Deviation from expected?
Race and life expectancy in the
United States during the Great Depression‡

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Abstract
Prior work has highlighted increases in life expectancy in the US during the Great Depression, 1929–1933 (Tapia Granados and Diez Roux 2009). This is surprising relative to the tenet that life expectancy is correlated with human welfare. However, this result coheres with one side of recent debates about mortality and recessions. We refine prior work by constructing Lee-Carter interval estimates of life expectancy during the Great Depression, based on trends before 1929 (which are increasing and very noisy). Relative to expectation, life expectancy did not grow unusually during the Great Depression, for the total population. However, nonwhites saw greater-than-expected increases in life expectancy. This suggests a sort of dose-response relationship whereby among groups experiencing the depression more severely (viz., nonwhites), mortality improved when the economy worsened. However, at the level of total population (i.e., all races), the effect is not strong enough to be considered different from expectation.

Introduction
During the Great Depression (1930-33), the economy slowed (GDP fell and unemployment soared), yet life expectancy increased in the United States

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Scholars routinely invoke the somewhat counterintuitive finding of the Great Depression when theorizing about the health and mortality costs of contemporary economic crises. For this reason, it is important to critically evaluate life expectancy in the US following the Great Depression. This paper attempts to differentiate between two principal explanations for increase in life expectancy in the early 1930s in the US. First, scholars argue that life expectancy rose during the Great Depression, even more than past trends would have predicted, ostensibly due to a cause-and-effect relationship. The second explanation, by contrast, contends that life expectancy rose during the Great Depression (albeit not unusually so), because even the enormous economic upheaval did not derail continued mortality reductions expected from the early twentieth century trend.

The ability to distinguish among the explanations above holds two key implications. First, if we detect no evidence of an association between the Great Depression and an unexpected increase in life expectancy, then this result would lead to careful examination of the provenance and quality of data and methodology used in prior research to make such claims of an association. Second, if our rigorous approach yields a positive relation between the Great Depression and life expectancy, results would bolster additional replication efforts, in other places and times in which economic downturns occur, to understand the dynamic relation between the economy and population mortality.

Increasing life expectancy is the hallmark of mortality in the twentieth century. Thus, we consider is whether rises in life expectancy during 1930–
33 were unusual relative to past trends, or were typical of them. Can life expectancy be regarded as a juggernaut (Oeppen and Vaupel 2002), one that even the Great Depression did not dislodge? Or, is the noise in the time series great enough that it’s extremely difficult to assert an association (causal or otherwise) between the Great Depression and changes in life expectancy? We take a counterfactual approach, and project life expectancy based on data from 1900–29, into the years 1930–40. We then compare this expected interval it to the observed life expectancy in the US.

Data and methods

Before describing our approach to the mortality time series, we highlight data underlying our temporal definition of the Great Depression. The dimensionality of the problem is high, and assigning a precise start date is difficult (Eichengreen 2004). We use calendar-year mortality data, so we require only calendar-year precision in dating the Great Depression. Figure 1 presents two key economic statistics, the calendar-year unemployment rate and inflation-adjusted per-capita gross domestic product, from Carter et al. (2006) (see Darby 1976 for discussion of measuring unemployment during this period). The unemployment rate rose dramatically in 1930 relative to 1929, and peaked in 1932. In 1933, unemployment was still high but was declining, and by 1934 had declined dramatically further (although was still high in compared to most of the twentieth century). Per-capita GDP peaked in 1929 and tumbled in 1930–33; in 1934 economic output as measured by this indicator started to rebound. The last “normal” year, so to say, is 1929,
while the start of the recovery is 1933. Thus, as indicated by the vertical bands on figure 1, we define the Great Depression as 1929–33, inclusive.

Our approach to the mortality data is to examine the observed trends in life expectancy in the United States, 1929–40, with especial attention to 1929–33 (the Great Depression, narrowly defined). We compare these trends with probability intervals of life expectancy during the same period, the construction of which is described immediately below. Is life expectancy countercyclical? That is to say, does it rise when human welfare — defined broadly and economically — declines?
We use national data on mortality rates by age and sex for the United States, 1900–40 (U.S. Department of Health, Education, and Welfare 1956). This data represents the longest series of pre-Great Depression mortality data available. Consistent with earlier reports, we analyze data for the total population, as well as for whites and nonwhites separately. Apart from white/nonwhite, these historical data do not have information on racial categories. All analyses are done separately by sex. For 1900–32, the data are from the Death Registration Area (DRA), a subset of the country. To test against compositional changes in the DRA affecting our results, we replicated the analysis using a balanced panel (specifically, the death registration states of 1910, using data from Linder and Grove 1943). The balanced panel analysis is presented in the Appendix.

To calculate a range of plausible life expectancies during the 1930s, we used Lee-Carter mortality estimation and projection (Lee and Carter 1992). Since its development over twenty years ago, this technique enjoys wide use in demography. We use the Lee-Carter technique to characterize the data from 1900–29 (only). Next, we use the patterning from 1900–29 to project annual mortality for 1930 through 1940 (inclusive). The knot year is 1929, i.e., the projection is constrained to equal the data for that year. The year we call the start of the Great Depression is the knot year, so in the strict sense projection begins in 1930. We then compare the projection interval thus generated to the observed data.

The Lee-Carter technique is typically used for making mortality forecasts (Lee 2000). Thus, it is worth describing further our approach that applies this technique to retrospective data. We ask whether the increase in life
expectancy, 1930–33, was unusual relative to contemporary trends and variations in life expectancy that could be expected purely from history. In short, we use data from before 1930 to construct a counterfactual near-term (10-year) projection. This projection provides an estimate of life expectancy in the 1930s using only information from before the 1930s. The Lee-Carter approach is more appropriate than a polynomial or other extrapolation of the 1900–29 life expectancy trend, given that this series exhibits more nuanced autocorrelation. The Lee-Carter approach further provides a projection interval (akin to a confidence interval, but it is not a statistical confidence interval and we will not refer to it as such). This projection interval allows the analyst to determine whether observed values of life expectancy fall within the projection interval had the “perturbation” (e.g., the Great Depression) not occurred. The failure of observed values to lie outside of the projection interval would not support the relation between life expectancy rising due to the Great Depression.

Knot procedure: Bell (1997)

Alternate approaches, such as ARIMA time series models, require at least 50 years of data to perform well (Box et al. 2008), and so are not well suited to the United States case, where data begin in 1900.

Analysis was performed using IDL 8.4 (Exelis Visual Information Solutions, Inc., Boulder, CO) and Stata 13.1 (StataCorp LP, College Station, TX).
Figure 2: All races life expectancy, 1900–40, US. Males (left, blue) and females (right, red). With Lee-Carter projection interval for 1930–40, based on 1900–29. Due to the influenza pandemic, 1918 (dotted lines) was omitted from the variance calculation.

Figure 3: Same as figure 2, but for whites only.
Results & Discussion

Conclusion

Life expectancy increased during the Great Depression (Tapia Granados and Diez Roux, 2009); making this observation requires only looking at the data, not any statistical test. This is in and of itself interesting, since it may be regarded as counter-intuitive.

Nevertheless, for the population as a whole, the rise in life expectancy in 1930-1933 does not lie outside of the Lee-Carter projection interval. This circumstance indicates that continuation of secular trend — in process well before the Great Depression and potentially independent of it — may explain the pattern of life expectancy in the early 1930s.
Race-specific analyses, however, reveal a divergence in life expectancy “signatures” after 1930. Nonwhite Americans (overwhelmingly African-Americans during this period) show a sharp rise in life expectancy in 1930–1933 that exceeds the upper projection interval. This rise, moreover, returns to the projection interval in 1934, which researchers view as the end of the worst of the Great Depression. By contrast, white Americans show a life expectancy that increases minimally from 1930 to 1933.

Strengths of our approach include that we use widely accepted and validated Lee-Carter methods to derive a projection interval for life expectancy. Given the data constraints of only 30 annual pre-Great Depression mortality values, the Lee-Carter method improves upon earlier methods in its ability to identify, and use, past history of the life expectancy series to derive an expected projection interval. An additional strength of our approach involves the use of a balanced panel of data with known consistency and comparability across a relatively long time period. We also analyzed blacks and whites separately, which allowed us to confirm distinct differences in life expectancy patterns after the Great Depression.

Appendix
Figure 5: Same as figure 2, but for death registration states of 1910, only. The year-to-year variance in this figure is not influenced by changes in the composition of the death registration area (unlike figure 2).

Figure 6: Same as figure 5, but for whites only.
Figure 7: Same as figure 5, but for nonwhites only.

<table>
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<th>Population</th>
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Table 1: Test of normality of year-to-year differences in Lee-Carter $k$ values. To use the standard Lee-Carter projection (Brownian random walk with drift), these should be normally-distributed; in all cases the Shapiro-Wilk test fails to reject the null hypothesis of normality. The adjustment for 1918 — which considers alternate scenarios in which 1917 and 1919 do, or do not, have a missing value in-between them — has no effect.
Works Cited


