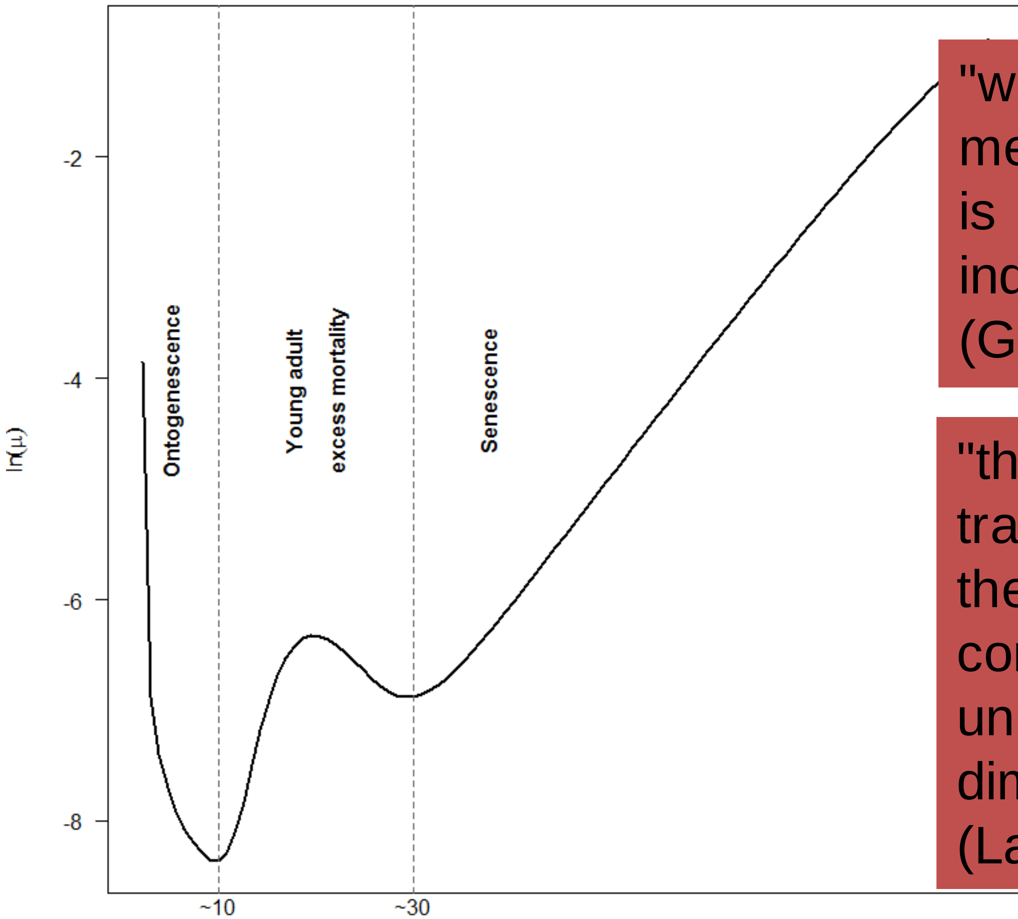
MEASURING YOUNG ADULT EXCESS MORTALITY
A NON-PARAMETRIC ADDITIVE APPROACH

ADRIEN REMUND
CARLO GIOVANNI CAMARDA

WORKSHOP OF THE EAPS HEALTH, MORBIDITY AND MORTALITY WORKING GROUP
PRAGUE
16-18 SEPTEMBER 2015

FORCE OF MORTALITY



"we determine from the data the mean force of mortality (…), [but] is this consistent with the individual hypothesis ?" (Greenwood 1928, 273)

"there must be a gradual transition from [life to death] but the contrast between them is so complete that we are quite unable to measure the diminution of life" (Lazarus 1874, 212)

DEFINITIONS

	Senescence	Ontogenescence	Young adult excess mortality
Age (indicative)	> ~30	< ~10	~ 10 – 30
Definition	“a persistent decline in the somatic function of an organism with increasing chronological age, leading to decreased survival probability and/or fecundity" (Williams and Day 2003, 1478)	"a population-level phenomenon in which the death rate of each cohort tends to decrease with increasing age between conception and maturity" (Levitis 2011, 801)	"a temporary deviation of the aggregated age-specific death rate from the exponential trend due to senescence, during adolescence and/or early adulthood" (Remund 2015)
Theories	Antagonistic pleiotropy Mutation accumulation	Selection effect Increasing robustness …	Endogenous Exogenous Selection
Level	Individual	Individual or cohort	Individual or cohort

ENDOGENOUS HYPOTHESIS

- **Psychology**

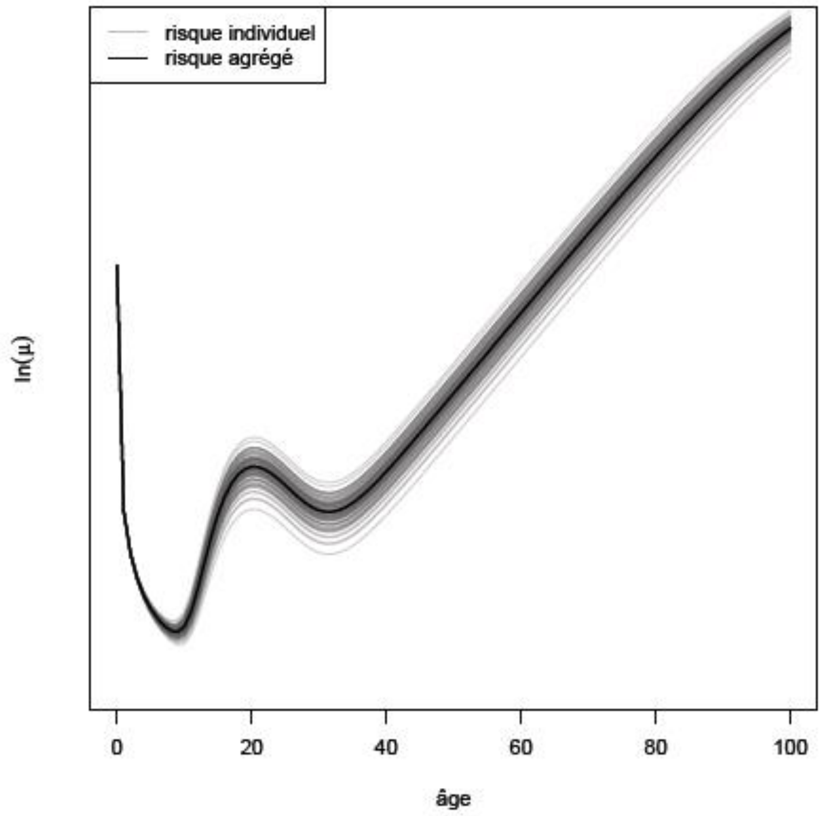
  "storm and stress period of life" (Hall 1904, 306)
- **Psychoanalysis**

  "increase of impulses (…) is inseparable from puberty" (Freud 1968)
- **Neuropsychology**

  "maturational changes in brain contribute to the age-specific behavioral characteristics of adolescence" (Spear 2000, 418)

ENDOGENOUS HYPOTHESIS

All individuals experience a temporary increase in their risk of death



EXOGENOUS HYPOTHESIS

- **Ethnology**

  "adolescence does not exist"
  (Huerre et al. 1990)

- **Demography & Sociology**

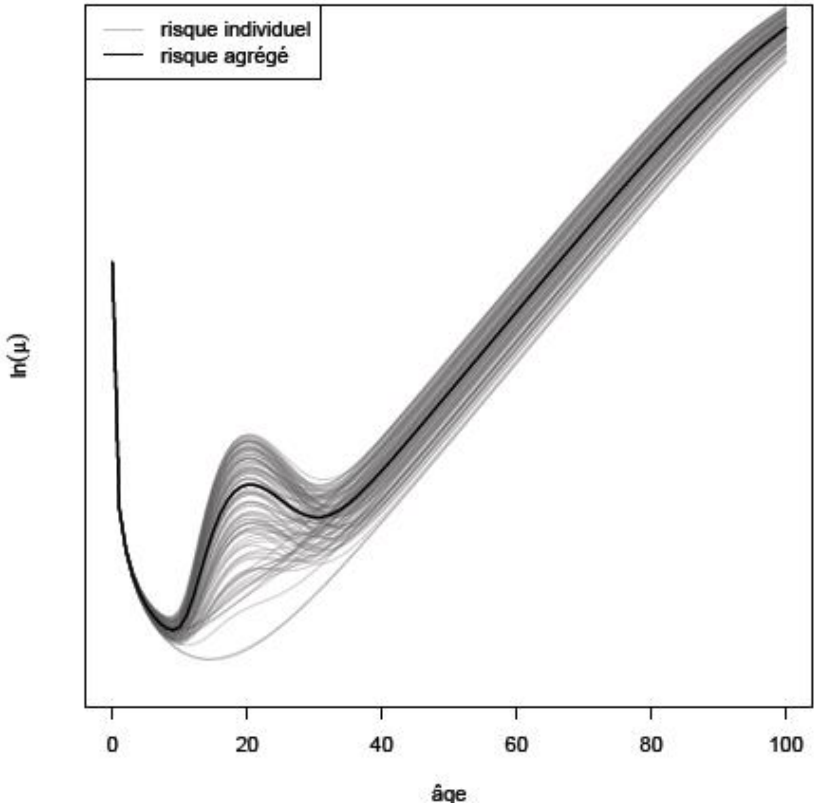
  "markers for the entry into roles considered typical for adults" (Billari 2001, 119)

- **Socioeconomics**

  "Youth are (…) the losers of globalization"
  (Mills and Blossfeld 2013, 8)

EXOGENOUS HYPOTHESIS

Individuals may or may not experience a temporary increase in their risk of death, depending on their social, cultural and economic environment



SELECTION HYPOTHESIS

Heterogeneity's Ruses:
Some Surprising Effects of Selection on Population Dynamics

JAMES W. VAUPEL and ANATOLI I. YASHIN*

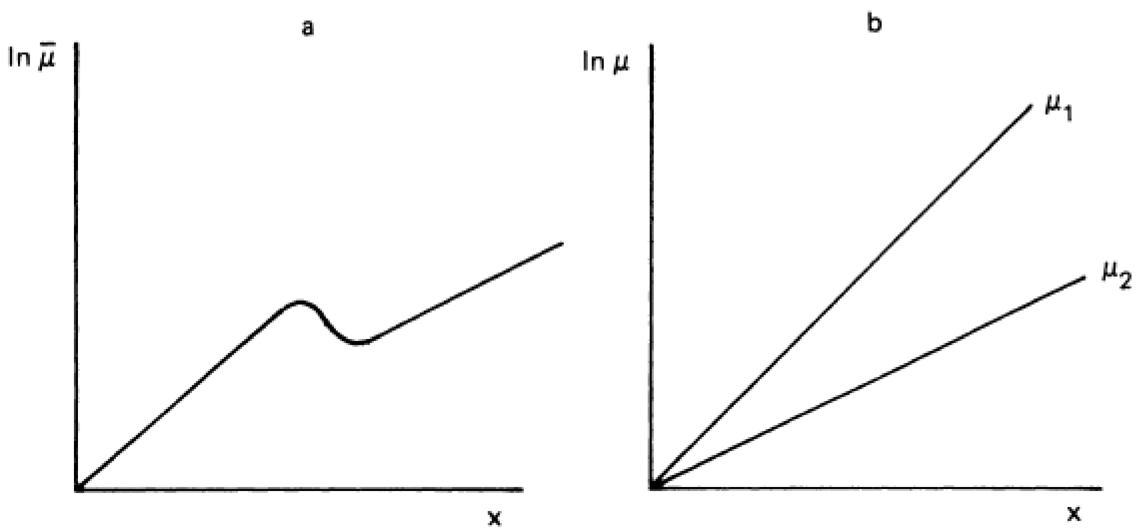
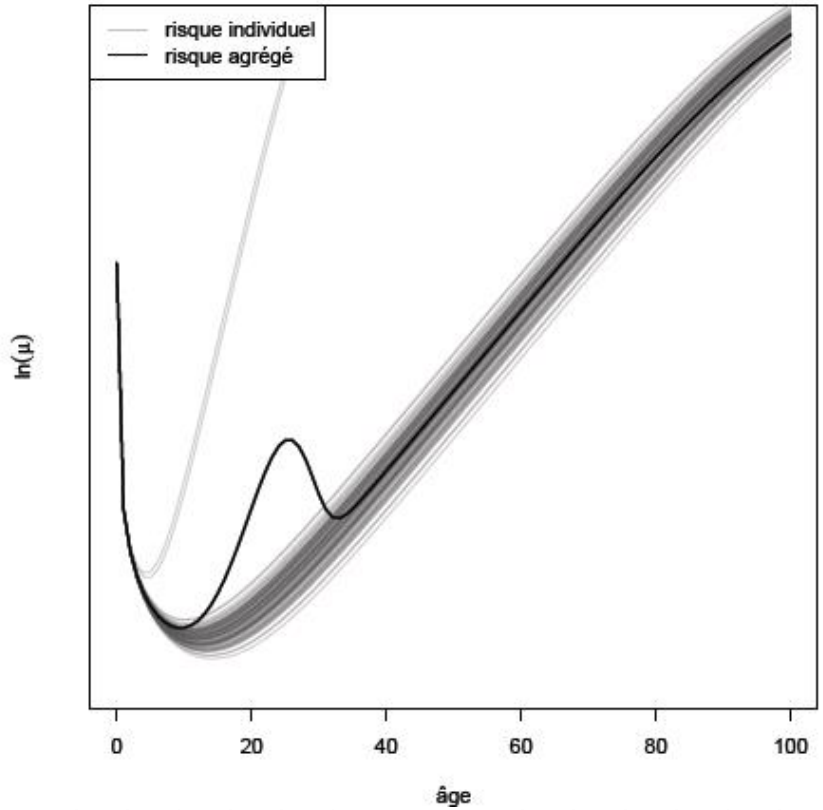


Figure 3. The observed hazard rate may rise steadily, then decline, and then rise again even though the hazard rates for the two subcohorts are steadily rising. The curve for $\bar{\mu}$ was calculated from (2), (3), and (4) using $\mu_1(x) = .0001 \cdot \exp(.2x)$, $\mu_2(x) = .0001 \cdot \exp(.1x)$, and $\pi(0) = .5$. The curves are shown for values of x from 0 to 75. Note that $\bar{\mu}$ and μ_i are plotted on logarithmic scales.

SELECTION HYPOTHESIS

No individual experiences a temporary increase in his/her risk of death but there are diverging subpopulations generating an artificial hump



EMPIRICAL PREDICTIONS

	endogenous	exogenous	selection
1. Universal between populations	yes	no	no
2. Limited to adolescence	yes	no	no

METHOD

- **Parametric** (e.g. Heligman-Pollard) vs. **Non-parametric** (e.g. spline)
- **Interpolation** (partly arbitrary) vs. **Components** (data driven)

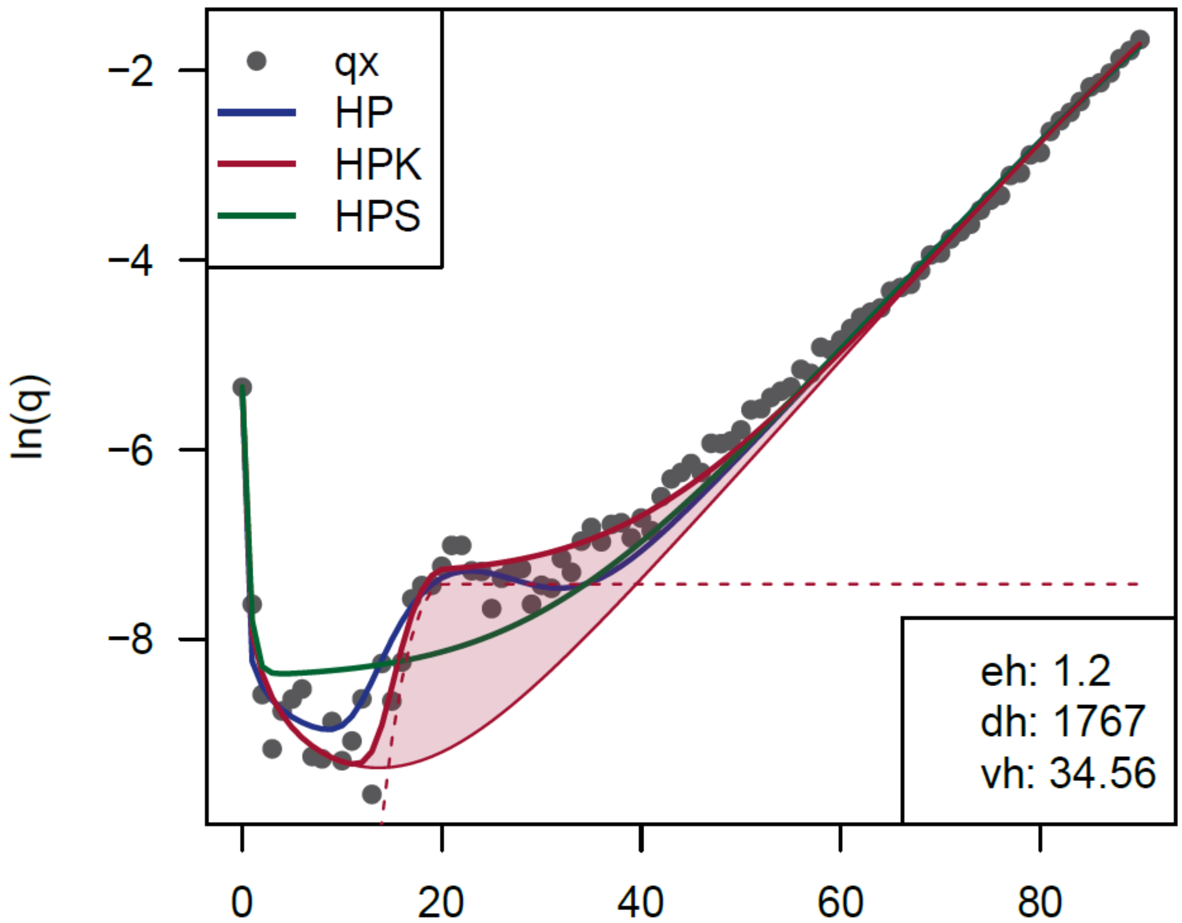
PARAMETRIC MODELS

$$\text{HP : q(x)=A}^{(x+B)^C} + De^{-E\cdot(ln(x)-ln(F))^2} + \frac{GH^x}{1+GH^x}$$

$$\text{HPS : q(x)=A}^{(x+B)^C} + D + \frac{GH^x}{1+GH^x}$$

$$\text{HPK : q(x)} = \begin{cases} A^{(x+B)^C} + De^{-E\cdot(ln(x)-ln(F))^2} + \frac{GH^x}{1+GH^x} & \text{pour } x \leq F \\ A^{(x+B)^C} + De^{-k\cdot E\cdot(ln(x)-ln(F))^2} + \frac{GH^x}{1+GH^x} & \text{pour } x > F \end{cases}$$

PARAMETRIC MODELS



EXISTING MODELS

- Parametric (e.g. Heligman-Pollard)
  - Advantages: 3 components
  - Disadvantages: rigidity + overparametrisation

- Non-parametric (e.g. splines)
  - Advantage: flexible + parsimonious
  - Disadvantage: one single component

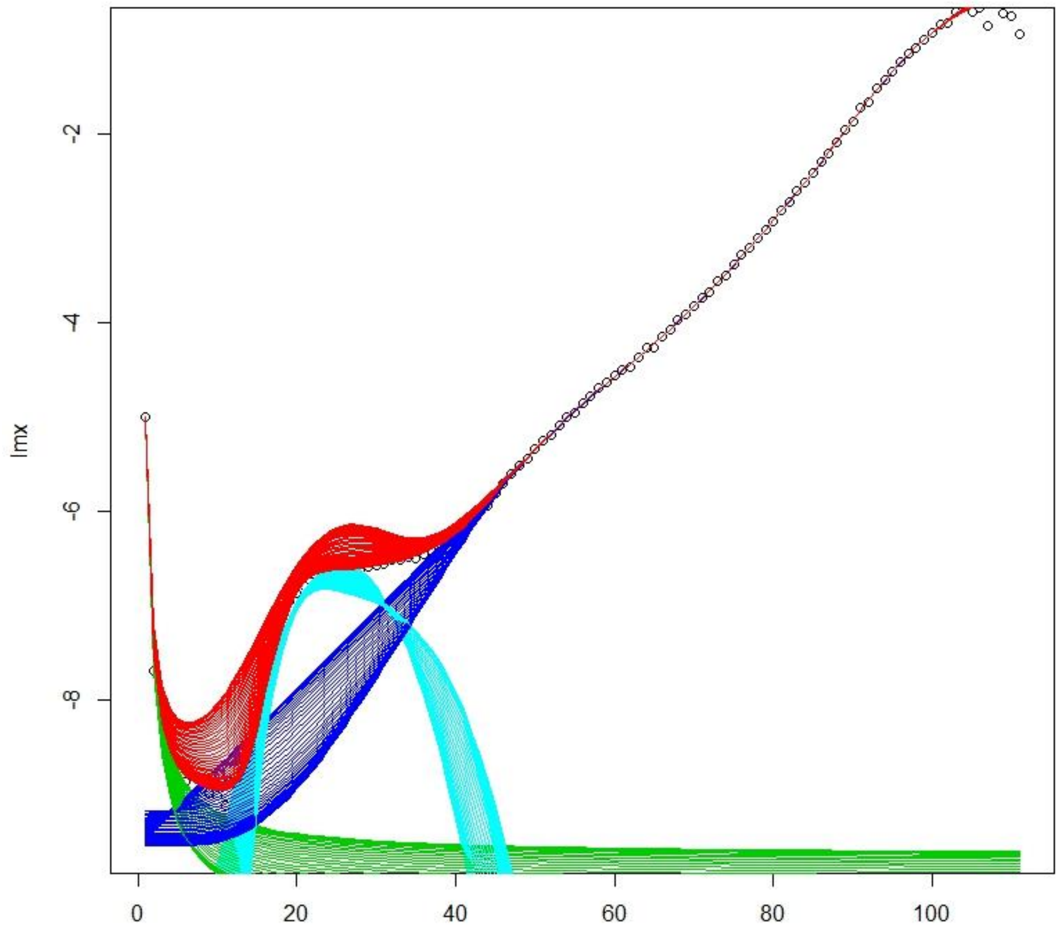
- Solution: Sum of Smooth Exponentials

SUM OF SMOOTH EXPONENTIALS

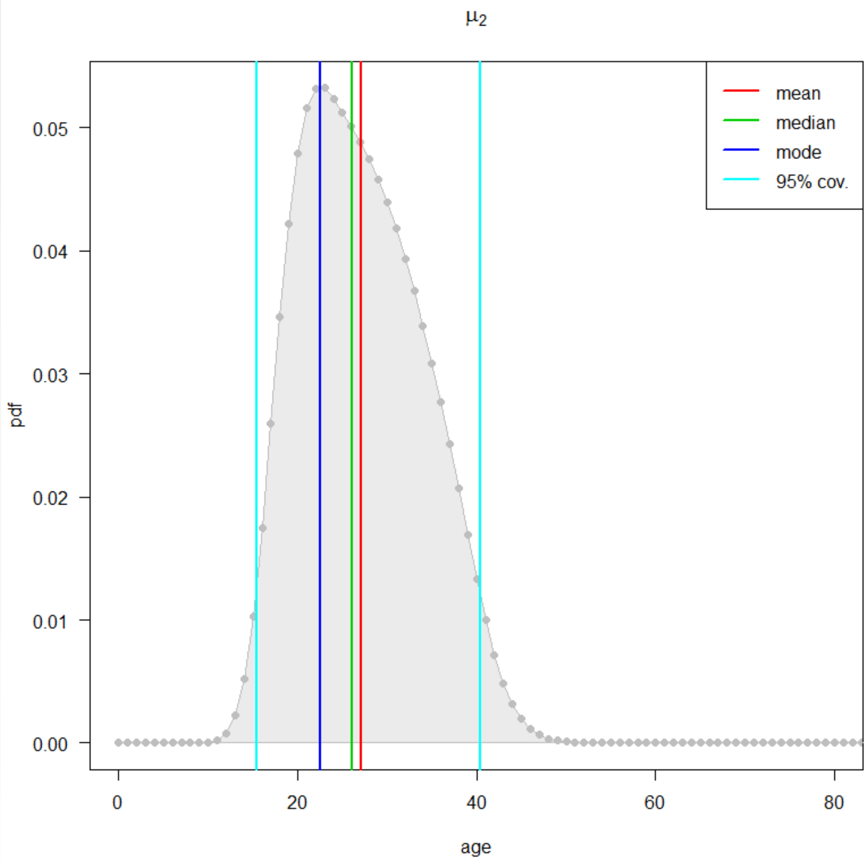
$$\mu = \mu_1 + \mu_2 + \mu_3$$

- μ_1, μ_2 and μ_3 are all Poisson p-splines
- Estimated by iterative re-weighted least squares
- Constraints
  - μ_1: decreasing with age
  - μ_2: concave with age
  - μ_3: increasing with age

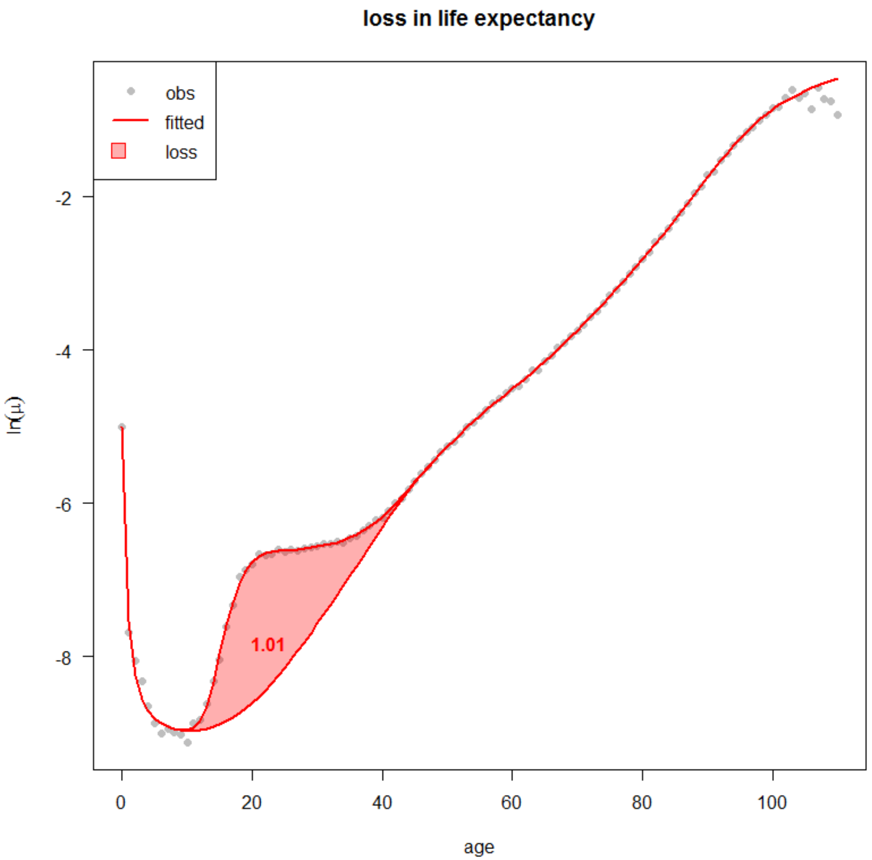
SUM OF SMOOTH EXPONENTIALS



OUTPUTS



μ2
mean
median
mode
95% cov.
pdf
0.00
0.01
0.02
0.03
0.04
0.05
0
20
40
60
80
age

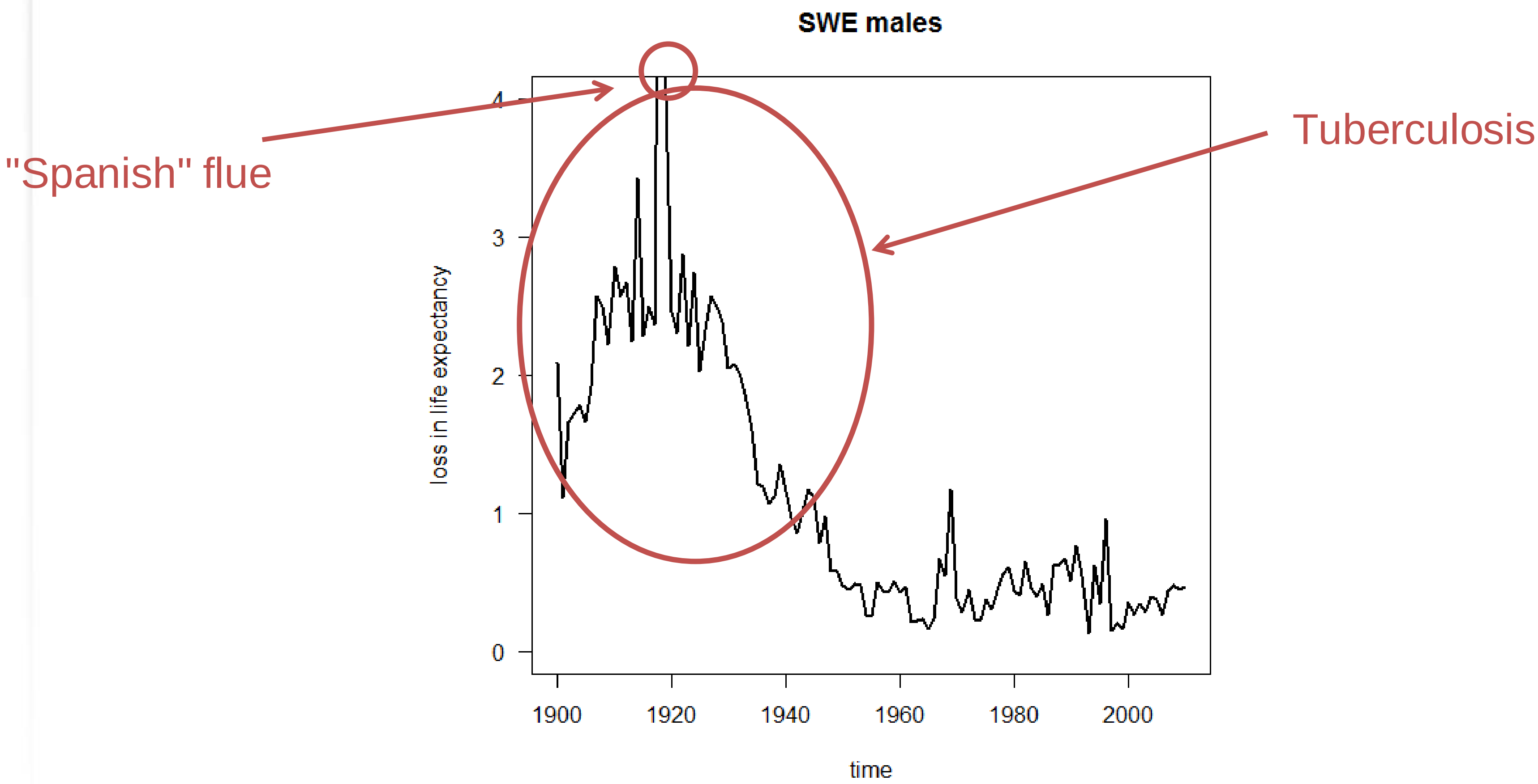


loss in life expectancy
obs
fitted
loss
1.01
ln(μ)
-2
-4
-6
-8
0
20
40
60
80
100
age

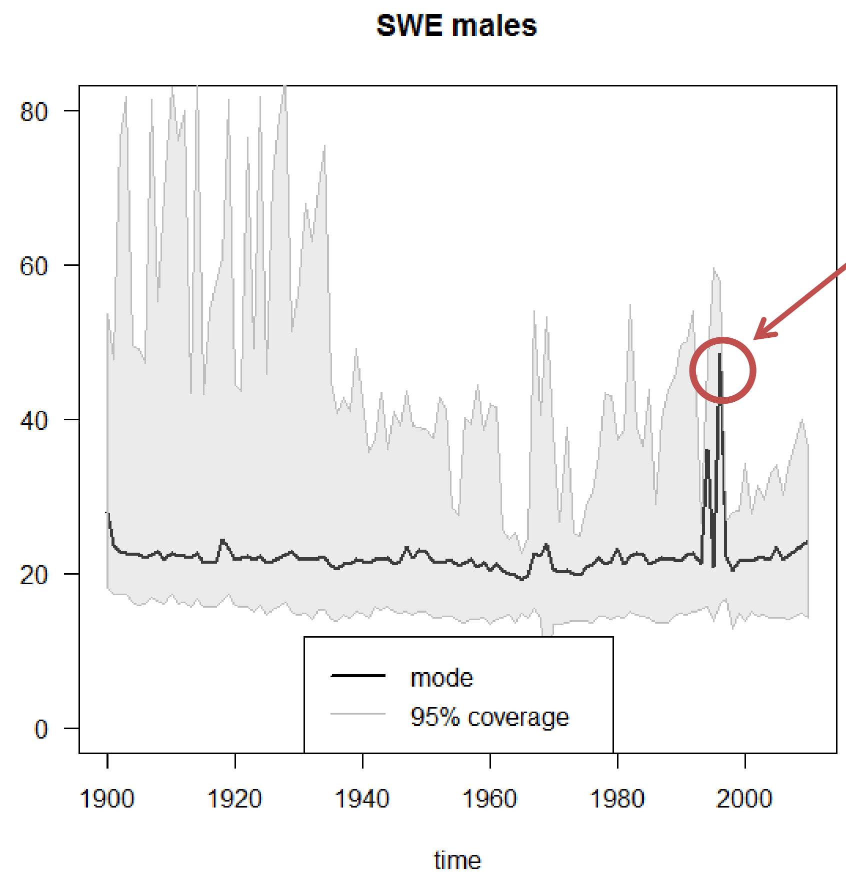
DATA

- Swedish age-specific death counts & exposures from HMD by periods and cohorts
- Non-extinct cohorts extrapolated with Hyndman & Ullah (2007)

INTENSITY - PERIOD

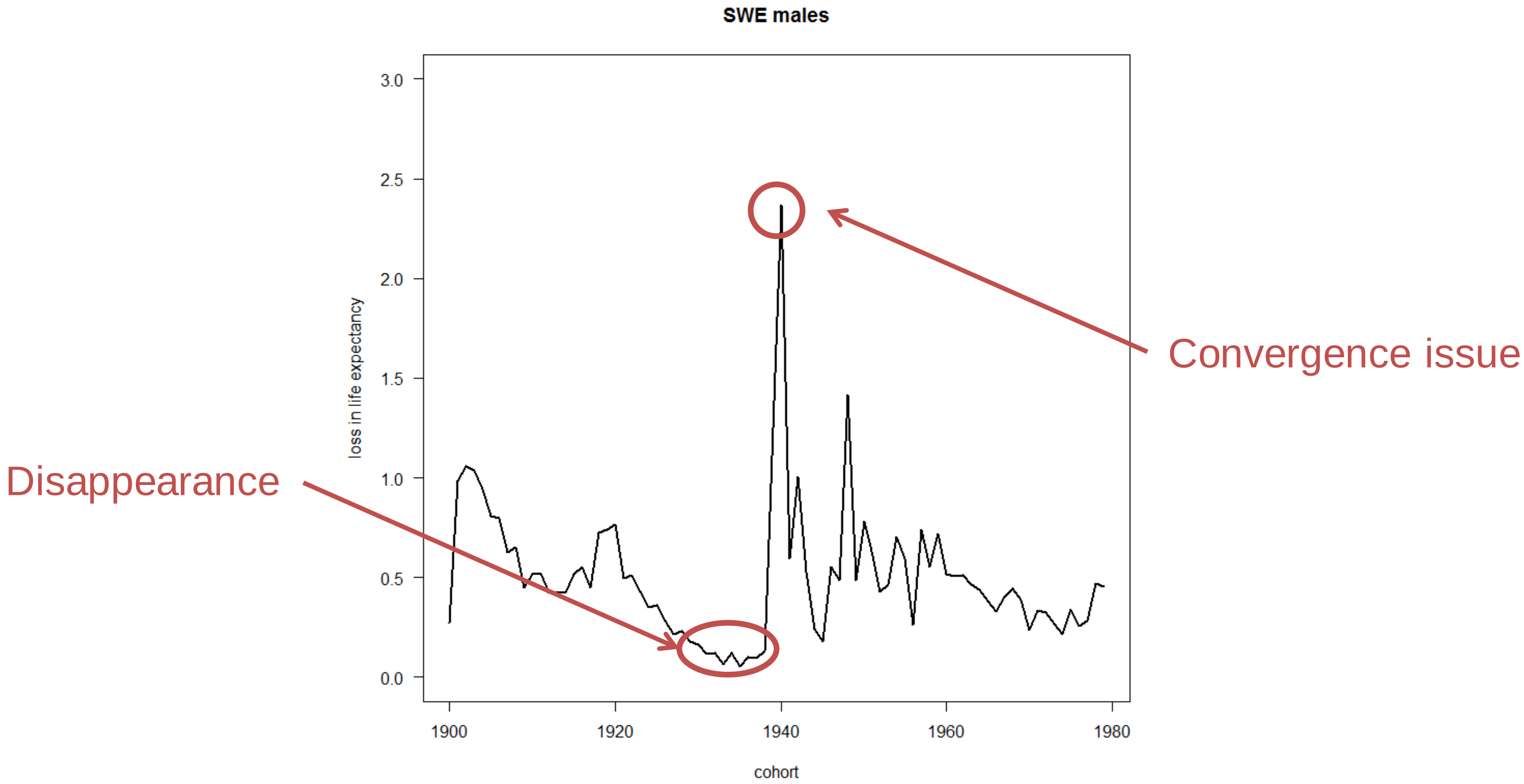


LOCATION & DISPERSION - PERIOD

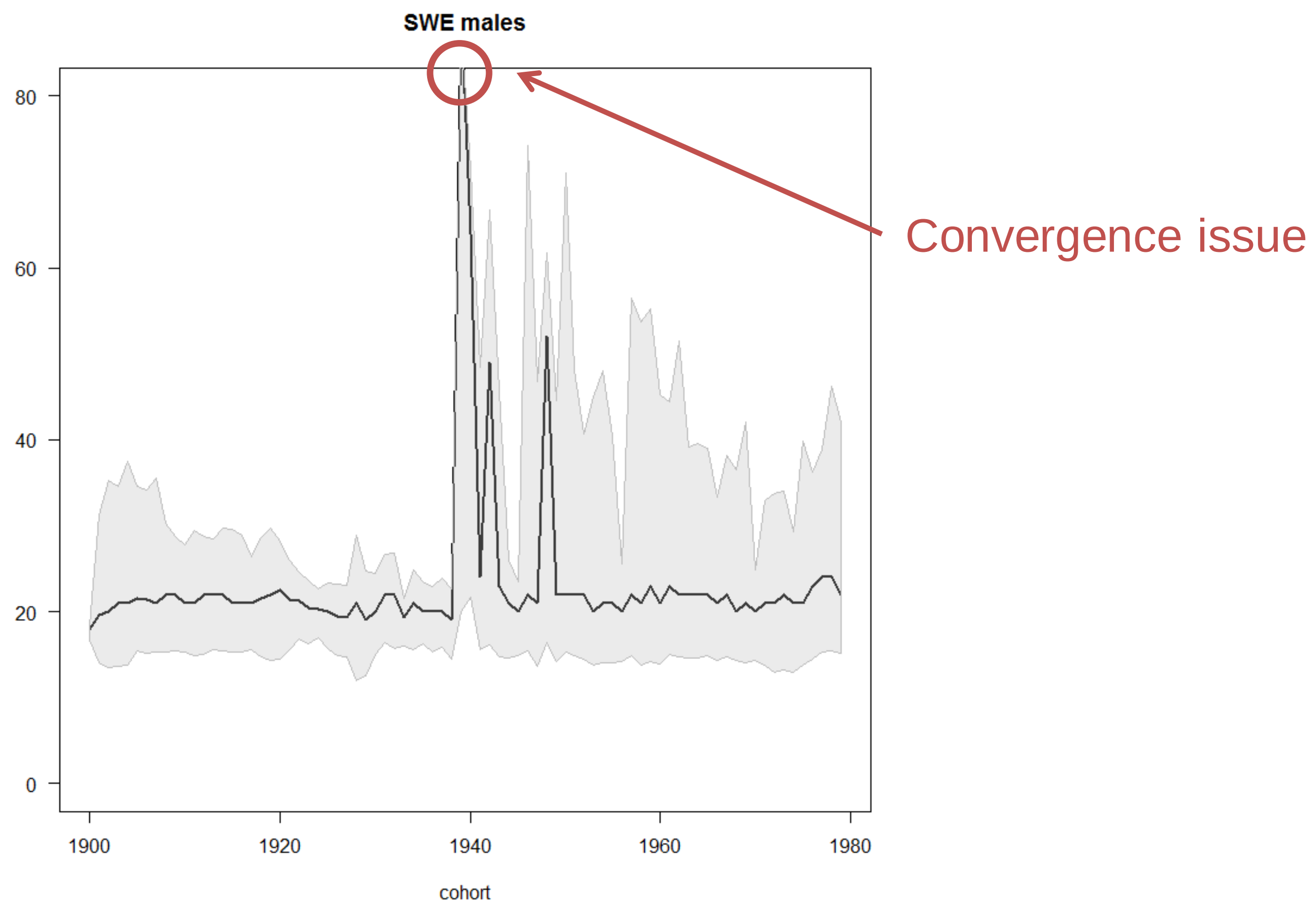


Convergence issue

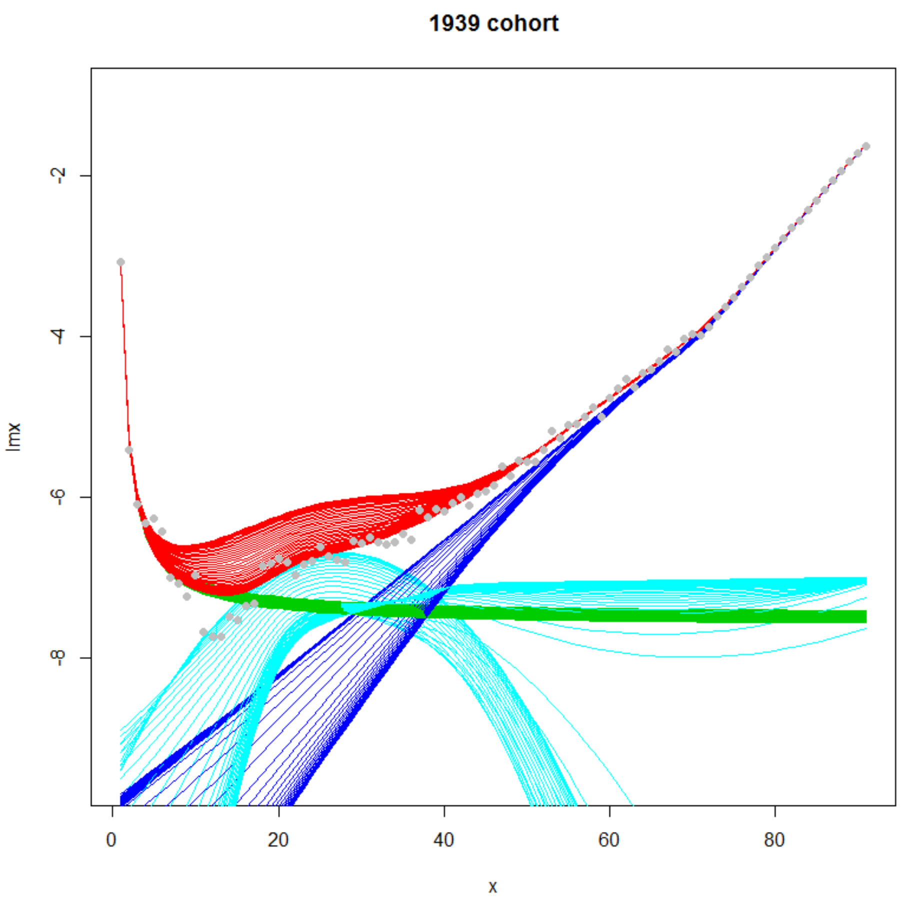
INTENSITY - COHORT



LOCATION & DISPERSION - COHORT



LIMITATIONS



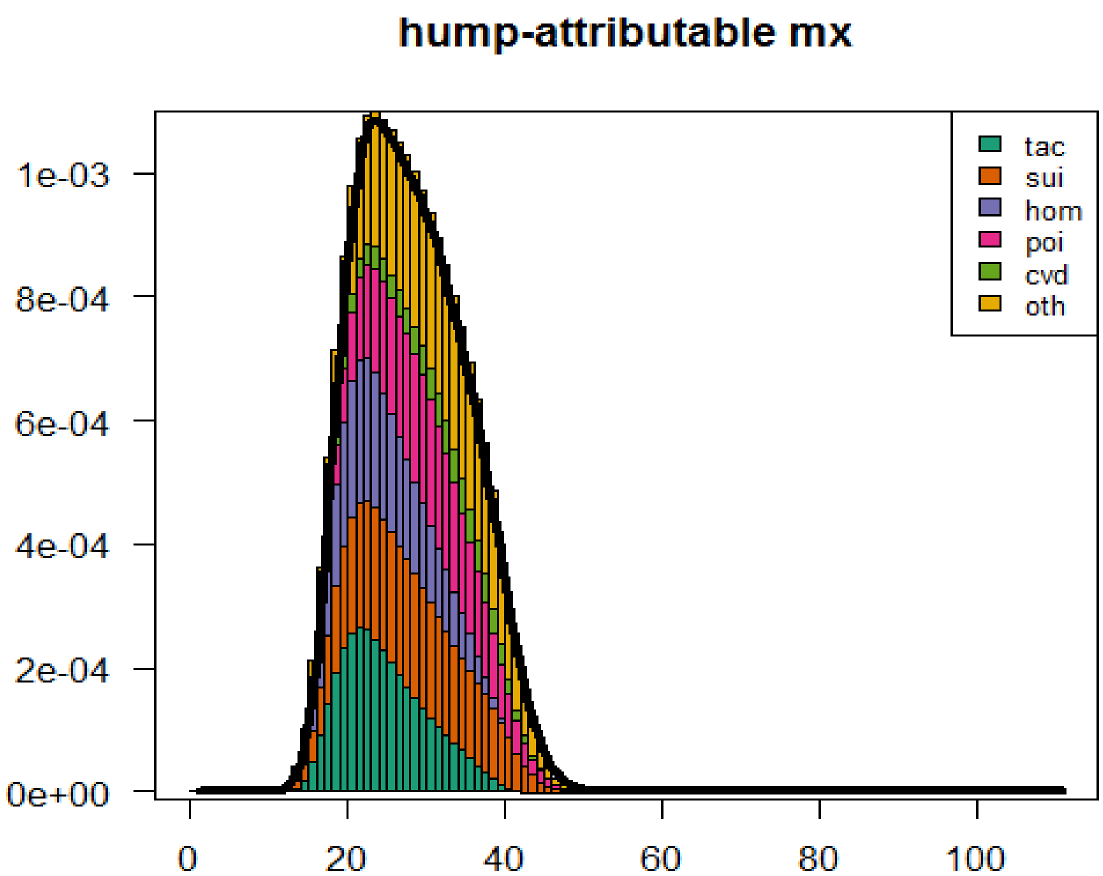
CONCLUSIONS

- SSE combines the best of the non-parametric and the components approaches
- Isolates the young adult mortality hump
- In Swedish males the hump varies over time
  - In intensity and dispersion => exogenous
  - Not in centrality => endogenous
  - Disappeared for 1930 cohort => exogenous
  - Decreased along TB => exogenous

FUTURE WORK

- 2D estimation (age & time)
  - Use neighboring years to smooth the evolutions
  - More smoothing parameters to estimate
  - Might solve the convergence issue
- Cause-specific analysis
  - Method: CoD decomposition of the hump
  - Data : HMD, MODICOD & DIMOCHA

CAUSE DECOMPOSITION



REFERENCES

- Camarda G. et al. (2010). *Sums of Smooth Exponentials* in Bowman (ed) *Proceedings of the 25th International Workshop on Statistical Modelling*
- Remund, A. (2015). *Jeunesses vulnérables ? Mesures, composantes et causes de la surmortalité des jeunes adultes*, PhD thesis, University of Geneva.
- Camarda, G. (2012). *MortalitySmooth: An R Package for Smoothing Poisson Counts with P-Splines*, *Journal of Statistical Software*, vol. 50, no. 1

THANK YOU FOR YOUR ATTENTION!

adrien.remund@unige.ch

carlo-giovanni.camarda@ined.fr