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The Inequality of Lifetime Pensions

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Abstract: At older ages, most people are supported by pension systems that provide payments based on prior contributions. An important, but neglected, aspect of inequality in how much people receive in pensions is the number of years they live to receive their pension. We examine inequality in lifetime-accumulated pensions and show the importance of mortality for understanding inequalities in pension payments, and contrast it to inequalities in working-age earnings and yearly pension payments among older adults. In contrast to most previous research on old-age inequality comparing different social groups, we focused on total-population-level inequality. Using Swedish register data covering the retired population born from 1918–1939, we found that lifetime pensions are much more unequal than pre-retirement earnings and yearly pensions. Our findings also show that mortality explains more than 50 percent of the inequality of lifetime pensions within cohorts, and plays an important role in explaining changes in inequality across cohorts (192 percent among men and 44 percent among women). Pension policies can affect lifetime pension inequality, but such effects are limited in magnitude unless they directly affect the number of years of receiving pensions.

Keywords: aging; retirement; social stratification; mortality; decomposition analysis; Sweden

MOST research on social stratification in contemporary populations has focused on working ages. With rapidly aging populations increasing across the rich world, inequality at retirement ages is becoming a more relevant component of how societies are stratified. Focusing on the retired population, prior research has examined inequality in retirees' consumption and disposable income (Deaton and Paxson 1994). In this study, we took a different and broader approach by examining how the total pension income over an entire lifetime is distributed in a population. We investigated how much of the total pensions received over an individual's life-course (typically through transfers from younger generations in government-funded pension schemes) is determined by how long they live as well as their prior income, education, occupation, and other pre-retirement characteristics.

Here, a lifetime pension is defined as the accumulated pension payments from all parts of a pension system from the typical retirement age of 65 to death. In addition to helping understand how pension systems function, examining the distribution of lifetime pensions provides complementary perspectives on old-age inequality as well as shedding new light on the social stratification system at large. It shows how the earnings advantage/disadvantage is carried over to later life, coupled with inequalities in longevity. Besides, longer lives and larger lifetime pensions both tend to be concentrated among individuals with higher socioeconomic status (SES), who tend to leave more bequests to their children. This process may reinforce the

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reproduction of inequality across generations. However, lifetime pension inequality itself has been rarely examined, let alone its importance on the intergenerational persistence of social inequality.

We used several decades of Swedish taxation data together with death registers and censuses covering the entire country to provide a holistic perspective on how much lifetime pensions differ between individuals over 22 birth cohorts. We had three aims. First, we quantified the extent to which lifetime pensions are unequally distributed in Sweden, and compared it with inequality in prior labor earnings and in yearly pension income. By focusing on older ages, we were able to examine an aspect of inequality that has often been overlooked in the literature. Second, we used a Gini decomposition approach to examine different factors that contribute to lifetime pension inequality, finding that the most important reason why some individuals accumulate more pensions is simply because they live longer. Third, using counterfactual analyses, we explored the sensitivity of lifetime pension inequality to changes in pension policies and mortality scenarios. Importantly, we found that the demographic driver of mortality trends is more important in generating future trends of pension distributions than the external force of pension policies.

Background

Previous Research on Old-Age Inequality

Social scientists have been examining inequality since the 19th century. The majority of research has taken a cross-sectional approach, focusing on inequality in earnings or disposable income of the current working-age population. It has been less common to examine inequality among all members of society (Solt 2020). Population aging in recent decades has made it increasingly important for researchers to examine inequality in older populations. Before the 1960s, the retired population was a relatively small part of the total population in high-income countries. In 1960, 8.3 percent of the total population of the OECD countries was older than 65, and this had increased to 17.5 percent as of 2020 (OECD 2022), an increase that will continue. Given the increasing share of the older population in high-income countries, research on income inequality of older individuals is surprisingly scarce. A large literature has focused on the prevalence and causes of old-age poverty (Barrientos, Gorman, and Heslop 2003; McLaughlin and Jensen 1993), but less is known about population-level old-age inequality.

An important line of research on old-age social stratification has examined inequality in pension income, often with comparisons with inequality at younger ages. As pension income replaces labor income as the primary source of income after retirement, there may be changes in income inequality after retirement. Will inequality become smaller, larger, or remain stable when a cohort enters retirement? The *cumulative advantage/disadvantage hypothesis* predicts that income inequality increases with age (Ferraro and Shippee 2009). This is because when individuals age, early advantages/disadvantages in health, education, income, and other aspects of social life carry over to later life, contributing to an increased income gap at older ages. Conversely, the *redistribution hypothesis* predicts that income inequality narrows after retirement, as public pension systems tend to redistribute money from the rich to the poor (O'Rand and Henretta 1999), particularly relevant in countries with more progressive pension systems (Brown and Prus 2006).

Empirical evidence is mixed. Whereas cross-sectional research found higher inequality among Americans aged 75+ than among younger Americans (Crystal and Shea 1990), cohort studies found an increasing income gap over age (Crystal and Waehrer 1996; Crystal et al. 2017). In the more redistributive Canadian system, inequality declined in older age (Prus 2000), suggesting that the pension system reduced inequality. Using U.S. longitudinal data, Hungerford (2020) found that cohort-specific income inequality is roughly stable as the cohort ages and starts to receive pensions.

An important issue that has not been considered in previous research is attrition due to death. Even if income changes little as people age, income inequality may narrow simply because survivors to older ages are an increasingly positively selected and increasingly homogeneous group in terms of both health and income. Therefore, the role of mortality selection is important for studies on inequality among retirees. A broader lifetime perspective that accounts for differences in mortality is needed.

Researchers have also examined the *net pension wealth* of individuals at different ages (Johnson, Sambamoorthi, and Crystal 1999; Bönke et al. 2019; Kuhn 2020; Olivera 2019). Net pension wealth is the current value of expected future pension flow, including (returns to) individually funded pension funds and benefits from governmental, collective agreement, or employer-linked pension plans, as well as individual savings and funded pension plans. This line of research provides a good forecasted picture of inequality in pensions from the perspective of currently working individuals, given that individuals' future pension streams are mostly based on their pension plans and lifetime income histories. As it is calculated for living individuals, it is not affected by how long that person in practice will live (in contrast to our empirical approach). As such, measuring the inequality in net pension wealth is informative to gauge (future) pension inequality, absent the effect of within-cohort inequality in mortality.

Our focus on lifetime-accumulated pensions is related to the study of wealth inequality. Net pension wealth is an important part of older adults' total wealth, but it is usually not included in studies on wealth inequality, as net pension wealth is hard for individuals to gauge (Ekerdt and Hackney 2002; Sierminska, Brandolini, and Smeeding 2006). In a society without pensions or annuities, such as pre-industrial or contemporary low-income societies, individuals must save for consumption in old age, and such savings are an important component of wealth. Wealth is extremely unequally distributed (with a Gini coefficient between 0.5–0.9) in many countries (Pfeffer and Waitkus 2021). At older ages, wealth is no doubt an important dimension of inequality, perhaps more so than at working ages. In many high-income societies, wealth sources such as housing are also often important for the living standards of older individuals. Similar to the United States, Sweden has one of the most unequal wealth distributions in the world (Pfeffer and Waitkus 2021). The extremely high concentration of wealth means that pension income is relevant for most individuals, as large shares of the population have very modest savings and wealth and depend on pension income. Relatedly, researchers have shown that wealth inequality is smaller in countries without generous public pensions, as a large amount of wealth is then accumulated across a broader section of society (Domeiji and Klein 2002). Our study is valuable as a complementary perspective on common forms of savings for retirement (e.g., properties or cash) that represent a fixed amount of wealth unrelated to longevity. In theory, these forms of savings can be annuitized, but this is rare.

Another related approach is to study inequality in end-of-life assets (Poterba, Venti, and Wise2017). This approach is more relevant to understanding intergenerational transfers of wealth. Unlike our approach, such research does not focus on ages at death or the accumulation of resources during retirement.

Lifetime Pensions, the Fairness of Pension Systems, and Pension Reforms

A major goal of pension systems is to make sure that individuals have adequate resources no matter how long they live (Ayuso, Bravo, and Holzmann 2017). By contributing to pension systems at working ages, individuals can expect to have stable retirement incomes. This is particularly important for people with low prior earnings because higher earners usually have other means, such as private savings, to support their retirement lives (U.S. Government Accountability Office 2019). Pensions thus act as insurance against living for a long time. Through them, resources are redistributed from the short-lived to the long-lived. Consequently, lifetime pension inequality is likely to be larger than the inequality in pre-retirement earnings because those who had lower earnings tend to have shorter lifespans. Redistribution through unequal lifespans is in some aspects an intended goal of pension systems, but it is simultaneously an important source of inequality. To achieve the goal of old-age poverty alleviation, public pension systems also tend to distribute resources from high-income to low-income earners. Such inter-personal redistribution itself constitutes a major function of pension systems as a part of a larger welfare state (Ebbinghaus 2021).

Decomposing the sources of lifetime pension inequality as we have done in this article for Sweden can help understand how pension systems de-facto balance the different (contradicting) goals of pension systems. Intended levels of progressiveness of pension systems and redistribution between the rich and the poor may not be realized due to the regressive effects of mortality inequality (Tan and Koedel 2019). Such effects may be substantial if blue-collar workers have substantially shorter lifespans while still making substantial contributions during working ages. If so, the effect may be that pension systems as a component of the welfare state, even become regressive and redistribute resources away from poorer individuals with worse health, towards richer individuals with better health. This is the case in Germany and Italy (Haan et al. 2020; Mazzaferro, Morciano, and Savegnago2012). A recent growing line of research has shown how mortality inequality increases pension inequality between socioeconomic groups, and that differential mortality should be accounted for when considering the progressivity of pension systems (Brown 2003; NASEM 2015; Sánchez-Romero et al. 2020).

Previous studies have examined the impact of pension systems moving from (often unsustainable) defined-benefits (DB) systems to systems that better account for population aging, such as Notional Defined Contribution (NDC) systems and funded systems (Barr and Diamond 2009; Lee and Sánchez-Romero 2019; Mazzaferro et al. 2012). The cohorts we examined were generally exposed to a stable DB pension environment before major reforms to the system were made for later cohorts (Palme 2005). Research has also examined how population aging together with changing policy environment impacts intergenerational fairness in pension systems, examining which cohorts have been "winners" or "losers" in the relative balance between contributing to the system and receiving benefits (Bravo et al. 2021). We did not examine this aspect but focused on within-cohort inequality.

In light of recent policy debates such as linking retirement age with life expectancy, we also examined the impact of such policies on the distribution of lifetime pensions. The direction of the impact may be expected, but the magnitude is not known. For example, increasing the minimum pension will reduce lifetime pension inequality but it is unclear how large the reduction is. Particularly, it is interesting to compare policy impacts with the impact of the demographic force–change mortality patterns. Is lifetime pension inequality predominantly determined by demography? How important are pension reforms? We examine these aspects through counterfactual analysis.

Group- Versus Population-Level Approaches

Most of the aforementioned studies on lifetime pension inequality examined differences in average lifetime pensions across socioeconomic groups. Such a group-level approach does not account for the potentially large heterogeneity within socioeconomic groups. It is reasonable to assume that the explanatory power of socioeconomic variables for total lifetime pension variation is limited at the group level, and that much inequality is found within rather than across groups.

Alternatively, measuring population-level lifetime pension inequality, as we did in this study, is complementary to previous group-based studies. It illustrates how much societal income redistribution through public pension systems is influenced by variations in mortality (and not only differences in mortality across groups). Thus, a population-level approach contributes to the debate on the fairness of pension systems and gives a broader overview of pension inequality.

In Sweden, mortality explains around one-quarter of the total differences in average lifetime pensions between socioeconomic groups, and the rest is mostly attributable to inequality in pre-retirement earnings (Shi and Kolk 2022). It is unknown how much of the total-population-level lifetime pension inequality can be explained by such between-group differences in average lifetime pensions.

Determinants of Lifetime Pensions

Figure 1 presents a model of how different factors are linked with a lifetime pension. A lifetime pension is predominantly a direct function of the yearly pension and retirement lifespan, although to some extent other factors may also directly affect lifetime pensions (e.g. spousal deaths will result in widowhood pensions).

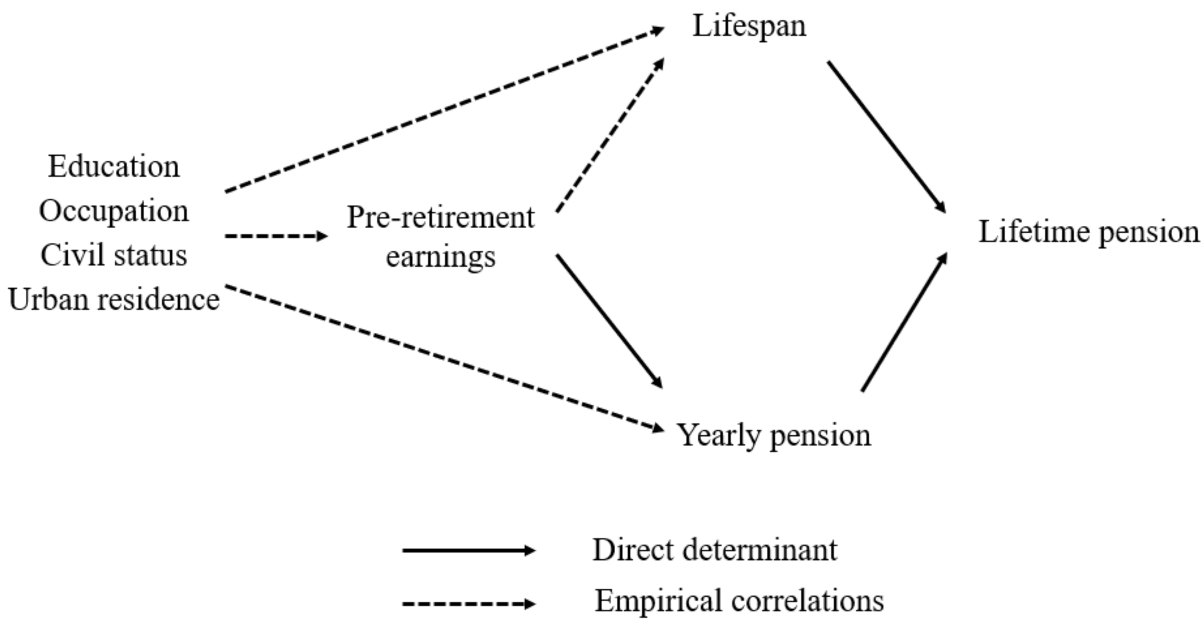

Figure 1: A theoretical model of a lifetime pension.
Source: Authors' own.

Accordingly, inequality in lifetime pensions comes from the variations in lifespans and yearly pensions. From a life-course perspective, yearly pensions are shaped by life-cycle events before retirement. Previous studies have examined how education, marital history, employment trajectory, and retirement pattern are associated with income inequality in later life (Crystal et al. 1992; Fasang 2012; Halpern-Manners et al. 2015; Riekhoff and Järnefelt 2018). Undoubtedly, these are important factors. Yet the most direct determinants of yearly pension income are arguably levels and trajectories of pre-retirement earnings. This is because second-pillar pensions are calculated based on earnings-based contributions. Thus, we hypothesize that once pre-retirement earnings are accounted for, other working-age socio-demographic factors have limited effects on lifetime pension inequality.

Lifespan is another key determinant of the lifetime pension. If everyone were to die at the same age, lifetime pension inequality would be the same as yearly pension inequality. If those with lower yearly pension incomes tended to have longer lifespans, then lifetime pension inequality would be smaller than yearly pension inequality. This is unlikely to be the case, as in reality, people with lower incomes tend to have shorter lifespans (Fors, Wastesson and Morin2021; Shi et al. 2022). At least as importantly, lifespan variation is in itself a source of inequality and will independently contribute to variations in lifetime pensions. This is of particular importance, as government welfare systems such as pensions often try to reduce inequalities in the population. In this case, higher SES groups have lower mortality, and will thus benefit more from a typical pension system from a lifespan perspective. Based on this reasoning, we expected lifetime pension inequality to be larger than yearly pension inequality. An interesting and unexplored question is therefore: what matters more for lifetime pension inequality—lifespan or pre-retirement earnings?

For our cohorts, as we will show later, earnings inequality among men at working ages was rather stable with a modest U-shaped function. Earnings inequality declined among women due to rising female labor force participation over time, and consequently, income has become increasingly less concentrated among a small group of full-time working women (Shi and Kolk 2022). Reduced earnings inequality will likely lead to a decline in lifetime pension inequality across cohorts of women. Likewise, if lifespan variation has declined over cohorts, lifetime pension inequality may have become smaller. A recent study on 195 countries showed that lifespan inequality at ages above 65 has increased over time, in contrast to declines in the inequality in total adult lifespans (Permanyer and Scholl 2019). It is noteworthy that the study by Permanyer and Scholl (2019), like most previous studies (e.g., Myers and Manton 1984), was based on period life tables, rather than real cohorts (as in our study). Due to data limitations, it is unclear how the lifespan variation in old age has changed across cohorts.

Research Gaps and Our Contributions

Most of the aforementioned studies examined older adults at a certain point in their lives (implicitly, conditioning upon surviving to the examined ages). These studies can be compared directly to inequality studies on working-age populations. This approach is preferred if understanding inequality in consumption and living standards is of primary interest. In comparison, studying lifetime pensions is more related to savings and wealth, and shows the *actual monetary distribution* of pension systems. This makes our study more relevant for addressing questions of fairness and financing of pension systems. This is because research on yearly pensions does not account for the role of mortality, which results in some individuals in practice receiving less in pensions over their lifetime than longer-lived individuals. This relates to the well-documented social inequalities in mortality, which affects pension systems in a systematically regressive way (Goldman and Orszag 2014), but also relates to differences in mortality across individuals that are unrelated to SES.

Our approach is similar to estimating the amount of savings an individual would in practice need in a world without any actuarial or pension-like system to cover their de-facto consumption at older ages. Pension systems annuitize such payments, thereby protecting adequate consumption from being impacted by lifespan variations. Lifetime pensions directly correspond to the actual observable amounts of cash an individual receives from a pension system. As such, they represent values that can serve as benchmarks for how much individuals would need to de-facto save through means such as wealth and housing to meet their consumption needs in retirement, hypothetically in the absence of a pension system.

In research on pension wealth, future pension payments were often estimated according to actuarial calculations, and future inequality in old age was forecasted for individuals at earlier life-course stages. However, these calculations were implicitly or explicitly based on mortality forecasts that by nature are population averages. Sophisticated approaches can take account of differences in average mortality between social groups, but they have not accounted for within-group heterogeneity. We, by contrast, analyzed cohorts where individuals have either died or reached advanced ages, and the uncertainty of future pension flows or lifespans of survivors is modest.

One purpose of a pension system is to act as longevity insurance, and pension wealth measures the stake in such insurance. Here, we explored the important but neglected research question: how much do different individuals de-facto receive in pension payments? By using a novel decomposition approach together with additional robustness analysis, we provide insights into explaining why certain individuals receive more in pensions and how this is explained by factors such as mortality and prior earnings. Relatedly, prior work has examined equity in pension systems (Sánchez-Romero et al. 2020), but such analyses typically compared predefined social groups rather than population-level inequalities. Therefore, we contribute to knowledge on how and for whom pension systems work as longevity insurance and how much working-age income inequality is reinforced through such systems in old age.

Finally, through examining lifetime pension inequality, we provide insights into understanding the social stratification system at large—especially inequalities at older ages that are related to the intergenerational reproduction of inequality. The longer lifespans of people with higher SES mean that they accumulate more pensions over their entire life-course. This implies that their children are likely to receive more bequests, thus reinforcing inequality in future generations. In many contexts, savings and wealth are important for transfers within families from working to older members, although this may be less the case in Sweden (Lee and Mason 2011).

The Swedish Context

Sweden is a social-democratic welfare state with a generous pension system, where much of within-life-course transferal is done through public transfers (Esping-Andersen 1990). It had a comparably generous pension system during our study period (Korpi 1995), and for our cohorts, income inequality was among the lowest in the world (Atkinson 2003). During the period, Sweden also had among the lowest levels of old-age poverty in the world (Korpi 1995). Intergenerational residence was very uncommon, and few older individuals received financial transfers from their children (Lee and Mason 2011). Female labor force participation and wages were substantially lower than those of men for our earlier cohorts, but increased rapidly for the later cohorts we studied (Bygren, Gähler, and Magnusson 2021).

The retirement age was around 65 for our cohorts born from 1918–1939, with some minor occupational variation, although it was common to receive retirement benefits earlier than that (Hagen 2013). Sweden had an individualized pension system and individual taxation during the period, although the guarantee pension was partly based on civil status. The cohorts were mostly covered by the combination of a guarantee pension (a universal basic minimum pension for everyone), a state, DB, and income-related pension (the Allmän Tillägspension, with payments on 60 percent of the qualifying salary, based on the highest 15 years of earnings over a 30-year qualification period), and additional occupational pensions obtained through collective agreements (covered most of the labor force and constituted between 15 percent–30 percent of total pensions, depending on occupation, sex, and cohort). Replacement rates were often more than 80 percent of the final salary after combining all pillars (Hagen 2013). The entire system was strongly earnings-related and also covered quite high incomes; consequently, the link between income and pension was stronger than in many other countries, and thus the pension system in Sweden is less progressive than in many other OECD countries (OECD 2011).

For our earliest cohorts, Sweden had among the highest life expectancies globally. In more recent cohorts, Sweden still has exceptionally low mortality rates in working ages but has relatively high mortality among the oldest old (Drefahl, Ahlbom, and Modig2014). Sex differences in life expectancy are among the smallest in the world.

Methodology

Data

Our dataset covers the full population of Swedish-born persons born between 1918–1939. We linked multiple registers provided by Statistics Sweden using unique personal identification numbers. The *total population registers* provide basic demographic information, including sex, birth year, and country of birth. The *migration registers* document in- and out-migration records. The *death registers* provide the date of death for deceased persons. The *taxation registers* provide information on labor earnings and pension income from 1968 onward, based on the end-of-year tax filings. The 1970–1990 *censuses* contain information on occupational status, civil status, and residence in metropolitan counties. We restricted our sample to individuals who had never migrated after age 50 and survived to age 65, resulting in a total of 1,694,060 individuals. The registers are recorded yearly up to 2018, whereas the censuses are conducted every five years (1970, 1975, 1980, 1985, 1990). For those who survived to 2019, we forecasted their lifespans and pension flows, as explained below and in more detail in Online supplement A1.1. Although the Swedish registers are not publicly available, we provide R codes (https://osf.io/dgwsv/) that could be useful to researchers with data access and those planning to conduct similar analyses (Shi and Kolk 2023).

Variables

Our outcome variable *lifetime pension* is the total inflation-adjusted taxable pension incomes (in 2018 SEK) from age 65 to death, which includes state pensions, occupational pensions, widowhood pensions, and private pensions (which is very uncommon) and does not include sickness and disability pensions covering ages before the statutory retirement age. It was derived from yearly taxation records of all sources of income. For individuals who survived to 2019, future annual pension incomes were assumed to equal the average annual pension of the last three years observed (2016–2018). This applied to ages above 80 for our first cohort. It was a reasonable approximation, as our data show that inflation-adjusted pension incomes are very stable after age 80 (see Table A1).

Lifespan is the remaining years of life at age 65. As our data ran up to the year 2018, we included complete lifespans and also used a simulation approach (based on the Gompertz age-mortality relationship with earnings as an additional predictor; see details in Online supplement A1.1) to forecast lifespans for individuals who survived to 2019. In total, 30.3 percent of the individuals survived to 2019. The forecasted person-years constituted 12.0 percent of the total person-years. For our earliest cohorts, we used virtually only observed mortality data, and more person-years were imputed for more recent cohorts. When aggregated, our forecasted mortality estimates are equivalent to those forecasted by Statistics Sweden at the national level (2020).

Labor earnings are defined as the average annual pre-tax labor earnings from ages 50–59, including income from work but not capital gains. Both labor earnings and pension income are presented with the unit of 1,000 Swedish krona (SEK, corresponding to around 125 USD), and were adjusted for inflation using 2018 as the base year. The exchange rate of SEK to USD varied over the period, with an average of approximately 8 SEK to 1 USD.

We included several control variables in the regression models for decomposition analysis. *Education* has four categories: primary (64.6 percent), secondary (24.6 percent), tertiary (8.3 percent), and missing (2.5 percent). *Occupation* was operationalized using the Erikson-Goldthorpe-Portocarero (EGP) occupational schema (Erikson, Goldthorpe, and Portocarero 1979) with nine categories, including one for those out of employment or missing (17.6 percent). *Civil status* has four categories: married/cohabiting (77.7 percent), divorced/separated (10.0 percent), widowed (3.4 percent), and never married (9.8 percent). *Metropolitan county* is a dummy variable set as 1 for persons residing in metropolitan counties (Stockholm, Gothenburg, and Malmö; 34.0 percent) during working ages. Occupation, civil status, and metropolitan county were derived from six waves of census data from 1970–1990, when the age of the individual was 50–54. Table A2 shows the descriptive statistics.

Gini Decomposition

We decomposed the Gini coefficient of lifetime pensions according to explaining variables. One way to calculate the Gini coefficient (G) is:

$$G = \frac{2}{n\mu} \sum_{i=1}^{n} y_i R_i - 1 \quad (1)$$

where y_i is the lifetime income for individual i, R_i is the rank of the lifetime pension for that individual, μ is the mean of lifetime pensions of the population, and n is the number of individuals.

To identify the contributions of predicting variables to the Gini of lifetime pensions, we applied a Gini decomposition method proposed by Wagstaff, Van Doorslaer and Watanabe (2003), which has been used to decompose income inequality (Zhong 2011). This method can decompose the Gini coefficient according to multiple contributing factors simultaneously. It starts with the following linear regression model with k independent variables:

$$y_i = \alpha + \sum_k \beta_k x_{ki} + \epsilon_i \quad (2)$$

we substitute Eq. (2) into Eq. (1) and then rearrange the new equation as:

$$G = \sum_k \left(\frac{\beta_k \overline{x}_k}{\mu}\right) C_k + \frac{GC\epsilon}{\mu} \quad (3)$$

where $\overline{x}_k$ is the mean of variable k, C_k is the concentration index of variable k (using lifetime pensions as the ranking variable), and $GC\epsilon$ is the generalized concentration index for ϵ_i, which is analogous to the Gini coefficient (Shorrocks 1983). Therefore, Eq. (3) shows that the Gini coefficient of lifetime pensions of a given time can be partitioned into two parts. The first is the deterministic component. The second is the residual component, which shows the inequality in lifetime pensions that cannot be explained by the independent variables. To evaluate the contributions of the independent variables to the changes in the Gini between two cohorts, we took the difference between the two cohorts.

Counterfactuals

We calculated counterfactuals to examine how changes in pension policies and mortality may impact the inequality of lifetime pensions. Three pension policies were examined. First, increasing the minimum pension, examined by raising the minimum floor pension level to a level whereby the total yearly pension income of the entire cohort was raised by 10 percent. Second, adding a progressive tax scheme, which reduced the total yearly pension income of a cohort by 10 percent. Figure A2 shows the tax rate across levels of gross annual pension income for the 1928 cohort. Third, raising retirement ages, examined by shifting the yearly pension income variable to older ages. Fourth, we examined hypothetical changes in mortality whereby everyone lived 1–3 years fewer or more. Pensions in the additional years were assumed to be the same as those in the year before actual/forecasted death.

Results

Summary Statistics

Figure 2 shows that average remaining years of life at age 65, average annual earnings over ages 50–59, and lifetime pensions all increased steadily over the period for both men and women (see also Figure A3). Education, pre-retirement earnings, pension at age 70, and lifetime pension are moderately or strongly correlated with each other, whereas lifespan is only weakly correlated with the socioeconomic variables except for lifetime pension (Tables A3). The correlation between pensions at age 70 and pre-retirement earnings is around 0.8 for both men and women.

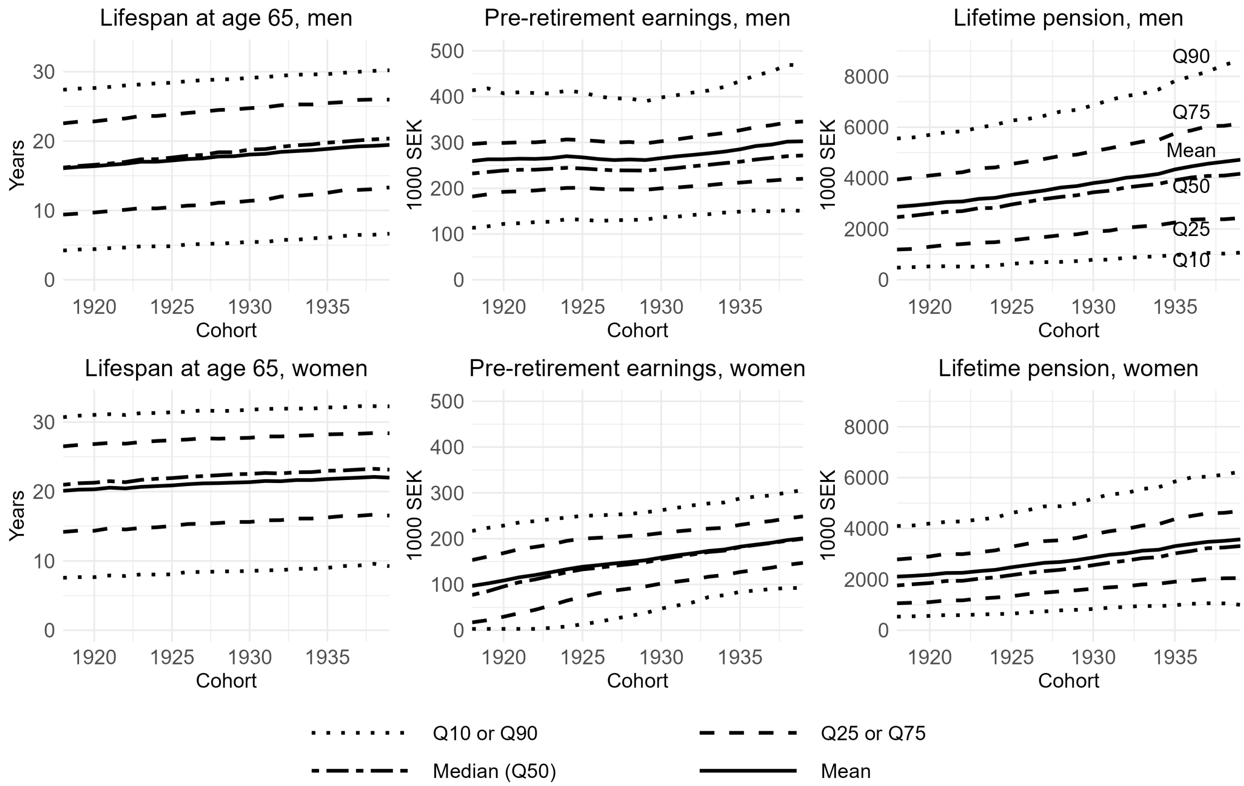

Figure 2: Summary statistics for the main variables.
Source: Authors' calculations based on Swedish register data.
Notes: The solid lines show cohort-specific means for the variables, the two-dashed lines show the medians, the dashed lines show the 25th and 75th quantiles, and the dotted lines show the 10th and 90th quantiles. Calculations for lifespans were based on forecasted mortality and pensions after the year 2018.

Lifetime pensions are strongly correlated with pensions at age 70, lifespan, and pre-retirement earnings, and moderately correlated with years of education.

Analysis of variance decomposition shows that differences in the average lifetime pensions between earnings quintiles (a division often used) explain less than 35 percent of the total variance in lifetime pensions; for education, the between-group component is less than 15 percent (Figure A4). Therefore, the vast majority of the population-level total variance in lifetime pensions is overlooked in group-level analyses, and is unexplained by mean differences in lifespans and yearly pensions across social groups.

Descriptive Accounts of Old-Age Inequality in Sweden

The left panels in Figure 3 show the Lorenz curves of four key variables for individuals born in 1918. For men, the Gini coefficient was 0.23 for pensions at age 70, 0.29 for pre-retirement earnings, 0.30 for lifespan, and 0.41 for lifetime pensions. The top-right panel displays the relative value of the outcome for each percentile, which also shows lifetime pensions are the most unequal among the four variables. The

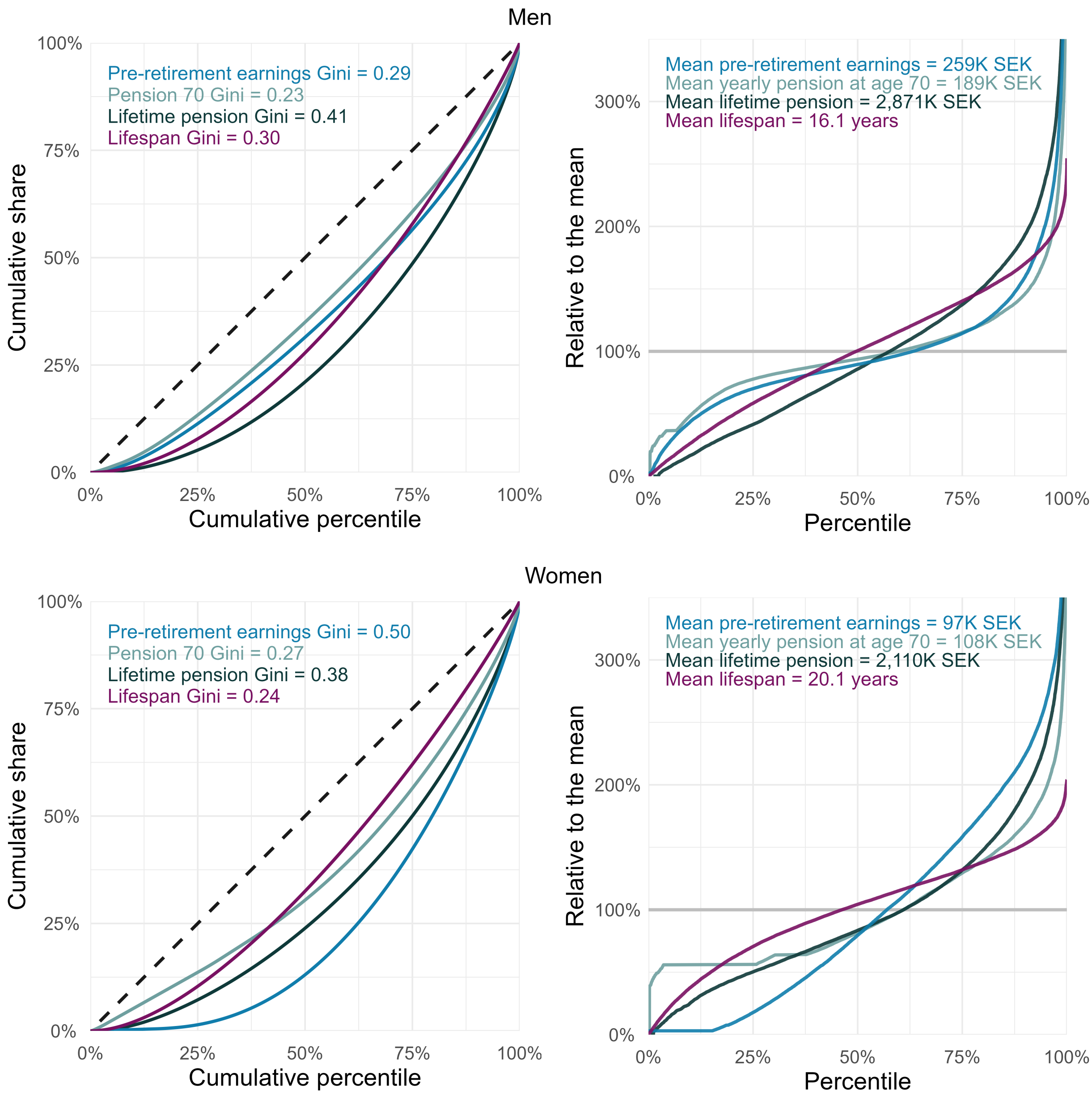

Figure 3: Inequality of the three economic outcomes for Swedish men (top) and women (bottom) born in 1918. *Notes*: The left panels show the Lorenz curves for pre-retirement earnings, pensions at age 70, lifetime pensions, and lifespan. The right panels show relative levels of the four different outcomes (pre-retirement earnings, pensions at age 70, lifetime pensions, and lifespan), as compared to the mean value of that outcome. *Source*: Authors' calculations based on Swedish register data.

differences are particularly marked in the bottom half of the distribution, where lifespans and lifetime pensions are very unequally distributed, whereas the distributions of pensions and earnings are more equal. Earnings and yearly pensions become very unequal at the very top of the distribution.

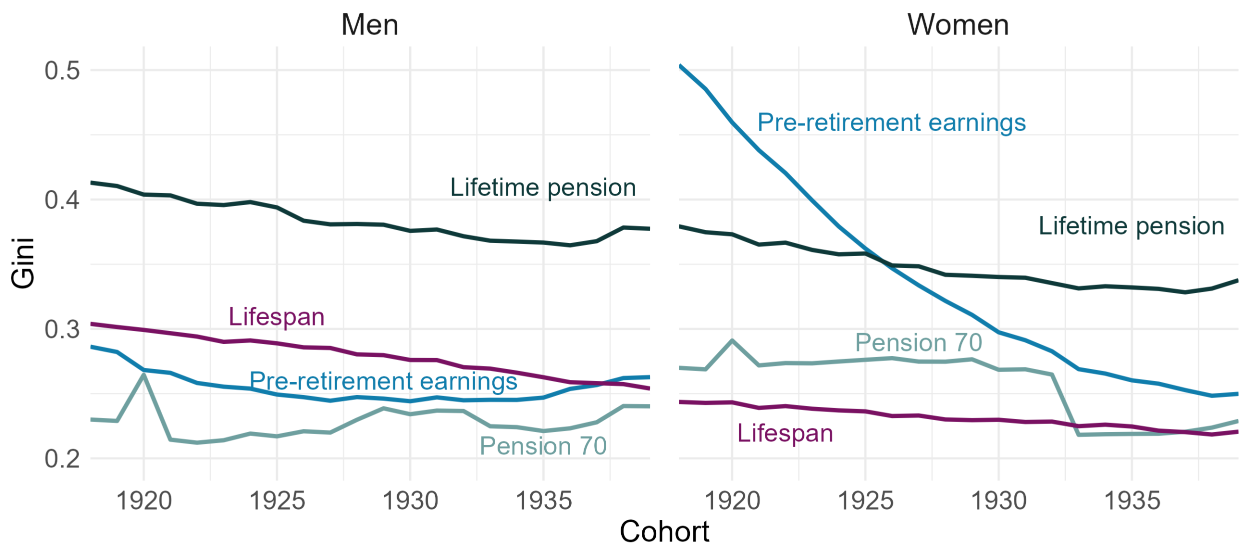

Figure 4: Gini coefficients for pre-retirement earnings, pension at age 70, lifetime pension, and lifespan. *Source*: Authors' calculations based on Swedish register data.

The results for women are different. Pre-retirement earnings had the highest Gini (0.50), whereas lifespan had the lowest Gini (0.24). The high level of earnings inequality resulted from a significant proportion of women having earnings close to zero: 15.2 percent of women had pre-retirement earnings below 3,000 SEK. The Gini for lifetime pensions for women (0.38) was slightly higher than for men. The bottom-right panel shows the large share of women having no earnings, and also shows the impact of a minimum pension, in that virtually everyone in the 1918 cohort had at least 55 percent of the mean pension (the couple-level guarantee pension), and a different group had around 62 percent (the single guarantee level). For later cohorts, the Lorenz curves of earnings for women much more closely resemble those for men, with a Gini between 0.2–0.3.

Cohort trends of the Gini coefficient for these variables are presented in Figure 4. For men, the ranking of the Gini coefficients among the variables was largely consistent across cohorts. The Gini coefficient for lifetime pensions declined from 0.41 to 0.38 from 1918 to 1939 for men. The level of inequality in lifetime pension was much higher than that of the other variables over the whole period. The Gini coefficient for pre-retirement earnings declined from 0.29 in 1918 to 0.24 in 1930, and subsequently increased to 0.26 in 1939. The Gini coefficient for lifespan decreased consistently from 0.30 to 0.25 over the period.

Clearly, for earlier female cohorts, the ranking of the Gini coefficient for these variables is different from that of male cohorts. For females born in 1918, the highest Gini coefficient was pre-retirement earnings, followed by 0.38 for lifetime pensions, 0.27 for pensions at age 70, and 0.24 for lifespan. The Gini coefficient for pre-retirement earnings fell strongly to 0.25 in 1939 due to increasing female labor force participation over the period. Initially, earnings were strongly concentrated in the rather small group of full-time working women in the early cohorts, and as this

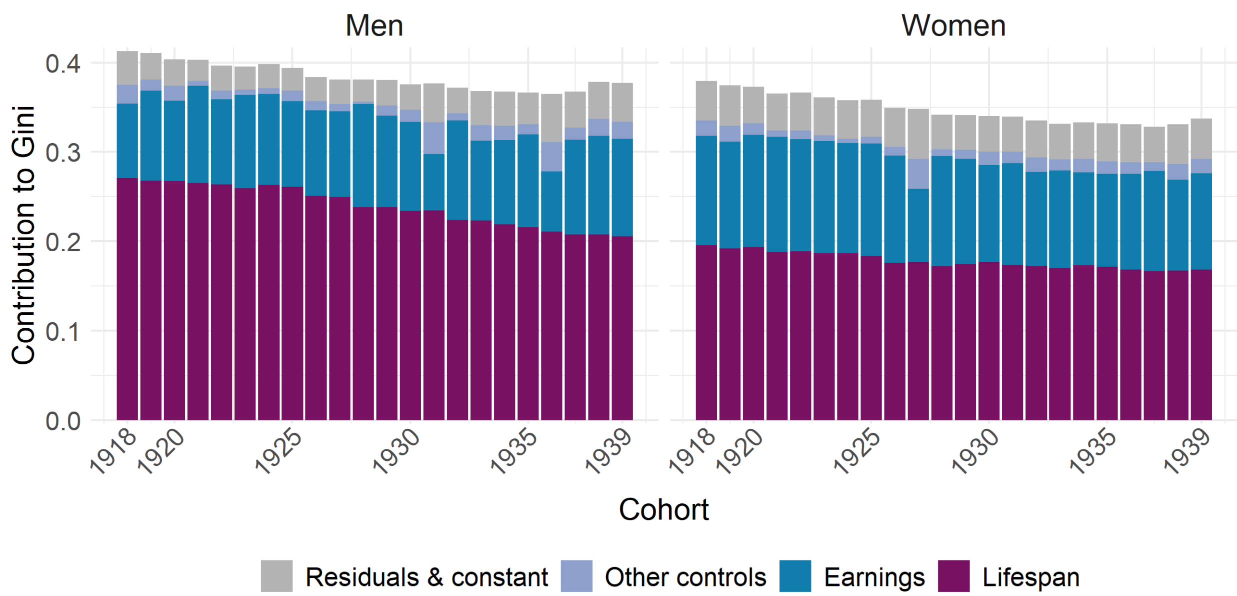

Figure 5: Decomposition of the lifetime pension Gini into contributing factors.
Source: Authors' calculations based on Swedish register data.
Notes: For the decomposition, we used the method proposed by Wagstaff et al. (2003). Other controls were education, civil status, occupation (EGP schema), and metropolitan county. See Figures A6 and A7 in the online supplement for the coefficients of lifespan and pre-retirement earnings from the regression models.

group became much larger over time, earnings were also distributed more equally. The Gini coefficient for lifetime pensions declined to 0.34 for the 1939 female cohort, higher than that of the other variables. The Gini coefficient for lifespans declined slightly to 0.22 in 1939. The pension inequality at age 70 was rather constant, but decreased for cohorts after 1933 due to reforms in the guarantee pension in 1994 (Ministry of Health and Social Affairs 2010).

We also show a set of other inequality measures such as the P90/P10 ratio in Tables A4 and A5. Additionally, the absolute difference in average lifetime pensions between men and women increased across cohorts, but the relative difference (ratio) between men and women decreased (Figure A5).

Explaining Changes in the Inequality in Lifetime Pensions

Figure 5 presents the results of decomposing the Gini coefficient (of each cohort) into components attributable to covariates (see regression coefficients for lifespan and pre-retirement earnings in Figures A6–A7). We found that lifespans are the most important source of lifetime pension inequality among all the variables. Across cohorts, the contribution of lifespans was between 0.17 and 0.20 for women, and between 0.21 and 0.27 for men. Earnings contributed more in both absolute and relative terms for women than for men. The contribution of earnings ranged between 0.08 and 0.13 for women, and between 0.06 and 0.11 for men.

Table 1: Changes in the Gini of the total pension income between the 1918 and 1939 cohorts.

	Men		Women	
	Contribution	Percentage	Contribution	Percentage
Lifespan	−0.063	191.9%	−0.022	44.2%
Earnings	0.025	−76.1%	−0.025	49.5%
Education	0.003	−9.7%	0.002	−3.3%
Occupation	−0.009	27.3%	−0.008	15.1%
Civil status	0.000	0.8%	0.002	−4.7%
Metropolitan county	0.000	1.4%	−0.001	2.6%
Residual	0.012	−35.5%	0.002	−3.5%
Total	−0.033	100.0%	−0.050	100.0%

Source: Authors' calculations based on Swedish register data.
Note: In all the calculations, inflation was adjusted to SEK in the year 2018.

Table 1 shows the contributions of different variables to the total changes in lifetime pension inequality between 1918 and 1939. For women, the Gini coefficient declined by 0.050 between the two cohorts, of which 44.2 percent was attributed to lifespan, 49.5 percent to earnings, and 15.1 percent to occupation. Other variables played a relatively minor role. For men, the Gini coefficient decreased by 0.033, which was mostly explained by lifespan. Lifespans contributed a decline of 0.063, 191.9 percent of the total change. Thus, if lifespan changes had not occurred, lifetime pension inequality would have increased, consistent with findings in the standardization approach (upper-right panel in Figure 5). Earnings contributed -76.1 percent of the total change, meaning that by eliminating the effect of earnings, lifetime pension inequality would have declined even more, inconsistent with the standardization approach (lower-right panel in Figure 5). This is mainly because the standardization approach only considers the compositional effect of earnings. Although the earnings inequality declined between the two cohorts (compositional effect), the link between earnings and lifetime pensions increased (allocation effect), which drove the Gini coefficient up. The allocation effect can be seen in the regression coefficient for earnings, which increased over time for both men and women (Figure A3).

Robustness Analysis

To test the robustness of the decomposition results, we applied additional methods. First, we used a standardization approach where the distribution of either earnings or lifespan was set to be constant across cohorts (see methods in Online supplement A1.2 and results in Figure A8). The results indicate that lifetime pension inequality would have been higher than what was observed if lifespan or pre-retirement earnings distributions had been constant. For men, changes in lifespan distribution are more important to explain the cohort declines in lifetime pension inequality than changes in earnings distribution; but for women, changes in earnings distribution are more important.

We also used two R^2-based methods, partial R^2 and decomposing the R^2. Both show how the variance in lifetime pensions is explained by covariates (see methods in Online supplement A1.3 and results in Figures A9–A10). The general patterns seen in the Gini decomposition remain. For instance, lifespan explains more than 60 percent of the variance that cannot be explained by other covariates for both sexes. Earnings explains around 40 percent of the variance when controlling for other predictors.

Impacts of Changes in Policy and Mortality on Lifetime Pension Inequality

Figure 6 presents how pension policies and mortality changes may impact the inequality of lifetime pensions. The impacts are consistent across cohorts. For illustration purposes, we will discuss the results for the 1928 cohort (details in Table A6). The observed Gini was 0.39 for men and 0.35 for women. We first examined a policy that raised the guaranteed pension by 118 percent (an increase from 61,300 to 133,400 SEK in 2018 inflation-adjusted terms) so that the total yearly pension payments to the entire cohort were increased by 10 percent. Such a policy reduced the Gini for both sexes but much more for women. The Gini for women would drop by 19.7 percent, but by only 3.6 percent for men, which is not surprising due to known sex differences in pension incomes. A progressive tax scheme (Figure A2) where the total yearly pension payments were reduced by 10 percent would reduce inequality, but only modestly.

Postponing retirement ages uniformly for the whole population would increase the inequality in lifetime pensions: A one-year increase in retirement age would increase the Gini by 3.2 percent and 2.6 percent for men and women, respectively, whereas a four-year increase would increase the Gini by 11.5 percent and 9.0 percent for men and women, respectively. Changes to the retirement age and lifespan both affect the number of years individuals receive pensions, and thus they have a relatively strong impact on the Gini of lifetime pensions. Lengthening this period with pension payments for everyone (through earlier retirement or longer lifespans) reduced inequality as it decreased the variance in the years of receiving pensions.

By definition, the Gini for lifetime pensions would remain constant if individuals at different locations of lifetime pension distribution experienced the same proportional changes. Individuals who die earlier tend to have smaller lifetime pensions, and they are more affected by such policies and lose a higher proportion of their lifetime pensions. Hence, lifetime pension inequality increases with universal increases in retirement age. Figures A11–A12 show how different scenarios would lead to proportional changes across people with different levels of observed lifetime pensions, which helps explain the direction of the changes in the Gini under different scenarios.

Discussion

Inequality in old age has many dimensions. In the current study, we examined inequality in the total pension income over the life-course and showed the relative

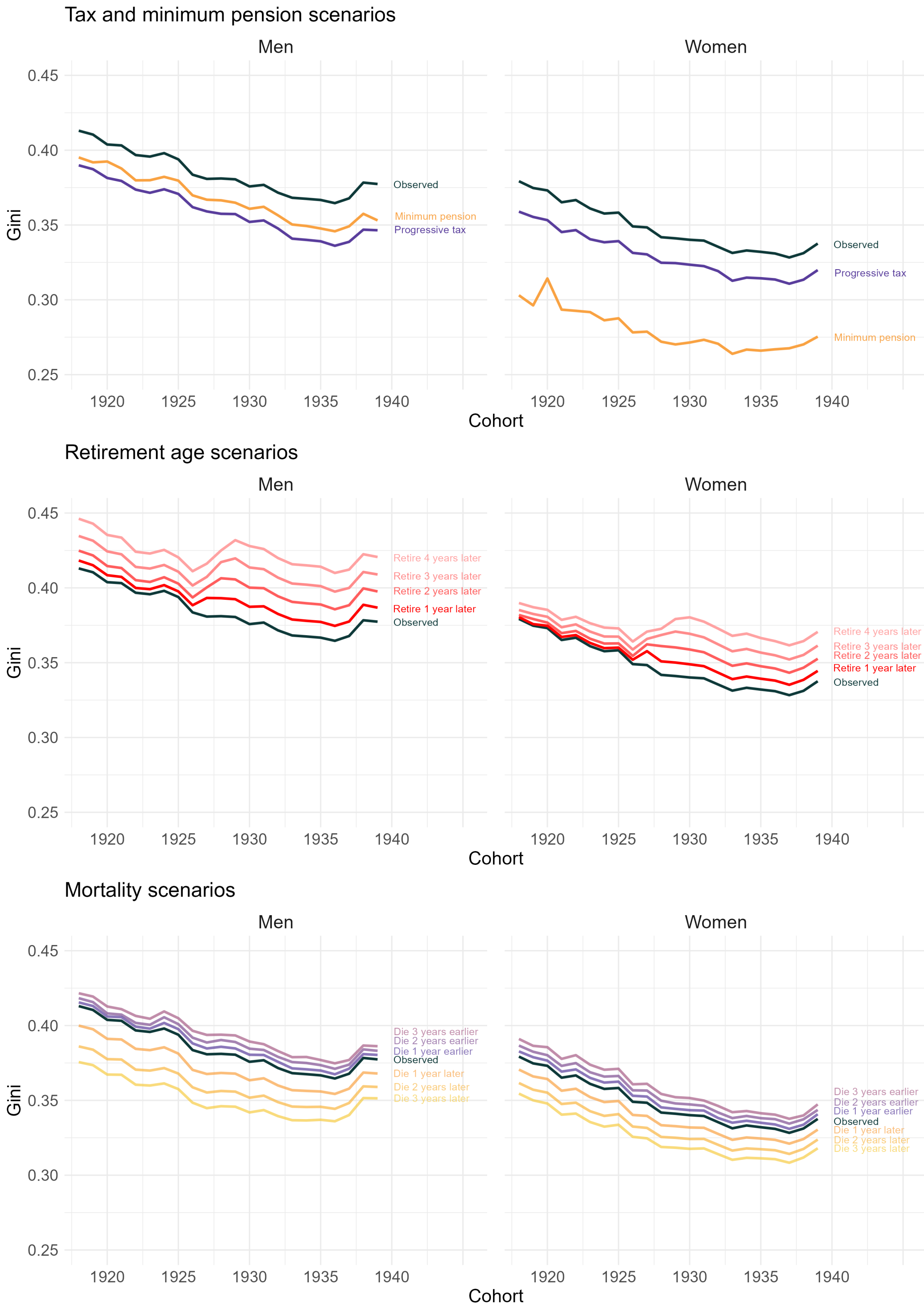

Figure 6: Counterfactual trajectories of lifetime pension Gini.
Source: Authors' calculations based on Swedish register data.

importance of factors such as mortality and pre-retirement earnings for determining lifetime pension inequality. We highlight three important findings. First, lifetime pension payments are more unequally distributed than both pre-retirement earnings and yearly pension income. Second, lifetime pension inequality is mostly attributable to lifespan inequality, and to a lesser extent to inequality in pre-retirement earnings. The effects of other socio-demographic factors, such as education, occupation, and civil marital status, are negligible once lifespan and earnings are controlled for. Third, we found a declining trend in lifetime pension inequality across cohorts. For men, this is predominantly attributable to cohort declines in lifespan inequality. For women, the role of declining pre-retirement earnings inequality—largely driven by rising female labor force participation—is on par with declining lifespan inequality in explaining the downward trend of lifetime pension inequality. We also found that the effects of pension policies on lifetime pension inequality are limited in magnitude unless they directly affect the number of years of receiving pensions.

Our findings are relevant for ongoing debates on pension design in contemporary aging populations. Reducing old-age poverty and redistributing incomes from the rich to the poor is a goal for pension designers in many welfare states. Ensuring progressive replacement rates is a common strategy to achieve such redistributive goals. On a yearly basis, we did find less inequality in pension incomes than in pre-retirement earnings, thus supporting the redistribution hypothesis of the age pattern of income inequality (O'Rand and Henretta 1999). It is not surprising that lifetime pensions are more unequally distributed than yearly pensions, because longer lifespans tend to be concentrated among people with higher yearly pension incomes. This is important for government policy, as it implies that the pension system distributes resources from those who live longer to those who live shorter. Of equally great importance is that the lifetime pension is a product of inequalities in both lifespans and yearly pension levels, and thus shows great variation across individuals. Our contrafactual analyses show that even rather large changes to the progressivity in how pensions are paid are relatively less important for total pensions when compared to changes in the timing of retirement or mortality changes that affect the number of years an individual receives a pension. This is in line with the overall great importance of lifespan for understanding lifetime pensions inequality within cohorts and its changes across cohorts.

The regressive role of mortality has been confirmed by prior research on lifetime pension inequality between socioeconomic groups (e.g., NASEM 2015; Tan and Koedel 2019). It is recently found that among Swedish men born in 1925, those with primary education accumulated on average three million SEK (around 375,000 USD) less than their counterparts with tertiary education, and mortality explained one-quarter of the total difference (Shi and Kolk, 2022). In the current study, the explanatory power of mortality in overall lifetime pension inequality is much larger than between-group differences in lifetime pensions. Hence, we highlight the importance of inequality in mortality (mostly within but not between social groups) as one of the most fundamental aspects of old-age inequality. Lifespan variation is a fundamental factor determining the size of total pension payments to individuals, and it profoundly impacts the ways pension systems work.

Pension systems have several goals. Some of them counteract each other. In particular, in this study, we highlight one dimension of pension systems: the insurance function. This ensures an adequate yearly stream of income regardless of how long individuals live (i.e., resources are redistributed from the short-lived to the long-lived), and it has a crucial impact on inequality in the total pensions. As this is one of the explicit goals of pension systems, it is both "a feature and a bug" of pension systems. Nevertheless, it deserves to be highlighted and quantified, as it is of critical importance, and it is important to understand the social role of pensions. The fact that mortality is the most important contributing factor (net of prior earnings, education, occupation, and other life-course determinants) means that the insurance goal dominates other pension goals.

We argue that it is impossible to think about fairness and inequality in old age without taking account of both demographic and socioeconomic differences, as well as how they interplay. We showed that most of the regressive effect of mortality takes place at the individual level rather than at the group level, the latter of which has been the topic of most research on unequal distributional aspects of pension systems. Thus, within-social-group mortality heterogeneity deserves more attention in further research on pension inequalities.

The pension amount a person receives is likely a reasonable approximation of their consumption needs over their lifespan. Our calculations of total pensions are useful as a benchmark for how much resource (through savings, inherited wealth, within-family transfers, or capital stocks, such as housing) an individual needs to save to cover their consumption needs in retirement in the absence of a pension system. We show that there is marked variation and inequality across individuals regarding this amount, and consequently, relying on fixed savings that are not annuitized (e.g., housing, savings, or money paid in a lump sum at retirement) is highly risky as an individual strategy. Thus, our approach illustrates the social utility of pension systems as a form of longevity insurance. It also shows just how substantial a role a modern high-income country's pension system has in transferring resources from the short-lived to the long-lived (and the important inequalities that may arise from such transfers).

This study also provides new perspectives on the social stratification literature. First, our study can help elucidate research on wealth inequality. Comparative studies have shown that the magnitude of wealth inequality varies considerably across countries, with Sweden (with a Gini over 0.85) being one of the most unequal (Pfeffer and Waitkus 2021). Such cross-country variation can be partly explained by differences in welfare systems. In a country like Sweden with a generous (and non-optional) welfare and pension system, those with average and lower SES have less incentive to accumulate wealth over the course of their lives, as the welfare system protects them against contingencies such as old age and disability (Domeiji and Klein 2002). Rankings of countries in studies on wealth inequality typically do not include the present value of pensions, which may result in differences in how countries are ranked (Pfeffer and Waitkus 2021). Different measures (i.e., net pension wealth, total wealth with and without net pension wealth, lifetime-accumulated pensions) are conceptually different. In future work, it would be interesting to explore how inequality levels vary across different measures and interplay with each other.

Second, our study highlights an important subpopulation, the retirees, who deserve more attention from social stratification scholars. Because of population aging, inequality at post-retirement ages is an increasingly important component of the social stratification system. Systematic mortality differentials according to socio-demographic characteristics make it necessary to incorporate mortality into the analysis of pension inequality. Examining lifetime pension inequality, therefore, provides a broader perspective on old-age inequality. Moreover, lifetime pension inequality may be translated into inequalities in end-of-life assets and bequests whereby economic inequality is reproduced across generations. Intergenerational social immobility may therefore be partly explained by lifetime pension inequality in which mortality differentials play a crucial role. This intergenerational aspect could be more thoroughly examined in future work.

Another important perspective is that a shrinking lifespan distribution alone reduces lifetime pension inequality. Previous research using period data has shown an increasing trend of lifespan inequality among older people in developed countries (Engelman, Canudas-Romo, and Agree 2010; Permanyer and Scholl 2019), in contrast to overall lifespan at birth, where the variance is decreasing and the shapes of survivorship curves are becoming more "rectangularized" (Myers and Manton 1984). Using cohort data, Engelman et al. (2010) showed that in Sweden, the variation in remaining years of life at ages 50 and 75, measured using standard deviation, plateaued for women and slightly increased for men between 1900–1916. To the best of our knowledge, no study has shown cohort trends of old-age lifespan variation measured by the Gini coefficient. In contrast to previous findings, we have shown that lifespan variation at age 65 declined across Swedish men and women born between 1918–1939.

In our results, the declining lifespan variation among retirees contributed significantly to the decline in lifetime pension inequality. Future work may examine whether cohort trends in lifespan inequality at older ages in other countries are similar. If so, lifetime pension inequality in those countries may also decline accordingly. If lifespan variation has indeed widened in other countries, it may lead to negative consequences for inequality at old ages, as the population-level variation in age at death is such an important determinant of total pensions. Consequently, the trends in lifetime pension inequality in other countries would probably be the opposite of what was observed in our study. This is an important topic for future research. In light of the importance of lifespan inequality, we want to stress that it is noteworthy that the lifetime pension inequality in all contexts is persistently larger than other types of inequality (except wealth). It seems likely that mortality trends thus will impact pension inequality in very substantial but also non-obvious ways, which may override the importance of other changes in pension design and income inequality. The important role lifespan inequality plays in affecting differences across both cohorts and social groups in terms of inequalities in how much total pension is paid is likely not known among governments and policymakers when they design pension policies, and this may give rise to unintended consequences. The substantial redistribution of income from individuals (with often similar contributions to the pension system) with worse health and short lives towards those with better health and longer lives is substantial. We show that most of this effect takes place at the individual level (through individual level differences in life span), rather than at the group level (e.g. across educational groups).

Several features of our dataset should be noted when interpreting our results. First, our analysis was restricted to Swedish-born individuals. Although Swedish-born individuals constitute the majority of these earlier cohorts, it is interesting for future research to explore how including migrants affects the results. Second, we studied inequalities among individuals who survived to age 65. Lifetime pension inequality would be larger if the analysis begins from younger ages, considering the potentially large number of individuals who contributed to the pension system but died before pensionable ages. Third, lifetime earnings would be a better measure of prior earnings than the one used (average earnings over ages 50–59). Given that low-SES individuals tend to start and stop working earlier than their high-SES counterparts, our measure better captures lifetime earnings for high-SES than for low-SES individuals.

Fourth, our study used a joint variable with all kinds of pension payments—both a strength and a weakness. It is plausible that different components of pension systems play different, and even contradictory roles in generating inequalities in total pensions. For instance, poverty alleviation through guarantee pensions would help at the lower end of the earnings distribution (those most likely to be suffering from shorter retirement spans), earnings-related public pensions (including NDC adjustment) would reproduce inequalities (and not compensate for mortality disadvantages), funded pensions would provide savings that do not insure against longevity risks unless transferred into annuities. It would be interesting for future studies to examine how these contradictory pension instruments and goals drive the future trends of pension inequalities. In particular, in the context of rising life expectancy, like many other OECD countries, Sweden introduced an NDC system in the 1990s to ensure intergenerational fairness and pension sustainability (Palme 2005). It is unclear how this will impact redistribution and lifetime pension inequality. The cohorts in our study were largely exposed to earlier, relatively uniform DB pension systems. Hence, we could not assess the impacts of different pension systems. Future work may extend our research to incorporate more recent cohorts who have been affected by the new systems.

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