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How the Growing Gap in Life Expectancy May Affect Retirement Benefits and Reforms

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Abstract

Older Americans have experienced dramatic gains in life expectancy in recent decades, but an emerging literature reveals that these gains are accumulating mostly to those at the top of the income distribution. We explore how growing inequality in life expectancy affects lifetime benefits from Social Security, Medicare, and other programs and how this phenomenon interacts with possible program reforms. We first project that life expectancy at age 50 for males in the two highest income quintiles will rise by 7 to 8 years between the 1930 and 1960 birth cohorts, but that the two lowest income quintiles will experience little to no increase over that time period. This divergence in life expectancy will cause the gap between average lifetime program benefits received by men in the highest and lowest quintiles to widen by $130,000 over this period. Finally we simulate the effect of Social Security reforms such as raising the normal retirement age and changing the benefit formula to see whether they mitigate or enhance the reduced progressivity resulting from the widening gap in life expectancy.

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People with higher socioeconomic status have historically enjoyed longer life expectancies than those with lower socioeconomic status. While this phenomenon has been documented since the 1970s (Kitagawa and Hauser, 1973), researchers have only recently begun to explore how the gap in life expectancy by socioeconomic status is evolving over time. Although there are some inherent challenges in this work, the emerging consensus of this nascent literature is that the gap is wide and has been increasing over time (Waldron, 2007; Bound et al, 2014). Recent well-publicized studies by Case and Deaton (2015) and Chetty et al (2016) have helped to bring this issue to the attention of the general public.

While the widening gap in life expectancy in the US is increasingly well documented, its impact on government programs such as Social Security and Medicare has received far less attention. Yet the implications for these programs are potentially quite substantial. These programs provide benefits annually from the age of initial benefit claim, which occurs between ages 62 and 70 for Social Security retired worker benefits and at age 65 (or earlier, in the case of disability) for Medicare, until death. When life expectancy increases for those at the top of the income distribution, they collect additional years of benefits. There is little corresponding increase in taxes paid, except to the extent that having a longer life expectancy may induce people to work longer. By contrast, if those at the bottom of the income distribution are not experiencing a similar increase in life expectancy, there is no increase in their total lifetime benefits. Thus the widening gap in life expectancy has the potential to greatly affect the lifetime progressivity of entitlement programs as well as their long-term solvency.

A recent National Academies panel on which we participated explored the growing gap in life expectancy by socioeconomic status and its implications for government entitlement programs (Committee on the Long-Run Macroeconomic Effects of the Aging U.S. Population, 2015; hereafter, the Committee). In this paper, we build upon the Committee's work and expand on the implications of its findings for the US and other countries facing widening inequality in life expectancy.

Our analysis proceeds in three steps. First, we project how life expectancy at older ages is evolving over time by socioeconomic status. We use lifetime income quintile as our core measure of socioeconomic status and estimate sex-specific mortality models that allow for differential trends by income quintile, using data from the Health and Retirement Study (HRS) linked to Social Security earnings histories. From these models, we project survival after age 50 for the 1930 and 1960 cohorts, by income quintile and sex. Next, we estimate the present value of lifetime benefits by cohort, income quintile, and sex. We include benefits from Social Security, Disability Insurance, Supplemental Security Income, Medicare, and Medicaid and look at benefits, benefits net of taxes, and net benefits as a share of lifetime wealth. These projections are based on the Future Elderly Model (FEM), a demographic and economic simulation model that uses data from the HRS and other sources and has been employed to project trends in health care outcomes and costs in studies such as Goldman et al (2005). Finally, we use the FEM to estimate the effect of potential reforms to Social Security and Medicare. In each case, we simulate the reform's effect on lifetime benefits and discuss how this compares to and interacts with the changes in benefit progressivity that are occurring due to changing life expectancy by income quintile.

Our paper offers a number of contributions relative to the previous literature. First, we summarize the complex methodological issues involved in projecting life expectancy by socioeconomic status and provide new estimates to complement those in other studies. Second, we assess the progressivity of government programs and how this is changing over time due to the widening gap in life expectancy by socioeconomic status. While there are studies that explore the progressivity of individual programs such as Social Security or Medicare (e.g., Liebman, 2002; Bhattacharya and Lakdawalla, 2006), this is the first study of which we are aware that estimates the progressivity of all key programs in a single analysis and thus can assess the progressivity of government programs for the elderly as a whole. Moreover, the previous literature has tended to look at progressivity at a point in time, rather than how it evolves over time with a widening gap in life expectancy, which is the primary focus of this study. Finally, there are relatively few studies that focus on the distributional effects of possible reforms to Social Security or other government programs (Gustman and Steinmeier, 2014 and Coronado et al, 2002 are examples), and those few do not focus on how this might be changing over time with the growing gap in life expectancy.

We have several major findings. First, consistent with other recent studies, we confirm that life expectancy at older ages has been rising fastest for the highest socioeconomic groups. For those born in 1930, the gap in life expectancy at age 50 between male workers in the bottom 20 percent and top 20 percent of lifetime earnings is 5 years, according to our estimates. For males born 30 years later (in 1960), the projected gap at age 50 between high and low earners widens to almost 13 years, an increase of nearly 8 years. Results for women appear to be even more pronounced, although we consider them to be somewhat less reliable. Second, we find that there is a growing gap by lifetime income in projected lifetime benefits from programs such as Social Security and Medicare. For the 1930 cohort, the present value of lifetime benefits at age 50 is roughly equal for those in the highest and lowest quintile of lifetime income, as those at the top receive more from Social Security while those at the bottom receive more from Disability Insurance, Supplemental Security Income, and Medicaid. For the

1960 cohort, by contrast, there is a $130,000 gap in benefits between the highest and lowest quintiles, as high earners are increasingly likely to receive benefits over longer periods of time, relative to lower earners. Finally, we show that there are a number of Social Security reforms that would make the program more progressive, although their impact on progressivity tends to be small compared to the changes arising due to differential changes in life expectancy.

I. Background on Socioeconomic Status and Mortality

For the US, research on differences in mortality by socioeconomic status (SES) has a long history, including the landmark study by Kitagawa and Hauser (1973) that found important differences in 1969 mortality by educational attainment. Differences in the mortality of African Americans and Whites also have been documented throughout the 20th century, with a gap of 7.1 years in 1993. That gap has declined since then, to 3.4 years in 2014. Given this, one might have expected that SES differences had narrowed in general, but the opposite is the case. Study after study has found that SES differences have been widening in recent decades, whether SES is measured by educational attainment or by income. Before reviewing these studies, we will briefly consider some of the methodological difficulties in this area.

Methodological Issues

One of the biggest problems is reverse causality: while differences in SES may lead to differences in health and survival through various routes, it is also true that differences in health may lead to differences in income by affecting the ability of adults to work, by incurring out of pocket health care costs, and perhaps by affecting the educational attainment of children early in life and thereby earnings throughout life (Smith, 2004, 2007). Education-based measures of SES are at less risk in this regard than income based measures, because unlike income, education is largely fixed early in life. For our purposes here, reverse causality is not necessarily an issue, because if ill health causes both lower income and shorter life the consequence is nonetheless that the lower income person in question receives government old age benefits over fewer years. The one possibility that we do need to exclude is that a short-term illness causes both a short-term decline in income and a higher risk of death, because this association of short term changes will exaggerate the implications for receipt of government benefits over the longer term. Use of a long-term measure of income, as will be discussed later, greatly reduces this problem, particularly if it describes incomes earlier in life relative to the survival outcome.

When the analysis period spans many years, there is a different problem: the meaning of an inflation adjusted dollar of income changes over time, and relative position in the income distribution of each year or generation may be a more meaningful measure. For this reason, the standard approach has been to use income quantiles rather than absolute income, as the SES measure.

While measuring SES by educational attainment reduces the problem of reverse causality, it brings a new problem: increasing adverse selection for those in low attainment categories such as less than high school graduation, as the general level of attainment in the population rises. Increasing adverse selection at lower attainment levels, and decreasing positive selection for the higher attainment levels, make it difficult to interpret changes over time, and could, for example, lead to estimates of declining life expectancy for the lower attainment groups (Dowd and Hamoudi, 2014). One way to avoid this problem is to define attainment by percentile position in the educational distribution for each birth cohort.

The use of quantile measures for education or income helps to avoid some problems, but it also has a drawback. A positive finding still leaves us not knowing whether a widening dispersion in income or earnings is causing a widening dispersion in mortality by SES.

Recent Literature on Education and Mortality

Many studies in the past eight years have reported life expectancy differences by educational attainment that are both strikingly wide and increasing. Meara et al (2008) compare remaining life expectancy at age 25 for men (denoted e_{25}) with at least some college to that of men with high school or less in 2000. For African American men, the difference was 8.4 years and for White men it was 7.8 years, and in both cases the differences had increased by 1 or 2 years since 1990. Rostron et al (2010) compared e_{45} for the highest and lowest education category in the early 2000s, finding a difference of 10-12 years for females and 11-16 years for males. Olshansky et al (2012) found that life expectancy at birth for white women with less than high school education actually declined by 4 or 5 years from 1990 to 2008. This study also found that e_0 for men with more than 16 years of education was 13.4 years more than those with less than high school in 1990, rising to 14.2 years by 2008, with an increase for women from 7.7 to 10.3 years. None of these studies addressed the problem of increasing adverse selection. Bound et al (2014) address this issue by analyzing education quartiles for 1990 and 2010. With this approach they find no decline in life expectancy for low education women, but they do find a difference of 6-7 years in the median age at death in 2010 between the bottom quartile of males and the top three quartiles, and this difference had roughly doubled since 1990. Hendi (2015) also explicitly addresses the selection problem using different methods. This study finds a difference in e_{25} between less than high school and college of about ten years for both White men and women, and finds that the difference is growing. It also finds that e_{25} declined for least-educated White women, with only some of the measured decline accounted for by selection. A study by Goldring et al (2015) reported no evidence that mortality declines were numerically greater for high education men than for low, but they did not consider whether *proportional* declines may have been greater for them, so it is not clear whether their findings are inconsistent with the other studies. Case and Deaton (2015) found a significant increase between 1999 and 2013 in all-cause mortality of middle-aged non-Hispanic men and women, with more dramatic increases for those with less education and for whites. They suggest a potential connection with the opioid epidemic and more broadly with economic distress. Overall, the findings of the studies using educational measures are very consistent in showing very large and widening differences.

Recent Literature on Income and Mortality

A seminal study by Waldron (2007) based on mortality and earnings data from Social Security and Medicare engendered a wave of closely related studies using a similar design based on the Health and Retirement Survey (HRS) linked to Social Security earnings histories. Waldron measured income as the average of non-zero Social Security earnings at ages 45 to 55. It was not possible to use full lifetime earnings because many workers joined Social Security later in their careers when coverage was expanding. For those reporting zero earnings in a year, it was not possible to distinguish between those with no earnings and those whose earnings were not covered by Social Security. Waldron related quantiles of this earnings measure to mortality observed in later years in the age range 60 to 89 in the years 1972 to 2001, with ages depending on the birth cohort.[1] She projected future mortality for each birth cohort in order to get a measure of e_{65}. A striking chart shows that for the birth cohort of 1913, there was only a half-year difference in e_{65} between the top half of the earnings distribution and the bottom half. For the cohort born 28 years later in 1941, however, this difference had grown to 4.6 years, and while e_{65}

[1] Fewer and fewer years are observed for the more recent cohorts, ending in only one year for the 1941 birth cohort.
[2] The discussion in this section in large part reflects the contributions of Committee member David N. Weil.
[3] A workers whose NRA is 67 receives 70% of the PIA if he claims at age 62 and 124% of the PIA if he claims at

for the bottom half of the earnings distribution rose by only a bit over one year, for the top half it rose by about 6 years.

While Social Security data covers a huge population and has rich earnings histories, it also has very few covariates. Bosworth and Burke (2014), building on Waldron's studies, chose to use the Health and Retirement Survey (HRS). Its sample is relatively small, but it is linked to the Social Security earnings histories and it has exceptionally rich information on health, disability, assets, pensions, and many other variables of potential interest. Bosworth and Burke measure income as quantiles of the average of non-zero earnings for ages 41-50, and relate this to mortality above age 50. For couples, they allocate to each the sum of their individual incomes divided by the square root of two, to adjust for economies of scale in household consumption. A later study by Bosworth, Burtless and Zhang (2016) uses a similar design but analyzes data from both HRS (through the 2012 wave) and SIPP (Survey of Income and Program Participation). The results are quite similar to Waldron. There is a difference in e_{50} between the highest and the lowest earnings decile of 9 to 12 years for males and females born in 1940, a big increase relative to the difference for the birth cohort of 1920.

Chetty et al. (2016) use tax data to study the gradient in life expectancy in different geographies. The results suggest not only a growing gradient by income, but that the magnitude of the gradient is smaller in more affluent, more educated areas than in less affluent, less educated ones.

One recent exception to the growing body of literature showing expanded life expectancy gaps is Currie and Schwandt (2016), who find that low-income counties have narrowed the gap in life expectancy at birth (but not at age 50) with high-income countries. An important research agenda involves reconciling the results for children with those for adults, including by examining differences in childhood mortality at the individual rather than county level.   In general, however, the literature points to substantial increases in life expectancy differentials for adults.

II. Background on the Progressivity of Government Programs

Conceptual Issues

The growing gap in life expectancy by SES forces society to grapple with a key question – is it "fair" for groups that experience larger gains in life expectancy to receive larger gains in the present value of government benefits?[2] For most government programs, policy makers do not focus on lifetime benefits because there is no obvious time dimension: in any given year, people who are alive pay taxes and receive benefits such as national defense and clean air. But for programs where the ages at which taxes are paid and benefits received differ significantly, this issue becomes critical. For brevity, we discuss this issue in terms of Social Security only, although similar arguments may apply to Medicare and other programs.

With Social Security, two concepts dominate discussions regarding fairness. The first is the expected rate of return on payroll tax contributions. In a system with an actuarially fair rate of return, the present value of real benefits received is equal to the present value of real contributions. In the US, early cohorts received more than fair average rates of return due to the transfers inherent in starting a pay-as-you-go system; current and future cohorts receive less than fair returns because of the costs of these transfers (Leimer, 1995). Of greater relevance here is whether the average rates of return for different SES groups within a cohort are similar. Similar rates of return across groups may align with basic notions of fairness, enhance political support for the system, and minimize work disincentives. As the gap in life expectancy grows, the

[2] The discussion in this section in large part reflects the contributions of Committee member David N. Weil.

average rate of return for the high SES group increases because longer life does not much increase tax payments by members of the group but it does raise their years of benefits. If societal notions of fairness dictate that all groups should receive an equal rate of return, then the effects of the growing gap in life expectancy on the distribution of lifetime benefits are undesirable.

The second key consideration for society is the extent to which Social Security should redistribute from those with high lifetime earnings to those with low lifetime earnings. Any such action naturally tends to make the rates of return unequal across groups, but may nonetheless be desired by society, motivated by a utilitarian concern for the poorest members of society. While the growing gap in life expectancy does not reduce the absolute benefits received by low-SES groups (unless their life expectancy is declining), it does render the system relatively less generous to such groups; moreover, it may threaten absolute benefits of low-SES groups by straining the program's finances. In practice, the US system seems to embrace both the rate of return framing of Social Security (by referring to payroll taxes as contributions and tracking each worker's contributions over his or her life) and its redistributive role (by employing a progressive benefit formula, as discussed below).

Another salient feature of Social Security is that it is an annuity. Such a system necessarily redistributes from the short-lived to the long-lived, generating *ex post* inequality in the rate of return. This may be contrasted with the *ex ante* inequality that would arise, for example, if one group paid more in taxes but received the same benefit amount as another. *Ex post* inequality does not offend notions of fairness because it is unpredictable – some 60-year-olds live a long time, some do not – and the fact that the system provides larger lifetime benefits to those who live longer is what it is designed to do, in order to insure against the risk of having a long life and many years of consumption to finance. This may become problematic, however, if there are identifiable groups that vary in life expectancy, as this introduces a non-random aspect to the inequality. Moreoever, since *ex post* inequality penalizes those with short lives and they are disproportionately low earners, it undermines the progressivity of Social Security that is embedded in the benefits formula.

Background on Government Programs

While a discussion of the institutional features of all government programs for the elderly is impractical, we provide a few details that are most salient for the programs' distributional impact. We focus on Social Security, since most reform proposals we later consider concern it.

Individuals are eligible for Social Security if they have 40 quarters of covered earnings. To calculate benefits, past earnings are multiplied by a wage index and an average of the top 35 years of indexed earnings is calculated (Average Indexed Monthly Earnings, or AIME). A piecewise linear formula is applied to the AIME to create the Primary Insurance Amount (PIA), the basis for the monthly benefit. The formula introduces progressivity because the rate at which AIME is translated into PIA declines as AIME increases. In 2016, each dollar of AIME up to the first bend point of $856 is converted into 90 cents of PIA; the conversion factor is 32 percent until the next bend point of $5,157 and 15 percent for earnings beyond this value.

The monthly benefit depends on the age at initial benefit claim. Workers may claim as early as 62, the Early Eligibility Age (EEA), and as late as 70. Workers receive the PIA if they claim at the Normal Retirement Age (NRA), which has been rising over time from age 65 (for those born by 1937) to 67 (for those born in or after 1960). Workers face an actuarial reduction (increase) for claiming before (after) the NRA, designed to ensure that the expected benefits received over a worker's lifetime are roughly the same regardless of claiming age.[3] [4] Dependent and surviving spouses and children of insured workers are eligible for benefits; individuals who are dually entitled receive the larger of the benefits to which they are entitled.

The Disability Insurance (DI) program is integrated with Social Security and its benefit is similar, except there is no reduction for early claiming; eligibility requires passing a medical screening and meeting recent work requirements. When DI recipients reach the NRA, they move to Social Security. Social Security and DI benefits are funded by payroll taxes of 6.2 percent of earnings by both employers and employees, up to a taxable maximum of $118,500 in 2016. The Supplemental Security (SSI) program provides cash benefits to low-income individuals who are age 65 and up, or who are blind or disabled. Benefits are $733 for a single person and $1,100 for a couple but are reduced dollar-for-dollar against other benefits and income.

Medicare is available at age 65. Individuals are eligible if they or a spouse has worked 40 quarters. Medicare includes hospital insurance (part A) as well as optional supplemental insurance that pays for physician services and prescription drugs (parts B, C, and D). Part A is financed by payroll taxes on earnings, while other parts are financed by premiums and (mostly) general revenues. Medicaid provides health insurance to low-income individuals; it is the primary payer of long-term care services, which are not generally covered by Medicare.

Recent Literature on Progressivity

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[3] A workers whose NRA is 67 receives 70% of the PIA if he claims at age 62 and 124% of the PIA if he claims at age 70. Whether the reduction factor is, in fact, actuarially fair for a typical worker is a matter of some dispute. Shoven and Slavov (2013) argue that the gains from delaying Social Security have increased dramatically since the 1990s due to a combination of low interest rates, increasing longevity, and legislated increases in the gain for claiming delays beyond the NRA (the "Delayed Retirement Credit").

[4] A further complication in the benefit calculation is the Social Security earnings test. Before the NRA, workers face a reduction in benefits if they earn above an exempt amount ($15,720 in 2016). However, upon reaching the NRA, the worker is credited for any lost months of benefits through a recomputation of the actuarial adjustment. Although there is some evidence the earnings test may affect claiming behavior (Gruber and Orszag, 2003), it does not affect the (ex ante) progressivity of Social Security, and so we abstract from it in our discussion.

Estimating the progressivity of Social Security and other programs raises new challenges, starting with how to measure it. One option is to compare the replacement rate (ratio of benefits to average earnings) at different points in the income distribution.[5] The OASDI Trustees (2013) find the replacement rate for a worker is 42% for an average-wage worker, 56% for a low-wage worker, and 35% for a high-wage worker. Naturally, the benefit amount rises with past earnings, even though the replacement rate falls. By this measure, Social Security is highly progressive.

The replacement rate excludes contributions, however, yielding an incomplete picture of progressivity.[6] Some alternatives that address this (Geanakoplos et al, 1999) include the internal rate of return (rate at which an individual must be willing to trade off between present and future income in order for the present value of benefits and taxes to be equal), benefit/tax ratio (ratio of these present values, calculated at the market rate of discount), and the net transfer (difference of these present values). As before, one can compare these measures at different points in the income distribution. Liebman (2002) finds that the IRR is much higher for low-income workers.

The results from any analysis of progressivity depend, to some extent, on decisions the researcher must make in order to carry out the calculations, including the earnings measure used to determine an individual's place in the income distribution. Gustman and Steinmeier (2001) and Coronado et. al (2011) find that the progressivity of Social Security is reduced or eliminated when using lifetime rather than annual earnings, household rather than individual earnings, and potential (with full-time work at the current hourly wage) rather than actual earnings.[7]

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[5] While it is typical to use career earnings, some use final earnings or an average of earnings in the years just before retirement; Goss et. al. (2014) compare replacement rates using alternative earnings measures.

[6] Economic theory suggests that the incidence of employer contributions to Social Security may fall on workers, in the form of reduced wages; evidence from Gruber (1997) supports this hypothesis, and virtually all analysts adopt this convention in their calculations.

[7] These changes reduce progressivity because there may be people who have low earnings by the initial earnings measure and receive high net transfers who would be reclassified as higher earners under the new definition, such as a part-time worker (higher potential than actual earnings) or non-working spouse (higher household than individual

Another factor that is of particular interest here is differential mortality. As discussed earlier, large and growing differences in mortality by SES are expected to reduce progressivity. Liebman (2002) shows that when using mortality probabilities that vary only by age and sex, low SES groups gain more from Social Security than do high SES groups; however, when race- and education-specific mortality tables are used, the progressive effect of the non-linear benefit formula is largely undone, due to the shorter life expectancy of low-SES groups.

Turning to other programs, DI benefits are even more progressive than Social Security because low-income workers are more likely to go on DI. A CBO analysis (2006) finds much of the progressivity of the overall OASDI system is due to DI benefits. Analyses of Medicare progressivity come to differing conclusions – Bhattacharya and Lakdawalla (2006) find that Medicare Part A expenditures are much larger for the less educated, while McClellan and Skinner (2006) find total Medicare expenditures to be roughly similar by zip code income level. Medicaid expenditures are unsurprisingly skewed towards low-SES groups, though De Nardi et al (2013) find that use of Medicaid by high-income groups rises markedly with age, as individuals spend down their assets and become eligible.

III. Empirical Methods

We now turn to discussing our own projections of the gap in life expectancy by SES and the progressivity of Social Security and other government programs. In the work of the Committee (2015) that we discuss here, estimates follow the approach of Bosworth and Burke, using waves of the HRS from 1992 to 2008, covering cohorts born 1912 to 1957 (with different years of coverage by cohort), and calculating mid-career earnings averaged over ages 41 to50, with zeros replaced by imputations based on regressions. Earnings above the taxable cap were

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earnings). Progressivity also falls when including earnings above the taxable maximum or using a higher discount rate (Fullerton and Mast, 2005) or using only workers who survive to age 62 in the analysis (CBO, 2006).

estimated based on the month in which the cap was reached. Incomes for individual members of couples were assigned incomes equal to the sum of their individual incomes divided by the square root of 2. Quintiles of mid-life income were assigned separately for males and females. We analyzed quintiles of mid-life income (which we also refer to as lifetime income) in relation to mortality by age and sex for ages 50 and above, as the data coverage permitted.

We estimated probit equations for each sex, with a linear time trend to capture the general improvement of health and mortality, the earnings quintile, and a quintile specific time trend to capture changes in mortality dispersion. We did not include other available covariates such as education or race/ethnicity, because to do so would work at cross-purposes of the goal of our study. For our purposes it does not matter whether such variables are associated with differences in health and mortality, as they surely are; even if these associations accounted for all the difference in mortality, it would still be true that lower income people have shorter lives and receive government benefits for fewer years in old age. For similar reasons we do not include biomarkers or measures of health status as covariates. We carried out a number of robustness and sensitivity checks with alternative model specifications.

For our analysis of progressivity, we make use of the Future Elderly Model (FEM), a demographic and economic simulation model designed to predict the future costs and health of the elderly and to estimate how this could be affected by health trends or policy reforms.[8] The FEM begins with a cohort of Americans at age 50 drawn from the HRS data. Each individual in the cohort has a measure of lifetime income (measured as described above) and an initial health status. The FEM features models that relate characteristics like age, income, and health status to the probability of transitioning into various health and financial states, including retirement,

[8] More details about the FEM model and these calculations are available at www.nap.edu/GrowingGap under the resources tab.

Social Security claiming, DI claiming, disease, and death. These models are inherently associative rather than causal, although exogenous variation that occurs during the sample period can help to identify model parameters – for example, individuals in the HRS face different NRAs, which helps to identify the effect of being exactly at versus younger than the NRA on the probability of transitioning to Social Security receipt. While the HRS (1992-2008 waves) is the primary data source for the FEM, information from the 2002-2004 Medicare Current Beneficiary Survey (MCBS) and 2002-2004 Medical Expenditure Panel Survey (MEPS) is used for estimating health expenditures. The estimates from the transition models are combined with individual characteristics to estimate the probability that individuals will transition across the various health and financial states over a two-year period. Using updated characteristics, the model predicts transitions over the next period, and this process is repeated until everyone in the cohort has died.

The baseline scenario is based on the initial health status distribution of the 1930 cohort and its estimated mortality gradient. We then modify the initial health status distribution and mortality gradient to that of the (simulated/projected) 1960 cohort and contrast the new results to baseline. Health status does not enter directly into mortality or medical spending, so these outcomes are driven entirely by the mortality gradient. Health does influence some economic outcomes, so the differences in initial health prevalence will lead to some cohort differences in trajectories after age 50 in earnings, labor force participation, and claiming of Social Security, DI, and SSI, although the two cohorts have the same earnings up to age 50 by construction. We also use the 2010 policy environment for both calculations, to isolate the effect of changing mortality gradient alone. As a final step, we modify the policy environment and simulate new results to contrast to the baseline, in order to show the effect of the reforms on lifetime benefits.

We report our results in terms of three related outcome measures: the present value of benefits at age 50 (expected benefits received after age 50 discounted back to that age using a real rate of 2.9 percent), the present value of net benefits (same but net of all taxes paid after age 50), and the present value of net benefits as a share of inclusive wealth (net benefits relative to a measure that includes asset holdings at age 50, after-tax earnings after age 50, and net benefits after age 50, all in present value at age 50). We measure benefits received and taxes paid after age 50, as opposed to on a full lifetime basis, because the FEM starts with a cohort of 50-year-olds drawn from the HRS. Our measure of benefits should be quite similar to a lifetime measure, since most benefits from Social Security, Medicare, and the other programs are received after age 50, although our net benefit measure will overstate the extent of net transfers from the government because it excludes taxes paid before age 50. However, the focus of our study is on the *change* in gross and net benefits resulting from mortality changes after age 50, which is unaffected by the exclusion of taxes earlier in life.

IV. Results

Mortality Projections

Later we will report the results of simulation experiments that isolate the effect of the widening mortality dispersion on the lifetime value of government benefits received after age 50. These simulations contrast these values under the mortality regimes of the birth cohort of 1930 and 1960. For this reason we will present our results for these two birth cohorts. However, it is important to keep in mind that we do not actually observe even one year of deaths at age 50 or above for the 1960 birth cohort, because it turns age 50 in 2010 and the latest wave of the HRS that we use is 2008. Thus the mortality results for this birth cohort are slightly out-of-sample estimates based on the fitted model. For the 1930 birth cohort, turning 50 in 1980, we have observations from age 62 in 1992 to age 78 in 2008. To estimate e_{50} we must extrapolate mortality to older ages until the cohort has died out, and this we do by assuming that the trends estimated in the model continue, including the quintile divergence. The trends and projections for overall life expectancy arrived at in this way are quite similar to those in the Social Security Administration projections, which were also used by Waldron (2007) for this purpose. But because those Social Security projections assume some deceleration of mortality decline as time passes, the Committee projections of e_{50} are slightly higher.

The Committee estimates of remaining life expectancy at age 50 by sex and income quintile are shown in Figure 1. Life expectancy at 50 is a convenient summary measure, but for our simulations we of course used the survival probabilities to each age, which are not shown here. For the male birth cohort of 1930, e_{50} is lowest for the bottom quintile and rises steadily as we move to higher quintiles, reaching a level 5.1 years higher for the top quintile. For the 1960 male birth cohort the lowest quintile has slightly lower e_{50} than the 1930 cohort, but then rises to a level 12.7 years higher for the top quintile, indicating a very large increase in the dispersion.

For females, the results are a bit more erratic, and this appears to be the case in other studies as well, such as Waldron (2007) and Bosworth and Burke (2014). For the female birth cohort of 1930, e_{50} is fairly flat across the first three or four quintiles, and then rises for the fifth quintile which is 3.9 years higher than the first. For the 1960 cohort, e_{50} is 4.0 years lower for the bottom quintile than for the 1930 cohort, a striking decline. Thereafter it rises steadily but slowly to the fourth quintile, with levels very similar to those for the 1930 cohort, showing no gain at all between the cohorts. Only for the top quintile has e_{50} risen substantially, and it achieves a level 13.6 years higher than the bottom cohort. These estimates for females should be treated with caution.

There are, of course, many sources of uncertainty in our estimates of mortality differences by income quintile, and even more so in the growth in these differences between the cohorts of 1930 and 1960. While we were not able to assess this uncertainty formally, we did also prepare mortality projections for the 1960 cohort on the assumption that the dispersion increased only half as rapidly as in our baseline projection shown in Figure 1. We also carried out simulation experiments based on these alternative projections.

Progressivity of Lifetime Benefits

Next, we discuss our findings with respect to the progressivity of lifetime benefits from government programs, contrasting the experience under the mortality conditions of the 1930 and 1960 cohorts. Recall that this exercise is not meant to obtain a projection of actual benefits for these two cohorts, but rather to isolate the effect of the changing mortality gradient and initial health distribution on lifetime benefits. In our simulation experiments the policy environment and earnings up to age 50 are the same for both cohorts, though the actual two birth cohorts had different experiences.

We begin with Social Security, reporting results in Figure 2a. For males in the 1930 cohort, benefits rise with earnings quintile – workers in the lowest quintile can expect to receive, on average, $126,000 of benefits over the rest of their lives (discounted to age 50), while workers in the top quintile can expect to receive $229,000, or 82% more than the lowest income workers. The fact that higher earners receive higher benefits is not surprising, since the monthly benefit amount rises with AIME, albeit in a non-linear fashion. As these benefit values are not scaled by earnings (as with a replacement rate measure) and do not include taxes (as with money's worth measures), we cannot directly infer the progressivity of Social Security from these estimates.

More interesting for our purposes is how the results change when we move from the mortality regime of the 1930 cohort to that of the 1960 cohort. The additional 6-8 years of life expectancy for the top three quintiles leads to large increases in expected Social Security benefits, with benefits for the top quintile in 1960 reaching $295,000. The difference between the highest and lowest quintiles is $173,000, or 142% of the lowest income worker's benefit. These results suggest that Social Security is becoming significantly less progressive over time due to the widening gap in life expectancy.[9]

The results for women, as shown in Figure 2b, also show benefits rising with earnings quintile in the 1930 cohort, with expected benefits of $112,000 for women in the lowest quintile and $208,000 for women in the top quintile. Benefits here are any received by the individual, including dependent spouse and survivor benefits derived from the earnings record of the spouse. Due to their lower career earnings and benefit entitlements, women's total expected benefits are about 90% as large as those for men, though they can expect to live 4-5 years longer. As for men, the gap between the top and bottom of the distribution is large and widening over time – this difference is 86% of the bottom quintile's benefits for the 1930 cohort but jumps to 158% for the 1960 cohort. These changes are larger than those for men because the model predicts a decline in life expectancy for lower income women over time, but the overall message is the same – diverging life expectancy is making Social Security less progressive over time.

Expected DI benefits (Figures 3a and 3b) are smaller than expected Social Security benefits because the probability of ever receiving DI is far lower. While Social Security benefits rise with earnings quintile, DI benefits decline sharply – for males with the mortality regime of the 1930 cohort, benefits are $25,000 for the lowest quintile, $11,000 for the middle quintile and $4,000 for top quintile. While a low-AIME worker on DI receives a smaller benefit than a high-

[9] These figures refer to gross benefits; we discuss benefits net of taxes below.

AIME worker on DI, the low-AIME worker is so much more likely to receive DI that his expected DI benefit is larger. The pattern for women is the same but the values are less than half as large, due to their lower career earnings and lower probability of ever going on DI. Unlike Social Security, expected DI benefits are stable across cohorts, since increases in life expectancy are concentrated in the third through fifth quintiles, which have relatively low probabilities of DI claiming.[10] Thus the progressivity of DI benefits is unchanged over time.

SSI benefits (Figures 4a and 4b) are also larger for the lower quintiles because of a higher probability of receipt. For men in the 1930 cohort, expected benefits are $11,000 in the lowest quintile, $4,000 in the second, and negligible for the others. Values are about twice as large for women, because of their longer life expectancy and higher probability of ending up with the low income necessarily to qualify for SSI. Here too changes across cohorts are small.

Moving to health care benefits, we first note that those with lower lifetime income have higher annual Medicare expenditures. For example, for 67-year-old males, Medicare expenditures in the lowest income quintile are 48 percent higher than in the top quintile; for females at this age, the increase is 69 percent. This ratio attenuates somewhat with age, likely because the least healthy people in the bottom quintile die earlier.

In terms of lifetime Medicare benefits (Figures 5a and 5b), for men in the health and mortality regime of the 1930 cohort, benefits are relatively flat by earnings quintile. Males in the lowest quintile can expect to receive $162,000 in lifetime benefits, only 6 percent more than those in the top quintile, as the higher annual Medicare expenditures of the lower income group is roughly offset by their shorter life expectancy. But widening disparities change this picture considerably for the regime of the 1960 cohort of males, where those in the bottom quintile can

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[10] In results not shown here, the FEM model predicts that the probability of claiming DI over a two-year period for the 1930 cohort peaks around age 62 at nearly 20% for Q1 males, versus roughly 10% for Q2 and Q3 males and 5% or less for Q4 and Q5 males; predicted claiming behavior for later cohorts is similar.

expect to receive just 78 percent of the lifetime benefits for those in the top quintile. For the regime of the 1930 cohort of females, those in the lowest income quintile receive about 30 percent more in lifetime Medicare benefits than those in the top, due to the steeper income gradient in annual spending for women. But as with males, the distribution of benefits is changing over time. For the regime of the 1960 cohort, lifetime Medicare benefits for females in the lowest income quintile are only 92 percent of the benefits in the top quintile.

Medicaid benefits (Figures 6a and 6b) are highly skewed towards those with low lifetime earnings. For the regime of males in the 1930 cohort, the present value of Medicaid from age 50 on is \$77,000 for those in the lowest earning quintile, \$35,000 in the second, and just \$16,000 for those in the highest quintile. For females – who are much more likely to use nursing homes – the disparities are even larger: the average lifetime Medicaid benefit from age 50 is \$164,000 in the lowest quintile but only \$21,000 in the highest quintile. Widening disparities in life expectancy over time have little effect on Medicaid benefits for men (as for DI and SSI), but diminish the gap between benefits for high and low income women as a result of our (somewhat less reliable) estimates of falling life expectancy for women at the bottom of the income distribution.

Finally, we calculate the present value of total benefits from Social Security, Disability Insurance, Supplemental Security Income, Medicare, and Medicaid (Table 1). For the regime of males in the 1930 cohort, the present value of gross total benefits is about \$400,000 in both the bottom and top quintiles, with somewhat lower benefits for the middle quintiles. This pattern reflects the fact that high-income workers receive larger benefits from Social Security, while low-income workers receive more from DI, SSI, and Medicaid. Moving to the regime of the 1960 cohort, gross benefits for males in the top quintile are \$132,000 higher than those for males in the bottom quintile. This is due to the larger Social Security and Medicare benefits received by high-income males under this regime.

When looking at net rather than gross benefits (Table 2), benefit levels are naturally lower. However, the effect of moving to the 1960 regime is nearly identical. While higher earners pay more in taxes than lower earners, the pattern is not markedly different between the mortality regimes of the 1930 and 1960 cohorts. To summarize, our key finding is that changing the mortality and health regime from that of the 1930 to the 1960 cohort causes the gap between average lifetime benefits received by men in the highest and lowest quintiles to widen by about $130,000. The change arises from the impact of mortality on benefits and not on taxes.

For the regime of the 1930 cohort females, the top quintile has lower average lifetime benefits levels than those at the bottom, largely because Medicaid benefits, which deliver larger benefits to those towards the bottom of the earnings distribution, are a larger factor in the total for females than for males. The difference is even larger when looking at net benefits. Of chief interest, however, is how this changes with the mortality regime. In the earlier regime, women in bottom quintile received $129,000 more in gross benefits than those in top quintile. For the regime of the 1960 cohort, women in the top quintile receive $28,000 more, reflecting a shift of $157,000 in their favor. While we consider the mortality projections for women to be somewhat less reliable for men, the main point that changing mortality leads benefits to accrue increasingly to women at the top of the income distribution nonetheless seems sound.

We also estimate the effect of the changing mortality gradient on net lifetime benefits as a fraction of inclusive wealth. We find that the share of wealth accruing from net benefits rises by 7 percentage points for the top quintile of male earners when we contrast the 1930 to 1960 mortality regime, but falls slightly for the lowest quintile. For females, the share rises by 5.4 percentage points for the top earners and falls by 3.6 percentage points for the bottom earners.

As a result, whatever the baseline pattern of progressivity, the overall progressivity of lifetime benefits as defined by this measure declines markedly for both males and females. To put it another way, the switch to the 1960 mortality regime increases the fraction of wealth represented by entitlement benefits by 5 to 7 percent for top earners, and reduces these resources by 0 to 4 percent for the lowest earners.

Two observations about these findings are noteworthy. First, the preceding discussion focused mostly on the top versus the bottom quintile. But the comparison for males applies also to roughly the top half of the income distribution relative to the bottom half. Second, the increased gaps in the present value of net benefits are driven primarily by Social Security (where the absolute level of present value dollars for top earners is projected to rise significantly relative to bottom earners) and Medicare (where the program is projected to move from being roughly neutral with respect to lifetime earnings to one in which the present value of benefits for higher-earning males is much larger than for lower earners).

Policy Reform Simulations

Our final goal is to analyze policy reforms to determine how they would affect the progressivity of government programs and interact with projected changes in life expectancy. The reforms we simulate – five that affect Social Security and one that affects Medicare – were chosen because they are either frequently mentioned in policy discussions or meet objectives with which many stakeholders would agree. Unfortunately, the structure of the FEM made it impossible to simulate certain reforms, such as raising the Social Security maximum taxable earnings amount. The policy simulations we study include: raising the Social Security EEA by 2 years (to age 64), raising the Social Security NRA by 3 years (to age 70); reducing the cost-of-living adjustment applied to benefits by 0.2 percent per year; reducing the top PIA factor by one-third (from a 15% to 10% rate); reducing the top PIA factor to 0 above median AIME; and raising the Medicare eligibility age by 2 years (to age 67).

There are two mechanisms by which a policy change may translate into change in benefits. The first, which can be characterized as the “mechanical effect,” results directly from the policy change, holding behavior constant. For example, if the NRA were raised by 3 years, a worker claiming benefits at age 67 would see the monthly benefit amount fall from 100 percent of the PIA to 80 percent, experiencing a 20 percent reduction in benefits. The second channel, which can be characterized as the “behavioral effect,” results from changes in individual behavior in response to the policy. For example, the individual may claim Social Security later, work longer, or be more likely to claim DI. These responses can be captured by the FEM.

We show results for all reforms on Table 4, for brevity reporting only the change in net benefits as a fraction of inclusive wealth for the 1960 mortality regime resulting from the reform; we discuss results for males only in the text, though the table includes values for females also. We begin with the increase in the EEA. At first glance, it might seem that this policy would have little effect on the present value of benefits given the common belief that the actuarial adjustment is roughly actuarially fair. We find that this reform raises net benefits as a share of wealth by 0.1 for males in the lowest quintile under the 1960 mortality regime and by 0.4 for males in the highest quintile. Under our assumptions, the actuarial adjustment for delayed claiming is slightly more than fair, so when individuals are forced to claim later by this policy change, lifetime benefits increase, particularly for high-income individuals who have longer life expectancies. The policy change is thus mildly regressive, although its effects are fairly small.

Raising the NRA has a much bigger effect – we estimate that lifetime Social Security benefits fall by $30,000 (or 25% of the pre-reform value) for the lowest quintile of males in the

1960 mortality regime and by $59,000 (20%) for the highest quintile. The percentage drop need not be the same in the two quintiles because the behavioral response of the two groups to the policy change (captured by the FEM) could differ; also, the same response – say, postponing retirement and claiming by one year – could have a different effect on lifetime benefits because of differences in life expectancy. As low income males experience the larger percentage drop in benefits, this policy might be considered regressive. Yet the policy change reduces benefits as a share of wealth by 4.8 percent for males in the lowest quintile and by 5.2 percent for males in the highest quintile, as the larger dollar loss for high income males ends up being a slightly larger share of their lifetime wealth (as captured by our inclusive wealth measure). Viewed by this metric, the policy change is progressive. Thus, the progressivity of this policy change is somewhat sensitive to the particular measure used.

Reducing the cost-of-living adjustment (COLA) has a modest effect on benefits, reducing them by 0.4 percent of wealth for males in the lowest quintile under the 1960 mortality regime and by 0.6 percent for males in the highest quintile. The larger effect for high income men is due to their longer life expectancy, since the effect of a lower COLA is cumulative over time. Reducing the top PIA factor by one-third has a fairly modest impact of 0.1 percent of wealth for low-income males and 0.3 percent for high-income males; the larger effect on high-income males is expected, since the top PIA factor applies only to earnings past the second bend point of AIME (e.g., at higher earning levels). A related policy with a much bigger impact is reducing the top factor to zero and moving the second bendpoint to the median of AIME. This policy, which would reduce benefits for the top half of earners, is chosen an as example of a substantial benefit cut designed to have a smaller impact on low earners. We find that this policy would reduce benefits as a share of wealth by 1.1 percent for males in the lowest quintile and by 3.4

percent for men in the highest quintile. Finally, we simulate raising the Medicare eligibility age. This policy has a fairly similar effect across quintiles in dollar terms, reducing lifetime Medicare benefits by $8,000 for low-income males in the 1960 mortality regime and by $7,000 for high-income males. Measured as a share of inclusive wealth, there is a loss of 1.4 percent for low-income males and 0.5 percent for high-income males, indicating a regressive policy.

Overall, most of these policy changes would make overall net benefits more progressive. The exceptions are raising the EEA or the Medicare eligibility age, which make benefits less progressive. When compared to the changes in progressivity occurring due to mortality trends, however, the effect of these policies on progressivity is generally fairly small. For example, consider the policy reducing the top PIA factor to zero above median AIME, which is the most progressive of the policies we simulated. Absent any policy change, the gap in lifetime Social Security benefits between males in the highest and lowest income quintiles grows from $103,000 in the 1930 mortality regime to $173,000 in the 1960 mortality regime. Implementing this policy would eliminate 60 percent of the increase, so that the gap under the 1960 regime would be $131,000. This illustrates the scale of the policy reform that would be needed to counteract the changes in progressivity of government benefit programs that we project are occurring due to the widening gap in life expectancy.

V. Discussion

Life expectancy at older ages has been growing steadily in the U.S. over the past several decades. Yet there is growing awareness that these gains are not being shared equally. Our study confirms a substantial increase in the life expectancy gap between higher and lower earners. For men, we project that the gap in life expectancy at age 50 between males in the highest and lowest quintiles of lifetime earnings will grow from 5 years for the 1930 cohort to nearly 13 years for the 1960 cohort. Estimates for women, while somewhat less reliable, show a similar if not larger change over time.

We also assess the effects of the growing gap in life expectancies among older adults on the major entitlement programs. The larger life expectancy gap means that higher-income people will increasingly collect retirement benefits over more years than will lower-income people. We estimate the value of net lifetime benefits for different income groups from Social Security, Disability Insurance, Supplemental Security Income, Medicare, and Medicaid. Our estimates suggest that these net lifetime benefits are becoming significantly less progressive over time because of the disproportionate life expectancy gains among higher-earning adults. The changes in life expectancy between the 1930 and 1960 mortality regimes generate an increase in benefits equivalent to an increase of 6.9 percent of wealth (measured at age 50) for men in the highest income quintile, while benefits for men in the lowest income quintile are essentially unchanged. Women in the top income quintile gain 5.4 percent of wealth, while those in the bottom quintile receive lower benefits, according to our estimates.

We then consider how the differential changes in mortality would affect analyses of some possible reforms to government programs for the elderly in the face of population aging. For example, many proposals to increase the normal retirement age under Social Security are motivated by the rise in mean life expectancy. The mean, however, masks substantial differences in mortality changes across earnings categories. We show the impact of that proposal and other possible Social Security and Medicare refoms on lifetime benefits across the earnings categories and in a manner that reflects their different life expectancy trajectories. We find that while there are policy reforms that tend to raise the progressivity of government programs, the effect of these reforms are fairly small when viewed next to the reduction in progressivity that is occurring due to the growing gap in life expectancy. This suggests that policy changes that (alone or in combination) are more progressive than those we simulate here would be needed to undo the effect of the widening longevity gap on the progressivity of government programs.

Social Security, Medicare, and the other programs included in our study face rising expenditures over time, straining the aibility of existing revenue sources to fully fund benefit promises at current tax rate. The US is far from unique in this regard – rising longevity, falling birth rates, and slowing economic growth threaten the long-term solvency of entitlement programs in many countries, particularly where financed via a pay-as-you-go mechanism or out of general revenues. Many countries have already implemented reforms to public pension, disability insurance, and other social insurance programs, for example by raising retirement ages or altering benefit formulas in a way that reduces program generosity, and many countries continue to comtemplate implementing additional reforms. As policy makers continue to face these difficult choices, it may be useful for them to take into account the important implications of the increasing gap in life expectancy.

References

Bhattacharya, Jayanta and Darium Lakdawalla (2006). "Does Medicare Benefit the Poor?" *Journal of Public Economics* 90:277-292.

Bosworth, Barry, and Kathleen Burke (2014). "Differential Mortality and Retirement Benefits in the Health and Retirement Study," Economic Studies at Brookings.

Bosworth, Barry, Gary Burtless, and Kan Zhang. (2016). "Later Retirement, Inequality In Old Age, And The In Old Age, And The Growing Gap In Longevity Between Rich And Poor," Economic Studies at Brookings.

Bound, John, Arline Geronimus, Javier Rodriguez, and Timothy Waidmann (2014). "The Implications of Differential Trends in Mortality for Social Security Policy," Prepared for the 16th Annual Joint Conference of the Retirement Research Consortium, August, Washington, DC.

Case, Anne and Angus Deaton (2015). "Rising Morbidity and Mortality in Midlife Among White non-Hispanic Americans in the 21st Century." *Proceedings of the National Academy of Sciences* 112(49): 15078-15083.

Chetty, Raj, Michael Stepner, Sarah Abraham, Shelby Lin, Benjamin Scuderi, Nicholas Turner, Augustin Bergeron, and David Cutler (2016). "The Association between Income and Life Expectancy in the United States, 2001 – 2014," *The Journal of the American Medical Association* 315(14):1750-1766.

Committee on the Long-Run Macroeconomic Effects of the Aging U.S. Population Phase II (2015). *The Growing Gap in Life Expectancy by Income: Implications for Federal Programs and Policy Responses*. Washington, D.C.: The National Academies Press.

Congressional Budget Office (2006). "Is Social Security Progressive?" Economic and Budget Issue Brief.

Coronado, Julia Lynn, Don Fullerton, and Thomas Glass (2011). "The Progressivity of Social Security," *The B.E. Journal of Economic Analysis & Policy (Advances),* article 70.

Coronado, Julia, Don Fullerton, and Thomas Glass (2002). "Long-Run Effects of Social Security Reform Proposals on Lifetime Progressivity," in Martin Feldstein and Jeffrey B. Liebman (eds.), *The Distributional Aspects of Social Security and Social Security Reform*. Chicago: University of Chicago Press.

Currie, Janet and Hannes Schwandt (2016). "Mortality Inequality: The Good News from a County-Level Approach," IZA Discussion Paper 9903.

De Nardi, Mariacristina, Eric French, and John Bailey Jones (2013). "Medicaid Insurance in Old Age," National Bureau of Economic Research Working Paper 19151.

Dowd, Jennifer B., and Amar Hamoudi. (2014). "Is Life Expectancy Really Falling for Groups of Low Socio-Economic Status? Lagged Selection Bias and Artefactual Trends in Mortality," *International Journal of Epidemiology,* 43(4): 983-988.

Fullerton, Don and Brent Mast (2005). "Income Redistribution from Social Security," Washington, D.C.: American Enterprise Institute Press.

Geanakoplos, John, Olivia S. Mitchell, and Stephen P. Zeldes (1999). "Social Security Money's Worth," in *Prospects for Social Security Reform*, Olivia S. Mitchell, Robert J. Myers, and Howard Young (eds.), Pension Research Council of the Wharton School of the University of Pennsylvania.

Goldman, Dana P., Baoping Shang, Jayanta Bhattacharya, and Alan M. Garber (2005). "Consequences of Health Trends and Medical Innovation for the Future Elderly," *Health Affairs* 24:W5R5.

Goldring, Thomas, Fabian Lange, and Seth Richards-Shubik (2015). "Testing for Changes in the SES- Mortality Gradient When the Distribution of Education Changes Too," NBER Working Paper No. 20993.

Goss, Stephen, Michael Clingman, Alice Wade, and Karen Glenn (2014). "Replacement Rates for Retirees: What Makes Sense for Planning and Evaluation?" Social Security Administration Actuarial Note Number 155, July.

Gruber, Jonathan (1997). "The Incidence of Payroll Taxation: Evidence from Chile," *Journal of Labor Economics* S72-S101.

Gruber, Jonathan and Peter Orszag (2003). "Does the Social Security Earnings Test Affect Labor Supply and Benefits Receipt?" *National Tax Journal* 56 (2003) 755-773.

Gustman, Alan, Thomas Steinmeier, and Nahid Tabatabai (2014). "Distributional Effects of Means Testing Social Security: An Exploratory Analysis," National Bureau of Economic Research Working Paper 20546.

Gustman, Alan L. and Thomas L. Steinmeier (2001). "How Effective is Redistribution Under the Social Security Benefit Formula?" *Journal of Public Economics* 82:1-28.

Hendi, Arun S. (2015). "Trends in U.S. Life Expectancy Gradients: the Role of Changing Educational Composition," *International Journal of Epidemiology* 44(3):946-955.

Kitagawa, Evelyn M., and Phillip M. Hauser. *Differential Mortality in the United States: A Study in Socioeconomic Epidemiology*. Cambridge, MA: Harvard University Press.

Leimer, Dean R. (1995). "A Guide to Social Security Money's Worth Issues," *Social Security Bulletin* 58:3-20.

Liebman, Jeffrey B. (2002). "Redistribution in the Current U.S. Social Security System," in Martin Feldstein and Jeffrey B. Liebman (eds.), *The Distributional Aspects of Social Security* *and Social Security Reform*. Chicago: University of Chicago Press.

Liu, Bette, Sarah Floud, Kirstin Pirie, Jane Green, Richard Peto, Valerie Beral (2016). "Does Happiness Itself Directly Affect Mortality?" The Prospective UK Million Women Study," *The Lancet* 387(10021):874-881.

McClellan, Mark and Jonathan Skinner (2006). "The Incidence of Medicare," *Journal of Public Economics* 90:257-276.

Meara, Ellen, Seth Richards, and David M. Cutler (2008). "The Gap Gets Bigger: Changes in Mortality and Life Expectancy, by Education, 1981-2000," *Health Affairs* 27(2):350-360.

OASDI Trustees (2013). "The 2013 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds," May.

Olshansky, S. Jay, Toni Antonucci, Lisa Berkman, Robert Binstock, Axel Boersch-Supan, John T. Cacioppo, Bruce Carnes, Laura L. Carstensen, Linda P. Fried, Dana P. Goldman, James Jackson, Martin Kohli, John Rother, Yuhui Zheng, and John Rowe (2012). "Differences in Life Expectancy Due to Race and Educational Differences Are Widening, and Many May Not Catch Up," *Health Affairs 31*(8):1803-1813.

Rostron, Brian L., John L. Boies, and Elizabeth Arias (2010). "Education Reporting and Classification on Death Certificates in the United States," *Vital and Health Statistics 2*(151).

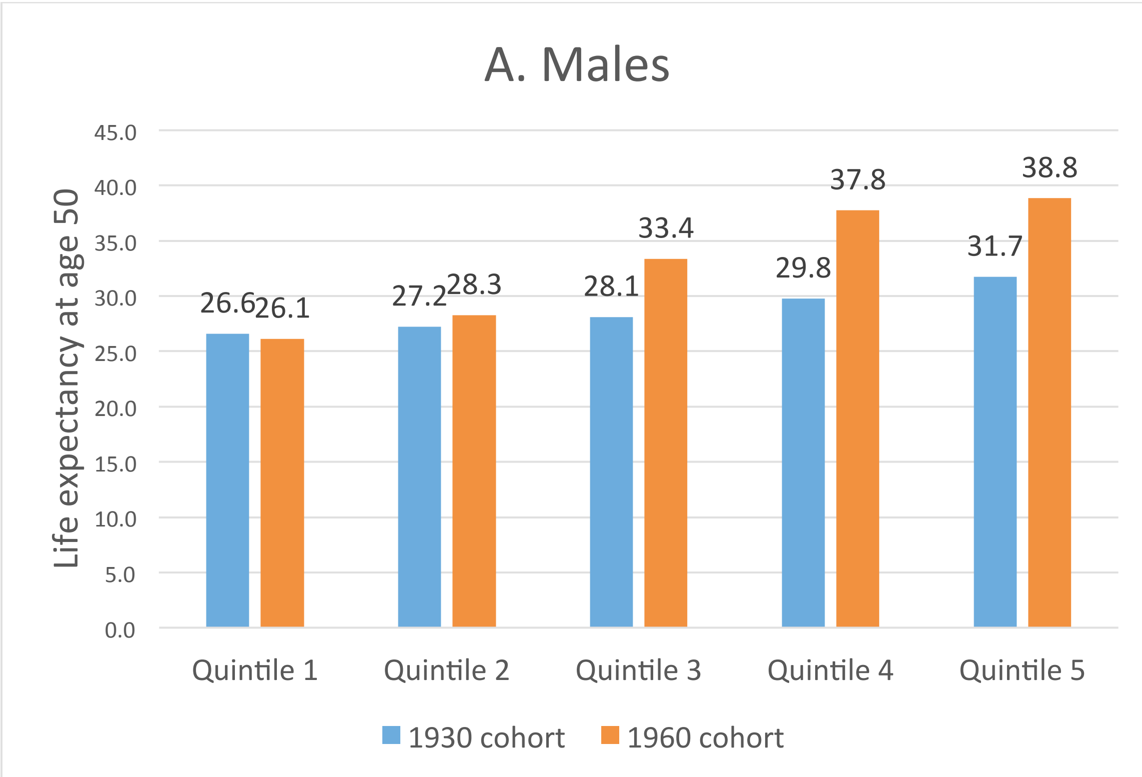
Shoven, John B. and Sita Slavov (2013). "Recent Changes in the Gains from Delaying Social Security," NBER Working Paper 19370.

Smith, James P. (2004). "Unraveling the Health-SES Connection," in Linda J. Waite (ed.), *Aging, Health and Public Policy: Demographic and Economic Perspectives (Volume 30).* New York: Population Council.

Smith, James P. (2007). "The Impact of Socioeconomic Status on Health Over The Life-Course," *Journal of Human Resources 42*(4):739-764.

Waldron, Hilary. (2007). "Trends in Mortality Differentials and Life Expectancy for Male Social Security-Covered Workers, By Socioeconomic Status," *Social Security Bulletin 67*(3):1-28.

Figure 1: Life expectancy at age 50, actual and projected, for birth cohorts of 1930 and 1960, by income quintile



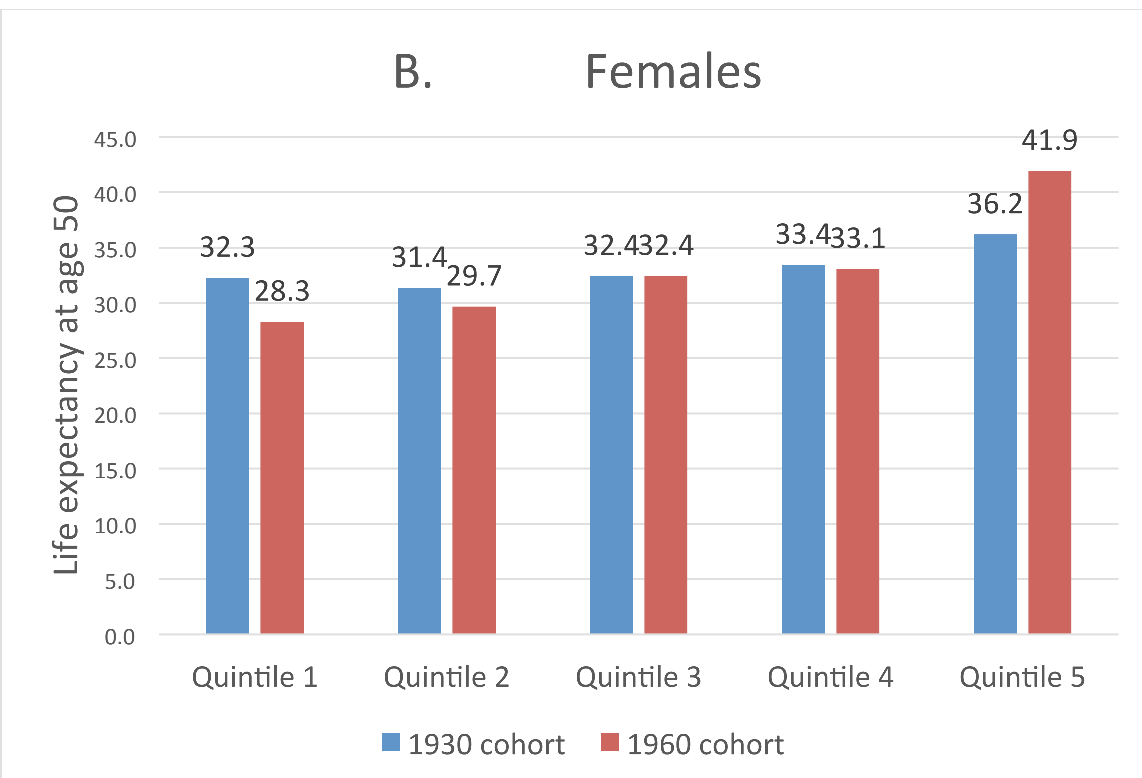
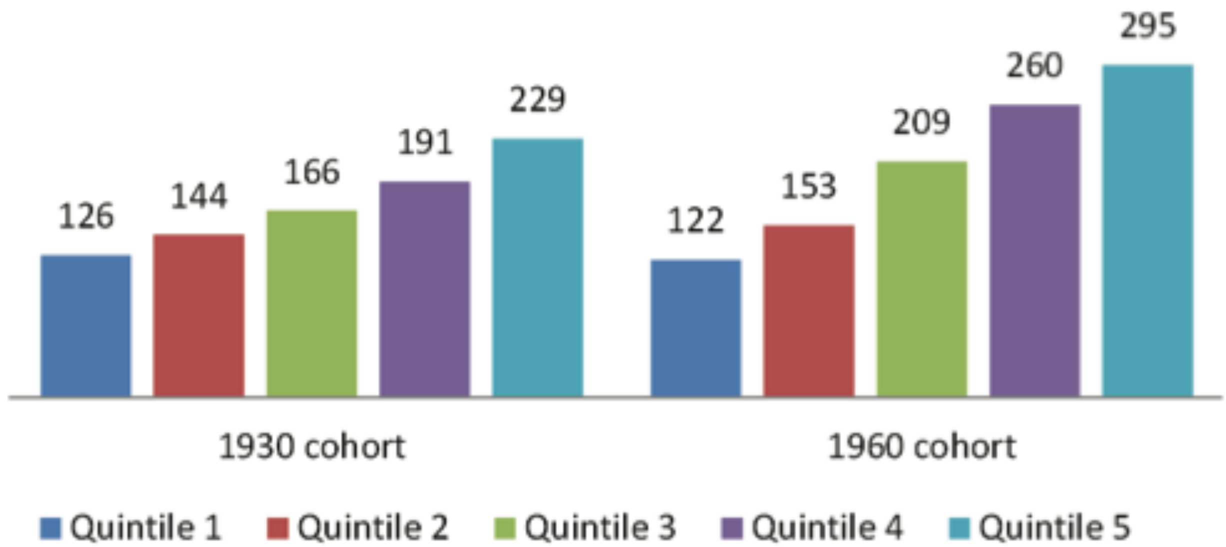


Figure 2: Average lifetime Social Security benefits by lifetime income quintile, 1930 vs. 1960 mortality regime (in thousands of dollars)

A. Males



B. Females

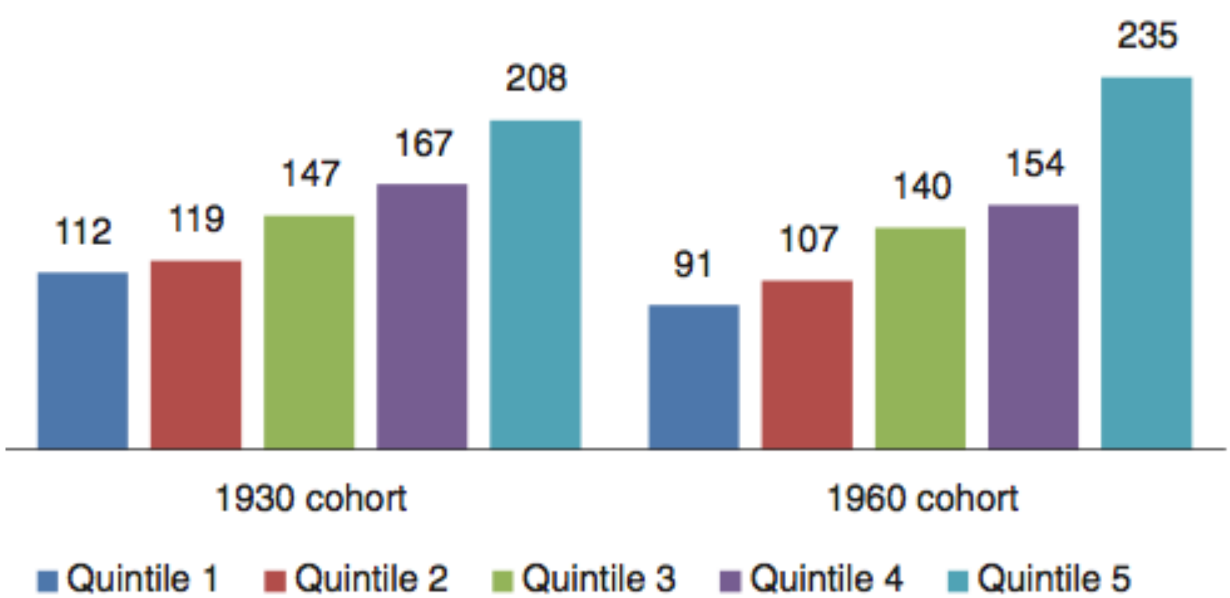
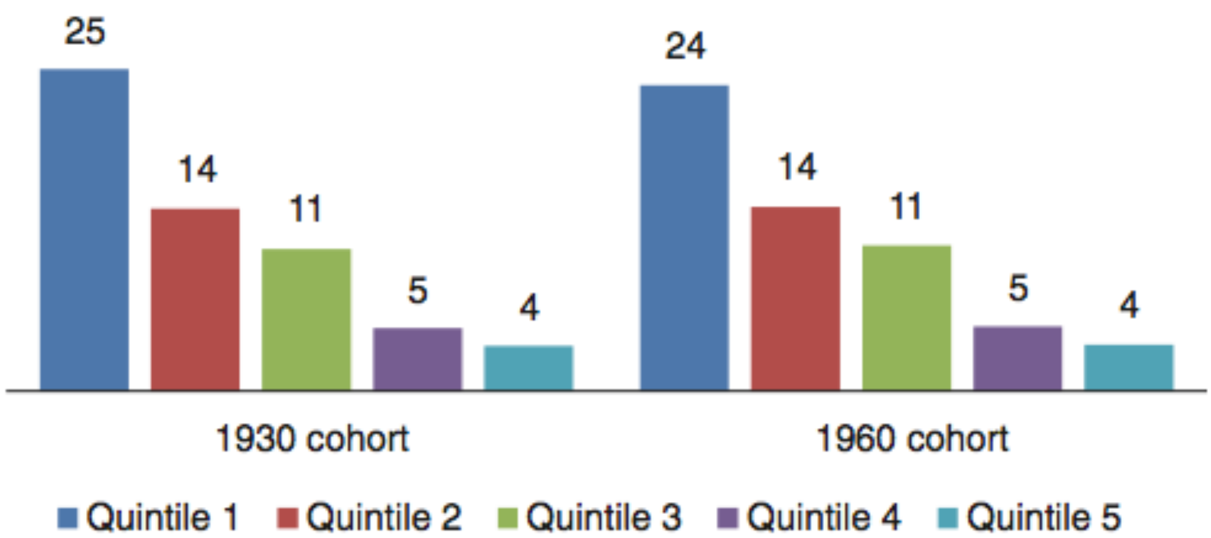


Figure 3: Average lifetime Disability Insurance benefits by lifetime income quintile, 1930 vs. 1960 mortality regime (in thousands of dollars)

A. Males



B. Females

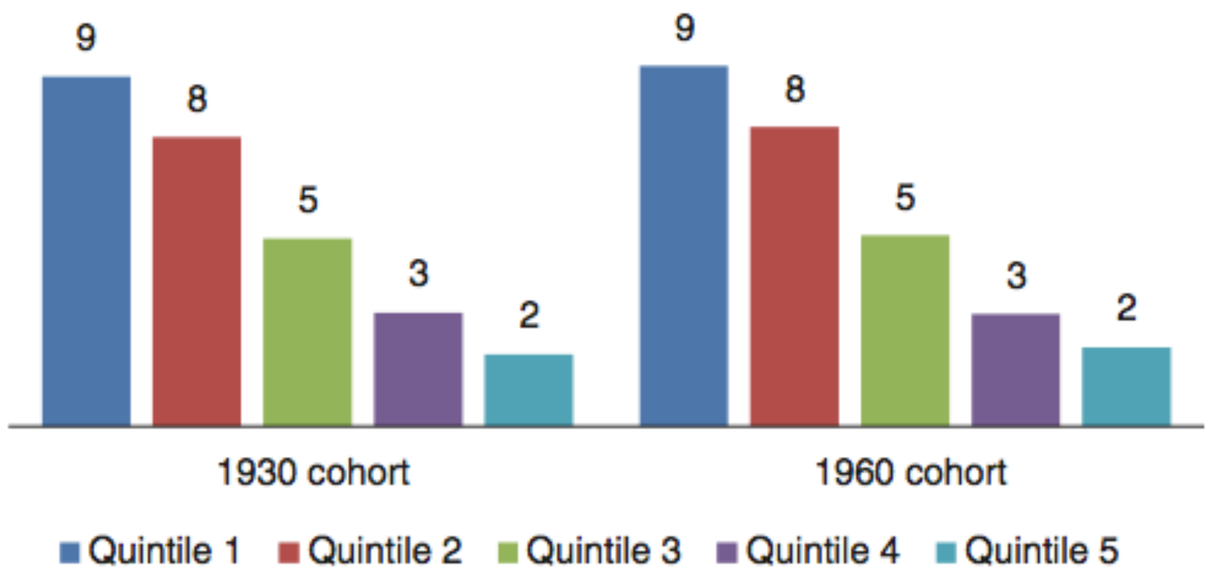
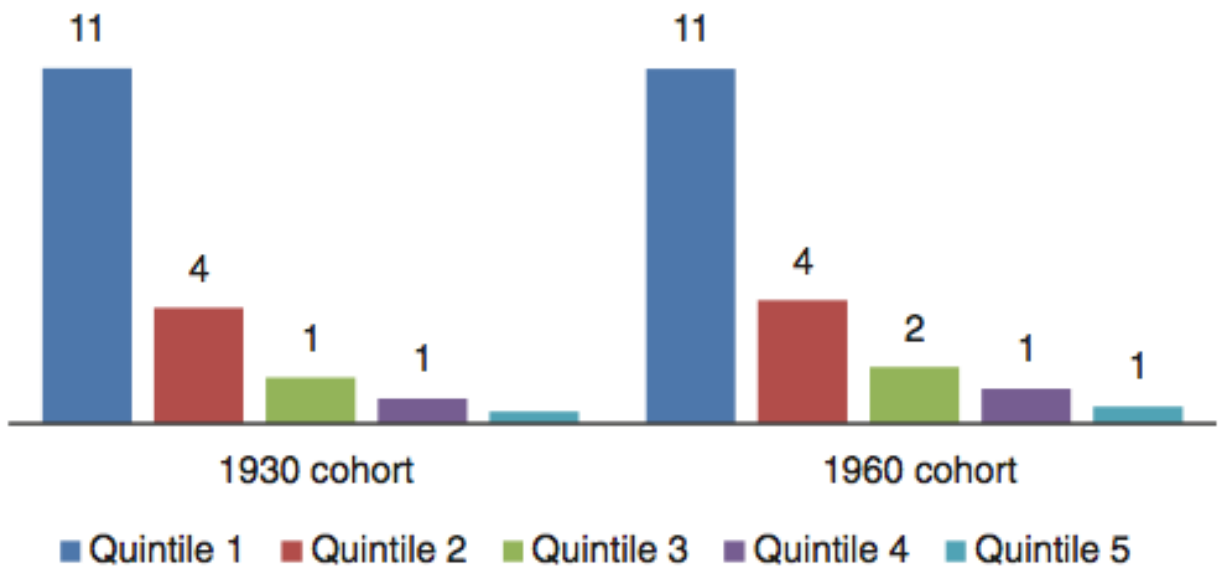


Figure 4: Average lifetime Supplemental Security Income benefits by lifetime income quintile, 1930 vs. 1960 mortality regime (in thousands of dollars)

A. Males



B. Females

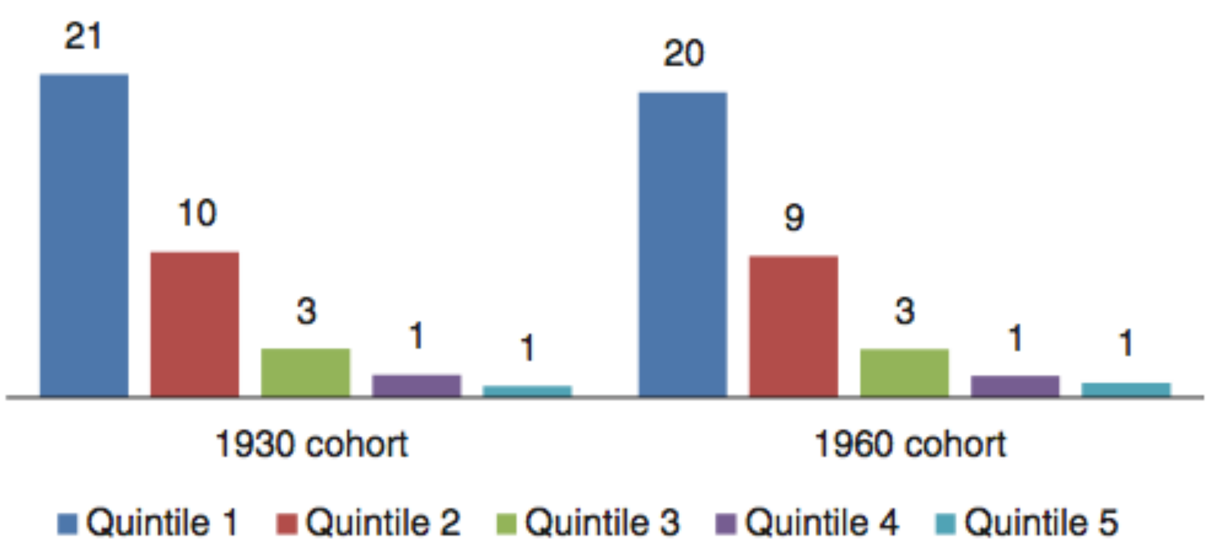
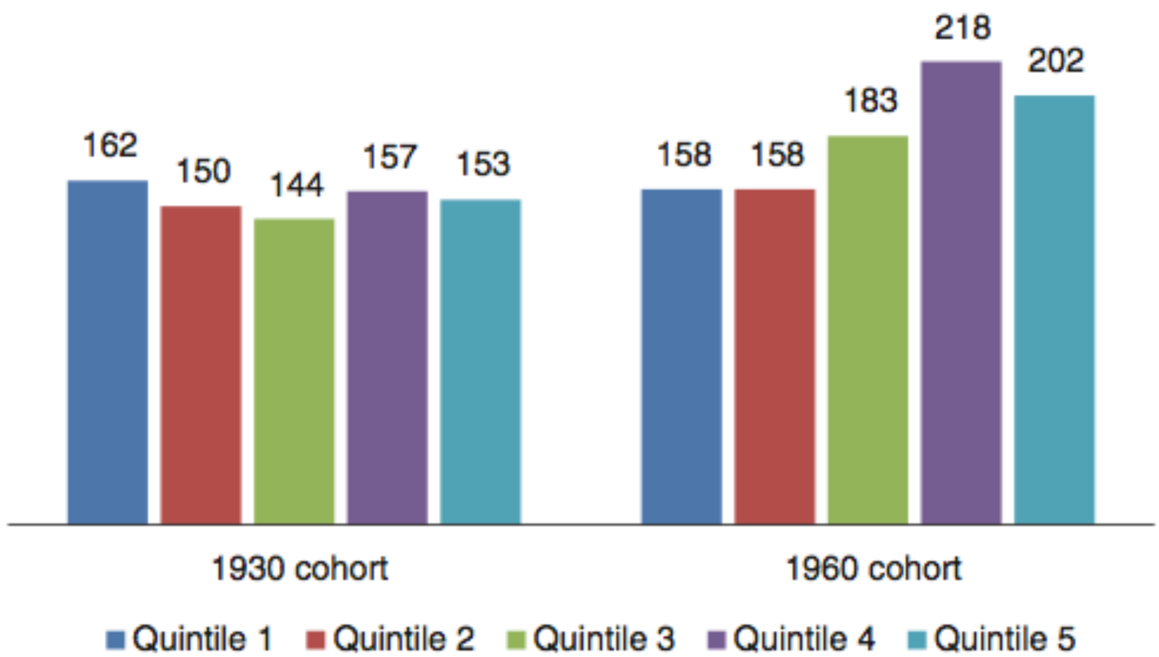


Figure 5: Average lifetime Medicare benefits by lifetime income quintile, 1930 vs. 1960 mortality regime (in thousands of dollars)

A. Males



B. Females

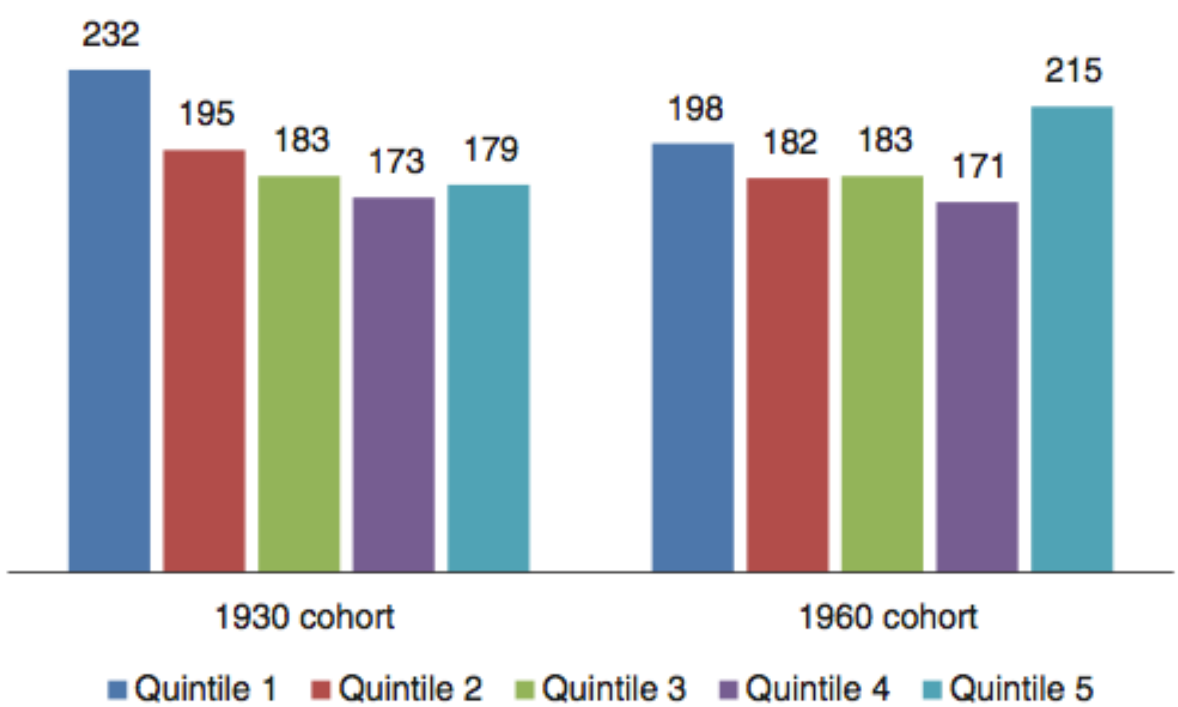
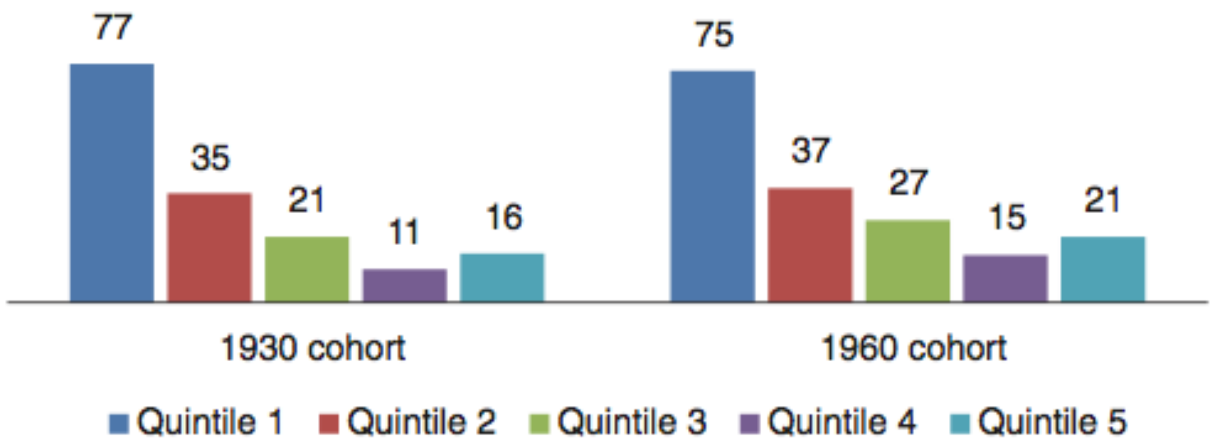


Figure 6: Average lifetime Medicaid benefits by lifetime income quintile, 1930 vs. 1960 mortality regime (in thousands of dollars)

A. Males



B. Females

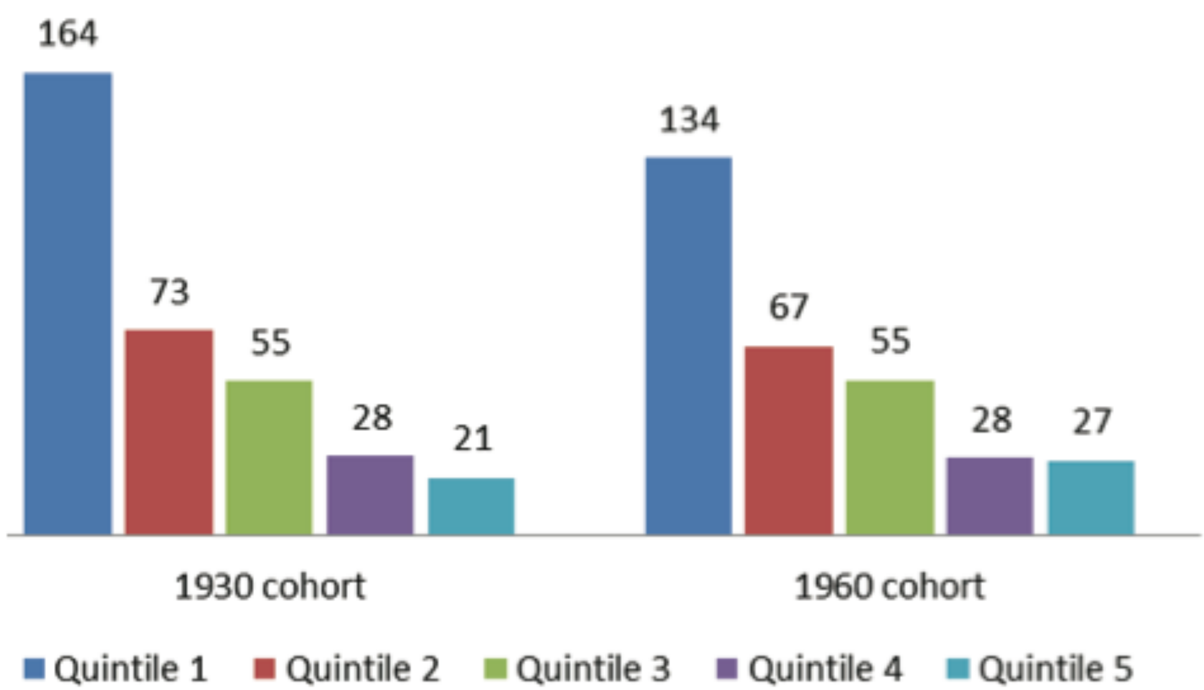


Table 1: Present Value of Entitlement Program Benefits at Age 50, by Sex, for People Under the Mortality Regimes of the 1930 and 1960 Birth Cohorts

	Present value of benefits at age 50 based on the mortality profile for those	
Earnings Quintile	Born in 1930	Born in 1960
Males		
Lowest	$402,000	$391,000
2	347,000	366,000
3	344,000	432,000
4	364,000	499,000
Highest	402,000	522,000
Gap, High-Low	*$0*	*$132,000*
Ratio, High/Low	*1.00*	*1.34*
Females		
Lowest	$539,000	$452,000
2	405,000	373,000
3	394,000	386,000
4	373,000	357,000
Highest	410,000	480,000
Gap, High-Low	*-$129,000*	*$28,000*
Ratio, High/Low	*0.76*	*1.06*

Table 2: Present Value of Net Benefits (benefits received minus taxes paid after age 50) at Age 50, by Sex, for People Under the Mortality Regimes of the 1930 and 1960 Birth Cohorts

	Present value of net benefits at age 50 based on the mortality profile for those	
Earnings Quintile	Born in 1930	Born in 1960
Males		
Lowest	$319,000	$310,000
2	246,000	266,000
3	217,000	301,000
4	202,000	331,000
Highest	189,000	306,000
Gap, High-Low	*–$130,000*	*–$4,000*
Ratio, High/Low	*0.59*	*0.99*
Females		
Lowest	$487,000	$402,000
2	341,000	310,000
3	296,000	290,000
4	251,000	236,000
Highest	240,000	310,000
Gap, High-Low	*–$247,000*	*–$92,000*
Ratio, High/Low	*0.49*	*0.77*

Table 3: Present Value of Net Benefits as a Share of Present Value of Inclusive Wealth at Age 50, by Sex, for People Under the Mortality Regimes of the 1930 and 1960 Birth Cohorts

	Present value of net benefits at age 50, relative to inclusive wealth, based on the mortality profile for those		
Earnings Quintile	Born in 1930 (%)	Born in 1960 (%)	Percentage Point Change
Males			
Lowest	45.7	45.6	–0.1
2	34.9	36.8	1.9
3	26.9	33.3	6.4
4	20.0	28.9	8.8
Highest	14.4	21.4	6.9
Females			
Lowest	69.0	65.4	–3.6
2	56.6	54.8	–1.8
3	45.3	44.9	–0.4
4	34.7	33.5	–1.3
Highest	25.4	30.8	5.4

Table 4: Impact of Policy Reforms on Net Benefits as a Share of Inclusive Wealth at Age 50, by Sex, for People Under the Mortality Regimes of the 1960 Birth Cohorts

Earnings Quintile	Percentage Point Change					
	Raise EEA	Raise NRA	Lower COLA	PIA 10% Rate	PIA 0% Rate from Median	Raise Medicare Age
Males						
Lowest	0.1	-4.8	-0.4	-0.1	-1.1	-1.4
2	0.2	-5.5	-0.5	-0.1	-1.4	-1.1
3	0.5	-5.7	-0.6	-0.1	-2.1	-0.8
4	0.5	-5.5	-0.7	-0.2	-2.7	-0.7
Highest	0.4	-5.2	-0.6	-0.3	-3.4	-0.5
Females						
Lowest	0.2	-3.1	-0.2	0.0	-0.3	-1.5
2	0.3	-4.0	-0.3	0.0	-0.5	-1.5
3	0.6	-4.7	-0.4	-0.1	-0.9	-1.4
4	0.6	-4.9	-0.4	-0.1	-1.1	-1.2
Highest	0.6	-4.9	-0.5	-0.1	-1.3	-0.7