Estimating Pattern of U.S. Mortality Improvement over Age and Time

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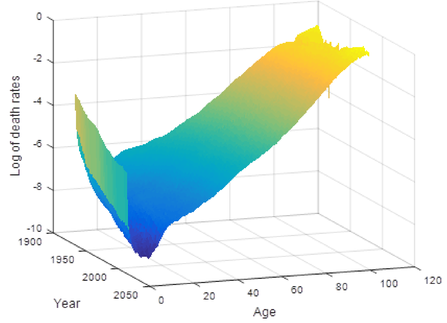
Objective To estimate rates of mortality improvement over age and time for the United States

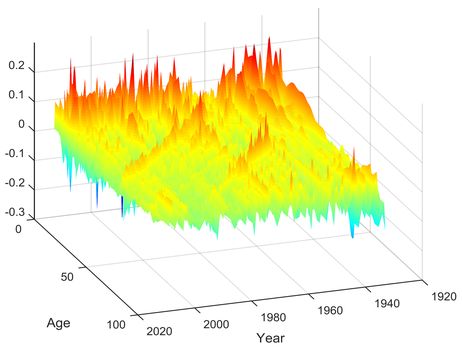
U.S. death rates, Females, 1933-2014



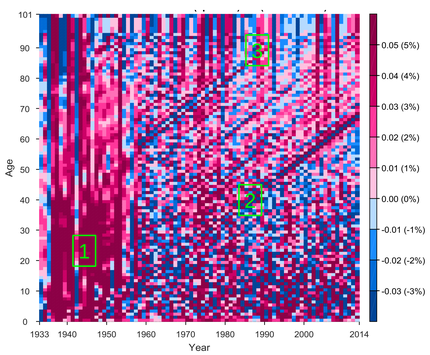
Direct estimates of rates of mortality improvement

$$r_{xt} = -ln\frac{m_{x,t+1}}{m_{x,t}}$$

are noisy. This is a 3D plot of r_{xt}:



And this is a Lexis map of r_{xt}:

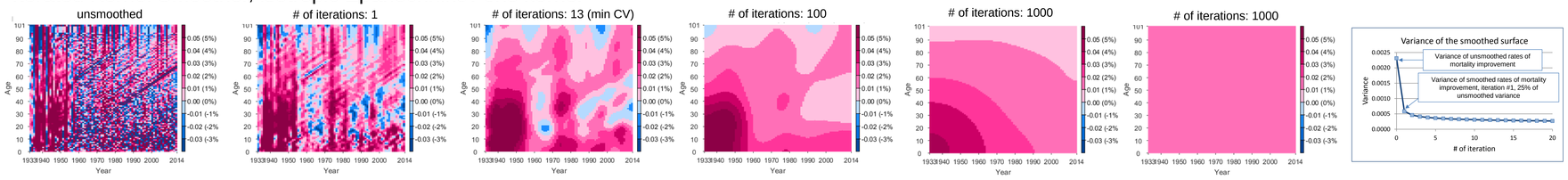


Direct estimates reveal only:

- Remarkable mortality progress at child and adult ages in the period from 1933 to about mid-1950s, 3% for males and 5% for females, on average annually (1)
- Cohort effects: elevated mortality of the cohorts born around 1946 and around 1900 (2)
- It is not clear if these cohort effects are genuine or just an artifact of data imperfections (3)

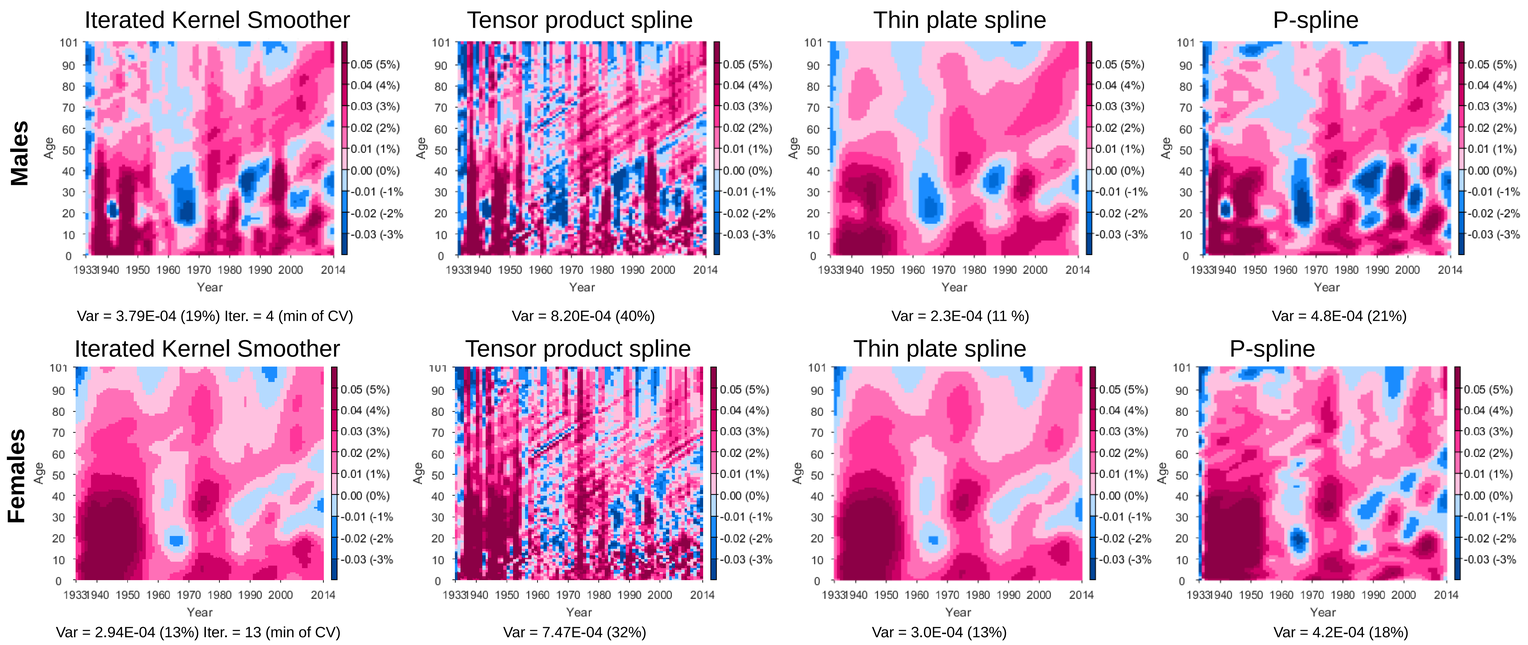
Methods: Iterated Kernel Smoother, Tensor product spline, Thin plate spline, P-spline

Iterated Kernel Smoother, isotropic Epanechnikov 3x3 kernel



Mean value of smoothed rates of mortality improvement is constant at 1.75. Mean value of residuals is zero.

Estimated surfaces of mortality improvement with default smoothing parameters



Var = 3.79E-04 (19%) Iter. = 4 (min of CV)

Var = 8.20E-04 (40%)

Var = 2.3E-04 (11 %)

Var = 4.8E-04 (21%)

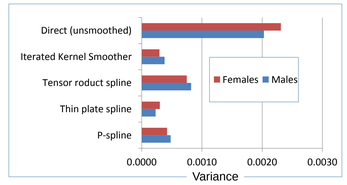
Var = 2.94E-04 (13%) Iter. = 13 (min of CV)

Var = 7.47E-04 (32%)

Var = 3.0E-04 (13%)

Var = 4.2E-04 (18%)

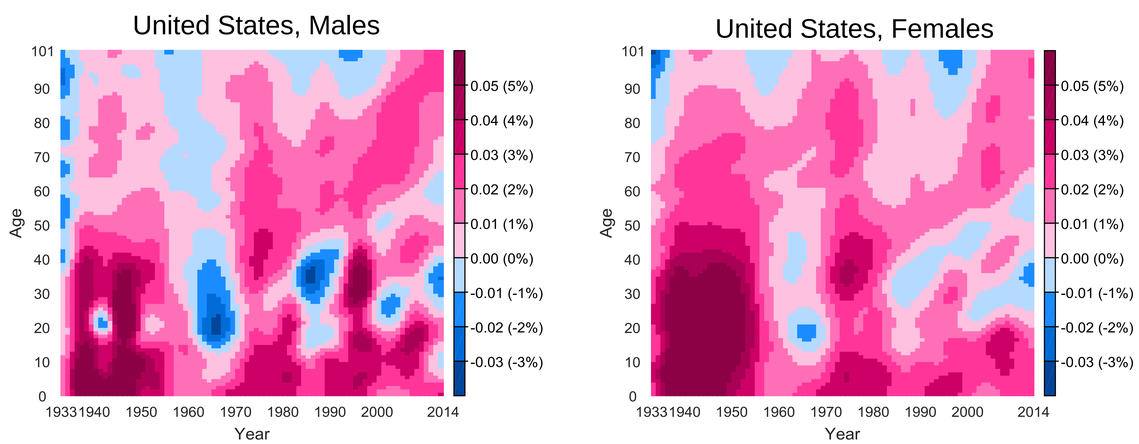
Variance of direct and smoothed estimates
By method and sex



Conclusions (Methods)

- The results are similar among the methods provided that their degrees of smoothing are similar;
- Selection of the method is less important than the degree of smoothing;
- Exploration of surface of mortality improvement highly benefits from by computing estimates at different degrees of smoothing and exploring them in a movie-like fashion;
- Estimates of surfaces of mortality improvement with default parameters produced by Iterated Kernel Smoother, Thin Plate Spline, and P-spline appear to be smoothed yet revealing. P-spline produced less smooth estimates with variance of about 20% (as compared with variance of the direct estimates) than Iterated Kernel Smoother and Thin Plate Spline (13%). Estimates produced by Tensor Product Spline with default parameters are clearly undersmoothed (35%);
- Estimates with variance of about 10-15% (as compared with variance of the direct estimates) appear to be a good balance between smoothness and approximation.

Final estimates produced by Iterated Kernel Smoother with variance of the smoothed surfaces 13% as compared with variance of the direct estimates (9 iteration for males, and 13 for females)



Conclusions (Estimates)

- The estimates reveal age shifting pattern of US mortality decline—if before the 1950s mortality was declining faster at younger ages, now the fastest declines occur at ages above 60;
- The estimates also clearly reveal two recent adverse developments—increasing mortality among young adults in the mid-30s and adults in the mid-50s. If the former is a new phenomenon, the increases among 50 years old could be a cohort effect originated in the mid-1980s, at onset of HIV/AIDS epidemics.

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