



Faculty of Science
CHARLES UNIVERSITY IN PRAGUE

Mortality shifting concept evaluation and proposal of the age-specific mortality shifts

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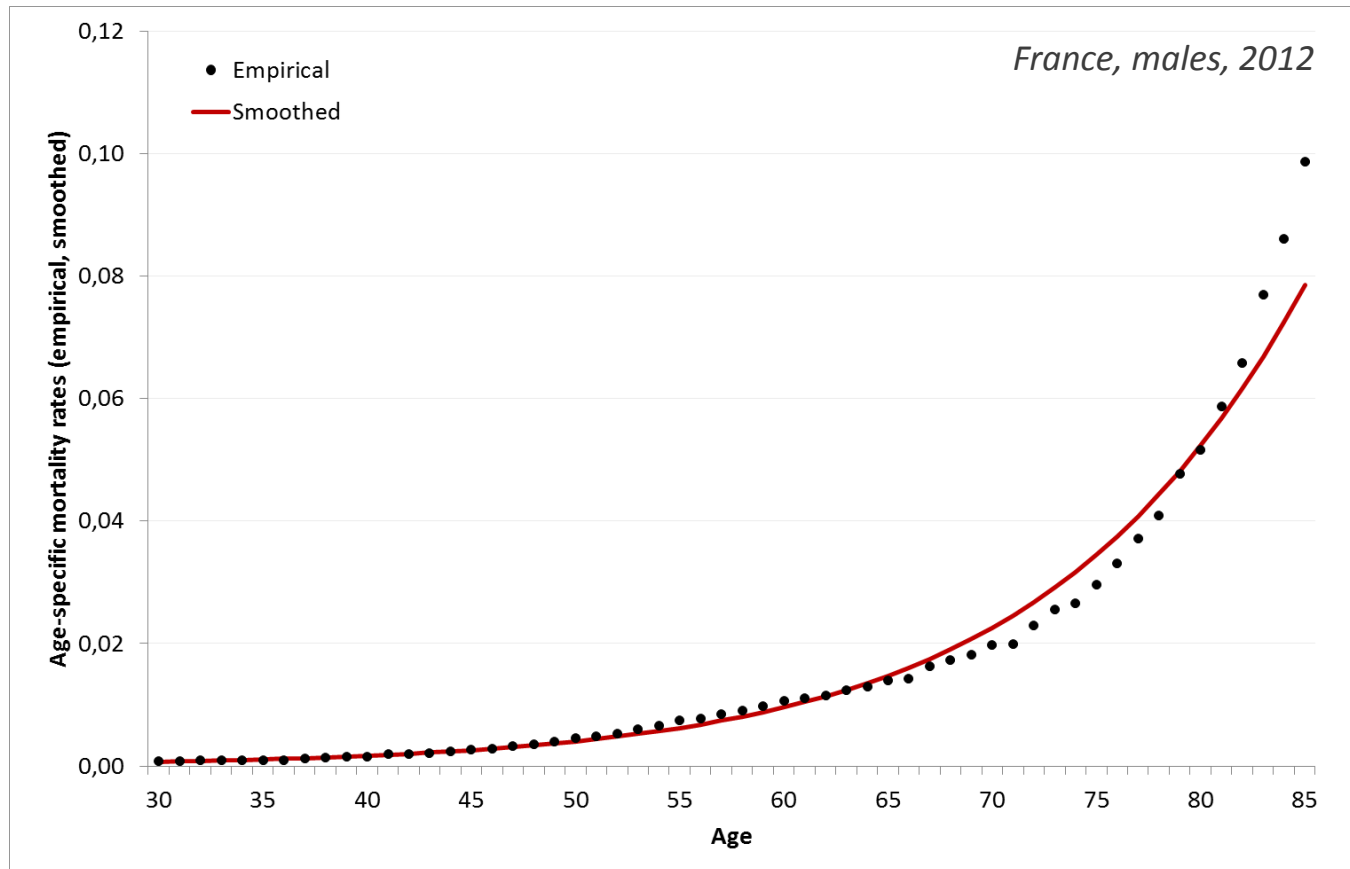


Aim of the study

- To introduce clearly how the mortality shifting could be defined
- To evaluate the results of Bongaarts (2005 = **shifting logistic model with estimation of the amount of the parallel mortality shift**) for other countries, than it is shown in the original paper (post-communist countries), or longer time period
- Propose a generalized model – **age-specific mortality shifts**
- To introduce clearly how the mortality shifting could be defined

Mortality shifting

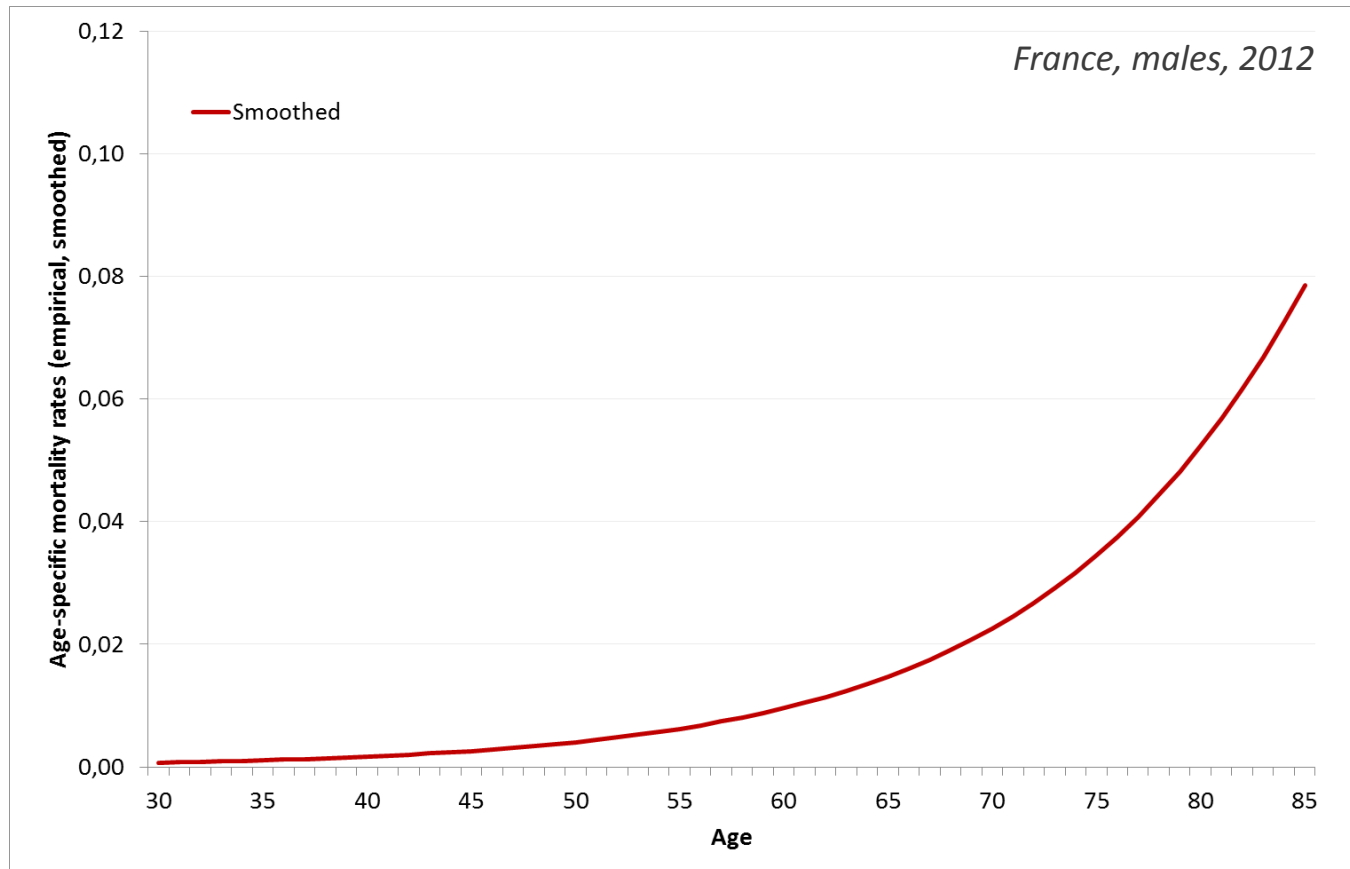
- A parallel shift of mortality (hazard) curves





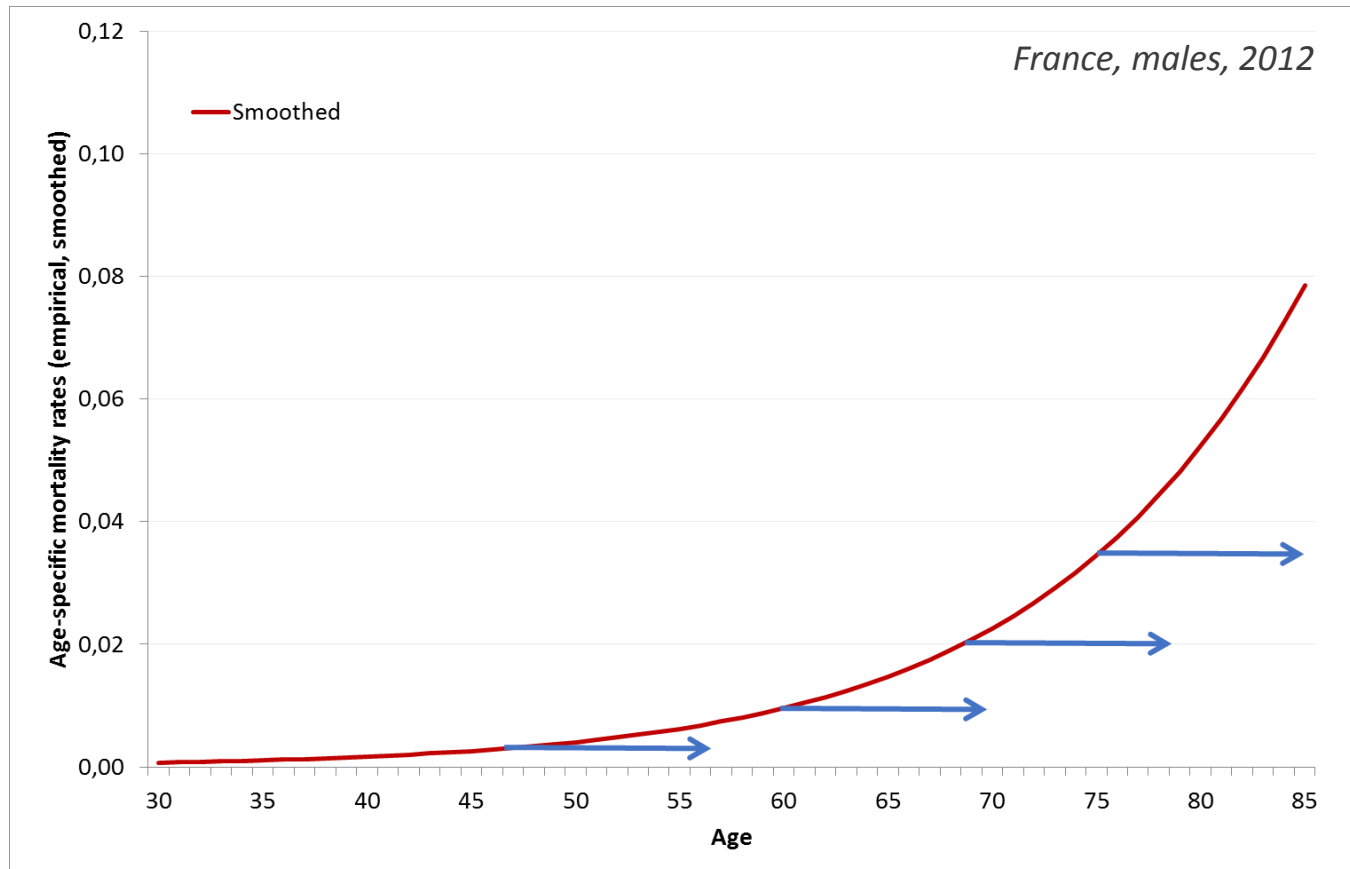
Mortality shifting

- A parallel shift of mortality (hazard) curves



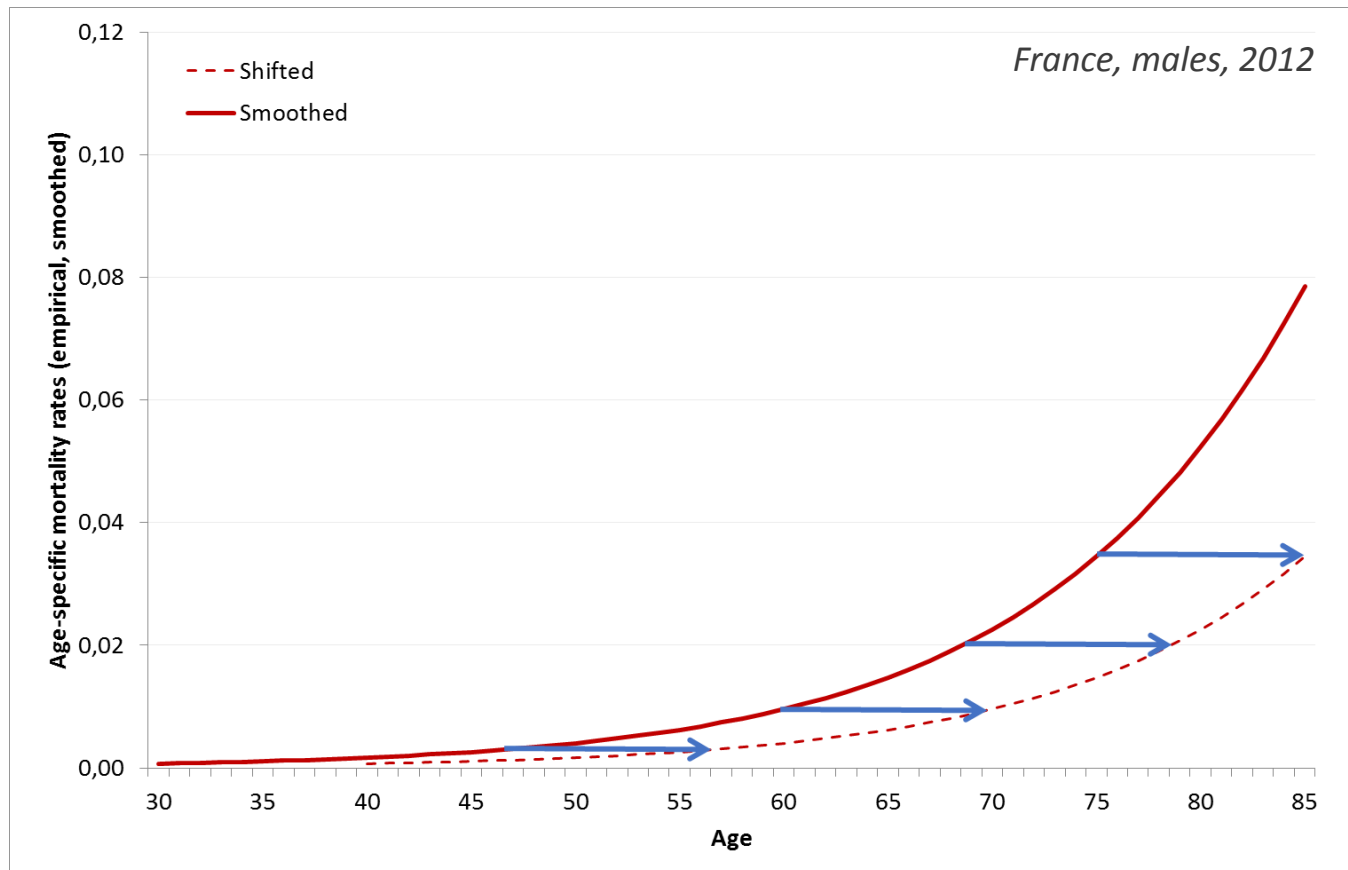
Mortality shifting

- A parallel shift of mortality (hazard) curves



Mortality shifting

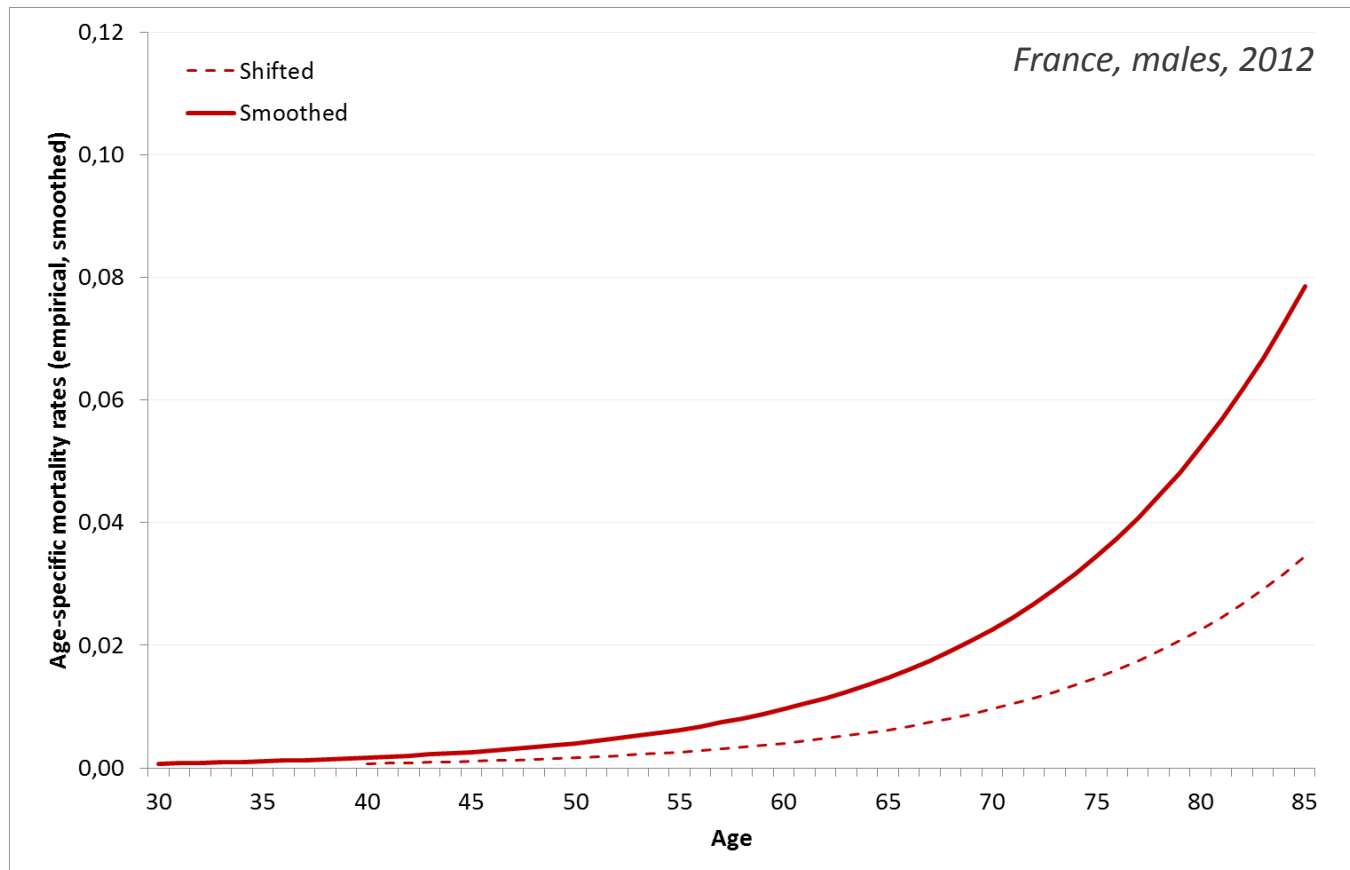
- A parallel shift of mortality (hazard) curves





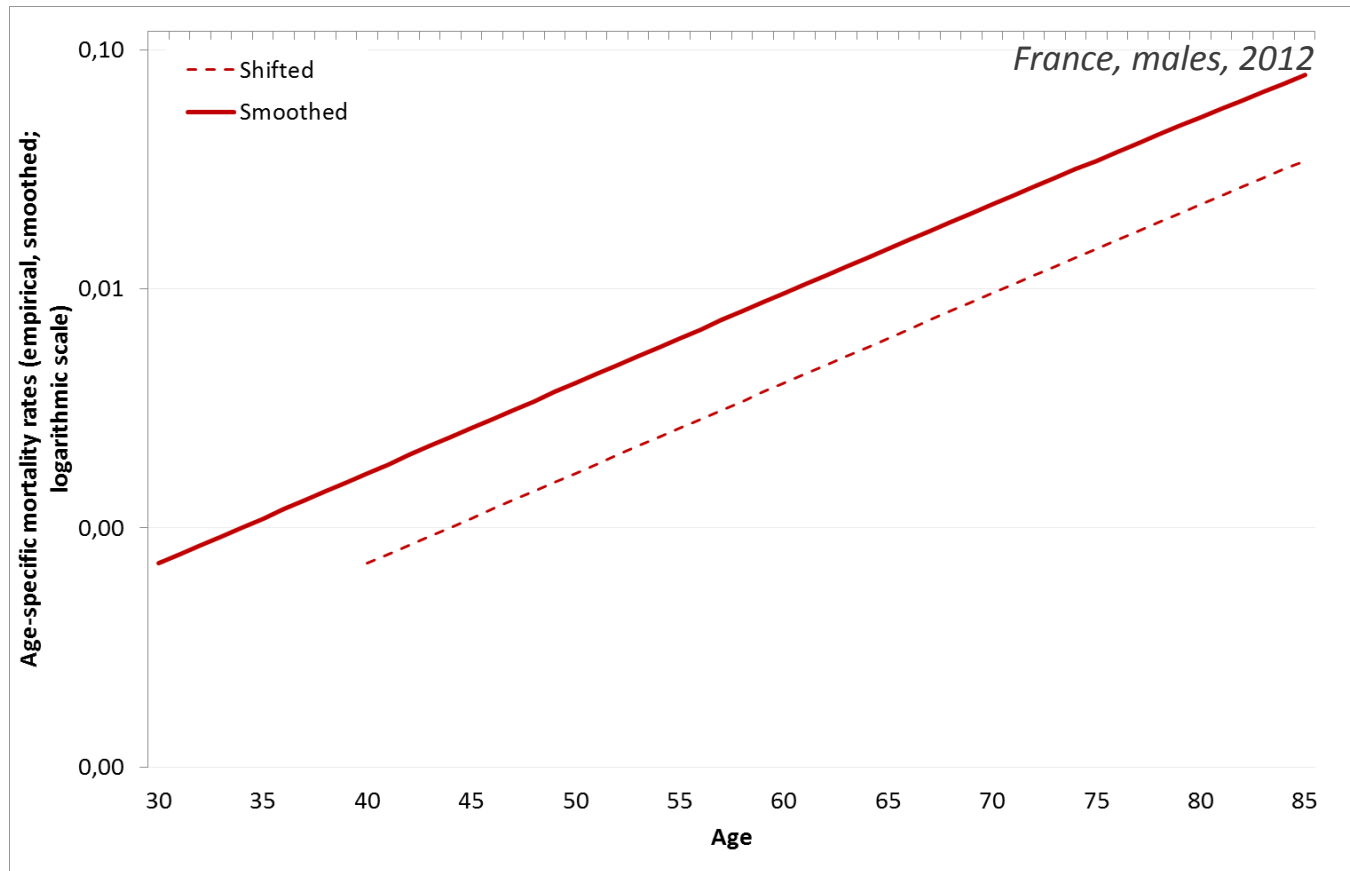
Mortality shifting

- A parallel shift of mortality (hazard) curves



Mortality shifting

- A parallel shift of mortality (hazard) curves





Mortality shifting

- A parallel shift of mortality (hazard) curves
- Only adult ages are considered
- Theoretical background: BONGAARTS, J. 2005. Long-range trends in adult mortality : Models and projection methods. *Demography*. February 2005, Vol. 42, No. 1, pp. 23–49.

- Considered the logistic model

$$\mu_{x,t}^S = \frac{A_t \cdot \exp(B_t \cdot x)}{1 + A_t \cdot \exp(B_t \cdot x)}$$

- **The slope parameter was considered as constant in time**

- Shifting logistic model
- The amount of the shift $S(t)$

$$\mu_{x,t}^S = \frac{A_t \cdot \exp(B \cdot x)}{1 + A_t \cdot \exp(B \cdot x)}$$

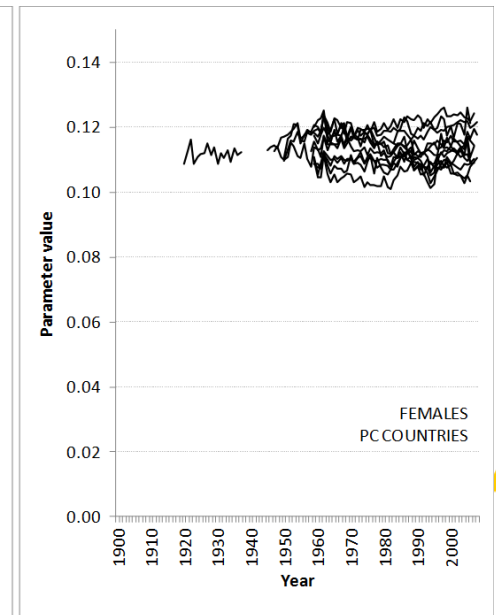
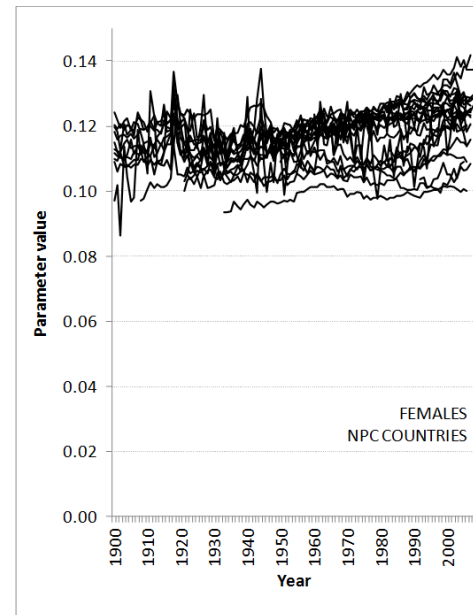
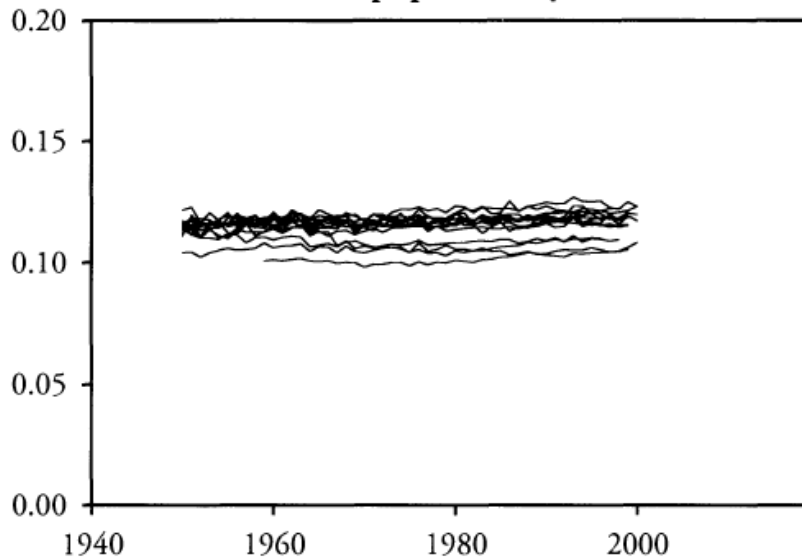
- $t - t_0 = \text{interval where the shift is studied}$

$$S(t) = - \frac{\ln\left(\frac{A_t}{A_{t_0}}\right)}{B}$$

Shifting logistic model - evaluation

- Assumption of the constant slope parameter...

b. Slope parameter $\beta(x)$

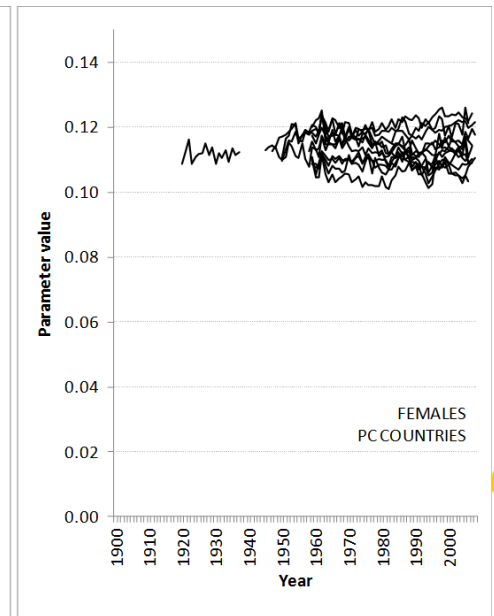
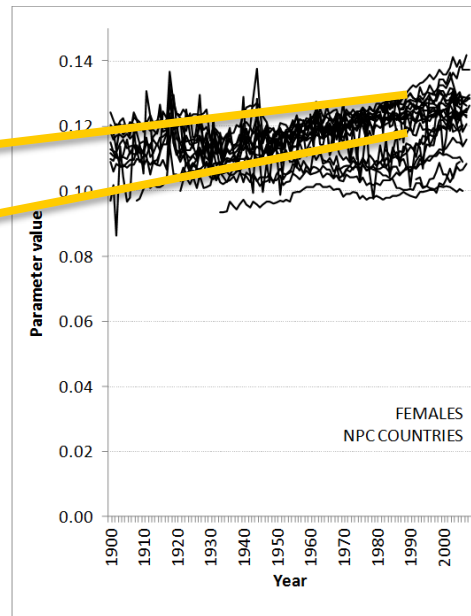
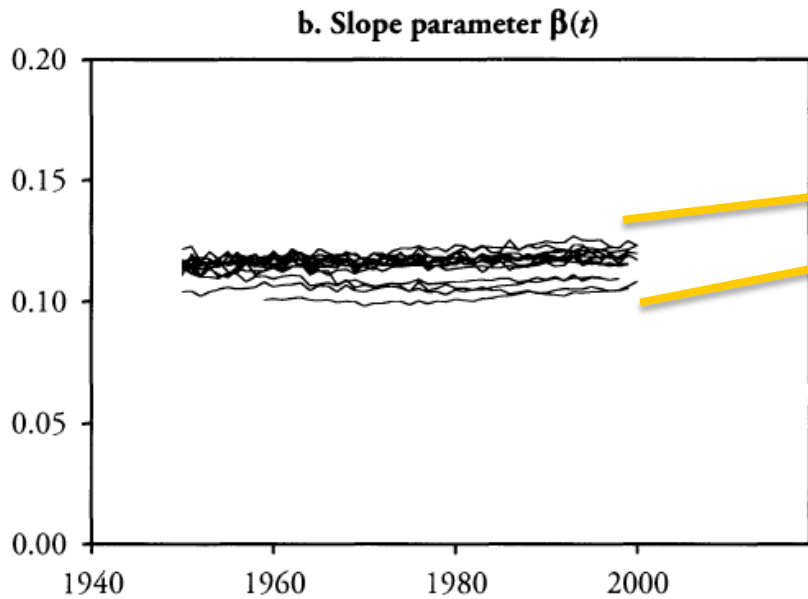


Bongaarts, 2005
Females, 14 Western European countries, 1950–2000

Hulíková, K. 2013. *Selected demographic methods of mortality analysis.* LAP LAMBERT Academic Publishing, *Females, all HMD countries, 1900–2010*

Shifting logistic model - evaluation

- Assumption of the constant slope parameter...



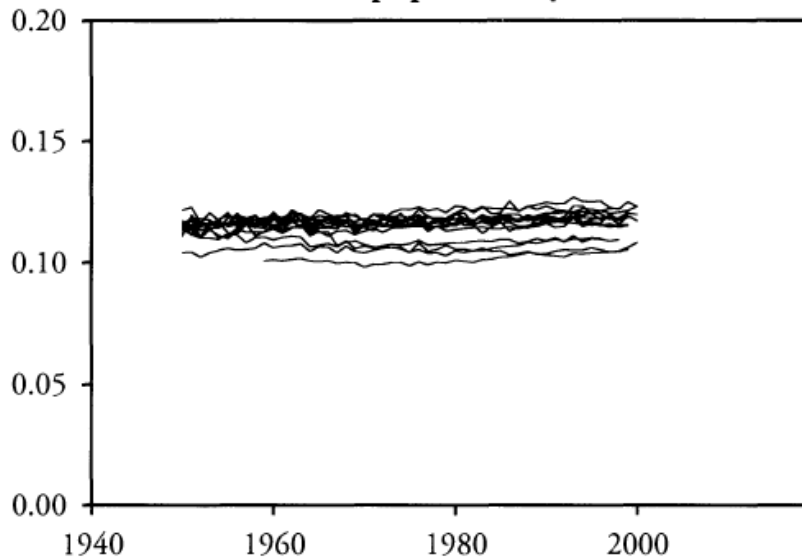
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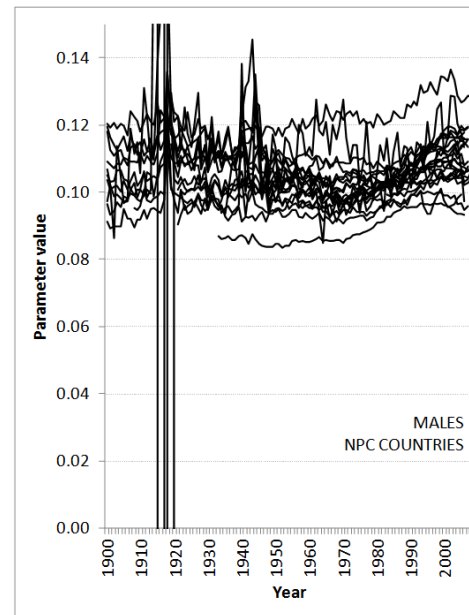
Shifting logistic model - evaluation

- Assumption of the constant slope parameter...

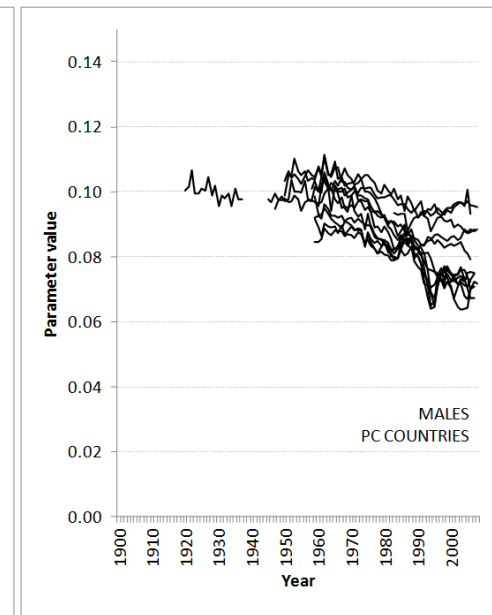
b. Slope parameter $\beta(x)$



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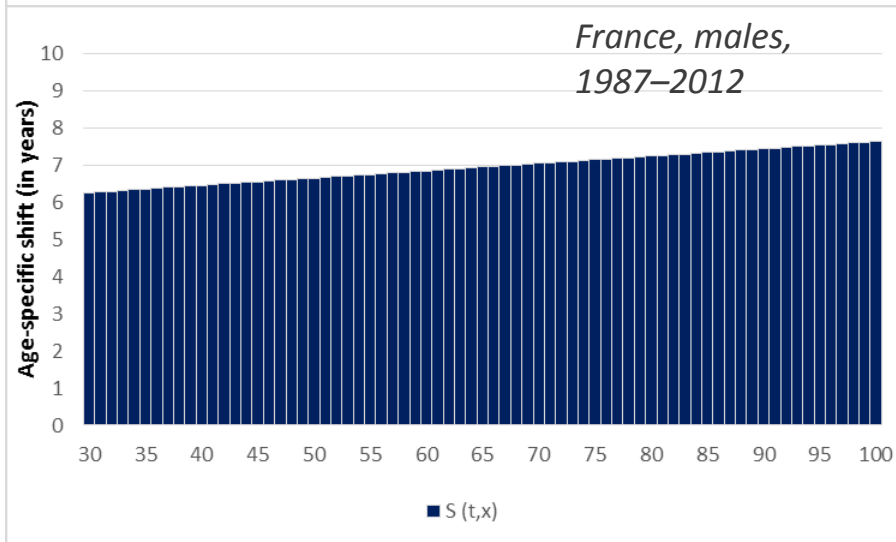
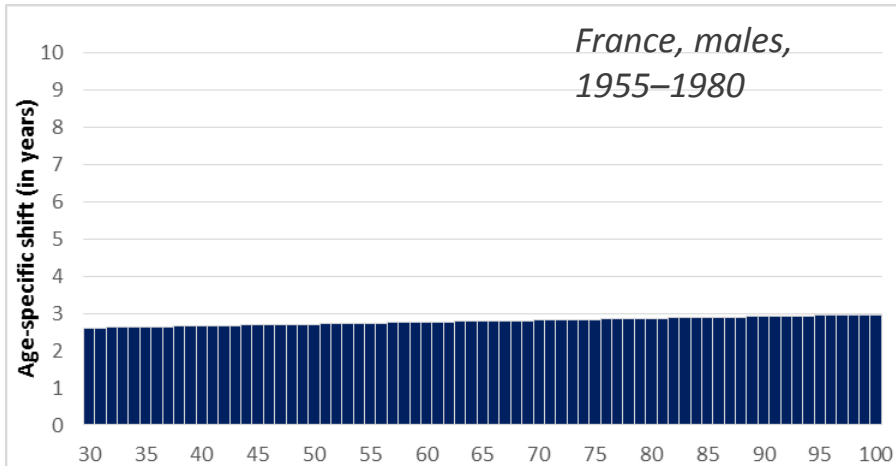
Age-specific mortality shifts

- The logistic model is used
- The assumption of time-invariant parameter B was left behind, parameter B was considered as time-variant
- Age-specific mortality shifts:

$$S(x, t) = \frac{x(B_{t_0} - B_t) - \ln\left(\frac{A_t}{A_{t_0}}\right)}{B_{t_0}} = x * \frac{(B_{t_0} - B_t)}{B_{t_0}} - \frac{\ln\left(\frac{A_t}{A_{t_0}}\right)}{B_{t_0}}$$

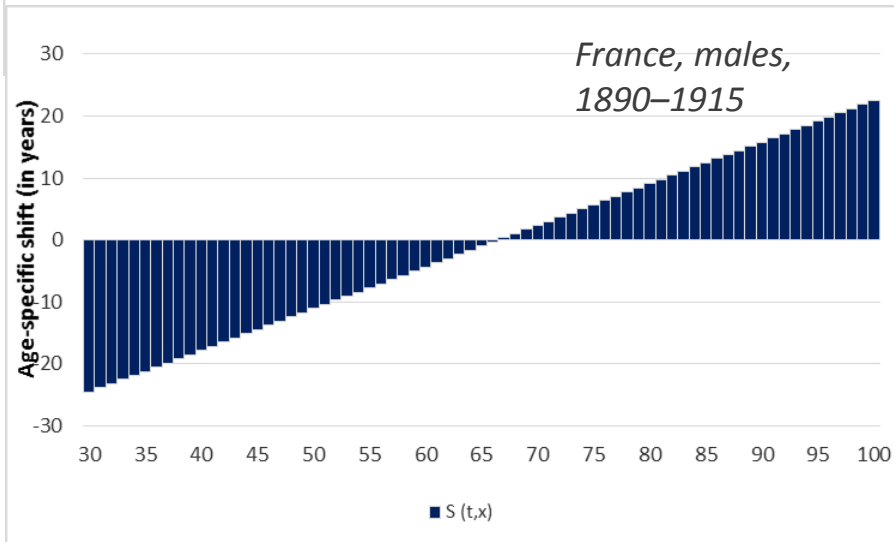
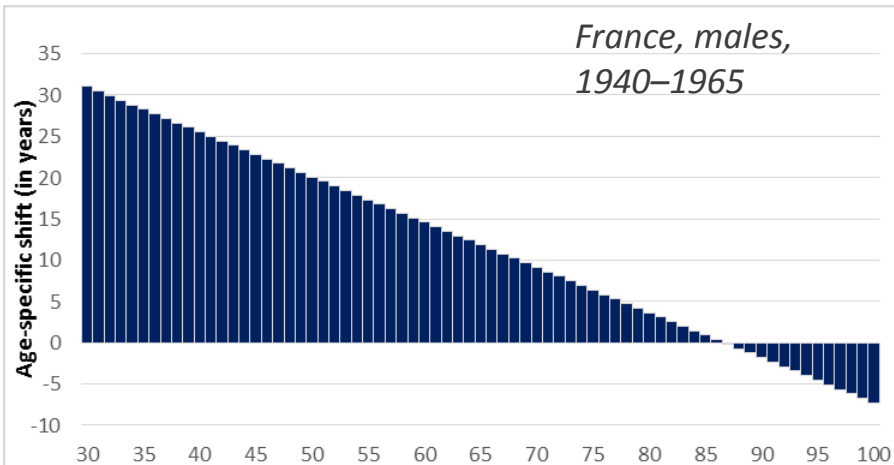
- Using the logistic model (the same could be easily proved also for the exponential model) the age-specific shifts have linear trend with age. The slope of the line in the circle. $t - t_0 = 25$ years

Age-specific mortality shifts (France, males)



- Linear trend of the age-specific mortality shifts
- Value of the slope of the trend is very small, express **nearly the parallel shift**
- The slope increased at the end of the 20th century
- Also the amounts of the age-specific shifts increased

Age-specific mortality shifts (France, males) – what can also happen...



- Negative or positive slope parameter of the age-specific mortality shifts
- There is not any parallel shift at all
- Moreover, there could be calculated some „threshold age“ where the shifts become negative (for negative slope) or positive (for positive slope)

Conclusions

- Proved that the slope parameter in the logistic mortality model cannot be generally taken as constant in time
- Generalization of the shifting logistic model: the age-specific shifts
- A specific feature of smoothing parametric functions (logistic as well as exponential): the age-specific shifts are a linear function of age
 - There could be found a „threshold age“ where the sign of the age-specific shifts changes – question: does it correspond with reality?
 - Important question in the mortality analysis (and above all for forecasting mortality) of adults and specifically of the oldest-old



Conclusions

- The mortality shift (parallel) could be defined as a situation where the slope parameter of the age-specific shifts is nearly constant, i.e. the age-specific shifts are nearly the same for all the ages
- Parametric functions are very useful tool for mortality smoothing. However, their applicability for forecasting is only limited
- It has to be kept in mind, that simple parametric functions (exponential, logarithmic), do not include the time-dimension



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Thank you for the attention
and enjoy the rest of the conference!

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