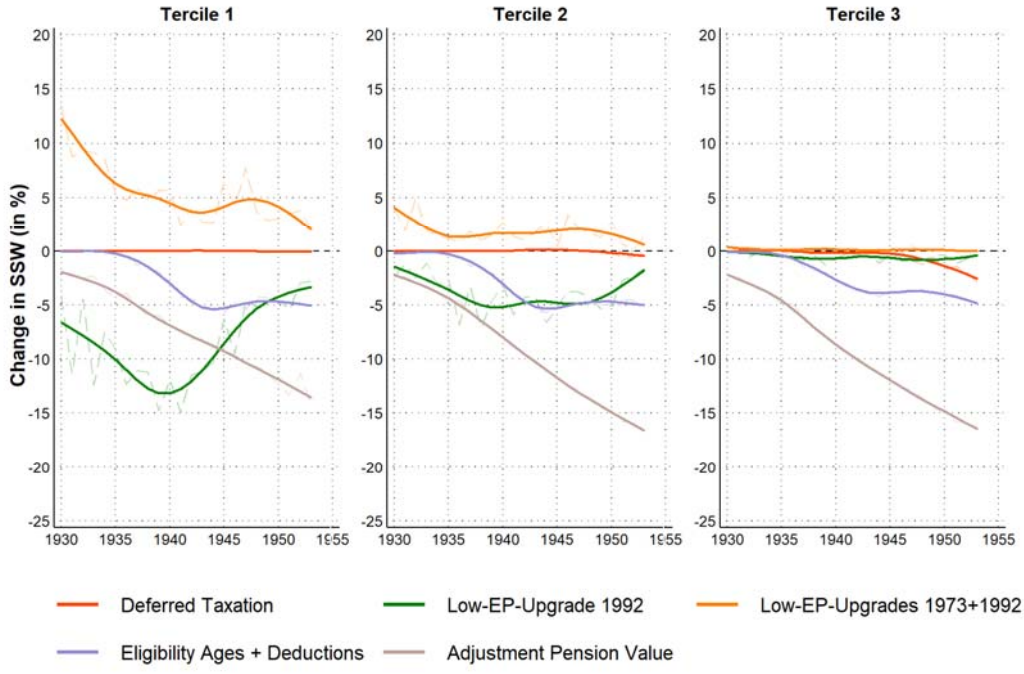
For females (Figure 12.A), we observe that because of the 1992-mechanism, cohorts born before 1940 exhibit SSW losses of 5% to 10% in the bottom and middle terciles. Even in the top tercile, we find negative effects from the reform, although they are smaller. There are two plausible explanations for why SSW is higher without the reform: Firstly, for these cohorts, the losses due to the less generous increase in their pension entitlements outweigh the gains from the additional years considered, during which their pension entitlements are increased. Secondly, the negative effect on SSW due to the reform may be attributed to the stricter eligibility rules of the 1992-Low-EP-upgrade, leading to fewer women receiving improvements in their pension claims. In fact, out of all women aged 60 born before 1940, only 36% benefited from the mechanism introduced in 1992, while 55% would have received an increase in their pensions under the 1973 legislation.

Figure 12: Counterfactual, alternative scenarios, SSW

A. Women



B. Men



Note: Each line shows the difference in SSW between the full with-reforms scenario and a scenario that excludes that specific reform. The line thus shows the effect of that reform on SSW. A positive value indicates an increasing effect on SSW, a negative value a decreasing effect.

Source: Own calculation based on SOEP v37.

For cohorts born after 1940, the diminishing effect of the new regulation on SSW becomes apparent. This is to be expected as the proportion of working years prior to 1973, which are the only ones being

upgraded under the old mechanism, decreases for younger cohorts. On the contrary, it is surprising that there are no SSW increasing effects for younger cohorts. One potential explanation might be that for younger cohorts the years prior to 1973 more and more represents their first working years with normally still low wages and therefore potentially earnings points lower 0.75. Under the 1997-upgrade those first earnings points would be upgraded regardless of their later employment history, while this is not the case under the 1992-upgrade. However, we may be overestimating this effect as our predicted earnings points profiles result in relatively low earnings points at younger ages.

Furthermore, eligibility criteria were less strict for the older mechanism. For instance, among all cohorts born after 1940, only 44% of 60-year-old women would see an increase in their pensions under the 1992-mechanism, compared to 69% under the 1973-mechanism.

For men (Figure 12.B), the picture is quite similar, although the negative effect on SSW is smaller across the two upper terciles. The strongest effect can be found among men in the bottom tercile, where the reform reduces SSW by 15% for the 1940 cohort. In the middle tercile, the effect is around 5%, and for the third tercile, there is almost no effect at all. Similar to women, the proportion of men benefiting from an upgrade of low earnings points is larger without the 1992 reform. For cohorts born before 1940, the share of males at age 60 benefiting from such an upgrade is 23 percentage points higher under the old legislation. For cohorts born after 1940, this number increased to 30 percentage points. However, in the long term, the introduction of the 1992-mechanism should have a positive effect on SSW also for men, particularly for cohorts entering the labor market after 1973.

1973-Low-EP-Upgrade

Excluding only the 1992-Low-EP-upgrade mechanism gave insights that were not straightforward to interpret and additionally removing the 1973-mechanism in this scenario might help to do so. We therefore exclude from our benefit calculation the two most important upgrade mechanisms for low-income periods and expect that these two reforms had very strong (increasing) effects on SSW in the first tercile, effectively reducing inequality. There might be, however, also some effect in the middle and top terciles, because both regulations do not consider income from other household members and because we assigned individuals to terciles using equivalent household income.

The results, depicted by the orange lines in Figure 12, show that the mechanisms have increased SSW. For females of all terciles, the positive effect on SSW starts from a higher level and then gradually decreases until the cohort of 1935, remaining stable thereafter. Specifically, in the bottom tercile, SSW is initially more than 10% higher, but by 1935, the difference falls to 5%. In the middle tercile, the mechanisms increase SSW initially even by 15% and in the long term by almost 5%. The effect in the top tercile is relatively small, with less than 5%.

For men in the bottom tercile, the effect on SSW is similar to what we found for women in the bottom tercile. As in the previous scenario, we do not observe any effect for the top tercile and only very small effects for men in the middle tercile. This highlights that, compared to women in the higher income

groups, men in these income groups do not appear to benefit from the mechanism. The reason for that is that women with lower pension entitlements are more likely to belong to a higher tercile due to their husbands' income than vice versa.

The introduction of deductions and changes in retirement ages

In our fourth scenario, we aim to examine the impact of the introduction of deductions and the associated increase in the statutory eligibility age. Initially, we assume that the differences between the terciles are relatively small because the percentage reduction in pensions is uniform across the terciles. However, distinctions between the terciles may arise due to varying retirement behaviors, as earlier retirement result in higher deductions. We showed in Section 6 that differences in retirement behavior across income groups seem to be stronger for men and would therefore expect a stronger effect for them.

As the deductions reduce pension benefits, the introduction of this reform should have a negative effect on SSW compared to a scenario without the reform (depicted by the purple line in Figure 12). There might be a difference between men and women because of two reasons: Firstly, the 1937 to 1940 cohorts were already subjected to actuarial adjustments when they claimed the old-age pension because of unemployment, while the same cohorts could continue to use the old-age pension for women without adjustments. As the scheme because of unemployment is less relevant for women, some female cohorts do not face deductions while men from the same cohort using the other scheme do. Secondly, the claiming age in the scheme for women remained constant at age 60, while in the unemployment scheme it was increased to age 63 for cohorts born before 1952. Consequently, for women it was possible to retire earlier, but at the same time this also meant that potential deductions were higher for women.

Including this reform reduces SSW for both men and women. The difference between this specific reform and the scenario that includes all reforms grows for men born from 1936 and for women born from 1939 onwards, reaching its maximum for the cohorts born in 1943 (for men) and 1944 (for women). These observed differences in impact between genders are primarily due to the first reason discussed earlier, that deductions were introduced differently in the special retirement schemes. Individuals born after 1945, regardless of gender, experience approximately a 5% decrease in their SSW because of that reform. Notably, the reform had a slightly lesser impact on men in the highest income tercile, whereas for women, those in the lowest income tercile were slightly less affected. This pattern for men correlates with differences in retirement timing; men in the highest income tercile tend to claim their pension benefits later, which results in fewer deductions following the reform's introduction.

Indexations of pension benefits to wage growth

Until 1992, pension benefits were indexed to gross wages, i.e., the actual pension value (see Section 2.1) increased in proportion to gross wages. The 1992 reform changed this to an indexation to net wages to prevent a vicious cycle generated by the inclusion of taxes and social security contributions in gross wages. In 2001, the indexation formula was augmented by a term that weakened the proportionality to net wage growth in four steps, the so-called *"Riester-Treppe"*.

These two changes to the pension adjustment formula resulted in lower pensions and subsequently reduced SSW. As these reductions, in relative terms, were uniform across the income distribution, we would expect the effect of the reforms on pension inequality to be limited. However, a differential effect may arise due to social assistance. In theory, also pensions at or below the social assistance level would be reduced by a reform that uniformly decreases pension benefits. However, these individuals would still receive social assistance income and are therefore unaffected by such a reform, while those in the middle and top tercile would face lower benefits. However, while this would reduce inequality, it does not imply that individuals in the bottom tercile are better off, as social assistance is designed to only cover basic needs. In fact, the number of social assistance recipients could even increase if the growth in pensions falls behind the growth in social assistance as a result of the reforms.

The overall negative influence of the reform on SSW is evident across all income terciles and for both genders, as indicated by the brown lines in Figure 12. The effect on the oldest cohort considered is small, as the net wage adjustment of pensions, introduced in 1992, is only partially included in their expected SSW calculations. Initially, for the first cohort observed and across all groups, the reform leads to a modest reduction in SSW by only 1% to 2%. However, this effect intensifies for later cohorts.

For men, the decline in SSW is relatively steady, with a slightly more pronounced decrease for cohort born in 1935 and onwards, likely due to the introduction of the *"Riester-Treppe"* and the sustainability factor affecting these cohorts. By the 1953 cohort, the reform has reduced SSW by 16% for those in the middle and upper terciles. The impact is somewhat less for the lowest tercile, with a reduction of approximately 14%, since individuals from this group are more often eligible for social assistance income.

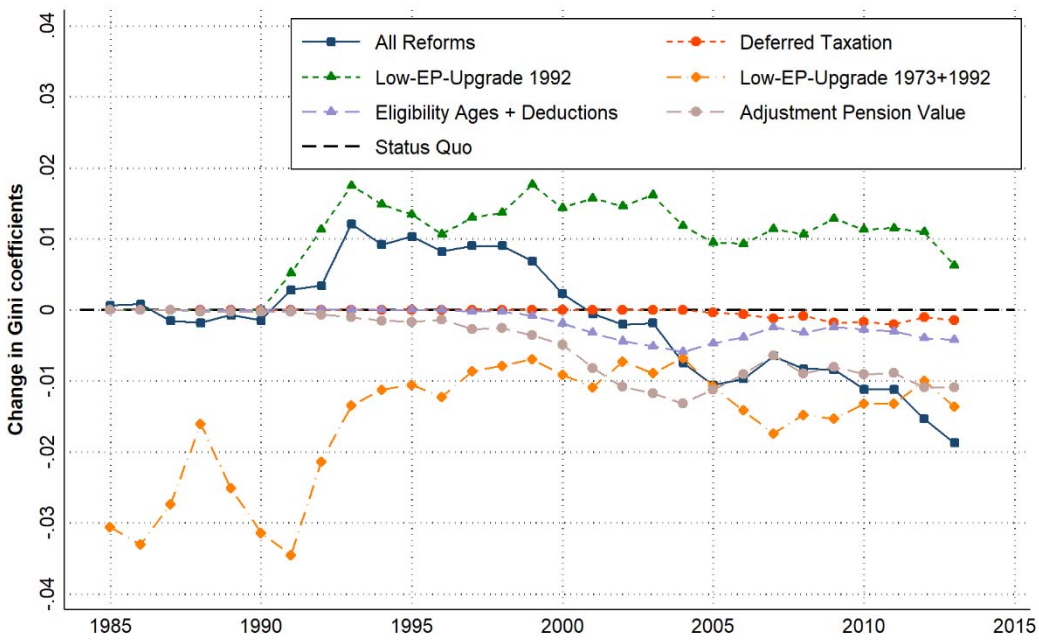
For women, we observe stronger differences across the terciles. The top tercile follows a trend similar to high-income men, but the SSW for women in the lower and middle terciles decreases more slowly due to the reforms. Given that women's pensions are on average lower, social assistance income plays a more crucial role for them, making the reform's effect less severe. For the 1953 cohort of women, SSW is reduced by about 15% in the top tercile, dropping to 11% in the middle tercile and only 8% in the bottom tercile. This pattern suggests that particularly women in the bottom tercile benefit from social assistance income.

8. Conclusions

Germany, like many other countries, has undergone a series of pension reforms which generally decreased benefit generosity and increased the retirement age due to demographic pressures. One may suspect that these reforms have increased income and wealth inequality, and maybe more so for retirees than for employees. In order to test this hypothesis, we employed counterfactual simulations in which we predict how the income and social security wealth distributions would have developed if these reforms had not taken place, compared to the actual development of the income and social security wealth distributions.

Figure 13 summarizes our findings, showing the difference in Gini coefficients between several counterfactual scenarios without reforms and the historical development that contains the sequence of reforms between 1985 and 2014. The scenarios without reforms include one scenario that counterfactually excludes all reforms, as well as the scenarios discussed in Section 7 in which we counterfactually excluded specific reforms. The difference between the counterfactual without-reform scenarios and the historical with-reforms scenario indicates the effect of the reforms on the Gini coefficient. A positive difference suggests that a specific reform increased inequality (since its exclusion would have reduced inequality), and vice versa.

Figure 13: Effect on inequality in SSW at age 63, Gini coefficient differences



Note: The graph shows how a specific reform affected the Gini coefficient of Social Security Wealth compared to a scenario that includes all reforms except that respective reform. A positive difference indicates that such a reform led to higher Gini coefficients and therefore to more inequality, and vice versa.

Source: Own calculation based on SOEP v37.

When all reforms are excluded (shown by the blue solid line), we observe that the entire reform package initially increased inequality. Especially between 1990 to 2000, the Gini coefficient was increased by the reform by 0.01. After 2000, however, reforms had an inequality-decreasing effect and reduced the Gini coefficient by 2013 by 0.02. The inequality-reducing effect essentially results from the protection of low incomes against benefit reductions by means of basic income support (see Appendix 1).

One particular reform responsible for the initial trend is the introduction of the 1992-Low-EP-upgrade mechanism (shown by the green dashed line), which increased Gini coefficients even more than a scenario that excludes all reforms. It is important to note, that this increase in inequality is attributed to the 1992 reform replacing the 1973-Low-EP-upgrade mechanism, which was more generous in several aspects, though not in all. To provide a clearer picture on the effect of these mechanisms, we also present

a scenario excluding both the 1973 and 1992 upgrade mechanisms (represented by the orange line).[31] Our analysis reveals that both mechanisms combined significantly reduced inequality, but the impact was less pronounced after the replacement of the 1973 mechanism in 1992. Despite this, the introduction of the 1992-Low-EP-upgrade mechanism is expected to have an inequality-reducing effect, as it enhances low earning points accrued until 1992, whereas the older mechanism only improved EP gathered before 1973.

The reduction in inequality in later years can be linked to several reforms, notably changes to the pension adjustment formula (as indicated by the brown line) and the introduction of actuarial adjustments along with higher eligibility ages for retirement (represented by the purple line). Despite these reforms, theoretically, applying uniformly across all income groups – dependent on retirement age – they should not directly influence inequality. The observed decrease in inequality actually stems from the fact that lower-income groups are effectively shielded from the impact of these reforms either because their pensions already were below the threshold for social assistance or because the reforms would push pensions below this level. We show in Appendix 1 that there is no decrease in inequality once we assume there would be no social assistance income.[32]

The final reform that we analyze, namely deferred taxation, shows very small effects that slightly reduce inequality among the most recent cohorts, as shown by the red line in Figure 13. Given its gradual implementation, we anticipate that these effects will become more pronounced over time, enhancing its potential to decrease inequality in pensions.

In conclusion, our analysis reveals that the aggregate impact of pension reforms has led to an increase in inequality in terms of social security wealth between the 1990s and 2000s and decreased inequality thereafter. The decrease in inequality is driven by social assistance being a lower bound for benefit size and only partially by pension reforms that affect income groups differently. We divided the total effect of the pension reforms into two components: The first component is the mechanical effect, that keeps retirement probabilities constant and only considers changes in benefit calculation. The second component is the behavioral effect, which describes how SSW differs because of altered retirement probabilities. Our findings indicate that in the German context the behavioral effect is statistically significant but economically small. We find some differences across genders: Contrary to the effect for men, the reforms appear to have a mitigating effect on inequality among women. Furthermore, the behavioral effect is less pronounced for women than for men.

[31] Note to not compare this scenario with the without-reforms scenario as the latter includes the 1973-Low-EP-upgrade mechanism as it was introduced before 1984.

[32] The introduction of pension allowances in the calculation of basic income support will lead to a lower inequality-reducing effect of these reforms, as the allowance itself depends on the pension amount. On the other hand, the allowance itself should reduce inequality. Note that the allowance is not part of our calculations, as it was introduced only in 2021.

9. **References**

Barišić, M., and Consiglio, V. S. (2020): 'Frauen auf dem deutschen Arbeitsmarkt: was es sie kostet, Mutter zu sein: Kurzexpertise', Bertelsmann.

Börsch-Supan, A., and C. Quinn (2015): 'Taxing Pensions and Retirement Benefits in Germany', MEA Discussion Paper 10-2015.

Börsch-Supan A., T. Bucher-Koenen, S. Kluth, M. Haupt, and N. Goll (2015): 'Vor- und Nachteile höherer Flexibilität als Instrument zur Erhöhung der Beschäftigung Älterer', MEA Discussion Papers 06-2015.

Börsch-Supan, A., J. Rausch, and N. Goll (2020): 'Social Security Reforms and the Changing Retirement Behavior in Germany', in Börsch-Supan, A. and C. Coile (eds.): Social Security Programs and Retirement around the World: Reforms and Retirement Incentives, University of Chicago Press, Chicago, Chapter 5, pp. 175-226.

Börsch-Supan, A. and N. Goll (2021): 'Ziele verfehlt: Eine Analyse der neuen Grundrente', ifo Schnelldienst, Vol. 74, Iss. 06, pp. 34-39.

Börsch-Supan, A., T. Bucher-Koenen, N. Goll and F. Hanemann (2021): 'Targets Missed: Three Case Studies Exploiting the Linked SHARE-RV Data', Journal of Pension Economics and Finance.

Börsch-Supan, A., I. Ferrari, N. Goll, and J. Rausch, (2023): 'Retirement Decisions in Germany: Micro-Modelling', in Börsch-Supan, A. and C. Coile (eds.): Social Security Programs and Retirement around the World: The Effects of Reforms on Retirement Behavior. University of Chicago Press.

Deutsche Rentenversicherung Bund (DRV) (2022): 'Rentenversicherung in Zahlreihen', DRV-Schriften, Band 22, Berlin, [https://statistik-rente.de/drv/].

Geyer, J., M.M. Grabka, and P. Haan (2021): '20 Jahre Riester-Rente: Private Altersvorsorge braucht einen Neustart', DIW Wochenbericht, Vol. 88, Iss. 40, pp. 667-673, Berlin.

Goebel, Jan, Markus M. Grabka, Stefan Liebig, Martin Kroh, David Richter, Carsten Schröder, and Jürgen Schupp. 2019. The German Socio-Economic Panel (SOEP). Jahrbücher für Nationalökonomie und Statistik (Journal of Economics and Statistics) 239 (2), 345-360.

Goll N. and F. Hanemann (2020): 'Financial Incentives and Heterogeneity in Retirement Behavior – An Empirical Analysis Based on SHARE-RV Data', MEA Discussion Papers 21-2020.

Haan P., D. Kemptner, and H. Lüthen (2020): 'The Rising Longevity Gap by Lifetime Earnings – Distributional Implications for the Pension System', The Journal of the Economics of Ageing, Vol. 17, 2020.

Huber, M., M. Lechner, and C. Wunsch (2013): 'The Effect of Firms' Partial Retirement Policies on the Labour Market Outcomes of their Employees', CESifo working paper No. 4343, München.

Kroh M, H. Neiss, L Kroll, and T. Lampert (2012): 'Menschen mit hohen Einkommen leben länger', DIW Wochenbericht, Vol. 79, Iss. 38, pp. 3-15, Berlin.

Kroll L.E., and T. Lampert (2009): 'Soziale Unterschiede in der Lebenserwartung - Datenquellen in Deutschland und Analysemöglichkeiten des SOEP' Methoden - Daten - Analysen 2009, Vol. 3, Iss. 1, pp. 3–30.

Lampert T. and L.E. Kroll (2014): 'Soziale Unterschiede in der Mortalität und Lebenserwartung' GBE Kompakt, Vol. 5, Iss. 2, 2014.

Ritter G.A. (2011): 'Die Rentenversicherung im Prozess der deutschen Wiedervereinigung' in Eichenhofer E., Rische H. and Schmähl W. (eds): Handbuch der gesetzlichen Rentenversicherung SGB VI, Chapter 3, pp. 67-103.

Ruland F., H. Rische, A. Reimann and G. Roßbach (2019): ‘Politikberatung durch die gesetzliche Rentenversicherung am Beispiel der deutsch-deutschen Wiedervereinigung‘, Zeitschrift Deutsche Rentenversicherung, 4/2019.

Seibold A. (2021): ‘Reference Points for Retirement Behavior: Evidence from German Pension Discontinuities’, American Economic Review, Vol. 111, No. 4, pp. 1126-65.

Statistisches Bundesamt (StaBA) (2015): ‘Generationensterbetafeln für Deutschland, Modellrechnungen für die Geburtsjahrgänge 1896-2009‘, Wiesbaden.

Unger R, and A. Schulze (2013): ‘Können wir (alle) überhaupt länger arbeiten? Trends in der gesunden Lebenserwartung nach Sozialschicht in Deutschland‘, Comparative Population Studies - Zeitschrift für Bevölkerungswissenschaft, Vol. 38, Iss. 3, pp. 545–564.

Wenau G., P. Grigoriev, V. Shkolnikov (2019): ‘Socioeconomic Disparities in Life Expectancy Gains among Retired German Men, 1997–2016’, J Epidemiol Community Health, 2019, Vol. 73., Iss. 7, pp.605-611.

Wolf I.K., H. Knopf, and C. Scheidt-Nave (2012): ‘Möglichkeiten und Grenzen retrospektiver Todesursachenrecherchen im Rahmen bundesweiter epidemiologischer Studien‘, Bundesgesundheitsblatt, Vol. 55, Iss. 3, pp. 431–435.

Appendix 1 – The role of social assistance

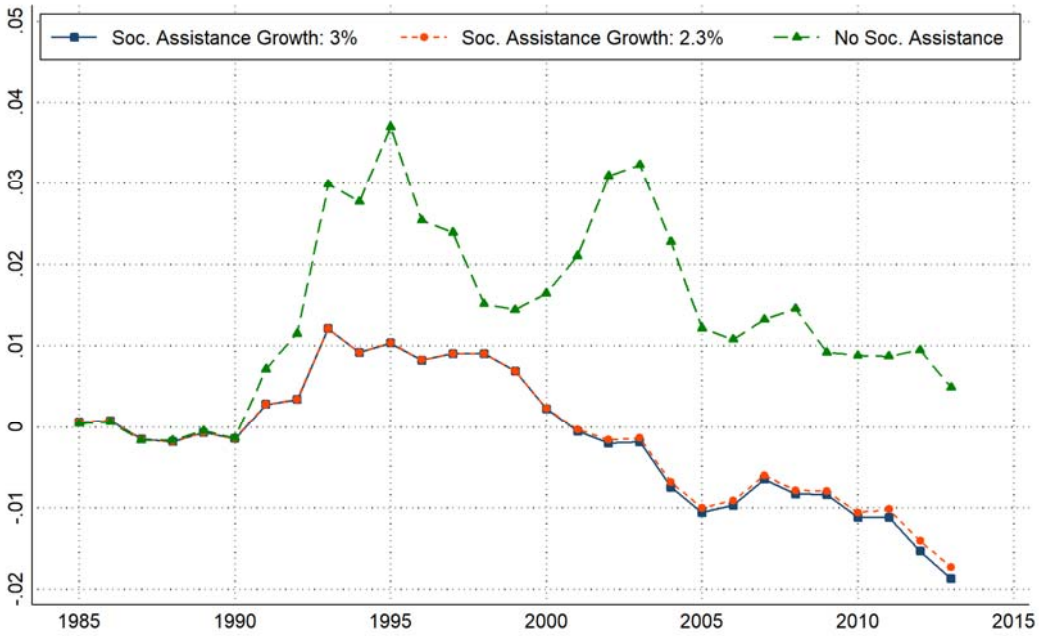
We found that the entire reform package in recent years led to a decrease in inequality and argued that social assistance plays a significant role in this outcome. To better understand the impact of this minimum income guarantee, we introduce two additional scenarios with varying assumptions about social assistance income, which we then compare to our standard scenario. In our standard scenario, social assistance is projected to increase annually by 3% after year 2020, the rate at which we assume gross wages to grow. The first alternative scenario assumes a lower growth rate of 2.3%, taking into account the average historical difference of 0.7 percentage points between the growth rate of social assistance and net wages between 2011 and 2021.[33] The second alternative scenario completely excludes social assistance, which is expected to substantially affect SSW for individual in the bottom income terciles. The analysis involves comparing changes in Gini coefficients under a scenario that encompasses all reforms (but with different social assistance assumptions) to a scenario without any reforms (using the same social assistance assumptions). Thus, observing a positive difference indicates that reforms, under the specified social assistance assumptions, led to an increase in Gini coefficients and therefore inequality.

In the scenario where the social assistance growth rate is assumed to be 2.3% (shown by the red line), the Gini coefficient differences are nearly the same as those in the standard scenario with a 3% growth rate, showing only a slight increase in more recent years. This is because, up until 2020, the actual historical growth rate of social assistance is applied, and only after 2020 do the assumed growth rates of 2.3% or 3% take effect. Consequently, for cohorts born later, more years post-2020 are included in the analysis, leading to a slightly more noticeable difference.

When social assistance is entirely excluded from the scenario (indicated by the green line), we find that Gini coefficients increase by as much as 0.03 due to the reforms, suggesting a significant increase in inequality. The disparity in Gini coefficients between this scenario and the one **assuming** a 3% growth rate is approximately 0.25 in the year 2013. When comparing the scenarios with the standard 3% growth rate, we observe a difference of 0.2 in the Gini coefficient in 2013 (see blue line). This suggests, together with some additional robustness checks (not shown), that a considerable share of the reduction in inequality can be attributed to the impact of social assistance.

[33] Note that this difference comes from a calculation that excludes housing benefits (so-called "*Wohngeld*"). Including housing benefits, the difference would only be 0.2 percentage points. As this is close to our base assumption, we rather use the smaller growth rate.

Figure A1: Effect of social assistance on inequality in SSW at age 63



Note: The graph shows differences in Gini coefficients between a scenario including all reforms and a scenario without any reform. The difference between the lines lays in the assumptions for social assistance, where we assume growth rates of 3% and 2.3%, as well as no social assistance at all. Positive values indicate increasing inequality, negative values decreasing inequality.

Source: Own calculation based on SOEP v37.