Journal of Economic Perspectives—Volume 23, Number 4—Fall 2009—Pages 175–190

Mortality Inequality

Sam Peltzman

The measures of inequality most familiar to economists are based on income at a point in time. For example, suppose A has ten times the annual income of B and a certain society has many like B and only a few like A. By most measures, this society would be deemed more unequal than one with only a few B's or with B's who are richer relative to A's. However, the typical income inequality measure leaves out an important dimension: the length of time over which an income or consumption stream is enjoyed (Becker, Philipson, and Soares, 2005). Thus, suppose A and B had identical annual incomes, but A lives twice as long. Clearly, A and B would not have the same total welfare. Moreover we might think the social distribution of welfare is rather unequal if there are only a few long-lived A's and many short-lived B's, notwithstanding their equal annual incomes. Any account of social inequality may be seriously incomplete if it ignores differences in longevity within the society.

When economists confront mortality differences, either within or between societies, they tend to emphasize the correlation between income and longevity. A common finding here is the "Preston curve," which shows that longevity increases with income, but at sharply decreasing rates either within or between societies (Preston, 1975; Cutler, Deaton, and Lleras-Muney, 2006). Across countries, this relation is meaningfully positive only for countries with per capita incomes below roughly half those in the developed world. Another finding is that rich–poor country differences in longevity have tended to decrease over time (Becker, Philipson, and Soares, 2005). I will pay some attention to the connection between longevity and income, but most of the emphasis here will be on inequality of lifetimes as an interesting phenomenon in its own right.

■ *Sam Peltzman is Ralph and Dorothy Keller Distinguished Service Professor of Economics Emeritus, Booth School of Business, University of Chicago, Chicago, Illinois. His e-mail address is ⟨samp@uchicago.edu⟩.*

The paper describes how changes in the inequality of lifetimes have contributed to changes in the social distribution of welfare. I address the following questions: How can we measure inequality of lifetimes? How has this kind of inequality changed over time? How is this inequality related to increased longevity? How do these trends differ across and within countries?

Unequal longevity was once a major source of social inequality, perhaps even more important in some sense than income inequality, for a long time. But over the last century, this inequality has declined drastically in high-income countries and is now comparatively trivial.

The Mortality Gini

Mortality Ginis and Income Ginis

Social scientists measure economic inequality in diverse ways, and there is similarly no single measure of inequality of lifetimes. In this paper, I will use a Gini coefficient of the latter inequality because the corresponding income measure is, among economists, perhaps the best known and most widely used measure that can be easily adapted for the present purpose.[1]

To understand the Gini coefficient for mortality, it's useful to begin by reviewing the Gini coefficient for income. Consider a graph that shows the percentiles of individuals on the horizontal axis and the cumulative percentage of income held by those households on the vertical axis. The distribution is cumulated according to the income rank of individuals (or households) from poorest to richest. The egalitarian hypothetical would appear as a 45-degree line on such a graph; each household would have the same income, and so 20 percent of households would have 20 percent of all income, 50 percent of households would have 50 percent of all income, and so on, so that the share of households and the share of income would coincide. A Lorenz curve shows the actual distribution of income on such a graph. The Lorenz curve coincides with the 45-degree line at the origin and at 100 percent, but is otherwise below this line because poorer households always have a smaller share of income than their share of households. That is, the bottom 20 percent of households have less than 20 percent of total income; the bottom 50 percent of households have less than 50 percent of total income. The Gini coefficient is the area between these two lines—the 45-degree line showing complete equality of incomes, and the Lorenz curve showing the actual distribution of incomes expressed as a percentage or share of the total area under the 45-degree line. The Gini coefficient grows with the degree to which a nation's income is concentrated in a few hands. In the extreme—in which one person receives all of the national income—the Lorenz curve would occupy none of this space and the Gini

[1] Range measures of inequality—like 90:10 income ratios (the income at the 90th percentile divided by the income at the 10th percentile)—have perhaps more intuitive appeal than Gini measures. But range measures but are hard to adapt to a mortality history where infant mortality rates—that is, zero years of life—of 20 percent or more are common, as is true in most countries through most of human history.

coefficient would be 100 percent. At the other extreme—perfect equality—the Gini would be 0, because the Lorenz curve would correspond to the hypothetical 45-degree line distribution.

Actual Gini coefficients for contemporary household income distributions in developed economies range from around 20 in the Scandinavian welfare states to 30 in continental Europe and 40 in the United States.[2] It will prove useful to keep this roughly two-fold range of contemporary income Ginis in mind in evaluating the history of mortality inequality.

Now instead of national income during a given year, think of another measure of total well being: years of life. Specifically, think of a cohort born today in the United States. The "poor" among them in terms of life-years will die tomorrow or shortly thereafter. The very "rich" in terms of life-years will live for perhaps a century. On average, each of these infants can expect to live well into their 70s. But as with average income per person, there will be dispersion around this average. Conceptually a Gini coefficient of this dispersion could be calculated by changing "income" to "life years" and proceeding as above. That is, suppose 1,000 people are born today and we can follow them all until death. Perhaps five will die right away, and these will have none of the life years enjoyed by the cohort. Another two or three will die at age 100, so they will have a total of 200 or 300 life years. Overall, these 1,000 infants will have a total of perhaps 78,000 life years. A hypothetical egalitarian distribution of this total would entail each infant living to precisely 78. As with income distributions, the Lorenz curve of the actual life-year distribution would lie below this hypothetical because some (the poorer in terms of life-years) die before 78. The "mortality Gini" would be the percentage of the area below the egalitarian cumulative distribution that is not occupied by the Lorenz curve of the cumulative distribution of lifetimes.

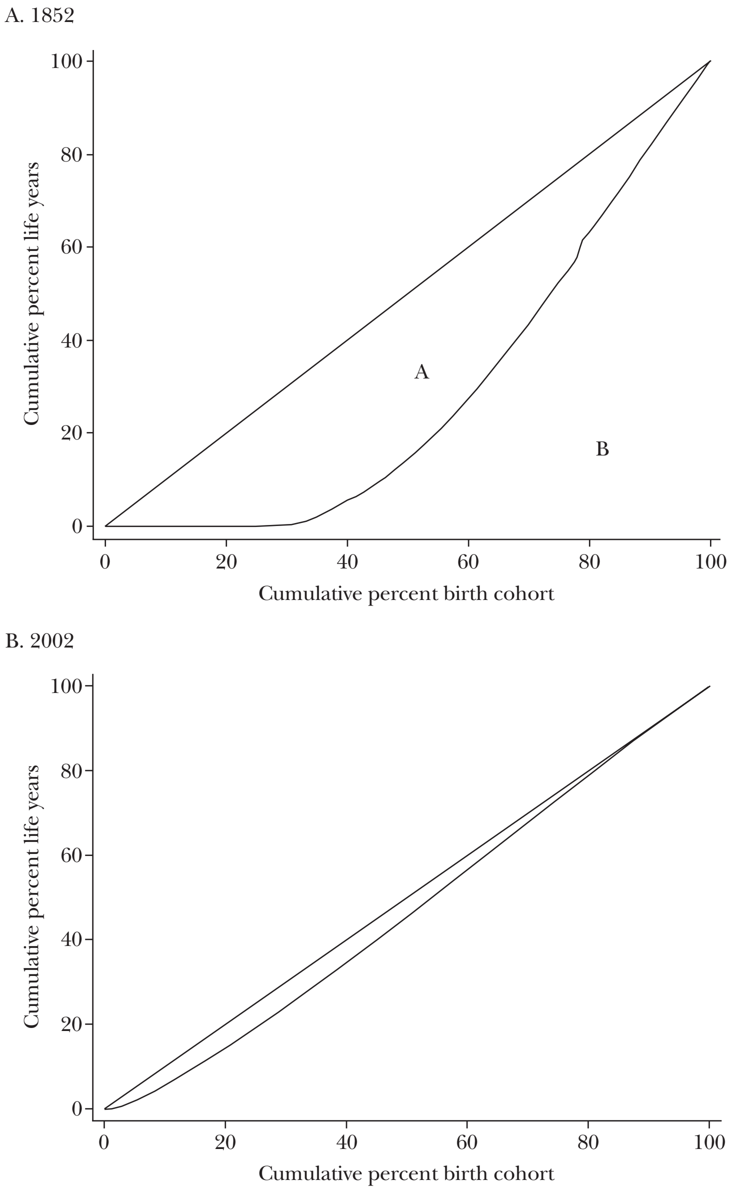
Figure 1 illustrates two mortality Gini coefficients for the United States 150 years apart. The 1852 Gini shows much more inequality—a much larger gap between hypothetical equality of lifetimes and their actual distribution—than the 2002 Gini. Indeed, by 2002 this gap has been reduced to a tiny sliver. These two much different Ginis summarize a main message of this paper.

Estimating Mortality Ginis Using Life Tables

We cannot of course do what has been just described for a contemporary birth cohort unless we wait around for another century or so. Nor can we do so retrospectively for cohorts born after the early twentieth century because significant numbers of them are still alive. Empirical demographers who face these data limitations adopt the shortcut of using contemporary mortality records to generate an estimate of the life-year distribution for contemporary birth cohorts. This estimate is called a "life table," and all the data in this paper are based on life tables. A brief description is useful in understanding these data and their limitations.

[2] Mid-2000s Ginis were 23 for Sweden, 30 for Germany, and 38 for the United States according to OECD estimates found at ⟨http://stats.oecd.org/index.aspx?r=199232⟩.

Figure 1
The U.S. Mortality Gini for 1852 and 2002



Note: The Lorenz curve (the line separating areas A and B in the top panel) shows the actual cumulative distribution of life years lived by a birth cohort that experiences mortality rates prevalent in 1852 or 2002. If everyone lived the same number of years, this cumulative distribution would be the straight 45 degree line above area A. The Gini coefficient is the percentage of the total area below this 45 degree line (A + B) occupied by the area above the Lorenz curve (A). The Gini for 1852 is 47.6 percent. The Gini for 2002 is 10.8 percent.

A life table lists the number of survivors at each age from a hypothetical birth (age = 0) cohort of 100,000. The (negative) first difference of this survivor function is mortality, or, in percentage terms, the mortality rate. For example, if the first three entries (for ages 0, 1, and 2) in a life table are 100,000, 95,000, and 92,000, respectively, it would be telling us that 5,000 infants out of the hypothetical 100,000 births die before their first birthday and another 3,000 die before their second. The table would also imply a mortality rate, or risk of death, of 3.16 percent (3,000 deaths divided by 95,000 survivors) between the first and second birthdays.

In practice, a life table is built up from mortality rates, not vice versa. Indeed, the workhorse life table of empirical demography is just a summary of contemporary mortality experience. For example, the most well-known statistic commonly derived from a life table is expected years of life at birth, which is around 78 years for the United States today. This number does not mean that babies born today can expect to live 78 years. It is just a summary statistic for the life table—the mortality-weighted average age of death (or equivalently total years of life for the cohort/100,000) for today's population. Thus, today's babies would have average lifetimes of 78 years only if progress in reducing mortality stops cold, so that today's babies will incur the same mortality risk at each future age as we observe in today's population. Since mortality risks have been declining over time, a more realistic life expectancy for a baby born today in the United States would exceed 78 years.

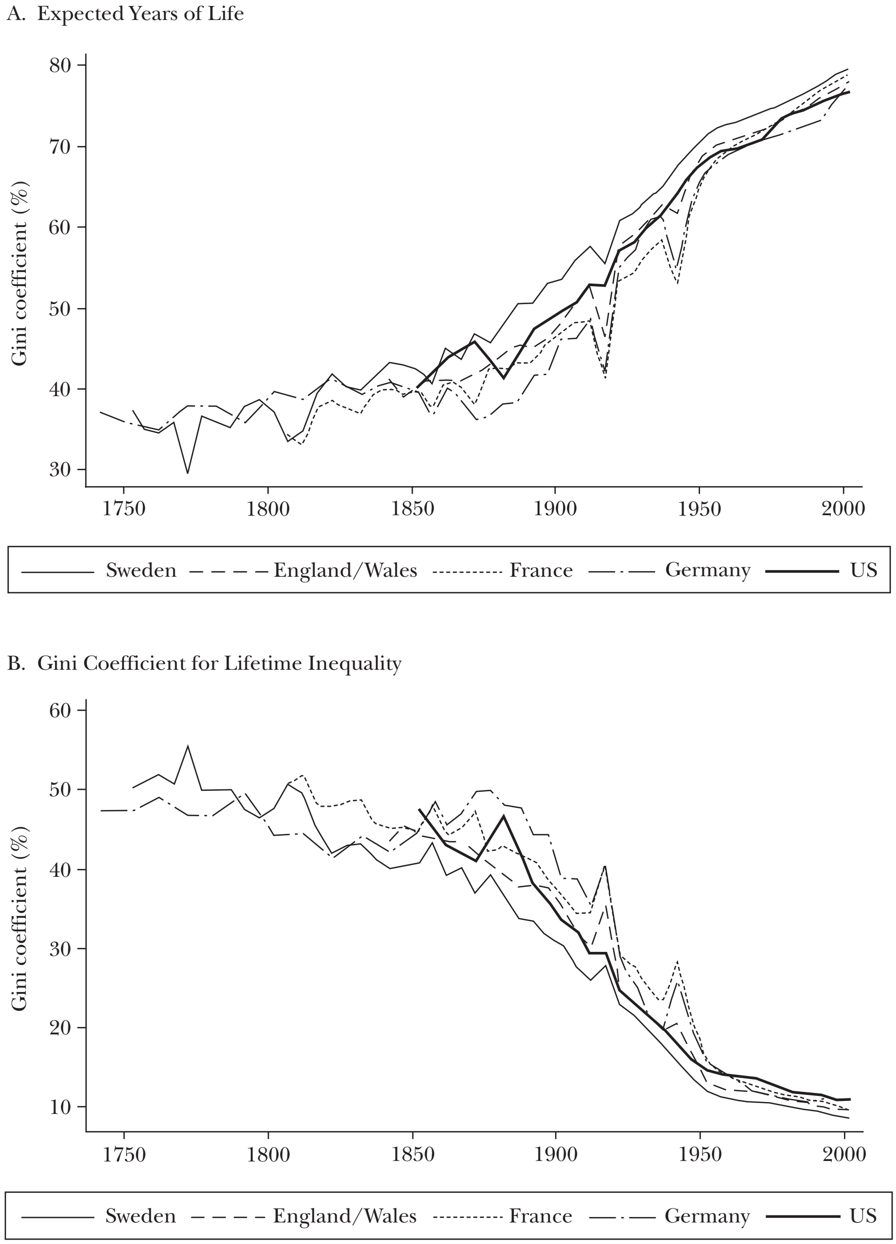
The History of Mortality Inequality

Figure 2 portrays available histories from life table data from varying dates beginning around 1750 for five countries: the United States, England and Wales, France, Germany, and Sweden. I refer the interested reader to a related working paper for more extensive data and more intensive analysis than I attempt in this paper. This working paper also contains a full description of data sources and estimation issues that I will mainly ignore here.[3] Suffice it to say that the data quality varies, even among these five developed countries. At one extreme, Sweden has reasonably complete coverage of the population from the middle of the eighteenth century, which is why I have included this relatively small country here. The United States is at another extreme, where life expectancy before the 1930s is estimated from fragmentary data. U.S. data are shown as a thicker solid line for ease of reference.[4]

[3] See the working paper with the same title as this one and a related appendix (Peltzman, 2009). The appendix is also available with this paper at the journal's website, ⟨http://e-jep.org⟩. Much of the life table data comes from two online databases: The ⟨http://www.mortality.org/⟩ database was developed primarily by researchers at the Department of Demography of the University of California at Berkeley and also at the Data Laboratory of the Max Planck Institute for Demographic Research in Rostock, Germany. The ⟨http://www.lifetable.de/⟩ data was also created by researchers from these two institutions, as well as researchers from the Institut national d'études démographiques in Paris, France.

[4] All references to specific years in this paper are to mid-points of a five-year interval beginning at years zero and five. The life table data are generally averaged over these intervals to reduce measurement error.

Figure 2
Expected Life and Inequality of Life for Five Rich Countries, 1742–2002



Note: Data are five-year averages centered around year shown.

The top panel in Figure 2 shows the familiar life expectancy measure. The bottom panel shows the Gini coefficient for the inequality of lifetimes within each country. The Gini coefficients are constructed, as described above, from Lorenz curves of cumulative distributions of life years arrayed from the poorest (infant deaths) to the richest (centenarians). The two panels of Figure 2 show little or no change in either life expectancy or inequality of life expectancy before 1850, but continual progress thereafter. The progress accelerates around 1900 and then slows after 1950. There is also some narrowing of the cross-country dispersion of both of life expectancy and the Gini coefficient over time. Becker, Philipson, and Soares (2005) emphasized the narrowing of life expectancy differences between rich and poor countries, but Figure 2 suggests the phenomenon is pervasive. The small differences that remain today place the United States at the bottom of this group of five countries in life expectancy and at the top in terms of inequality of lifetimes.

The cumulative reduction of mortality inequality is startling. In the first century of our data, mortality Ginis range around 40 to 50. That is, they exceed the upper range of household income Ginis that prevail today in the developed world. The decline in mortality inequality since the mid nineteenth century is hardly interrupted by either of the two world wars or by the influenza epidemic circa 1920. This decline has taken the mortality Ginis of today down to levels that are much lower than—on the order of half—the lowest contemporary income Ginis in these countries. As a result, the changes in life expectancy represent not only a gain in welfare, by extending life on average, but have also contributed greatly to social equality. Indeed, the numerical decline in mortality Ginis seems to have exceeded the decline of income Ginis in the last century or so, and this might hint at a larger contribution to social equality from improved longevity than from income redistribution.[5] Of course, some caution is warranted in directly translating either an income or mortality Gini coefficient into a welfare measure.[6]

The two panels of Figure 2 appear to be mirror images, but this apparent correspondence reflects the interplay of opposing forces, rather than any mechanical connection between life expectancy and inequality. Here, it helps to simplify and think of gains in life expectancy as having three dimensions: 1) an increased

[5] To get at the role of income redistribution policies in reducing income Ginis, we would like to first measure the Gini for a society without redistribution policies and then measure the Gini for the same society after it implements these policies. All rich countries today have redistributive tax and spending policies, so the best we can hope to do is to compare Ginis from a society that has little redistribution to one that has much redistribution. We need to go back a long way to find examples of societies without substantial redistribution. And unfortunately there is insufficient data to make definitive estimates of Ginis for any historical example of a non-redistributive society. However, the few scraps of data we do have suggest that extensive, Scandinavian-style redistribution may have reduced Ginis on the order of 15 to 20 percentage points. This inference comes from a comparison of the United States around a century ago with Sweden today. The United States of that era had little redistribution, but its income Gini seems to have been around today's figure of approximately 40. This conclusion is based on the similarity of Kuznets' (1953) estimate of the top 5 per cent income share in 1917 (24.6 percent) with today's figure. If we then take 40 as a no-redistribution base for the Gini and compare it with Sweden's contemporary Gini in the low 20s we would get a 15- to 20-point effect from redistribution policies. Of course this estimate has to be taken with a great many grains of salt, since many factors other than redistribution policies distinguish the United States of 1917 from contemporary Sweden. Additional caution is warranted in assuming that there is a single Gini, like 40, that characterizes societies without redistribution.

[6] For example, one issue is that income Ginis weigh each dollar equally and mortality Ginis weigh each life-year equally. Such equal weighting may be inappropriate for welfare comparisons between the two kinds of Ginis, or between different values of either kind.

probability of surviving to old age (or a reduced probability of dying prematurely); 2) increased expected lifetimes of those who do die prematurely; and, 3) increased life expectancy for the aged. These three dimensions of progress are summarized for England and Wales since the mid-1800s in Table 1, where premature death is defined to occur before 80. (English data are used here because they are of fairly uniform quality over the period, but the patterns for any other country in Figure 2, including the United States, would be similar to those in Table 1.) Progress occurs in all three dimensions, but it is decidedly uneven. Specifically, there is a substantial narrowing of the gap between the life expectancy of those who die prematurely and those who do not, as seen in the last column of the table. A number of factors have combined to add 30 years to the expected lifetimes of those who die before the age of 80: reduced infant mortality; the virtual elimination of infectious diseases, like tuberculosis, which killed substantial numbers of middle-aged adults; improvements in recent decades in heart disease treatment; and other factors. By contrast, life expectancy for those who make it to their 80th birthday today is not much different today than it was in the time of Charles Dickens. Essentially, progress in life-years has consisted of getting more people to live closer to a relatively unchanging upper limit and almost eliminating mortality risk at young ages. Today over half the population can expect to live to 80, but almost nine in ten of these 80 year-olds will die in the next 15 years. Of the half who do not make it to 80, only one in five will die before 60 (vs. two of three in 1842). In other words, this compression in the ages at which people die has driven the decline in mortality inequality.

The decline in mortality risk has also resulted in a drastically reduced probability of dying prematurely (as shown in column 1 of Table 1). This aspect of progress against mortality actually promotes inequality. To see why, suppose that, counter to historical fact, there had been no compression in the ages at which death occurs. Say, for example, those who died before 80 always died at 50 and those who survived past 80 died at 85. Then if no one survives to 80, we have a completely egalitarian mortality distribution—everyone dies at 50. There is also complete equality at the other extreme case where all survive to 85. In between these extremes, the relation between average longevity and inequality is a non-monotonic inverse-U shape. Inequality increases with longevity when we start with no one surviving to 85—close to the situation in the England of 1842—and then we see growth in the fraction that does survive to old age. Inequality increases as this fraction grows (up to .5, in this example) and then declines as the fraction grows further. This nonmonotonic connection between average longevity and inequality might be called a "mortality Kuznets curve," because it employs the same mechanism as Kuznets' (1955) argument about the connection between growing average income and income inequality. His point was that a gradual shift of population from a low-income agriculture to a higher-income urban sector would initially raise income inequality. This gradual shift would raise average income, but it would cause inequality to follow an inverted U-shape, with complete equality at the start when all people are farmers or at the end when all are city-dwellers. In the current context, the analogue to per capita income would be average life expectancy, and the low-income sector that gradually gets smaller would be the group that dies

Table 1
Selected Mortality Data. England and Wales, 1842–2002

Year	*Percentage surviving past 80* *(1)*	*Expected years of life for*			*Ratio of years lived for deaths after and before age 80*
		Those who die before 80 *(2)*	*Those who die after 80* *(3)*	*All births* *(4)*	*(5) = (3)/(2)*
1842	9.6%	36.5	85.0	41.1	2.33
1902	11.9%	43.2	84.6	48.1	1.96
1952	30.1%	62.2	85.3	69.2	1.37
2002	54.8%	66.3	87.7	78.0	1.31

Note: Data from 5-year life tables for England and Wales. Year is mid-point of 5-year interval.

before old age. The reason that mortality inequality has continually decreased is that this mortality Kuznets effect has been overwhelmed by the substantial narrowing of the difference in longevity between those who die before and after reaching old age.

The largest contributor to this narrowed gap—and thereby to reduced mortality inequality—has been dramatically reduced infant and early childhood mortality. Today such mortality has been nearly eliminated in the developed countries. The probability that an infant born in a developed country today will survive to his or her fifth birthday exceeds .99: for example, in 2002 this probability was .994 for England and Wales and .992 for the United States. This is a sharp contrast with much of human history. For example, in the mid nineteenth century, 23 of every 100 U.S. infants born did not reach their first birthday. Another seven would die before reaching age five. In England, then somewhat richer and more urban than the United States, the corresponding figures were 15 deaths before age one and another eleven deaths between ages one and five.[7] Subsequent progress here was slow and uneven until a dramatic acceleration in the twentieth century.[8]

One way to gauge the impact of childhood mortality on mortality inequality is to calculate mortality Ginis for the cohort that survives to age five. That is, we ask how equally the extra life years lived by this cohort are distributed over subsequent lifetimes that could end before a 6th birthday or after a 106th. In the mid nineteenth century, mortality Ginis for those surviving to age five were about half those for the birth cohort.[9] Over the next 150 years these "age 5 and up" Ginis declined and are now substantively identical to the figures for a birth cohort (because the cohorts are

[7] These data are from the U.S. life table for 1852 and the England and Wales life table for 1842. The specific probabilities for the United States are .229 for death before age one and .304 for death before age five. For England and Wales, these two probabilities are .145 and .257, respectively.
[8] For example, the England/Wales data for 1902 are hardly different than for 1842—a .141(.208) probability of death before one (five). The corresponding U.S. probabilities for 1902 were .117 (.173), a measurable improvement over 1852. By 1947, all these probabilities had fallen to under .05.
[9] For example, the mortality Gini for the 1852 U.S. cohort surviving to age five is 23.7, compared to the 47.6 percent for that year's birth cohort, as shown in panel A of Figure 1. For England and Wales in 1842, the corresponding Ginis are 25.6 and 43.5, respectively.

now substantively identical). So, by this set of measures, half the historic decline in mortality inequality is due to the elimination of infant and early childhood mortality, and the other half comes from the compression of adult lifetimes.

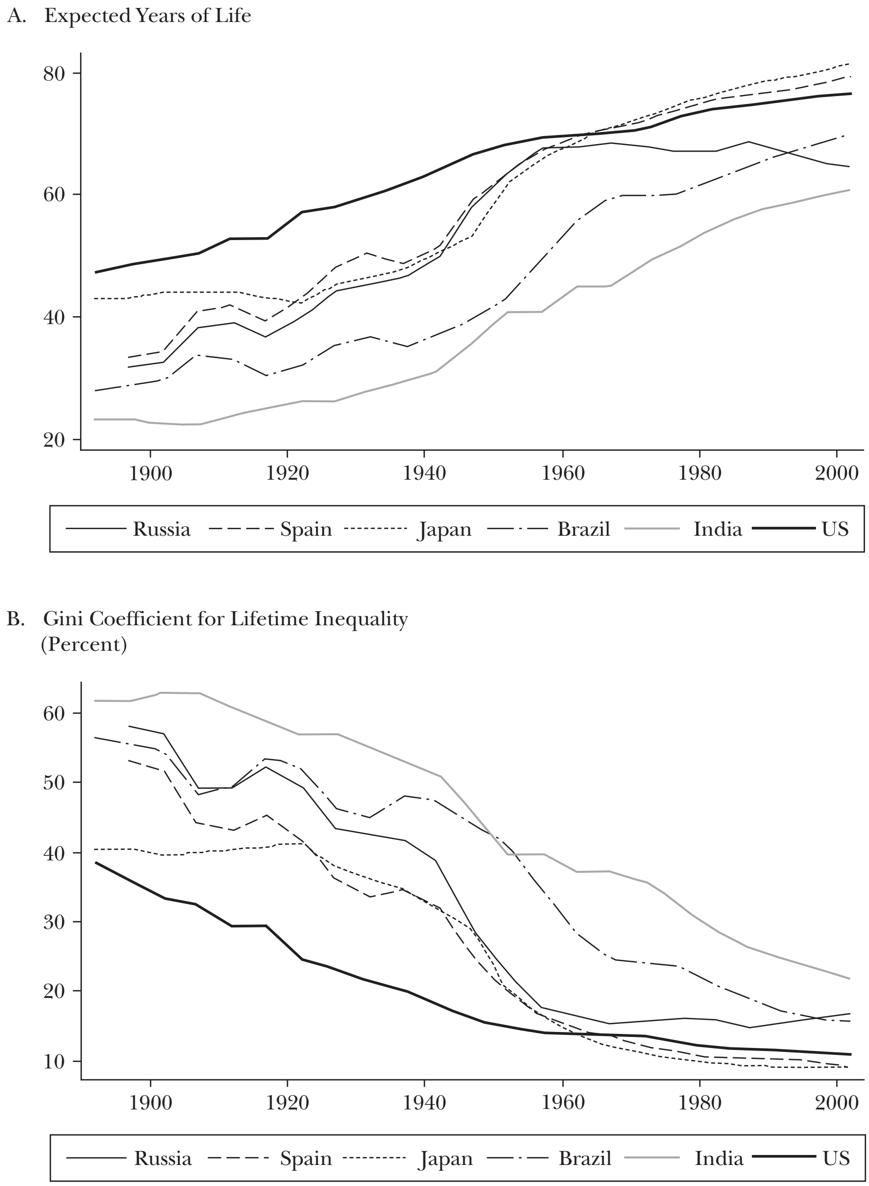
Figure 3 shows data for a more diverse group of five countries over the twentieth century, with U.S. data included for comparison. All five were low-income countries at the start of the period. India remains a low-income country today. By global standards, Brazil is usually counted as middle-income. Spain and Japan became high-income countries in the second half of the twentieth century. Spain is typical of a tier of southern European countries, such as Italy and Greece, that have converged on their northern European neighbors over this period. Russia has a singular history over this period demographically, as well as along other dimensions. The data for this diverse group show a noticeable change at around the midpoint, which is both near the end of World War II and also the beginning of a revolution in the treatment of infectious disease.

Over the first half of the twentieth century, expected lifetimes increase on average about as fast in percentage terms for this group as for the high-income countries in Figure 2. Accordingly, the high-income countries maintain something like a 50 percent advantage in life expectancy. This advantage then contracts sharply in the second half of the twentieth century. This pattern is shown in the top panel of Figure 3, where the five poorer countries are on average converging in life expectancy toward the U.S. level, with Japan and Spain eventually exceeding the U.S. level. The mortality Ginis shown in the bottom half of Figure 3 follow a similar pattern. There is some evidence of a mortality Kuznets effect here in that the rich–poor country differences in the Ginis actually tend to widen before World War II, even though life expectancy differences remain essentially the same.

The countries depicted in Figure 3 display a considerable variety in their mortality experience. The two countries that eventually reach high-income status—Spain and Japan—attained the mortality profiles of high-income countries by about 1960, or well before their economic convergence was complete. Brazil and India appear to follow high-income country trends in mortality with a lag of 50 to 100 years. They begin the twentieth century with life expectancies and mortality Ginis that are similar to or worse than the pre-1850 life expectancies and mortality Ginis of the high-income countries from Figure 2. But then Brazil and India experience gradual progress that accelerates after 1950, a period in which high-income countries' progress on mortality decelerates. A marked difference remains in expected lifetimes and inequality between Brazil and India, on the one hand, and the high-income countries, on the other, but at the start of the twenty-first century, this difference seems to be narrowing steadily.

The same cannot be said of the singular case of Russia, which of course was the Soviet Union during much of the relevant period. Up to the late 1950s, the Soviet experience looks very much like Spain's—Russia looks like a developing European country that has nearly closed the mortality gap with its rich neighbors. Then, unlike any other sizeable country for which we have similar time series, the progress in life-years stops and then reverses. The retrogression accelerates after the breakup of the Soviet Union. Life expectancy in Russia has declined by three years since the

Figure 3
Expected Life and Inequality of Life for Five Poorer Countries and the United States: 1892–2002



mid-1950s. During this time, Russia (like much of the world) has experienced substantially reduced infant mortality. The significant absolute deterioration in lifetimes has occurred among mature males. Life expectancy for a 50 year-old Russian male is now around three or four years lower than in the 1950s. He has no greater life expectancy than his counterpart at the coronation of the last Tsar:

specifically, a 50 year-old Russian male could expect to live another 18.4 years in 1897 and another 18.8 in 2002. With this combination of forces, the Russian mortality Gini has been flat since the 1950s.

Geographic Mortality Inequality: U.S. States and Counties

Social inequality has a geographic dimension within as well as across societies. Even within a common political and legal system and a shared base of medical knowledge, social indicators vary geographically. Here I summarize geographic differences in mortality within the United States using data from states and counties.[10] For this purpose, I focus mainly on differences in life expectancy, and in particular on differences at the extremes of the geographic distribution.

Figure 4 summarizes the available data at the state level from 1910 to 2000. It shows the ratio of expected lifetimes in the states that comprise the highest and lowest population deciles on this measure. The "highest decile" refers to the set of states that have the highest life expectancy and contain approximately one-tenth of the U.S. population; the "lowest decile" is defined analogously. Life expectancy within each decile is the population-weighted mean of the states within the decile.

These interstate differences follow a path similar to the developed country mortality Ginis in Figure 2. The differences fall substantially until around 1950, after which there is a marked deceleration. By 1960, in fact, the state-level convergence in expected lifetimes had ended. In the subsequent 40 years, the difference in expected lifetimes between the highest and lowest deciles has moved narrowly around a mean of roughly 5 percent. The upward blip in 1990 is due to the AIDS epidemic, of which the effect on average life expectancy crested in the early 1990s.

State per capita incomes during this time also show a pattern of a sharp convergence that ends abruptly. For example, the income counterpart to the ratio plotted in Figure 3—that is, the population-weighted ratio of state per capita incomes in the states that define the highest and lowest population deciles on this measure—falls by over half from 3.7 in 1930 to 1.6 in 1970, but it is trendless thereafter. The commonality in the falling state-level inequality of mortality and income is not surprising given the well-documented link between income and health. However, the state-level convergence of lifetimes is too large to be explained entirely by converging incomes: income-corrected longevity differences across states also decline substantially up to 1970.[11]

County-level data, available from 1972 to 2002, permit a more fine-grained look at geographic differences in mortality. This post-1970 period is particularly

[10] The choice of geographical unit is driven by data considerations. County-level data are the finest practical subdivision of the population for which life tables can be constructed. They are readily available from 1970 on. Prior to 1930, state-level data are available only for a subset of states.

[11] Specifically, I estimated a Preston-curve (approximated by a quadratic in state per capita income) and then adjusted each state's life expectancy for the effect of deviations from national mean income. A redrawn Figure 3 based on this "income-corrected longevity" looks almost identical to the figure in the text, albeit at a slightly lower average level.

Figure 4
Inequality of Life Expectancy across U.S. States, 1910–2000
(*Ratio of life expectancy in highest decile to that in lowest decile***)**

Note: Life expectancy within each decile is the population-weighted mean of the states within the decile. The 20 non-South states with data available from 1910 on are: California, Colorado, Connecticut, Indiana, Massachusetts, Maryland, Maine, Michigan, Minnesota, Montana, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rode Island, Utah, Vermont, Washington, Wisconsin.

interesting because of the widening income inequality after about 1980. We can ask whether trends in geographic mortality inequality tended to reinforce or offset the widening income inequality. Table 2 seeks to illuminate this question by examining the extremes of the geographic distribution.

The mortality data in Table 2 are from five-year life tables estimated for each of the more than 3,000 U.S. counties. The data sort the county populations into deciles based on the counties' expected lifetimes. Thus, for example, the first line of the table tells us that the population decile at the top of the 2002 distribution lived in counties with average expected lifetimes of 79.8 years, and this exceeded the 73.2 years of the lowest decile by around 9 percent. The table also has related data, including the average Gini measure of mortality inequality for the population within these counties. Perhaps unsurprisingly, the lowest decile counties have lower incomes and education and larger within-county mortality inequality than the top decile counties. The patterns in these data over time are broadly complementary or reinforcing. County-level differences in expected lifetimes tend to narrow in the first decade of the period from 1972 to 1982 and then widen in the next two decades from 1982 to 2002.[12] The associated income differences and mortality Gini

[12] I exclude 1990 from the comparison to avoid distortion from the effects of the AIDS epidemic.

Table 2
Mortality at the Top and Bottom in U.S. Counties: 1972, 1982, 2002

	1972			*1982*			*2002*		
Variable	*Lowest decile*	*Highest decile*	*Ratio: highest/ lowest*	*Lowest decile*	*Highest decile*	*Ratio: highest/ lowest*	*Lowest decile*	*Highest decile*	*Ratio: highest/ lowest*
Expected life years	66.54	73.54	1.11	70.95	76.31	1.08	73.17	79.83	1.09
Change in ratio						*−0.030*			*+0.015*
Mortality Gini	16.43	11.78	0.72	13.89	10.69	0.77	12.94	9.12	0.70
Family income ($1,000)	9.61	13.81	1.44	20.03	27.02	1.35	50.66	93.24	1.84
Mean years education	9.67	11.77	1.22	10.83	12.51	1.16	12.26	13.78	1.12

Note: All data are population-weighted county means within each of the deciles. Mortality data are from five-year county life tables centered on the year indicated. Income and education are from nearest census year. "Lowest decile" is defined as the 10 percent of the population living in counties with the lowest average life expectancy in each year. "Highest decile" is defined similarly for the population decile with highest county average life expectancy.

differences follow the same time pattern. (In education levels, however, county differences narrow in every period.) Overall, the county-level differences in longevity in 2002 are roughly where they were in 1972, with around 10 percent—about seven or eight years—separating the top and bottom deciles. By contrast, the related income differences have widened noticeably from 44 percent in 1972 to 84 percent in 2002.

This pattern of an initial narrowing of inequality followed by a reversal is robust to alternative ways of classifying the counties. For example, we might worry about random turnover of the counties at the extremes of the life expectancy distribution. But if we slice the data into a fixed set of counties that are defined by household income (as of the 1970 census), rather than longevity, and then follow these counties over the subsequent period, we get the same pattern of falling then rising inequality of income and expected life. Other classification schemes produce the same pattern.[13]

Thus, the recent history of mortality inequality in the United States has a glass-half-full, glass-half-empty aspect, in which the perspective depends on the starting point. The widening geographic inequality in mortality inequality since 1980 at the county level has been noted elsewhere (Singh and Siapush, 2006). It is not yet clear whether this phenomenon marks a reversal of the apparently flat trend since 1960 in geographic mortality inequality as measured at the state level. A clearer lesson lies in the overriding importance of progress in reducing mortality, as exemplified by the nearly identical expected lifetimes of the highest mortality decile in 1972 and the lowest mortality decile in 2002—that is, the poorest (in

[13] For example, this pattern is obtained if the deciles are sorted by life expectancy in 1972, or by "predicted" life expectancy from a regression with income and education measures on the right-hand side or by education instead of income.

life-years) counties of today are about as well off as the richest counties of a generation ago.

To place the intra-U.S. geographic dispersion in life expectancy in international context, the top decile of the U.S. population is a year or two below the very top of the international distribution, which might be exemplified by Japan. The bottom decile of the U.S. population in life expectancy is at roughly the average life expectancy level of Mexico or Argentina. In terms of characteristics, while the places in the bottom decile of the U.S. life expectancy distribution tend to have low income and education, substantial variety remains uncaptured by such observables. For example, Duval County, Florida, (including the city of Jacksonville) and Queens, New York, are at the borders of the lowest and highest life expectancy deciles respectively. Queens has around five years higher life expectancy, but these two counties have comparable incomes, and Duval actually has a higher education level.

Summary

The substantial increase in longevity over the last century, both in the United States and around the world, is well-known. This essay has documented another aspect of that progress: a considerable contribution to social equality. The dominant fact about this history from a worldwide perspective is how much this aspect of human inequality has diminished. In the mid-eighteenth century, the very different ages at which people died translated into a mortality Gini measure on the order of 50. By the end of the twentieth century, the same measure in a developed country is 10 or less. Even in less-developed countries, like Brazil or India, mortality is today distributed more equally than income is distributed in an advanced welfare state. Inequality of lifetimes is well along in a historical transformation from a major source of social inequality into a minor one.

This transformation reflects the particular way in which progress in reducing mortality has played out. It has spared vast numbers of people from death in infancy and adulthood, but not from death in old age. The upper limit of life seems to be around 100 years for the entire 250 years documented here. (While the number of centenarians has increased, they remain a tiny minority. The probability of surviving past 100 is on the order of .01 for contemporary developed country life tables.) Progress has consisted of moving more and more people closer to that upper limit, and that compression is what the very low mortality Ginis of today are measuring. Interestingly, if significant progress occurs in raising that upper limit on life expectancy, then the long decline in mortality inequality may reverse itself.

■ *I thank Ivan Rivas, Wladimir Zanoni, Ricardo Estrada, and Pablo Celhay for valuable research assistance and Timothy Taylor, James Hines, and other editors for comments on a previous draft.*

References

Becker, Gary, Tomas Philipson, and Rodrigo Soares. 2005. "The Quantity and Quality of Life and the Evolution of World Inequality." *American Economic Review,* 95(1): 277–91

Cutler, David, Angus Deaton, and Adriana Lleras-Muney. 2006. "The Determinants of Mortality." *Journal of Economic Perspectives,* 20(3): 97–120.

Kuznets, Simon. 1955. "Economic Growth and Income Inequality." *American Economic Review,* 45(1): 1–28.

Kuznets, Simon. 1953. *Shares of Upper Income Groups in Income and Savings.* National Bureau of Economic Research.

Peltzman, Sam. 2009. "Mortality Inequality," with appendix. Working Paper no. 225, George J. Stigler Center for the Study of the Economy and the State. http://research.chicagobooth.edu/economy/docs/stigler225.pdf.

Preston, Samuel H. 1975. "The Changing Relation between Mortality and Level of Economic Development." *Population Studies,* 29(2): 231–48.

Singh, Gopal K., and Mohammed Siapush. 2006. "Widening Socioeconomic Inequalities in US Life Expectancy, 1980–2000." *International Journal of Epidemiology,* 35(4): 969–79.

This article has been cited by:

1. Martina Otavova, Christel Faes, Catherine Bouland, Eva De Clercq, Bram Vandeninden, Thierry Eggerickx, Jean-Paul Sanderson, Brecht Devleesschauwer, Bruno Masquelier. 2022. Inequalities in mortality associated with housing conditions in Belgium between 1991 and 2020. *BMC Public Health* **22**:1. . [Crossref]
2. Marinko Skare, Małgorzata Porada-Rochoń. 2022. Technology and social equality in the United States. *Technological Forecasting and Social Change* **183**, 121947. [Crossref]
3. Robin Markus Auer. Mens Humana in Corpore Humano—Body-Hacking the Human Experience 69-85. [Crossref]
4. Predrag Bejaković, Marinko Škare, Romina Pržiklas Družeta. 2021. SOCIAL EXCLUSION AND HEALTH INEQUALITIES IN THE TIME OF COVID-19. *Technological and Economic Development of Economy* **27**:6, 1563-1581. [Crossref]
5. Wei Xu, Michal Engelman, Jason Fletcher. 2021. From convergence to divergence: Lifespan variation in US states, 1959–2017. *SSM - Population Health* **16**, 100987. [Crossref]
6. Nick Cowen, Vincent Geloso. 2021. Capital, Ideology, and the Liberal Order. *Analyse & Kritik* **43**:2, 413-435. [Crossref]
7. Luubaatar Badarch, Munkhjargal Gochoo, Ganzorig Batnasan, Fady Alnajjar, Tan-Hsu Tan. Ultra-Low Resolution Infrared Sensor-Based Wireless Sensor Network for Privacy-Preserved Recognition of Daily Activities of Living 1-5. [Crossref]
8. Tan-Hsu Tan, Luubaatar Badarch, Wei-Xiang Zeng, Munkhjargal Gochoo, Fady S. Alnajjar, Jun-Wei Hsieh. 2021. Binary Sensors-Based Privacy-Preserved Activity Recognition of Elderly Living Alone Using an RNN. *Sensors* **21**:16, 5371. [Crossref]
9. Hampton Gray Gaddy. 2021. A decade of TFR declines suggests no relationship between development and sub-replacement fertility rebounds. *Demographic Research* **44**, 125-142. [Crossref]
10. Moshe A. Milevsky. 2020. Swimming with wealthy sharks: longevity, volatility and the value of risk pooling. *Journal of Pension Economics and Finance* **19**:2, 217-246. [Crossref]
11. Moshe Arye Milevsky. Biological (and Other) Ages 259-279. [Crossref]
12. G. Newton-Howes, M. K. Savage, R. Arnold, T. Hasegawa, V. Staggs, S. Kisely. 2020. The use of mechanical restraint in Pacific Rim countries: an international epidemiological study. *Epidemiology and Psychiatric Sciences* **29**. . [Crossref]
13. Mathias Kifmann, Kerstin Roeder. 2019. The political sustainability of a basic income scheme and social health insurance. *Journal of Public Economic Theory* **21**:6, 971-990. [Crossref]
14. N.M. LEVCHUK, L.V. LUSCHIK. 2019. Inter-Individual Inequality in Length of Life in Ukraine. *Demography and social economy* **4**:2, 52-64. [Crossref]
15. Tom S. Vogl. 2018. Dynamics of Child Mortality Inequality. *AEA Papers and Proceedings* **108**, 348-352. [Abstract] [View PDF article] [PDF with links]
16. Moshe Arye Milevsky. 2018. Swimming with Wealthy Sharks: Longevity, Volatility and the Value of Risk Pooling. *SSRN Electronic Journal* **76**. . [Crossref]
17. Lionel Kesztenbaum, Jean-Laurent Rosenthal. 2017. Sewers' diffusion and the decline of mortality: The case of Paris, 1880–1914. *Journal of Urban Economics* **98**, 174-186. [Crossref]
18. Petar Stankov. Contemporary Views on Welfare and Reforms 9-41. [Crossref]
19. Petar Stankov. Policy Convergence Vs. Welfare Convergence 69-97. [Crossref]
20. Vanesa Jordd, Miguel NiiooZarazza. 2017. Global Inequality in Length of Life: 195002015. *SSRN Electronic Journal* . [Crossref]

21. Kurt Sartorius, Benn Sartorius. 2016. Service delivery inequality in South African municipal areas: A new way to account for inter-jurisdictional differences. *Urban Studies* **53**:15, 3336-3355. [Crossref]

22. Florence Jusot. 2016. L'évolution favorable de l'espérance de vie correspond-elle à une augmentation du bien-être lié à la santé ?. *médecine/sciences* **32**:3, 231-232. [Crossref]

23. Joseph T. Lariscy, Claudia Nau, Glenn Firebaugh, Robert A. Hummer. 2016. Hispanic-White Differences in Lifespan Variability in the United States. *Demography* **53**:1, 215-239. [Crossref]

24. Glenn Firebaugh, Francesco Acciai, Aggie J. Noah, Christopher Prather, Claudia Nau. 2014. Why Lifespans Are More Variable Among Blacks Than Among Whites in the United States. *Demography* **51**:6, 2025-2045. [Crossref]

25. . The Cambridge Economic History of Australia **17**, . [Crossref]

26. Sam Peltzman. 2014. Socialized medicine and mortality. *International Journal of Health Care Finance and Economics* **14**:3, 179-205. [Crossref]

27. Duncan O. S. Gillespie, Meredith V. Trotter, Shripad D. Tuljapurkar. 2014. Divergence in Age Patterns of Mortality Change Drives International Divergence in Lifespan Inequality. *Demography* **51**:3, 1003-1017. [Crossref]

28. David N. Weil. Health and Economic Growth 623-682. [Crossref]

29. Sushanta K. Mallick. 2013. Disentangling the Poverty Effects of Sectoral Output, Prices, and Policies in India. *Review of Income and Wealth* **18**, n/a-n/a. [Crossref]

30. Alain Trannoy. 2012. Inégalités de santé : le rôle des transmissions intergénérationnelles. *Économie publique/Public economics* :24-25, 17-39. [Crossref]

31. Claudia Nau, Glenn Firebaugh. 2012. A New Method for Determining Why Length of Life is More Unequal in Some Populations Than in Others. *Demography* **49**:4, 1207-1230. [Crossref]

32. Anatoliy I. Yashin, Konstantin G. Arbeev, Svetlana V. Ukraintseva, Igor Akushevich, Alexander Kulminski. 2012. Patterns of Aging-Related Changes on the Way to 100. *North American Actuarial Journal* **16**:4, 403-433. [Crossref]

33. Johannes Schoder, Peter Zweifel. 2011. Flat-of-the-curve medicine: a new perspective on the production of health. *Health Economics Review* **1**:1. . [Crossref]