Longer and Increasingly Unequal Lifespans in OECD Countries: Implications for Social Security and Retirement Policy[†]

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Abstract

This paper analyzes the trends in retirement lifespans in 26 OECD countries in the context of the ongoing efforts to reform public pensions. We investigate mean remaining years of life and lifespan inequality at age 60 across birth cohorts 1900-1960. In most countries life expectancy is increasing rapidly and the distribution of retirement lifespan is widening. We analyze how policy makers can balance the demographic trends by adjusting the entitlement age for full pension benefits. For selected countries (United States, Germany, Japan and Belgium), we derive the inter-generationally fair entitlement ages and compare them to the actual adjustments (if any) that have been implemented.

Keywords: Public Pensions, Entitlement Age Reform, Mortality, Inequality, OECD Countries.

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1 Introduction

Clear signs of population aging, such as a rising median age and old-age dependency ratios, are now evident in most countries. This trend is expected to accelerate dramatically in the coming decades, especially in developed and transition countries (e.g., Bloom and Canning, 2008).[1] Longer average lifespans for each successive cohort due to declining mortality profiles are contributing to this aging phenomenon (e.g., Yin and Bennett, 2012).

The amount of resources societies will have to make available for future generations of retirees will crucially depend on the distribution of remaining lifespans at retirement age. For example, estimates for the United States suggest that every year in life expectancy increases the outlays of the Social Security program by approximately 1 billion dollars. Without adjustments, the Trustees of Social Security expect that over a 75-year period, the program would require additional revenue equivalent to $8.6 trillion in present value dollars to pay all scheduled benefits (SSA-T 2012).

Looking at average life expectancy, however, provides an incomplete picture of how mortality at old age is affecting individuals' retirement well-being and, in turn, the finances of public pension programs. Individuals who live longer tend to be healthier and have higher lifetime earnings (e.g., De Nardi et al. 2009). Consequently, they also have a greater (annual) claim on pension wealth compared to individuals with average mortality from the same birth cohort.[2] For that reason, the variation or inequality of remaining lifespan is of particular interest.

In this paper we investigate the changing distribution of (remaining) lifespan at retirement age and the challenges for public pension systems that flow from the demographic trends. We employ estimates of cohort mortality for 26 OECD countries and predict the distribution of the remaining years of life at age 60. In most countries, age 60 is an important milestone in the life course. Labor force participation rates tend to fall rapidly after age 60 and workers gain eligibility to collect (reduced) retirement benefits around this age (Gruber and Wise 2005; SSA 2008/2009).[3] Many countries have responded to rising

[1] Estimates for the US suggest that there are currently 2.8 workers for each Social Security beneficiary. By 2033 there will be 2.1 workers for each beneficiary.

[2] We note that the health-earnings relationship is thought to be bi-directional.

[3] For example, in the U.S. workers are eligible for early benefits at age 62.

retirement lifespans with increases in the Full Retirement Age (*FRA*), the age at which public pension beneficiaries are eligible for their full benefits. We will analyze to what extent the *FRA* are sufficient, adopting the perspective of inter-generational actuarial fairness. We will also analyze the implications of rising inequality in retirement lifespans on public pensions.

Demography has a long tradition of analyzing the distribution of lifespan at birth. The seminal work in this area shows a pattern of rising average lifespan with declining variability over time as advances in medicine and hygiene significantly lowered mortality risks early in life (Fries 1980; Myers and Manton 1984; Wilmoth and Horiuchi 1999; Kannisto 2000, 2001).[4] Using historic data on Sweden, Japan and the United States, Wilmoth and Horiuchi (1999) compare 10 measures of (absolute) variability and show their close correlation.[5] The remaining lifespan at traditional retirement ages (age 60 or 65) and its variability has received less attention. Research on mortality among the oldest old shows significant extensions in longevity over time; however, the pace of longevity progression differs greatly within countries (e.g., across gender lines) and across (Thatcher et al., 1998).

Individuals who reach retirement age are a more homogenous group as a result of mortality selection (Vaupel et al. 1979). However, the composition of the population of individuals who reach a given (nominal) longevity milestone, say age 60, has changed (e.g., Sanderson and Scherbov 2010). Due to medical advances in the treatment of many cancers and the treatment of cardiovascular disease, as well as changes in health behaviors (most notably a decline in smoking), the chances of survival to an older age for all individuals have improved considerably (e.g., Preston et al. 2012). As a result, the distribution of remaining length of life at that age may have become more unequal across cohorts (Heiland and Movsesyan, 2013), contrary to the documented trend of increasing mortality compression when the entire life course is considered (or after age 10).[6]

[4]Evidence from in-depth studies on selected countries is also available. See, for example, Nusselder and Mackenbach (1996) for evidence from the Netherlands, Paccaud et al. (1998) for Switzerland, and Cheung and Robine (2007) for Japan.

[5]The pattern of declining inequality in length of life has also been found in studies of lifespan past age 10 ("adult mortality") (Edwards and Tuljapurkar 2005; Edwards 2011).

[6]Previous evidence from the analysis of deaths in the United States is consistent with the idea that the spread of the lifespan distribution at retirement age may not be narrowing. Myers and Manton (1984) report that the standard deviation of deaths above age 60 in the US increased between 1962 and 1979. Subsequent research on the ages at death between 1962 and 1984 by Rothenberg et al. (1991) showed the same pattern. Whether remaining lifespans are becoming more concentrated is important for the ongoing debate on the existence of a limit to human longevity (Fries 1980; Olshansky et al. 1990; Oeppen and Vaupel 2002). In light of the US evidence, Wilmoth and Horiuchi (1999, p.476) wrote: *A fixed maximum human lifespan*

2 Trends in Age 60 Mortality in OECD Countries

2.1 Demographic Data and Methodology

We analyze trends in the distribution of retirement lifespan in 26 OECD countries for birth cohorts 1900-1960. We employ single year death rates at ages 60-110 for male and female cohorts from the Human Mortality Database (www.humanmortality.org), the premier source of historic mortality data.[7] We combine the death rates observed up to year 2009 with projected death rates thereafter to construct complete age-specific mortality profiles for all cohorts. For example, for the 1930 birth cohort in the United States (US), we combine the observed death rates up to age 78 with the projected values for ages 79 to 110. For generations born after 1948, the survival curves are entirely based on projected values. Using the survival curves for each cohort, we obtain the distribution of the remaining years of life at age 60 which is used to calculate the mean and the standard deviation of the remaining lifespan.

The projected death rates are the predicted values from a modified logistic mortality model. Specifically, we assume that the death rate, $\mu_a(i)$, at exact age a for the average individual in birth cohort i (cohort 1900 is denoted by $i = 1$) takes the form:

$$\mu_a(i) = \frac{\beta\gamma^a i^\delta}{1+\beta\gamma^a i^\delta}. \tag{1}$$

The underlying logistic form (also known as the Kannisto model) goes back to Perks (1932) and fits mortality at older ages particularly well (e.g., Thatcher et al., 1998). Following Heiland and Movsesyan (2013), we have enhanced the basic model with a quadratic age term and a cohort trend to account for mortality declines across generations. Convenient for estimation, the logit of $\mu_a(i)$ is linear in age, age squared, and cohort:

$$logit(\mu_a(i)) = \ln(\beta) + \ln(\gamma_1)\cdot a + \ln(\gamma_2)\cdot a^2 + \ln(\delta)\cdot i = \beta' + \gamma_1'\cdot a + \gamma_2'\cdot a^2 + \delta'\cdot i \tag{2}$$

must result in a continued compression of mortality as death rates decline; therefore the failure to observe such a compression suggests either that no limit exists or that it is not currently in sight.

[7] As explained in the notes accompanying the files, single year data are sometimes the product of aggregate raw data which have been split into single years of age using the methods described in the Methods Protocol. The original raw data are available for download from the HMD website.

where $\beta' \equiv \ln(\beta), \gamma_1' \equiv \ln(\gamma_1), \gamma_2' \equiv \ln(\gamma_2)$ and $\delta' \equiv \ln(\delta)$ are parameters to be estimated.

Heiland and Mosesyan (2013) provide OLS estimates of this model for 28 countries by sex based on HMD data (cohorts 1900+, age 60+). For the US, the estimated coefficients (standard errors in parentheses) for men are $\beta_M' = -4.27665$ (0.23952), $\gamma_{M,1}' = -0.03217$ (0.00644), $\gamma_{M,2}' = 0.00074$ (0.00004) and $\delta_M' = -0.01843$ (0.00014), and for women $\beta_W' = -5.03173$ (0.10002), $\gamma_{W,1}' = -0.04329$ (0.00265), $\gamma_{W,2}' = 0.00090$ (0.00002), and $\delta_W' = -0.09984$ (0.0002). R-squared (adjusted) is 0.996 for males and 0.998 for females, indicating a very strong model fit. (See Heiland and Mosesyan, 2013, Table 5.)

Using actual and predicted death rates, we construct lifetables for remaining lifespans at age 60 for cohorts 1900-1960. The life tables are used to calculate the average lifespan at age 60 (e60) and the standard deviation (s60). The standard deviation is a measure of how dispersed or "unequal" the lifespans are distributed about the average remaining life expectancy.[8]

Figure 3 provides a comparison between the actual and projected probabilities of dying for the 1900 and the 1930 cohort in the US (men and women combined). Death rates are observed up to age 108 for the 1900 cohort and age 78 for the 1930 cohort. The modified logistic model fits the 1930 cohort data very well. For the 1900 cohort, the model predicts slightly greater mortality than observed during ages 78-98. The model accurately captures the key change in the US age-mortality pattern: a proportional decline in age across cohorts, that is, mortality rates are lower overall for the 1930 cohort but also rise more slowly with age than the 1900 cohort. (A shift down in the mortality profile implies longer life expectancy.)

2.2 Distribution of Retirement Lifespan

We present the results using a series of graphs, one for each country, showing the mean and the standard deviation of the remaining lifespan for birth cohorts 1900-1960. We also provide summary tables for means and standard deviation (see Tables 1 and 2). For males and females combined, we also report the mean and standard deviation when imputing unobserved death rates using observed mortality

[8]Studies on the compression of mortality have used the standard deviation to describe changes in the inequality of lifespan (e.g., Myers and Manton 1984; Rothenberg et al. 1991; Wilmoth and Horiuchi 1999; Edwards 2011).

of preceding cohorts. This assumes no declines in mortality after 2009, providing a useful reference scenario.

For those born in 1900 the mortality experience is all but complete. For the 1930 cohort the mortality risk profile is observed up to age 78, or 18 years past age 60, which is approximately equal to the average remaining lifespan of individuals born in 1900. Thus, when looking at our results for the 1930 cohorts, it is important to remember that a significant part of the mortality trajectory has been realized; death rates after age 78 obtained from out-of-sample forecasts. The results for the 1960 cohorts are entirely based on predicted death rates.

Northern Europe: Finland, Iceland, Norway and Sweden

As shown in Figure 7(d), the Swedish 1900 birth cohort has an average remaining lifespan at age 60 of 19.7 years (17.7 for men and 21.6 for women). We predict that this number will increase to 23.3 years (21.2 for men and 25.1 for women) for the 1930 cohort and 27.1 years (25.5 for men and 28.3 for women) for the 1960 cohort.

The standard deviation for men and women combined is expected to increase from 9.3 to 10 years between the birth cohorts 1900 and 1930. We project a further increase to 10.5 years by the 1960 cohort. The increase is driven to a large extent by the variability of age at death among Swedish men who are experiencing an increase in the standard deviation from 8.8 to 9.8 years across the 1900-1930 cohorts and who are predicted to see their remaining years at age 60 deviate by 10.4 years from the average life expectancy by the 1960 cohort. For women the variability around the mean is forecast to increase slightly from 9.4 to 9.7 years across the 1900-1930 cohorts and is predicted to reach 10.1 years for the 1960 cohort.

The distributions of remaining lifespan in Norway and Iceland are fairly similar to those of Sweden. As shown in Figure 7, Iceland displays greater average lifespans and standard deviations than Sweden and Norway but the differences are projected to narrow across cohorts. Some notable differences exist between Finland and the other nordic countries. While the levels of (absolute) variation as measured by the standard deviation are comparable to Sweden and Norway, remaining life expectancy at age 60 is significantly greater in Finland. As a result, the lifespan distribution is relatively more dispersed in Finland.

Western Europe I: Ireland and United Kingdom

As shown in Figure 10(b), the cohort born in 1900 in the UK has an average remaining lifespan at age 60 of 17.9 years (15.2 for men and 20.3 for women). We predict that life expectancy at age 60 will rise to 22.1 years (20.2 for men and 23.7 for women) for the 1930 cohort and 27 years (26.2 for men and 27.5 for women) for the 1960 cohort. The standard deviation for men and women combined is expected to increase from 9.5 to 10.5 years between the birth cohorts 1900 and 1930. We project a further increase to 11.3 years by the 1960 cohort. The increase in variability around the average remaining lifespan reflects a trend apparent in both male and female old-age mortality. For men, the standard deviation of lifespans is projected to increase to 10.2 years among those born in 1930 from 8.7 years for those born in 1900. British men born in 1960 are predicted to see their remaining years at age 60 deviate by 11.5 years from the average life expectancy. For women the variability is predicted to increase from 9.5 to 10.2 years across the 1900-1930 cohorts and is projected to reach 10.7 years by the 1960 cohort.

As shown in Figure 10, the (projected) trend in the lifespan distribution in Ireland is similar to that in the UK. Average remaining lifespans are lower across cohorts in Ireland than in the UK, while the standard deviations are similar in magnitude up to, approximately, the 1920 cohort. By the 1960 cohort, however, we project that average life expectancy will be almost equal between the two countries, as a result of rapid improvements in longevity among Irish females.

Western Europe II: Austria, Germany and Switzerland

As shown in Figure 5(a), the cohort born in 1900 in Austria has an average remaining lifespan at age 60 of 17.5 years (15.1 for men and 19.5 for women). We predict that life expectancy at age 60 will rise to 22.7 years (20.1 for men and 25.1 for women) for the 1930 cohort and 28.2 years (26 for men and 30.4 for women) for the 1960 cohort.

The standard deviation for men and women combined is expected to increase from 9 to 10.3 years between the birth cohorts 1900 and 1930, and reach 10.9 years by the 1960 cohort. The predicted increase in variability around the average lifespan reflects rising heterogeneity in old-age mortality, especially among Austrian men. The latter experience an increase in the standard deviation from 8.5 to 10.2 years across the 1900-1930 cohorts and are predicted to reach a standard deviation of 11.1 years by the 1960 cohort. For women the variability about the mean is predicted to increase from 9 to 9.9 years across the 1900-1930 cohorts and is projected to reach 10.5 years by the 1960 cohort.

As shown in Figure 5, the (projected) trends in the lifespan distribution in Germany and Switzerland are very similar to those in Austria. Average remaining lifespans are significantly higher in Switzerland and slightly lower in Germany. The early birth cohorts in Switzerland have higher standard deviations but we project a slower rise in (absolute) variability compared to Austria and Germany. By the 1960 cohort, we project that all three countries will have similar levels of dispersion in retirement longevity.

Western Europe III: Belgium, Denmark, Luxembourg and Netherlands

As shown in Figure 6(d), the cohort born in 1900 in the Netherlands has an average remaining lifespan at 60 of 19.5 years (17.2 for men and 21.6 for women). We predict that this number will increase to 22.1 years (19.7 for men and 24.2 for women) for the 1930 cohort and 25.3 years (23.5 for men and 26.6 for women) for the 1960 cohort.

The standard deviation for men and women combined is predicted to rise from 9.4 to 9.9 years between the birth cohorts 1900 and 1930. A further increase to 10.3 years by the 1960 cohort is projected. The increase is driven almost entirely by Dutch men who are experiencing an increase in the standard deviation from 8.9 to 9.6 years across the 1900-1930 cohorts and whose distribution is predicted to reach a standard deviation of 10.2 years by the 1960 cohort. For women the variability around the mean is predicted to increase marginally from 9.4 to 9.6 years across the 1900-1930 cohorts and is projected to increase to 9.8 years by the 1960 cohort.

As shown in Figure 6, the distributions of remaining lifespan across generations in Denmark are very similar to those in the Netherlands. Belgium and Luxembourg are noticeably different but similar to each another. The latter have lower lifespans and variability for the 1900 cohort but are expected to see more rapid increases in the mean and the standard deviation of age at death compared to Denmark and the Netherlands. We forecast that Belgium and Luxembourg will reach average life expectancy of 28 years by the 1960 cohort, compared to 23 and 25 years for Denmark and the Netherlands. The corresponding standard deviations for the 1960 cohorts in Belgium and Luxembourg are projected to be 11.0 and 11.2 years, compared to 10.2 and 10.3 years in Denmark and the Netherlands.

Southwestern Europe: France, Italy, Portugal and Spain

As shown in Figure 9(a), the cohort born in 1900 in France has an average remaining lifespan at 60 of 19 years (16.3 for men and 21.5 for women). We predict that life expectancy at age 60 will rise to 24.3 years (21.1 for men and 27.2 for women) for the 1930 cohort and 29.4 years (26.5 for men and 32 for women) for the 1960 cohort.

The standard deviation of remaining years of life for men and women combined is expected to increase from 9.7 to 10.8 years between the birth cohorts 1900 and 1930. We project a further increase to 11.4 years by the 1960 cohort. The increase in variability around the average remaining lifespan reflects greater variability in lifespans among both the male and the female population. For men, the standard deviation of lifespans is projected to increase to 10.5 years among those born in 1930, up from 9.1 years for those born in 1900. French men born in 1960 are predicted to see their remaining years vary about the average life expectancy by 11.2 years. For women the standard deviation is predicted to gradually increase from 9.6 to 10.9 across the 1900-1960.

As shown in Figure 9, the (projected) trends in the lifespan distribution in Italy, Spain and Portugal are quite similar to those in France. The average remaining lifespan is lower in Portugal, and the gap is expected to widen across generations. Inequality in lifespans is widening in all countries. We predict that the standard deviation for the population overall will range between 10.94 years in Portugal and 11.41 years in France.

Central Europe: Czech Republic, Poland, Slovakia and Estonia

As shown in Figure 8(b), the average lifespan of the 1900 birth cohort in Poland is 18.1 years (15.9 for men and 19.8 for women). This number is expected to increase to 19.3 years (16.4 for men and 22 for women) for the 1930 cohort and 21.2 years (17.8 for men and 24.6 for women) for the 1960 cohort.

The standard deviation for men and women combined increased from 8.9 to 9.9 years between the birth cohorts 1900 and 1930. We project a further increase to 10.1 years by the 1960 cohort. The increase is driven by male and female mortality which are experiencing increases. For men the standard deviation is forecast to increase from 8.5 to 9.5 years across the 1900-1930 cohort and is predicted to remain at 9.5 years by the 1960 cohort. The standard deviation among the female population is expected to reach 9.7 years for the 1930 cohort and 10.1 years for the 1960 cohort, compared to 8.9 years for the 1900 cohort.

The trend in the distribution of remaining lifespan in Slovakia and Estonia is similar to that in Poland. As shown in Figure 8, Slovakia and Estonia display similar levels of longevity for the initial cohort but slightly less dispersion. While the mean and the spread are predicted to rise across cohorts, we predict that the levels remain below those of Poland.

More notable differences exist between Poland and the Czech Republic. While the average lifespans are lower for the 1900 cohort in the Czech Republic than in Poland, they are projected to be greater by the 1960 cohort. The standard deviation is lower initially and comparable to levels predicted for Poland by the 1960 cohort.

North America: Canada and the United States

As shown in Figure 4(b), the average lifespan of the 1900 birth cohort in the US is 18.6 years (15.9 for men and 21 for women). This number is expected to increase to 22.3 years (20.5 for men and 23.8 for women) for the 1930 cohort and 25.9 years (25.1 for men and 26.1 for women) for the 1960 cohort.

The standard deviation for men and women combined increased from 10.3 to 10.6 years between the birth cohorts 1900 and 1930. We project a further increase to 11.2 years by the 1960 cohort. The increase is driven by male mortality which is experiencing an increase in the standard deviation from 9.5 to 10.4 years across the 1900-1930 cohort and is predicted to reach 11.3 years by the 1960 cohort. For women the variability declined slightly from 10.4 to 10.3 years across the 1900-1930 cohorts but is projected to increase to 10.6 years by the 1960 cohort.

As shown in Figure 4, the (projected) trends in the lifespan distribution in Canada are very similar to those in the US. The average remaining lifespans and standard deviations are projected to rise more in Canada than in the US. As in the US, we project a gradual increase in the dispersion of the distribution across cohorts.

Asia Pacific: Australia, New Zealand and Japan

As shown in Figure 11(c), the cohort born in 1900 in Japan has an average remaining lifespan at age 60 of 18.8 years (16.8 for men and 20.8 for women). We predict that life expectancy at age 60 will rise to 25.6 years (22.1 for men and 29 for women) for the 1930 cohort and 30.9 years (27.6 for men and 32.3 for women) for the 1960 cohort. The latter levels are the highest found among the set of developed and transition countries studied here.

The standard deviation for men and women combined is expected to increase from 9.8 to 11.2 years between the birth cohorts 1900 and 1930. We project a further sizeable increase to 12.8 years by the 1960 cohort. The increase in variability around the average lifespan is largely attributable to greater variability in female old-age mortality. The standard deviation of the lifespan of Japanese women is projected to reach 11.1 years among those born in 1930, up from 9.6 years for those born in 1900. Women born in 1960 who reach age 60 are predicted to see their remaining years deviate from average (remaining) life expectancy by 14.8 years. This is the greatest variability found in any of the 28 countries investigated here. For Japanese men the variability is predicted to increase from 9.2 to 12 years across the 1900-1960 cohorts.

Average remaining lifespans among the 1900 cohorts in Australia and New Zealand are lower than in Japan and we predict that this pattern will persist across cohorts (see Figure 11) despite rapid increases (especially in Australia). The (predicted) distributions in Australia and New Zealand also tend to be more concentrated around the mean, suggesting greater homogeneity in age-at-death here compared to Japan.

3 Mortality Trends and Pension Benefit Adjustment Policy

3.1 Background

Most public pension systems are built around a Full Retirement or Entitlement Age (*FRA*), at which workers with sufficient contributions (often measured on the basis of durations of covered employment). Many countries also allow workers to take up reduced benefits at some Early Retirement Age (*ERA*) and offer credits for postponed benefit take-up up to some Maximum Retirement Age (*MRA*). The adjustments to benefits are typically measured in constant (monthly or annual) percentage reductions or credits that accumulate depending on the duration between actual age at take-up and *FRA*.

The adjustment rules applicable to a particular cohort (in some countries also sex) can be summarized in an "adjustment schedule." Given information on a person's pension value at *ERA*, and assuming that this value does not change meaningfully after *ERA* because of covered employment, the adjustment schedule provides individuals with the economically relevant parameters of their pension. Figure 12 details *ERA*, *FRA*, *MRA*, the penalty structure and the credit structure for selected cohorts under U.S. Social Security. All covered workers born prior to 1937 faced an *FRA* of exact age 65. In 1956 (1961 for men) Social Security introduced an *ERA* of 62 for women. A delayed retirement credit applies up to an *MRA* of age 70. *ERA* has remained constant but *FRA* has increased across cohorts and is scheduled to be 67 years for those born in 1960 and thereafter. Figures 1-2 provide OECD-wide information on the adjustment schedules as of 2006 and the long-term trends in the *FRA*.[9]

Changes in the adjustment schedule may be motivated by actuarial considerations. Comparing benefit contributions to receipts across generations ("fairness of return"), an appropriate increase in the *FRA* can offset the effect of longer lifespans on lifetime benefit receipt (outlays). Looking at the present value of benefits at different take-up ages for a given demographic or at the same take-up age across different generationswithin generations), an appropriate decrease in the degree of convexity of the adjustment schedule can maintain the equality of lifetime benefits across take-up ages for (average-mortality) individuals ("fairness of adjustment schedule"). In this paper, we are only concerned with the latter kind

[9]The table contains some inaccuracies. For example, the *FRA* listed for the U.S. is 67, while it should be 66.

of actuarial fairness. Some authors refer to this fairness of the adjustments as actuarial equivalence or neutrality (e.g., Duggan and Soares, 2002; Queisser and Whitehouse, 2006).

Studies have generally concluded that benefits are close to actuarially fair for average-mortality beneficiaries (Myers and Schobel, 1990; Duggan and Soares, 2002; Munnell and Sass, 2012; Heiland and Yin, 2013).[10] Figure 13 shows the annual average real interest rate of long-dated treasuries between 1954 and 2010. The long-term trend is positive but the series is quite volatile (the linear trend only explains 6.7% of the variation in the interest rate) and the trend reversed to negative in the mid 1980s. For example, Heiland and Yin (2013) estimate that the deviation from the fair age-related adjustment has been reduced from 4-5% for average-mortality beneficiaries born in 1917 to less than 1% for average retirees born after 1942. This is primarily the result of the expansion of the Delayed Retirement Credit (*DRC*) and the increase in the Full Retirement Age (FRA). The increases in the *DRC*s and the increases in the FRA from age 65 to 66 have resulted in a steeper adjustment schedule, one that is more consistent with actuarial fairness for average-mortality claimants.

Choosing a benefit adjustment schedule that is actuarially fair to Social Security means that the present value of lifetime benefit payouts is invariant to age at take-up for (average-mortality) beneficiaries from the asset value perspective of Social Security. Whether adjusting benefits at rates that are actuarially fair for average-longevity beneficiaries in this sense also minimizes the variance of Social Security outlays is unknown. In preparation to answer this question within the framework developed below, we briefly describe the main properties of actuarially fair adjustment schedules.

3.2 Actuarial Fairness

Discounting to the ERA at instantaneous rate $r > 0$, the condition for actuarial fairness of the adjustment schedule in the sense of equal cash values across take-up ages for a given demographic can be formally written in terms of present values of annuities with different start dates:[11]

[10]This characterization of the findings is correct when considering discount rates consistent with values used by the Social Security actuaries based on long-dated treasury bonds. When higher discount rates—more in line with individual subjective time discount rates—are applied, then Social Security's adjustment schedules tend to be too flat to be actuarially fair for average beneficiaries (see Heiland and Yin, 2013).

[11]This continuous time analysis is adopted from the discrete time version presented in Heiland and Yin (2013).

$$PV_{fair}^{ERA} \equiv \int_{FRA}^{ERA+D} PIA \cdot e^{-r(a-ERA)} p(a)da \equiv \int_{c}^{ERA+D} (1+R_f(c))PIA \cdot e^{-r(a-ERA)} p(a)da, \ \forall c \in [ERA, MRA]. \tag{3}$$

In Eqn. (3), $ERA+D$ denotes some oldest age, that is D may be thought of as the maximum remaining lifespan at ERA. Since full benefits are obtained at the FRA, the age at which actual and fair benefits must be equal, we impose $R_f(FRA) = 0$ (i.e., $AF(FRA) = 1$). We also set $p(ERA) = 1$ since we focus on individuals who are eligible to claim old-age benefits. The set of age-related adjustments $R_f(.)$ implied by Eqn. (3) is the fair adjustment schedule. PV_{fair}^{ERA} is the present value of lifetime benefits (discounted to ERA) if the age-related adjustments are actuarially fair.

Equation (3) defines how the fair adjustments depend on the ERA, the FRA, the survival schedule, $p(a)$, and the discount rate, r. The choice of the value for the discount rate may differ depending on whether we take the perspective of Social Security or the population of beneficiaries. The importance of that distinction will become clear in the next section.

Since R_f is constant given c, we can easily derive the fair schedule from Eqn. (3). For any claiming age $c \in [ERA, MRA]$ the fair adjustment factor, AF_f, is:

$$AF_f(c) = 1 + R_f(c) = \frac{\int_{FRA}^{ERA+D} e^{-r(a-ERA)} p(a)da}{\int_{c}^{ERA+D} e^{-r(a-ERA)} p(a)da} - 1. \tag{4}$$

Inspecting Eqn. (4), we observe two key properties of the schedule of the fair adjustment factor. First, it increases at an increasing rate in the take-up age. This implies, for example, that the (cumulative) penalty for early take-up increases by smaller amounts for each additional period (month) of earlier take-up before FRA. The (strictly) convex shape of the fair schedule makes sense because if an individual takes up benefits at an earlier age, the increase in the monthly penalty can be smaller since it will be applied over a longer period. Second, as the probability of survival to the next age, $p(.)$, increases, the fair adjustment schedule becomes flatter, rotating clockwise at the FRA (see Heiland and Yin 2013 for a proof). Intuitively, if life expectancy increases, actuarial fairness of the adjustment schedule requires that the penalty for early take-up be lowered because the same penalty reduces the present value of the lifetime benefit stream more (relative to take-up at FRA) for a person with a longer (expected) lifetime. Also, an increase in the discount rate, r, has the opposite effect of a decline in mortality; as the discount rate increases (time value of money rises), earlier benefits become more valuable and hence must be penalized more heavily to achieve actuarial fairness across take-up ages.

Equation (4) requires data on age-specific mortality rates. An important special case arises when we focus on a (average) person with remaining life expectancy at age ERA of D years. This implies setting $p(a) = 1$ for $a \leq ERA + D$ and $p(a) = 0$ for $a > ERA + D$. The fair adjustment schedule simplifies to:

$$AF_f^D(c) = \frac{e^{-r(FRA-ERA)} - e^{-rD}}{e^{-r(c-ERA)} - e^{-rD}}. \quad (5)$$

Notice that $AF_f^D(c = FRA) = 1$ by construction. For illustration, suppose $ERA = 62$, $FRA = 66$, $D = 20$, and $r = 0.03$. For these individuals who have a remaining life expectancy at age 62 of 20 years, the fair Adjustment Factor for take-up at age 62 is 0.7494. In other words, from their present value perspective at age 62, getting 75% of PIA and collecting benefits immediately is equivalent to waiting for four years and getting 100% of PIA starting at age 66.

3.3 Intergenerational Fairness

As shown above, holding ERA and FRA constant, actuarially fair benefit adjustment require that the schedule is flatter for individuals with lower mortality. In the context of declining old-age mortality across generations, it is easy to see that the application of this type of adjustment schedule would result in rising (real) benefit levels across cohorts for everyone who optimally (i.e., taking their longevity into account) claims between ERA and FRA (at least).

Building on the analytical framework introduced above, we incorporate the idea of intergenerational fairness of benefits into the analysis of the adjustment schedule. Intergenerational fairness requires that the present value of lifetime benefits for take-up at any (nominal) age c is the same across cohorts for average-mortality individuals (given PIA and discount rate, r). Adjustment schedules that are intergenerationally fair may not also be actuarially fair in the sense of equalized pension cash values across take-up ages. However, since it is arguably desirable to have adjustment schedules that satisfy both principles, it presents an important situation. If schedules meet both criteria (in expectation), then the present values of lifetime benefits are the same across take-up ages ("actuarial fairness") and across generations ("generational fairness") for average mortality individuals.

The question for policy makers is how to set the adjustment schedule to achieve intergenerational fairness? Assuming that the adjustments are also actuarially fair, we can answer this questions by determining the value for FRA that equalizes the present values of lifetime benefits across the generations for average mortality beneficiaries. Formally, given the (projected) survival functions for the baseline generation, $p_0(a)$, and the comparison generation, $p_1(a)$, this condition can be stated as follows:

$$PV_f^{ERA}(c = FRA_0|p_0) \equiv \int_{FRA_0}^{ERA+D} PIA \cdot e^{-r(a-ERA)} p_0(a)da \equiv \int_{FRA_1}^{ERA+D} PIA \cdot e^{-r(a-ERA)} p_1(a)da, \quad (6)$$

where FRA_0 and FRA_1 denote the baseline and the comparison FRA, respectively. It is easy to see that the intergenerationally fair FRA increases as mortality decreases (survival increases) in the comparison population. For the special case of a constant mortality hazard, $\mu(a) = \mu > 0$, so that $p(a) = e^{-\int_{ERA}^{a}\mu(u)du} = e^{-\mu\cdot(a-ERA)}$, a closed-form solution for FRA_1 exists:

$$\begin{aligned}
&\int_{FRA_0}^{ERA+D} PIA \cdot e^{-r(a-ERA)} p_0(a)da \equiv \int_{FRA_1}^{ERA+D} PIA \cdot e^{-r(a-ERA)} p_1(a)da \\
&\int_{FRA_0}^{ERA+D} PIA \cdot e^{-r(a-ERA)} e^{-\mu_0(a-ERA)}da \equiv \int_{FRA_1}^{ERA+D} PIA \cdot e^{-r(a-ERA)} e^{-\mu_1(a-ERA)}da \qquad (7)\\
&FRA_1 = -\frac{1}{r+\mu_1}\ln\left[e^{-(r+\mu_1)(ERA+D)} - \frac{r+\mu_1}{r+\mu_0}e^{-(r+\mu_0)(ERA+D)} + \frac{r+\mu_1}{r+\mu_0}e^{-(r+\mu_0)FRA_0}\right].
\end{aligned}$$

The effect of an *increase* in mortality on FRA is found to be:

$$\frac{dFRA_1}{d\mu_1} = \left[\frac{1+(ERA+D)(r+\mu_1)}{(r+\mu_1)^2}\right] e^{-(r+\mu_1)(ERA+D-FRA_1)} - \frac{1+FRA_1(r+\mu_1)}{(r+\mu_1)^2}. \quad (8)$$

It can be shown that the sign of this expression is negative if $ERA+D > FRA_1$, which is true in all pension systems. (Recall that $ERA+D$ denotes some maximum age in the life table.) This analysis confirms that intergenerational fairness implies that the adjustment schedule shifts out as death risk decreases. Policy makers can use Eqn. 8 to approximate the increase in FRA that is required to maintain balanced benefit levels across generations with different mortality. Closer investigation of this derivative also shows that it is greater (implying more responsiveness to demographic changes) at a lower discount rate. Intuitively, at a lower discount rate the survival risk rationale becomes relatively more important.

3.4 Application and Case Studies

Over the past three decades, many developed countries have implemented changes to their public pension systems to deal with the ever-longer retirement lifespans of their populations. In most cases, reforms passed years ago are only now taking effect as the targeted generations are reaching retirement age. While each country's mandatory pension system has unique characteristics, in most cases the changes are either ad-hoc adjustments of the FRA or "demographic factors" embedded in the benefit formula, resulting in shifts in the adjustment schedule discussed above (Whitehouse, 2010).

In this section, we analyze the pension reform developments in four OECD countries (U.S., Germany, Japan and Belgium) in the context of the demographic trends and the principle of intergenerational fairness. We perform a series of calculations to determine the intergenerationally fair FRA in each country. In keeping with the analysis of mortality trends in Section 2, we highlight the birth cohorts 1900, 1930 and 1960, which cover 60 years of demographic experience. We use the old-age survival curve for the 1900 cohort (men and women combined) to calculate baseline cash pension values for take-up at FRA under different discounting assumptions. Given this reference value, and applying a numerical approach to solve Eqn. 6, we obtain the intergenerationally fair FRAs for cohorts 1930 and 1960, overall and for each sex separately, and compare them to the actual (planned) FRAs.[12]

We present results for three alternative (constant) discount rate (r) scenarios. Our baseline case is an annual rate of 2.68%. The value is chosen to be consistent with averages used by the U.S. Actuarial Office of Social Security based on (real) yields of long-dated U.S. treasury bonds (see Girola, 2005). The value is calculated from 1954-2012 time series data on average annual yields of 20-year treasuries

[12]For consistency across cohorts, all lifetime benefit flow calculations are discounted by time opportunity cost and mortality risk to the earliest retirement age available to workers in the 1900 cohort (i.e., ERA or the youngest FRA if there is no early take-up adjustment provision). For U.S. cohorts that is age 62, while it is age 60 in Germany, Japan and Belgium.

available from the Federal Reserve (www.federalreserve.gov), deflated by the Consumer Price Index (CPI-U), shown in Figure 13. We contrast the results for this rate with a low interest rate scenario of 0%, based on current rates, and a high discounting scenario of 9%.[13]

A few caveats are in order. The analysis abstracts from inter-cohort changes in program generosity unrelated to entitlement age.[14] The choice of the 1900 birth cohort (age 60 in 1960) as reference generation is somewhat arbitrary. As discussed above, one advantage of choosing an early cohort is that mortality is basically complete. By anchoring the comparison around a very early generation, the analysis sets up for dramatic effects. However, this is only the case because of the rapid mortality declines that are affecting the pension systems. Also, reporting the "interim" cohort of 1930 (age 60 in 1990) allows for very interesting comparisons to the 1960 cohort (age 60 in 2020). As discussed in more detail below, in most countries retirees from the 1930 cohort were unaffected by the first wave of entitlement age reform while they enjoyed much longer lifespans than their counterparts born in 1900. By the time the 1960 cohort will reach retirement age, on the other hand, significant increases in the retirement age will have taken place. By looking at the change in the intergenerationally fair FRA across cohorts 1960 and 1930, even if the levels may be exacerbated because of early baseline cohort, we can meaningfully evaluate whether entitlement age reforms are progressing at an demographically correct pace.

United States

Individuals aged 62 or older who had earned income subject to the Social Security payroll tax for at least 10 years (if born in 1929 or later) are eligible for retirement benefits under the Social Security Old Age (SSOA) benefits program. Earnings are subject to the tax up to an income maximum that is

[13] The high discounting scenario is meant to better capture the subjective time preferences of typical retirees. It is motivated by evidence on the distribution of discount rates provided by Gustman and Steinmeier (2002). They estimate a life cycle model of retirement using data from the Health and Retirement Study and allowing individuals to be risk-averse. They find that 21% of respondents have rates between 5% and 10%, the range that contains the median value. Close to 40% of respondents have time preference rates below 5%.

[14] For example, the average SSOA pension wealth has increased somewhat in real terms over time. This is primarily due to real wage gains, rising labor force participation (especially among women), and program expansion. Benítez-Silva and Yin (2009, p.7, Table 3) report that the average monthly benefits (in constant 2005 dollars) among retirees of age 62 increased from $1,066 in 1994 to $1,135 in 2004.

updated annually according to increases in the average wage.[15] To determine the benefit amount, the Social Security Administration calculates the Primary Insurance Amount (*PIA*) of a worker as a convex piece-wise linear function of the worker's average earnings subject to Social Security taxes taken over her 35 highest earnings years.

The traditional *FRA* in the U.S. has been age 65. The option to collect early reduced benefits at age 62 was introduced in 1956 for women (1961 for men). Delay of take-up past *FRA* earns Delayed Retirement Credits up to age 70. The benefit adjustment schedule of the system has been modified several times (e.g., Myers, 1994; Heiland and Yin, 2013). Most importantly for the present analysis, the amendments passed in 1983 have extended the *FRA* from exact age 65 for cohorts born before 1938 to exact age 66 for cohorts born in 1943-1955. The 1-year increase was phased in in 2-months steps across successive cohorts 1938-1943. The Greenspan reform will result in an additional similar one-year increase in the *FRA*, to be phased in across birth cohorts 1954-1960, reaching *FRA* of exact age 67 for beneficiaries born in 1960 and thereafter. The 1983 deliberations left the *ERA* unchanged at age 62, owing to the popularity of early take-up, but the shift in the adjustment schedule of course meant lower payout rates at all ages (e.g., Myers, 1994).

Further adjustments to the *FRA* are currently being debated. For example, in December 2010, President Obama's National Commission on Fiscal Responsibility and Reform (NCFRR, 2010) proposed steps to address the long-run solvency problems of Social Security. The commission recommended that retirement benefits be reduced by indexing the retirement ages to approximate gains in life expectancy. Specifically, the NCFRR suggested that the *ERA* and the *FRA* be increased by one month every two years after *FRA* reaches age 67 under current law. According to their calculations, the *ERA* would increase to 63 by 2046 and 64 by 2070, while the *FRA* would reach 68 and 69 in those years.

Table 4 lists the actual and generationally fair *FRA*s for birth cohorts 1900, 1930 and 1960 by country (U.S., Germany, Japan and Belgium) and discount rate scenario (low discounting: 0%; moderate discounting: 2.68%; high discounting: 9%). Consistent with the previous discussion, the first three columns in the top panel list the *FRA* for U.S. beneficiaries born in 1900 and 1930 as 65, and, for those

[15]Six percent of the 162.5 million workers with Social Security taxable earnings in 2008 had earnings at or above the maximum amount (SSA-S, 2010, Table 4.B1).

born in 1960, as 67. In the remaining columns, we report the estimated generationally fair entitlement ages for beneficiaries overall (columns 4-5), for average male beneficiaries (columns 6-7), and for average female beneficiaries by birth cohort. Given that the SSOA adjustment schedule is not gender-specific, the results based on the overall average mortality patterns are particularly instructive.

Our baseline moderate discount rate scenario suggests that to maintain actuarial balance in entitlements across cohorts 1900-1930, the FRA needed to increase from age 65 to age 67 and 6 months. Of course, the FRA in the U.S. did not increase at all across these cohorts that saw life expectancy at age 60 rise by 3.75 years (see Table 1). Retirement lifespans are predicted to lengthen by another $3\frac{1}{2}$ years, on average, across cohorts 1930-1960, translating into an additional increase in the fair FRA by 2 years and 4 months under baseline discounting. The scheduled 2-year increase in the FRA across cohorts 1930-1960 is a step in the right direct, but our analysis suggests that a much larger increase in the FRA may be needed to bring the benefit structure back into long-term generational balance.

Looking across the range of discount rate scenarios, it is clear that the fair FRA is sensitive to the level of the discount rate. If interest rates were to stay low for a long period, then same-sized mortality changes would require greater increases in the FRA to maintain intergenerational balance. For example, at 0% discount rate, we predict that the (projected) $3\frac{1}{2}$-years gains in longevity across cohorts 1930-1960 can be balanced with an increase in FRA by 3 years and 9 months, compared to just nine more months in the high discount rate scenario (9%). Across gender lines, the results for the U.S. illustrate what impact unequal progress in longevity has on the pace of intergenerationally fair adjustment. As discussed above, recent generations of males in the U.S. have been experiencing more rapid gains in old-age longevity than their female counterparts. This explains the greater demographically adjusted FRAs among men shown in Table 4.

Germany

The German old-age pension insurance system (Federal Republic of Germany before 1991) is more differentiated than SSOA historically, but a 1992 reform similar to the 1983 SSOA amendments has made the systems more comparable in terms of retirement ages and benefit adjustment (Börsch-Supan and Wilke, 2003). Prior to 1972 reform legislation, the normal retirement age for workers with at least five years of service was age 65. Certain groups were excepted, most notably, women with 15 years of contributions could claim *full* benefits at age 60 (similarly for workers with long unemployment spells or who suffered a work disability). In 1973 greater flexibility in benefit take-up was granted to a wider group. Workers with 35 or more covered years became eligible to take up *full* benefits as early as age 63. As a result, 63 became the effective *FRA* for male workers.[16] Unlike in the U.S., there was no option to collect earlier reduced benefits at that time but individuals who continued to work received a delayed retirement credit of 0.6 percent for each month worked after age 65 up to age 67.

A major reform package passed in 1992 that raised the *FRA* for all pension types (other than disability) to age 65 and established systematic (actuarial) adjustments before and after *FRA* using the prior minimum eligibility ages (age 60 for eligible women; age 63 for longtime insured workers) as *ERA*s (see Börsch-Supan and Wilke, 2003). Subsequent reforms in 1999 and 2007 have resulted in gradual increases in the *FRA*(s) and *ERA*(s). Most importantly, the *ERA* for women will increase to 65 and the *FRA* for all workers but the longtime insured will increase by 1 month per birth year across cohorts 1947-1958 and by 2 months per year across cohorts 1959-1964, reaching age 66 in 2024 and age 67 in 2031.

The second panel in Table 4 shows the results of the generational fairness analysis. We note that until recently male and female workers faced different entitlement ages; as a result, meaningful comparison also has to be gender-specific. The results for Germany show dramatic increases in the intergenerationally fair *FRA* across cohorts due to ever-lower old-age mortality. Unlike in the U.S., however, the effective *FRA* was actually reduced across male cohorts 1900-1930. This resulted in an unusually large discrepancy between actual (effective) *FRA* and our fair *FRA* among male workers (5 years and 3 months at 2.68% discount rate). However, the measures put in place over the past two decades, such as increasing the *FRA* from 60 for women born in 1930 to 66 and 4 months for women born in 1960, turn out to be the most aggressive corrective steps observed in this comparative analysis. Under baseline discounting, we predict that the intergenerationally balanced *FRA* for female beneficiaries born in 1960 will be 65

[16]For workers with comparable earnings histories, the incentive to continue working is likely stronger in the German scheme since workers collect pension points for each year of service. SSOA considers the 35 highest earnings years.

and 8 months, which is close to the actual value of 66 and 4 months. For men, however, the discrepancy between actual and fair values is very high. We predict a fair *FRA* of 72 and 3 months for male beneficiaries born in 1960 under baseline discounting, compared to an actual age of entitlement for full benefits of 66 years and 4 months.

Japan

The national pension system of Japan consists of a flat-rate scheme, "Old-Age Basic Pension", supplemented by an earnings-related pension component, "Old-Age Employee Pension." The current *NRA* for the basic pension is 65 for men and 63 for women. For the earnings component the *NRA* is currently 61 for men and 60 for women. Traditionally, the *NRA*s were 60. The basic pension *NRA* is increasing from 60 to 65 between 2001 and 2013 for men and between 2006 and 2018 for women. The *NRA* of the earnings part is increasing from 60 to 65 by 2025 for men and by 2030 for women. No further increases in the *NRA* are scheduled at this time but the previous government debated further increases in the *FRA*. Early benefit take-up at a reduced rate at age 60 and delayed benefit take-up with a credit is (or will be) possible in both pensions.

As discussed above, old-age mortality has been declining rapidly across the cohorts studied here. This is especially true for Japanese women. On the other hand, Japan also instituted one of the largest (gradual) increases in the *FRA* (5 years). The results in Table 4 suggest that for men the *FRA* reform will likely keep the gap between the actual and the theoretically fair *FRA* somewhat close: The intergenerationally *FRA* estimated for Japanese men born in 1960 is 66 years and 7 months under baseline discounting. However, the exceptional trajectory of old-age longevity of Japanese women and the slow roll-out of the higher *FRA* (especially for women) will leave Japan with a similarly overall intergenerationally unbalanced system than SSOA: For the 1960 cohort and under baseline discounting, we predict fair *FRA*s of 68 years and 7 months for women. This compares to actual *FRA*s for women of 65 for the basic pension and 62 for the earnings component.

Belgium

The national pension system in Belgium differs from the standard scheme in ways that make it difficult to determine the *NRA*. The system allows workers to claim their full benefits at the time when they pass a threshold number of contribution years, subject to a minimum age of 60. While there is a normal retirement age of age 65, workers can traditionally (and currently) retire with full benefits at age 60 if they have sufficient years of contributions (35 years traditionally, currently 40 years). By raising the service years requirement for full benefits, the system is currently increasing the effective *NRA* after decades of continuity. The reforms currently under way will lead to a minimum retirement age of 62 for those with 40 years of service. There is no option to claim early reduced benefits or to collect credits for delayed retirement.

To apply our approach to the system in Belgium that lacks a definite FRA, we calculated intergenerationally fair FRAs under two extreme scenarios for actual (effective) FRA: FRA of age 60 vs. age 65 for birth cohort 1900. Table 4 shows that if the system is effectively an FRA 60 scheme for the 1900 birth cohorts but an FRA 65 scheme for the 1930-1960 cohorts, then the required rise in the FRA to adjust benefits across generations for increasing lifespans is not much ahead of the actual FRA. This conclusion would not hold if age 60 had continued to be the effective FRA, but given the requirement of 45 years of covered service this is unlikely to be the case.

4 Discussion and Conclusion

Our analysis of lifespan past age 60 confirms a well-documented secular trend toward longer lives (Edwards 2011; Christensen et al. 2009). We forecast significant increases in retirement lifespans for current and future generations. Our predictions extrapolate from the mortality experience of cohorts in the (more recent) past. Risk to these forecasts exists in the form of structural changes and uncertainty regarding the determinants of mortality (Bennett and Olshansky 1996; Olshansky et al. 2009). For example, the consequences of the obesity epidemic for remaining lifespans have yet to be fully realized and understood (Preston et al. 2012; Olshansky et al. 2005). If these predictions hold true, the retirement benefit outlays by Social Security programs around the world will rise substantially.

We show that the policy response to date—mainly through increases in the *FRA*s—has been inadequate to offset longer lifespans. Given estimates for the US that every year in average lifespan increases Social Security outlays by approximately 1 billion dollars, the 3.4 year increase in remaining lifespan at age 60 between birth cohorts 1930 and 1960 (see Table 1) may result in 3.4 billion dollars in additional expenses. Our analysis indicates that *FRA*s need to be increased by as many as 3 years in the US, 6 years for German males, and 3.5 years for Japanese females just to maintain inter-generational balance. Even more substantial increases in *FRA*s would be necessary if real cuts to benefits—as currently debated in the US—were to be achieved. Matters are complicated by the fact that the trend toward longevity extension are expected to remain strong and pension trust fund managers have a history of underestimating mortality improvements (Olshansky et al. 2005). The greater variation of remaining lifespan among future generations of retirees implies more uncertainty about the benefit actual outlays for these cohorts.

These developments have important implications for future retirees. Future generations can expect further, potentially dramatic, increases in *FRA*s. Such increases have the same cost-savings effect as direct benefit cuts but an easier narrative as they can be tied to population aging directly while maintaining early eligibility ages. Individuals will try to make up for the lost retirement wealth through longer working lives and lower consumption levels pre-retirement (more savings). As lifespans rise more workers will reach age 62 and get to draw their benefits.

Finally, it is clear that low-mortality beneficiaries are least impacted by the increases in the *FRA*s. Moreover, since individuals who live longer tend to have higher lifetime earnings (e.g., De Nardi et al. 2009; Lee and Tuljapurkar 1997), they are expected to also have a greater (annual) claim on pension wealth compared to the average mortality individual in their birth cohort. Using data on individuals' pension wealth (Primary Insurance Amount, PIA) and longevity from the Health and Retirement Survey (HRS), a survey of a recent cohort of American retirees, we observe a correlation coefficient of 0.14 between PIA and remaining lifespan. While this is a modest level of correlation, it does suggest that longevity gains disproportionately benefit those who are better-off. Means-testing of benefits can be used to make the burden associated with Social Security full retirement age reform more equitable.

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Table 1: **Average Remaining Lifespan, Birth Cohorts 1900, 1930 and 1960**[a]

	Birth Cohort 1900				*Birth Cohort 1930*				*Birth Cohort 1960*			
	All	Male	Female	Imputed	All	Male	Female	Imputed	All	Male	Female	Imputed
Finland	17.54	14.87	19.65	17.54	22.79	19.84	25.45	22.39	28.29	25.84	30.76	23.34
Iceland	21.00	18.79	22.95	21.00	23.66	22.01	25.27	23.25	27.14	25.81	28.60	23.76
Norway	19.59	17.39	21.60	19.59	22.69	20.54	24.64	22.53	26.17	24.33	27.56	23.46
Sweden	19.68	17.66	21.57	19.68	23.30	21.23	25.14	23.08	27.07	25.46	28.28	23.94
Ireland	17.32	15.51	19.11	17.32	21.48	19.26	23.69	21.38	26.75	24.44	28.72	22.87
UK	17.92	15.19	20.28	17.92	22.13	20.24	23.71	21.90	26.95	26.21	27.45	23.22
Austria	17.52	15.10	19.51	17.52	22.73	20.14	25.09	22.29	28.22	26.00	30.38	23.29
Germany	17.67	15.34	19.61	17.67	22.20	19.58	24.63	21.75	27.32	25.05	29.67	22.56
Switzerland	19.35	16.80	21.49	19.35	24.35	21.79	26.59	23.87	29.32	27.26	31.07	24.70
Belgium	17.87	15.43	20.06	17.87	22.74	20.06	25.13	22.30	27.78	25.41	29.78	23.07
Denmark	19.15	17.09	21.03	19.15	20.57	18.88	22.02	20.62	22.95	21.80	23.66	21.99
Luxembourg	17.15	14.90	19.22	17.15	22.33	19.86	24.55	21.85	28.10	25.74	30.02	23.18
Netherlands	19.53	17.22	21.61	19.53	22.08	19.74	24.16	22.06	25.30	23.49	26.56	23.21
France	19.04	16.25	21.54	19.04	24.30	21.09	27.21	23.76	29.43	26.50	32.03	24.65
Italy	18.90	16.71	20.85	18.90	23.72	20.91	26.27	23.12	29.11	26.40	31.44	23.82
Portugal	18.99	16.89	20.61	18.99	22.28	19.72	24.72	21.75	26.61	23.78	29.51	22.76
Spain	19.40	17.17	21.14	19.40	23.78	20.94	26.77	23.31	28.33	24.98	32.00	24.20
Czech Republic	16.59	14.33	18.52	16.59	19.51	16.96	21.75	19.56	23.17	20.70	25.41	20.83
Poland	18.11	15.85	19.81	18.10	19.33	16.43	22.00	19.54	21.24	17.82	24.60	20.59
Slovakia	17.62	15.93	19.18	17.62	18.41	15.61	20.90	18.60	19.81	16.41	22.95	19.71
Estonia	18.38	15.47	19.98	18.38	18.31	14.97	21.13	18.68	19.65	15.72	23.48	20.20
Canada	18.95	16.49	21.47	18.95	23.45	21.25	25.29	22.97	27.93	26.35	28.76	23.59
USA	18.55	15.93	20.97	18.55	22.31	20.45	23.76	22.15	25.87	25.11	26.07	23.05
Australia	18.19	15.60	20.67	18.19	24.26	22.12	26.23	23.43	30.42	29.24	31.51	24.60
New Zealand	18.03	15.86	20.15	18.03	23.10	21.26	24.67	22.54	28.51	27.44	29.16	23.21
Japan	18.82	16.80	20.80	18.82	25.56	22.12	28.96	24.83	30.85	27.64	32.30	25.67

Notes: [a]Source: Heiland and Movsesyan (2013).

Table 2: **Standard Deviation of Remaining Lifespan, Birth Cohorts 1900, 1930 and 1960**[a]

	Birth Cohort 1900				*Birth Cohort 1930*				*Birth Cohort 1960*			
	All	Male	Female	Imputed	All	Male	Female	Imputed	All	Male	Female	Imputed
Finland	9.38	8.76	9.32	9.38	10.41	10.25	9.87	9.91	11.17	11.38	10.62	9.39
Iceland	9.80	9.56	9.60	9.81	9.91	9.81	9.78	9.46	10.44	10.39	10.17	9.06
Norway	9.27	8.83	9.22	9.27	9.96	9.71	9.63	9.69	10.43	10.39	9.88	9.14
Sweden	9.31	8.81	9.36	9.30	9.96	9.75	9.69	9.60	10.48	10.39	10.07	9.08
Ireland	8.89	8.33	9.08	8.89	10.21	9.87	10.06	10.06	10.99	10.87	10.72	9.32
UK	9.47	8.65	9.51	9.46	10.47	10.24	10.19	10.12	11.28	11.46	10.66	9.47
Austria	9.04	8.49	8.99	9.04	10.33	10.19	9.90	9.81	10.91	11.09	10.50	9.26
Germany	9.02	8.45	9.03	9.02	10.33	10.02	10.00	9.83	10.95	10.87	10.64	9.29
Switzerland	9.61	9.10	9.50	9.61	10.26	10.15	9.77	9.75	10.74	10.84	10.15	9.20
Belgium	9.27	8.66	9.26	9.27	10.25	9.88	9.89	9.73	11.00	10.84	10.46	9.34
Denmark	9.41	8.90	9.47	9.41	9.97	9.65	9.90	9.96	10.22	10.12	9.89	9.37
Luxembourg	9.03	8.51	9.00	9.03	10.41	10.10	10.06	9.79	11.21	11.30	10.51	9.08
Netherlands	9.42	8.89	9.41	9.42	9.87	9.58	9.55	9.77	10.26	10.23	9.75	9.20
France	9.70	9.06	9.58	9.69	10.78	10.47	10.20	10.14	11.41	11.23	10.87	9.60
Italy	9.38	8.96	9.30	9.37	10.57	10.25	10.20	9.94	11.31	11.04	10.98	9.42
Portugal	8.93	8.64	8.84	8.92	10.10	9.82	9.92	9.45	10.94	10.68	10.87	8.88
Spain	9.41	9.10	9.31	9.41	10.31	10.06	10.07	9.75	10.97	10.76	11.08	9.23
Czech Republic	8.42	7.94	8.33	8.42	9.78	9.51	9.49	9.72	10.40	10.26	10.07	9.21
Poland	8.92	8.52	8.85	8.91	9.89	9.47	9.70	9.98	10.08	9.54	10.10	9.60
Slovakia	8.55	8.27	8.50	8.55	9.39	8.95	9.25	9.57	9.51	8.93	9.55	9.23
Estonia	8.77	8.30	8.62	8.77	9.77	9.09	9.66	10.11	9.67	8.97	9.77	9.68
Canada	10.14	9.43	10.23	10.14	10.67	10.35	10.31	10.14	11.34	11.27	10.69	9.77
USA	10.28	9.51	10.37	10.28	10.57	10.40	10.25	10.31	11.16	11.31	10.56	9.88
Australia	9.78	9.02	9.85	9.78	10.85	10.66	10.45	9.99	11.84	11.88	11.10	9.26
New Zealand	9.45	8.74	9.63	9.45	10.67	10.37	10.39	10.06	11.55	11.61	10.77	9.59
Japan	9.75	9.24	9.84	9.74	11.20	10.46	11.14	10.30	12.78	11.33	14.81	9.78

Notes: [a]Source: Heiland and Movsesyan (2013).

Table 3: **Full Retirement Age, Actual vs. Demographically Adjusted, Selected Cohorts**[a]

Interest Rate (r)	*FRA*-Actual Values			*FRA*-Demographically Adjusted Values (Reference: Cohort 1900)					
	United States (Present: FRA=66; Ultimate: FRA=67)								
				Overall		*Males*		*Females*	
	1900	1930	1960	1930	1960	1930	1960	1930	1960
0.0%	65	65	67	68+10mo	72+7mo	69+9mo	74+9mo	67+9mo	70+1mo
2.68%	65	65	67	67+6mo	69+10mo	68+2mo	71+5mo	66+9mo	68+2mo
9.0%	65	65	67	66+1mo	66+10mo	66+5mo	67+7mo	65+9mo	66+2mo
	Germany[b] **(Present: FRA=65; Ultimate: FRA=67)**								
				Overall		*Males*		*Females*	
	1900	1930	1960	1930	1960	1930	1960	1930	1960
0.0%	65 (60)	63 (60)	66+4mo			69+10mo	75+10mo	65+1mo	70+6mo
2.68%	65 (60)	63 (60)	66+4mo			68+3mo	72+3mo	61+11mo	65+8mo
9.0%	65 (60)	63 (60)	66+4mo			66+5mo	67+11mo	60+10mo	61+5mo
	Japan[c] **(Present: Basic-Flat/Earnings: FRA^m=65/61, FRA^f=63/60; Ultimate: FRA=65/65)**								
				Overall		*Males*		*Females*	
	1900	1930	1960	1930	1960	1930	1960	1930	1960
0.0%	60/60	60/60	65/64 (65/62)	67	74+4mo	65+6mo	71+7mo	68+8mo	76+11mo
2.68%	60/60	60/60	65/64 (65/62)	63+10mo	67+8mo	63+2mo	66+7mo	64+7mo	68+7mo
9.0%	60/60	60/60	65/64 (65/62)	61+1mo	61+11mo	61	61+11mo	61+2mo	61+10mo
	Belgium[d] **(Present: Minimum Retirement Age=60 w/ 35 years of service; Ultimate: MRA=62 w/ 40 years of service)**								
				Overall		*Males*		*Females*	
	1900	1930	1960	1930	1960	1930	1960	1930	1960
0.0%	60	65/60	65/62	65	70+4mo	64+9mo	70+6mo	65+2mo	70+1mo
2.68%	60	65/60	65/62	62+10mo	65+9mo	62+10mo	66+2mo	62+10mo	65+5mo
9.0%	60	65/60	65/62	61	61+7mo	61+1mo	61+11mo	60+11mo	61+4mo
	Belgium[d] **(Present: Minimum Retirement Age=60 w/ 35 years of service; Ultimate: MRA=62 w/ 40 years of service)**								
				Overall		*Males*		*Females*	
	1900	1930	1960	1930	1960	1930	1960	1930	1960
0.0%	65	65/60	65/62	70+4mo	75+10mo	70+2mo	76+1mo	70+4mo	75+4mo
2.68%	65	65/60	65/62	68+5mo	71+11mo	68+6mo	72+5mo	68+4mo	71+4mo
9.0%	65	65/60	65/62	66+5mo	67+7mo	66+7mo	68+1mo	66+3mo	67+2mo

Notes: [a]Source: Author's calculations. Actual values reported in parentheses are for women if there are gender differences in adjustment policy. [b]In Germany, *FRA* is currently 65 (scheduled to reach age 67) and early collection of reduced benefits is currently permitted at age 63 with 35 years of contributions (or in the case of long-term unemployment). [c]In Japan, the pension consists of a flat-rate and an earnings-related component. Both schemes are experiencing increases in the *FRA* from 60 to 65. Early benefit take-up at a reduced rate is possible in both schemes. [d]In Belgium, workers with 40 years of contributions can currently retire with full benefits as early as age 60. The requirement on service years and the minimum retirement age at full benefits is increasing.

Table 4: **Full Retirement Age, Actual vs. Demographically Adjusted, Selected Cohorts**[a]

Interest Rate (r)	***FRA*-Actual Values**			***FRA*-Demographically Adjusted Values (Reference: Cohort 1900)**					
				United States (Present: FRA=66; Ultimate: FRA=67)					
				Overall		*Males*		*Females*	
	1900	1930	1960	1930	1960	1930	1960	1930	1960
	65	65	67	67+6mo	69+10mo	68+2mo	71+5mo	66+9mo	68+2mo
				Germany (Present: FRA=65; Ultimate: FRA=67)					
				Overall		*Males*		*Females*	
	1900	1930	1960	1930	1960	1930	1960	1930	1960
	65 (60)	63 (60)	66+4mo			68+3mo	72+3mo	61+11mo	65+8mo
				Japan (Present: Basic-Flat/Earnings: FRA^m=65/61, FRA^f=63/60; Ultimate: FRA=65/65)					
				Overall		*Males*		*Females*	
	1900	1930	1960	1930	1960	1930	1960	1930	1960
	60/60	60/60	65/64 (65/62)	63+10mo	67+8mo	63+2mo	66+7mo	64+7mo	68+7mo
				Belgium (Present: Minimum Retirement Age=60 w/ 35 years of service; Ultimate: MRA=62 w/ 40 years of service)					
				Overall		*Males*		*Females*	
	1900	1930	1960	1930	1960	1930	1960	1930	1960
	60	65/60	65/62	62+10mo	65+9mo	62+10mo	66+2mo	62+10mo	65+5mo

Notes: [a]Source: Author's calculations. Actual values reported in parentheses are for women if there are gender differences in adjustment policy. [b]In Germany, *FRA* is currently 65 (scheduled to reach age 67) and early collection of reduced benefits is currently permitted at age 63 with 35 years of contributions (or in the case of long-term unemployment). [c]In Japan, the pension consists of a flat-rate and an earnings-related component. Both schemes are experiencing increases in the *FRA* from 60 to 65. Early benefit take-up at a reduced rate is possible in both schemes. [d]In Belgium, workers with 40 years of contributions can currently retire with full benefits as early as age 60. The requirement on service years and the minimum retirement age at full benefits is increasing.

Country	*Scheme*	*Early age*	*Reduction*	*Normal age*	*Increase*
Australia	Targeted	na		65	0.57-3.28%[1]
Austria		62/60	4.2%	65	4.2%
Belgium		60	0	65	0
Canada		60[2]	6%	65	6%
Czech Republic		60/56-60[3]	5.6%[4]	63/59-63[3]	8.1%[4]
Denmark	Public	na		65	5.35%[5]
Finland	Targeted	62	4.8	65	7.20%
	Earnings-related	62	7.2%/0[7]	65	0/4.8%[8]
France	Public	na		60	3%
	Occupational	55	7%	60	0
Germany		62	3.6%	65	6%
Greece		55	4.5%[9]	65	0[10]
Hungary	Public	60/59	0/1.2-3.6%[11]	62	6%
Iceland	Occupational	62	7.2-9.6%[12]	67	7.2-9.6%[12]
Ireland		na		65	na
Italy		62/60	2.6-3.1%[13]	65/60	0[13]
Japan	Basic	60	6%	65	8.40%
	Earnings-related	na		65	na
Korea		60	na	65	na
Luxembourg		60[14]	0	65	na
Mexico		60[15]	auto	65	auto
Netherlands		na[6]		65	na
New Zealand		na		65	na
Norway		na		67	na
Poland	Notional accounts	na		65/60	3.7%/4.4%[16]
Portugal		55	4-4.5%[17]	65	10%
Slovak Republic	Points	any age[18]	6%	62	6%
Spain		61	6-8%[19]	65	2%
Sweden	Notional accounts	61	4.1-4.7%[20]	65	4.9-6.1%[20]
	Occupational	55	varies[21]	65	varies
Switzerland	Public	63/62	4.5%[22]	65/64	5.2-6.5%[23]
	Occupational	60/59	2.9%[22]	65/64	2.9%[22]
Turkey		na		60/58	na
United Kingdom		na		65	10.4%[24]
United States		62	5-6.67%[24]	67	8%

Notes: Where pension ages for men and women differ they are shown as M/F. "na" means that early retirement or deferral of pension is not available. Schemes where the concept of these adjustments are irrelevant have been ignored. Some countries have legislated changes to some parameters that are not yet in effect: the Table shows the long-term position with all such reforms fully in place. The ability to combine work and pension receipt (particularly after normal pension ages) is common. More detail on country pension systems can be found in OECD (2005). Calculations for late retirement assume a maximum retirement age of 70.

1. The pension bonus is paid as a one-off, lump sum. It is calculated as 9.4% of age-pension entitlement at the time of retirement multiplied by the number of years of deferral squared. The unisex annuity factor for Australia varies from 16.5 at age 65 to 14.3 at age 69. This can be used to calculate the value of the pension bonus as a proportion of the age-pension benefit stream. The result is then comparable with the adjustments to benefits applied in other countries. The values shown are annualized for 1 and 5 years of deferral respectively. With 3 years' deferral, for example, the bonus is equivalent to an increase in age pension of 1.8% per year of deferral.
2. Only the earnings-related pension (not the basic or targeted benefits) can be drawn early.
3. Pension age for women varies with the number of children that they have had.
4. Calculated for a full-career working entering at age 20. The adjustments are defined as 3.6% reduction and 5.2% increase in the total accrual factor rather than the benefit.
5. The adjustment is based on the reciprocal of life expectancy at the age at which the pension is drawn. Life expectancy has been calculated from the World Bank/UN population database projections for 2040.
6. There are separate early-retirement programmes.
7. The adjustment applies for one year from 62 to 63. There is then no adjustment but instead accelerated accrual in the earnings-related scheme.
8. There is no adjustment until age 68 because of accelerated accrual in the earnings-related scheme. The adjustment shown applies from 68 onwards.
9. The pension is not reduced if 37 years of contributions have been made.
10. There is accelerated accrual during the deferral period but no increment to already accrued benefits.
11. There is no reduction if 38 years of contributions have been made; rate of reduction varies with fewer years.
12. Adjustment for private-sector workers depends on scheme. The adjustment for public-sector workers is 6%.
13. Adjustment for early retirement has been calculated from government-provided transformation coefficients projected for 2040. After age 65, the transformation coefficient is constant.
14. Early retirement is conditional on 40 years' insurance.
15. Early retirement is conditional on 1250 weekly contributions (25 years).
16. The adjustments for late retirement have been calculated from projected G-values using the World Bank/UN population database for 2040. Those shown are for men and women at age 60 and 65 respectively. The implicit adjustments increase with age.
17. Adjustment is at a 4.5% rate. However, with more than 30 years' contributions at age 55, the number of years over which the pension is adjusted is cut by one year for each complete 3 years of contributions beyond 30 years. The 4% rate is shown because this would apply for retirement at 55 for a full-career worker who enters the system at age 20.
18. Early retirement is conditional on pension entitlement exceeding 1.2 times the subsistence minimum.
19. The adjustment is higher with fewer years of contributions.
20. The implicit adjustments are calculated from G-values. They increase with age. They also take account of the distribution of the account balances of people who die before claiming the pension.
21. There is no reduction for retirement from age 62. In the age range 55-62, reductions vary between employers.
22. See the annex on "benefit equivalence" for a description of how this was calculated.
23. The increment for late retirement increases with age.
24. This represents an increase on the 7.4% increment that used to be paid. A lump-sum payment of deferred pension plus interest can now also be claimed instead of a pension increment.
25. The reduction is 6.67% for the first 3 years of early retirement and 5% thereafter.

Figure 1: Current Pension Rules in OECD Countries (Source: Whitehouse and Queisser, 2006, Table 5)

	1949	*1958*	*1971*	*1983*	*1989*	*1993*	*1999*	*2002*	*2010*	*2020*	*2030*	*2040*	*2050*
Australia	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	66.0	67.0	67.0
Austria	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Belgium	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Canada	70.0	69.0	68.0	67.0	66.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Czech Republic		60.0	60.0	60.0	60.0	60.0	60.0	60.5	61.0	62.2	63.5	65.0	65.0
Denmark	65.0	65.0	67.0	67.0	67.0	67.0	67.0	67.0	65.0	65.0	67.0	67.0	67.0
Finland		65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
France		65.0	65.0	65.0	60.0	60.0	60.0	60.0	60.5	61.0	61.0	61.0	61.0
Germany	63.0	63.0	63.0	63.0	63.0	63.0	63.0	63.5	65.0	65.0	65.0	65.0	65.0
Greece	55.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0	60.0	60.0	60.0	60.0
Hungary	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	64.5	65.0	65.0	65.0
Iceland		67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0
Ireland	70.0	70.0	70.0	70.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Italy	60.0	60.0	60.0	55.0	55.0	55.0	55.0	57.0	59.0	61.0	65.0	65.0	65.0
Japan		60.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Korea						60.0	60.0	60.0	60.0	60.0	62.0	64.0	65.0
Luxembourg	65.0	65.0	65.0	65.0	65.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Mexico		65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Netherlands	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
New Zealand	65.0	60.0	60.0	60.0	60.0	60.0	61.1	64.1	65.0	65.0	65.0	65.0	65.0
Norway	70.0	70.0	70.0	70.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0
Poland	60.0	60.0	60.0	60.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Portugal	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Slovak Republic		60.0	60.0	60.0	60.0	60.0	60.0	60.0	62.0	62.0	62.0	62.0	62.0
Spain	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Sweden	67.0	67.0	67.0	67.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Switzerland		65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Turkey			60.0	45.0	45.0	45.0	45.0	44.0	44.9	48.6	53.1	57.7	62.3
United Kingdom	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	66.0	67.0	68.0
United States	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	66.0	66.0	67.0	67.0	67.0
Average	***64.3***	***63.9***	***63.9***	***63.2***	***62.8***	***62.5***	***62.6***	***62.7***	***63.0***	***63.5***	***64.1***	***64.4***	***64.6***

Source: National officials, OECD calculations and Turner (2007).

Note: Germany refers to West Germany for the period 1949-2002. Czechoslovakian data are used for the Czech and Slovak Republics where appropriate. Where there is more than one value per calendar year, these have been averaged.

(a) Men

	1949	*1958*	*1971*	*1983*	*1989*	*1993*	*1999*	*2002*	*2010*	*2020*	*2030*	*2040*	*2050*
Australia	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**61.0**	**62.0**	**64.0**	66.0	67.0	67.0
Austria	65.0	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**63.0**	65.0	65.0
Belgium	**55.0**	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Canada	70.0	69.0	68.0	67.0	66.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Czech Republic		60.0	**55.0**	**57.0**	**57.0**	**57.0**	**57.0**	**58.0**	**58.7**	**60.7**	**63.3**	65.0	65.0
Denmark	65.0	**60.0**	**62.0**	**62.0**	**62.0**	67.0	67.0	67.0	65.0	65.0	67.0	67.0	67.0
Finland		65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
France		65.0	65.0	65.0	60.0	60.0	60.0	60.0	60.5	61.0	61.0	61.0	61.0
Germany	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.5**	65.0	65.0	65.0	65.0	65.0
Greece	55.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0	60.0	60.0	60.0	60.0
Hungary	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**59.0**	64.5	65.0	65.0	65.0
Iceland		67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0
Ireland	70.0	70.0	70.0	70.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Italy	**55.0**	**55.0**	**55.0**	55.0	55.0	55.0	55.0	57.0	59.0	61.0	65.0	65.0	65.0
Japan		60.0	**60.0**	**60.0**	**60.0**	**61.0**	**63.0**	65.0	65.0	65.0	65.0	65.0	65.0
Korea						60.0	60.0	60.0	60.0	60.0	62.0	64.0	65.0
Luxembourg	65.0	65.0	65.0	65.0	65.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Mexico		65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Netherlands	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
New Zealand	65.0	60.0	60.0	60.0	60.0	60.0	61.1	64.1	65.0	65.0	65.0	65.0	65.0
Norway	70.0	70.0	70.0	70.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0
Poland	60.0	60.0	60.0	60.0	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**
Portugal	65.0	65.0	65.0	65.0	**62.0**	**62.0**	**62.0**	65.0	65.0	65.0	65.0	65.0	65.0
Slovak Republic		60.0	**55.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	62.0	62.0	62.0	62.0
Spain	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Sweden	67.0	67.0	67.0	67.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Switzerland		**60.0**	**60.0**	**60.0**	**62.0**	**62.0**	**62.0**	**62.0**	**63.0**	**64.0**	**64.0**	**64.0**	**64.0**
Turkey			60.0	45.0	45.0	45.0	45.0	**40.0**	**41.0**	**45.2**	**50.4**	**55.6**	**60.8**
United Kingdom	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	**60.0**	65.0	66.0	67.0	68.0
United States	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	66.0	66.0	67.0	67.0	67.0
Average	***62.9***	***62.5***	***62.1***	***61.7***	***61.1***	***61.1***	***61.2***	***61.4***	***61.9***	***62.9***	***63.7***	***64.1***	***64.4***

Source: National officials, OECD calculations and Turner (2007).

Note: Data shown in **bold** type indicates that pension ages are different for women than men. Germany refers to West Germany for the period 1949-2002. Czechoslovakian data are used for the Czech and Slovak Republics where appropriate. Where there is more than one value per calendar year, these have been averaged.

(b) Women

Figure 2: Trends in Full Retirement Age in OECD Countries (Source: Chomik and Whitehouse, 2010, Tables 1 and 2)

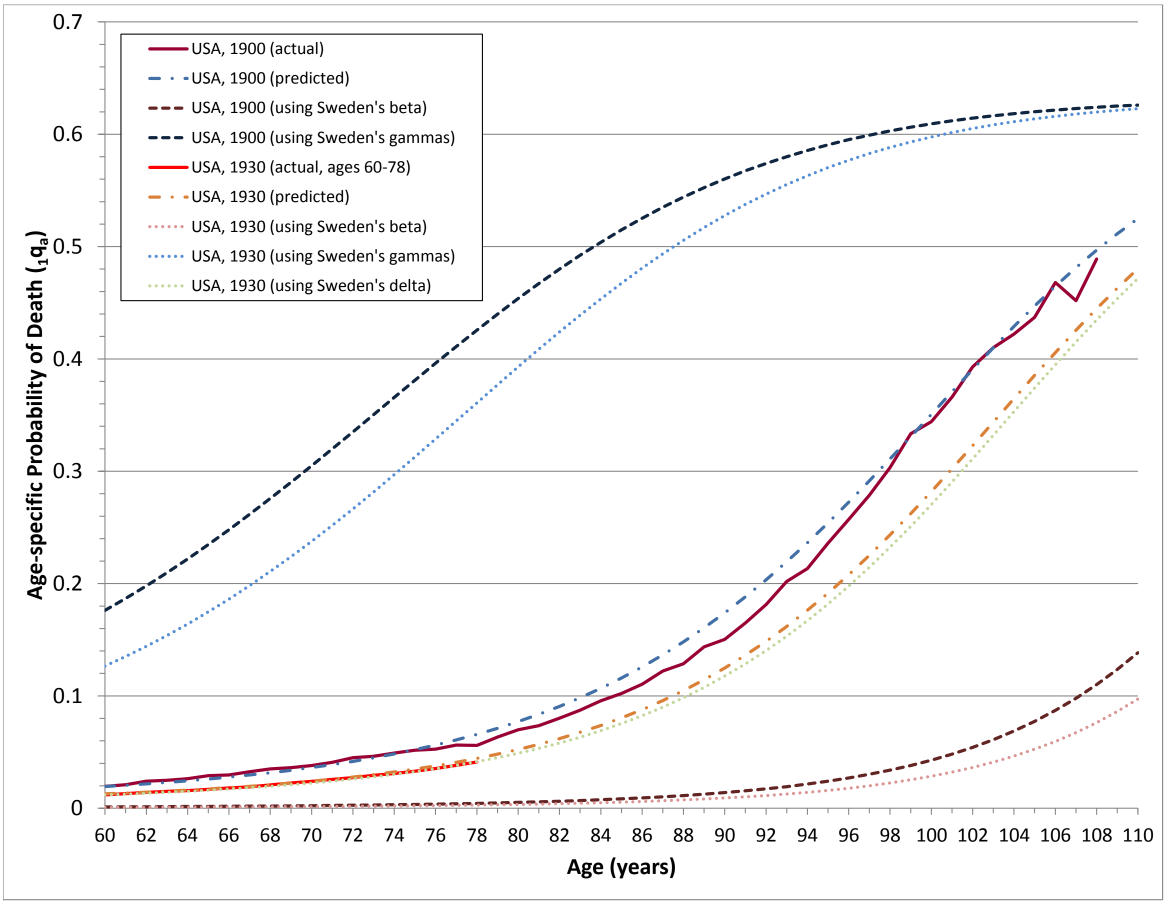
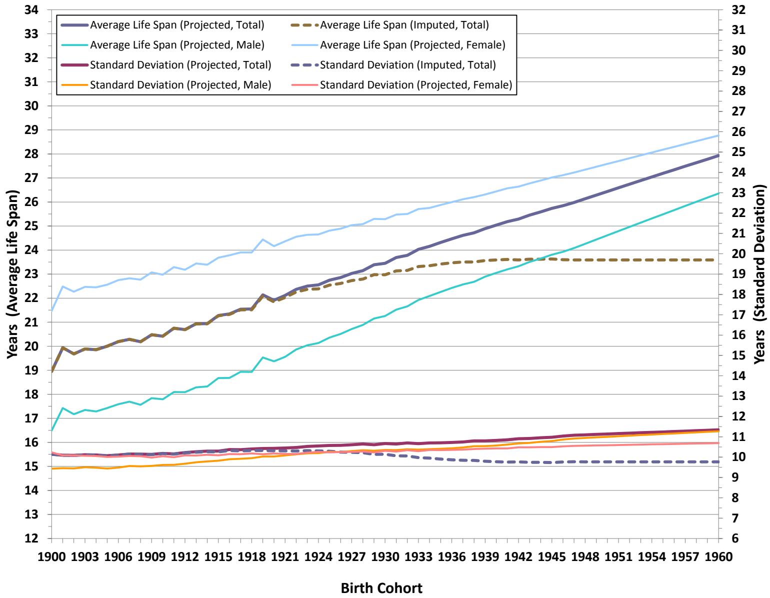
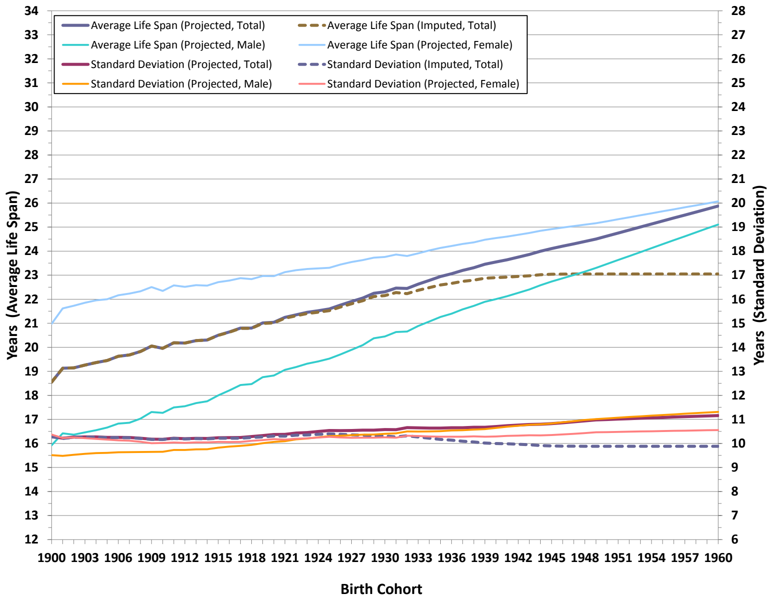


Figure 3: Actual and predicted probability of dying, United States, cohorts 1900 and 1930.

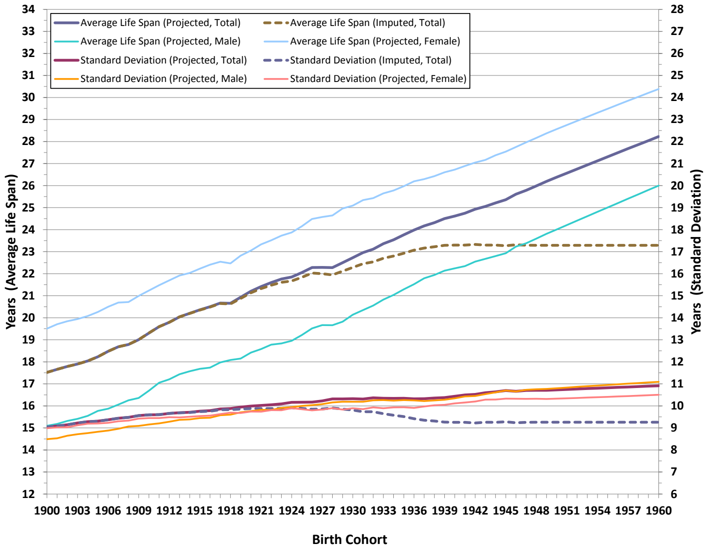


(a) Canada

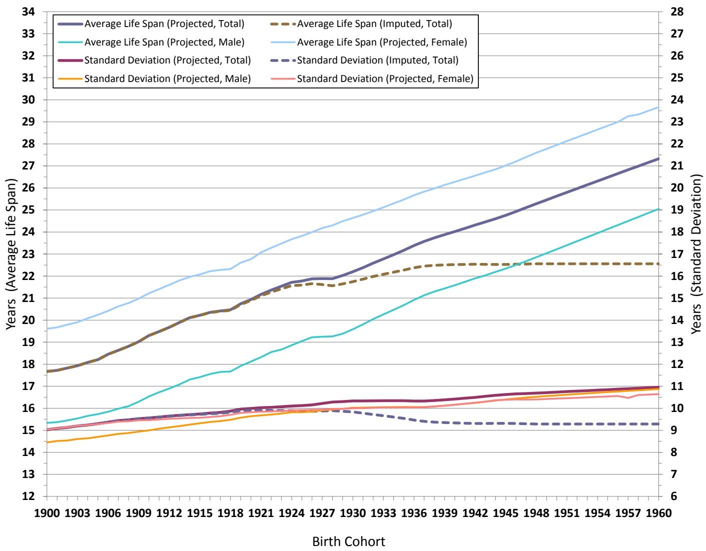


(b) USA

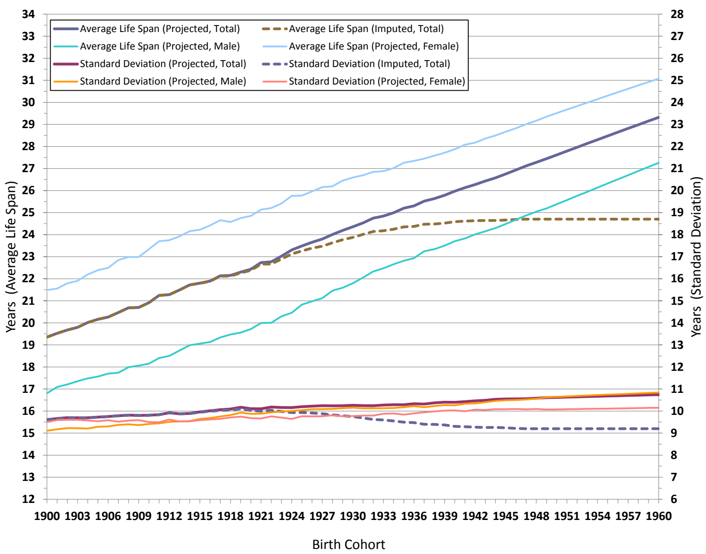
Figure 4: Lifespan past Age 60, Average and Standard Deviation, Canada and USA. (Source: Authors' calculation based on cohort life table data and projections.)



(a) Austria

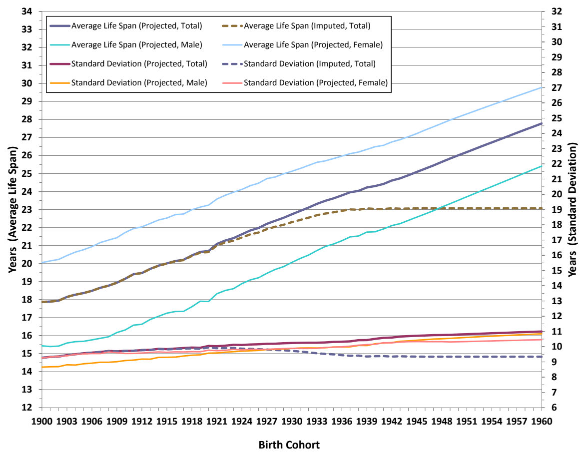


(b) Germany

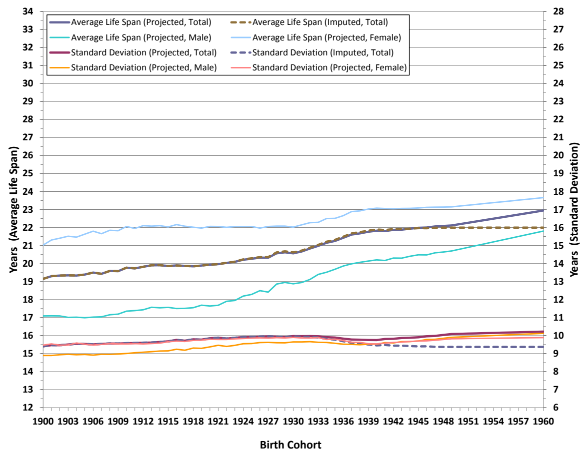


(c) Switzerland

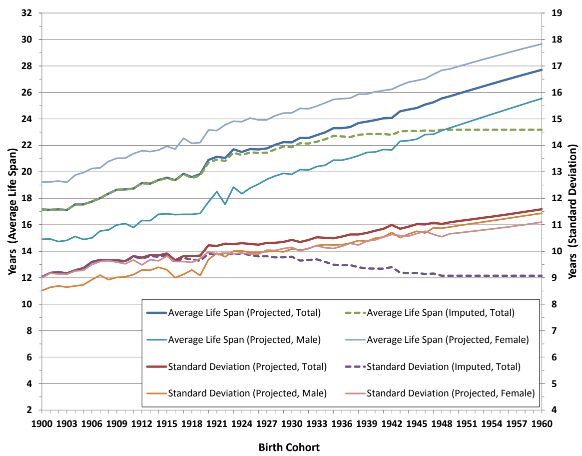
Figure 5: Lifespan past Age 60, Average and Standard Deviation, Austria, Germany and Switzerland. (Source: Authors' calculation based on cohort life table data and projections.)



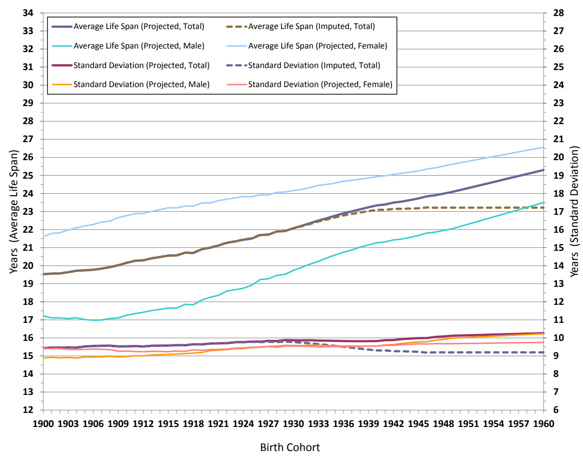
(a) Belgium



(b) Denmark

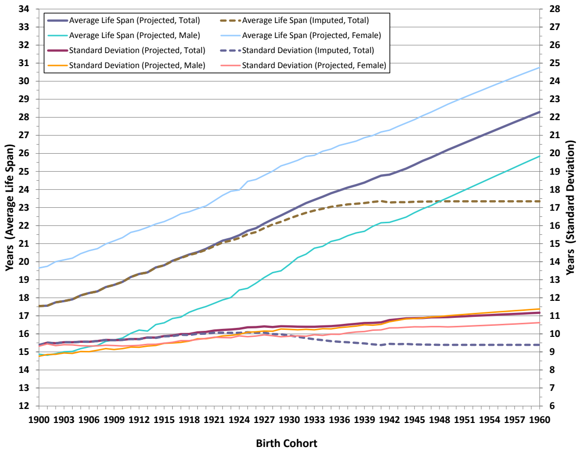


(c) Luxembourg

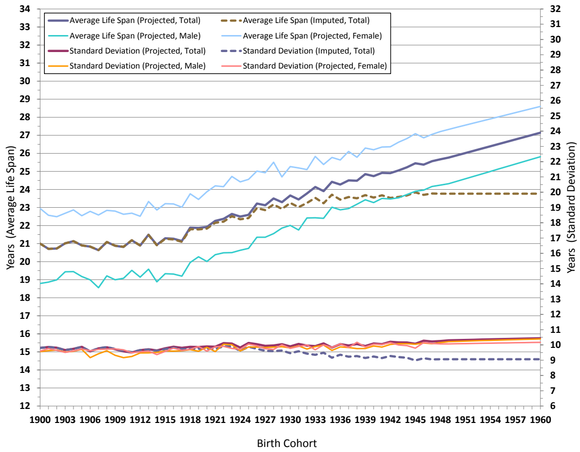


(d) Netherlands

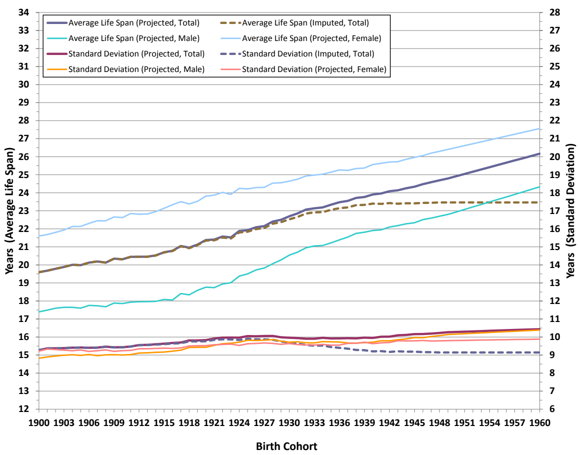
Figure 6: Lifespan past Age 60, Average and Standard Deviation, Belgium, Denmark, Luxembourg and the Netherlands. (Source: Authors' calculation based on cohort life table data and projections.)



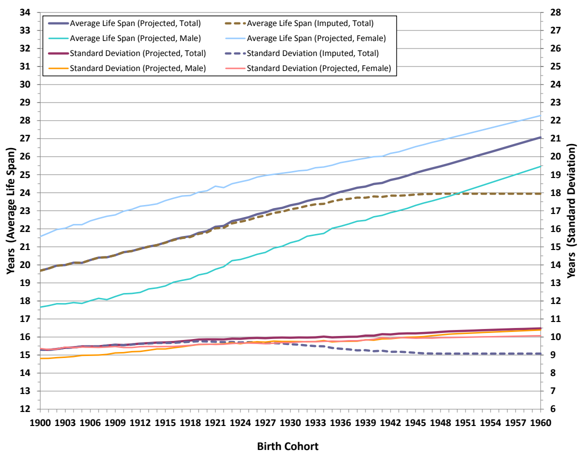
(a) Finland



(b) Iceland

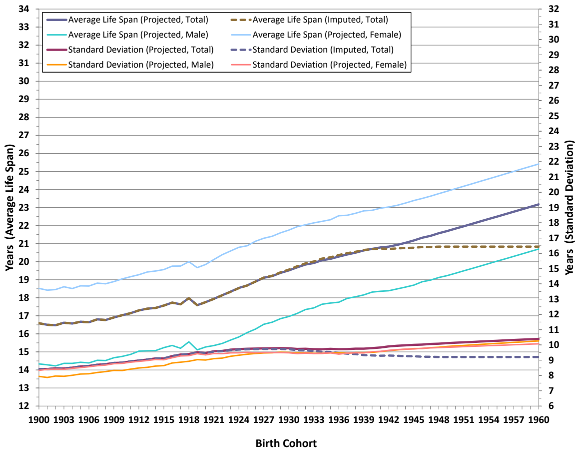


(c) Norway

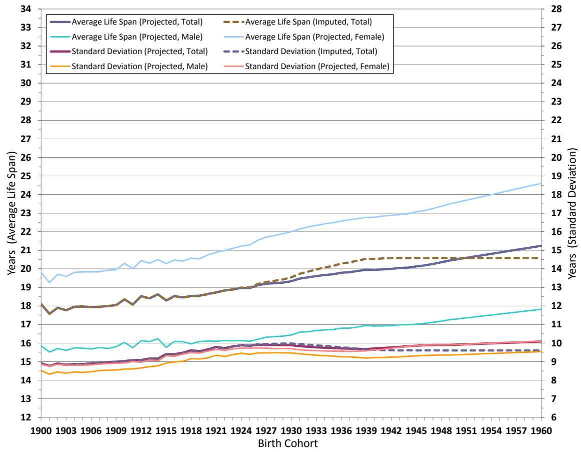


(d) Sweden

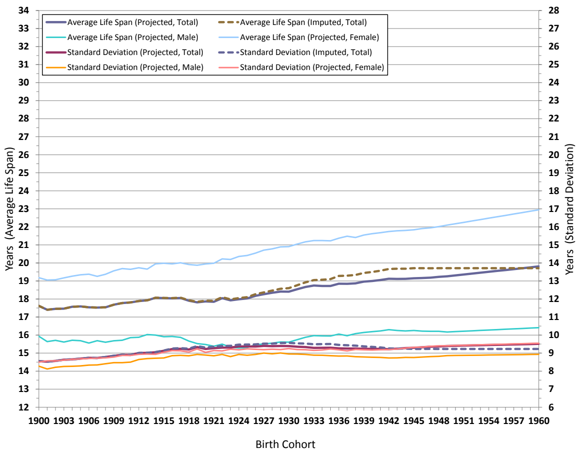
Figure 7: Lifespan past Age 60, Average and Standard Deviation, Denmark, Finland, Iceland, Norway and Sweden. (Source: Authors' calculation based on cohort life table data and projections.)



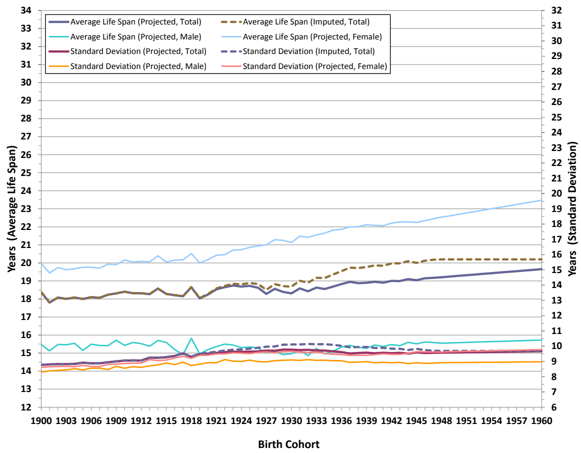
(a) Czech Republic



(b) Poland

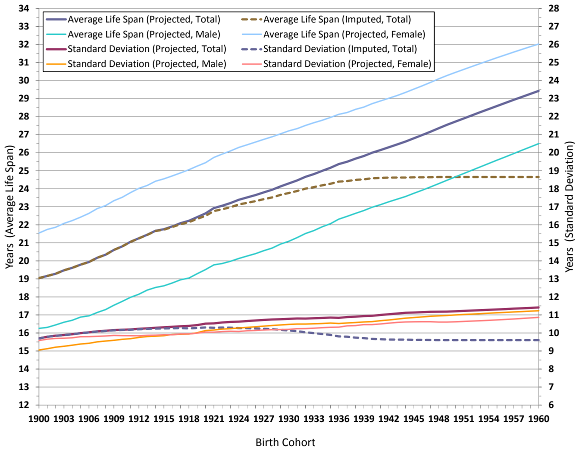


(c) Slovakia

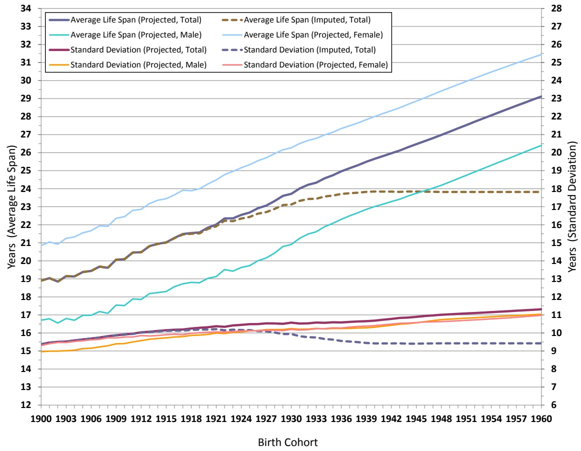


(d) Estonia

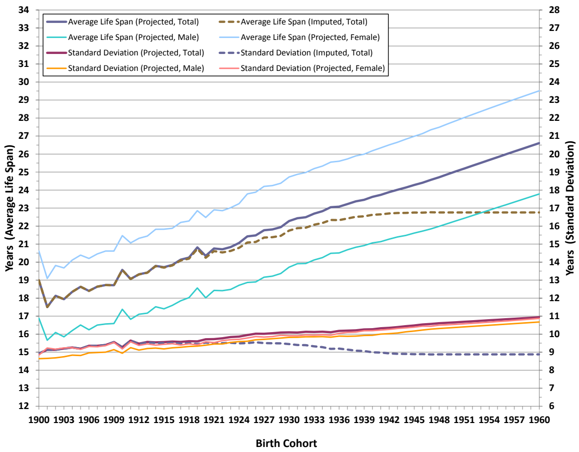
Figure 8: Lifespan past Age 60, Average and Standard Deviation, Czech Republic, Poland, Slovakia and Estonia. (Source: Authors' calculation based on cohort life table data and projections.)



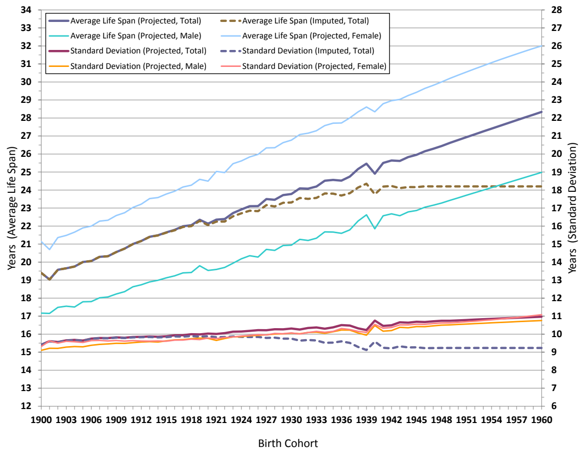
(a) France



(b) Italy

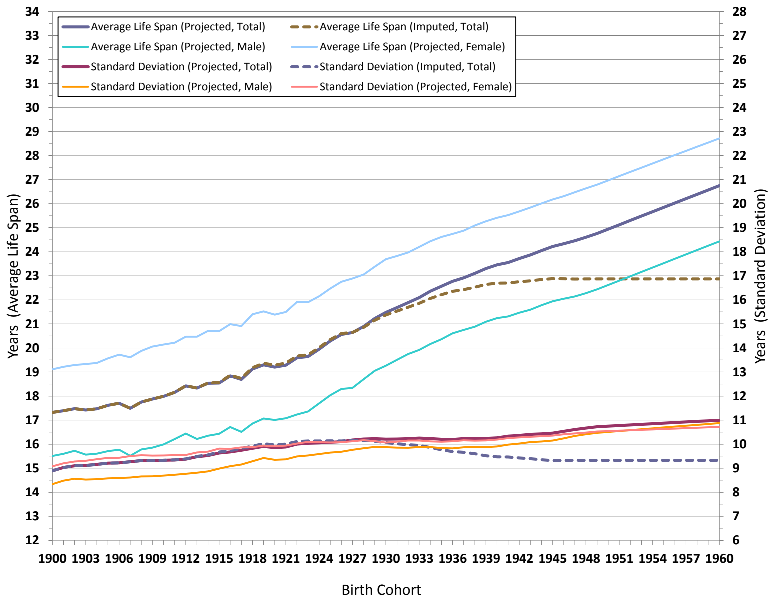


(c) Portugal

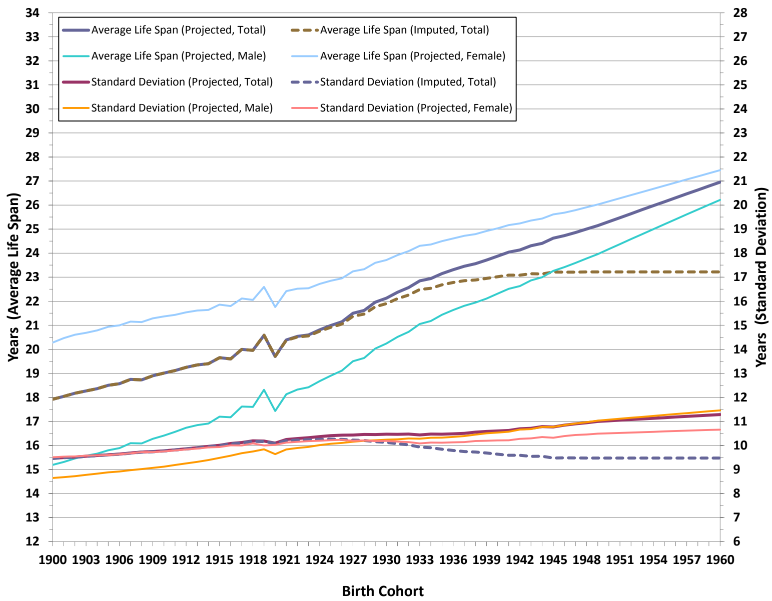


(d) Spain

Figure 9: Lifespan past Age 60, Average and Standard Deviation, France, Italy, Portugal and Spain. (Source: Authors' calculation based on cohort life table data and projections.)

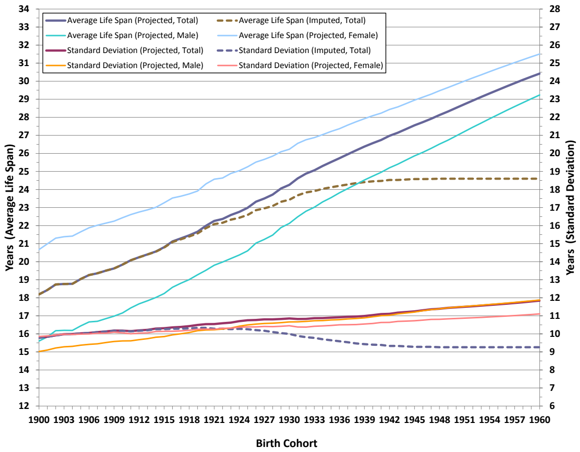


(a) Ireland

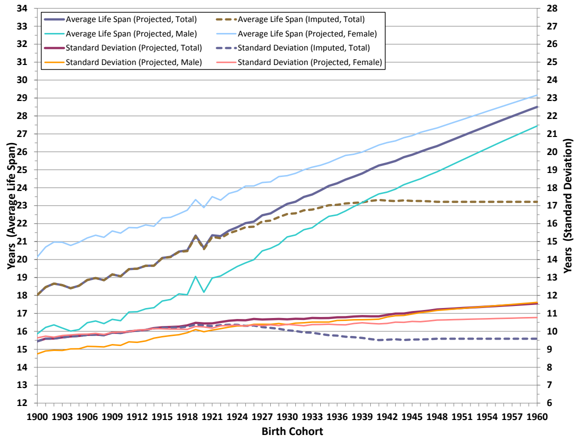


(b) UK

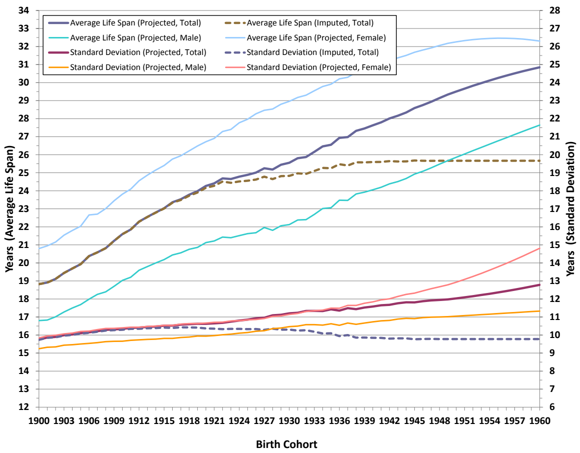
Figure 10: Lifespan past Age 60, Average and Standard Deviation, Ireland and UK. (Source: Authors' calculation based on cohort life table data and projections.)



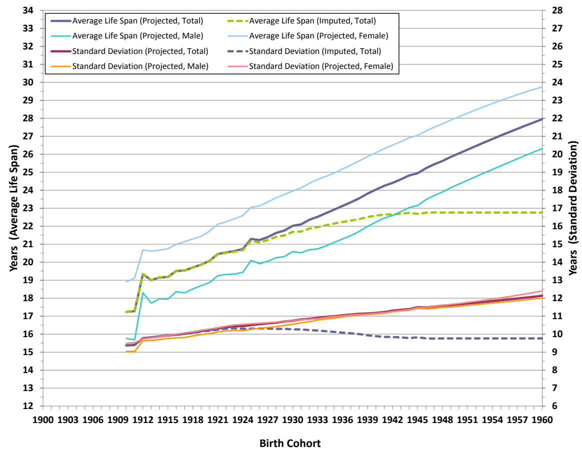
(a) Australia



(b) New Zealand



(c) Japan



(d) Taiwan

Figure 11: Lifespan past Age 60, Average and Standard Deviation, Australia, New Zealand, Japan and Taiwan. (Source: Authors' calculation based on cohort life table data and projections.)

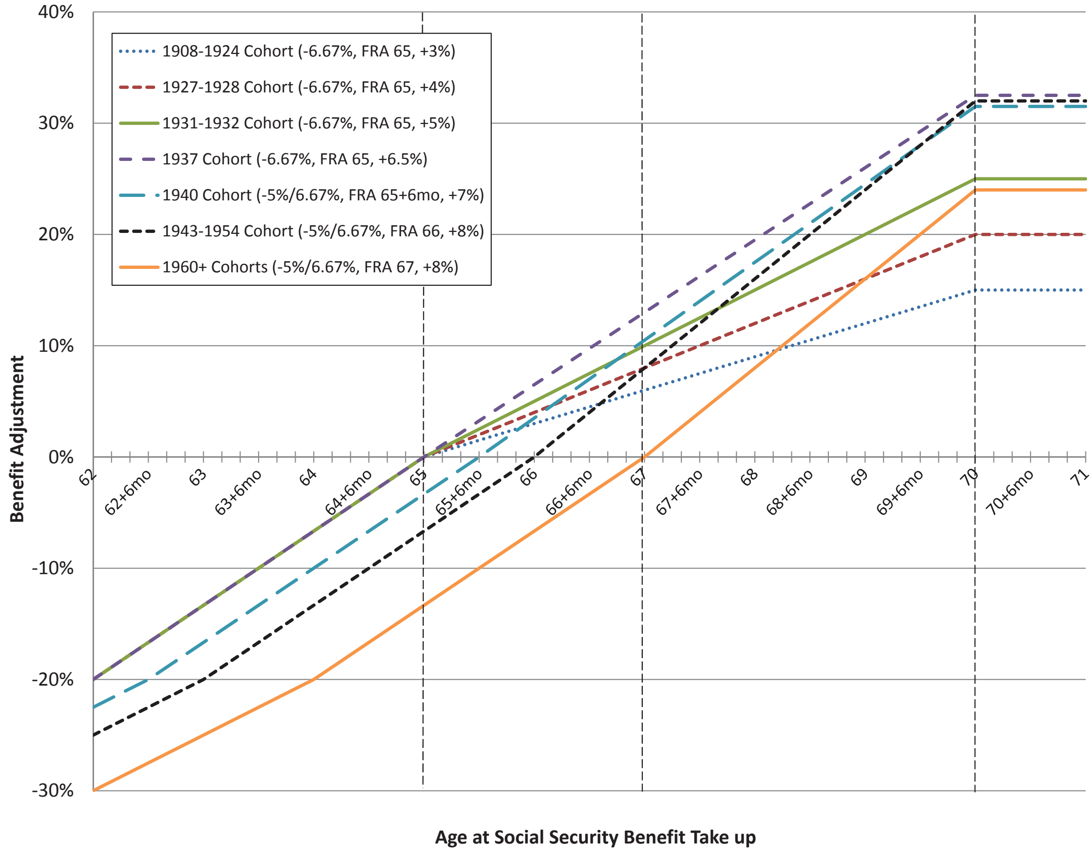


Figure 12: Social Security Retirement Benefit Adjustment Schedules for U.S. Workers, Selected Cohorts. (In parentheses: *FRA* and annual early and delayed adjustment percentages.)

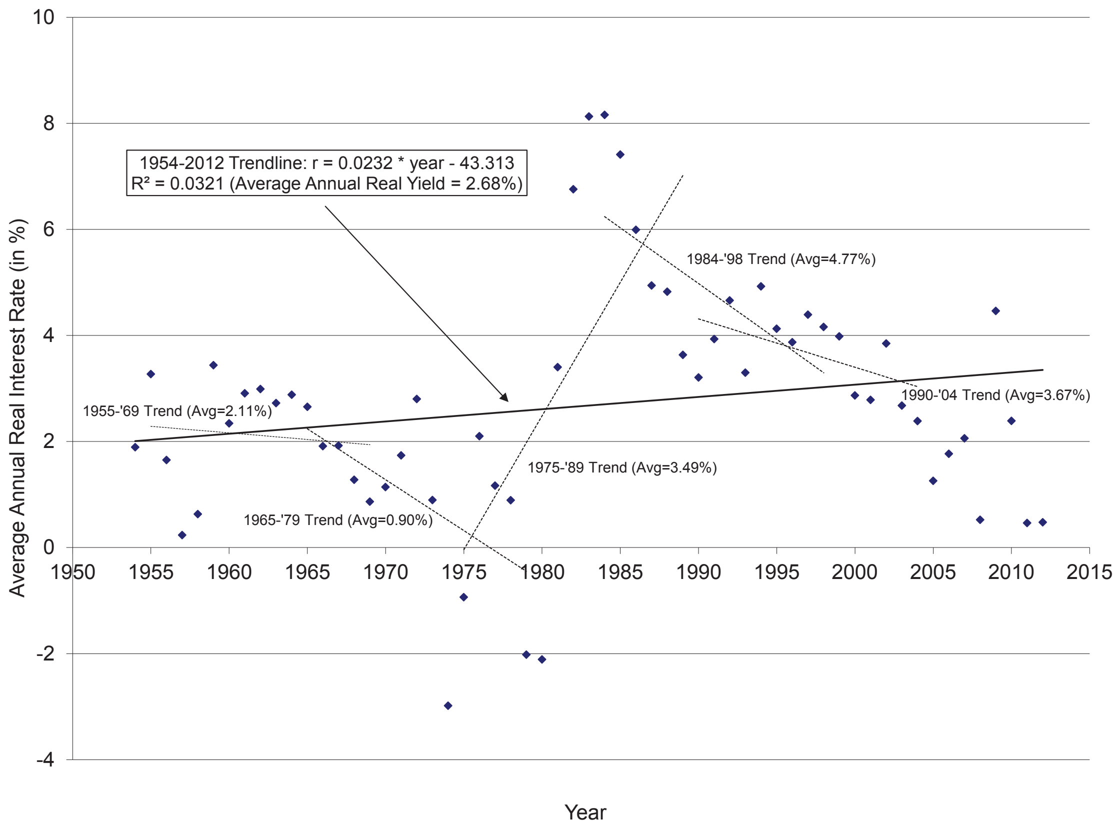


Figure 13: Average Annual Real Interest Rate of 20-year Constant Coupon Treasuries, Long-run and 15-year Linear Trends.