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Rising Mortality and Life Expectancy Differentials by Lifetime Earnings in the United States

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Abstract*

Are mortality and life expectancy differences by socioeconomic groups increasing in the United States? Using a unique data set matching high-quality administrative records with survey data, this study explores trends in these differentials by lifetime earnings for the 1983 to 2003 period. The results indicate a consistent increase in mortality differentials across sex and age groups. The study also finds a substantial increase in life expectancy differentials: the top-to-bottom quintile premium increased around 30 percent for men and almost doubled for women. These results complement recent research to point to almost five decades of increasing differential mortality in the United States.

Keywords: Differential mortality; Life expectancy; Lifetime earnings; Trends
JEL: I12, J11

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1. Introduction

Since the seminal work of Kitagawa and Hauser (1973), a large and growing body of research has emerged focusing on the extent, causes, and trends of differential mortality in the United States. The ensuing research effort has been unique not only in its depth but also in the fact that it encompassed work from researchers from diverse fields such as demography, public health, epidemiology, economics, sociology, and psychology. This cross-disciplinary interest has several distinct causes. First, health inequality may arise due to differences in health behavior or access to health services across groups which can be prevented or attenuated through public intervention (Gepkens and Gunning-Schepers, 1996; Cooper, Hill and Powe, 2002). Second, welfare measures solely based on economic variables such as Gross Domestic Product give an incomplete and potentially biased representation of standards of living (Deaton and Paxson, 1998; Becker, Philipson and Soares, 2005; Steckel, 2008). Third, if education and income have a causal impact on mortality, then education or redistribution policies can have an impact on health (Evans and Snyder, 2002; Lleras-Muney, 2005). Finally, differential mortality has the potential of undoing the progressivity built into the Social Security benefit formula as well as other entitlement programs such as Medicare (Congressional Budget Office, 2006; Bhattacharya and Lakdawalla, 2006).

Several studies (Duleep, 1989; Feldman et al., 1989; Pappas et al. 1993; Preston and Elo, 1995) have provided fairly consistent evidence of increasing differential mortality by education from 1960 to the mid 1980s for men, though results for women are more mixed. The robustness of these results, however, is not as strong as one might first think. Though each of these studies used a different data set to measure the post-1960 socioeconomic status mortality differential, each used as their base point the Kitagawa-Hauser (1973) study. If the Kitagawa-Hauser mortality differential by income were underestimated, all four studies would show a spurious increase in the differential.[1] Unlike these studies, Schalick et al. (2000) computed death rates for 1967 and 1986 using data from the National Mortality Followback Survey and the National Health Interview Survey and provided evidence of increasing differential mortality by income groups for individuals aged 35 to 64 years old.[2]

[1] In the Kitagawa-Hauser (1973) study, 1960 Census records where matched to death certificates. The estimated differentials in mortality may be biased due to a substantial rate of nonmatches (more than 20 percent in each race-sex group), and the possibility that the matching rate was different across socioeconomic characteristics.

[2] Nevertheless, there are problems in classifying individuals by one-year income groups, as will be discussed below.

Two recent studies have documented a significant increase in differential mortality across education groups. Meara et al. (2008), using data from the National Longitudinal Mortality Study that spans 1981 to 1988 and 1991 to 1998, as well as census population estimates matched to death certificated data for years 1990 and 2000, found that with the exception of black males, all recent gains in life expectancy at age 25 have favored individuals with some college or more education, raising educational differentials by 30 percent. Similarly, Hadden and Rockswold (2008), matching U.S. Vital Statistics and population estimates for individuals ages 25 to 64 in 2000, found significant increases in relative and absolute indices of mortality inequality by education groups compared to estimates from 1986, especially for men and white individuals.

Given the significance of these results, it is important to determine the robustness of these results when using other socioeconomic markers and data sources, especially taking into account that an important part of the recent evidence on rising differential mortality by education groups has been obtained by using education data from death certificates which has been shown to have significant measurement errors (Sorlie and Johnson, 1996). Moreover, data on education used to construct the denominators in mortality rates is also reported and it has been shown to suffer from significant reporting errors (Black, Sanders and Taylor, 2003). Hence, changing patterns in reporting errors could generate at least part of the findings from these studies.

This paper explores trends in differential mortality during the period 1983 to 2003 for the 35 to 75 population classifying individuals by measures of lifetime earnings. As described in more detail below, the study uses reliable administrative records matched to survey data, hence it can provide more definitive evidence regarding the rise on health inequality in terms of mortality during the last two decades. Results from the study are particular valuable as they complement a recent study by Waldron (2007) who used data from Social Security records and found evidence of a marked increase in differential mortality by lifetime earnings for the 60 and older male Social Security-covered population in the 1972 to 2001 period.

There are two additional reasons why it is useful to check trends in differential mortality by lifetime earnings instead of education groups (besides measurement problems of the education variable). First, during the period under analysis, 1983 to 2003, there has been a significant increase in income inequality (Gottschalk and Danziger, 2005); hence it is interesting to know whether this increase in economic inequality has been accompanied by an increase in health inequality using the same underlying variable to classify individuals. Second, results from this paper can be used as an input in studies of progressivity of public programs such as Social Security and Medicare, which typically classify individuals by lifetime earnings.

Moreover, unlike Waldron (2007), Meara et al. (2008) and Hadden and Rockswald (2008), which investigated in general whether higher earners or the better educated enjoyed larger advantages in mortality reductions, this study goes a step further and explores increases in life expectancies by individuals in different *quintiles* of the lifetime earnings distribution. This refinement is particularly important in light of the fact that the rise in income inequality in recent decades in the United States has been mainly attributed to relative gains by those individuals at the very high end of the income distribution rather than by other shifts in the income distribution.

The study uses a unique data set constructed by matching extensive demographics data from the 1984, 1993, 1996 and 2001 panels of the Survey of Income and Program Participation (SIPP) to earnings, benefits and mortality data from the Social Security Administration (SSA) and earnings data from the Internal Revenue Services (IRS). The earnings data are particularly rich, as they contain the history of Social Security-covered earnings as well as information for this variable from tax income returns from the Internal Revenue Services (IRS) for the period 1978 to 2003.[3] The resulting sample contains roughly 130,000 individuals aged 35 to 75, for which the mortality window ranges from 3 to 21 years, yielding a total of approximately 1.2 million person-year observations. The uniqueness of this data set lies in its sample size, representativeness, time period covered, and comparability across time, and in the fact that it includes high-quality longitudinal individual-level earnings data.

As in this study, Waldron (2007) used Social Security data and hence shared some of these advantages (sample sizes, comparability across time, and time period covered). However, that study had limited demographic information (no survey data) and only capped Social Security earnings for covered jobs (no IRS data). Furthermore, while Waldron (2007) used Tobit regressions to impute earnings above the Social Security taxable maximum, the current study used additional information in the data set to infer in which quarter the individual reached the taxable maximum for years before 1978. Using the quarters of coverage information to estimate

[3] Earnings data from IRS, as opposed to Social Security sources, is uncapped and includes earnings from both Social Security covered and uncovered jobs.

earnings above the taxable maximum is preferable to using other methods, based on strong assumptions, such as Tobit, for estimating above the taxable maximum.[4]

Typically studies of trends in differential mortality have classified individuals by education (Duleep, 1989; Feldman et al., 1989; Pappas et al. 1993; Preston and Elo, 1995) or current income groups (Schalick et al., 2000). There are two problems associated with measuring differences in mortality rates in a given year across groups defined by income in the previous year. First, this strategy suffers from reverse causality: individuals who experience health shocks (which increase their mortality probability) may drop out of the labor market and simultaneously suffer a drop in income. As a result, this approach will overstate the true correlation between permanent income and mortality. Second, yearly income is a noisy measure of permanent income. Taking into account only this effect, we should expect that estimates of differential mortality by income in a specific year will underestimate the extent of differential mortality by permanent income.

This paper aims to tackle these two problems by classifying individuals using average lagged earnings and excluding from the average computation years immediately preceding when mortality is ascertained. In this way, the problem of reverse causation is at least partially addressed by distancing the measurement of earnings from the measurement of mortality. The problem of attenuation bias due to noisy yearly data is tackled by computing long averages of yearly earnings.[5] More specifically, lifetime earnings measures are constructed using long averages of past earnings. For individuals older than 53, earnings from age 41 to 50 are used to capture years when the person was most closely attached to the labor market. For younger individuals, averages ranging from 5 to 10 years were computed without including the immediately preceding three years (e.g., for individuals aged 43, earnings from age 31 to 40 are used).

As an initial step, the paper first estimates the *extent* of differential mortality by race, ethnicity, education, marital status, disability status, and particularly by lifetime earnings quintiles, using data for the whole period. Regarding the results by lifetime earnings, it

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[4] This procedure was first used by Duleep (1986).

[5] The idea of distancing the measurement of earnings from the measurement of mortality to tackle the problem of reverse causality was first introduced by Duleep (1980), who used the longitudinal Social Security earnings data to explore how the income-mortality relationship is affected as progressively earlier measures of earnings are related to mortality. Duleep (1986) also explored the effect on the income-mortality relationship of using several years of earnings as opposed to a single year

contributes to a small but growing literature. Duleep (1986) matched Social Security earnings data to mortality records to predict the death probability in a five-year window (1973 to 1978) using a five-year average of earnings (1968 to 1972). Menchik (1993) used the National Longitudinal Survey of Mature Men and constructed a measured of average earnings up to age 61 to use as a control while probing for the effect of poverty on mortality. McDonough et al. (1997) employed data from the Panel Study of Income Dynamics to construct ten-year panels in which income is averaged over the first five years and mortality status is ascertained over the subsequent five years. More recently, studies by Waldron (2007) and Duggan, Gillingham and Greenlees (2007) have used large samples from Social Security Administration (SSA) records to provide very precise estimates of mortality differentials by lifetime earnings.

The findings in the current study regarding the extent of differential mortality by lifetime earnings can be summarized as follows. First, there are large differentials in age-adjusted mortality rates across individuals in different quintiles of the individual lifetime earnings distribution (e.g., men ages 35 to 49 in the bottom quintile have age-adjusted mortality rates 6.4 times larger than those in the top quintile). Second, controlling for race, Hispanic origin, marital status, and education only slightly reduces these differentials. Third, differentials for men are slightly larger for individual compared with household lifetime earnings, but the opposite is true for women.[6] Fourth, men and women have similar differentials when average household lifetime earnings are used to sort individuals into quintiles. Finally, differentials decrease markedly with age.

With respect to trends in differential mortality by lifetime earnings, there is substantive evidence pointing toward an increase in differential mortality in the period 1983 to 2003. For example, in the period 1983 to 1997, men ages 35 to 49 in the bottom lifetime earnings quintile had mortality 5.9 (1.8 for women) times higher than those in the top quintile; in the period 1998 to 2003 this ratio increased to 8.3 (4.8 for women). This increase in differential mortality is also found for all other age-sex groups, when sorting individuals by household earnings and even when using alternative measures of lifetime earnings.

Results regarding changes in life expectancy between 35 and 76 years during the period under analysis show consistent and strikingly clear evidence that the gradient between life

[6] "Household lifetime earnings" refers to the average lifetime earnings of the individual and his or her spouse (if he or she is or was married).

expectancy and lifetime earnings has become steeper for both men and women. In the case of men, estimated increases in life expectancy are monotonically increasing across lifetime earnings quintiles. While life expectancy for men in the bottom quintile seem to have not changed, estimated increases for those in the second to top quintile are estimated as: 0.4, 0.6, 0.7 and 0.8 years, respectively. For women, the same general pattern emerges of widening life expectancy differentials across lifetime earnings quintiles. However, women in the lower two quintiles have suffered decreases in life expectancy (0.3 and 0.1 years for the bottom and second quintile), whereas it has remained unchanged for the middle quintile and increased for the top two quintiles (0.1 and 0.4 years for the fourth and top quintiles).

It is worth noting that in the data set used, the quality of the earnings information increased over time; this increase in quality of information could bias the results toward finding increasing differential mortality. The increase in data quality is due to the fact that, for the period 1951 to 1977, only Social Security earnings are available.[7]

Taking these concerns into account, several robustness checks were performed to explore whether the uncovered pattern expresses a true phenomenon rather than a data artifact. First, as a way to tackle the problem of using years of non-covered employment trends in differential mortality were computed dropping from the calculation of the lifetime earnings measure years with zero earnings. Second, the analysis was repeated using a two-year average of earnings in ages *A*-3 and *A*-4 (where *A* is the person's age) in order to use earnings only from IRS sources. In both cases, the same patterns of increasing differential mortality were observed, giving support to the view of a real increase in mortality differentials across lifetime earnings groups in the last 20 years.

2. Data and Sample Construction[8]

This study uses data from the 1984, 1993, 1996, and 2001 panels of the Survey of Income and Program Participation (SIPP), matched to several files administered by the Social Security Administration (SSA) containing information on earnings, disability, and mortality. The SIPP

[7] The coverage of Social Security increased markedly in the early 1950s but it slowed significantly starting in 1957; at that point about 80 percent of the total earnings in the economy were in jobs covered by Social Security (Committee on Ways and Means, *2004 Green Book*). For this reason, this paper uses earnings only for the period 1957 to 2003.
[8] An Appendix containing more detailed information on the data used as well as the methods to construct the sample is available from the author upon request.

provides information for a representative sample of the U.S. non-institutional population, with data on cash and noncash income, taxes, assets, liabilities, demographics, labor force status, and participation in government transfer programs.[9] Information from SSA files include information on the following areas: yearly Social Security taxable earnings for the period 1951 to 2003 (including a variable which can be used to proxy in which quarter the individual reached the taxable maximum), federal income taxable earnings fro the period 1978 to 2003, Social Security benefits, and month and year of death.

To create the sample for this study (the Mortality sample), I construct a panel data set in which the unit of observation is a person-year, containing basic demographic and economic variables from the SIPP. For time-varying variables (education, marital status, and spouse links), monthly information from the SIPP is used to construct yearly observations. Observations in which the person was 24 years of age or younger are dropped. Second, information on Social Security annual earnings from 1951 to 2003, federal income taxable earnings from 1978 to 2003, disability status, and year of death is attached to the sample. Third, the resulting intermediate data set is "aged" forward, completing years outside the SIPP window with information from the last year of available SIPP data up to the year 2003 (or up to the year of death if earlier).[10] Last, only observations for individuals ages 35 to 75, born in 1909 or later, are kept.[11] The resulting data set is a panel data where the unit of observation is a person-year. It includes yearly observations for individuals from the year they first entered the SIPP until 2003 (or until their death year, if they died before 2003).[12]

To construct the measures of lifetime earnings used in the study the following steps are taken. First, total annual earnings for the years 1957 to 2003 are obtained. Second, measures of lifetime earnings are constructed using five- to 10-year averages of past indexed earnings. Last, quintiles of lifetime earnings within sex, five-year age, and five-year cohort groups are computed. Each of these steps is described next.

[9] For more details on the SIPP, see www.bls.census.gov/sipp/index.html.

[10] That is, for an individual with SIPP data in 1984, 1985, and 1986, additional yearly observations for 1987 onward are created using the variable values from 1986.

[11] Individuals younger than 35 are dropped because it is necessary to observe their earnings at ages while they were potentially attached to the labor market to construct the measures of lifetime earnings. Those born before 1908 are dropped because there is no earnings data for ages 48 and younger for them. Finally, given the cohort restriction imposed in the sample, individuals older than 75 are eliminated from the sample to ensure that the sample contains individuals in the same age range across time.

[12] Sample statistics are presented in Subsection 2.3.

For the period 1957 to 1977, Social Security taxable earnings from the SER are used. For individuals with capped earnings, a procedure was followed to impute earnings above the taxable maximum using information on the quarter in which the individual reached the taxable maximum. For years 1980 to 2003, annual earnings were computed using earnings data from federal income tax sources (IRS). For the years 1978 and 1979, due to the presumably low quality of the IRS data, the total earnings variable was set for individuals with capped earnings as the weighted average between total earnings in 1977 and 1980.[13] All earnings were indexed using the Personal Consumption Expenditure deflator.

When constructing this measure, the goal was to approximate the permanent earnings level of the individual while he or she had the closest attachment to the labor market. Also, in order to mitigate the problem of reverse causality, the measure does not include earnings received in the three years preceding when mortality was ascertained. Hence, for individuals ages 53 and older, the permanent earnings measure was constructed as the 10-year average earnings from ages 41 to 50. For younger individuals of age *A*, the measure is constructed by averaging earnings between age *A*-3 and the maximum of 28 and *A*-12. For example, for an individual age 35, earnings between ages 28 and 32 will be used; for a 45-year-old person, the measure averages earnings between ages 33 and 42.

Finally, to avoid interactions between earnings levels and sex, age and cohort, I sort all individuals alive in a year into quintiles of the lifetime earnings distribution computed *within* sex, five-year age and five-year cohort groups. Thus, results in the study show differences in mortality rates by lifetime earnings when individuals are compared with others of the same sex and similar age and year of birth.

The Mortality sample constructed for this study constitutes a unique data set for exploring the relationship between lifetime earnings and mortality. However, the way that it was constructed (pooling SIPP panels, matching them to SSA records and filling years forward) may raise doubts about the representativeness of the sample. The question is whether the results are representative of a certain period of time (the period of time when mortality was ascertained). Because individuals in the Mortality data set enter the sample when they first are interviewed in

[13] Low quality of the IRS data in 1978 and 1979 stems from problems in the implementation of the new earnings collection process.

the SIPP and remain in the sample until the year 2003 (or date of death), the sample contains observations for the years 1983 to 2003, but its composition is tilted toward later years.

To tackle this problem, and to make the sample representative for the period 1983 to 2003, population counts by age, sex, race, Hispanic origin, and year were obtained from U.S. Census intercensal estimates.[14] The same age restriction used for constructing the Mortality sample was applied to the Census data (only individuals ages 35 to 75 were kept). Next, weights were constructed to match to the Census data and the distribution of observations in the Mortality sample by sex, five-year age, race, Hispanic origin, and five-calendar-year groups. Table 1 shows that the age, sex, and race distributions in the unweighted Mortality sample are similar to the Census counterparts. However, the distributions by year are quite different. Finally, comparing Columns 3 and 4, we see that when the Mortality sample is reweighted, the distributions by age, sex, race, Hispanic origin, and year closely match the distributions in the Census data. Therefore, the constructed weights are used for all results presented in the remainder of the paper.[15]

3. The Extent of Differential Mortality by Lifetime Earnings

This section presents estimates of the extent of differential mortality by lifetime earnings. In the first subsection, mortality ratios are reported for groups defined by race, Hispanic origin, education, marital status, disability status, and lifetime earnings quintiles. The ratios, computed separately by sex, present relative mortality rates between each group and the whole population after the rates have been adjusted for differences in the age distribution. The second subsection focuses on differences in mortality rates by lifetime earnings, using logistic regressions to adjust for different sets of covariates. The final subsection presents robustness checks of the main findings in this section.

3.1. Mortality Ratios

The mortality ratio for a certain subpopulation in certain age group (e.g., black men ages 35 to 49) is computed in the following way:

[14] The Census estimated counts were obtained at http://www.census.gov/popest/estimates.php.

[15] Additionally, the distribution by other covariates of the Mortality sample is quite similar to the SIPP distribution for different years across the 1983 to 2003 period. Also, to gauge the quality of the mortality data, death rates by age and sex were compared to those from the Human Mortality Database and found to be very similar.

$$Mortality\ Ratio_{BLACK\ MEN} = \frac{\sum_{a=35,\ldots,49} weight_a * mortality\ rates\ of\ black\ men_a}{\sum_{a=35,\ldots,49} weight_a * mortality\ rates\ of\ all\ men_a}$$

where *mortality rates of black men* $_a$ is the one-year age-specific mortality rate for black men age a, *mortality rates of all men*$_a$ is the one-year age-specific mortality rate for all men age a and *weight*$_a$ corresponds to the fraction of men age a from all men in this age group in the sample.

The numerator is the age-adjusted one-year mortality rate for black men and the denominator is the average mortality rate for all men in the sample. Hence, a ratio of one for a certain group indicates that, once we adjust for differences in the age distribution, the group has the same mortality rate as all individuals in that age-sex group. A ratio higher than 1 (e.g., 1.5) means that the group has a higher age-adjusted mortality rate than all individuals of the same sex in the sample (50 percent higher).

Table 2 presents mortality ratios for men by age groups. Ratios by race, Hispanic origin, education, marital status, and Social Security Disability Insurance (DI) status replicate the general patterns documented in previous studies on differential mortality. Focusing on individuals of ages 35 to 75, we see that blacks have a 48 percent higher age-adjusted mortality rate (compared with all men), Hispanics a 6 percent lower rate, and college graduates a 38 percent lower mortality rate.[16] Being never married, separated/divorced, or widowed is associated with a 51 percent to 57 percent higher mortality rate, and individuals who have ever received DI have a 270 percent greater mortality risk.[17] Examining Columns 3 to 5 of Table 2, we see evidence of the well-documented pattern of mortality differentials decreasing with age (though more slowly for differentials by education).

The bottom panel of Table 2 presents mortality ratios by lifetime earnings quintiles computed within sex, five-year age, and five-year cohort groups. For quintiles computed by individual or household lifetime earnings we observe similar patterns, although the gradient is slightly stronger when using individual lifetime earnings. Overall, there is a strong relationship between these measures of lifetime earnings and mortality. Individuals ages 35 to 49 in the bottom lifetime earnings quintile have a 125 percent higher mortality rate, while those in the top

[16] In this subsection, for brevity, mortality rates refer to age-adjusted mortality rates.
[17] Mortality ratios for individuals currently on DI are not computed for age groups 35 to 75 and 65 to 75 because individuals on DI have their status updated to Social Security retirees when they turn 65.

quintile have a 65 percent lower rate. The decrease in mortality differentials by age group is very strong. The ratio of age-adjusted mortality rates of bottom to top lifetime earnings quintiles for men ages 35 to 49 is 6.4 (2.25/0.35), dropping to 2.7 for men ages 50 to 64 and to only 1.5 for men ages 65 to 75.[18]

Table 3 presents mortality ratios for women. Overall, the patterns of differential mortality by race, Hispanic origin, education, marital, and DI status found for men are also present for women except for certain differences. First, Hispanic women have adjusted mortality rates that are generally closer to those of all women compared to mortality differences between Hispanic men and all men. Second, mortality rate differences for all women across marital status are less pronounced than those for men, especially for women ages 65 to 75. Third, the mortality "penalty" for being on DI or having ever been on this program is higher than for men, but the patterns are still similar.

To compare estimates of differential mortality by lifetime earnings between men and women, we can focus on the bottom panels of Tables 3 and 4. Although the gradient is steeper for men than for women when using individual lifetime earnings, it is strikingly similar when using household lifetime earnings.[19] The former result should be expected, given men's greater attachment to the labor market (which suggests that men are relatively better "sorted" when individual lifetime earnings are used). However, the latter result is an interesting finding that deserves further exploration in future work.

3.2. Logistic Results

In this subsection, a discrete-time logistic model is run to estimate differences in mortality risks across individuals in different lifetime earnings quintiles under different specifications regarding controls included. The model used is a particular type of a survival model which allows estimating the impact of time-varying covariates. In this setting, the probability of death in the following year is modeled as:

$$\Pr ob(Death = 1) = \frac{e^{X'\beta}}{1 + e^{X'\beta}}$$

[18] Still, given that overall death rates increase very rapidly with age, decreasing relative mortality rates with age can be accompanied by increases in the differences in absolute mortality rates.

[19] For example, the ratio of age-adjusted mortality rates for the bottom to top quintiles of individual lifetime earnings is just 2.4 for women ages 35 to 49 compared with 6.4 for men in that age group. The analogous ratios using household earnings are 4.0 and 5.2 for women and men, respectively.

In the logistic regressions the dependent variable is an indicator that equals 1 if the individual died in the next year, and the key independent variable is the quintile of individual lifetime earnings to which the individual is assigned. Odds ratios are estimated relative to individuals in the bottom quintile.

Other discrete-time models that allow time-varying covariates, such as the Cox proportional hazard model, could have been estimated. However, as noted in Waldron (2007), given the structure of the data it is expected that the results are going to be very similar to those estimated from the Cox (1972) model. This expectation stems from the fact that mortality is measured at the year level, where there are a large number of ties in the data (i.e., two or more events showing in the data as happening at the same point in time). Allison (1995) showed that the discrete-time logistic model is equivalent to the discrete-time proportional odds model proposed by Cox (1972) when there are many ties in the data. Additionally, the fact that the data set includes multiple observations (years) for an individual does not make it necessary to apply some type of clustering adjustment. The independence of observations still holds because, when the likelihood function is factored, each term can be treated as independent (Allison, 1995).[20]

As expected, given that lifetime earnings quintiles are computed within sex, five-year age and five-year cohort groups, results from running models with no covariates are very similar to those when age and cohort are added linearly or as single-year dummies as controls. Given this, Figure 1 presents odds ratios from specifications with just three sets of controls: a) age and cohort, b) age, cohort, race, and marital status, c) age, cohort, race, marital status, and education. Results with age, cohort, and race are not presented because they are very similar to those when only age and cohort are added as controls.

All the patterns are robust when race, marital status, and education controls are added. Figure 1 shows that for men the degree of differential mortality by lifetime earnings slightly decreases when we control for these factors, but for women it slightly increases (when adding only race and marital status) or remains virtually unchanged (when adding all the mentioned controls).[21]

[20] This condition would be violated if one individual could have more than one event; still, this is not the case in this analysis because the event under consideration is death.
[21] Complete regression results are available from the author upon request.

It is difficult to compare these results to those from previous studies that used cross-section income measures instead of multi-year averages, because of differences in income concept used (earnings from employment versus income from all sources, individual earnings versus household earnings, and earnings in categories of levels versus quintiles), age groupings, and time periods used. However, it is interesting to note that although in this study mortality differentials are only slightly affected when adjusting for other covariates, in the study by Sorlie, Backlund and Keller (1995), which used income in a year data from the Current Population survey matched to National Death Index records, differentials were significantly reduced when adjusting for covariates. For example, for men ages 45 to 64, the mortality ratio between those in the top and bottom income groups (more than $50,000 and less than $5,000, respectively) was 0.32 when no covariates were used and 0.66 when a number of covariates were added to the model.[22]

Finally, I explore the robustness of the findings to the way the lifetime earnings measure is constructed. In particular, results obtained using two alternative measures are presented. In the first alternative, only years with positive earnings are included in the computation of the average to check whether years with zero earnings due to data problems (between 1957 to 1977 earnings from jobs not covered by Social Security are not included) or to temporary withdrawals from the labor market affect the results. In the second alternative, zero earnings years are included, but the six years prior to when mortality is ascertained are excluded to better handle the problem of reverse causation.[23] In general, the results are quite robust to these alternative measures of lifetime earnings.[24]

4. Trends in Differential Mortality by Lifetime Earnings

4.1. Main Results

This section presents evidence about changes in differential mortality by lifetime earnings for the period 1983 to 2003. For each of the six age-sex groups used in the study, observations are divided into two groups defined by time period: 1983 to 1997 (Early sample) and 1998 to 2003 (Late sample). The cut-off year selected creates two samples of roughly the same size .

[22] Still, the set of covariates added was not identical in both studies; in particular, employment status was added as a covariate in Sorlie, Backlund and Keller (1995) but not in the current study.
[23] For example, for an individual age 40, earnings between ages 28 and 34 are used (for a 50-year old, ages 38 to 44 are averaged).
[24] Full results are available from the author upon request.

Figure 2 presents logistic estimates of the one-year probability of dying by individual lifetime earnings quintiles for the Early sample (solid line) and the Late sample (dotted line). The graphs present substantive and consistent evidence of increasing differential mortality for all age-sex groups. For a better sense of the changes in magnitude, Table 4 presents estimates of the mortality odds ratios of the top quintile relative to the bottom for the six age-sex groups. A decrease in these ratios suggests that mortality rates for the top quintile have decreased faster than the bottom quintile, widening the mortality inequality across these groups. The top panel presents results when observations are sorted using individual earnings and the bottom panel when household earnings are used as the classifier.

For men, the drop in the top-to-bottom ratio is highest for those in the 50 to 64 age group, which decreases from 0.47 to 0.21 (a 56 percent reduction). Though the estimates for the other two age groups are not statistically significantly different across time periods, still the magnitude of the drop in this ratio is substantial (29 percent for individuals aged 35 to 49 and 12 percent for those aged 65 to 75).[25] For women, the drop in the ratio is statistically significant and substantial for those younger than 65. The drop for women in the 35 to 49 age group is 62 percent whereas for those aged 50 to 64 it is 43 percent. Results when using household lifetime earnings as the classifier, presented in the bottom panel, also point towards increases in differential mortality across the board. Taken together, these estimates provide evidence of a substantial increase in mortality inequality across sex and age groups for the time period analyzed.

The evidence of widening mortality when individuals are sorted into quintiles of the lifetime earnings distribution may reflect an increase in the dispersion of the distribution of lifetime earnings (with a constant relationship between earnings and mortality) or, alternatively, an increase in the slope of the earnings-mortality gradient. To shed some light on this issue, Table 5 presents average lifetime earnings by age group, sex, and quintiles for the Early and Late samples. The table shows that, although the distribution of lifetime earnings for women has become more dispersed, the distribution for men has remained quite stable for those ages 35 to 64 (though top earners have gained in this period) and has widened for those ages 65 to 75. Given that differentials have increased for all age-sex groups and that the increase has not been

[25] A more dramatic way to illustrate the increase in the differential for men aged 35 to 49 is to pose the changes in terms of the increase in the mortality ratio of bottom to top quintiles: from 5.8 to an astounding 8.3.

limited to the mortality ratios of the top to bottom quintiles, it seems that the earnings-mortality gradient is indeed becoming steeper.

4.2. Robustness Checks

This subsection presents several robustness checks to gauge the reliability of the evidence found on increasing differential mortality in the last 20 years. The basic motivation for this exercise stems from the fact that the quality of the earnings data is increasing over time and, as noted before, this can create an artificial increase in the correlation between earnings and mortality.

The results of the robustness checks are presented in Table 6. The top panel of this table presents odds mortality ratios of the top quintile relative to the bottom by age group, time period and alternative average lagged earnings measures. The first line replicates results from Table 4 (i.e., results obtained using the basic measure of individual lifetime earnings). The second line presents results when including only positive earnings years; the third line shows ratios when at least the six years prior to the mortality window are excluded. The fourth line presents results when averaging the third and fourth year before when mortality is ascertained (e.g., for a person age 50, earnings for ages 46 and 47 are averaged). The advantage of this last measure is that it uses only earnings data from IRS sources (uncapped and including noncovered Social Security jobs).

Comparing columns 2 to 3, 4 to 5 and 6 to 7, we see that for all earnings measures there is evidence of increasing differential mortality (that is, the ratio of the top to bottom quintile mortality is decreasing over time). Similarly, the bottom panel of Table 6 shows that the evidence of increasing differential mortality by lifetime earnings is also robust across alternative measures of lifetime earnings for women.

5. Trends in Life Expectancy by Lifetime Earnings

The previous section documents a significant and consistent increase in the relative mortality of the bottom to top lifetime earnings quintile across sex and age groups during the period under study. Though in principle this finding can be interpreted as evidence of widening inequality in terms of health, it is important to first explore how life expectancies across lifetime groups have evolved during the period. An increase in relative bottom-to-top mortality can take place with a larger decrease in mortality rates in the bottom lifetime earnings quintile group compared to the top group.[26] Hence, this section presents evidence on trends in life expectancy by lifetime earnings quintiles groups.

Discrete-time logistic hazard models are estimated to predict one-year mortality rates by single year of age, quintile and time period. As in the previous section, time periods are defined as Early (1983 to 1997) and Late (1998-2003). Separate regressions are run by sex, time period and age groups (35 to 49, 50 to 64 and 65 to 75). The explanatory variables included in the regressions are dummies for own lifetime earnings quintiles and a linear term for age.

Standard methods to compute life expectancies from mortality rates are not suitable in this case because, as individuals age, they can move from one lifetime earnings group to another. To tackle this issue, a recursive method of computing life expectancies similar to the one used to compute value functions in dynamic programming problems is used. A necessary input for this procedure is the use of one-year transition probabilities across quintiles, which are computed as the fraction of cases that individuals in quintile *x* in a certain year end up in quintile *y* in the next year (among those that survive to the next year). These 5x5 transition matrices are computed by sex, age groups and time periods.[27] Given the way that lifetime earnings measures are computed with long averages and fixed after age 53, the matrices show very high persistence and close to full persistence for older age groups.

Because in the study mortality rates are computed for individuals aged 35 to 75, life expectancies are computed only up to age 76. The following procedure is used, separately for sex and time period, to compute life expectancies by age and lifetime earnings quintiles. The first step is to compute life expectancy for each quintile group at age 75. As we are computing life expectancy up to age 76, we can compute it simply as:[28]

$$V(75,x) = p(a,x)*0.5 + [1 - p(a,x)]*1$$

where $V(a,x)$ is the life expectancy up to age 76 of individuals aged a and classified in the lifetime earnings quintile x and $p(a,x)$ is the predicted mortality of individuals aged a in lifetime earnings quintile x. The next step is to compute life expectancy at earlier ages up to age 35. To

[26] For example, if mortality for the bottom quintile falls from 1 percent to 0.5 percent and mortality for the top quintile from 0.5 percent to 0.2 percent, then results will show an increase in relative bottom-to-top mortality even though the bottom group enjoyed a larger absolute decrease in this rate and potentially a larger gain in life expectancy.

[27] Estimated transition matrices as well as results from estimated regressions for this section as available from the author upon request.

[28] We assume that individuals that died during the period live, on average, half of the year.

do so, we solve recursively the following equation starting at age 74 and going backwards up to age 35,

$$V(a,x) = p(a,x)*0.5 + [1 - p(a,x)]*\left[1 + \sum_{y=1}^{5} t(x,y)*V(a+1,y)\right]$$

where *t(x,y)* is the probability that an individual in quintile *x* who survives to the next year is assigned to quintile *y*. The equation shows that life expectancy at each age, for an individual in a certain quintile, can be computed taking into account that if he dies that year he will live, on average 0.5 years, and if he survives to the next year he will live one extra full year plus the weighted average of the life expectancy for individuals one year older in different quintiles where the weights correspond to the probability that he end up in each quintile. As mentioned, this procedure is separately executed for each sex and time period.

Figure 3 presents the estimated life expectancies between ages 35 and 76 by period (Early versus Late) and lifetime earnings quintiles. To interpret the results, note that if mortality rates were 0 for all quintiles in a period, life expectancy would have been 41 years. The figure shows very clearly that the life expectancy to lifetime earnings gradient has rotated, pivoting in the estimated life expectancy for the bottom quintile group and becoming significantly steeper. That is, while the bottom quintile has not experienced any gain in life expectancy, those in higher quintiles have enjoyed gains and these gains have been monotonically larger for those in higher quintiles. The magnitude of the changes has been substantial; for example, the top-to-bottom life expectancy differential has increased by close to 30 percent, from 2.7 to 3.6. Moreover, note that these estimates corresponding to average life expectancy for the Early and Late periods. Hence, assuming a linear trend over time, they can be interpreted as increases that occur in only 10 years, between 1990 and 2000.

In the case of women (Figure 4), it is also apparent that the gradient has become steeper. However, as on average the life expectancy between ages 35 to 76 years for women has been quite modest (close to 0.1 years), the gradient has rotated, pivoting in the middle quintile. That is, women in the bottom two quintiles have experienced decreases in life expectancy while those in the top two have enjoyed gains. Again, the changes are perfectly ordered across lifetime earnings by quintile groups. In terms of magnitude, the top-to-bottom differential has also increased markedly, doubling from 0.7 to 1.5 years.

6. Conclusions

This paper estimates the extent and trends of mortality and life expectancy differentials by lifetime earnings for individuals ages 35 to 75 using a large panel data set containing information on mortality, earnings history, and demographic and economic characteristics. Measures of lifetime earnings are constructed to deal with the problems of reverse causality and noise in yearly earnings data present in estimates of differential mortality by previous year income. The results can be summarized as follows. First, a strong negative relationship is found between one-year mortality and lifetime earnings, robust when controlling for usual covariates, weaker for women than for men, and decreasing with age. Second, results indicate a substantial increase in differential mortality by lifetime earnings across sex and age groups in the period 1983 to 2003. Third, the evidence also points to a significant increase in life expectancy differentials by lifetime earnings quintile groups for both men and women.

When interpreting these results it is important to note the following caveat. Given the post-1964 expansion of transfer programs, a reasonable supposition is that such programs siphoned off from the labor force chronically ill persons with a higher than average probability of death. Such a phenomenon would increase the inverse relationship between earnings and mortality. Still, during the period under analysis, the prevalence of individuals on the Social Security Disability Insurance (DI) program did not increase dramatically (from 1980 to 2000, it increased from 2.1 percent to 3.0 percent of the 20 to 64 population according to figures from the 2005 Trustees Report). Moreover, if the underlying explanation for the evidence on increasing differential mortality is due to the increase in the DI enrollment, we should observe a significant attenuation of the rise in differentials when using the alternative lifetime earnings measures presented above. However, Table 6 shows that the increase in differentials is as strong for the baseline measure as with the alternative ones.

These findings raise concerns by themselves but even more when they are placed in the context of previous results in the literature of differential mortality in the United States. Recent research has shown a significant increase in mortality and life expectancy differentials across education groups (Meara et al, 2008; Hadden and Rockswold, 2008). Also, Waldron (2007) found compelling evidence of increases in differential mortality for men aged 60 and older using mortality data covering the period 1972 to 2001. Four previous studies (Duleep, 1989; Feldman et al., 1989; Pappas et al. 1993; Preston and Elo, 1995) found quite consistent evidence of increasing differential mortality for the period 1960 to the mid 1980s for men though for women they were somewhat mixed. Taken together, these results suggest an increase in differential mortality for almost the last five decades.

The evidence on widening inequality in the United States mirrors similar results reported in studies for Western European countries. In particular, Mackenbach et al. (2003), using data from national longitudinal sources in six Western European countries (Finland, Sweden, Norway, Denmark, England/Wales, and Italy), found that relative inequalities in total mortality have increased in these countries from the early 1980s to the early 1990s. Similarly, Bronnum-Hansen and Baadsgaard (2007) explored trends in differential mortality by education in Denmark in the period 1981 to 2005 and found that social inequality in life expectancy has widened during the period.

The empirical results presented in this study on increasing differential mortality raise a number of important questions, in particular the following: What are the causes and consequences of increasing differential mortality by lifetime earnings? With respect to causes, the explanations that have been put forward to explain differential mortality can be used to check whether they can explain the rise in this correlation. In particular, a potential explanation for increasing differential mortality by lifetime earnings could be that the correlation between poor lifestyle habits (such as smoking, poor diet, and lack of exercise) and low lifetime earnings have increased over time. However, preliminary evidence for this hypothesis is mixed.[29] Another explanation could be that differences in access to health services are becoming more unequal across individuals in different socioeconomic groups. In particular, recent advances in medical treatments, as opposed to those achieved in the 1950s and 1960s, may benefit to a greater extent individuals with higher socioeconomic status.

Increasing differential mortality also has implications for the long-term budget outlook. First, if the "life-expectancy premium" for high earners is increasing over time, this may worsen the budgetary pressures facing the U.S. Social Security system, given that high earners receiving larger benefits will collect them (on average) for a longer period of time (Diamond and Orszag, 2004) . Second, studies that established the progressivity of Social Security have used historical

[29] Preliminary evidence for this hypothesis is mixed. Zhang and Wang (2004) reported that for most demographic groups the relationship between body mass index and socio-economic status has weakened in the 1971 to 2000 period. Kant and Graubard (2007) found no evidence of an increase in the relationship between certain healthier diet profiles and socio-economic characteristics. Finally, the association between smoking and education has become significantly stronger in the 1965 to 1993 period (Garfinkel, 1997).

data on the correlation between earnings and mortality in order to account for the effect of differential mortality on progressivity measures. However, if differential mortality by lifetime earnings continues to increase over time, then we should expect that, holding other factors constant, the progressivity of the system will diminish.

The increase in income inequality in the United States during the last quarter of the twentieth century has attracted a great deal of attention, both in the academic literature and in policy circles. However, a subject of equal or greater concern should be that the country is also becoming increasingly unequal in terms of health.

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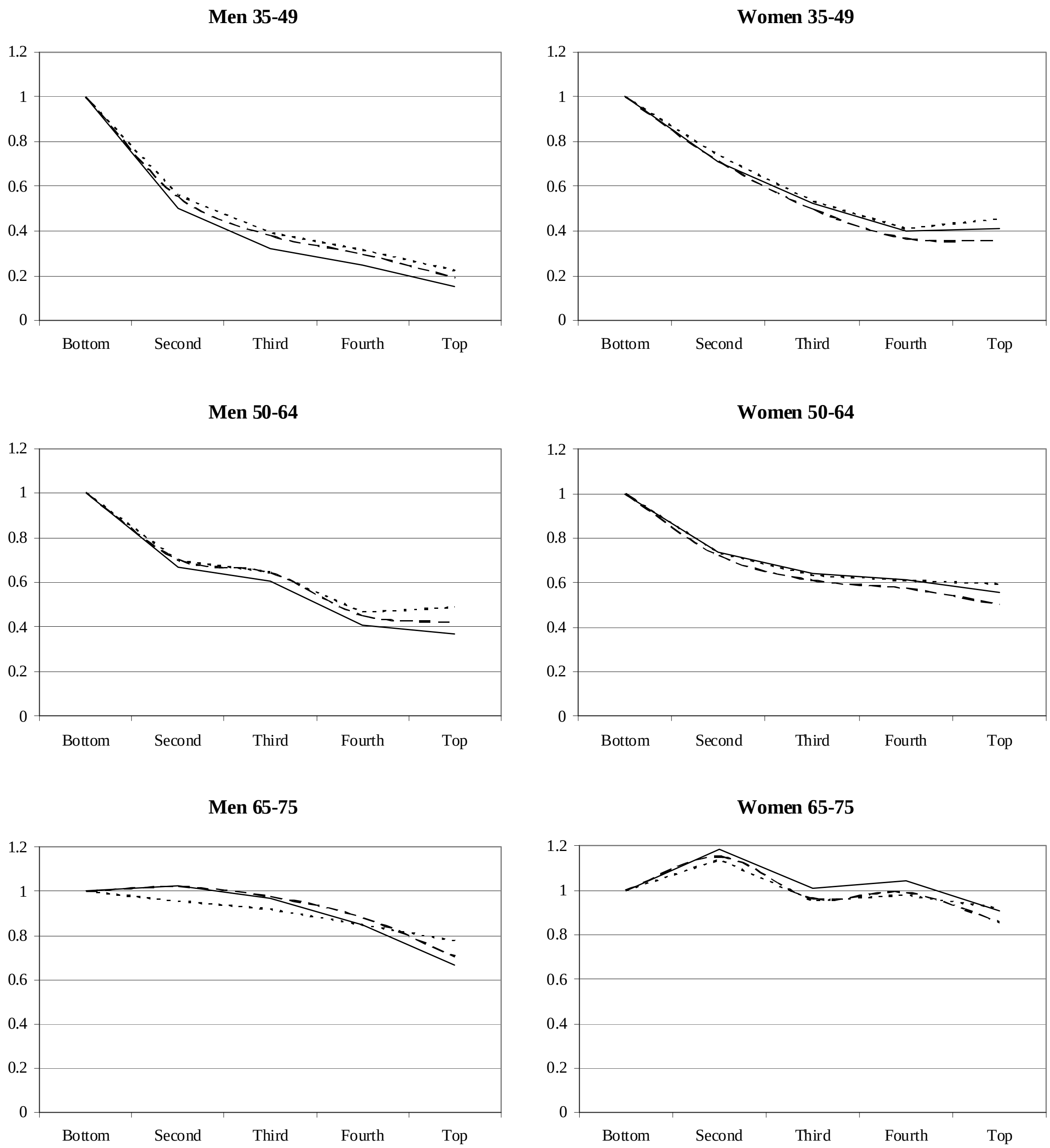
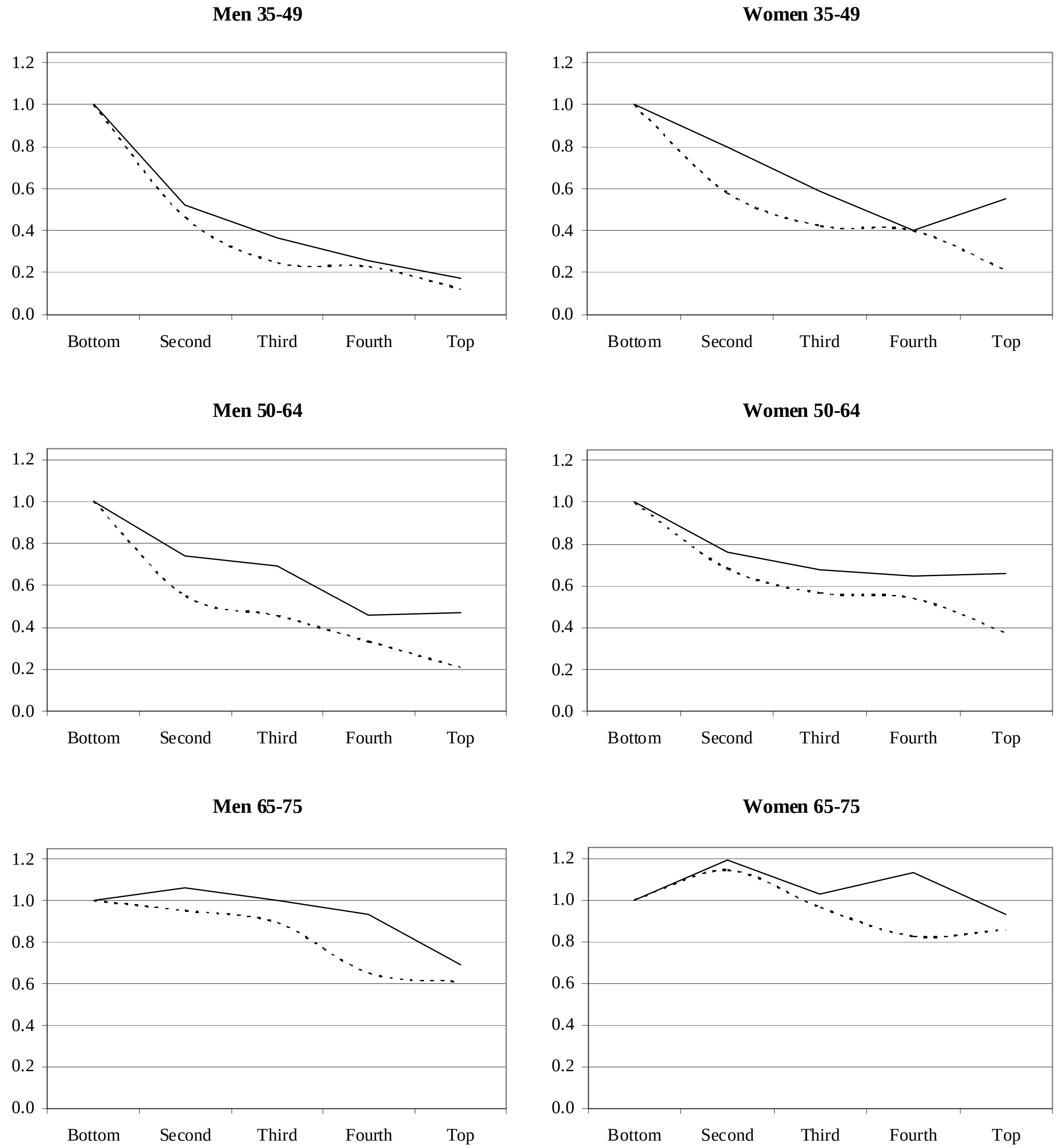
Figure 1. Adjusted Odds Ratios of One-Year Mortality by Individual Lifetime Earnings Quintiles



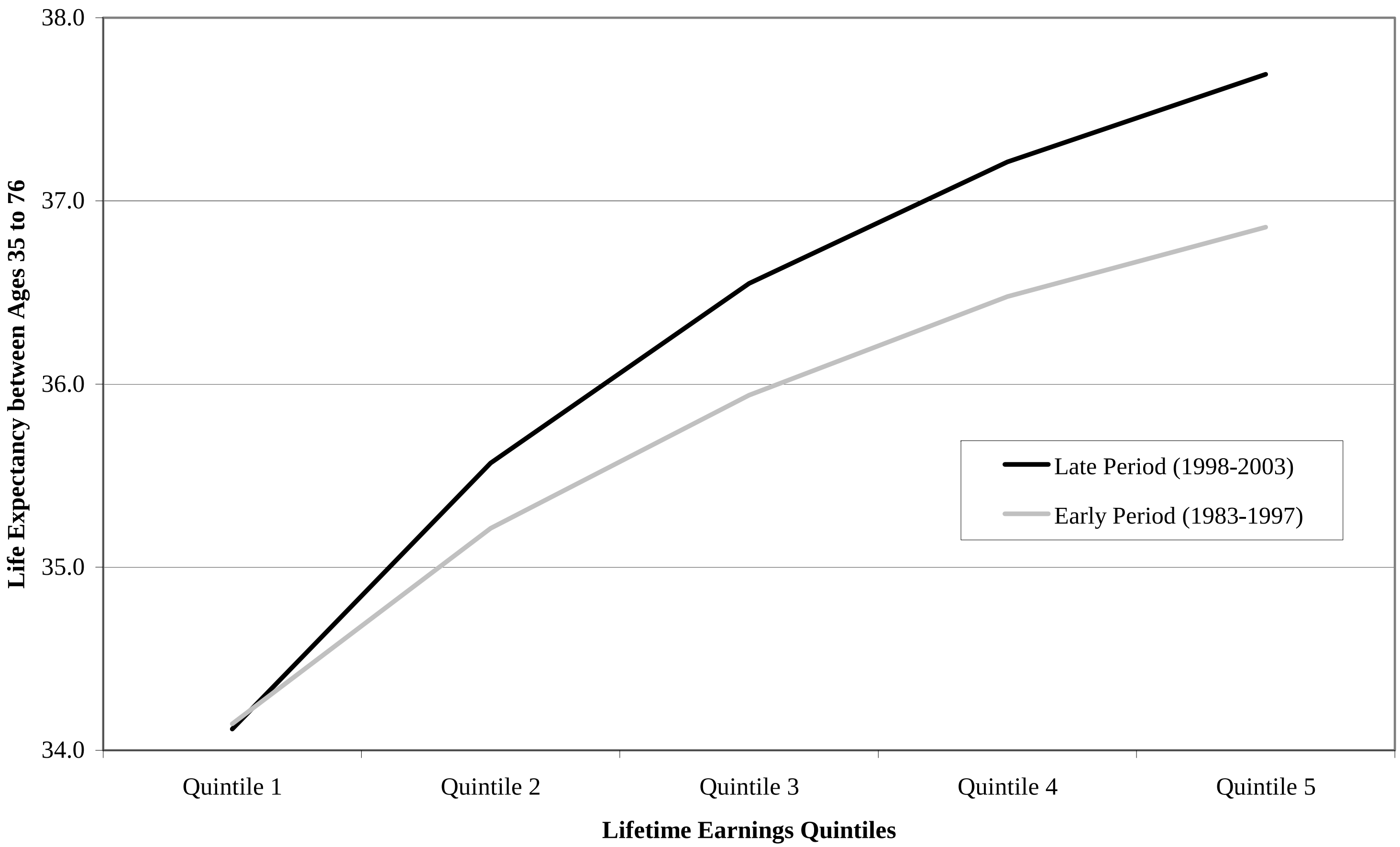
Note: Adjusted odds ratios are obtained from logistic regressions of one-year mortality indicators on individual lifetime earnings quintiles adjusting for age and birth year (solid line); age, birth year, race, and marital status (dashed line); and age, birth year, race, marital status, and education (dotted line).

Figure 2. Adjusted Odds Ratios of One-Year Mortality by Individual Lifetime Earnings Quintiles 1983-1997 versus 1998-2003



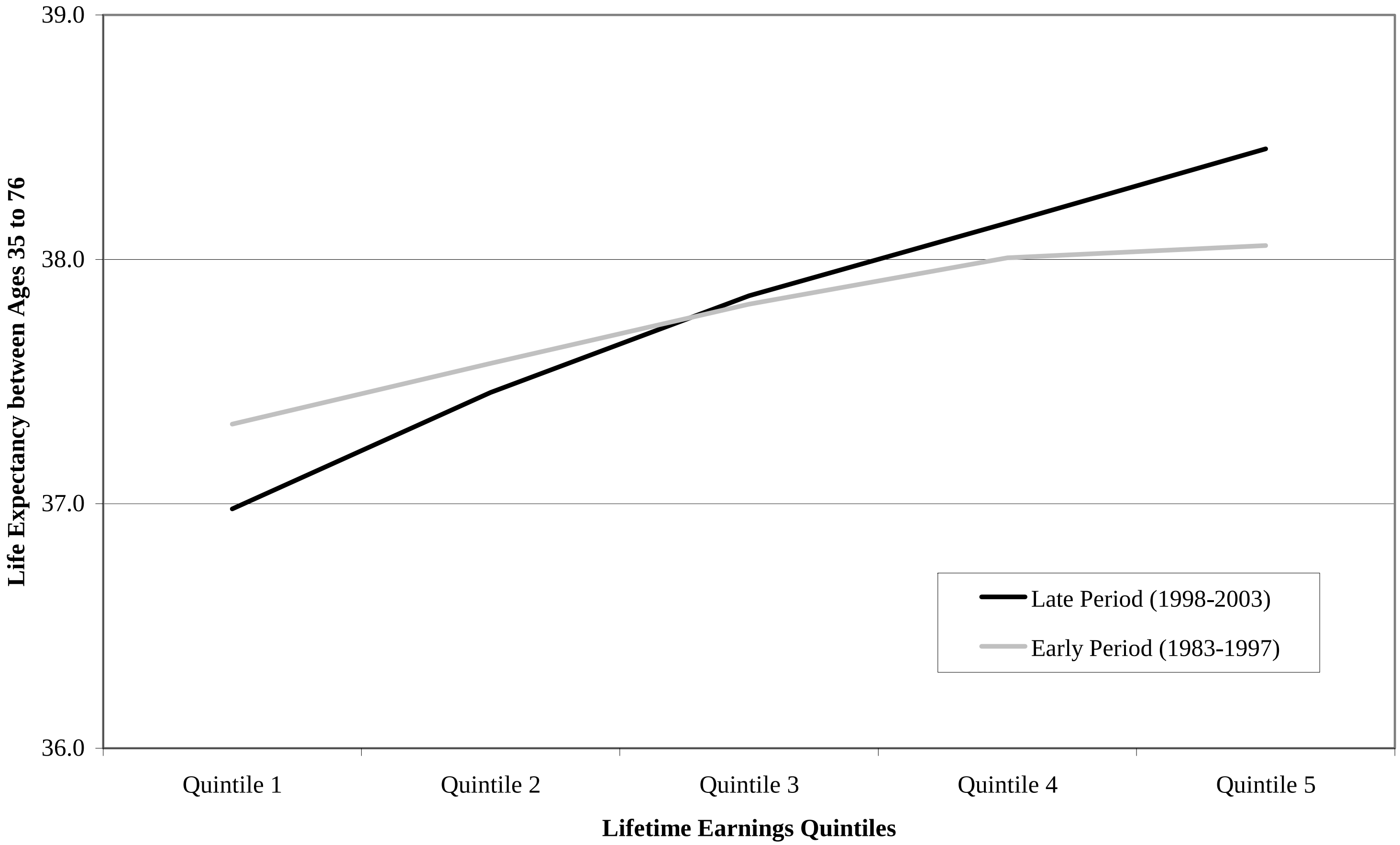
Note: Adjusted odds ratios for the period 1983 to 1997 (solid line) and the period 1998 to 2003 (dotted line) are obtained from logistic regressions of one-year mortality indicators on individual lifetime earnings quintiles, adjusting for age and birth year.

Figure 3. Trends in Life Expectancy between Ages 35 and 76 by Lifetime Earnings Quintiles - Men



Note: Discrete-time hazard logistic regressions are estimated to compute one-year mortality rates by single year age-quintile-period groups. One-year transition probabilities across quintiles are computed by sex, period and age groups. Using these results, life expectancies between ages 35 and 76 are computed recursively (see Section 5 for further details).

Figure 4. Trends in Life Expectancy between Ages 35 and 76 by Lifetime Earnings Quintiles - Women



Note: Discrete-time hazard logistic regressions are estimated to compute one-year mortality rates by single year age-quintile-period groups. One-year transition probabilities across quintiles are computed by sex, period and age groups. Using these results, life expectancies between ages 35 and 76 are computed recursively (see Section 5 for further details).

Table 1. Comparison of the Mortality Sample's Descriptive Statistics and Census Data

	Mortality Sample		
	Unweighted	Weighted	Census
% Male	47.4	47.8	47.7
Average Age	51.5	51.4	51.4
% Age 35-49	49.3	49.9	49.9
% Age 50-64	33.9	32.7	32.7
% Age 65-75	16.8	17.4	17.4
Race and Ethnicity			
% White	86.3	85.8	85.7
% Black	10.2	10.5	10.5
% Other Race	3.5	3.7	3.8
% Hispanic	6.7	7.5	7.4
Observation year			
Average	1996.6	1993.7	1993.7
% Year 1983-1987	9.2	20.3	20.3
% Year 1988-1992	11.5	22.2	22.3
% Year 1993-1997	27.4	24.7	24.6
% Year 1998-2002	42.5	27.1	27.1
% Year 2003	9.4	5.7	5.7

Note: Census male, age, and race statistics correspond to average yearly statistics weighted by population counts for each year in the period 1983 to 2003. The weights used in the Mortality Sample Weighted column were constructed to match the sample distribution by sex, five-year age group, race, Hispanic origin, and five-calendar-year group to the U.S. Census counts in the period 1983 to 2003.

Table 2. Mortality Ratios, Men

Age group		35-75	35-49	50-64	65-75
All		1.00	1.00	1.00	1.00
Race and Ethnicity					
White		0.96	0.90	0.95	0.98
Black		1.48	1.74	1.58	1.35
Other Race		0.82	1.13	0.79	0.76
Hispanic		0.94	0.98	0.93	0.93
Education					
Less than High School		1.32	1.56	1.36	1.23
High School		1.02	1.11	1.05	0.98
Some College		0.91	0.97	0.89	0.90
College		0.62	0.55	0.64	0.62
Marital Status					
Never Married		1.57	1.95	1.66	1.42
Married		0.86	0.72	0.85	0.90
Separated/Divorced		1.51	1.56	1.46	1.53
Widowed		1.53	1.53	1.93	1.26
Disability Insurance					
Currently on DI		-	8.22	12.90	-
Ever on DI		3.69	8.24	4.18	2.15
Lifetime Earnings Quintiles					
Top	Individual	0.64	0.35	0.61	0.74
	Household	0.77	0.40	0.73	0.90
Fourth	Individual	0.80	0.56	0.68	0.94
	Household	0.85	0.54	0.82	0.96
Third	Individual	1.00	0.73	0.99	1.08
	Household	0.90	0.83	0.79	0.99
Second	Individual	1.12	1.13	1.10	1.14
	Household	1.07	1.16	1.07	1.05
Bottom	Individual	1.44	2.25	1.63	1.10
	Household	1.41	2.07	1.60	1.10

Note: The mortality ratio for a group is computed by dividing the weighted average of the one-year age-specific mortality rate for the group, where the weights correspond to the fraction of men in the sample in that age, by the male mortality rate in the sample. DI corresponds to Social Security Disability Insurance. Mortality ratios for individuals currently on DI are not computed for age groups 35 to 75 and 65 to 75 because individuals on DI have their status updated to Social Security retirees when they turn 65.

Table 3. Mortality Ratios, Women

Age group		35-75	35-49	50-64	65-75
All		1.00	1.00	1.00	1.00
Race and Ethnicity					
White		0.95	0.93	0.93	0.96
Black		1.48	1.53	1.58	1.42
Other Race		0.92	0.89	1.01	0.88
Hispanic		1.03	0.92	0.99	1.07
Education					
Less than High School		1.37	1.61	1.48	1.26
High School		0.93	1.12	0.89	0.91
Some College		0.81	0.78	0.82	0.81
College		0.65	0.58	0.64	0.68
Marital Status					
Never Married		1.39	1.92	1.60	1.16
Married		0.81	0.75	0.81	0.83
Separated/Divorced		1.29	1.35	1.32	1.26
Widowed		1.29	1.53	1.44	1.16
Disability Insurance					
Currently on DI		-	10.12	16.24	-
Ever on DI		4.10	10.86	4.54	2.51
Lifetime Earnings Quintiles					
Top	Individual	0.84	0.68	0.79	0.90
	Household	0.74	0.49	0.71	0.81
Fourth	Individual	0.93	0.66	0.86	1.03
	Household	0.87	0.75	0.76	0.96
Third	Individual	0.95	0.86	0.90	1.00
	Household	1.00	0.79	0.92	1.09
Second	Individual	1.09	1.17	1.03	1.11
	Household	1.02	1.04	1.09	0.99
Bottom	Individual	1.21	1.65	1.41	1.01
	Household	1.36	1.96	1.53	1.15

Note: The mortality ratio for a group is computed by dividing the weighted average of the one-year age-specific mortality rate for the group, where the weights correspond to the fraction of women in the sample in that age, by the female mortality rate in the sample. DI corresponds to Social Security Disability Insurance. Mortality ratios for individuals currently on DI are not computed for age groups 35 to 75 and 65 to 75 because individuals on DI have their status updated to Social Security retirees when they turn 65.

**Table 4. Trends in Differential Mortality by Lifetime Earnings:
Estimated Odds Ratios of One-Year Mortality, Top Relative to Bottom Quintile**

Individual Earnings

		Odds Ratios		Reduction in Ratio	
		1983-1997	1998-2003	Percentage point	Percent
Men	35-49	0.17	0.12	0.05	29%
	50-64	0.47	0.21 **	0.26	56%
	65-75	0.69	0.61	0.08	12%
Women	35-49	0.55	0.21 **	0.34	62%
	50-64	0.66	0.38 **	0.28	43%
	65-75	0.93	0.86	0.07	8%

* Significantly different from the 1983-1997 period estimates at the 5 percent level.
** Significantly different from the 1983-1997 period estimates at the 1 percent level.

Household Earnings

		Odds Ratios		Reduction in Ratio	
		1983-1997	1998-2003	Percentage point	Percent
Men	35-49	0.23	0.14	0.09	40%
	50-64	0.57	0.26 **	0.26	45%
	65-75	0.88	0.66 *	0.22	25%
Women	35-49	0.32	0.13 *	0.19	59%
	50-64	0.60	0.23 **	0.37	61%
	65-75	0.73	0.65	0.08	11%

* Significantly different from the 1983-1997 period estimates at the 5 percent level.
** Significantly different from the 1983-1997 period estimates at the 1 percent level.

Table 5. Average Individual Lifetime Earnings by Sex, Age Group, Period, and Lifetime Earnings Quintiles, 1983-1997 versus 1998-2003

	Men					
	35-49		50-64		65-75	
	1983-1997	1998-2003	1983-1997	1998-2003	1983-1997	1998-2003
Average Individual Lifetime Earnings						
Top	76,216	85,207	92,722	110,112	69,695	83,795
Fourth	44,281	44,073	49,913	53,633	39,313	46,862
Third	31,913	30,653	36,367	37,636	29,893	34,852
Second	20,349	19,079	22,373	22,796	16,201	20,325
Bottom	5,940	5,225	5,378	5,706	1,793	3,303

	Women					
	35-49		50-64		65-75	
	1983-1997	1998-2003	1983-1997	1998-2003	1983-1997	1998-2003
Average Individual Lifetime Earnings						
Top	40,033	49,733	35,777	48,327	25,461	30,634
Fourth	20,641	24,794	17,769	24,761	10,809	14,152
Third	11,082	14,259	8,672	13,949	3,352	5,819
Second	4,109	6,057	2,707	5,536	457	1,169
Bottom	372	746	106	425	0	3

Note: Quintiles of individual lifetime earnings in a certain year are computed within five-year age, sex, and five-year cohorts for individuals alive that year.

Table 6. Trends in Differential Mortality by Individual Lifetime Earnings
Estimated Odds Ratios of One-Year Mortality. Top Relative to Bottom Quintile
Using Alternative Average Lagged-Earnings Measures

	Men					
	35-49		50-64		65-75	
	1983-1997	1998-2003	1983-1997	1998-2003	1983-1997	1998-2003
Alternative Average Lagged-Earnings Measures						
Basic measure (includes zero earnings years and excludes at least three years prior to mortality window)	0.17	0.12	0.47	0.21	0.69	0.61
Basic measure but including only positive earnings years	0.20	0.14	0.45	0.24	0.59	0.50
Basic measure but excluding at least six years prior to mortality window	0.23	0.12	0.49	0.22	0.69	0.60
Two-year average of years (age-3) and (age-4). Example: for an individual age 40, this is the average of earnings at ages 36 and 37. Sample: Ages 35-60	0.20	0.12	0.27	0.13	-	-

	Women					
	35-49		50-64		65-75	
	1983-1997	1998-2003	1983-1997	1998-2003	1983-1997	1998-2003
Alternative Average Lagged-Earnings Measures						
Basic measure (includes zero earnings years and excludes at least three years prior to mortality window)	0.55	0.21	0.66	0.38	0.93	0.86
Basic measure but including only positive earnings years	0.52	0.22	0.82	0.50	0.79	0.75
Basic measure but excluding at least six years prior to mortality window	0.70	0.28	0.66	0.38	0.94	0.86
Two-year average of years (age-3) and (age-4). Example: for an individual age 40, this is the average of earnings at ages 36 and 37. Sample: Ages 35-60	0.47	0.18	0.36	0.24	-	-

Table 7. Trends in Life Expectancy between Ages 35 and 76 by Lifetime Earnings Groups

	Men					
	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Quintile 5-Quintile 1
Early Period (1983-1997)	34.1	35.2	35.9	36.5	36.9	2.7
Late Period (1998-2003)	34.1	35.6	36.5	37.2	37.7	3.6
Absolute Change	0.0	0.4	0.6	0.7	0.8	**0.9**
	Women					
	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Quintile 5-Quintile 1
Early Period (1983-1997)	37.3	37.6	37.8	38.0	38.1	0.7
Late Period (1998-2003)	37.0	37.5	37.9	38.1	38.5	1.5
Absolute Change	-0.3	-0.1	0.0	0.1	0.4	**0.7**

Note: Discrete-time hazard logistic regressions are estimated to compute one-year mortality rates by single year age-quintile-period groups. Separate regressions are run by sex, period and age groups (35 to 49, 50 to 64 and 65 to 75). Explanatory variables include lifetime earnings quintiles and age. To capture the fact that individuals may switch lifetime earnings groups as they age, one-year transition probabilities across quintiles are computed by sex, period and age groups. Using predicted one-year mortality rates and estimated transition probabilities, life expectancies between ages 35 and 75 are computed recursively (see Section 5 for further details).