The increasing longevity gap - Distributional implications for the pension system *

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In this paper we exploit social security records from the German Pension Insurance to document the heterogeneity in life expectancy by lifetime earnings and we analyze how the the lifetime gap by lifetime earnings has evolved between different cohorts. In line with previous studies we provide evidence that the earnings related lifetime gap is increasing. This increase is especially pronounced for men, somewhat smaller for East German women, and is not present for West German women. We then propose a decomposition to disentangle the role of the increasing earnings inequality between the cohorts and the effect of changes in the earnings gradient on life expectancy. Finally, we study the distributional implications of the increasing lifetime gap for the pension system. First, we show how the heterogeneity in life expectancy affects the distribution and the inequality of social security wealth and we document how this has evolved between the cohorts. Second we calculate internal rates of return of the pension system and compare the rates by lifetime earnings and between cohorts. We find that the inequality in the social security wealth and in the internal rate of return of the pension system is increasing.

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1 Introduction

During the last decades most OECD countries have seen a strong increase in the inequality of earnings, consumption and wealth, see, e.g. Katz and Autor (1999), Krueger and Perri (2005) or Piketty and Saez (2007). Moreover, recent studies have confirmed the increase in inequality when studying lifetime earnings. For example Kopczuk, Saez, and Song (2010) for the US or Bnke, Corneo, and Lthen (2015) for Germany use social security records and document that inequality of lifetime earnings has been increasing over time and between cohorts.

At the same time there exists striking evidence that life expectancy is highly correlated with different measures of income and wealth. Studies have documented that life expectancy is increasing with wages, income, wealth, or eduction see e.g. Cutler, Deaton, and Lleras-Muney (2006), Lleras-Muney (2005), Chetty. Consistent with the increase in earnings inequality several studies provide evidence that the earnings related lifetime gap has been increasing over time Kiebele, Jasilionis, and Shkolnikov (2013), or Chetty, Michael Stepner, and Cutler (2016).

In this paper we provide novel evidence about the increasing lifetime gap. In particular, we exploit social security records from the German Pension Insurance to document the heterogeneity in life expectancy by earnings over the full working life and we analyze how the lifetime gap has evolved between the cohorts 1905 and 1944. Further, in order to better understand the increase in the lifetime gap we use a decomposition to disentangle the role of the increasing earnings inequality and the effect of changes in the earnings gradient on life expectancy. Finally we study the implications of the increasing lifetime gap on the distributional effects of the pension system. In particular, we analyze how the cohort specific increase in the lifetime gap affects the distribution of the social security wealth and of the internal rates of returns.

Our paper extends the previous literature in several dimensions. First, we focus on a longer time period than previous studies and document the increase in the longevity gap by gender and region for the cohorts 1905 until 1944. Second, the decomposition analysis provides important insights why the longevity gap has been increasing. In particular, we show if the increase in the longevity gap is explained by the increasing earnings inequality between the cohorts or if the earnings gradient has changed. Third we provide novel evidence about the role of the pension system. It has been previously documented that earnings related heterogeneity in life expectancy can offset the distributional effects of a progressive pension system as implemented in the US (see e.g. Feldstein and Liebman (2002),) or can lead to regressive effects in a proportional system as currently in place

in Germany (see, e.g. Breyer and Hupfeld (2010), **?**, or Gustman and Steinmeier (2001). We extend this literature and show how the distributional effects of the pension system have changed between the different cohorts.

The paper is organized as follows. In the next section we introduce the data from the German pension insurance which we use for our analysis and provide information about the institutions of the German pension insurance. Then we introduce the method we use to estimate cohort specific mortality rates and how these depend on lifetime earnings. Based on this method we estimate the cohort specific heterogeneity in life expectancy separately for men and women and for East and West Germany and we document how the earnings related lifetime gap has evolved over the cohorts. In the final section we link theses findings to the pension system and analyze the distributional implication of life expectancy for the pension system.

2 Data

In this section we describe the data from the German pension insurance which we use for our analysis. In addition we provide some institutional background about the German pension system and relevant pension reforms.

2.1 The German Pension Insurance Data

We use several administrative data sets from the German pension insurance. Due to its mandatory nature, the pension insurance records monthly information on working lives and pension prospects of 80% of all West German men (BCL, 2015). Due to a large share of housewives in older cohorts, information on West German women is not as reliable and their socioeconomic situation is not reflected well in the pension accounts. East Germans are slightly better represented. Since there was full employment for both sexes in the GDR, most of them have a complete employment biography (at least until the fall of the iron curtain). However, the pension system of the GDR included voluntary components and pension information of East Germans is not as representative of the overall earnings situation as it is for West Germans.

The pension insurance also records retirees time of death. In the first part of our analysis, we merge that information with data on the retiree stock. Both data sets stem from the topic area file SUFDemographie2013, which contains 1% (survivors) and 10% (decedents) samples for calendar years 1993-2013. To get sufficient numbers of observations, we select cohorts 1910-1945. This leaves us with about 1.5 million surviving and 0.5 million decedent West German men.

Further, we want to look at how differential mortality affects the payouts of the pension system. Therefore, we calculate rates of return of pension contributions. This requires information on all contributions as well as pension prospects and their exact timing. We employ waves 2002-2011 of the Versicherungskontenstichprobe (VSKT), which includes complete monthly employment biographies for cohorts 1935 until 1983. To get an overlap with the results on differential mortality, we select cohorts 1935 to 1945. We follow Lüthen (2015) and exclude individuals with special pension arrangements like miners or self-employed as well as those with more than 25 years of missing information in the main employment phase between 30 and 60. This leaves us with about 3000 men (see Appendix A for further details on sample selection and numbers of observations).

[SOME TABLE]

2.2 Institutional background

[TO BE COMPLETED]

3 Heterogeneity in life expectancies

In this section, we first discuss the methodology that we use in order to extract the information on the survival probabilities and life expectancies from our data. We proceed with a presentation of life expectancies at the statutory pension age 65 by cohort groups and earnings point deciles. In a decomposition analysis, we show to what extend changes in the intra-cohort heterogeneity of life expectancies can be attributed to the rise in inequality of individuals' earnings biographies.

3.1 Method

We estimate conditional mortality probabilities based on a logistic probability model. In line with the structure of our data, we regress a variable that indicates death (i.e. discontinuation of a pension) within the following 12 months (December to November of the following year) on a age variable that indicates age on November 30th. We assume that the mortality rate is a function of a 4th order polynomial of the age variable. This functional form assumption is strongly supported by the comparison with a non-parametric specification (see figure XXX in the Appendix). The parametric assumptions allow us to also account for cohort groups, earnings point deciles, and their interactions

in the probability model:

$$\text{Prob}(\text{death}_{itcd}) = \Lambda\left(\beta_0 + \sum_{p=1}^{4} \beta_p \text{t}^p + \eta_c + \mu_d + \nu_{cd}\right) \tag{1}$$

where $\Lambda(\cdot)$ is the logistic distribution function and individual i is in cohort group c and in earnings point decile d. The variable/subscript t indicates the individual's age on November 30th. Cohorts are grouped into eight 5-year birth cohort groups ($1905 - 10, 1915 - 19, \ldots, 1940 - 44$).

The model is estimated by the method of maximum likelihood. Based on the model and the parameter estimates (see Appendix XXX), we predict conditional mortality rates for a grid of age $\times$ cohort group $\times$ earnings point decile. The age grid is running from age 65 to age 99. We assume that individuals die with probability 1 in the year they turn 100. Using the implied conditional survival probabilities, we can compute life expectancies at age 65 by cohort groups and earnings point deciles. We can also use the conditional survival probabilities directly in order to compute pension wealth at age 65 by cohort groups and earnings point deciles as well as the respective internal rates of return of the pension system.

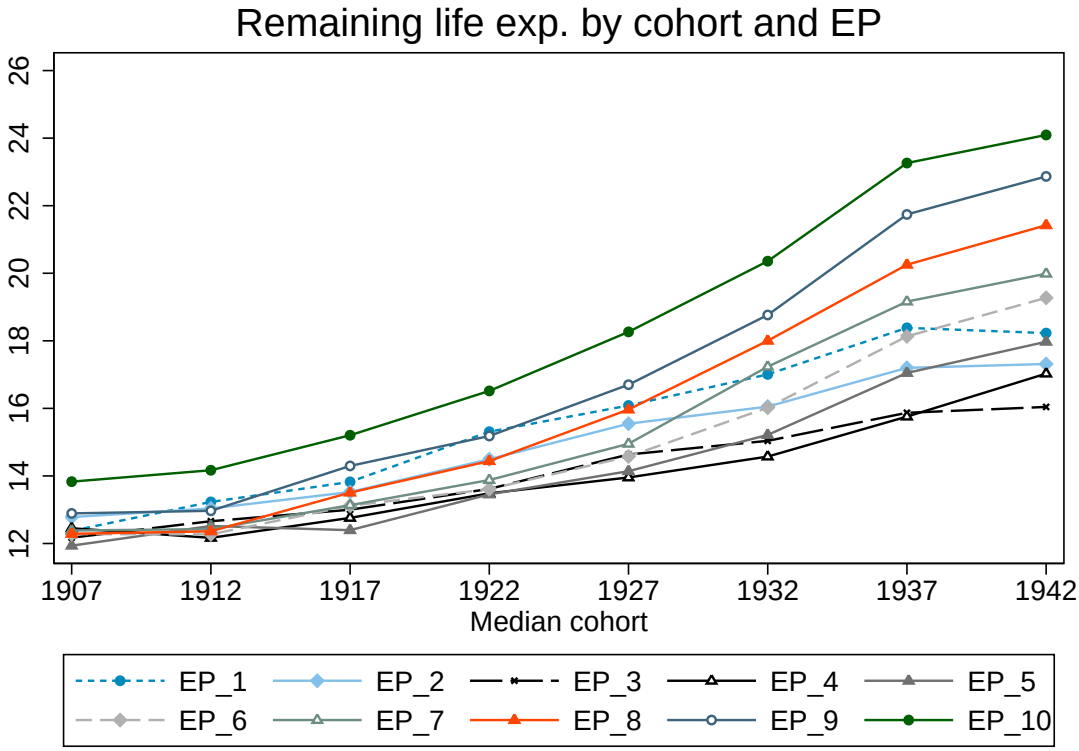
3.2 Cohort specific life expectancy by earnings point deciles

We present the life expectancies at the legal retirement age of 65. The estimations are based on the methodology discussed in the previous subsection. This analysis not only allows us to study the within-cohort heterogeneity in life expectancies, but also shows the pronounced cohort trends of this heterogeneity. We make the analysis separately by region of residence (West and East Germany) and by gender.

3.2.1 Males

Figure 1 shows life expectancies for West German men. While we find comparatively little heterogeneity by earnings point deciles for the oldest cohort group born between 1905 and 1910 (about two years between the decile with the lowest and the decile with the highest life expectancy), this changes dramatically over time. For the cohorts born between 1940 and 1944, we find a difference of almost nine years. This not only suggests that the conditions of life must have changed quite differentially for individuals in the different deciles, it also points to substantial distributional effects through the longevity insurance provided by the pension system (see second part of the paper).

Figure 1: Life expectancies of West German men at age 65



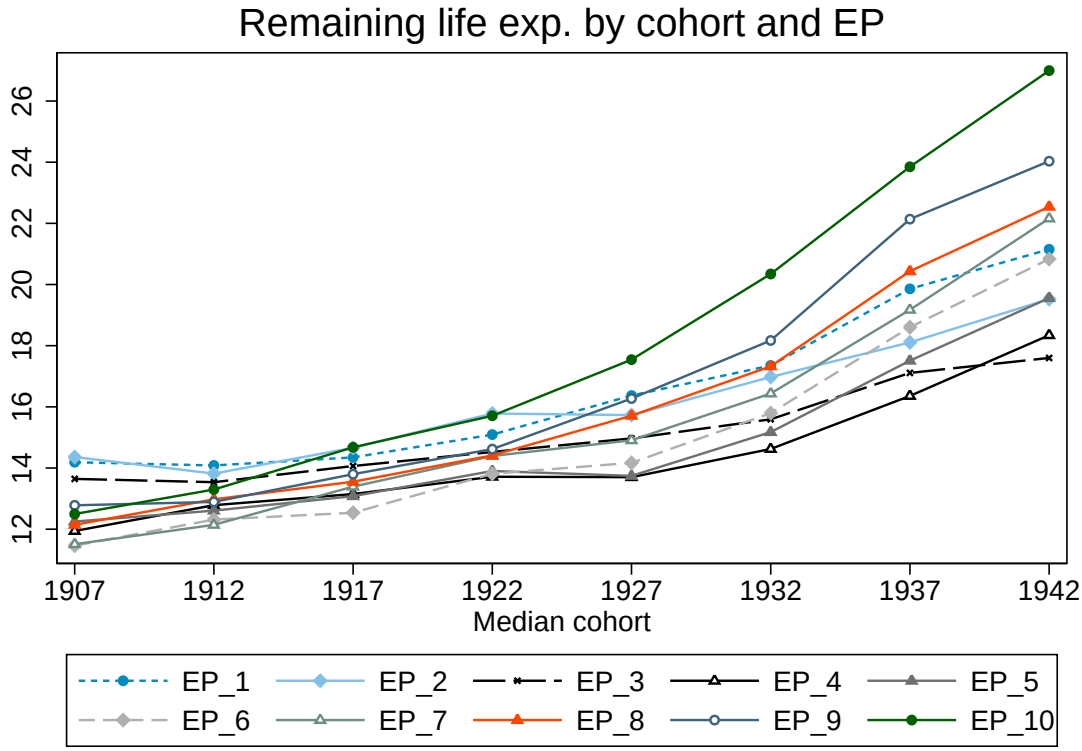
We observe a cohort trend of rising life expectancies for all earnings point deciles. However, this trend is markedly stronger for individuals in the higher earnings point deciles. Between the cohorts from 1907 and 1942, we "only" see a rise in life expectancy by 3 to 4 years for the lower deciles. For the highest decile, however, the rise in life expectancy amounts to about ten years in the same period of time.

We see a fairly similar picture for the East German men (see figure 2). This is interesting because their life courses have been quite different. The heterogeneity in life expectancies even seems to be slightly larger than for West German men.

3.2.2 Females

We find much less heterogeneity in life expectancies by earnings point deciles for West German women. This meets our expectations because for these women education and

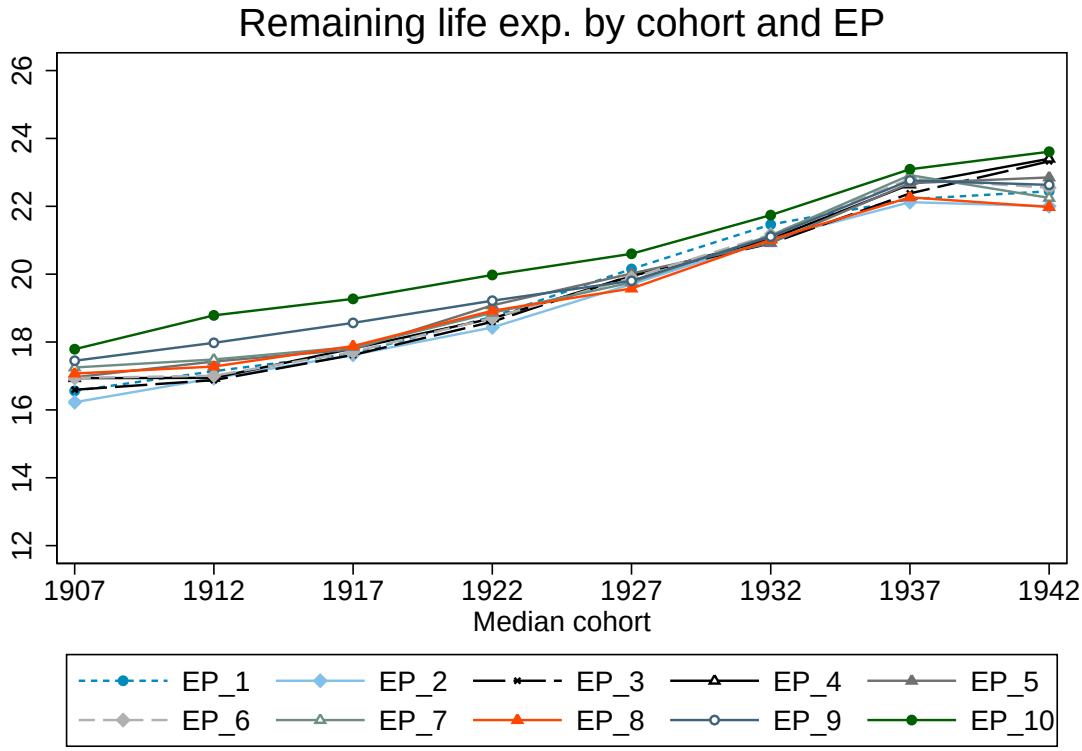
Figure 2: Life expectancies of East German men at age 65



social status correlate much less with their pension claims than this is the case for men. Both factors have been found to be crucial determinants of life expectancy. The within-cohort variation by deciles amounts to about 2 years. Interestingly, we do not see a conclusive cohort trend in the heterogeneity of the life expectancies. If there is such a trend at all, the heterogeneity has decreased over time.

For East German women, we find a picture that is somewhat in-between the one that we observe for West German women and the one that we observe for men. The heterogeneity in life expectancies is increasing over cohorts. The level of heterogeneity starts off from a lower level than we observe observe for men or even West German women and, then, approximately triples between the cohorts from 1907 and 1942. The overall level of inequality is still substantially smaller than for men. The life expectancy at age 65 ranges between 21 and 25 years for the 1942 cohort.

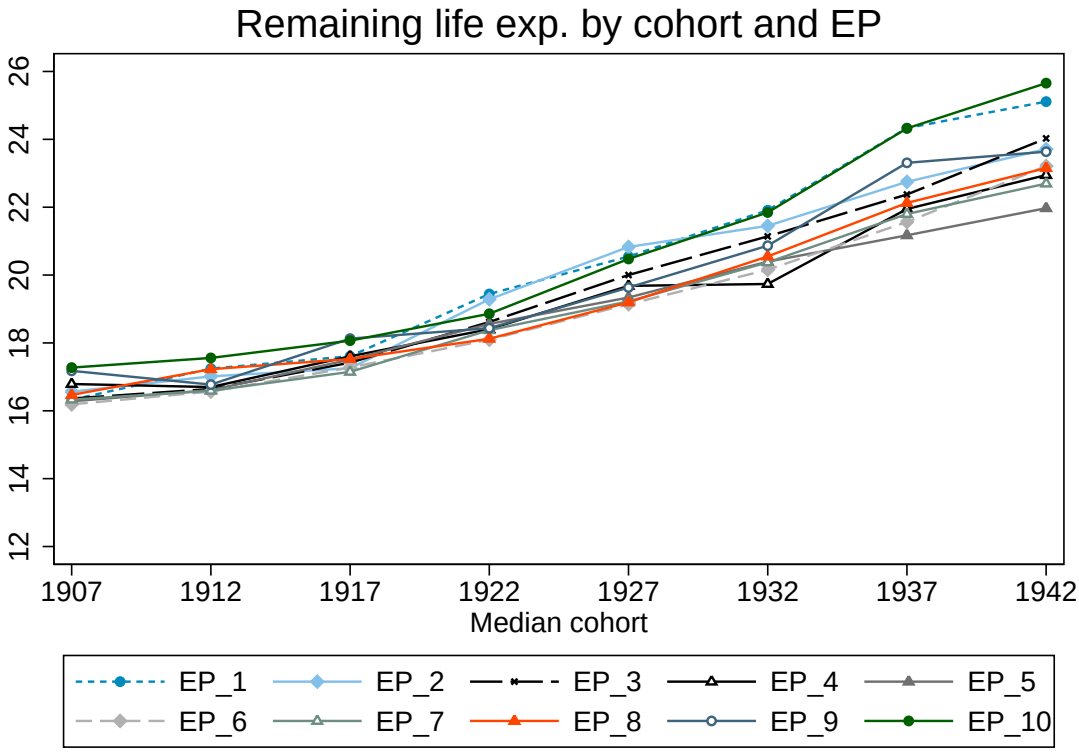
Figure 3: Life expectancies of West German women at age 65



3.3 Decomposition

[TO BE COMPLETED]

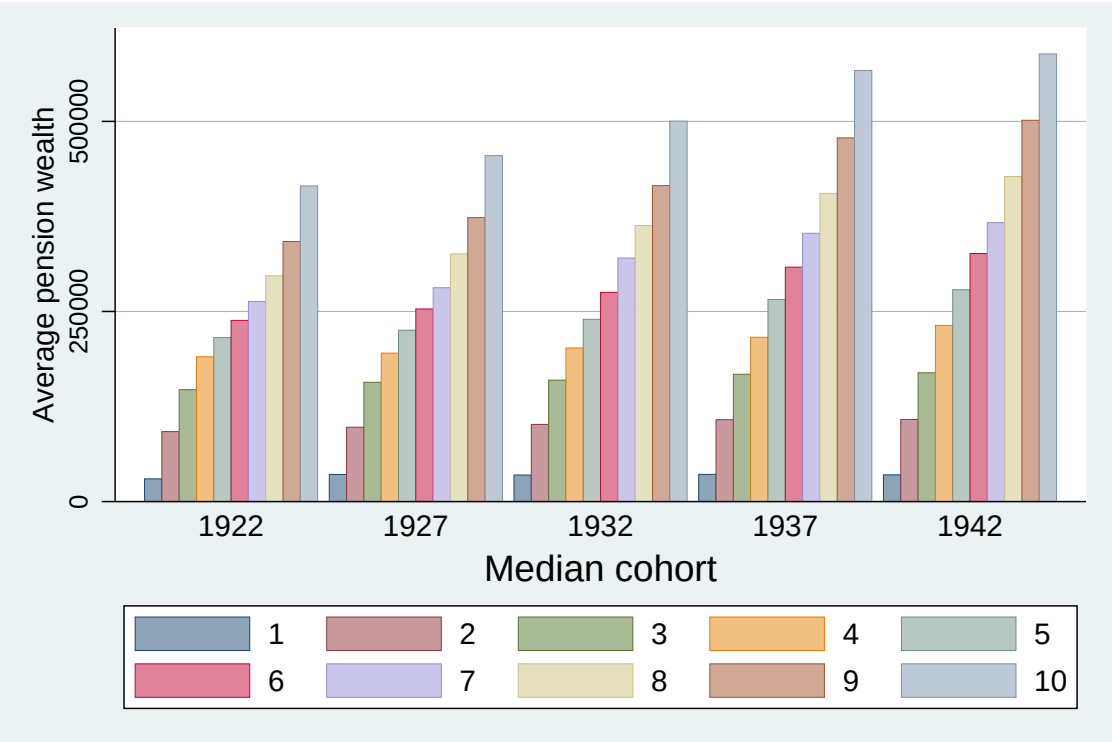
Figure 4: Life expectancies of East German women at age 65



4 Implication of life expectancy for the pension system

4.1 Inequality of Social Security Wealth

Figure 5: Average pension wealth at age 65 by decile over cohorts



Annotation: Real 2015 values. All five median cohorts are grouped into 5-cohort groups, i.e. cohort 1922 is an average of cohorts 1920-1924.

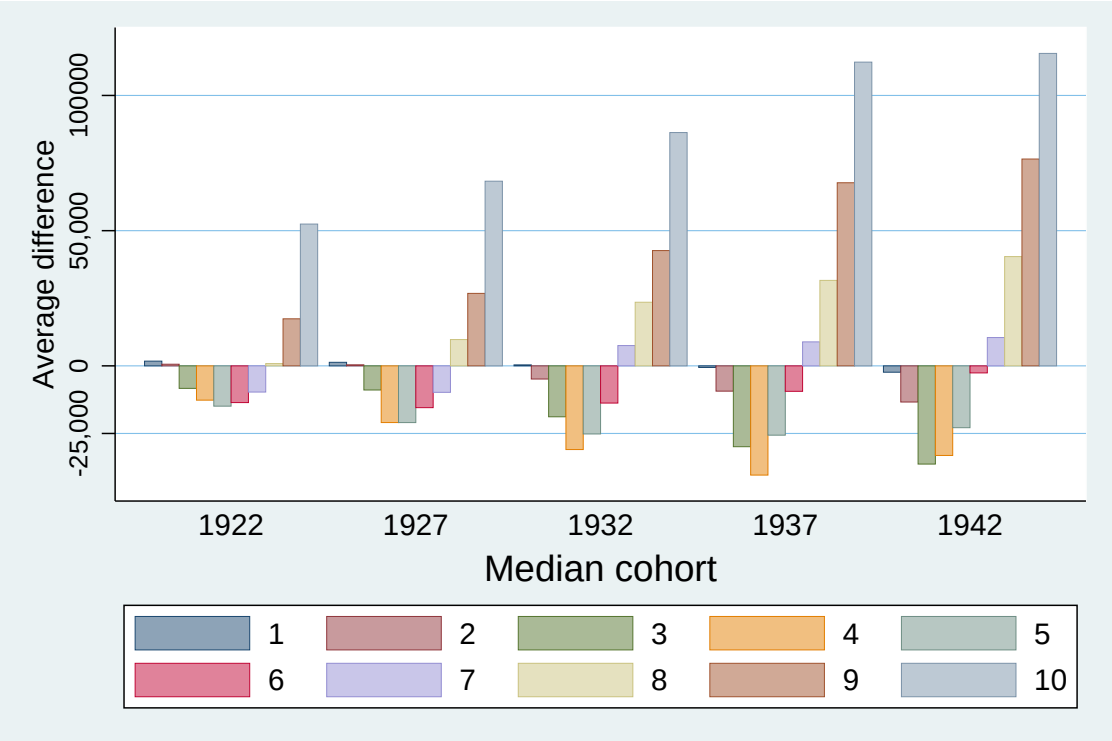
This section shows some details about the average pension wealth across deciles and cohorts. The pension wealth is constructed by calculating the pension from age 65 up until age 99 while regarding the decile-specific mortality rate. All pensions are 2015 real values, with pension received after 2016 are assumed to stay constant in 2016 real values. Figure 5 displays the distribution of pension wealth by decile over five different cohort groups. Pension wealth differs greatly by decile, ranging from nearly 0 for the lowest groups up to more than 600,000 for the highest decile of the youngest cohort. Further, it becomes apparent that pension wealth increases greatly across cohorts. TO DO: Show role of increasing life expectancy vs. developments in the pension system + condition on age 65.

Table 1: Ginis of pension wealth at age 65 with and without differential mortality over cohorts

Cohort	1922	1927	1932	1937	1942
Gini under					
differential mortality	29.14	29.06	30.39	31.19	32.65
average mortality	26.42	25.47	25.69	25.29	26.41

Annotation: Real values. All five median cohorts are grouped into 5-cohort groups, i.e. cohort 1922 is an average of cohorts 1920-1924. Gini is multiplied by 100.

Figure 6: Difference between pension wealth at age 65 with and without differential mortality by decile over cohort



Annotation: Real 2015 values. All five median cohorts are grouped into 5-cohort groups, i.e. cohort 1922 is an average of cohorts 1920-1924.

The distribution also becomes more unequal and grew from a Gini of 0.29 to a Gini of 0.33. This growth in pension wealth inequality can be solely regarded to the increase in differential mortality: Column 2 of table 1, which display the distribution of pension wealth while applying average mortality rates, not only shows greater inequality but also no trend. The differences between the two values of pension wealth, one with and one without differential mortality, are displayed in Figure 6. These values are shown to be increasing over cohorts.

4.2 Distribution of internal rates of returns

[TO BE COMPLETED]

5 Conclusion

In this paper we provide novel evidence about the increasing lifetime gap. In particular, we exploit social security records from the German Pension Insurance to document the heterogeneity in life expectancy by earnings over the full working life and we analyze how the lifetime gap has evolved between the cohorts 1905 and 1944. Further, in order to better understand the increase in the lifetime gap we use a decomposition to disentangle the role of the increasing earnings inequality and the effect of changes in the earnings gradient on life expectancy. Finally we study the implications of the increasing lifetime gap on the distributional effects of the pension system. In particular, we analyze how the cohort specific increase in the lifetime gap affects the distribution of the social security wealth and of the internal rates of returns.

For men, we observe a cohort trend of rising life expectancies for all earnings point deciles. However, this trend is markedly stronger for individuals in the higher earnings point deciles. Between the cohorts from 1907 and 1942, we "only" see a rise in life expectancy by 3 to 4 years for the lower deciles. For the highest decile, however, the rise in life expectancy amounts to about ten years in the same period of time. For West German women, we find much less heterogeneity in life expectancies by earnings point deciles and no cohort trend. For East German women, we see a picture that is somewhat in-between the one that we observe for West German women and the one that we observe for men.

Taking into account differential mortality rates in the computation of pension wealth, the distribution becomes substantially more unequal. A comparison of pension under differential mortality with a hypothetical scenario of homogenous mortality rates shows how the inequality increased over cohorts.

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