

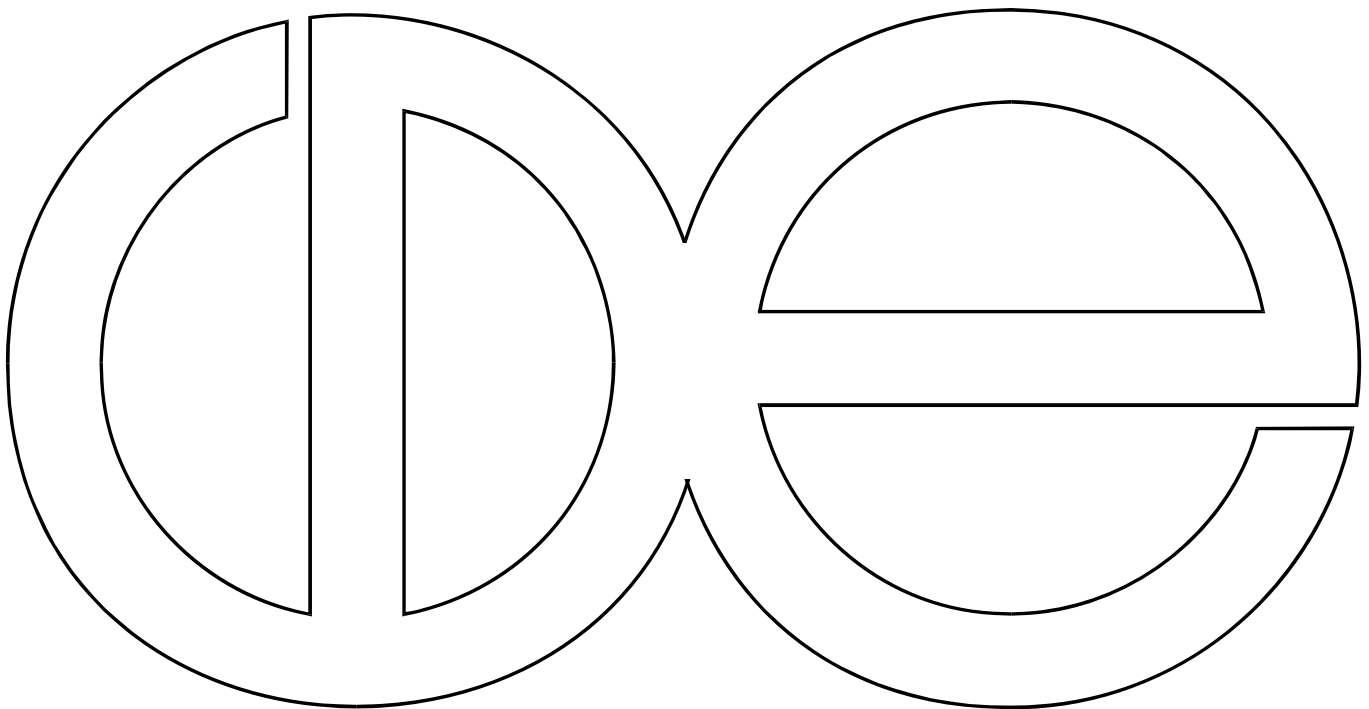
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**Why are We Getting Worse? A Historical Accounting
of Modern US Life Expectancy Disadvantage**

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Why are We Getting Worse?

A Historical Accounting of Modern US Life Expectancy Disadvantage¹²

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1 Background

Recent reports issued by the National Academy of Sciences argue convincingly that Americans experience higher mortality and worse health than their peers in developed countries {1–3}. Americans face shorter lives than individuals in other developed, high-income countries. Indeed, as of 2012 US life expectancy at birth among females ranked in the mid-30s worldwide, a full two years below the OECD-member average and trailing top performing countries by over four years {4, 5}. Conditions among males are slightly better as departures amount to 1.4 and 3.6 years respectively. Empirical evidence reveals that the disadvantage is visible both in mortality between ages 0 and 50 and over 50. Americans, however, may do better if they survive to older ages: at least in the most recent life tables conditional life expectancies at ages 65–70 years are closer to the average of peer countries {5}, and at the oldest ages (75+ years) the US appears to experience an advantage {1, 2}. Aside from this anomaly at older ages, Americans simply do not live as long as their peers in other wealthy nations.

The US disadvantage is not only visible in clear-cut indicators such as life expectancy but also in a broad array of health status measures, including pediatrics outcomes (birth weight and length of gestation), adolescent and adult mental health, child and adult obesity, diabetes, teenage pregnancy, and accidents and injuries {3}. The poor ranking of the US is nearly uniform and visible over a long arch of the life span, from birth to late adulthood. This suggests that the mortality disadvantage is a symptom of a generalized malaise that affects individuals at all stages of their life cycle.

Intriguingly, the US did not always experience the life expectancy disadvantage we see today. In the 1950s and 1960s US life expectancy at birth and at ages over 45 was at or above the OECD member average {4}, infant mortality ranked among the five lowest, and older men already enjoyed a similar advantage as they experience today, albeit starting at younger ages. Sometime during the late 1970s and early 1980s the pace of US gains in life expectancy slowed abruptly, infant mortality stood out as an egregious outlier among OECD

countries (except Mexico), and female mortality underperformed male mortality and began falling behind more rapidly. From then on peer countries pulled away from the US and have done so uninterruptedly for nearly 30 years {1, 2}.

What caused this change of trajectory? Does the three-decade-long slow-down in life expectancy gains apply equally to both genders at all times since 1960? Does it manifest uniformly at all ages? And if not, at what ages does the US exhibit an advantage and what are the ages that drag down the pace of progress in survival? What causes of deaths are responsible for the bulk of differences and which ones place the US at an advantage at older ages? Have these ages and causes of deaths remained stationary, are they changing in some orderly and systematic fashion or, alternatively, are there no regular, discernible patterns in the data available to us?

2 This Paper

Because this is well-trodden territory we first identify gaps in knowledge left open by previous research that we intend to fill. Even though a large body of research compares mortality trends in developed countries, and several recent reports document contemporary relative mortality conditions in the US {6–9}, some key features of US mortality, and the contrast with other developed countries, have not been fully investigated, are poorly studied or accounted for, or are not identified at all. In this paper we focus on the following three issues.

2.1 Complete coverage of the key time interval

Even though overall trends have been explored for an extended period of time, detailed analyses are mostly focused on the most recent period, typically not longer than the last two or three decades {9}. In this paper we perform systematic analyses of complete life tables for the period 1955-2010, a time interval starting prior to the onset of US disadvantage and ending with the most recent official life tables and cause of death statistics.

2.2 Age-cause specific time trends and determinants

There is some ambiguity about which age groups (and causes of death) are responsible for US disadvantage. Some accounts claim that mortality before age 50 {8} is where the roots of the problem may lie, in others it is mortality at ages above 50 {1, 2}, and yet others find that it is the age group 0 to 5 that exerts a powerful tug and explains a significant part of the differences between the US and other countries {3}. Similarly, there is also some uncertainty about the causes of death that contribute most to the disparities. Whereas a recent reports suggests that the main contributors to the comparative US slowdown in conditional life expectancy at age 50 and over are lung cancer, respiratory diseases, and mental and nervous system diseases {1, 2, 6}, others point to the role of pediatric conditions and their influence on neonatal mortality as well as to deaths associated with exogenous causes in early adulthood (accidents, homicides, suicides) {3}.

Part of the reason for this uncertainty is that past research focuses on limited age segments (over 50 {6}; between 0 and 50 {3}) giving only passing attention to others or concentrates on observed patterns in relatively short, recent periods of time, ignoring patterns in the more distant past {9}. It may well be that the role different age groups and causes of death play changes over time. If so, generous time and age diversity must be included in all analyses.

To shed light on these issues we focus on long time trends of differences (1955-2010) and use standard decomposition techniques to estimate the contribution of various age groups and causes of deaths to changes in overall, age-specific conditional, and temporary life expectancy. We use country fixed-effects models for age-cause specific mortality rates and introduce counterfactual scenarios to single out the age groups and causes of death that exert large influences in the contrast between the US and other countries over time.

2.3 Analyses of particular age groups

In the analyses carried out in this paper, as well in past research findings, two age groups stand out. First, the US fares particularly poorly in infant and child mortality {3}. One

possibility is that there is an increasing proportion of live births that are short and very short gestational ages. Others tend to brush off the US disadvantage as a secondary result of very high infant mortality among African Americans and other minorities. In this paper we examine more thoroughly the role of birth composition by gestation and race/ethnicity and find that neither of them account for the US ranking in infant mortality.

Second, it has been repeatedly noted {1, 2} that the US does particularly well at older ages. In some findings the age at which US mortality begins to look better is 85 {10}. In others the key age at which US mortality rates fall below the comparison group descends to age 75 {1, 2}, and yet in others it is as low as 65 {8}. Variability in the age of crossing and the existence of the crossing itself could be a function of period effects or diversity of cohorts or even the ebb and flow of mortality in benchmark countries. Because of the large swath of time we cover, consistency of benchmarks for comparisons, and exploration, albeit partial, of cohort specific analyses, we shed some light on this issue. In particular, we verify that the crossing age, far from being fixed throughout the period under study, shows systematic increases. A time trend in the crossing age poses a puzzle but it also offers an opportunity to discern between alternative hypotheses that may explain the US advantage at older ages.

3 Data and Methods

As most other research in this area, we use two sources of data. The first is country age-specific deaths and population estimates from the Human Mortality Database (HMD) for the years 1955-2010, separately by sex. These data include information for the US and a set of 16 high-income comparison countries.¹ We use these to construct life tables for the US, the set of comparison countries, and some counterfactual scenarios according to standard life table construction. Similarly, we use birth cohort specific mortality and population estimates in the last section of the paper to construct cohort life tables for the US and other countries

¹ Comparison countries: Australia; Austria; Canada; Denmark; Finland; France; Germany; Italy; Japan; Netherlands; Norway; Portugal; Spain; Sweden; Switzerland; and United Kingdom.

starting in 1933.

To calculate mortality rates by age and cause we use a second data source, the World Health Organization (WHO) cause of death database that provides information on the distribution of causes of death by age groups. We choose ten broad groups of causes of death using categories from the International Classification of Diseases (ICD) harmonized across versions of ICD.² The deaths in these categories typically account for about 90% of all deaths. To ensure comparability with other research the death rates we compute are unadjusted for omission and age misstatement, and death rates by causes are not adjusted to account for ill-defined causes. Deaths classified in the category “ill-defined” are lumped together with the “other” or residual causes category.

For both overall mortality data from HMD and age-specific distributions of cause of death from WHO we have some instances of incomplete or missing data for a given year or small set of years. We correct this issue by applying the data from the nearest year. These corrections simplify our analyses but have virtually no effect on results.^{3,4} For Germany we take data from West Germany (Former Federal Republic) through 1990 and then from 1991 to 2010 the current Federal Republic of Germany.

Information on mortality for the US population for the year 2009 by sex and race/ethnicity is taken from life tables estimated by the National Center for Health Statistics (NCHS).

We deviate somewhat from the standard approach to performing the comparison between the US and the other countries. First, in some sections of the paper we use three comparison populations. The first is a year- and age-specific “superpopulation” or the pool of all countries, except the US. This population combines the mortality experiences of peer nations and functions like a composite or weighted average (weighted by population). The

² Collapsed cause of death categories: Neoplasms; Circulatory; Respiratory; Digestive; Diabetes and metabolic; Infections; Accidents, Homicide, Suicide, and External; Senility and Ill-defined; Pregnancy-related; Infancy; Residual.

³ HMD corrections: Germany (1955 from 1956); Australia, Canada, Finland, Italy, Japan, Netherlands, Norway, Spain (2010 from 2009).

⁴ WHO corrections: Canada (2010 from 2009); Australia (2005 from 2004); Italy (2004 from 2003, 2005 from 2006); Portugal (2004 from 2003, 2005 from 2003, 2006 from 2007).

second is a year- and cause-specific “optimal” mortality pattern constructed by chaining together the lowest mortality rates (and distributions of causes of death) observed at each age during that year and constructing a corresponding life table based on those rates. Each year-specific optimal set of rates represents the minimum mortality pattern that could have been achieved at that particular time. The use of this age-specific pattern of mortality as a benchmark has the advantage that, unlike comparisons with the pooled age specific pattern, we know precisely the nature of the benchmark: it is the lowest mortality level that could have been attained at any point in that time. Even though this pattern does not represent the experience of any observed country (neither does the pooled life table), it stands out as a target that could be reached with optimal performance: all deviations from it are departures that could theoretically be eliminated if the US performed as well as countries that yield the lowest age specific rates in any time period. In other words, each set of rates and the corresponding life table represents an aspirational target. Finally, the third benchmark is the “worst” life table derived by chaining together the highest age-specific mortality rates (and corresponding cause of death distributions) observed each year. Each set of rates is plausible for a given year but they constitute what is to be avoided rather than what is to be achieved. Together the optimal and worst life tables bound the expected range of overall mortality among wealthy countries.

Second, to assess mortality levels we use either life expectancy at various ages, average duration of life within any age segment, or age specific mortality rates, M_x . Rather than using rank scores of the M_x ’s to compare the performance of the US to that of other countries, we use the ratios of the M_x ’s in the US to those of the benchmark (either the pooled set of rates or the optimal). While other reports present results in ranks, we ignore rank order scores since they convey no information about the magnitude of differences and these are significant for the hypotheses we wish to falsify. The ratios of M_x ’s are not problem-free since they are (perhaps overly) sensitive to magnitudes (e.g., they tend to attain high values when the absolute values of the M_x ’s are low). But, unlike the pitfall of rank order scores,

we can handle this problem in a number of sensible ways that remove most of the distortions. To distinguish the set of ratios calculated with the pooled, optimal, and worst age patterns we will use the symbols PM_x , OM_x , and WM_x , respectively.⁵

4 Analyses

4.1 Patterns of Disadvantage: Historical Trends

We start with a replication of findings already aired by other researchers. Figure 1 displays female and male life expectancies at birth for the US and the pooled, optimal and worst benchmarks. Figure 2 shows the same data but re-expressed as US relative standing compared to the pooled, optimal, and worst, while Figure 3 shows the same but for conditional life expectancy at age 50. Figure 4 shows relative temporary life expectancy in the interval 0 to 50 years.

In 1955 both American females and males enjoyed relative life expectancy advantages and were comfortably situated in the upper half of the optimal-worst range. Females exceeded average life expectancy by 2.3 years and males by 1.0 years. Unfortunately, for both males and females these advantages were short-lived and we begin to see slightly different relative trajectories by sex.

By 1960, average mortality in comparison countries caught up to US males and by 1965 surpassed it by 1.0 years. With the exception of a few years around 1980, from 1965 on US males lagged average life expectancy by between 1.0 and 2.6 years but the disadvantage remained fairly stable around 1.9 years, widening a little bit. That is, though they continued to lag, US males made similar gains in life expectancy magnitude during that time. By 2010, the US disadvantage was 2.3 years and life expectancy was closer to the “worst” bound than

⁵ Other researchers {3} suggest the use of a different metric for comparison, namely, the difference between the date the US attained a given value of M_x and the date when the benchmark countries did so. Because minute differences in some rates are associated with large swaths of time (the first derivatives of rates with respect to time are quite small), this indicator is problematic as well and, in many cases, difficult to interpret.

the average. Put another way, 2010 US male life expectancy was roughly the same as the average male life expectancy from 10 years earlier and optimal life expectancy from 20 years earlier.

Female life expectancy followed a somewhat different—and more dramatic—pattern. The 2.4 year US female life expectancy advantage observed in 1955 was gone by 1965. From then to about 1980 it nearly perfectly tracked average female life expectancy, but starting around 1980 yearly gains slowed and the disadvantage grew substantially as average female life expectancy continued to increase unabated. By 2010, the previous advantage had flipped to a 3.1 year disadvantage, life expectancy was much closer to the “worst” bound than the average, and life expectancy matched the average and optimal bound from 15 and 25 years earlier, respectively.

The contrasts with the optimal and worst populations are stark and worth reiterating. Never in the past (at least after 1955) has the US been even close to the optimal life expectancy. Among females the US trailed it by about 3 years for 25 years (1955-1980). By 2010 the disparity had grown to about 6 years among females while remaining steady at around 4.5 years among males. Unlike the comparison with a pooled benchmark, differences from the optimal mortality pattern suggest that the US has not moved from a better status to a worse one but rather that it has always lagged behind and has become steadily worse for longer than half a century. This is made even clearer by the yearly difference relative to the worst life table: throughout the period examined and among both males and females, US conditions have converged systematically toward the worst cases scenario.

As shown in Figures 3 and 4, the US disadvantage exists everywhere in the life span albeit with somewhat different time profiles. Life expectancy at age 50 trails the pooled (and optimal) benchmarks for nearly the entire observation window among males and since 1985 among females. Losses of years of life lived before age 50 exceed those in the pooled and optimal benchmarks as early as 1960-65 among both males and females. Comparisons with the worst cases scenario confirm a wholesale, steady, uninterrupted deterioration since

at least 1970. They also reveal that although the deceleration of gains in survival applies to all ages, those involving early life through late adulthood (0-49) have a persistent effect throughout the period under study, whereas ages over 50 exert a heavy tug only more recently. We revisit this issue and its implications in the decomposition analyses.

Figure 5 displays ratios of age-specific mortality rates observed in the US to those experienced in the pooled benchmark for selected years. It shows a remarkably consistent pattern reproduced over time. The pattern has three features. First, the US disadvantage between ages 35 and 60 has persisted and increased for over 60 years. Second, the US disadvantage at early ages (before age 10) did not exist before 1975 but grew alarmingly since then and has spread to encompass ages between 10 and 50. Third, the US does indeed experience an advantage at older ages but with a twist: the advantage is progressively displaced toward older ages. We will show below that if one projects forward the ages above which the US experiences lower mortality, the fraction of the population enjoying such advantage will decrease to nearly 0 by the year 2025.

Figures 6 and 7 display the ratios of observed mortality rates to those in the optimal and worst mortality patterns, respectively. Although the contrast with the optimal life table expresses identical Mx -age-specific profiles as those in Figure 5, the size of disparities are larger by an order of magnitude. Note that in the best year (1955) the US mortality rates at ages between 15 and 50 was between two to three times as large as those in the optimal pattern and that between ages 55 and 85 in the last year of observation (the worst of the lot) the US population experienced mortality rates between ages 0 and 50 that were close to twice as high as those in the optimal pattern. Finally, Figure 7 displays the ratios relative to the worst benchmark. This figure is a convincing illustration of the end of an era as the US performance progressively converges toward the worst pattern for ages above 75, namely, the only age interval where the US received passing marks.

The contrast with the optimal pattern reveals, once again, that health conditions experienced by the US population are far removed from what could be experienced given what

is feasible and achievable. The contrast with the pooled benchmark is more benign but deceiving as it is influenced by poorly performing countries included in the pooled benchmark. Finally, the contrast with the worst life table highlights the evanescent character of better conditions at older ages.

4.2 Role of Race and Minority Groups

Is the observed disadvantage now or in the past due to the presence of sizeable US minorities that experience subpar mortality patterns? This question has been posed frequently by researchers {11, 12} and laypeople alike. We argue that the question is entirely inappropriate when one uses a pooled benchmark as a contrast since many, if not all, countries in the pooled data also contain sizeable minorities that may similarly contribute to increased mortality levels in their respective countries.⁶ The question, however, is more reasonable if it pointed to deviations from the optimal mortality patterns. Indeed, it is legitimate to investigate to what an extent the US departure from the optimal mortality pattern is due to differential mortality within the country.

But even ignoring these arguments, the facts suggest that within-US race heterogeneity has little to do with its disadvantageous position. Calculation of mortality patterns for the ethnic group that performs best should reveal if, indeed, the overall US disadvantage is mostly due to poor performance of certain groups. Rather than following the time series of mortality rates for the group that represents the majority, Non-Hispanic Whites (NHW), it suffices to focus on the most recent period. The 2009 differences of life expectancies between Non-Hispanic White females and males and the pooled benchmark are 2.3 years at age 0, 1.5 and 1.0 years at age 50, and 0.2 and 0.4 years in temporary life expectancy (0-50), respectively. Thus, the exclusion of African Americans from the base population makes hardly a dent on the original contrasts.

⁶ The argument that the US disadvantageous position only reflects the poor performance of minority groups leads to a paradox: if one excludes from all calculations one minority group, say African Americans, there is no reason why we should not exclude also Hispanics. But if we do so the US disadvantage increases by about a year for both males and females, a result of the so-called Hispanic paradox.

Figure 8 shows these ratios for NHW females and males relative to pooled rates for 2009. As expected, the magnitude of the ratios flattens out. What persists in the graph, however, is that there are no marked differences in the magnitude of the ratios and, importantly, no discernible changes in the age profile of departures from parity.

4.3 Time trends in age patterns of departures from benchmarks

The pattern of Mx ratios using the pooled (PRx) benchmark is remarkably regular and we can model it with high precision using a four parameter linear model with an idiosyncratic normally distributed error assumed to be $N(0, 1)$:

$$PR_x = \alpha + \beta * PR_{sx} + \gamma * t + \delta * I_{sx} + \phi * D_{60} + \epsilon$$

where PR_x is the ratio of the US mortality rate at age x to the pooled benchmark, PR_{sx} is a standard ratio (here we use the patterns observed in 1955)⁷, t is the fraction of years elapsed since 1955, I_{sx} is an interaction term between time and the standard set of ratios, and D_{60} is a dummy variable attaining the value 1 if age is below 50. The latter term enables us to capture effects that shift the observed pattern away from the standard differently at ages below 50. The constant (α) raises or lowers the ratios above the standard. Its value is influenced by the passage of time (expressed in $\gamma * t$ units) as well as by age location (in units of $\phi * D_{60}$). The parameter β controls the magnitude of changes in ratios relative to changes of age: the lower it is the least responsive are observed ratios to age changes everywhere. The interaction term reduces or increases the impact of this parameter.

Table 1 displays estimated parameters for the model for males and females. The model fit is reasonably good, the coefficients of time are, as expected, positive, namely as time passes the ratios worsen, the value of β are larger than 1, that is, on average the observed ratios are more responsive to the passage of age than in the standard. The interaction effects

⁷ Similar but sharper results obtain with the optimal rates as standard.

indicate that the sensitivity to age changes decreases with time and substantially so. This surely reflects the fact that as time passes US mortality rates attain higher values at all ages before 60. Importantly, the effect of the dummy variable (age younger than 10) is large, statistically significant, and properly signed: it shows that the sustained upward shift in the ratios throughout this period is larger at younger and adult ages than at very old ages. Figure 9 displays the predicted values of the ratios for selected years.

One implication of the model is that the growing disadvantage in mortality experienced by the US is strongly associated with mortality below ages 65 or 70. A second implication is that the age at which the US begins to experience advantageous conditions relative to the benchmark shifts upwards by about 0.51 years per year (males and females combined).

4.4 The contribution of age groups and causes of death

What age groups and causes of deaths are responsible for the increased relative deterioration of US mortality since 1955? We use a standard procedure first proposed by Pollard {13} and then operationalized by Arriaga {14} to estimate the fraction of the total difference between the US life expectancy at age x and those in the two benchmarks (pooled and optimal) that is attributable to age groups and causes of deaths (and both, simultaneously). We use the 10 groups of causes of death listed above and 19 age groups, which we later collapse for display into 10-year chunks.⁸

Tables 2-4 show the full age-cause decomposition of life expectancy at birth for the US compared to the pooled average for 1955, 1980, and 2010. We include these for completeness but acknowledge it is difficult to decipher time trends from them. Overall trends in age- and cause-specific decomposition results for the US versus the pooled average in 1955, 1980, and 2010 are shown visually in Figures 10-12, which are easier to interpret. Table 5 shows the marginal decomposition results for age groups over time for the US compared to the pooled average and Table 6 shows the marginal decomposition results for causes of death over time.

⁸ Raw age groups for decomposition are 0-1, 1-4, 5-9, 10-14, 15-19, 20-24, 25-59, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, and 85 and up.

These are displayed graphically in Figures 13 and 15, respectively. We collapse some ages and causes of death to highlight the most important components in Figures 14 and 16.

The overall pattern in Table 5 and Figures 13 and 14 is grim. In 1955 the US held a relatively advantageous position compared to the pooled average for both males and females but this was wiped out soon thereafter and by 2010 both males and females experienced near uniform disadvantage. Two things stand out: First, in 1955 the US experienced strong advantage from birth to age 10. The US also fared better in the oldest two age groups, though much less significantly. Second, the US increasingly fell behind in virtually every age group. US advantages attenuated and often became disadvantages, and disadvantages exaggerated further. While there was a bit of a bump for the oldest males and females in the years around 1980, this was short-lived. The patterns by cause of death in Table 6 and Figures 15 and 16 are a bit different. For females the cause of death pattern mirrors age groups: near uniform growing disadvantage or attenuation of advantage. This was also mostly true for males with two notable exception: neoplasms and cardiovascular mortality, the first showing moderately increasing US advantage and the latter attenuating disadvantage.

Now that we have laid out the foundation of decomposition of life expectancy we return to the motivating question of this section: What age groups and causes of deaths are responsible for the increased relative deterioration of US mortality since 1955? To address this directly we construct a difference-in-difference decomposition from the raw decompositions shown above. The results of this analysis show the age- and cause-specific components of narrowing or widening US life expectancy disadvantage, which are shown in Table 7 and graphically in Figure 17. From 1955 to 2010, we see a few trends: US mortality from birth to age 10 generally increases the US life expectancy disadvantage (males and females); infections and accidents/homicide/suicide and external causes of death from early adulthood through midlife increase US disadvantage (males and females); senility in the oldest ages increases US disadvantage, particularly for females; and respiratory and digestive cases of death for ages above 50 increase US disadvantage. But this is not the whole story. Cardiovascular

causes of death strongly *narrow* US disadvantage from midlife on for men and for females at the oldest ages. That is, while the US still trails the pooled average in these areas the disadvantage is decreasing, resulting in a narrowing of the overall disadvantage.

In the above analyses we have focused mostly on the pooled average with passing reference to the optimal composite. In the last part of this section we present several counterfactuals constructed from either the pooled average or optimal composite. We are most interested in life expectancy at birth, conditional life expectancy at age 50, and temporary life expectancy from birth to age 50. We investigate how these quantities change for the following counterfactuals:

1. The US experienced the average/optimal IMR
2. The US experienced the average/optimal mortality rates for ages 15-50
3. The US experienced the average/optimal mortality rates for ages 50-70

Results from these calculations for 2010 are in Table 8 and 9. Life expectancy at birth, conditional life expectancy at age 50, and temporary life expectancy between birth and age 50 for these scenarios are shown graphically in Figures 18 through 20 and Figures 21 through 23. For the counterfactuals constructed using the pooled average we see the greatest improvement in e_0 for males when substituting M_x values for ages 15-49, but for females the greatest improvement results from substituting M_x values for ages 50-69. For the counterfactuals constructed using the optimal composite we see equal improvement in e_0 for males when substituting M_x values for ages 15-49 or ages 50-69. For females the greatest improvement again results from substituting M_x values for ages 50-69. This confirms that the greatest source of US male life expectancy disadvantage occurs during ages 15-49, but for females the source is later in life, above age 50.

4.5 Early life mortality and the contribution of disadvantaged groups

In this section we test the hypothesis that the bulk of the recent increase in the US disadvantage would vanish if one could reduce the infant mortality rate (IMR) and, in particular, (a) use different definitions of live births, (b) eliminate the surplus of deaths due to an unfavorable distribution of births by gestational age, and (c) alter the distribution of births so that it is less influenced by births who experience poorer health conditions.

As we saw before the contribution of infant mortality in particular, and child mortality more generally, to the disparity between the US and other countries has been increasing rapidly and is very large. It follows that identifying the factors that determine infant mortality could go a long way in explaining the poor US performance in the last 50 years.

There are three objections to the using quantities heavily influenced by the infant mortality rate (IMR, such as life expectancy at birth), to gauge the state of health in the US. Finally, the third objection (see (iii)) is misleading and leads to some surprising inferences that confirm even more strongly the US disadvantage.

Objection 1: Definition of a live birth It has been argued in many circles that comparisons of infant mortality rate between the US and peer countries in the OECD are inappropriate {15–17}. Lack of comparability stems from the definition of live births or the number of events that constitutes the denominator of an “infant mortality rate” (more correctly defined as the probability of dying before the first year of life). The US and most developed countries adhere to a common definition. But despite this appearance of agreement there are still persistent differences in the criteria adopted by countries. (See Table 2 from {18}.) Thus, whereas the US includes all live births, other countries apply exclusionary criteria that lead to reductions in the denominator that include births who are exposed to the highest risk of mortality. However, it is unlikely that these differences can account for the US disadvantage in IMR or neonatal rate because only 0.16% of all US live births are infants weighing

less than 500 grams. If we use a definitional standard that excludes this group altogether we adjust the US IMR (2005-2010) by about 0.85, reducing it from 6.8 to 5.8. Although the same adjustment ought to be applied to several of the countries in the comparison groups, we simply compare the new life tables with the unmodified pooled benchmark. The new contrast is thus highly conservative and reflects the maximum reduction in the difference between the US and peer countries that could be expected after adjustments. After recalculation of estimates of IMR, life expectancies, temporary life expectancies, and differences with benchmark we find that the adjustments have only trivial consequences (figures not shown).⁹

In summary, although the objection is well-justified, removing the source of potential distortion leads to trivial changes in the relative magnitude of differences in life expectancy and in relative rankings and the original contrasts in mortality between the US and the pooled benchmark withstand scrutiny.

Objection 2: Length of gestation The IMR is a weighted average of gestational age-specific IMR, where the weights are drawn from the distribution of live births by gestational age. It has been argued that the US apparent IMR disadvantage (and the resulting unfavorable level of life expectancy) is a product of a rather unusual composition of births by length of gestation, one that contains a far higher fraction in the low durations (below 36 weeks) than in peer countries. In fact, among all 2004 US births about 12% were preterm. Contrast this with Sweden or Norway where preterm births account for not more than 6 or 7% of all births. Since preterm births are at higher risk, the US IMR could be higher even if the gestation-specific rates were lower. How much of the observed difference in IMR and in life expectancy at birth between the US and other countries is due to difference in gestational age-specific mortality? How much is due to composition of births by length of gestation?

The key objection is that part of the US disadvantage in IMR (and possibly life ex-

⁹ The US life expectancy rank moves from second to last to about fourth to last in the set of 21 countries considered here. The total improvement in life expectancy at birth is less than 0.1 years—not much of an improvement.

pectancy at birth) may be induced by an unfavorable composition of births by gestation, as if this were a non-health-related factor playing a role akin to the age distribution in the computation of deaths rates. But the composition of births by length of gestation is part and parcel of the phenomenon being studied since it reflects not just medical decisions and technology but also maternal health and behaviors influenced by smoking, drug and alcohol use, and substandard prenatal care. Even if all the difference between the US and other countries IMR were solely due to different composition by length of gestation we cannot dismiss it as an “artifact.”¹⁰

But even if we set aside these problems, computations that eliminate the influence of composition of birth by length of gestation do not alter the US disadvantage in IMR and life expectancy. The four graphs contained in Figure 24 tell the story. The first graph displays the observed IMR, where the US ranks second to last. When one uses quantities that exclude very short gestation births (less than 22 weeks of gestation) the US IMR drops by about 0.85 of its observed value. As the second graph shows, since IMR in other countries also changes, the US ranking only increases from second last to fourth to last. Next we calculate how much of the US IMR is attributable to composition by length of gestation. We use the Swedish distribution as a standard and recalculate IMR for all countries in the comparison set. The result is in the third graph where we compare IMR adjusted for length of gestation. About two-thirds of the original difference between the US and Sweden appears to be associated with composition by length of gestation. What if all countries were able to approach the experience of Norway’s composition by length of gestation, the best of the lot? The results are in the last graph. As reflected in the contraction of the x-axis, all countries would improve but the US would still be ranked at the bottom.¹¹

In summary, although this objection is highly debatable because it obscures a funda-

¹⁰ It can be argued that a higher fraction of short gestation births is the result not of poor maternal and prenatal conditions but rather of medical practices and zeal, but this is a matter that should be investigated rather than asserted as a source of artifacts.

¹¹ In figures not shown we display the differences in life expectancy at birth after recalculating IMR under different assumptions about the distribution of births by length of gestation. As was the case with adjustments of the differences for definition of live births, recalculated differences contract by only insignificant amounts.

mental distinction between health mechanisms and measurement artifacts, the downward adjustment that results from a redistribution of US births by gestational age (from a disadvantageous one to a more salubrious) does not have a tangible impact on the US disadvantage at any age.

Objection 3: Racial and ethnic minorities The third objection is, we think, very difficult to justify and misleading. It asserts that the US disadvantage is an outcome of poor performance of selected race or ethnic groups and that the majority population experiences levels of mortality comparable or better than peer countries. This is an objectionable objection. First, as mentioned before, an identical argument can be made for countries in the comparison set: Sweden, Germany, Italy, France all have ethnic and racial minorities and disadvantaged groups as well and they could potentially experience conditions that make the national indicator look worse than for the rest of the population. And even if one accepts that race and ethnic heterogeneity contribute to national disparities, what should the target population be? It is easy to see that this leads to an unsolvable conundrum and effective dismissal of national indicators of anything, not just health.

What would the US IMR (and associated life expectancy at birth) be if the disadvantaged groups were not disadvantaged at all and were instead exposed to conditions similar to those experienced by the healthiest segment of the population? Note that unless we apply the same type of distinctions in all other countries, we are stacking the deck in favor of the US except in one case: when the USA disadvantage persists even after removing the influence of disadvantage groups.

We know that Non-Hispanic Blacks (NHB) are a disadvantaged minority (representing about 14% of all births) with a higher IMR that exerts considerable influence on the US national figures. Part of the difference is due to a disadvantageous birth composition by length of gestation. By the same token, though, some race/ethnic groups experience considerably better conditions than the majority, NHW—notably, Hispanics and Asians. If all groups

in 2006 experienced the same length of gestation composition of NHW, a more benign one than the one experienced by NHB, the US IMR would retreat from 6.8 to about 6.4. If, in addition, we apply an adjustment to remove the influence of very short gestation newborns (see above), the US IMR would drop to about 5.4, a figure that translates into paltry gains in IMR or life expectancy relative to peer countries. Finally, if both the composition by length of gestation and length of gestation-specific IMR of NHW applied to everybody in the US, IMR would be second to England and Wales but would overtake no country and its rank would stay the same.

Calculations above made some ethnic groups worse off. What about if instead of holding the NHW population as a standard we were to use race and ethnic groups that excel? How well would the US do if the entire population experienced the same conditions as Hispanics? It turns out that, at least for the target year in our calculations, the US IMR would drop to 3.7, would overtake 13 peer countries, and would be ranked sixth lowest.

4.6 The US advantage at older ages: a shifting landscape

We turn to the apparent advantage enjoyed by the US population at very old ages, over 70 or 75, after which the M_x ratios are favorable to the US relative to the pooled benchmark (see Figures 5-7). A comparison of time trends of differences in life expectancy at age 75 is useful to summarize the phenomenon. Figure 25 displays the differences in life expectancy at age 75 relative to both the pooled and optimal benchmark for the entire period.¹² The US starts out with an important advantage (1 year for males and females or about 13% of the average residual expected years of life after age 75). But its position deteriorates gradually over time and by 2005-2010 there is scarcely any advantage left. Note that the contrast with the optimal benchmark reveals that the US does not do well when compared to societies that experience optimal mortality rates at older ages. The results in Figure 25 are consistent with advantageous patterns of M_x that turn disadvantageous at progressively older ages, e.g.

¹² We use e_{70} because it is a good summary indicator of M_x for $x \geq 75$. However, the regularities we find are, with some minor variation, applicable to all M_x in open age interval 75+.

with crossing ages that become gradually older.

To obtain more precise estimates of crossing ages throughout the period examined, we use two methods. First, we estimate a model for M_x ratios (relative to pooled benchmark) identical to the one explored before but only from observations for ages 60 and above. Table 10 displays results for males and females. The fit of the model is tight¹³ ($R^2 > 85$), sensitivity to age changes is close to that of the standard ($\beta \sim 1$). This changes over time as the slope of the ratios with respect to the standard increases for more recent periods (i.e., positive interaction term). As reflected in the coefficient for time for males (0.45), mortality excess relative to the pooled benchmark increases whereas for females decreases (-1.03), at least in the neighborhood of ages at which the standard ratios approach 1. Estimates of crossing ages are computed from the parameters of the model.

Second, we compute model-independent estimates with simple linear interpolation of the M_x series in each calendar year. Unlike the model-dependent estimates, the results of interpolation are more affected by noise and multiple crossing at very old ages, particularly in the most recent period. Figure 26 displays interpolated and model-based estimates over the entire period for both males and females. Although, as expected, the model dependent estimates are smoother and more regular than the interpolated ones, the inferences are the same: prior to 1970 crossing ages are nearly invariant and from 1970 onward the time trend is approximately linear for both males and females. Despite differences, both sets of estimates confirm a clear, sharp increasing trend. An important feature of these estimates is that the gender differentials are minimal except at the tail end of the period we examine.

Table 11 shows results of fitting a linear trend to the observed crossing age. Among males the crossing age is increasing at a rate of about 0.59 years per year, but this slope is highly influenced by the most recent part of the trend. Among females the rate of increase is about 0.43 years per year.

A systematically increasing crossing age is inconsistent with past empirical research that

¹³ Part of the increase in the fit of the models is that there is only one crossing age after age 60 whereas there are two (the other being 0) when we consider the entire age span from 0 to 100.

suggests either an unchanging crossing age over time or one that varies within a fixed but small range {1, 2}. While the literature recognizes some variability in this age, previous analyses rested on the premise that the US did badly at ages over 50 but not at ages older than 75 or so. The finding is relevant because it shifts the grounds for hypothesis testing as it automatically rules out explanations that are plausible only when the crossing age is fixed (or is very old).

Why should a crossing age exist at all? The most obvious possibility is that the entire pattern of M_x ratios shifts upwards every year by the same magnitude at all ages. This, in turn, suggests the presence of a force that worsens the US mortality experience at all ages (relative to peer countries). The evidence examined before does indeed suggest the existence of such a process but it also shows that the shift is more significant at older ages (see Table 10). This points to a second possibility, namely, that there is deceleration of the rate of decrease of mortality in the US (relative to peer countries), that this process is stronger at older ages and, finally, that the rate of deceleration becomes steeper with time.

In what follows we review a number of alternative hypotheses and the associated empirical evidence. To do so we follow loosely arguments by Ho and Preston {9} with the caveat that theirs is mostly an attempt to explain sustained disadvantages at ages over 50 rather than to account for shifts of the age at which mortality patterns in the US are more advantageous. In fact, a number of their hypotheses are tenable only if the crossing age remains fixed over time. Preston and Ho make a convincing case for one of the explanations (quality of health care) that turns out to be unsuitable to account for a crossing of the US and peer mortality patterns.

The first four explanations reviewed below identify well-defined health-related conditions that could account for the US old age advantage and time trends in crossing ages. The last two suggest that both phenomena could be an artifact.

Access to health care According to this explanation the US does better at older ages because of almost universal coverage made possible by the adoption of Medicare after 1968. As Preston and Ho argue, if this were the correct explanation, the US old age advantage should vanish for mortality experienced by older cohorts who did not have access to Medicare. This is exactly the opposite of what the data show (see above). If anything, relative conditions worsen for the more recent cohorts who have had fuller Medicare coverage.

In addition we argue that there is no reason for the US to have an old age advantage solely because of implementation of quasi-universal coverage at ages past 65 because virtually all peer countries have had such coverage in place for a longer period of time than the US. Furthermore, and most important for our purposes, this conjecture cannot possibly explain the increasing trend in the crossing age. Indeed, if the explanation were correct one would expect to see a crossing age situated around age 65 or so and holding steady after 1968-1970.

Quality of health care Some data suggest that the older US population benefits more than peer countries from better screening for and treatment of chronic conditions responsible for a large fraction of mortality at older ages: cancer (particularly breast, colon, and prostate), Ischemic Heart Disease (HD), Acute Myocardial Infarction (AMI), cholesterol, and hypertension. The empirical evidence brought to bear in this case is not as strong as one would desire but the conjecture stands out as the most convincing nevertheless {9}.

Two issues remain to be sorted out, however. The first is that, under a strict interpretation, the empirical evidence presented leads us to expect a declining not a steady or increasing crossing age. If better health care applies equally to all (and health care access above age 65 is quasi-universal) and those who benefit from superior health care are no more frail than the rest of the population, one would expect the mortality rates of younger cohorts to decrease relative to peer countries and those at older ages to remain steady. This should shift the crossing age to younger ages, exactly the opposite of the observed pattern.

The second issue is as follows: a well-known result of the standard mortality hetero-

geneity model implies that better screening and treatment at some (early) ages generates a subpopulation that survives to older ages with higher than average frailty. If the steeper inflow of the frail is proportionately higher in the US (due to superior care at younger ages) one would expect the observed mortality rates at older ages to increase relative to peer countries but decrease at younger ages. The observed M_x age pattern is consistent with the first part of this prediction—an increasing crossing age could result from raising mean and variance of frailty—but, as shown before, totally incongruous with the second prediction. We cannot have it both ways: since only one of the conjectures prediction is consistent with the evidence we must conclude that better overall health care in the US cannot account for observed patterns.

Smoking Could smoking trends and the changing composition of cohorts by past smoking explain the existence of worse mortality and a linearly increasing crossing age? Given the contrasts in the history of smoking in the US and peer countries, one might suspect that smoking would be a key contributor to the US disadvantage in mortality at ages 50-70 among both males and females. There is evidence demonstrating that the US disadvantage is partially explained by excess smoking-attributable mortality {1, 2}. But, can smoking trends account for the increasing trend in crossing ages? Forerunners in the US smoking epidemic are men who entered their teens around 1935-40, reached their 50s in the 1970s and attained their 65th birthday around 1985. One would expect this and subsequent birth cohorts with high prevalence of smoking to experience relatively worse mortality than equivalent cohorts in peer countries.¹⁴ If so the age at which the US advantage surfaces for the first time must begin to shift upward as soon as the forerunners of the epidemic attain ages beyond which the risks of mortality attributable to smoking increase sharply (60-65). The experience for US females should be the same the same but lagging behind by ten to fifteen years.

To assess the role of smoking in the observed trends we compute the counterfactual M_x 's

¹⁴With the exception of the UK, the smoking epidemic in other high-income countries is believed to have started a decade or so later than in the US.

for the US and peer countries from 1955 on and re-estimate the crossing ages for each year of observation.¹⁵ The test is analogous to one performed by Preston and Ho for a single year but we add an important modification: we estimate a time trend on the fraction of deaths attributable to smoking from 1975 to 2010. For each year and single year of age we deflate the mortality rates on both the US and the pooled benchmark by an amount equal to the estimated fraction of all deaths attributable to smoking derived from the estimated trend. Finally, we compute the M_x ratios using the new, adjusted quantities. If smoking were the main or only explanation the adjusted ratios of M_x 's would display no trend in the crossing ages at all. Figure 27 shows that this is partially the case for both males and much less so for females. Raw adjusted and model-dependent (fitted) adjusted estimated trends of crossing ages are flatter for males than the unadjusted trend but only marginally so for females. In fact, a simple OLS time trend fitted to the adjusted (for smoking) crossing ages among males produces a slope of 0.10, down from 0.59 in the unadjusted estimates. For females, though, the slope declines from 0.42 to 0.15, a more than trivial reduction but not a convincingly conclusive one. A final caveat: among males the adjusted crossing age now hovers around 70, five years younger than the age above which the US is believed to perform much better than peers {1}.

The fact that adjustments for smoking reduce the time dependence of crossing ages is comforting for it suggests that smoking prevalence and its sequelae is an important factor behind the upward displacement of ages at which the US does better than peer countries. But the persistent gender differences are puzzling: if smoking is the main explanation it should work equally well among males and females. It does not: mortality among females continues to be better in the US above ages that increase over time even after adjusting for the gender lag in smoking uptake.¹⁶

¹⁵ We use the estimates of smoking attributable risks described in the National Academy of Science report {1}.

¹⁶ In addition to smoking, Preston and Ho also suggest obesity and associated excess mortality risks as an explanation for the US old age advantage. Since increasing obesity and its sequelae could also explain increasing crossing ages we attempted to adjust for it using a procedures analogous to the one we implemented for smoking. However, for it to make any difference, the obesity epidemic would have to have started much earlier than what it really did and more so for females than for males.

Could it be that both the US advantage at older ages and the time trend in crossing ages are simple artifacts?

Selection Selection processes whereby members of a birth cohort who survive to older ages are disproportionately drawn from among the sturdiest members produce mortality patterns that rise less rapidly at older ages. Because all populations are likely to experience selection processes, an explanation for the patterns of US advantages/disadvantages based on selection alone is only tenable if there is stronger selection (less rapidly rising old age mortality) in the US than elsewhere. The first mechanism that may produce this result is one whereby the US selection processes become increasingly weaker over time (due to health and mortality improvements at younger ages). If so, US mortality rates at older ages will be relatively higher and the age at which the slope of the mortality curve slows down should increase. But there is no reason to expect that the same process is not occurring elsewhere. If it is the observed pattern of M_x ratios can only occur if relaxation of the selection process is more rapid and intense in the US than elsewhere. The only way to prove this is by identifying a time trend in the correlation between mortality at older and younger ages becomes weaker by birth cohorts: it should gradually increase from negative values to positive values and should do so more rapidly in the US than elsewhere. Unfortunately, we have no data to confirm this prediction.

A second mechanism that produces this outcome involves the variance (and higher moments) of the frailty distribution at birth: the higher the variance, the stronger the force of selection is and, consequently, the lower the slope of old age mortality rates {19}. To verify the presence of this mechanism we should prove that the US population's frailty distribution at birth has larger variance than in peer countries. This is an unverifiable proposition. An indirect test can be performed, however. Since an important contributor to increasing variability in frailty in the US is rooted in its diverse ethnic composition, we can focus only on M_x patterns for the least heterogeneous population, namely, NHW. We showed before,

however, that the recalculated differences between US and peers hardly changes at all and this implies that the pattern of crossing ages is approximately the same among NHW than in the total.

Age misstatement It is well-known that in the US, and somewhat less so in other high income countries, mortality rates at older ages are oftentimes biased downward due to either overstatement of ages of the population or overstatement of ages at death {20}. In the US these biases have proven useful to account, at least partially, for the so-called Black-White cross over {21}. Although these biases are also present in European countries that rely on vital registration and censuses (but much less so countries with population registries), they seem to be of lower magnitude than in the US and/or start at older ages. If differential bias is consequential mainly at older ages, a cross-over between the US M_x 's and those in peer countries could take place. If so, we would expect lower M_x ratios than the true ones starting at an age when US (relative) overstatement of ages begins to be influential. If the error affects ages over 75 more so than younger ages we could observe deceptively low values of M_x 's for the US and differential age overstatement alone could explain the sustained US advantage over peer countries. But, could it account for the increasing age above which the US retains the advantage? The most obvious possibility is that the age at which age overstatement is relevant is being displaced upward, a result of better age declaration both in population censuses and vital registration, increasingly so among older people and, lastly, more pronounced in the US than in peer countries affected by the same problem.

Could age overstatement produce the pattern of increases in the ages of crossing? To test this explanation we proceed as follows. From extensive simulations {22} we estimate a pattern of age overstatement that is consistent with observed age overstatement both in the US around 1970 and Costa Rica around 2000, the only two countries for which we have available information {20}.¹⁷ We then compute ratios of undisturbed to observed M_x 's

¹⁷The underlying pattern of misreporting implies that the net proportion of individuals who overstate their ages increases from 0.05 at age 60 to 0.20 at age 99 and that the age reported is distributed symmetrically

obtained after applying two different patterns of age overstatement. These are displayed in Figure 28. The pattern with the sharpest rising ratios assumes absence of age overstatement at death; the other assumes both. Because the first of these two patterns leads to implausibly large correction ratios at older ages, our computations proceed assuming the second.

The product of the observed M_x ratios by the adjustment ratios in Figure 29 yields values that are unaffected by age overstatement in the US (only) data. If we assume that age overstatement decreases over time and in 2005 is, say, 90% of what it was in 1985 (but preserving the same age pattern) we obtain corrected M_x ratios for 1985 and 2005. These are plotted (together with those observed in the data) in Figure 29. The main message of this figure is this: correction for age overstatement leads to a virtual removal of the time trend of crossing age: between 1985 and 2005 the observed crossing age grew from about 70 in 1980 to about 80 in 2005, a 0.50 year per year increase consistent estimates obtained before. But once we remove the errors due to age overstatement there is scarcely any time trend left in the crossing ages: the interpolated estimate is about 72 years in both cases.

Admittedly, we do not know for sure what the true pattern of age overstatement in the US is, much less if its rate of improvement over time (if any) is as assume above. What the exercise does prove is that both the US advantage at older ages and any time trends therein could also be attributable to artifacts produced by a pattern of plausible (differential) data errors.¹⁸

5 Summary and Conclusions

We conclude with a brief summary of the most important findings. First, the US mortality disadvantage is a relatively recent phenomenon, one that was not present before 1975 or so. It affects the entire life span except, perhaps, very old ages. Observed disadvantages

around the true age with a maximum error of 5 years. We assume throughout that there are no differentials between males and females.

¹⁸ A more definitive proof of the role of age misstatement could be obtained from examination of mortality rates from Medicare data that are virtually immune to age reporting errors. However, we do not have access to appropriate information.

are more recent for females than for males but the their magnitude are roughly comparable. The relatively poor performance of the US is even more evident if we use both the optimal and the worst life tables as benchmarks: even at its best, US mortality was never even close to the optimal and in the most recent period it has deteriorated considerably by converging rapidly to the worst life table possible.

Second, the results of our decompositions are roughly comparable to the findings of others, though we cast the range of years, ages, and causes under investigation in a broader context. The one surprising finding from the difference-in-difference analyses was that cardiovascular causes of death strongly *narrow* US disadvantage from midlife on for men and for females at the oldest ages. Though the US still trails the pooled average in these areas the disadvantage is decreasing, resulting in a narrowing of the overall disadvantage. Unlike other research, however, we fail to find any substantial evidence of advantageous mortality at older ages affecting overall life expectancy.

Third, age patterns of US excess mortality are quite regular and can be modeled with a very simple representation that identifies (a) the speed of deterioration by age, (b) the existence of crossing ages, e.g. ages beyond which the US performs better than peers, and (c) time trends in the crossing ages. The model estimates enabled us to verify that while the US does indeed fare better at older ages, the advantage is measurable only in an increasingly shrinking swath of the age span.

Fourth, the US mortality disadvantage and its trends over time cannot possibly be attributed to excess infant mortality among some ethnic groups or, more generally, to the poor performance of minorities. In fact, the opposite inference is more appropriate: US mortality would look much better and move to the top of the ranks among peers if the NHW population had mortality patterns similar to those of some exceptionally performing minorities.

Fifth, time trends in crossing ages, e.g. the changing landscape within which the US enjoys an advantage, is puzzling. The upward shifts in the age over which the US experiences lower mortality are confirmed by using two independent estimation procedures. Though each

of them has drawbacks, it is unlikely that the tight relation they uncover between crossing ages and time is a computational artifact. But it could well be an artifact of increasingly less serious age overstatement at older ages. Further analysis should first confirm the pattern with impeccable and uncontested data, such as those from Medicare. Until that is done we can find some comfort resolving that smoking is a partial explanation but very incomplete and unsatisfactory since we are left with no explanation at all for the persistent trends among females.

Finally, the threat of an “artifact” due to selection does, as usual, raise its ugly head but it also opens the door for some intriguing research agenda ahead.

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Tables and Figures

Figure 1: *Life Expectancy at Birth by Sex (1955-2010)*

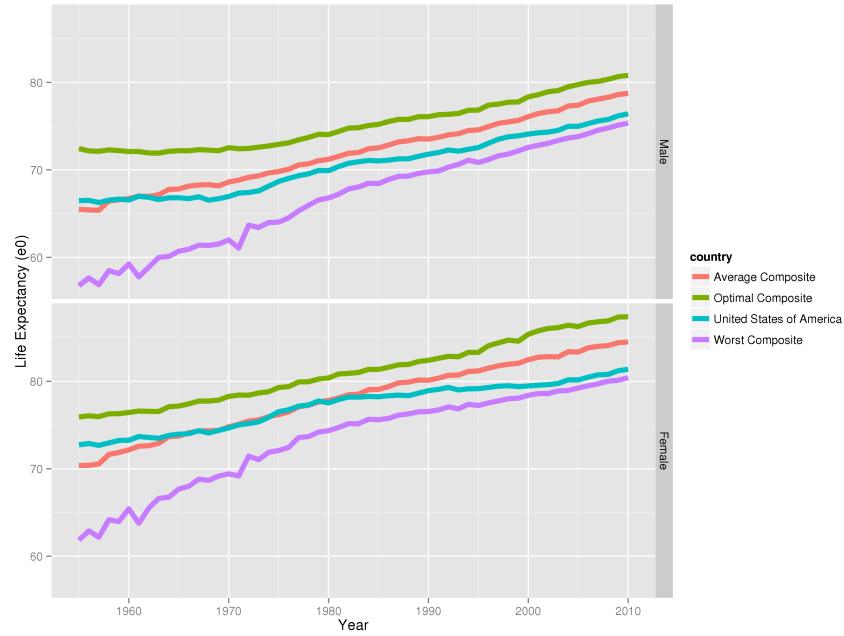


Figure 2: *Differences in Life Expectancy at Birth by Sex (1955-2010)*

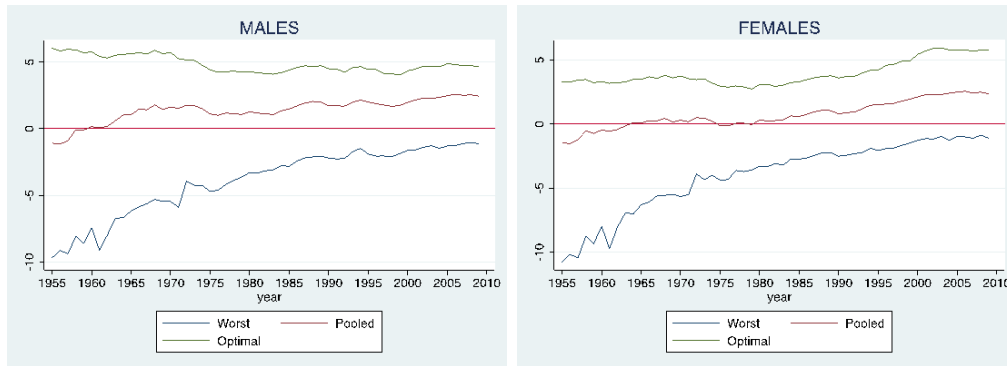


Figure 3: *Differences in Life Expectancy at Age 50 by Sex (1955-2010)*

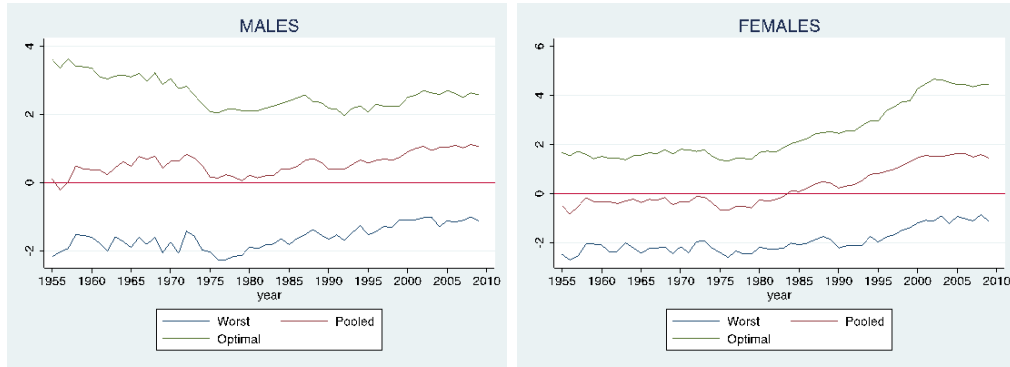


Figure 4: *Differences in Temporary Life Expectancy between Ages 0 and 50 by Sex (1955-2010)*

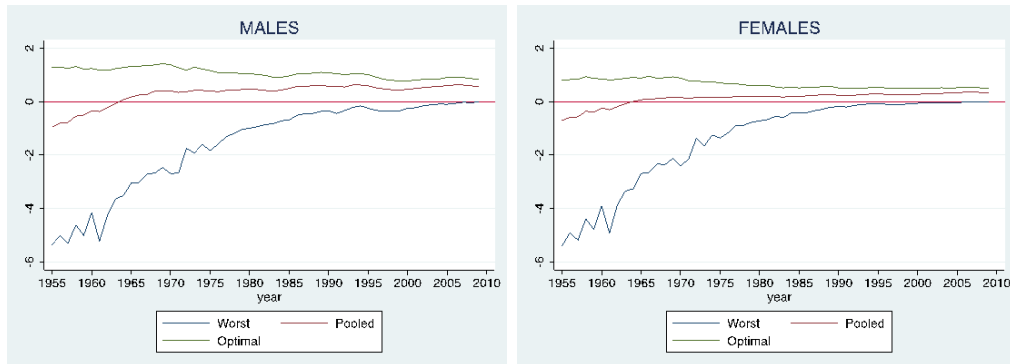


Figure 5: Ratios of US Mortality Rates to Pooled Benchmark Mortality Rates by Sex (1955-2010)

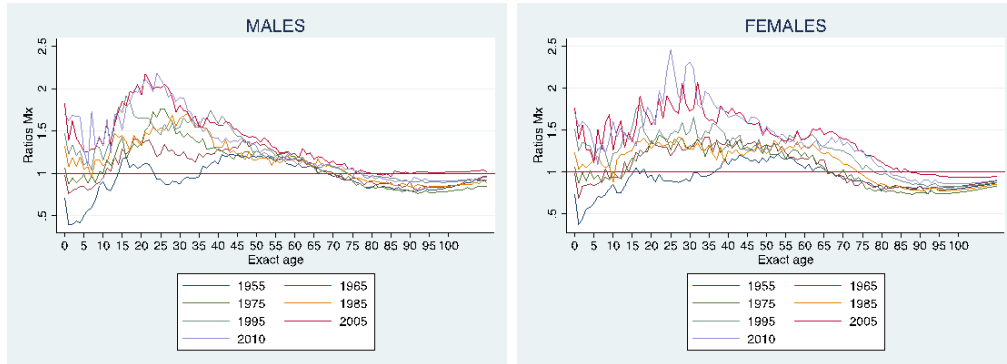


Figure 6: Ratios of US Mortality Rates to Optimal Benchmark Mortality Rates by Sex (1955-2010)

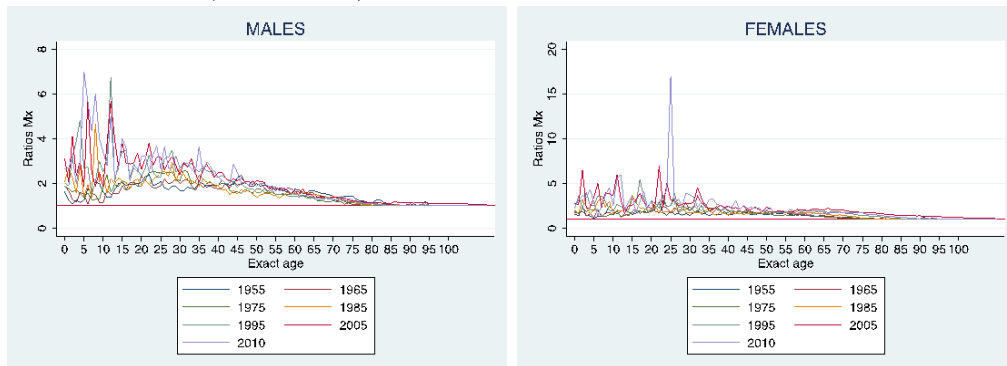


Figure 7: *Ratios of US Mortality Rates to Worst Benchmark Mortality Rates by Sex (1955-2010)*

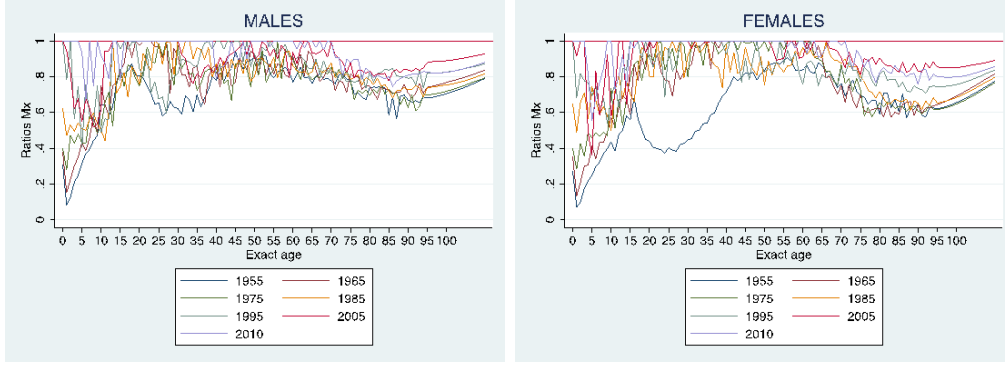


Figure 8: *Ratios of Mortality Rates in US Non-Hispanic White and US Total Population to Pooled Benchmark by Sex (2009)*

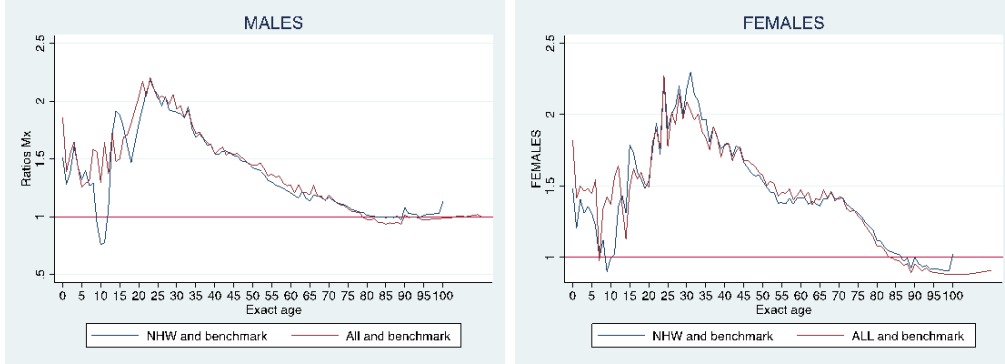


Table 1: *Estimates of Regression Model for M_x Ratios Using Pooled Benchmark by Sex (All Ages)*

	Males		Females	
Standard (β)	1.36	(0.033)	1.43	(0.033)
Time (t)	0.98	(0.050)	0.71	(0.050)
Interaction (δ)	-0.65	(0.052)	-0.32	(0.053)
Age=10 (θ)	0.32	(0.012)	0.32	(0.010)
Constant (α)	-0.33	(0.030)	-0.41	(0.031)
R^2	0.41		0.54	
N	6216		6216	

Standard errors in parentheses.

Figure 9: *Model-Dependent Ratios of US Mortality Rates to Pooled Benchmark by Sex (1955-2010)*

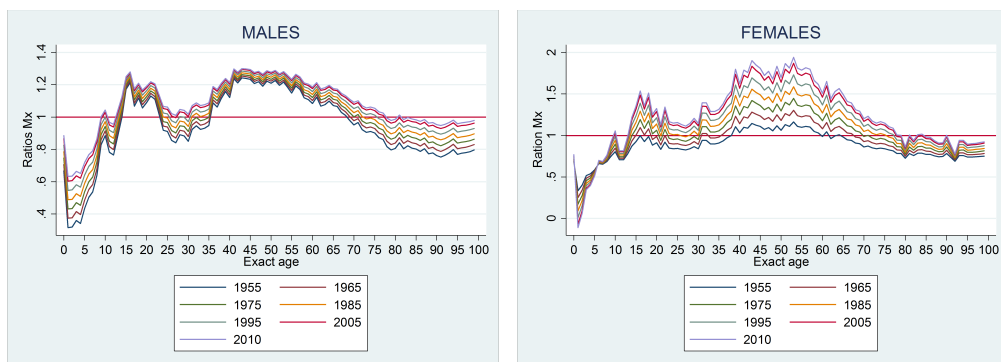


Table 2: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average (1955)*

Cause	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Males										
Neoplasms	-0.01	-0.01	-0.02	-0.00	0.00	0.04	0.04	0.04	-0.01	0.08
Circulatory	0.02	0.02	-0.00	-0.09	-0.36	-0.57	-0.49	-0.22	-0.14	-1.84
Respiratory	0.32	0.01	0.00	0.00	0.01	0.05	0.09	0.11	0.08	0.68
Digestive	0.30	0.02	0.03	0.01	0.01	0.04	0.06	0.04	0.01	0.53
Diabetes	-0.00	-0.00	-0.00	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01	-0.07
Infections	0.19	0.03	0.10	0.11	0.10	0.09	0.06	0.02	0.00	0.69
Acc/Hom/Suic	0.04	-0.10	-0.12	-0.07	-0.05	-0.02	-0.02	-0.01	-0.01	-0.35
Senility	0.10	0.01	0.01	0.02	0.02	0.05	0.07	0.16	0.24	0.68
Pregnancy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Infancy	0.22	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.20
Residual	0.15	0.02	0.02	0.01	0.01	0.03	0.06	0.07	0.03	0.40
23	1.34	-0.02	0.02	-0.00	-0.27	-0.31	-0.14	0.19	0.21	1.01
Females										
Neoplasms	-0.01	-0.01	-0.01	-0.02	-0.04	-0.05	0.00	0.03	0.00	-0.10
Circulatory	0.02	0.02	0.01	-0.02	-0.10	-0.21	-0.22	-0.14	-0.27	-0.91
Respiratory	0.35	0.01	0.01	0.01	0.01	0.02	0.06	0.13	0.14	0.72
Digestive	0.30	0.01	0.02	0.01	0.01	0.03	0.05	0.06	0.03	0.53
Diabetes	-0.00	-0.00	-0.00	-0.01	-0.01	-0.03	-0.04	-0.03	-0.01	-0.13
Infections	0.21	0.04	0.11	0.10	0.05	0.04	0.04	0.02	0.00	0.61
Acc/Hom/Suic	0.01	-0.02	-0.00	-0.03	-0.02	-0.01	-0.00	-0.00	-0.02	-0.10
Senility	0.10	0.01	0.01	0.02	0.02	0.03	0.08	0.24	0.53	1.03
Pregnancy	0.00	-0.00	0.02	0.03	0.01	0.00	-0.00	0.00	-0.00	0.05
Infancy	0.26	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.25
Residual	0.15	0.02	0.02	0.02	0.02	0.03	0.06	0.07	0.03	0.43
23	1.38	0.07	0.18	0.10	-0.07	-0.14	0.03	0.37	0.44	2.37

Expressed in years.

Positive values indicate US advantage, negative values US disadvantage.

Figure 10: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average (1955)*

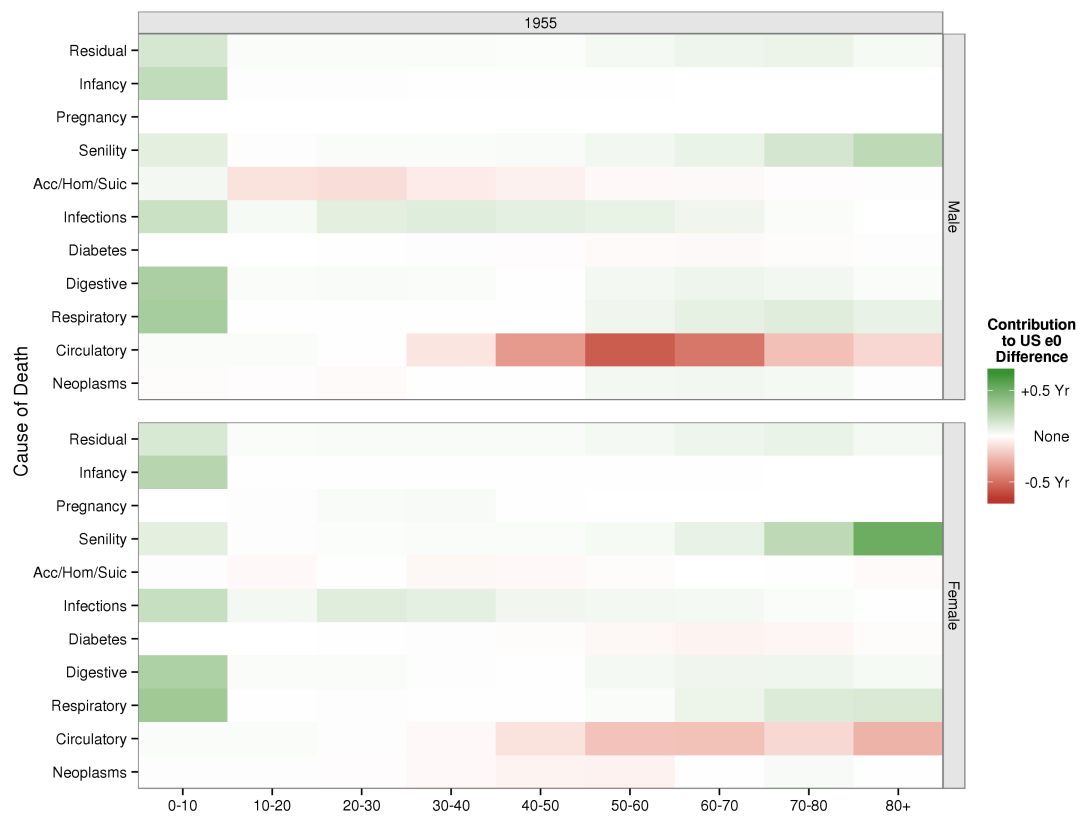


Table 3: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average (1980)*

Cause	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Males										
Neoplasms	0.01	0.01	-0.00	0.01	0.01	0.01	0.02	0.07	0.03	0.16
Circulatory	-0.01	0.00	0.00	-0.03	-0.15	-0.28	-0.26	-0.05	0.00	-0.77
Respiratory	0.03	0.00	-0.00	-0.00	-0.01	-0.01	-0.02	0.03	0.06	0.08
Digestive	-0.00	0.00	-0.00	-0.01	0.01	0.03	0.04	0.04	0.02	0.13
Diabetes	-0.00	-0.00	-0.00	-0.01	-0.00	-0.01	-0.01	-0.00	-0.00	-0.03
Infections	0.02	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.03
Acc/Hom/Suic	-0.02	-0.14	-0.36	-0.20	-0.07	-0.02	-0.00	0.01	0.01	-0.78
Senility	-0.06	0.00	0.00	0.00	0.00	0.00	-0.00	0.02	0.08	0.05
Pregnancy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Infancy	-0.10	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.11
Residual	-0.02	0.00	-0.01	-0.02	-0.01	-0.01	-0.01	0.01	0.02	-0.04
23	-0.16	-0.13	-0.37	-0.25	-0.21	-0.29	-0.24	0.14	0.22	-1.30
Females										
Neoplasms	0.01	0.00	0.00	0.00	-0.04	-0.10	-0.08	0.03	0.06	-0.10
Circulatory	-0.01	-0.00	-0.00	-0.02	-0.07	-0.15	-0.17	0.06	0.12	-0.25
Respiratory	0.03	0.00	0.00	-0.00	-0.01	-0.02	-0.02	0.03	0.13	0.14
Digestive	-0.00	-0.00	-0.00	-0.01	-0.02	-0.01	0.00	0.04	0.05	0.04
Diabetes	0.00	-0.00	-0.00	-0.00	-0.01	-0.02	-0.01	0.01	0.00	-0.03
Infections	0.01	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00
Acc/Hom/Suic	-0.03	-0.05	-0.08	-0.05	-0.03	-0.00	0.01	0.03	0.07	-0.13
Senility	-0.05	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.03	0.23	0.20
Pregnancy	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Infancy	-0.11	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.12
Residual	-0.02	-0.00	-0.01	-0.01	-0.02	-0.01	-0.01	0.02	0.04	-0.02
23	-0.17	-0.05	-0.10	-0.10	-0.20	-0.32	-0.29	0.23	0.71	-0.28

Expressed in years.

Positive values indicate US advantage, negative values US disadvantage.

Figure 11: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average (1980)*

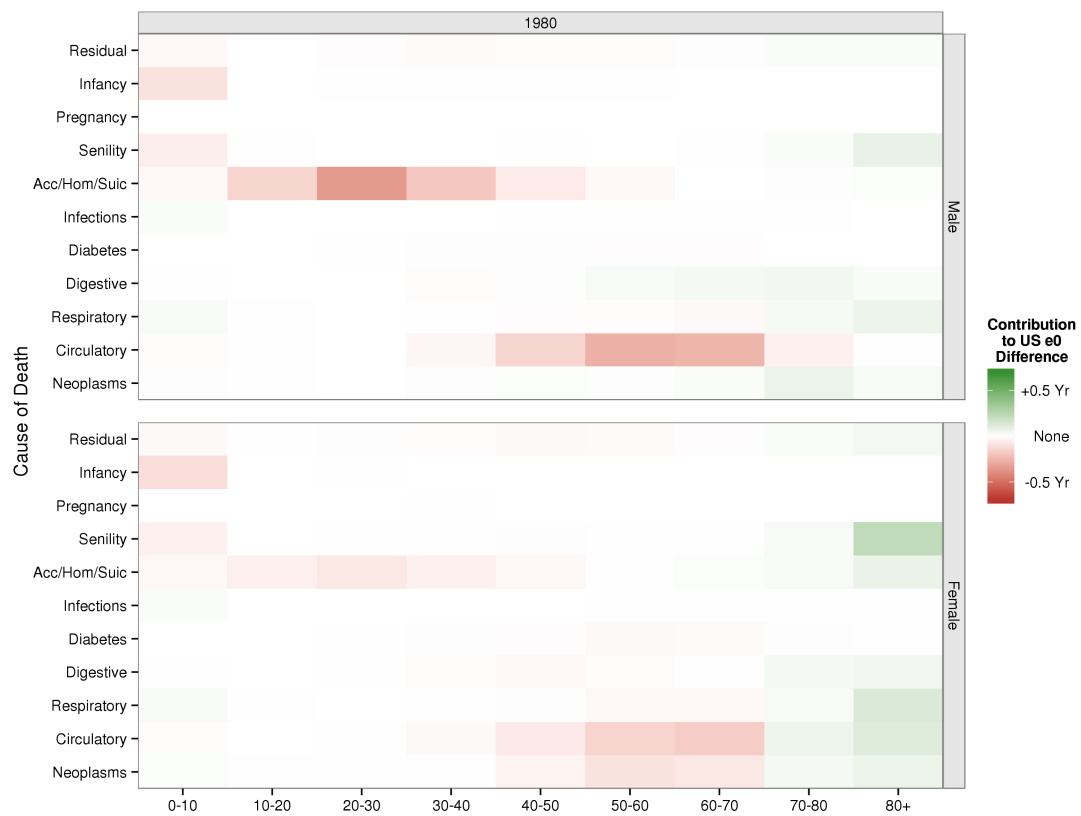


Table 4: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average (2010)*

Cause	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Males										
Neoplasms	-0.00	0.00	-0.01	-0.01	-0.00	0.01	0.05	0.10	0.14	0.29
Circulatory	-0.01	-0.00	-0.02	-0.05	-0.12	-0.22	-0.24	-0.11	-0.02	-0.79
Respiratory	-0.01	-0.00	-0.01	-0.01	-0.02	-0.04	-0.08	-0.05	0.13	-0.10
Digestive	-0.00	-0.00	-0.01	-0.01	-0.01	-0.03	-0.00	0.02	0.03	-0.01
Diabetes	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.05	-0.03	-0.01	-0.16
Infections	-0.01	-0.00	-0.01	-0.02	-0.04	-0.06	-0.04	-0.02	-0.01	-0.21
Acc/Hom/Suic	-0.07	-0.11	-0.30	-0.19	-0.15	-0.08	-0.02	-0.00	0.01	-0.90
Senility	-0.04	-0.00	-0.00	0.00	0.02	0.03	0.03	0.02	0.06	0.11
Pregnancy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Infancy	-0.15	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.16
Residual	-0.00	-0.00	-0.01	-0.01	-0.03	-0.05	-0.07	-0.11	-0.22	-0.50
23	-0.30	-0.11	-0.37	-0.31	-0.38	-0.49	-0.42	-0.18	0.12	-2.44
Females										
Neoplasms	0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.14	-0.14	0.04	-0.32
Circulatory	-0.01	-0.00	-0.01	-0.03	-0.08	-0.16	-0.23	-0.20	0.03	-0.70
Respiratory	-0.01	-0.00	-0.01	-0.01	-0.03	-0.06	-0.14	-0.18	0.02	-0.43
Digestive	-0.00	-0.00	-0.00	-0.01	-0.02	-0.03	-0.02	-0.01	0.05	-0.05
Diabetes	-0.00	-0.00	-0.00	-0.01	-0.02	-0.03	-0.05	-0.04	0.01	-0.14
Infections	-0.01	-0.00	-0.01	-0.02	-0.03	-0.04	-0.04	-0.03	-0.03	-0.20
Acc/Hom/Suic	-0.05	-0.04	-0.08	-0.08	-0.10	-0.06	-0.01	-0.00	0.02	-0.40
Senility	-0.04	0.00	-0.00	-0.00	-0.00	0.00	0.01	0.01	0.14	0.12
Pregnancy	0.00	-0.00	-0.01	-0.01	-0.00	-0.00	0.00	0.00	0.00	-0.02
Infancy	-0.14	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.15
Residual	0.00	-0.00	-0.01	-0.02	-0.04	-0.06	-0.09	-0.16	-0.53	-0.91
23	-0.25	-0.05	-0.15	-0.20	-0.33	-0.48	-0.72	-0.75	-0.25	-3.20

Expressed in years.

Positive values indicate US advantage, negative values US disadvantage.

Figure 12: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average (2010)*

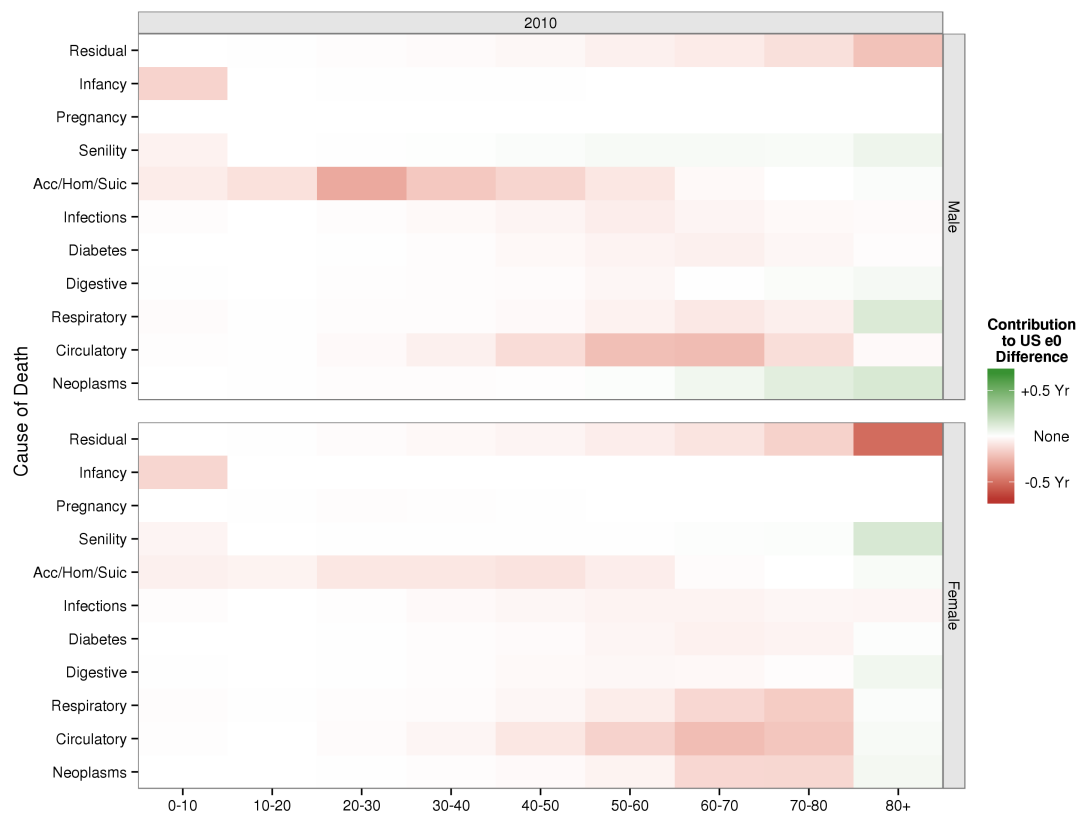


Table 5: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average, Age Components (1955-2010)*

Cause	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Males										
1955	1.34	-0.02	0.02	-0.00	-0.27	-0.31	-0.14	0.19	0.21	1.01
1960	0.66	-0.05	-0.04	-0.08	-0.35	-0.42	-0.19	0.14	0.16	-0.17
1965	0.19	-0.10	-0.19	-0.14	-0.34	-0.48	-0.21	0.14	0.14	-1.00
1970	-0.02	-0.13	-0.35	-0.25	-0.40	-0.55	-0.27	0.15	0.16	-1.66
1975	-0.06	-0.11	-0.35	-0.24	-0.25	-0.36	-0.21	0.19	0.26	-1.14
1980	-0.16	-0.13	-0.37	-0.25	-0.21	-0.29	-0.24	0.14	0.22	-1.30
1985	-0.26	-0.11	-0.26	-0.29	-0.24	-0.27	-0.26	0.01	0.19	-1.49
1990	-0.25	-0.16	-0.29	-0.38	-0.31	-0.28	-0.25	-0.00	0.19	-1.73
1995	-0.24	-0.18	-0.29	-0.38	-0.42	-0.35	-0.25	0.00	0.09	-2.02
2000	-0.26	-0.12	-0.23	-0.21	-0.33	-0.33	-0.33	-0.12	-0.04	-1.99
2005	-0.32	-0.15	-0.38	-0.28	-0.39	-0.43	-0.40	-0.13	0.07	-2.41
2010	-0.30	-0.11	-0.37	-0.31	-0.38	-0.49	-0.42	-0.18	0.12	-2.44
Females										
1955	1.38	0.07	0.18	0.10	-0.07	-0.14	0.03	0.37	0.44	2.37
1960	0.67	0.01	0.07	-0.01	-0.14	-0.20	-0.06	0.35	0.40	1.10
1965	0.18	-0.03	-0.04	-0.11	-0.21	-0.25	-0.09	0.36	0.41	0.23
1970	-0.03	-0.05	-0.09	-0.15	-0.26	-0.32	-0.12	0.35	0.53	-0.14
1975	-0.08	-0.03	-0.08	-0.11	-0.21	-0.26	-0.10	0.39	0.83	0.34
1980	-0.17	-0.05	-0.10	-0.10	-0.20	-0.32	-0.29	0.23	0.71	-0.28
1985	-0.21	-0.06	-0.08	-0.10	-0.19	-0.39	-0.43	0.02	0.59	-0.84
1990	-0.22	-0.07	-0.09	-0.13	-0.19	-0.41	-0.52	-0.10	0.55	-1.19
1995	-0.22	-0.08	-0.10	-0.17	-0.22	-0.45	-0.64	-0.31	0.16	-2.03
2000	-0.23	-0.06	-0.10	-0.16	-0.25	-0.45	-0.80	-0.62	-0.33	-2.99
2005	-0.27	-0.07	-0.14	-0.19	-0.32	-0.45	-0.78	-0.70	-0.26	-3.19
2010	-0.25	-0.05	-0.15	-0.20	-0.33	-0.48	-0.72	-0.75	-0.25	-3.20

Expressed in years.

Positive values indicate US advantage, negative values US disadvantage.

Figure 13: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average, Age Components (1955-2010)*



Figure 14: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average, Selected Age Components (1955-2010)*

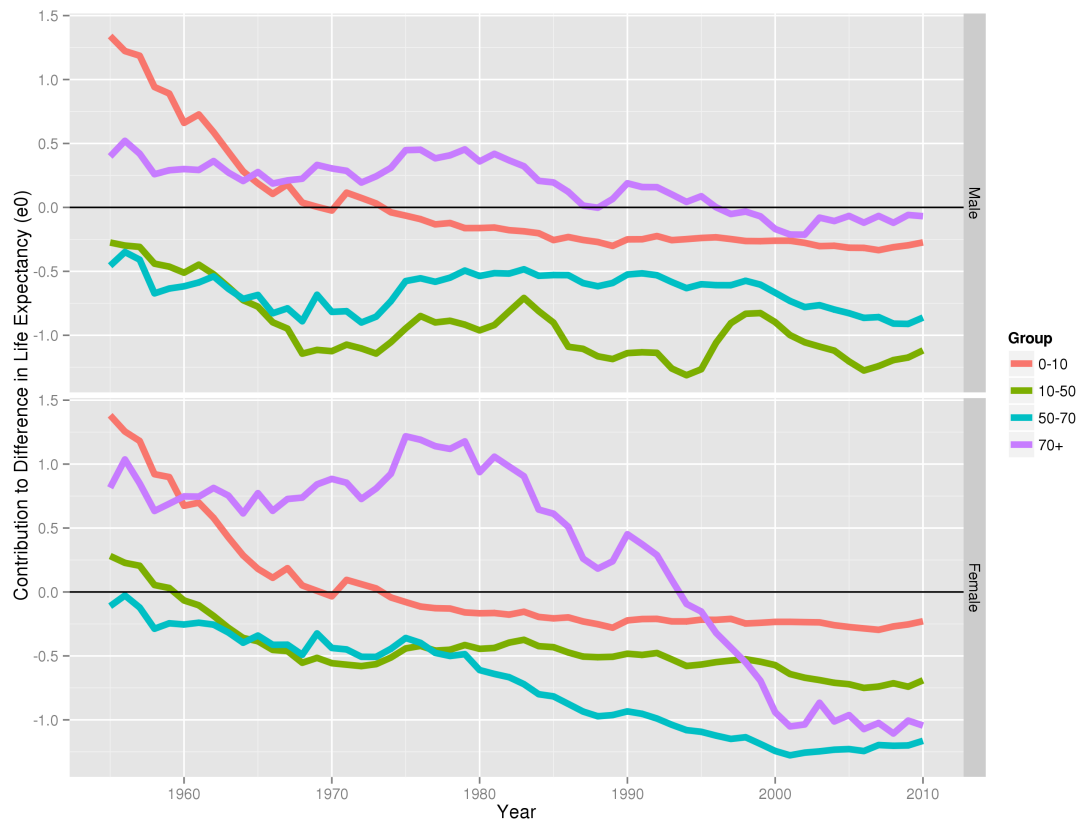


Table 6: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average, Cause Components (1955-2010)*

Cause	1	2	3	4	5	6	7	8	9	10	11	Total
Males												
1955	0.08	-1.84	0.68	0.53	-0.07	0.69	-0.35	0.68	0.00	0.20	0.20	1.01
1960	0.15	-1.82	0.40	0.31	-0.07	0.42	-0.30	0.44	0.00	0.03	0.03	-0.17
1965	0.16	-1.65	0.19	0.22	-0.06	0.23	-0.55	0.32	0.00	-0.08	-0.08	-1.00
1970	0.12	-1.50	0.23	0.09	-0.06	0.16	-0.75	0.18	0.00	-0.21	-0.21	-1.66
1975	0.16	-1.01	0.21	0.15	-0.02	0.08	-0.71	0.07	0.00	-0.09	-0.09	-1.14
1980	0.16	-0.77	0.08	0.13	-0.03	0.03	-0.78	0.05	0.00	-0.11	-0.11	-1.30
1985	0.18	-0.79	-0.03	0.10	-0.03	-0.08	-0.57	0.04	0.00	-0.16	-0.16	-1.49
1990	0.15	-0.63	-0.06	0.09	-0.07	-0.07	-0.65	0.12	0.00	-0.15	-0.15	-1.73
1995	0.23	-0.79	-0.02	0.07	-0.11	-0.06	-0.66	0.08	0.00	-0.13	-0.13	-2.02
2000	0.22	-0.89	-0.10	0.03	-0.15	-0.23	-0.57	0.07	0.00	-0.16	-0.16	-1.99
2005	0.25	-0.81	-0.08	0.01	-0.17	-0.22	-0.89	0.09	0.00	-0.18	-0.18	-2.41
2010	0.29	-0.79	-0.10	-0.01	-0.16	-0.21	-0.90	0.11	0.00	-0.16	-0.16	-2.44
Females												
1955	-0.10	-0.91	0.72	0.53	-0.13	0.61	-0.10	1.03	0.05	0.25	0.25	2.37
1960	0.03	-0.95	0.50	0.32	-0.13	0.31	-0.08	0.72	0.04	0.07	0.07	1.10
1965	0.06	-0.90	0.31	0.17	-0.09	0.13	-0.19	0.58	0.02	-0.05	-0.05	0.23
1970	0.03	-0.74	0.38	0.06	-0.07	0.11	-0.22	0.40	0.01	-0.19	-0.19	-0.14
1975	0.03	-0.26	0.32	0.08	-0.02	0.04	-0.14	0.28	0.01	-0.09	-0.09	0.34
1980	-0.10	-0.25	0.14	0.04	-0.03	0.00	-0.13	0.20	0.00	-0.12	-0.12	-0.28
1985	-0.22	-0.35	-0.06	0.03	-0.03	-0.06	-0.12	0.18	0.00	-0.13	-0.13	-0.84
1990	-0.33	-0.28	-0.20	0.03	-0.07	-0.09	-0.14	0.21	-0.00	-0.14	-0.14	-1.19
1995	-0.36	-0.69	-0.21	0.02	-0.13	-0.09	-0.17	0.14	-0.00	-0.12	-0.12	-2.03
2000	-0.46	-1.01	-0.38	-0.04	-0.19	-0.18	-0.22	0.11	-0.01	-0.14	-0.14	-2.99
2005	-0.38	-0.85	-0.39	-0.04	-0.18	-0.19	-0.37	0.12	-0.02	-0.17	-0.17	-3.19
2010	-0.32	-0.70	-0.43	-0.05	-0.14	-0.20	-0.40	0.12	-0.02	-0.15	-0.15	-3.20

Expressed in years.

Positive values indicate US advantage, negative values US disadvantage.

1=Neoplasms; 2=Circulatory; 3=Respiratory; 4=Digestive; 5=Diabetes and metabolic; 6=Infections; 7=Accidents, Homicide, Suicide, and External; 8=Senility and Ill-defined; 9=Pregnancy-related; 10=Infancy; 11=Residual.

Figure 15: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average, Cause Components (1955-2010)*

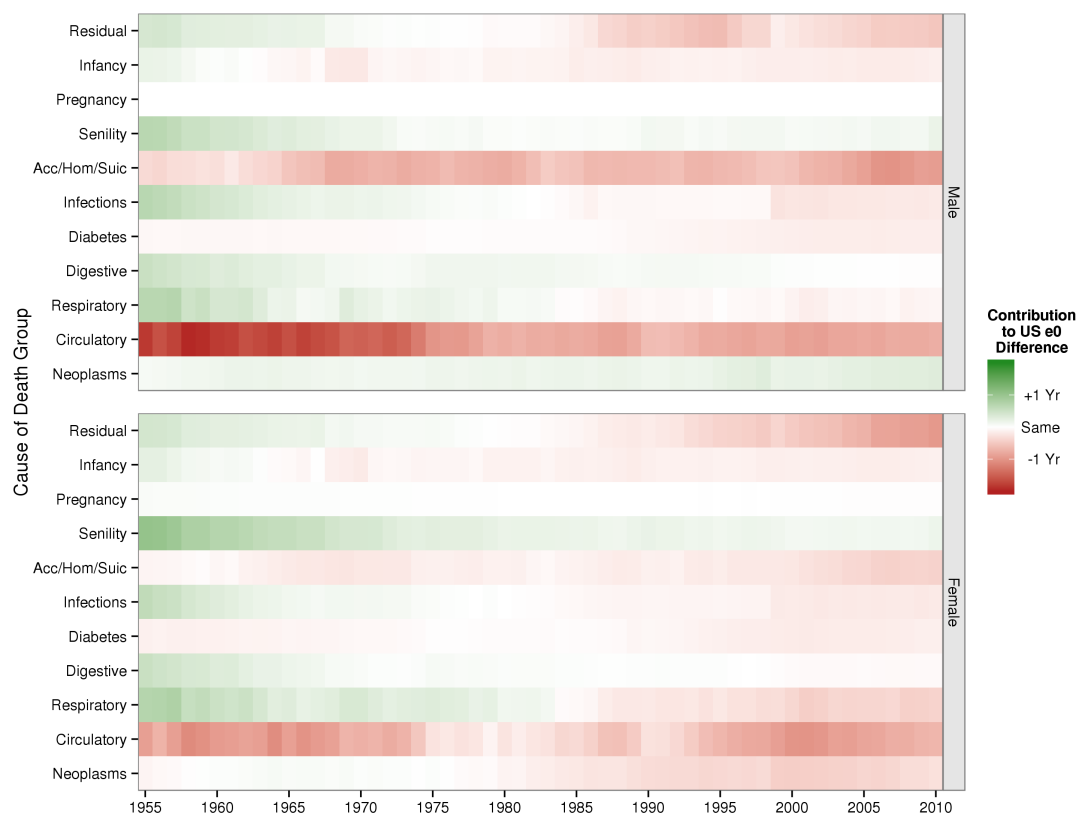


Figure 16: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Pooled Average, Selected Cause Components (1955-2010)*

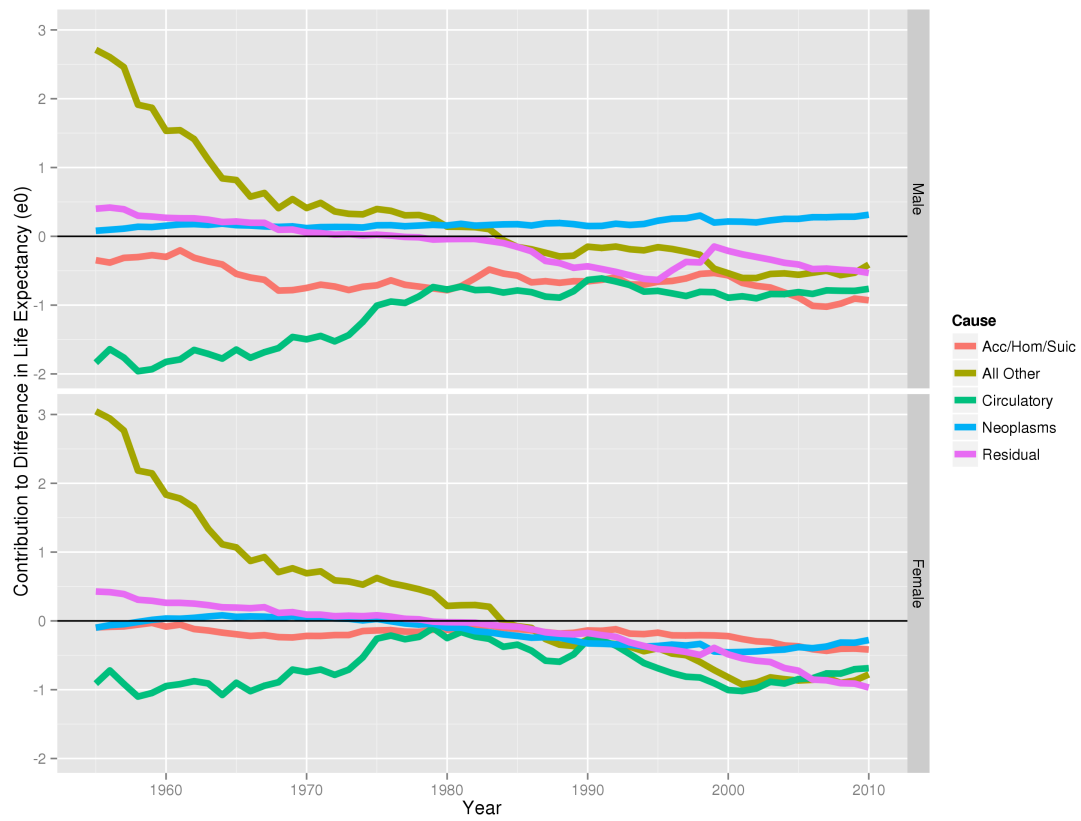


Table 7: *Decomposition of Change in Life Expectancy at Birth by Sex, US Compared to Pooled Average (2010)*

Cause	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Males										
Neoplasms	0.01	0.01	0.01	-0.01	-0.01	-0.05	-0.03	0.01	0.03	-0.03
Circulatory	-0.03	-0.02	-0.01	0.06	0.33	0.55	0.47	0.28	0.34	1.97
Respiratory	-0.40	-0.01	-0.01	-0.01	-0.03	-0.11	-0.20	-0.21	-0.09	-1.06
Digestive	-0.36	-0.02	-0.03	-0.03	-0.02	-0.09	-0.09	-0.06	-0.01	-0.71
Diabetes/Metabolic	0.00	0.00	0.00	-0.00	-0.01	-0.01	-0.01	-0.00	0.00	-0.04
Infections	-0.23	-0.03	-0.13	-0.16	-0.16	-0.17	-0.11	-0.04	-0.01	-1.04
Accidents/External	-0.11	0.02	-0.15	-0.10	-0.08	-0.05	0.01	0.01	0.02	-0.44
Senility/Ill-Defined	-0.16	-0.01	-0.02	-0.02	-0.02	-0.04	-0.09	-0.23	-0.28	-0.85
Pregnancy-Related	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Infancy	-0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.43
Residual	-0.18	-0.02	-0.03	-0.03	-0.04	-0.09	-0.15	-0.17	-0.12	-0.83
Total	-1.89	-0.09	-0.37	-0.29	-0.03	-0.06	-0.20	-0.41	-0.11	-3.45
Females										
Neoplasms	0.01	0.01	0.01	0.01	0.03	0.01	-0.13	-0.15	-0.01	-0.21
Circulatory	-0.03	-0.02	-0.02	-0.01	0.04	0.11	0.05	0.07	0.70	0.89
Respiratory	-0.42	-0.01	-0.02	-0.02	-0.03	-0.08	-0.21	-0.33	-0.20	-1.33
Digestive	-0.35	-0.02	-0.02	-0.02	-0.03	-0.08	-0.10	-0.10	-0.02	-0.75
Diabetes/Metabolic	0.00	0.00	0.00	-0.00	-0.00	0.01	0.02	0.02	0.01	0.05
Infections	-0.25	-0.05	-0.14	-0.13	-0.09	-0.09	-0.09	-0.05	-0.03	-0.92
Accidents/External	-0.06	-0.02	-0.07	-0.05	-0.06	-0.04	-0.01	0.00	0.05	-0.26
Senility/Ill-Defined	-0.15	-0.01	-0.02	-0.02	-0.02	-0.04	-0.11	-0.37	-0.62	-1.36
Pregnancy-Related	0.00	0.00	-0.04	-0.04	-0.01	-0.00	0.00	-0.00	0.00	-0.08
Infancy	-0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.47
Residual	-0.17	-0.02	-0.04	-0.05	-0.06	-0.10	-0.17	-0.23	-0.30	-1.14
Total	-1.91	-0.13	-0.36	-0.33	-0.24	-0.29	-0.75	-1.14	-0.41	-5.57

Expressed in years.

Positive values indicate narrowing US disadvantage, negative values widening US disadvantage.

Figure 17: *Decomposition of Change in Life Expectancy, US Compared to Pooled Average, By Sex (1955-2010)*



Table 8: *Counterfactual (Using Average) Changes in Life Expectancies by Sex, (2010)*

Scenario	e_0	e_{50}	$50e_0$
Males			
Observed US	76.2	29.7	48.7
Average M_0	76.4	.	48.9
Average $M_{15} - M_{49}$	77.3	.	49.1
Average $M_{50} - M_{69}$	77.1	30.6	.
Observed Average	78.6	30.7	49.3
Females			
Observed US	81.2	33.4	49.2
Average M_0	81.4	.	49.4
Average $M_{15} - M_{49}$	81.9	.	49.4
Average $M_{50} - M_{69}$	82.3	34.6	.
Observed Average	84.4	35.8	49.6

Figure 18: *Counterfactual (Using Average) Life Expectancy at Birth by Sex (1955-2010)*

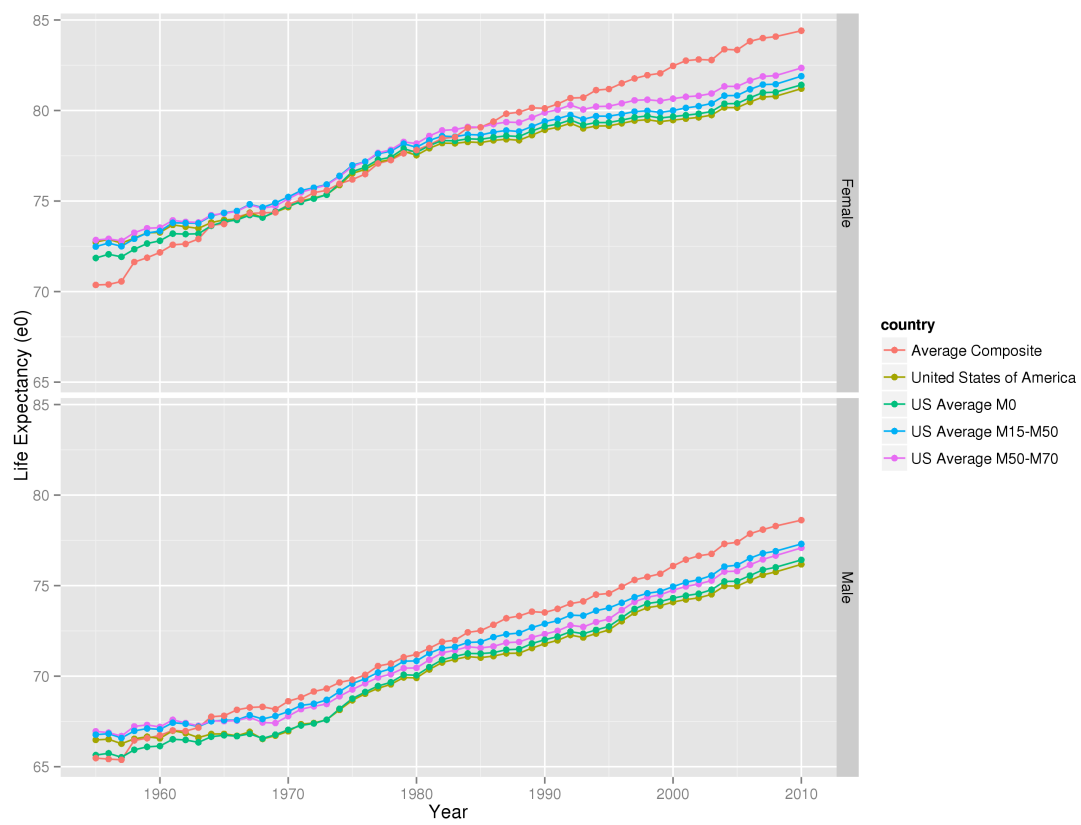


Figure 19: *Counterfactual (Using Average) Conditional Life Expectancy at Age 50 by Sex (1955-2010)*

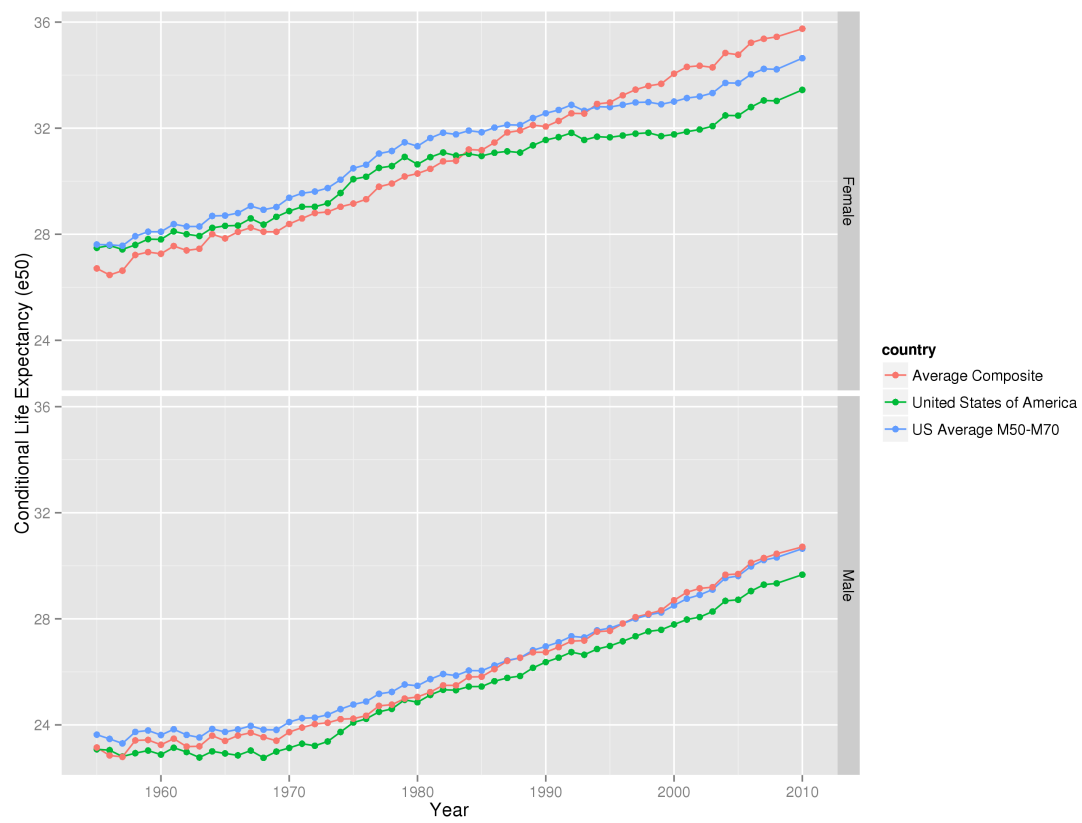


Figure 20: *Counterfactual (Using Average) Temporary Life Expectancy from Birth to Age 50 by Sex (1955-2010)*

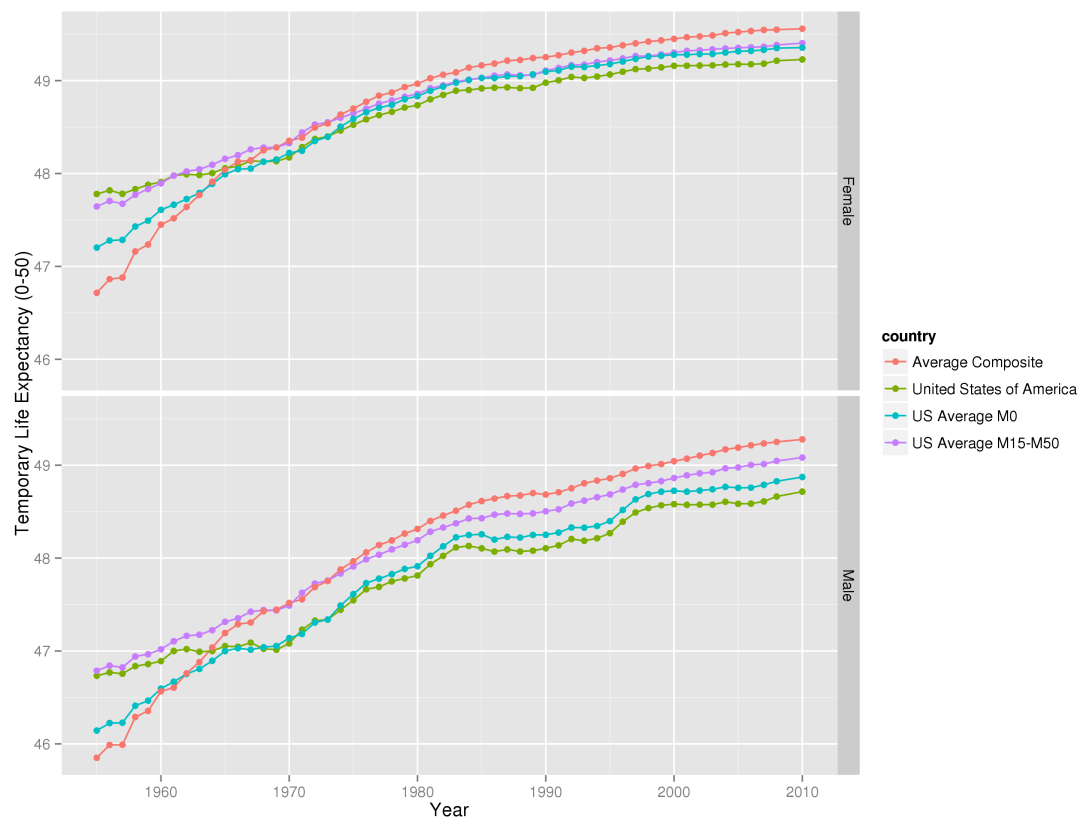


Table 9: *Counterfactual (Using Optimal) Changes in Life Expectancies by Sex, (2010)*

Scenario	e_0	e_{50}	$50e_0$
Males			
Observed US	76.2	29.7	48.7
Optimal M_0	76.5	.	48.9
Optimal $M_{15} - M_{49}$	77.8	.	49.2
Optimal $M_{50} - M_{69}$	77.8	31.4	.
Observed Optimal	80.7	32.2	49.5
Females			
Observed US	81.2	33.4	49.2
Optimal M_0	81.5	.	49.4
Optimal $M_{15} - M_{49}$	82.1	.	49.5
Optimal $M_{50} - M_{69}$	82.8	35.1	.
Observed Optimal	87.3	38.4	49.7

Figure 21: *Counterfactual (Using Optimal) Life Expectancy at Birth by Sex (1955-2010)*

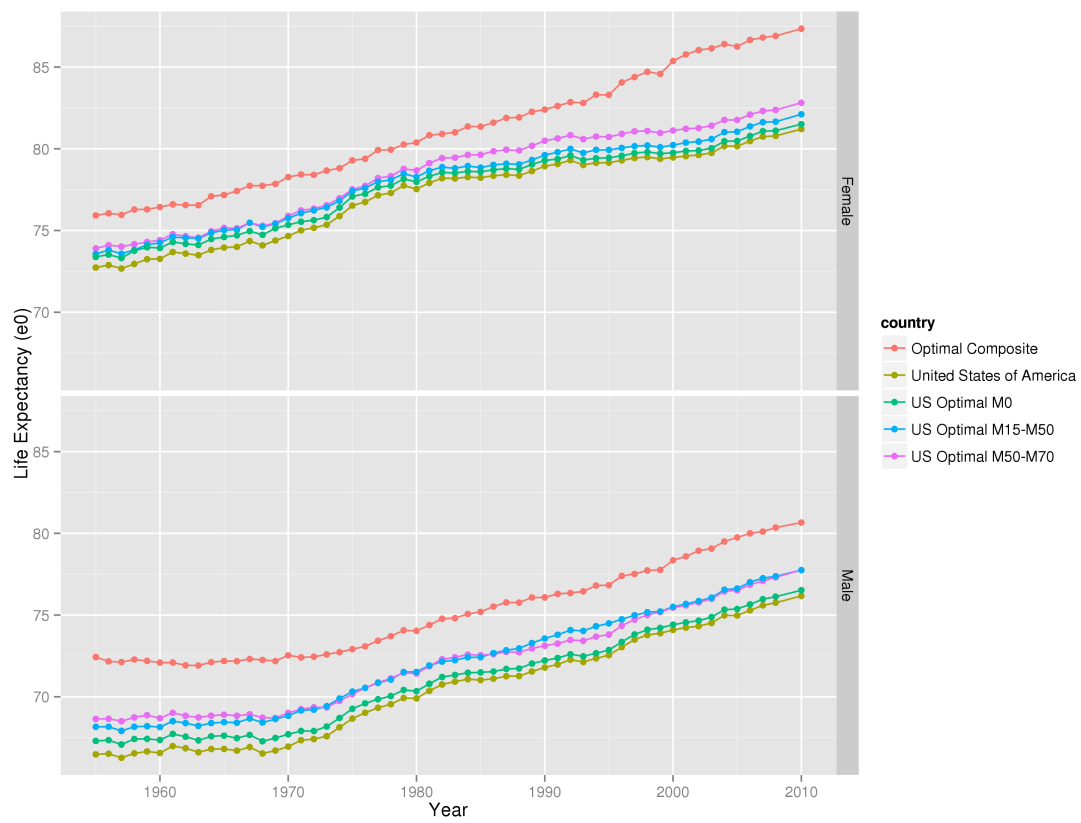


Figure 22: *Counterfactual (Using Optimal) Conditional Life Expectancy at Age 50 by Sex (1955-2010)*

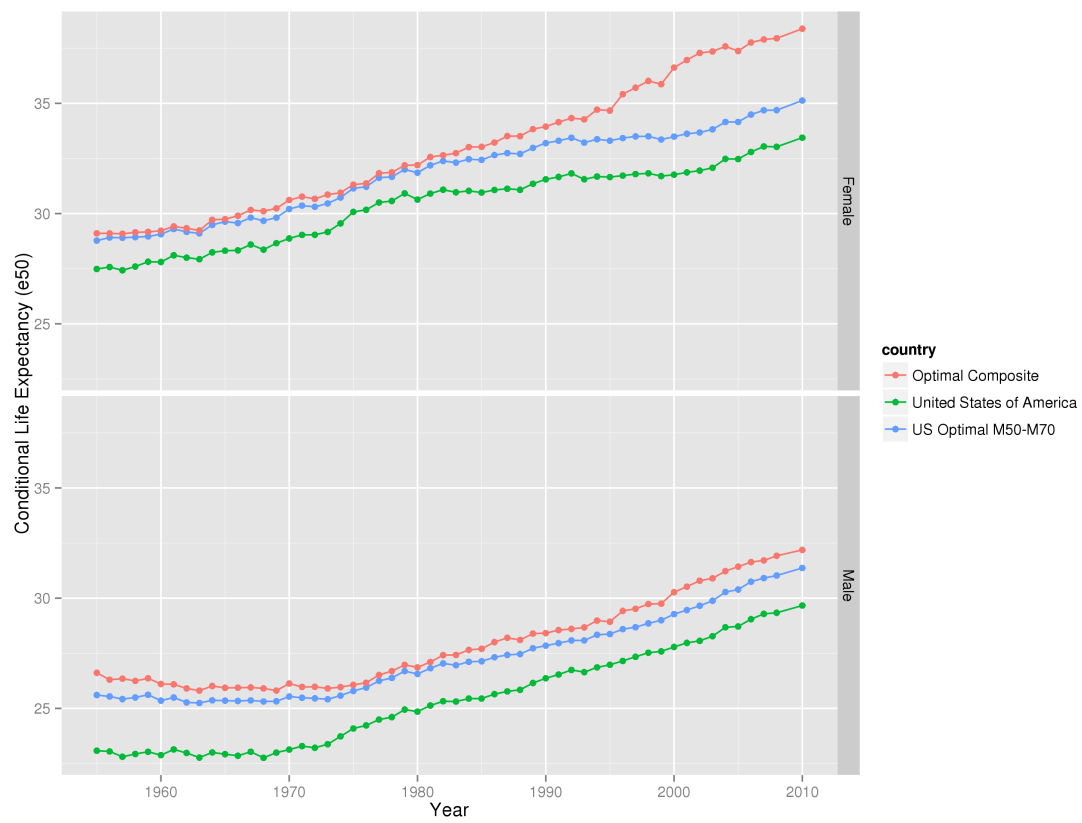


Figure 23: *Counterfactual (Using Optimal) Temporary Life Expectancy from Birth to Age 50 by Sex (1955-2010)*

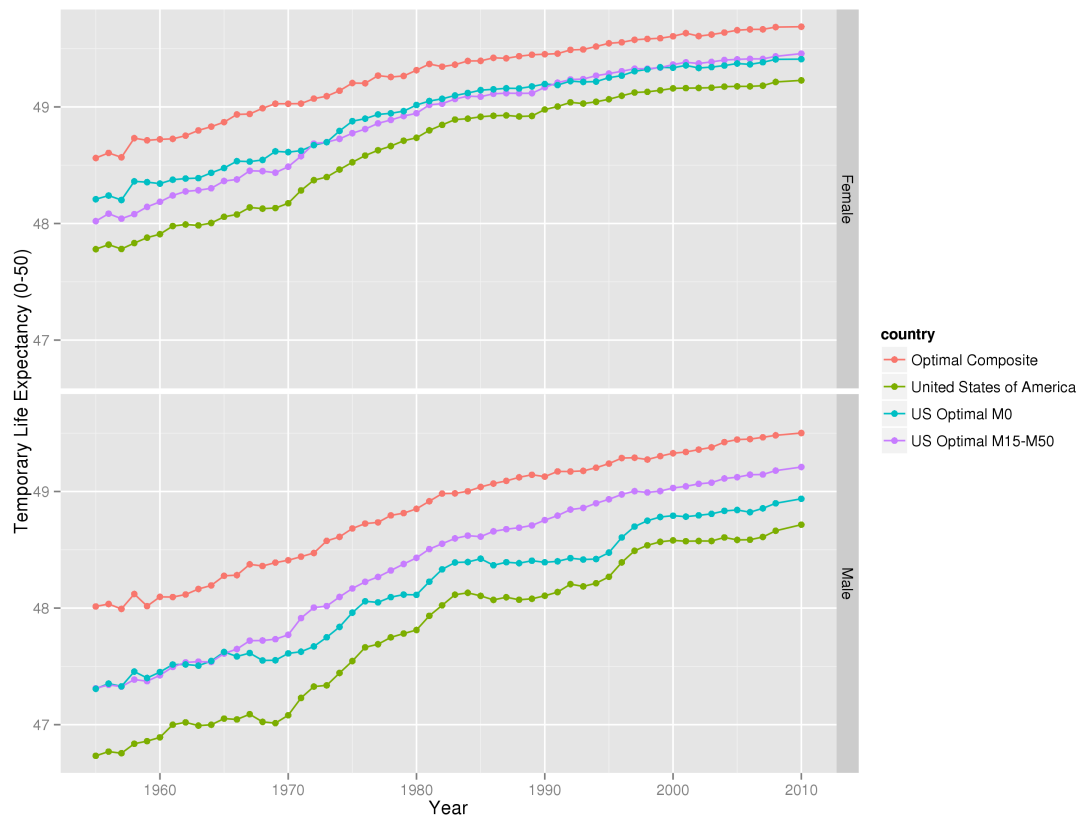


Figure 24: *Contrasts in Infant Mortality Rates and the Importance of Distribution by Length of Gestation (LoG)*

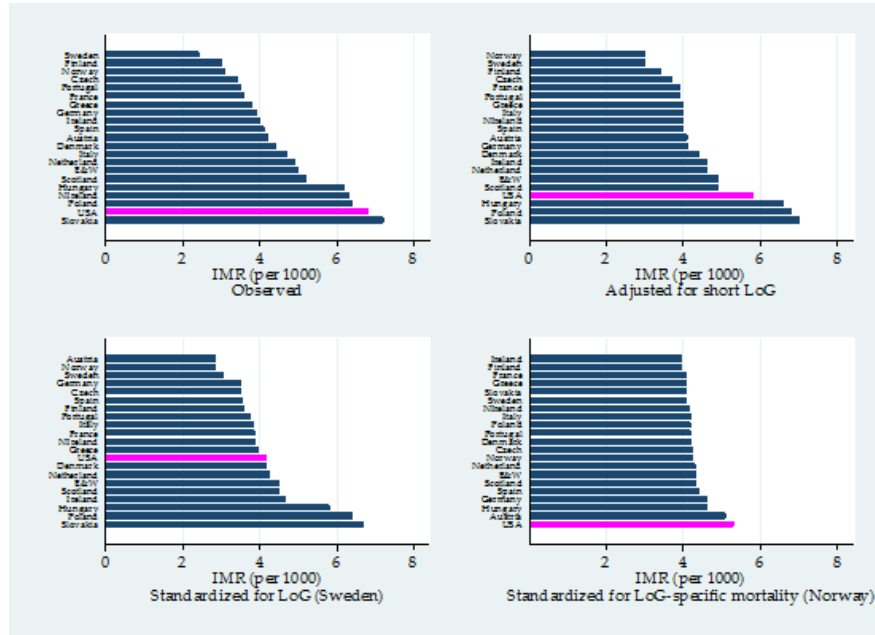


Figure 25: *Differences in Life Expectancy at Age 75 versus Pooled and Optimal Benchmark by Sex (1955-2010)*

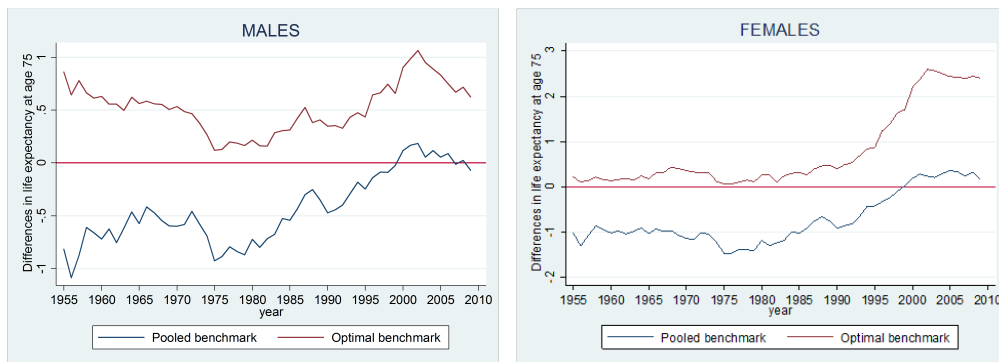


Table 10: *Estimates of Regression Model for M_x Ratios Using Pooled Benchmark by Sex (Ages ≥ 60)*

	Males		Females	
Standard (β)	1.15	(0.018)	1.03	(0.030)
Time (t)	0.45	(0.028)	-1.03	(0.045)
Interaction (δ)	-0.31	(0.032)	1.50	(0.052)
Constant (α)	-0.16	(0.016)	-0.07	(0.027)
R^2	0.84		0.87	
N	2856		2856	

Standard errors in parentheses.

Figure 26: *Observed and Model-Dependent (OLS) Crossing Ages by Sex (1955-2010)*

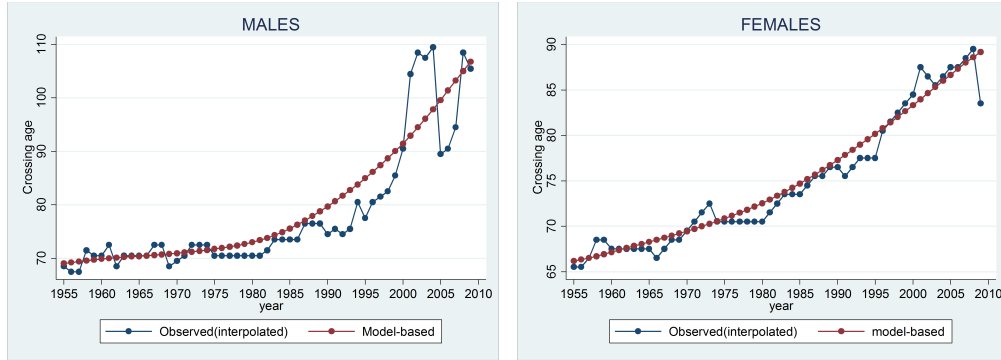


Table 11: *Fit of Crossing Ages with Simple Linear Trend by Sex*

	Males		Females	
Year	0.56	(0.070)	0.41	(0.019)
Constant	-1035	(126)	-745	(38)
R^2	0.60		0.87	
N	2856		2856	

Standard errors in parentheses.

Time not rescaled and measured in calendar years.

Figure 27: *Adjusted for Smoking and Model-Dependent (Nonparametric Fit) Crossing Ages by Sex (1955-2010)*

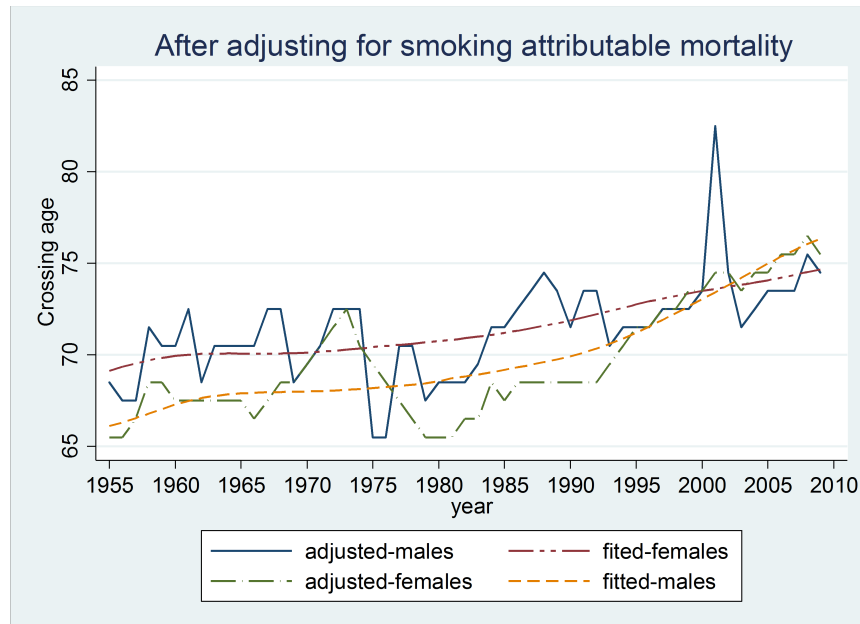


Figure 28: *Effects of Overstatement of Ages in Population and Deaths*

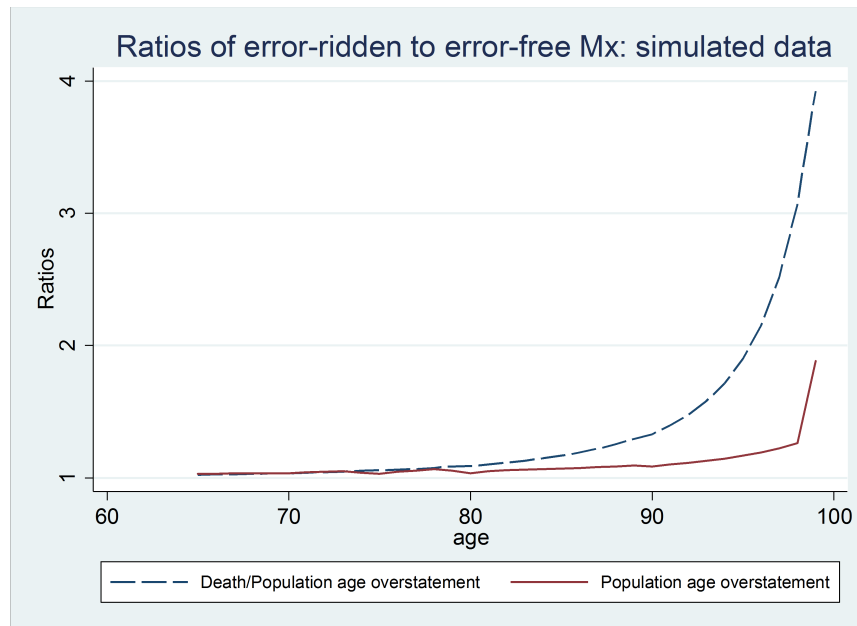
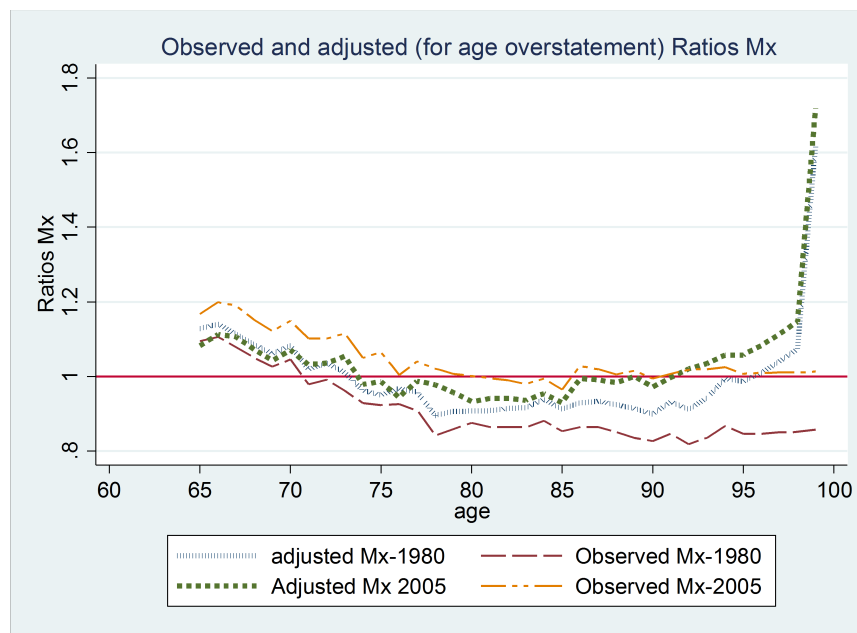


Figure 29: *Crossing Ages after Adjustment for Population Age Overstatement*



Appendix A: Additional Tables

Table 12: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Optimal (1955)*

Cause	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Males										
Neoplasms	-0.02	-0.00	-0.00	0.00	-0.05	-0.09	-0.10	-0.01	0.00	-0.26
Circulatory	-0.01	-0.02	-0.04	-0.17	-0.51	-0.83	-0.88	-0.59	-0.16	-3.21
Respiratory	-0.14	-0.01	-0.01	-0.01	-0.02	-0.05	-0.05	-0.02	0.02	-0.28
Digestive	-0.06	-0.01	0.00	-0.02	-0.07	-0.07	-0.08	-0.03	-0.00	-0.34
Diabetes	-0.00	-0.00	-0.01	-0.01	-0.01	-0.02	-0.03	-0.02	-0.01	-0.11
Infections	-0.02	-0.01	-0.01	-0.01	-0.00	-0.01	-0.01	-0.00	0.00	-0.08
Acc/Hom/Suic	-0.09	-0.20	-0.39	-0.22	-0.14	-0.05	-0.08	-0.04	-0.01	-1.22
Senility	-0.06	0.00	0.01	0.01	0.01	0.01	0.04	0.06	0.04	0.12
Pregnancy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Infancy	-0.57	-0.00	0.00	0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.56
Residual	-0.03	0.00	-0.00	0.01	-0.02	-0.02	-0.01	0.04	0.01	-0.01
23	-1.01	-0.24	-0.45	-0.42	-0.82	-1.13	-1.19	-0.62	-0.10	-5.95
Females										
Neoplasms	0.00	-0.01	-0.01	-0.03	-0.07	-0.03	-0.06	0.02	0.01	-0.17
Circulatory	-0.01	-0.01	-0.04	-0.10	-0.23	-0.43	-0.46	-0.41	-0.05	-1.74
Respiratory	-0.13	-0.01	-0.00	-0.01	-0.01	-0.02	0.02	0.06	0.02	-0.08
Digestive	-0.06	-0.00	-0.00	-0.02	-0.05	-0.05	-0.02	0.00	-0.00	-0.21
Diabetes	-0.00	-0.00	-0.01	-0.00	-0.02	-0.04	-0.07	-0.06	-0.00	-0.20
Infections	-0.04	-0.01	-0.01	0.01	0.00	0.00	0.01	0.01	0.00	-0.03
Acc/Hom/Suic	-0.09	-0.06	-0.09	-0.06	-0.06	-0.06	-0.02	-0.01	-0.01	-0.45
Senility	-0.05	-0.00	0.00	0.00	0.01	0.00	0.04	0.09	0.01	0.10
Pregnancy	0.00	-0.01	-0.01	-0.00	0.00	-0.00	-0.00	0.00	0.00	-0.01
Infancy	-0.43	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.43
Residual	-0.00	-0.01	-0.00	-0.01	0.00	-0.01	0.02	0.02	0.02	0.04
23	-0.81	-0.11	-0.16	-0.22	-0.42	-0.64	-0.55	-0.28	-0.00	-3.19

Expressed in years.

Positive values indicate US advantage, negative values US disadvantage.

Table 13: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Optimal (1980)*

Cause	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Males										
Neoplasms	0.01	-0.00	-0.01	-0.00	-0.06	-0.08	-0.08	0.02	0.02	-0.17
Circulatory	-0.02	-0.00	-0.00	-0.06	-0.21	-0.53	-0.63	-0.24	-0.09	-1.77
Respiratory	-0.01	0.00	0.00	-0.01	-0.02	-0.04	-0.06	-0.00	0.02	-0.12
Digestive	-0.01	-0.00	-0.01	-0.04	-0.07	0.00	0.01	0.02	0.01	-0.08
Diabetes	-0.00	-0.00	-0.00	-0.01	-0.01	-0.01	-0.02	-0.01	0.00	-0.06
Infections	-0.01	-0.00	-0.00	-0.01	-0.00	0.02	0.02	0.01	-0.01	0.02
Acc/Hom/Suic	-0.08	-0.24	-0.51	-0.30	-0.10	-0.03	-0.00	0.01	0.01	-1.26
Senility	-0.14	-0.01	-0.02	0.03	0.02	-0.03	-0.03	-0.01	-0.00	-0.19
Pregnancy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Infancy	-0.29	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.30
Residual	-0.05	-0.01	-0.01	-0.03	-0.04	-0.04	-0.03	-0.01	0.00	-0.22
23	-0.60	-0.26	-0.56	-0.43	-0.50	-0.74	-0.81	-0.20	-0.04	-4.13
Females										
Neoplasms	0.00	0.01	0.00	-0.01	-0.10	-0.19	-0.17	-0.01	0.06	-0.41
Circulatory	-0.03	0.00	-0.02	-0.03	-0.11	-0.19	-0.40	-0.28	-0.23	-1.29
Respiratory	-0.02	0.00	-0.00	-0.00	-0.01	-0.03	-0.06	-0.04	0.01	-0.15
Digestive	-0.01	-0.00	-0.01	-0.03	-0.05	-0.06	0.01	0.03	0.03	-0.08
Diabetes	-0.00	0.00	-0.00	-0.00	-0.01	-0.03	-0.04	-0.00	0.01	-0.08
Infections	-0.01	-0.00	-0.00	-0.00	-0.01	-0.00	0.00	0.00	-0.02	-0.04
Acc/Hom/Suic	-0.08	-0.10	-0.12	-0.08	-0.03	-0.02	0.03	0.03	0.03	-0.34
Senility	-0.09	-0.00	0.00	-0.01	-0.01	0.00	0.01	0.03	0.01	-0.07
Pregnancy	0.00	-0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	0.00
Infancy	-0.31	-0.00	-0.00	0.00	0.00	-0.00	-0.00	0.00	-0.00	-0.32
Residual	-0.04	-0.01	-0.01	-0.02	-0.02	-0.03	0.00	0.04	0.00	-0.07
23	-0.58	-0.11	-0.16	-0.18	-0.35	-0.54	-0.62	-0.20	-0.11	-2.85

Expressed in years.

Positive values indicate US advantage, negative values US disadvantage.

Table 14: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Optimal (2010)*

Cause	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Males										
Neoplasms	-0.01	-0.00	0.00	-0.01	-0.06	-0.15	-0.08	0.05	0.12	-0.14
Circulatory	-0.02	-0.01	-0.03	-0.06	-0.17	-0.29	-0.34	-0.23	-0.21	-1.36
Respiratory	-0.02	-0.00	-0.01	-0.02	-0.02	-0.06	-0.11	-0.12	-0.04	-0.41
Digestive	-0.00	0.00	-0.01	-0.02	-0.06	-0.08	-0.05	-0.01	0.02	-0.21
Diabetes	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.04	-0.01	0.01	-0.12
Infections	-0.02	-0.00	-0.01	-0.03	-0.05	-0.07	-0.05	-0.04	-0.02	-0.29
Acc/Hom/Suic	-0.08	-0.13	-0.40	-0.27	-0.16	-0.09	-0.05	-0.03	0.01	-1.20
Senility	-0.06	-0.01	0.00	0.00	-0.01	-0.00	-0.01	-0.02	-0.03	-0.14
Pregnancy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Infancy	-0.23	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.24
Residual	-0.02	-0.00	-0.02	-0.03	-0.05	-0.06	-0.07	-0.08	-0.07	-0.39
23	-0.45	-0.16	-0.48	-0.45	-0.60	-0.84	-0.80	-0.49	-0.21	-4.49
Females										
Neoplasms	-0.01	0.00	-0.00	-0.04	-0.07	-0.15	-0.32	-0.32	-0.01	-0.92
Circulatory	-0.01	0.00	-0.01	-0.04	-0.12	-0.18	-0.31	-0.42	-0.80	-1.88
Respiratory	-0.01	-0.01	-0.01	-0.02	-0.04	-0.09	-0.18	-0.22	0.21	-0.36
Digestive	-0.00	-0.00	-0.00	-0.02	-0.04	-0.06	-0.06	-0.04	0.01	-0.21
Diabetes	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.07	-0.08	-0.09	-0.31
Infections	-0.01	-0.00	-0.01	-0.02	-0.03	-0.05	-0.04	-0.03	-0.04	-0.23
Acc/Hom/Suic	-0.06	-0.06	-0.12	-0.10	-0.11	-0.05	0.01	0.02	-0.00	-0.47
Senility	-0.05	0.00	-0.00	-0.01	-0.00	-0.01	-0.01	-0.00	0.30	0.22
Pregnancy	0.00	-0.00	-0.01	-0.01	-0.00	-0.00	0.00	0.00	0.00	-0.02
Infancy	-0.24	0.00	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	-0.25
Residual	-0.01	-0.01	-0.02	-0.03	-0.05	-0.09	-0.14	-0.28	-1.08	-1.71
23	-0.39	-0.07	-0.20	-0.29	-0.47	-0.72	-1.12	-1.38	-1.51	-6.14

Expressed in years.

Positive values indicate US advantage, negative values US disadvantage.

Table 15: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Optimal, Age Components (1955-2010)*

Cause	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Males										
1955	-1.01	-0.24	-0.45	-0.42	-0.82	-1.13	-1.19	-0.62	-0.10	-5.95
1960	-0.96	-0.22	-0.36	-0.43	-0.79	-1.21	-1.02	-0.47	-0.07	-5.53
1965	-0.97	-0.20	-0.40	-0.43	-0.78	-1.16	-1.02	-0.36	-0.06	-5.37
1970	-0.92	-0.24	-0.58	-0.51	-0.76	-1.14	-1.02	-0.36	-0.07	-5.59
1975	-0.73	-0.22	-0.55	-0.46	-0.55	-0.81	-0.71	-0.20	-0.01	-4.25
1980	-0.60	-0.26	-0.56	-0.43	-0.50	-0.74	-0.81	-0.20	-0.04	-4.13
1985	-0.61	-0.21	-0.43	-0.45	-0.45	-0.66	-0.92	-0.43	-0.03	-4.18
1990	-0.54	-0.26	-0.53	-0.61	-0.51	-0.59	-0.79	-0.45	-0.01	-4.29
1995	-0.44	-0.27	-0.50	-0.65	-0.67	-0.66	-0.64	-0.36	-0.10	-4.28
2000	-0.44	-0.19	-0.38	-0.38	-0.60	-0.70	-0.74	-0.48	-0.36	-4.26
2005	-0.49	-0.21	-0.52	-0.43	-0.63	-0.83	-0.78	-0.55	-0.32	-4.77
2010	-0.45	-0.16	-0.48	-0.45	-0.60	-0.84	-0.80	-0.49	-0.21	-4.49
Females										
1955	-0.81	-0.11	-0.16	-0.22	-0.42	-0.64	-0.55	-0.28	-0.00	-3.19
1960	-0.81	-0.11	-0.18	-0.26	-0.51	-0.63	-0.53	-0.11	-0.02	-3.17
1965	-0.78	-0.10	-0.20	-0.34	-0.49	-0.65	-0.56	-0.05	-0.05	-3.21
1970	-0.83	-0.12	-0.23	-0.31	-0.51	-0.67	-0.58	-0.23	-0.11	-3.61
1975	-0.68	-0.09	-0.18	-0.26	-0.40	-0.53	-0.47	-0.15	-0.01	-2.76
1980	-0.58	-0.11	-0.16	-0.18	-0.35	-0.54	-0.62	-0.20	-0.11	-2.85
1985	-0.49	-0.10	-0.13	-0.17	-0.29	-0.62	-0.82	-0.40	-0.12	-3.13
1990	-0.45	-0.10	-0.15	-0.20	-0.29	-0.65	-0.97	-0.61	-0.04	-3.47
1995	-0.41	-0.12	-0.17	-0.24	-0.34	-0.65	-1.02	-0.82	-0.38	-4.15
2000	-0.39	-0.10	-0.15	-0.24	-0.38	-0.68	-1.22	-1.30	-1.44	-5.90
2005	-0.42	-0.10	-0.19	-0.26	-0.46	-0.67	-1.17	-1.31	-1.52	-6.10
2010	-0.39	-0.07	-0.20	-0.29	-0.47	-0.72	-1.12	-1.38	-1.51	-6.14

Expressed in years.

Positive values indicate US advantage, negative values US disadvantage.

Table 16: *Decomposition of Life Expectancy at Birth by Sex, US Compared to Optimal, Cause Components (1955-2010)*

Cause	1	2	3	4	5	6	7	8	9	10	11	Total
Males												
1955	-0.26	-3.21	-0.28	-0.34	-0.11	-0.08	-1.22	0.12	0.00	-0.56	-0.56	-5.95
1960	-0.30	-2.75	-0.53	-0.35	-0.11	-0.09	-1.03	0.15	0.00	-0.49	-0.49	-5.53
1965	-0.40	-2.47	-0.49	-0.30	-0.08	-0.09	-0.97	-0.04	0.00	-0.51	-0.51	-5.37
1970	-0.43	-2.08	-0.46	-0.31	-0.09	-0.06	-1.39	-0.19	0.00	-0.45	-0.45	-5.59
1975	-0.29	-1.52	-0.30	-0.20	-0.05	-0.02	-1.26	-0.12	0.00	-0.37	-0.37	-4.25
1980	-0.17	-1.77	-0.12	-0.08	-0.06	0.02	-1.26	-0.19	0.00	-0.30	-0.30	-4.13
1985	-0.17	-1.89	-0.14	-0.09	-0.06	-0.07	-1.05	-0.13	0.00	-0.31	-0.31	-4.18
1990	-0.24	-1.72	-0.01	-0.02	-0.12	-0.05	-1.06	-0.10	0.00	-0.30	-0.30	-4.29
1995	-0.23	-1.51	-0.09	-0.10	-0.14	-0.05	-1.01	-0.05	0.00	-0.20	-0.20	-4.28
2000	-0.12	-1.88	0.09	-0.19	-0.19	-0.27	-0.88	-0.08	0.00	-0.27	-0.27	-4.26
2005	-0.25	-1.29	-0.39	-0.21	-0.15	-0.31	-1.30	-0.12	0.00	-0.28	-0.28	-4.77
2010	-0.14	-1.36	-0.41	-0.21	-0.12	-0.29	-1.20	-0.14	0.00	-0.24	-0.24	-4.49
Females												
1955	-0.17	-1.74	-0.08	-0.21	-0.20	-0.03	-0.45	0.10	-0.01	-0.43	-0.43	-3.19
1960	-0.14	-1.54	-0.22	-0.22	-0.14	-0.07	-0.45	0.06	-0.02	-0.40	-0.40	-3.17
1965	-0.24	-1.30	-0.26	-0.23	-0.11	-0.05	-0.58	0.04	-0.02	-0.39	-0.39	-3.21
1970	-0.12	-1.54	-0.17	-0.27	-0.13	-0.07	-0.60	-0.04	-0.01	-0.51	-0.51	-3.61
1975	-0.12	-1.16	-0.14	-0.23	-0.07	-0.05	-0.45	-0.10	-0.00	-0.34	-0.34	-2.76
1980	-0.41	-1.29	-0.15	-0.08	-0.08	-0.04	-0.34	-0.07	0.00	-0.32	-0.32	-2.85
1985	-0.56	-1.29	-0.24	-0.06	-0.05	-0.08	-0.26	-0.13	-0.00	-0.26	-0.26	-3.13
1990	-0.82	-1.35	-0.29	-0.08	-0.16	-0.10	-0.19	-0.02	-0.00	-0.27	-0.27	-3.47
1995	-0.84	-1.92	-0.09	-0.07	-0.25	-0.05	-0.18	0.16	-0.00	-0.23	-0.23	-4.15
2000	-1.02	-2.46	-0.31	-0.19	-0.35	-0.19	-0.27	0.08	-0.01	-0.20	-0.20	-5.90
2005	-0.95	-2.13	-0.31	-0.20	-0.36	-0.21	-0.43	0.12	-0.02	-0.26	-0.26	-6.10
2010	-0.92	-1.88	-0.36	-0.21	-0.31	-0.23	-0.47	0.22	-0.02	-0.25	-0.25	-6.14

Expressed in years.

Positive values indicate US advantage, negative values US disadvantage.

1=Neoplasms; 2=Circulatory; 3=Respiratory; 4=Digestive; 5=Diabetes and metabolic; 6=Infections; 7=Accidents, Homicide, Suicide, and External; 8=Senility and Ill-defined; 9=Pregnancy-related; 10=Infancy; 11=Residual.

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