TIAA Institute

Research Dialogue | Issue no. 221
December 2024

How has the variance of longevity changed over time?

Executive summary

The unpredictability of one's lifespan is a major difficulty in retirement planning and provides the impetus for insurance products guaranteeing lifetime income. It's well known that this variance of longevity differs across demographic and socioeconomic groups, but the patterns of this variance over time haven't been studied.

This paper explores trends in the variance of longevity across groups, conditional on different starting ages, and over time, and quantifies the magnitude of differences in dollar terms using a wealth equivalence approach for a fair immediate annuity. Specifically, the analysis considers the following populations, all segregated by gender: the full U.S. population, low/high-education White and Black individuals, and annuitants. Life tables are estimated, as necessary, to supplement existing published life tables necessary to establish the life expectancy and the variance of age at death for each population. The tables are used to calculate these metrics conditional on surviving to ages 50, 62, 67 and 70, all chosen to represent pivotal ages with respect to retirement planning and policy.

The analysis finds:

1. The population-level variance of longevity has generally stayed stable since the 1970s.
2. Black and lower-educated individuals tend to face greater lifespan variation compared with their White and higher-educated counterparts in all years.
3. Among all the race-education groups explored, variance in longevity has increased, except for low-education Black males.
4. Annuitants generally face smaller lifespan dispersion compared with the general population at age 50 in all years.

Gal Wettstein
Center for Retirement Research at Boston College

Yimeng Yin
Center for Retirement Research at Boston College

5. The changes in the variance of longevity from 2000 to 2019, keeping life expectancy constant, would be associated with a 1.3% to 2.0% increase in the value of fair immediate annuities, all else held constant, for the population at large, with changes for sub-groups ranging from -6.1% (low-education Black males) to 13.6% (high-education Black males).

1. Introduction

Life expectancy and its swings over time receive significant attention from both academics and the public.[1] Much less attention, however, is paid to the variation in lifespan around its mean, the variance of longevity.[2] However, it's precisely this unpredictability of age of death that makes lifetime income provided by Social Security and annuities so valuable (Mitchell et al., 1999; Wettstein et al., 2021; and Arapakis & Wettstein, 2023). The variance of longevity also differs across demographic groups (e.g., Brown, 2002; Sasson, 2016; and Wettstein et al., 2021): Black and lower-education individuals tend to have greater dispersion in their remaining longevity even conditional on living to middle age. More generally, the lower the life expectancy of a demographic group, the higher the variance of their longevity tends to be (Milevsky, 2020). The literature hasn't documented well how this variance has changed over time. This relationship matters because the value of guaranteed lifetime income increases with longevity's variance (Arapakis et al., 2023).

This study examines changes in remaining lifespan variation at older ages over the past decades for various population groups and discusses their economic implications in terms of the value of lifetime income. The analysis first considers the general population, summarizing the overall temporal pattern of lifespan variation. This time trend, in turn, sheds light on the value of widely accessible lifetime income sources, policy reforms aimed at increasing such coverage (e.g., the safe harbor for annuities embedded within employer-sponsored retirement plans included in the SECURE 2.0 Act), and long-standing policies across many countries to provide annuity-like income to retirees. A prominent example of the latter is the old-age benefit of Social Security.

Second, the study examines how lifespan variation and its trends differ across demographic and socioeconomic-status groups. From a population perspective, the differential lifespan variations across population groups represent an important dimension of inequality (Sasson, 2016) and, when combined with changes in the composition of the population, are an important driver of population-level changes in the variance of longevity. From an individual standpoint, group-specific lifespan variation more closely represents the uncertainty in the time to death faced by given individuals and thus is more relevant to individuals' financial and retirement decisions involving selections of lifetime income.

Lastly, the analysis considers the annuitant population to see how valuable lifetime income is today compared with past periods for those who actually purchase annuities. Comparisons of annuitants to the general population in terms of the variance of longevity can inform regarding the value of marginal increases in lifetime income coverage. For example, if annuitants have lower longevity variation than the general population, we can infer that increasing annuitization will have increasing marginal returns to social welfare because those who are uncovered stand to gain even more than existing annuitants.

In all these populations, the variance of residual longevity is assessed at different ages. The results of this analysis thus shed light on which populations stand to gain the most from longevity insurance, and what point in the lifecycle is the most opportune for them to consider acquiring such insurance.

The results show that: 1) the population-level variance of longevity has generally stayed stable since the 1970s;[3] 2) looking across population groups, Black and lower-educated individuals tend to face greater lifespan variation compared with their White and higher-educated counterparts in all years; 3) among all race-education groups, variance in longevity has increased, except for low-education Black males, who saw a substantial decrease in lifespan variation over the 2000–2019 period, due to a significant reduction in premature death for this group; and 4) annuitants generally face smaller lifespan dispersion compared with the general population at age 50 in all years, suggesting that those who don't typically buy annuities stand to gain more from such longevity insurance.

To give a sense of the magnitude of changes in the variance of longevity over time and across groups, the analysis quantifies the dollar value of longevity insurance in a bare-bones lifecycle model. The goal here is not to evaluate annuities per se, but to use the change in the value of annuities as a measure of the magnitude of differences in lifespan uncertainty. The results show that, holding life expectancy constant, a one-year increase in the standard

1 For examples of academics' interest, see Canudas-Romo (2010); Montez et al. (2012); Chetty et al. (2016); and Shen et al. (2023). For examples of the public's interest, see Tavernise and Goodnough (2020) or Anthes and Mueller (2023).

2 Among the few exceptions are Sasson (2016) and Wettstein et al. (2021).

3 The full population includes groups besides white and Black race (such as Hispanic, Asian, and other groups), and the composition of the full population also changes over time. For these reasons, the full population may experience minimal changes in variance over time even as certain subgroups see greater shifts.

deviation of longevity would result in a 6.8% increase in the longevity insurance value of fair annuities, suggesting that the changes in the variance of longevity from 2000 to 2019, keeping life expectancy constant, are associated with a 1.3% to 2.0% increase in the value of annuities for the population at large, with changes for sub-groups ranging from -6.1% (low-education Black males) to 13.6% (high-education Black males).[4]

The paper proceeds as follows. Section 2 reviews the literature on the variance of longevity and its implications. Section 3 presents the methodology for the construction of life tables and the calculation of variance of longevity measures. Section 4 discusses the results. And Section 5 concludes that the variance of longevity has trended modestly up over the past two decades for almost all the demographic groups explored.

2. Why lifespan variation matters

The variation of lifespan is an integral aspect of the overall mortality pattern that provides valuable information that can't be summarized by central longevity indicators such as mean and median. Moreover, uncertainty over one's lifespan gives rise to the need to save for the possibility of living an unusually long time, with the attendant risk of outliving one's assets—longevity risk. Insuring against this risk through guaranteed lifetime income thus has important economic and welfare implications.

From an individual perspective, lifespan variation represents the uncertainty over age at death faced by individuals, an important consideration for financial and retirement planning. Conceptually, individual-level lifespan variation consists of two components: the likelihood of premature death at younger ages and that of survival to older ages.[5] Improvements in economic and medical conditions that reduce overall mortality rates contribute to longer life expectancy, but their impacts on the variance of longevity can be ambiguous: reducing mortality at younger ages reduces lifespan variation (compressing the left tail of the age-at-death distribution toward the average), while reducing mortality at higher ages increases lifespan variation (stretching the right tail of age-at-death distribution away from the average). Which effect dominates depends on how the mortality reductions are distributed across ages.[6]

Aside from economic and technological trends affecting the full population, lifespan variation also differs across demographic and socioeconomic status (SES) groups (Brown, 2002; Sasson, 2016; and Wettstein et al., 2021). In particular, Black and lower-education individuals, who generally have lower life expectancies, face greater variability in lifespan compared with their White and higher-education counterparts. This SES gradient in lifespan variation reflects unequal access to economic and health-related resources and represents an important dimension of inequality (Link & Phelan, 1995; Brown et al., 2012). In particular, the higher lifespan variation among lower-educated individuals largely results from an excess of premature deaths from various diseases and external causes (van Raalte et al., 2012), many of which are preventable. Moreover, the variance of longevity observed at the population level is partly attributable to the heterogeneity across demographic and SES groups.

The change in lifespan variation over time hasn't been well documented in the literature. A prominent exception is Sasson (2016), who examines how lifespan variation for various race-education groups at age 25, as measured by standard deviation of age at death, changed over the period from 1990 to 2010. The study finds that the standard deviation of longevity at age 25 increased by 1.5 years for high school-educated White individuals and stayed at lower levels for college-educated White individuals; the lifespan-variation metric for Black individuals plateaued or declined for almost all education groups.

In addition to documenting the statistical patterns of lifetime variation across population groups and over time, understanding the welfare and economic implications of these trends is important for researchers and policymakers. The economic cost of lifespan variation can be assessed under the framework of lifecycle models of consumption featuring survival uncertainty pioneered by Yaari (1965). In such models, a more dispersed age-at-death distribution, all else being equal, is associated with lower lifetime utility.[7] Using lifecycle models, Edwards (2013) estimates that the average American would be willing to give up about half a life year in exchange for one year less in the standard deviation of longevity.

As lifespan uncertainty is precisely the motivation for buying life annuities, the longevity insurance value of annuities, or lifetime income more broadly, can serve as a measure of the economic value of lifespan variation.[8] The longevity

4 It is important to note that the longevity insurance value of fair life annuities shown in this study doesn't represent the values of annuity products available on the market. The insurance value of annuities in this study is calculated using a simplified lifecycle model and is intended to be a convenient while meaningful measure of the welfare implications of the uncertainty of lifespan that can be compared across demographic and SES groups and over time. See the Methodology section for more details.

5 Zhang and Vaupel (2009) define a threshold age that separates early and late deaths.

6 See Gillespie et al. (2014).

7 See Edwards (2013) for a more detailed discussion.

8 This is particularly true in a simple model where no uncertainty over rates of return exists, since typical annuities also provide insurance against such market volatility.

insurance value of annuities is typically calculated as "wealth equivalence" in the literature—how much more wealth an individual would need to be as well off without annuities as they are with annuities. Wettstein et al. (2021) calculated the value of annuities for various race-educational attainment groups and found that annuitization is more valuable for Black individuals than for White ones, which corresponds to the much larger variance in lifespan for the former for every gender-education combination. Arapakis et al. (2023) similarly estimate the longevity insurance value of the Social Security Old-Age and Survivors Insurance (OASI) benefit and find that values are highly correlated with the standard deviation of lifespan across gender-race-education groups, with a correlation coefficient of 0.76.

Building on prior studies, this paper documents and compares the temporal patterns of lifespan variation at older ages for the general population, various race-educational attainment groups, and annuitants. The analysis focuses on several key ages at which important decisions regarding retirement planning are made. To quantify the magnitudes in relatable, dollar-value terms, the analysis also estimates the welfare implications of the changes in lifespan variations using the wealth equivalence approach.

3. Methodology

When available, this study takes existing life tables and analyzes the variance of longevity they imply. That is, given the mortality probabilities at each future age, the calculations yield the expected age of death and the standard deviation of possible ages of death around that mean age. However, no publicly available life tables exist for many of the sub-populations of interest. In these cases, we estimate such tables.

The variance of remaining longevity is calculated at a number of key ages: 50, 62, 67 and 70. These are ages at which individuals can make meaningfully different decisions about their work and retirement plans, corresponding, respectively, to the age at which they can begin to make catch-up contributions to tax-advantaged retirement accounts (as well as an early enough age more generally to substantially adjust saving rates); the earliest claiming age for Social Security; the full Social Security retirement age; and the maximum Social Security claiming age.

Mortality tables

This analysis uses a number of different life tables that apply to different populations.

General population. For the calculation of population-level life expectancy and variance of longevity, the study relies on population cohort life tables from the Social Security Administration (SSA).[9] SSA's life tables provide mortality rates by gender for ages from 0 to 119 for each birth cohort ranging from 1900 to 2095. The population-level analysis covers the period from 1970 to 2019 and calculates the life expectancy and variance of longevity at ages 50, 62, 67 and 70 in each year using the mortality profiles of the corresponding birth cohorts from the SSA life tables.[10]

Race-education groups. The analysis considers two racial groups (non-Hispanic Black and non-Hispanic White) and two educational attainment groups (low and high). The mortality tables by race and education groups are calculated using the two-step approach described in Wettstein et al. (2021), which is, in turn, based on the method described in Mitchell et al. (1999).

The first step calculates annual mortality rates for each gender-race-education group at a specific age using mortality data from the National Vital Statistics System (NVSS)[11] and demographic and SES information from the American Community Survey (ACS).[12] A Gompertz-Makeham curve is then fitted to these non-parametric age-specific mortality rates. Fitting this curve smooths the mortality curves and mitigates sampling error arising for small samples (particularly at older ages for Black populations, where the populations are relatively small).

The second step adjusts the annual mortality rates for future morality improvements. To do so, we rely on SSA's cohort mortality tables, yielding cohort life tables for each group. This approach is used to construct group-specific cohort life tables for the years 2000 through 2019.

The mortality tables used in this study differ in two important ways from those in Sasson (2016), who also examines lifespan variation by race and education. First, education groups in this study are defined in relative terms rather than years of educational attainment. That is, the classification of individuals to "low" and "high" education is done in relation to the median education for that individual's race-gender-cohort.[13] This approach accounts for possible selection on unobservable characteristics into higher education across

9 U.S. Social Security Administration (2024).

10 For example, the calculations for 2000 involve mortality tables for birth cohorts 1950 (for age 50), 1948 (for age 62), 1943 (for age 67) and 1930 (for age 70). 1970 is the first year for which cohort mortality rates are available for all four ages examined.

11 National Center for Health Statistics (2024).

12 U.S. Census Bureau (2020).

13 This approach is similar to Leive and Ruhm (2021) and Wettstein et al. (2021). Specifically, the educational attainment for each race-gender group is obtained by dividing respondents into those with below- and above-median educational attainment. Those with precisely median education are assigned to "high" and "low" educational attainment randomly.

race, gender and cohort. Second, this study uses cohort life tables that incorporate future improvements in mortality.

Annuitants. For the annuitant population, the study uses the following life tables published by the Society of Actuaries: the 1971 Individual Annuity Mortality Table (1971 IAM), the 1983 Individual Annuity Mortality Table (1983 IAM), the Annuity 2000 Mortality Table, and the 2012 Individual Annuity Mortality Table (2012 IAM).[14] The three IAM tables are constructed based on mortality rates from experience data collected prior to the reference years of these tables, which are then projected to the reference years using improvement scales.[15] The Annuity 2000 Table is the 1983 IAM table projected to 2000. Since these are period life tables, they're transformed into cohort life tables by assuming the same mortality trends as those for the full population, with the improvement scales constructed from the SSA cohort tables in the same way as the race-education mortality tables.

Measuring lifespan variation

The primary measure of lifespan variation is the standard deviation of age at death around life expectancy conditional on survival to age x, denoted as S_x, which is widely used in the demography literature—e.g., Edwards and Tuljapurkar (2005); Engleman et al. (2010); van Raalte et al. (2011); and Sasson (2016). We acknowledge, however, that standard deviation isn't a perfect measure of the relevant uncertainty of longevity because the age-at-death distribution at older ages is heavily skewed and truncated (Arapakis et al., 2023).

Wealth equivalence of fair annuities

Is a one-unit change to the standard deviation of longevity big or small? Answering this question in the abstract is difficult. To quantify the welfare implications of the evolution of mortality profiles, the analysis takes a wealth equivalence approach, giving a dollar value to these changes. Specifically, the analysis calculates the longevity insurance value of annuities contracts, which increases with the variance of longevity. The longevity insurance value is measured by the wealth equivalence of having an actuarially fair immediate life annuity contract—that is, the amount of additional wealth an individual with access to the annuity product would need to be as well off without access to any annuity product.

The wealth equivalence calculation in this study is based on a lifecycle model that abstracts from important real-world elements—such as Social Security benefits, partial annuitization, bequest motives and health-expense shocks at older ages. The model here is intentionally kept simple since our goal is not to evaluate annuities per se but to quantify the magnitude of changes in the variance of longevity. Thus, the resulting wealth equivalence is intended to be a convenient while meaningful measure of the welfare implications of the uncertainty of lifespan that can be compared across demographic and SES groups and over time.

The calculation of wealth equivalence involves solving the lifetime utility maximization problem for a rational individual with and without access to fair annuities. The individual has a constant relative risk aversion (CRRA) utility function $u(c_t) = \frac{{c_t}^{1-\gamma} - 1}{1-\gamma}$, where the risk aversion (also the degree of intertemporal substitution in consumption) parameter γ is assumed to be 2.[16] Assuming no bequest motives, the expected lifetime utility for an individual at age t_0 is given by

$$EU = \sum_{t=t_0}^{115} \beta^{(t-t_0)} P_t \, u(c_t) \, , \qquad (1)$$

where β is the individual's discount factor and t is age. P_t denotes the probability that the individual survives through age t and is calculated using the mortality table of the specific demographic group being considered.

The individual holds an initial wealth of W_0 at age t_0 and is subject to a lifetime budget constraint without access to any annuity products:

$$W_0 = \sum_{t=t_0}^{115} (1+r)^{-(t-t_0)} \, c_t, \qquad (2)$$

where r is the interest rate. The model doesn't consider stochastic returns on assets and uses a constant real interest rate of 2%.

If we allow the individual to purchase immediate life annuities that are actuarially fair for the individual's demographic group and assume the individual would fully annuitize their initial wealth,[17] the individual's lifetime budget constraint becomes:

$$W_0 = \sum_{t=t_0}^{115} P_t (1+r)^{-(t-t_0)} \, c_t. \qquad (3)$$

14 Society of Actuaries (2024). SOA mortality tables for annuitants typically include two versions: 1) a "basic" version that results directly from the morality rate calculations; and 2) a version with a margin (typically a percentage reduction) applied to the original mortality rates, which yields more conservative pricing and reserve calculations for annuity products compared against the basic version. This study uses the original mortality rates from the basic versions. The basic version of the 1971 IAM table is not available from the SOA website, thus the original mortality rates are obtained by dividing the rates from the table by the margin used (0.9).

15 The 1971, 1983 and 2012 IAM tables are based on, respectively, mortality experience data from 1963, 1971–1976, and 2000–2004 (Society of Actuaries, 2024).

16 As in Mitchell et al. (1999) and Wettstein et al. (2021).

17 A rational individual in this setting would choose to fully annuitize, as in Yaari (1965).

Comparing the two budget constraints shows that the access to annuities expands the individual's budget constraint by only requiring the initial wealth to equal the *expected present value* of lifetime consumption, as opposed to the *present value* of lifetime consumption in the case without annuities.

Using this lifecycle model, the analysis calculates the wealth equivalence of fair annuities by demographic/SES groups, gender, starting age, and year following three steps:

1. First, we calculate the lifetime utility at age t_0 for the individual with access to annuities (solving equation (1) subject to (3)). We denote this value by $U(W_0)$, where W_0 is the individual's initial wealth at age t_0.
2. Second, we repeat this calculation without annuities (solving equation (1) subject to (2)). We denote the lifetime utility in this world by $U^*(W_0)$.
3. Finally, we find an asset value M such that $U^*(W_0 + M) = U(W_0)$. M is defined as the wealth equivalence of fair annuities for the group—the amount of additional wealth at age t_0 the individual would have needed to be just compensated for not having access to annuities. The wealth equivalence is presented as a percentage of the initial wealth W_0.[18]

4. Results

The discussion in this section focuses on metrics calculated at ages 50 and 67 for ease of exposition. The full results including metrics calculated at all four starting ages can be found in the appendix.

Life expectancy

Before looking into the variance of longevity and its time pattern, we first briefly discuss the patterns of life expectancy over time and across different population groups. Table 1 shows the life expectancy at ages 50 and 67 in select years for men and women of the general population, annuitants and race-education groups.

As well documented in the literature, the life expectancy for the general population rose substantially from 1971 to 2012 (3.4 years for females and 5.1 years for males at age 50; 2.2 years for females and 4.2 years for males at age 67), though the improvement varies across population groups. Annuitants, who are generally wealthier and healthier compared with the general population,[19] not only have significantly higher life expectancies at all ages and in all years (between three and five years higher than the general population), they also saw greater improvements in expected lifespans from 1971 to 2012 (for life expectancy at age 50, 4.4 versus 3.4 years of improvement for females, 5.9 versus 5.1 years of improvement for males). The differential improvement in life expectancy may imply that annuitants have gained more from mortality-reducing technological and socioeconomic progress during the past decades.

Looking across race-education groups, patterns of life expectancy by demographic group are as expected—with women, White individuals, and higher-education individuals tending to live longer than their otherwise-equal counterparts.[20] With respect to trends over time, Black individuals generally saw greater improvement in life expectancy compared with their White counterparts (except for low-education males at age 67). Within racial groups, individuals in the higher relative education groups enjoyed greater improvement in life expectancy over time. These trends are both consistent with recent work showing declining racial gaps and increasing SES gaps in life expectancy at age 20 (Chetty et al., 2024).

The comparison between the life expectancies of race-education groups and the general population should be conducted with caution. First, the general population includes all demographic groups while only non-Hispanic Black and non-Hispanic White individuals are examined separately in this study. In particular, Hispanic individuals tend to have a higher life expectancy than White ones,[21] and the inclusion of Hispanics makes the population-level life expectancy higher compared with the average of Black and White groups in isolation (note, for example, that both the Black and White female life expectancies in 2000 are below that of the full population).[22]

Second, the life tables of race-education groups are estimated based on vital statistics from NVSS while the SSA cohort mortality tables, which are used for the calculations for the general population in this study, use different data sources to calculate mortality rates at ages 65 and older. This difference in the underlying data sources can result in a gap in life expectancy estimates (Barbieri 2018). In particular, past research has found that the NVSS-based life tables have higher life expectancy than the SSA-based ones.

18 With a constant relative risk aversion (CRRA) utility function, the wealth equivalence measured as a percentage of the initial wealth is not affected by the dollar amount of the initial wealth W_0 (see Kotlikoff and Spivak, 1981).

19 Nuss (2020).

20 An exception to these unsurprising patterns is that low-education Black individuals are estimated to have higher life expectancy than their higher-education counterparts in 2000. Future work will explore the robustness of this finding.

21 See, for example, Johnson et al. (2022) or Hill and Artiga (2023).

22 See Appendix A for a comparison of population-level life expectancies calculated with and without Hispanic individuals.

Variance of longevity

For the general population, S_{50} has stayed stable from 1971 to 2019 for both genders, with the measure decreasing slightly from 11.9 to 11.8 years for females and increasing slightly from 12.1 to 12.3 years for males. The standard deviation of age at death decreases with the starting age, as individuals survive the uncertainty of death at early ages. Thus, S_{67} for females is 8.8 years in 2019, increasing by 0.2 years from the 1971 level; males at age 67 saw a much larger increase in the standard deviation of longevity, with their S_{67} rising from 7.9 to 8.6 years from 1971 to 2019.

The pattern of lifespan variation at the population-level masks meaningful discrepancy across demographic/SES groups.[23] We present these differences in three ways, better illustrating their nuances. In addition to comparing the standard deviation measures in Table 2, we also plot the full age-at-death distributions for all gender-race-education groups in 2000 and 2019 (see Figure 1), in which the height of the density curves represents the probabilities of dying at given ages. Finally, for each population group we calculate a pair of probability-based measures of lifespan variation—the probability of dying at an age more than 10 years below the group-specific life expectancy and the probability of dying at an age more than 10 years above the life expectancy (see Table 3), which have more straightforward interpretations than standard deviations and allow for attributing changes in lifespan variation to mortality patterns at younger and older ages separately.

In all years, the lifespan dispersion is much greater for Black individuals as indicated by larger standard deviation of longevity and more dispersed age-at-death distributions; within racial groups, individuals with less education face larger lifespan variation than those with more education. These results are consistent with previous studies (e.g., Brown, 2012; Sasson, 2016; and Wettstein et al., 2021).

With respect to time trends, over the 2000–2019 period, S_{50} and S_{67} increased in all race-education groups (especially high-education Black and low-education White individuals) except for low-education Black males. In 2000, the standard deviations of longevity for low-education Black men are the largest among all population groups, but they decreased substantially during the following 20 years, reaching a level similar to those for the high-education Black and low-education White groups.

The age-at-death distributions and the chances of dying at younger or older ages show the same trends while also shedding light on potential sources of the change. The probabilities of dying 10 years below or above group-specific life expectancy generally fall in the range of 15% to 30%. High-education Black and low-education White individuals (of both genders) saw the largest increases in lifespan dispersion from 2000 to 2019 (see columns 2 and 3 in Figure 1, where the density curves in 2019 become more dispersed), with the overall changes similarly attributable to increased chances of dying at younger and older ages. The age-at-death distribution of high-education White individuals only shows a modest change during the 20-year period (the rightmost column in Figure 1), which results from small and offsetting changes in the probabilities of dying at younger and older ages. As the only group that has experienced a decrease in lifespan variation, low-education Black individuals saw a more prominent reduction in the chance of dying at younger ages (3.5 vs. 1.8 percentage-point reductions, respectively, in the probabilities of dying 10-years below and above life expectancy), suggesting that a significant decline in premature death is an important driver of the overall concentration of lifespan for this group.

The uncertainty of lifespan is particularly important for annuitants because insuring against longevity risk is the very motivation to purchase annuities. The magnitude of lifespan variation thus determines the economic value of annuity products. Nevertheless, at age 50, annuitants generally face smaller lifespan dispersion compared with the general population and their S_{50} values are relatively stable over the period from 1971 to 2012. In 2012, when the most recent mortality tables for annuitants are available, the S_{50} values for annuitants are 0.6 to 0.7 years lower than those for the general population and are close to the S_{50} values for high-education White individuals.

Interestingly, the gap in the variation of remaining lifespan between annuitants and the general population appears to close as individuals survive to older ages. By age 67, S_{67} for annuitants slightly exceeds that of the general population. As discussed above, annuitants are generally wealthier and healthier compared with the general population, and thus they may be less likely to suffer from premature death and more likely to survive to very old ages. The resulting age-at-death distribution for annuitants features a more right-skewed pattern, which is more compressed at younger ages and more stretched at older ages. At age 50, the more compressed distribution at younger ages dominates the calculation of standard deviation and yields lower S_{50} for annuitants than the general population; at age 67, in contrast, the more skewed distribution at older ages dominates and yields higher S_{67} for annuitants.

23 Disparity by SES group also contributes to the population-level measures; the calculations of population-level measures, which are based on SSA life tables, also include demographic groups other than Black and White individuals.

The pattern regarding the gender difference in lifespan variation is that men tend to have greater lifespan variation than women at age 50, while by age 67 men's lifespan variation becomes smaller than women's for most group-year combinations. This pattern suggests that premature death at younger ages (before 67) is a more important source of the uncertainty of lifespan for men compared with women.

The welfare implications of changes in lifespan variation

Interpreting changes in the standard deviation of longevity is challenging in isolation, and the other measures presented can't be easily summarized in a single number. To provide a more intuitive sense of how large the change in lifespan variation over the past two decades has been, we turn to a welfare analysis of annuities given these changing demographic trends. Specifically, we calculate the wealth equivalence of a fair annuity purchased at age 50 and at age 67, as a share of starting wealth at those ages. This measure implies, for example, that if an annuity has a wealth equivalence of 0.2 for a 50-year-old, that individual holding a fair annuity would need to be compensated by 20% of their wealth at age 50 to give it up.

Table 4 presents the wealth equivalence values for the demographic/SES groups examined in selected years over the 1971–2019 period. Overall, the magnitude of the longevity insurance value of annuities is substantial in our pared-down lifecycle model. For the general population, the value of fair annuities (under common values of model parameters) is equivalent to about 30% to 40% of a representative individual's initial wealth at age 50, and about 50% to 80% of their initial wealth at age 67.

Looking across demographic/SES groups, the pattern of the wealth equivalence of annuities is consistent with that of the standard deviation of lifespan. That is, the wealth equivalence values are higher for males, Black individuals, and those with less educational attainment, who tend to have more dispersed lifespan compared with those in their respective counterpart groups. Annuitants, the group that actually purchases annuities, derive less longevity insurance value from fair annuities than the general population; the wealth equivalence values for annuitants are similar to those for high-education White individuals (similar to the case of the standard deviation of lifespan), who have the lowest wealth equivalence values among all race-education groups. This outcome is partially due to the relatively low lifespan variation of annuitants compared with other groups.[24]

Nevertheless, despite the generally stable or rising standard deviation of longevity over the period, almost all demographic/SES groups experienced declining wealth equivalence values. For the general population, the wealth equivalence of annuities in 2012 was more than 15% lower for females and 25% for males relative to the 1971 levels. Meanwhile, annuitants saw a slightly smaller decline in wealth equivalence over the same period. Across race-education groups, the drop in wealth equivalence is most prominent for low-education Black individuals.

The declining wealth equivalence is a seemingly surprising result given the stable or slightly increasing pattern of lifespan variation (measured by the standard deviation of age at death) documented in the previous section. Such increased dispersion should, in theory, be associated with a stable or increasing longevity insurance value of annuities. This conflict can be reconciled by noting that the positive association between wealth equivalence and lifespan variation holds under a condition: the overall position of the age-at-death distribution (represented by life expectancy) must be maintained when varying the dispersion of lifespan. So, if life expectancy stays constant while lifespan variation increases, then wealth equivalence will also increase.

What if the condition is not met? In a lifecycle model, a variance-preserving rightward shift in the age-at-death distribution, which results in an increase in life expectancy and no change in variance, would reduce the value of wealth equivalence of fair annuities. The mechanism behind the negative association between life expectancy and wealth equivalence has not been examined in the literature and it is out of the scope of this study. (Appendix C provides an illustration based on hypothetical age-at-death distributions.) In short, the deferral of mortality credits to later ages, when remaining wealth is smaller, leads to a smaller willingness-to-pay for an annuity at younger ages.[25] Accordingly, the widespread improvement in life expectancy over the past decades has driven down the wealth equivalence of annuities despite the stable or upward trends in the variance of longevity.

Estimating the isolated impact of changes in longevity uncertainty

The following exercise disentangles, in a descriptive sense, the effects of life expectancy and the variance of longevity on the wealth equivalence of annuities using a linear regression approach. This analysis decomposes the change in wealth equivalence due to the increasing variance of longevity and to

24 Annuitants' lower overall mortality rates also contribute to this outcome, because the wealth equivalence calculations are based on group-specific actuarially fair annuities, the annual payment of which decreases with overall mortality levels.

25 Importantly, this mechanism doesn't depend on time discounting of mortality credits over a longer horizon. Indeed, the reduction of wealth equivalence with variance-preserving increases in longevity occurs even in the absence of any discounting.

the changes in mean longevity. In this way, the contribution of variance to changes in the wealth equivalence can be discussed, holding constant the effect of increasing life expectancy.

The analysis first calculates, for each gender-demographic/SES group at each starting age (50, 62, 67 and 70), the changes in wealth equivalence, life expectancy and standard deviation of longevity over the available time intervals. These calculations include year-over-year changes from 1971 to 2019 for the general population, year-over-year changes from 2000 to 2019 for the various race-education groups, and changes in 1983, 2000 and 2012 from the previous year with available data for annuitants. Using these changes as a sample (1,024 observations), we regress the changes in wealth equivalence on the changes in life expectancy and the changes in the standard deviation of longevity.

The regression results (see Table 5) confirm that wealth equivalence of a fair annuity increases with the dispersion of lifespan and decreases with life expectancy when holding the other variable constant (recall that the annual payout of a fair annuity will decline as life expectancy rises). The estimated coefficients suggest that, on average, a one-year increase in the standard deviation of longevity is associated with an increase in wealth equivalence of 6.8% of initial wealth, while a one-year increase in life expectancy is associated with a decrease in wealth equivalence worth 3.1% of initial wealth.

As shown in previous sections, the historical increases in life expectancy are substantially larger than the increases in the standard deviation of longevity for almost all demographic/SES groups. Thus, the impact of life expectancy dominates and causes wealth equivalence values to fall over time.

The exercise above allows us to answer our main question: How big has the change in lifespan variation been over the past decades? To do so, we first calculate the change in the standard deviation of longevity from 2000 to 2019 using values in Table 2 for each population group (except for annuitants, for whom the most recent data is in 2012) and then multiply them by the coefficient for changes in the standard deviation of longevity (6.8% for a one-year change) in Table 4. The calculations yield the total impact of the changes in lifespan variation over this period on the wealth equivalence of annuities, assuming life expectancy had remained unchanged.

Figure 2 shows the result of this calculation for individuals at age 50 by population groups. The stable time pattern of lifespan variation for the general population yields a small increase in wealth equivalence of less than 2%. Across race-education groups, the largest increases in wealth equivalence attributable to changes in lifespan variation are concentrated in high-education Black individuals (11.6% for females and 13.6% for males) and low-education White individuals (6.8% for females and 8.2% for males). High-education White individuals and low-education Black females have also seen an increase in wealth equivalence due to variance-of-longevity changes, though the magnitudes are modest (2% to 4%). The decrease in the standard deviation of longevity among low-education Black males, which is unique across gender-race-education groups, is associated with a 6.1% decrease in the value of longevity insurance for this group. The results for these race-education groups don't aggregate to the results for the general population, which are also affected by groups not examined in this study (such as Hispanic individuals) and changes in the heterogeneity across groups over time.

5. Conclusion

The variation of lifespan is an essential component of mortality patterns and has important welfare and economic implications. Lifespan variation represents the uncertainty regarding age at death faced by individuals and is precisely the reason sources of lifetime income, such as annuities, are valuable. Moreover, the differences in lifespan variation across demographic and SES groups reflect an important dimension of inequality.

This paper documents how the variance of longevity conditional on survival to older ages has changed over time for the general population, race-educational attainment groups and annuitants. The results show the population-level variance of longevity has generally stayed stable over the past five decades, while there is substantial heterogeneity across demographic and SES groups. In particular, Black and lower-education individuals tend to face greater lifespan variation compared with their White and higher-education counterparts in all years. Among all race-education groups, low-education Black men have seen a substantial decrease in lifespan variation over the 2000–2019 period while all other groups have seen an increase. Annuitants generally face less lifespan variation at age 50 compared with the general population, while the gap tends to close when individuals survive to older ages.

Quantifying the welfare implications of lifespan variation using the wealth equivalence of fair annuities, we find low-SES groups generally stand to gain more from annuities. Although the wealth equivalence of fair annuities has generally declined over the past decades, a decomposition analysis shows that the decline is attributable to increases in life expectancy, while lifespan variation is positively associated with wealth equivalence in isolation holding life expectancy constant.

This study provides further evidence showing that those who typically don't buy annuities actually stand to gain substantially from such longevity insurance. It also finds that the difference across demographic and SES groups in lifespan variation and the resulting longevity-insurance value has been persistent over time. These results emphasize the importance of widely accessible arrangements for guaranteed lifetime income, especially for lower-SES groups.

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TABLE 1. LIFE EXPECTANCY OF THE GENERAL POPULATION, ANNUITANTS, AND RACE-EDUCATION GROUPS BY AGE AND YEAR

Age	Year	Annuitants	General population	Black		White	
				Low education	High education	Low education	High education
Female							
50	1971	83.7	80.7	-	-	-	-
	1983	86.2	81.7	-	-	-	-
	2000	87.5	83.5	80.0	79.5	82.5	83.4
	2012	88.1	84.1	81.7	83.3	83.1	85.4
	2019	-	84.6	82.4	84.1	83.3	86.0
67	1971	85.6	83.6	-	-	-	-
	1983	87.0	83.9	-	-	-	-
	2000	88.0	84.9	83.4	81.7	84.3	84.4
	2012	88.8	85.8	85.1	85.5	85.3	86.5
	2019	-	86.2	85.8	86.1	85.8	86.9
Male							
50	1971	79.8	75.4	-	-	-	-
	1983	83.3	77.6	-	-	-	-
	2000	84.6	79.8	74.4	76.2	78.1	81.0
	2012	85.7	80.5	75.9	79.4	78.6	82.8
	2019	-	81.1	76.5	80.6	79.1	83.5
67	1971	82.2	79.2	-	-	-	-
	1983	84.2	80.2	-	-	-	-
	2000	86.0	82.4	81.1	79.5	81.3	82.7
	2012	87.1	83.4	81.2	82.6	82.4	84.5
	2019	-	83.9	81.4	83.8	82.9	85.0

Source: Authors' calculations based on life tables from multiple sources.

TABLE 2. STANDARD DEVIATION OF AGE AT DEATH OF THE GENERAL POPULATION, ANNUITANTS AND RACE-EDUCATION GROUPS BY AGE AND YEAR

Age	Year	Annuitants	General population	Black		White	
				Low education	High education	Low education	High education
Female							
50	1971	11.0	11.9	-	-	-	-
	1983	10.9	11.9	-	-	-	-
	2000	11.0	11.6	13.6	11.0	11.7	10.3
	2012	11.2	11.8	13.7	12.9	12.3	11.1
	2019	-	11.8	14.2	12.7	12.7	10.7
67	1971	8.3	8.6	-	-	-	-
	1983	8.6	8.6	-	-	-	-
	2000	9.0	8.8	9.8	7.5	8.6	7.8
	2012	9.0	8.7	9.6	9.6	8.9	8.5
	2019	-	8.8	10.1	9.6	9.1	8.3
Male							
50	1971	11.9	12.1	-	-	-	-
	1983	11.9	12.2	-	-	-	-
	2000	12.3	12.0	14.6	11.3	12.1	10.8
	2012	11.6	12.3	13.6	12.6	12.7	11.4
	2019	-	12.3	13.7	13.3	13.3	11.1
67	1971	8.2	7.9	-	-	-	-
	1983	8.7	8.1	-	-	-	-
	2000	9.4	8.5	9.8	7.5	8.2	7.7
	2012	8.7	8.5	9.2	8.9	8.5	8.3
	2019	-	8.6	9.4	9.4	9.2	8.0

Source: Authors' calculations based on life tables from multiple sources.

TABLE 3. PROBABILITIES OF DYING AT YOUNGER AND OLDER AGES RELATIVE TO LIFE EXPECTANCY BY GENDER, RACE AND EDUCATIONAL ATTAINMENT AT AGE 50

	Female				Male			
	Black		White		Black		White	
	Low education	High education	Low education	High education	Low education	High education	Low education	High education
Year	**Probability of dying 10 years below life expectancy**							
2000	23.5%	18.1%	19.0%	15.9%	29.9%	21.6%	22.8%	18.6%
2019	24.7%	21.8%	21.3%	16.8%	26.4%	23.6%	25.2%	17.5%
Change	*+1.2%*	*+3.7%*	*+2.3%*	*+0.9%*	*-3.5%*	*+2.0%*	*+2.4%*	*-1.1%*
Year	**Probability of dying 10 years above life expectancy**							
2000	27.3%	17.6%	20.1%	13.8%	27.9%	20.0%	21.8%	15.1%
2019	26.8%	21.8%	22.3%	13.7%	26.1%	25.2%	24.4%	16.7%
Change	*-0.5%*	*+4.2%*	*+2.2%*	*-0.1%*	*-1.8%*	*+5.2%*	*+2.6%*	*+1.6%*

Source: Authors' calculations based on life tables from multiple sources.

TABLE 4. WEALTH EQUIVALENCE OF FAIR ANNUITIES AS A PERCENTAGE OF INITIAL WEALTH BY GENDER AND DEMOGRAPHIC/SES GROUP

<table>
<tr><th colspan="8">Female</th></tr>
<tr><th rowspan="2">Age</th><th rowspan="2">Year</th><th rowspan="2">Annuitants</th><th rowspan="2">General population</th><th colspan="2">Black</th><th colspan="2">White</th></tr>
<tr><th>Low education</th><th>High education</th><th>Low education</th><th>High education</th></tr>
<tr><td rowspan="5">50</td><td>1971</td><td>0.26</td><td>0.33</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>1983</td><td>0.23</td><td>0.31</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2000</td><td>0.22</td><td>0.28</td><td>0.41</td><td>0.31</td><td>0.29</td><td>0.24</td></tr>
<tr><td>2012</td><td>0.22</td><td>0.27</td><td>0.37</td><td>0.32</td><td>0.30</td><td>0.24</td></tr>
<tr><td>2019</td><td>-</td><td>0.27</td><td>0.37</td><td>0.30</td><td>0.31</td><td>0.22</td></tr>
<tr><td rowspan="5">67</td><td>1971</td><td>0.47</td><td>0.58</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>1983</td><td>0.45</td><td>0.56</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2000</td><td>0.43</td><td>0.53</td><td>0.70</td><td>0.57</td><td>0.53</td><td>0.46</td></tr>
<tr><td>2012</td><td>0.41</td><td>0.49</td><td>0.58</td><td>0.57</td><td>0.51</td><td>0.45</td></tr>
<tr><td>2019</td><td>-</td><td>0.48</td><td>0.59</td><td>0.54</td><td>0.51</td><td>0.41</td></tr>
<tr><th colspan="8">Male</th></tr>
<tr><td rowspan="5">50</td><td>1971</td><td>0.33</td><td>0.46</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>1983</td><td>0.29</td><td>0.40</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2000</td><td>0.28</td><td>0.35</td><td>0.62</td><td>0.40</td><td>0.38</td><td>0.28</td></tr>
<tr><td>2012</td><td>0.25</td><td>0.34</td><td>0.52</td><td>0.38</td><td>0.39</td><td>0.28</td></tr>
<tr><td>2019</td><td>-</td><td>0.33</td><td>0.51</td><td>0.38</td><td>0.41</td><td>0.25</td></tr>
<tr><td rowspan="5">67</td><td>1971</td><td>0.60</td><td>0.83</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>1983</td><td>0.56</td><td>0.76</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2000</td><td>0.53</td><td>0.63</td><td>0.90</td><td>0.73</td><td>0.66</td><td>0.53</td></tr>
<tr><td>2012</td><td>0.45</td><td>0.58</td><td>0.82</td><td>0.67</td><td>0.63</td><td>0.50</td></tr>
<tr><td>2019</td><td>-</td><td>0.57</td><td>0.82</td><td>0.65</td><td>0.67</td><td>0.46</td></tr>
</table>

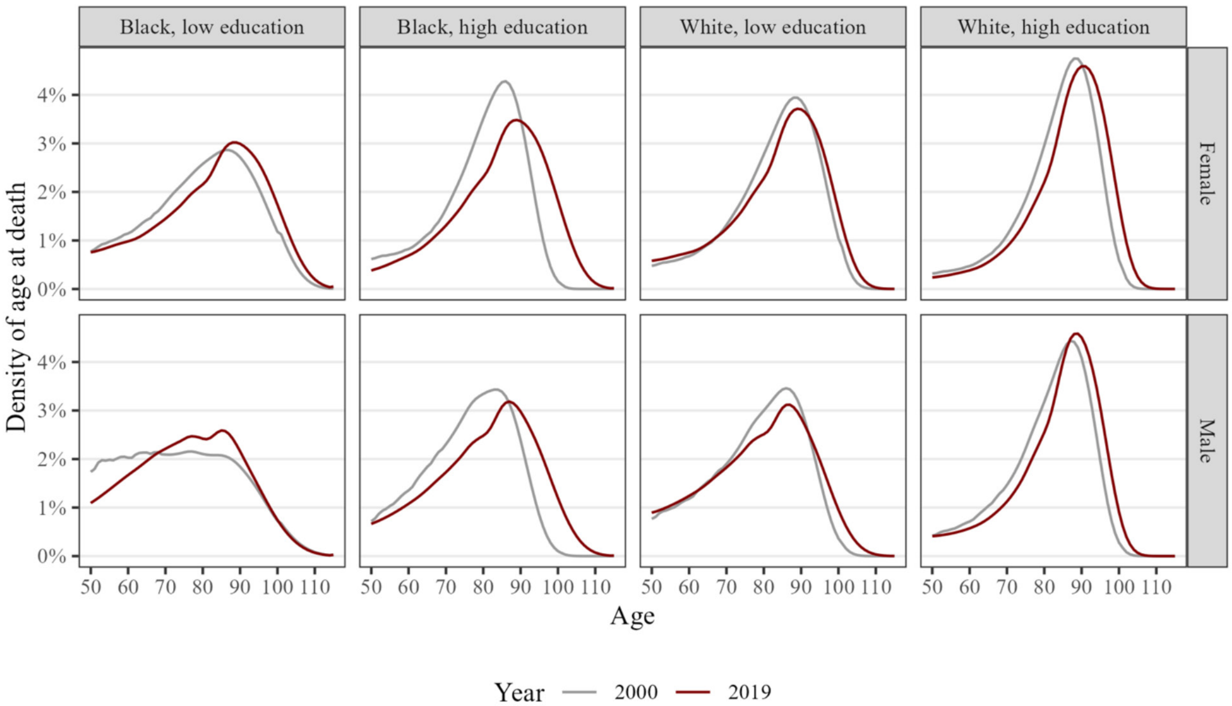
Source: Authors’ calculations based on life tables from multiple sources.

TABLE 5. EFFECTS OF LIFE EXPECTANCY AND VARIANCE OF LONGEVITY ON WEALTH EQUIVALENCE OF FAIR ANNUITIES

	Dependent variable: Change in wealth equivalence
Change in standard deviation	0.068***
	(0.001)
Change in life expectancy	-0.031***
	(0.001)
Constant	-0.001***
	(0.0003)
Observations	1,024
Adjusted R^2	0.789

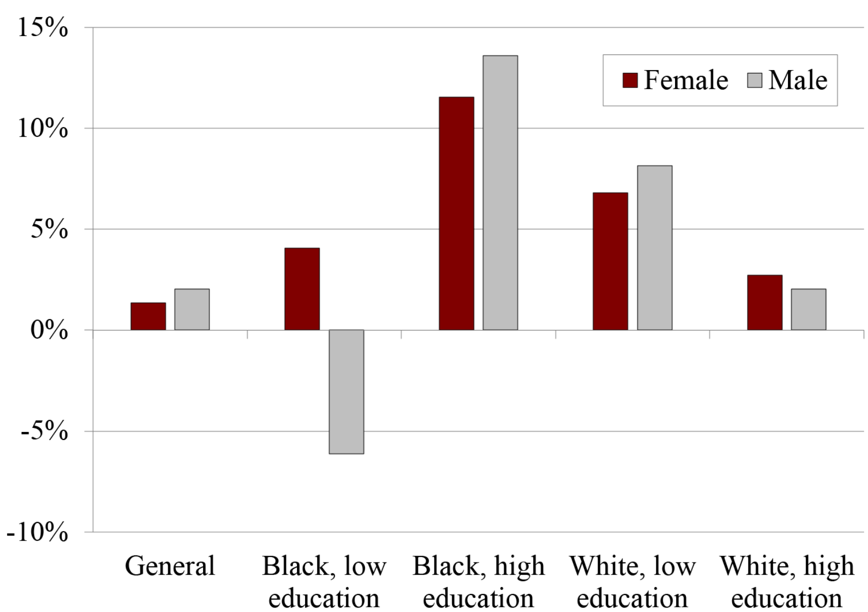
Note: *p<0.1; **p<0.05; ***p<0.01
Source: Authors' calculations based on life tables from multiple sources.

FIGURE 1. AGE-AT-DEATH DISTRIBUTION (DENSITY OF LIFESPAN) BY GENDER, RACE AND EDUCATIONAL ATTAINMENT AT AGE 50



Source: Authors' calculations based on life tables from multiple sources.

FIGURE 2. ESTIMATED EFFECTS OF CHANGES IN STANDARD DEVIATION OF LONGEVITY ON WEALTH EQUIVALENCE OF FAIR ANNUITIES AT AGE 50 OVER THE PERIOD 2000–2019, BY POPULATION GROUP



Source: Authors' calculations based on life tables from multiple sources.

Appendix A

Population-level life expectancy calculated with and without Hispanic individuals

TABLE A1. COMPARISON OF LIFE EXPECTANCY CALCULATED USING DIFFERENT LIFE TABLES

Gender	Year	Age	Life expectancy based on		
			NVSS/ACS with Black and White individuals only	NVSS/ACS with the entire population	SSA cohort life tables
Male	2000	50	79.1	79.4	79.7
		62	80.8	81.0	81.2
		67	81.8	82.1	82.3
		70	82.6	82.9	83.1
	2012	50	80.2	80.3	80.3
		62	82.2	82.4	82.2
		67	83.3	83.6	83.3
		70	84.4	84.4	84.0
Female	2000	50	82.6	83.4	83.4
		62	83.5	84.2	84.1
		67	84.2	85.0	84.9
		70	84.8	85.7	85.6
	2012	50	84.0	84.1	84.1
		62	85.1	85.2	85.1
		67	85.8	85.9	85.7
		70	86.4	86.5	86.3

Source: Authors' calculations based on NVSS and ACS data in various years and SSA cohort life tables (SSA 2024).

Appendix B

Illustrating isolated impacts of life expectancy and variance of longevity on the insurance value of fair annuities

With empirical age-at-death distributions derived from regular life tables, it's difficult to decompose the impact of a change in the shape of the distribution on the wealth equivalence of annuities into isolated effects from the shift of the position and the change of the dispersion of the distribution. The main challenge is to define proper mean-preserving changes in the dispersion and dispersion-preserving changes in the mean for the empirical age-at-death distribution. This appendix illustrates the isolated effects of changes in life expectancy and lifespan variation on wealth equivalence of fair annuities using a hypothetical age-at-death distribution under which all deaths are uniformly distributed over a given age range. With such distributions, shifts in position and dispersion can be easily defined independently.

The analysis considers four uniform age-at-death distributions for an individual at age 50:

1. **Baseline:** Deaths are uniformly distributed over a 21-year age window from 70 to 90 with no deaths at other ages, resulting in a life expectancy of 80 and a standard deviation of longevity of 6.1 years.
2. **Increasing life expectancy:** The distribution in 1 is shifted upward by five years to achieve a higher life expectancy of 85 years, while keeping the 21-year age window (now 75 to 95).
3. **Increasing lifespan variation:** The age window for death in 1 is expanded to 25 years, resulting in the same life expectancy of 80 but a higher standard deviation of longevity of 7.2 years.
4. **Increasing both:** The changes in 2 and 3 are combined, resulting in an age window for death from 73 to 97 with a life expectancy of 85 years and standard deviation of 7.2 years.

Using mortality tables derived from these age-at-death distributions, we calculate the resulting values of wealth equivalence of fair annuities following the method described in the main text and present the results in Table B1. Because the shift of position and the shift of dispersion are independently defined in 2 and 3, respectively, the resulting changes in wealth equivalence represent their isolated effects. Consistent with the discussion in the main text, an increase in life expectancy keeping the lifespan variation constant (row 2) reduces wealth equivalence; meanwhile, an increase in lifespan variation keeping life expectancy constant (row 3) raises wealth equivalence. The specific changes in cases 2 and 3 have a combined effect (row 4) leading to a lower wealth equivalence compared with the baseline, which mimics the observed decline of wealth equivalence over time discussed in the main text.

TABLE B1. HYPOTHETICAL UNIFORM AGE-AT-DEATH DISTRIBUTIONS AND THE CORRESPONDING WEALTH EQUIVALENCE OF FAIR ANNUITIES

	Range of the uniform age-at-death distribution	Life expectancy (LE)	Standard deviation (SD) of age at death	Wealth equivalence of fair annuities
1. Baseline	70–90	80	6.1	16.3%
2. Higher LE	75–85	85	6.1	13.2%
3. Higher SD	68–92	80	7.2	19.6%
4. Higher LE and SD	73–97	85	7.2	15.8%

Source: Authors' calculations.

Appendix C

Results of life expectancy, standard deviation of longevity and wealth equivalence for all four starting ages (50, 62, 67 and 70)

TABLE C1. RESULTS OF LIFE EXPECTANCY FOR ALL STARTING AGES

Female							
Age	Year	Annuitants	General	Black		White	
				Low education	High education	Low education	High education
50	1971	83.7	80.7	-	-	-	-
	1983	86.2	81.7	-	-	-	-
	2000	87.5	83.5	80.0	79.5	82.5	83.4
	2012	88.1	84.1	81.7	83.3	83.1	85.4
	2019	-	84.6	82.4	84.1	83.3	86.0
62	1971	84.7	82.4	-	-	-	-
	1983	86.5	82.9	-	-	-	-
	2000	87.6	84.2	82.0	80.8	83.6	83.9
	2012	88.4	85.1	84.0	84.6	84.5	86.0
	2019	-	85.6	84.6	85.2	84.9	86.5
67	1971	85.6	83.6	-	-	-	-
	1983	87.0	83.9	-	-	-	-
	2000	88.0	84.9	83.4	81.7	84.3	84.4
	2012	88.8	85.8	85.1	85.5	85.3	86.5
	2019	-	86.2	85.8	86.1	85.8	86.9
70	1971	86.1	84.3	-	-	-	-
	1983	87.5	84.7	-	-	-	-
	2000	88.4	85.6	84.4	82.4	85.0	84.9
	2012	89.2	86.3	85.9	86.2	85.9	86.9
	2019	-	86.7	86.6	86.7	86.4	87.3

TABLE C1 (CONTINUED)

Male							
Age	Year	Annuitants	General	Black		White	
				Low education	High education	Low education	High education
50	1971	79.8	75.4	-	-	-	-
	1983	83.3	77.6	-	-	-	-
	2000	84.6	79.8	74.4	76.2	78.1	81.0
	2012	85.7	80.5	75.9	79.4	78.6	82.8
	2019	-	81.1	76.5	80.6	79.1	83.5
62	1971	80.9	77.3	-	-	-	-
	1983	83.7	78.9	-	-	-	-
	2000	85.4	81.3	78.9	78.1	80.2	82.0
	2012	86.4	82.3	79.3	81.3	81.1	83.8
	2019	-	82.7	79.6	82.5	81.5	84.4
67	1971	82.2	79.2	-	-	-	-
	1983	84.2	80.2	-	-	-	-
	2000	86.0	82.4	81.1	79.5	81.3	82.7
	2012	87.1	83.4	81.2	82.6	82.4	84.5
	2019	-	83.9	81.4	83.8	82.9	85.0
70	1971	83.1	80.5	-	-	-	-
	1983	84.8	81.3	-	-	-	-
	2000	86.5	83.2	82.5	80.4	82.2	83.3
	2012	87.5	84.2	82.5	83.5	83.3	85.1
	2019	-	84.6	82.7	84.7	83.9	85.5

Source: Authors' calculations based on life tables from multiple sources.

TABLE C2. RESULTS OF STANDARD DEVIATION OF LONGEVITY FOR ALL STARTING AGES

Female							
Age	Year	Annuitants	General	Black		White	
				Low education	High education	Low education	High education
50	1971	11.0	11.9	-	-	-	-
	1983	10.9	11.9	-	-	-	-
	2000	11.0	11.6	13.6	11.0	11.7	10.3
	2012	11.2	11.8	13.7	12.9	12.3	11.1
	2019	-	11.8	14.2	12.7	12.7	10.7
62	1971	9.2	9.6	-	-	-	-
	1983	9.5	9.7	-	-	-	-
	2000	9.7	9.8	11.0	8.6	9.6	8.6
	2012	9.8	9.7	10.8	10.6	9.9	9.4
	2019	-	9.7	11.3	10.6	10.2	9.1
67	1971	8.3	8.6	-	-	-	-
	1983	8.6	8.6	-	-	-	-
	2000	9.0	8.8	9.8	7.5	8.6	7.8
	2012	9.0	8.7	9.6	9.6	8.9	8.5
	2019	-	8.8	10.1	9.6	9.1	8.3
70	1971	7.8	8.0	-	-	-	-
	1983	8.1	7.9	-	-	-	-
	2000	8.5	8.1	9.0	6.8	7.9	7.2
	2012	8.4	8.1	8.9	8.9	8.2	8.0
	2019	-	8.2	9.4	8.9	8.4	7.8

TABLE C2 (CONTINUED)

Male							
Age	Year	Annuitants	General	Black		White	
				Low education	High education	Low education	High education
50	1971	11.9	12.1	-	-	-	-
	1983	11.9	12.2	-	-	-	-
	2000	12.3	12.0	14.6	11.3	12.1	10.8
	2012	11.6	12.3	13.6	12.6	12.7	11.4
	2019	-	12.3	13.7	13.3	13.3	11.1
62	1971	9.4	9.1	-	-	-	-
	1983	9.8	9.5	-	-	-	-
	2000	10.3	9.6	11.2	8.7	9.4	8.7
	2012	9.8	9.7	10.5	10.1	9.7	9.3
	2019	-	9.8	10.7	10.7	10.4	9.0
67	1971	8.2	7.9	-	-	-	-
	1983	8.7	8.1	-	-	-	-
	2000	9.4	8.5	9.8	7.5	8.2	7.7
	2012	8.7	8.5	9.2	8.9	8.5	8.3
	2019	-	8.6	9.4	9.4	9.2	8.0
70	1971	7.5	7.2	-	-	-	-
	1983	8.0	7.3	-	-	-	-
	2000	8.8	7.7	9.0	6.7	7.4	7.1
	2012	8.1	7.8	8.4	8.1	7.7	7.7
	2019	-	7.9	8.6	8.7	8.4	7.4

Source: Authors' calculations based on life tables from multiple sources.

TABLE C3. RESULTS OF WEALTH EQUIVALENCE OF FAIR ANNUITIES FOR ALL STARTING AGES

Female							
Age	Year	Annuitants	General	Black		White	
				Low education	High education	Low education	High education
50	1971	0.26	0.33	-	-	-	-
	1983	0.23	0.31	-	-	-	-
	2000	0.22	0.28	0.41	0.31	0.29	0.24
	2012	0.22	0.27	0.37	0.32	0.30	0.24
	2019	-	0.27	0.37	0.30	0.31	0.22
62	1971	0.39	0.48	-	-	-	-
	1983	0.37	0.47	-	-	-	-
	2000	0.35	0.44	0.59	0.46	0.43	0.37
	2012	0.34	0.41	0.50	0.48	0.43	0.36
	2019	-	0.40	0.51	0.45	0.43	0.34
67	1971	0.47	0.58	-	-	-	-
	1983	0.45	0.56	-	-	-	-
	2000	0.43	0.53	0.70	0.57	0.53	0.46
	2012	0.41	0.49	0.58	0.57	0.51	0.45
	2019	-	0.48	0.59	0.54	0.51	0.41
70	1971	0.54	0.66	-	-	-	-
	1983	0.50	0.62	-	-	-	-
	2000	0.49	0.59	0.77	0.64	0.59	0.53
	2012	0.46	0.56	0.64	0.63	0.58	0.51
	2019	-	0.54	0.65	0.60	0.57	0.47

TABLE C3 (CONTINUED)

Male							
Age	Year	Annuitants	General	Black		White	
				Low education	High education	Low education	High education
50	1971	0.33	0.46	-	-	-	-
	1983	0.29	0.40	-	-	-	-
	2000	0.28	0.35	0.62	0.40	0.38	0.28
	2012	0.25	0.34	0.52	0.38	0.39	0.28
	2019	-	0.33	0.51	0.38	0.41	0.25
62	1971	0.51	0.71	-	-	-	-
	1983	0.45	0.64	-	-	-	-
	2000	0.43	0.53	0.80	0.60	0.55	0.43
	2012	0.38	0.49	0.72	0.57	0.54	0.42
	2019	-	0.48	0.72	0.55	0.58	0.38
67	1971	0.60	0.83	-	-	-	-
	1983	0.56	0.76	-	-	-	-
	2000	0.53	0.63	0.90	0.73	0.66	0.53
	2012	0.45	0.58	0.82	0.67	0.63	0.50
	2019	-	0.57	0.82	0.65	0.67	0.46
70	1971	0.67	0.91	-	-	-	-
	1983	0.63	0.84	-	-	-	-
	2000	0.60	0.71	0.97	0.83	0.74	0.61
	2012	0.51	0.65	0.89	0.74	0.70	0.57
	2019	-	0.63	0.89	0.72	0.74	0.52

Source: Authors' calculations based on life tables from multiple sources.

About the authors

Gal Wettstein is a senior research economist at the Center for Retirement Research at Boston College. He conducts research on labor market outcomes for older workers, health insurance markets and coverage, retirement decisions, and savings. He has authored studies on a wide array of topics in aging and presented to both academic and policy audiences, such as the American Economic Association, the National Tax Association, and the Office of Tax Analysis at the U.S. Department of the Treasury. Wettstein is a member of the National Academy of Social Insurance. Before joining the Center, he earned a doctorate in economics from Harvard University in the fields of health economics, labor economics, and public finance.

Yimeng Yin is a research economist at the Center for Retirement Research at Boston College. His research interests include public pensions, retirement security, and social insurance. He has conducted a wide range of research projects on funding risks and risk-sharing policies of state and local government pension plans and presented to policy and academic audiences. Before joining the center, he worked as a economic researcher at the Center for Policy Research at the Rockefeller College of Public Affairs and Policy at the University at Albany, SUNY, research analyst at the Rockefeller Institute of Government, and assistant researcher at the Center for Human and Economic Development Studies at Peking University, Beijing. He holds a Ph.D. in economics from the University at Albany, a M.A. in economics from Peking University, and a B.A in economics from Peking University.

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This research was supported by funding from the TIAA Institute. The content, findings and conclusions are the responsibility of the authors and do not necessarily represent the views of TIAA or the TIAA Institute. The authors thank Oliver Shih for excellent research assistance.

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