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"Mortality Effects of the Great Recession in High-Income Nations"

Recessions and Life Expectancy

Life expectancy – the defining indicator of population health – has risen dramatically over the past two centuries. The rise has been driven, at least indirectly, by economic growth. Causes of decreasing death rates such as improved sanitation, nutrition, housing, access to advanced medical care (Cutler et al. 2006), for example, would have been impossible without economic growth. Most agree, then, that economic growth is associated with increasing longevity – that "wealthier is healthier" (Pritchett & Summers, 1996), at least over the long run.

The short-run association of economic growth is less settled. Many studies find that mortality rates decline during recessions, so life expectancy rises faster during economic downturns that it does during economic growth (for reviews, see Burgard, Ailshire, and Kalousova, 2013; Catalano et al., 2011). That finding is hard to reconcile with the long-run trend – if the association between growth and longevity is positive in the long run, why is it negative in the short run? It is also puzzling in light of the well-established individual level association between income and longevity, since the rich tend to live longer than the poor.

We theorize that the following identity is the key to understanding trends in life expectancy, which we will be using to pinpoint the recession's effect on mortality:

$$\Delta\, life\ expectancy = \Delta\, incidence\ component + \Delta\, age\ component$$

The equation states that change in life expectancy is the sum of change in an incidence component and change in an age component. The incidence component is based on cause-specific probability of death – the probability that one will die of heart disease, for example, as opposed to some other cause. The age component is based on cause-specific average age at death. During periods of economic growth, change in life expectancy is driven primarily by change in the age component. We theorize that during recessions, by contrast, change in life expectancy is driven by change in the incidence component.

To understand why the incidence component comes to the fore during recessions, it is helpful to conceptualize rising life expectancy as removing deaths from the young and middle-aged, producing a higher proportion of individuals eligible to die at an advanced age. In fact, life expectancy increases in a population when death claims a declining proportion of the population, but the increase is particularly marked if the decrease in mortality occurs among the nonelderly. There are two kinds of mortality patterns that would lead to this result. In the first, a larger percentage of the population survives to old age because a shrinking proportion of them succumb to youthful or middle-aged causes of death, such as homicide. Hence life expectancy increases because of *shifts in the causes of death* – the *incidence component* of change in life expectancy.

In the second kind of change in mortality, life expectancy increases because *mortality declines without any change in the proportion of deaths due to each cause*. In fact, life expectancy rises with general declines in death rates, even when the probability of dying of heart disease, of cancers, and so on is unchanged. The intuition is that, when there are general declines in mortality rates, there are more survivors at older ages who are eligible to die of any cause, producing an increase in the cause-specific mean age at death. The *age component* of change in life expectancy is so called because it captures change in the cause-specific average age at death. During periods of economic growth, high-income nations exhibit a "normal" pattern of growth in life expectancy, meaning that causes of death change very slowly. As a result, change in the incidence component contributes little to change in life expectancy. At the same time, mortality rates for the young and middle-aged continue to decline, particularly with respect to the chronic diseases that cause the vast majority of deaths, so mean age at death rises across causes.

Periods of recession interrupt this normal pattern of change in life expectancy by reallocating the causes of death. By producing shifts in the causes of death, recessions tend to boost mortality rates for some causes and reduce rates for other causes. The upshot is that recessions can either boost or reduce life expectancy, *depending on how causes of death are reallocated*. The net effect on life expectancy is captured by the all-cause incidence component. A negative all-cause incidence component indicates a reduction in life expectancy due to a shift toward causes of death that primarily affect the young and middle-aged; a positive all-cause incidence component indicates an increase in life expectancy due to a shift away from youthful causes of death. Importantly, the incidence component can be quantified (as we show below), so it is possible to estimate *how much* the shifting of the cause-of-death pattern has boosted or reduced life expectancy.

By comparing the relative size of the incidence and age components before and during the Great Recession – for the U.S. and other high-income nations – we advance our understanding of how recessions affect life expectancy. The all-cause incidence and age components will provide a test of our hypothesis that the primary effect of recessions on life expectancy is to prompt shifts in the causes of death. Moreover, by decomposing change into its *cause-specific* age and incidence components, we can pinpoint the location of changes in life expectancy. From prior research we know, for example, that life expectancy is boosted during recessions by change in transport fatalities (e.g. Tapia Granados and Roux 2009). What we do not know is how much of the effect of traffic fatalities on change in life expectancy during a recession is due to change in the incidence of traffic deaths, and how much is due to change in average age of traffic victims. We present equations that are designed to answer that question by determining how much transport accidents as well as other causes of death, contributed to change in life expectancy before and during the Great Recession – and why. We expect to find that external causes – suicide, mental disorders, drug overdose, traffic fatalities, and so on – come to the fore during recessions because these are the causes that are most susceptible to "reallocation." Although external causes of death ordinarily contribute little to change in life expectancy because they are relatively rare, during recessions they are likely to become primary drivers of change in life expectancy because that's where the reallocation is most pronounced.

The Great Recession of 2008

Global markets were severely shaken in 2008 by a financial and economic crisis now known as the "Great Recession." In the United States the recession reduced the wealth of American families by almost 30%, according to a recent report from the Urban Institute (McKernan et al. 2014). The report goes on to note that declines in the housing market were only part of the story, since all major wealth components fell as a result of the recession.

The severity and global nature of the recession has led to widespread concern about its implications for population health. A report from the World Health Organization (WHO 2009, p. 14), for example, argued that quality of health care is likely to deteriorate – in rich as well as poor countries – because "Economic recession makes the task of defending health budgets more difficult." Aside from its possible effect on national health budgets, one might expect the Great Recession to undermine the health of Americans due to the collateral effects of job loss among the working age population – material hardship, more stress, loss of medical insurance, etc. – as well as wealth loss among both workers and retirees.

To this point, however, the best evidence indicates that the Great Recession has not reduced life expectancy (Stuckler et al. 2011; Burgard et al. 2013). This is attributable in part to reductions in traffic fatalities, as noted earlier. In addition, recessions might promote healthier living as people have more time for sleep and adopt better eating habits (Burgard et al. 2013). Perhaps the transmission of infectious diseases is also reduced during recessions (Burgard et al. 2013). Or perhaps the elderly receive better care during recessions, as institutional care facilities for the elderly are able to hire better workers, and families have more time for oversight of their elderly members (Burgard et al. 2013). The age vs. incidence decomposition method (elaborated below) provides a significant new tool for evaluating the merit of these explanations.

Data

We will use vital statistics to derive multidecrement life tables for the United States and other high-income countries for the years before and after the Great Recession of 2008. The life tables are age-sex-cause-specific, based on 21 causes. The 21 causes include the most common causes of death, plus causes that theory or prior research suggests are particularly relevant to the effect of recession on mortality (e.g., suicide; traffic accidents; falls). In selecting significant causes of death we were guided by our prior research on life expectancy (Nau and Firebaugh 2012; Firebaugh, Acciai, Noah, Prather and Nau, forthcoming a, b).

We will examine annual change in the age and incidence components beginning in 2000 for the United States. Because other nations have smaller populations, we must combine adjacent years to obtain reliable estimates of change in life expectancy attributable to causes of death, such as homicide, that are relatively rare but nonetheless central to change in life expectancy. For smaller nations, we will use 2-year, 3-year, or 4-year intervals for our calculations, depending on the size of the nation. Regardless of the size of the interval, the important comparison is life expectancy in the years leading up to the Great Recession with life expectancy in the years during and after the recesssion.

Because the Recession affected some nations more than others – and in different ways (nations varied in terms of job loss vs. wealth loss vs. decline in GDP, for example) – a cross-nation comparison provides analytic leverage that we could not obtain by focusing on a single nation.

Countries we will study include Germany, Greece, Spain, Italy, Hungary and Poland. Our goal is to analyze countries that have been affected by the Great Recession to different extents. Hungary and Poland, for instance, were quite similar in terms of GDP per capita and mean income until 2007 (Eurostat, 2014); however, Hungary has been hit by the Recession more severely than Poland. Italy and Spain are also quite similar in terms of macro-economic indicators, but the level of unemployment in Spain skyrocketed after the Recession (26.1% in 2012), while it only slightly increased in Italy (Eurostat, 2014). We also include Germany as a country only marginally affected by the Recession, and Greece, on the other hand, whose entire economy has collapsed as a consequence of the Recession.

Analytic Approach

Our method capitalizes on the observation that life expectancy at birth is the sum of probability-weighted cause-specific life expectancies, so life expectancy can be derived using age-specific mortality rates broken down by cause of death (Beltrán-Sánchez, Preston and Canudas-Romo 2008). For each point in time, we construct multi-decrement life tables to calculate the probability (*p*) of death and the mean age at death ($\bar{x}$) for each of our 21 causes of death (*c*). We then calculate the contribution of each of the causes to the change in longevity from year *T* to year *T+1*, separating the portion of the gap attributable to differences in the mean age at death ($\bar{x}_{cT+1} - \bar{x}_{cT}$) from the portion attributable to differences in the probability of dying of each cause ($p_{cT+1} - p_{cT}$). Since the overall life expectancy can be calculated as the probability-weighted sum of cause-specific life expectancies[1] , the change in life expectancy from time *T* to time *T+1*, $e_{T+1} - e_T$, is:

$$e_{T+1} - e_T = \sum_c p_{cT+1}\,\bar{x}_{cT+1} - \sum_c p_{cT}\,\bar{x}_{cT}, \qquad (1)$$

where $\sum_c p_{cT} = \sum_c p_{cT+1} = 1$. Because the probability (*p*) must sum up to 1 at any point in time, it follows that $\sum_c p_{cT} k = \sum_c p_{cT+1}\, k = k$, where *k* is a constant. In particular, let *k* be $\bar{e} = \frac{e_T + e_{T+1}}{2}$, the simple mean of the life expectancies for the two time points, so $\sum_c p_{cT}\,\bar{e} - \sum_c p_{cT+1}\,\bar{e} = \bar{e} - \bar{e} = 0$. By inserting the term $\sum_c p_{cT}\,\bar{e} - \sum_c p_{cT+1}\,\bar{e}$ (which equals zero) into (1) we obtain the foundational equation for determining the contribution of specific causes to change in life expectancy:

$$\begin{aligned} e_{T+1} - e_T &= \sum_c p_{cT+1}\,\bar{x}_{cT+1} - \sum_c p_{cT+1}\,\bar{e} - \sum_c p_{cT}\,\bar{x}_{cT} + \sum_c p_{cT}\,\bar{e} \\ &= \sum_c p_{cT+1}\,(\bar{x}_{cT+1} - \bar{e}) - \sum_c p_{cT}\,(\bar{x}_{cT} - \bar{e}). \qquad (2) \end{aligned}$$

[1] When the causes are exhaustive and mutually exclusive.

From (2) it follows that the contribution of each cause to change in the longevity gap is:

$$contribution\ of\ c\text{th}\ cause = p_{cT+1}(\bar{x}_{cT+1} - \bar{e}) - p_{cT}(\bar{x}_{cT} - \bar{e}). \qquad (3)$$

The first term, $p_{cT+1}(\bar{x}_{cT} - \bar{e})$, applies to victims of cause *c* at time *T+1*. The term is positive when the cause-specific mean age at death is higher than overall life expectancy ($\bar{e}$) and negative when it is lower. The second term in (3) is the same, except it refers to time *T*. If equation (3) – the contribution of cause *c* at time *T+1* minus its contribution at time *T* – is positive, then cause *c* boosted life expectancy over the period. If the two terms are the same, cause *c* did not affect life expectancy . If the difference is negative, then cause *c* reduced life expectancy over the period.

From (3) we can see that the effects of mean age at death and probability of death are intertwined because they weight each other. To separate out the age component for a specific cause, we remove the incidence component in (3) by setting p_{cT+1} and p_{cT} at its mean value ($\bar{p}_c = (p_{cT+1} + p_{cT})/2$) for the two points in time.[2] Thus the age component is:

$$age\ component\ for\ cause\ c = \bar{p}_c(\bar{x}_{cT+1} - \bar{x}_{cT}) \qquad (4)$$

We separate out the incidence component in the same way, that is, we remove the influence of differences in age at death in (3) by setting $(\bar{x}_{cT+1} - \bar{e})$ and $(\bar{x}_{cT} - \bar{e})$ at its mean, $(\bar{x}_c - \bar{e})$, where $\bar{x}_c = (\bar{x}_{cT+1} + \bar{x}_{cT})/2$. Inserting this value into (3), the incidence component is:

$$incidence\ component\ for\ cause\ c = (\bar{x}_c - \bar{e})(p_{cT+1} - p_{cT}) \quad (5)$$

Summing over all causes in (4) indicates how much of the change in life expectancy is attributable to change in the cause-specific mean age at death:

[2] This weighting is consistent with conventional practice in demography (Preston, Heuveline and Guillot 2001, pages 28-29). Note that the term “age component” refers to the contribution of age differences to a longevity gap rather than to the size of the age difference itself. Similarly, by “incidence component” we refer to the contribution of differences in cause-specific incidence to the longevity gap rather than to the size of the incidence differences themselves.

all-cause age component =

$$\sum_c \bar{p}_c(\bar{x}_{cT+1} - \bar{x}_{cT}) \qquad (6)$$

Likewise, summing over all causes in (5) indicates how much of the change in life expectancy is attributable to change in the probability of dying of specific causes:

all-cause incidence component =

$$\sum_c (\bar{x}_c - \bar{e})(p_{cT+1} - p_{cT}) \qquad (7)$$

The all-cause age and incidence components sum to the overall change in life expectancy from time *T* to time *T+1*.

Preliminary Results for the United States

Life expectancy in the US has been slowly but steadily increasing over the past 20 years (Sherry et al. 2013). We center our analysis around 2007, which is the year of the transition into the Recession, or the last year of economic growth. Since the most recent mortality data by age, sex, and cause of death that are publicly available[3] are relative to 2011, we analyze change in life expectancy occurred between 2003-2011, so that we are able to compare the mortality regime before (2003-2007) and after (2008-2011) the recession. During this period life expectancy kept increasing, though to varying degrees (see table 1).

[3] http://wonder.cdc.gov/.

Table 1. Life expectancy in the United States, 2003-2011.

Year	Life Expectancy	1-year increase
2003	77.27	
2004	77.67	0.40
2005	77.71	0.04
2006	77.97	0.26
2007	78.25	0.27
2008	78.37	0.12
2009	78.67	0.30
2010	78.87	0.20
2011	78.96	0.09

Source: authors' calculations from CDC detailed mortality files.

Table 2 reports the results of the decomposition applied to every pair of adjacent years, plus the decomposition for the whole period (2011 vs. 2003) as well as for before (2007 vs. 2003) and after (2011 vs. 2007) the Recession.

Table 2. Age-incidence decomposition, United States 2003-2011.

	Absolute numbers (years)			Percentages		
Years compared	Differences due to		Difference in life exp.	Differences due to		Difference in life exp.
	Incidence	Age of death		Incidence	Age of death	
2004 vs 2003	0.01	0.38	0.40	3.1	96.9	100
2005 vs 2004	0.01	0.03	0.04	24.5	75.5	100
2006 vs 2005	0.03	0.23	0.26	12.0	88.0	100
2007 vs 2006	0.01	0.26	0.27	4.2	95.8	100
2008 vs 2007	0.13	-0.01	0.12	105.2	-5.2	100
2009 vs 2008	0.06	0.25	0.30	18.4	81.6	100
2010 vs 2009	0.07	0.13	0.20	36.1	63.9	100
2011 vs 2010	0.04	0.05	0.09	40.1	59.9	100
2011 vs 2003	0.36	1.33	1.69	21.4	78.6	100
2007 vs 2003	0.07	0.90	0.97	7.1	92.9	100
2011 vs 2007	0.29	0.42	0.71	40.9	59.1	100

The age-incidence method provides insights on the dynamics of the mortality trend in the US. The main point that emerges from table 2 is that even though the overall trend in life expectancy does not seem to have been particularly affected by the Recession, the mortality regime did change. In fact, the 0.97 increase in life expectancy occurred between 2003 and 2007 was almost entirely (92.9%) due to change in age at death; in other words, the cause-specific mean ages at death increased, whereas the probability of dying of specific causes remained largely unchanged. Therefore, the age component was the main driver of change in life expectancy in times of economic growth. In the 4-year period (2007-2011) the incidence component became much more salient, accounting for over 40% of the change in life expectancy. This indicates that there was a reallocation of the causes of death. The cause-specific mean age at death continues to increase, although it does so more slowly, and at the same time we observe a significant change in the probability of dying. This change is particularly striking for the 2008 vs. 2007 comparison; so, in 2008—when the Recession took place—the gain in life expectancy was entirely attributable to a reallocation towards causes of death that strike at older ages. The negative value of the age component indicates that, in case the reallocation of causes of death had not occurred, life expectancy in 2008 would have been lower than in 2007.

For each of the comparisons in table 2 we will be able to provide the cause-specific age-incidence decomposition, so that we will be able to further our understanding on the role that the Recession has had on the mortality regime, in the United States, as well in other Western countries. In table 3, for instance, we report the results of the decomposition for 2011 vs. 2007. Over this 4 year period, almost half of the gain in life expectancy has to be attributed to external causes, despite the negative contribution of suicide and accidental poisoning; this result is particularly relevant because all external causes together account for only about 10% of all deaths. The gain in life expectancy between 2007 and 2011 due to external cause is due to both age and incidence component, although the latter contributes more. It is also notable that the sole incidence component for transport accident accounts for almost 11% of the 2007-2011 change in life expectancy, even if it includes only just over 1% of all deaths. To put things into perspective, over the same period the leading causes of death, which account for over 55% of all deaths, contributed to about 16% of the change in life expectancy.

Table 3. Cause-specific age-incidence decomposition, United States for 2011 vs. 2007.

Cause of Death		Unit = Year		
		Differences due to		Difference in life exp.
		Incidence	Age of death	
Leading causes				
1	Heart diseases	-0.03	0.07	0.04
2	Cancers	0.01	0.10	0.12
3	Cerebrovascular and circulatory diseases	-0.04	0.00	-0.04
	Totals for leading causes	**-0.06**	**0.18**	**0.12**
Chronic diseases				
4	Chronic lower respiratory diseases	0.01	0.03	0.04
5	Alzheimer's	0.04	0.01	0.05
6	Diabetes	0.00	0.01	0.01
7	Genitourinary diseases	-0.01	0.01	-0.01
8	Diseases of the digestive system	0.00	-0.01	0.00
	Totals for chronic diseases	**0.04**	**0.04**	**0.09**
Communicable diseases				
9	Influenza and pneumonia	-0.01	-0.02	-0.02
10	Septicemia	0.00	0.00	0.00
11	HIV/AIDS	0.02	0.01	0.03
12	Other infectious diseases	0.00	0.01	0.01
	Totals for communicable diseases	**0.01**	**0.01**	**0.02**
External causes				
13	Homicide	0.02	0.01	0.03
14	Suicide	-0.03	0.00	-0.03
15	Transport accident	0.08	0.03	0.10
16	Accidental poisoning	-0.04	0.01	-0.04
17	Falls	0.01	0.01	0.02
18	Mental and behavioral disorders	0.20	0.04	0.24
19	Other external causes	0.00	0.01	0.01
	Totals for external causes	**0.24**	**0.10**	**0.34**
Infant and child conditions				
20	Perinatal deaths and congenital anomalies	0.04	0.01	0.05
Other causes, nec				
21	NEC - Not elsewhere classified	0.01	0.09	0.10
Grand Total		**0.29**	**0.42**	**0.71**

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