

4<sup>th</sup> Human Mortality Database Symposium  
Similarities and peculiarities on the way to longer life

*Dmitri A. Jdanov*

*Vladimir M. Shkolnikov*

Berlin, 22-23 May 2017

**Decomposing current mortality  
differences into initial differences and  
differences in trends: the contour  
decomposition method**



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# History

First stage: decomposition between two life expectancies. Discrete method for decomposition of a difference between two life expectancies (Andreev, 1982, Arriaga, 1984, Pressat, 1985)

Second stage: general approaches which would solve the decomposition problem for wider classes of demographic measures (Das Gupta, 1994, Das Gupta, 1999, Vaupel and Canudas Romo, 2002, Shkolnikov, Valkonen, Begun and Andreev 2001, Andreev, Shkolnikov and Begun 2002, Horiuchi, Wilmoth and Pletcher 2008).

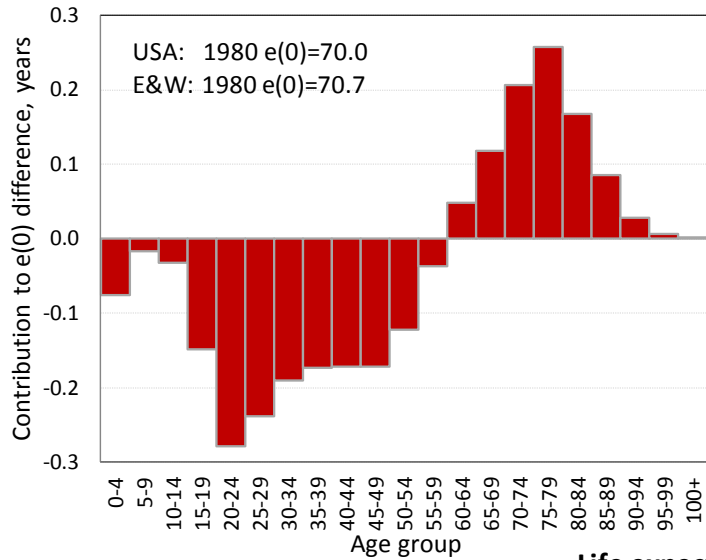
All these methods solve one and same problem: estimation of effects on the change in the dependent variable due to the change in each covariate. All these propose plausible solution of the problem, but results may differ.

We use general stepwise replacement algorithm as baseline method. Our approach may be repeated using other existing techniques but result will (probably) differ.

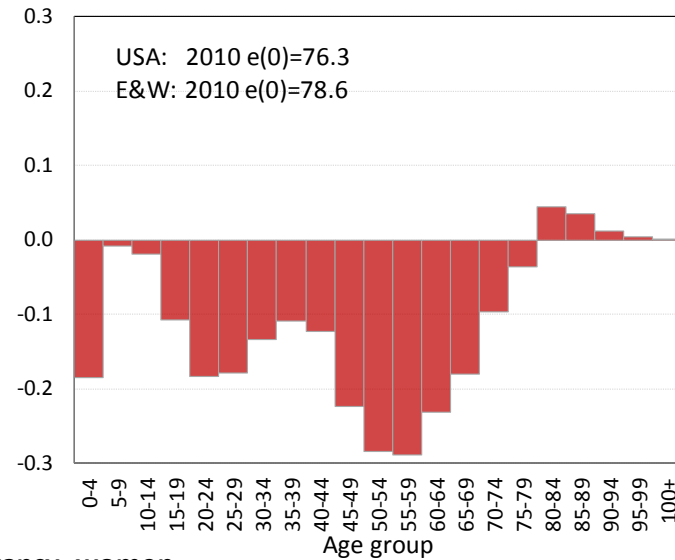
# Decomposition of LE: USA vs. England and Wales

1980

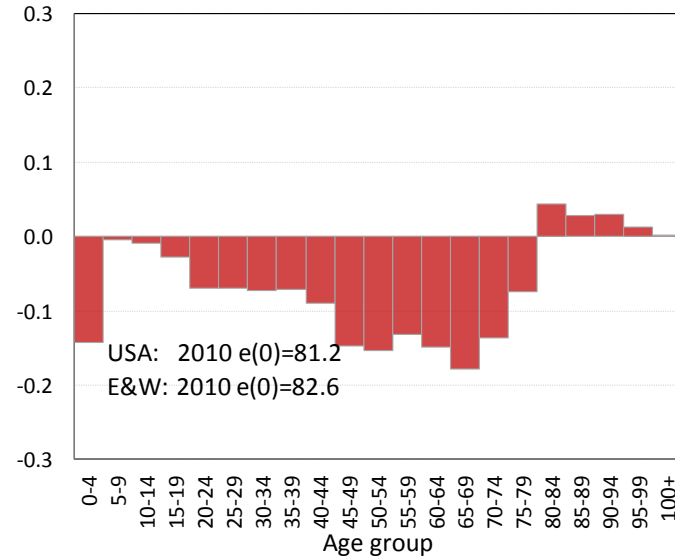
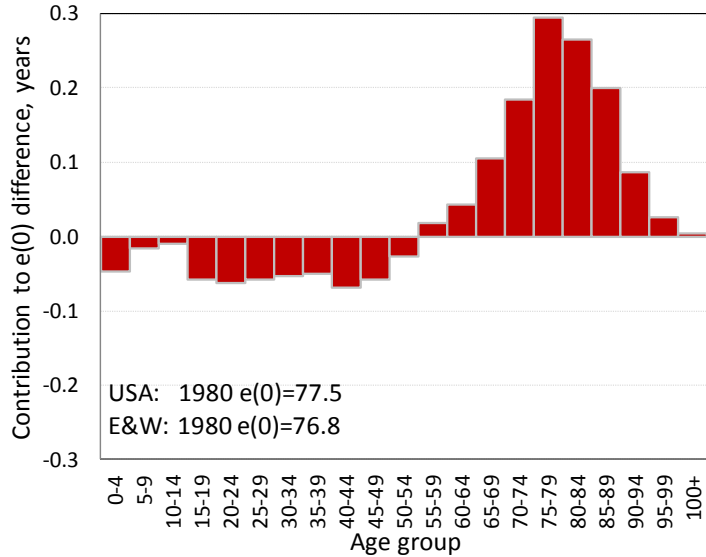
Life expectancy, men



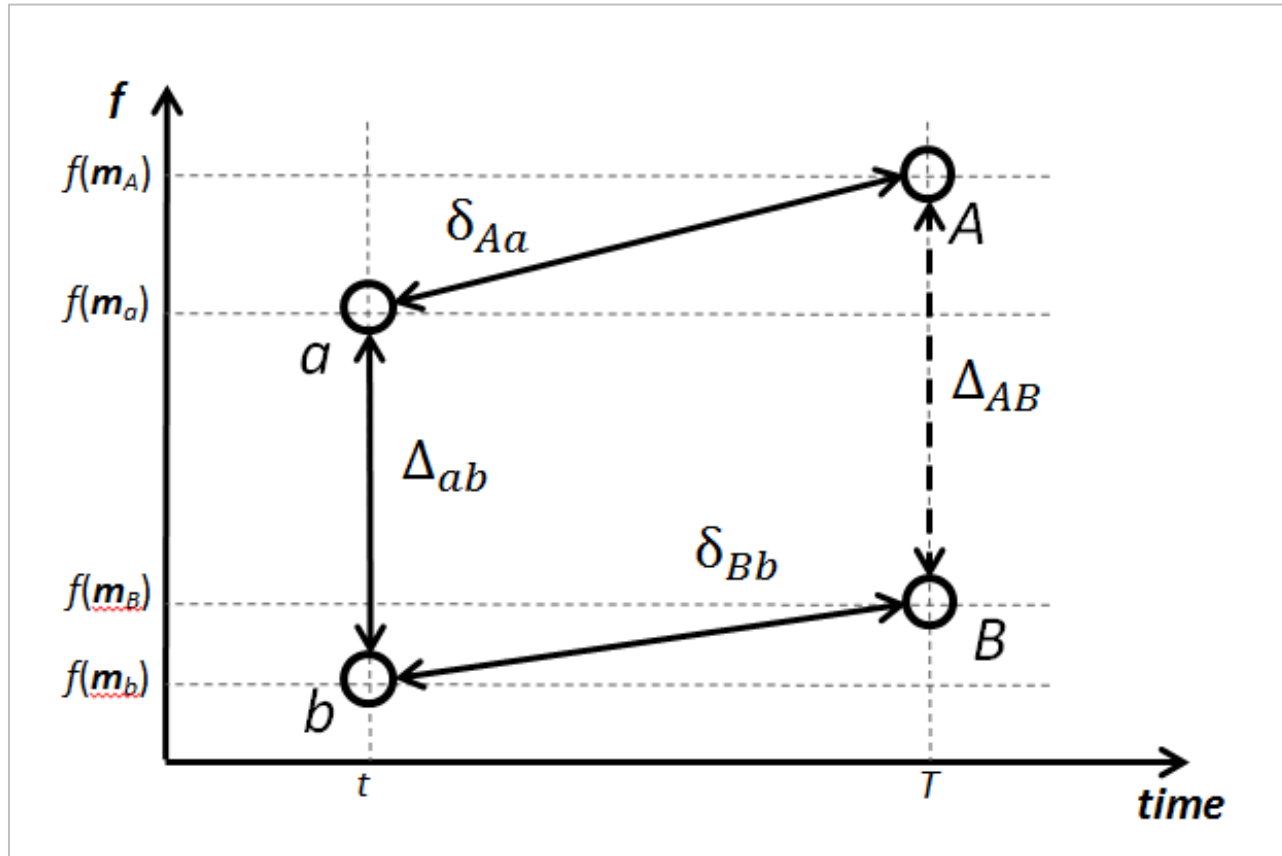
2010



Life expectancy, women



# Background



Assessment of contributions of different ages to the total difference at the time point  $T$ : impact of every age depends on the difference in event rates at the first time point ( $t$ ) and on the temporal changes in these rates in each population between time points  $t$  and  $T$ .

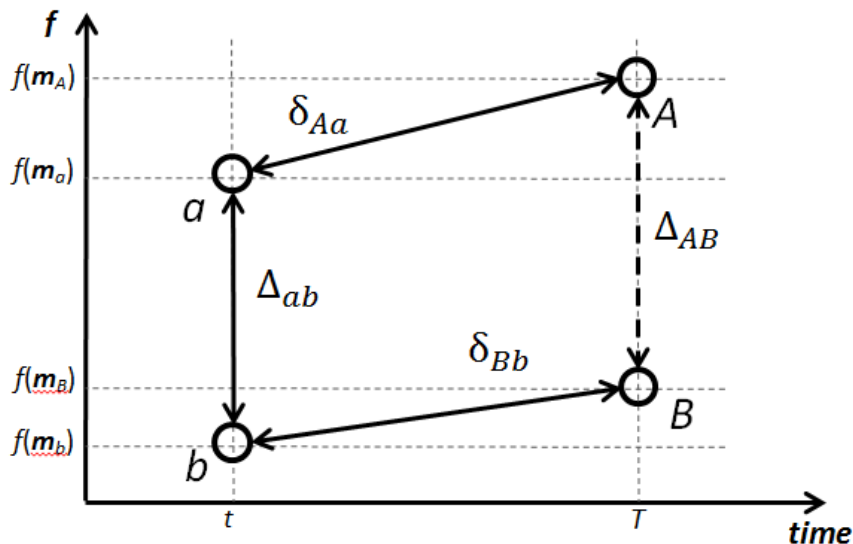
# Core of the problem

The decomposition task is to split the final difference  $\Delta_{AB} = f(\mathbf{m}_A) - f(\mathbf{m}_B)$  into additive age-specific cross-sectional (between country) contributions due to the initial cross-sectional difference and the longitudinal (within country) contributions due to event-rate changes.

The final cross-sectional age-components  $\Delta_{AB}^i$  cannot be expressed via the conventional age-components:

$$\Delta_{AB}^i \neq \Delta_{ab}^i + (\delta_{Aa}^i - \delta_{Bb}^i).$$

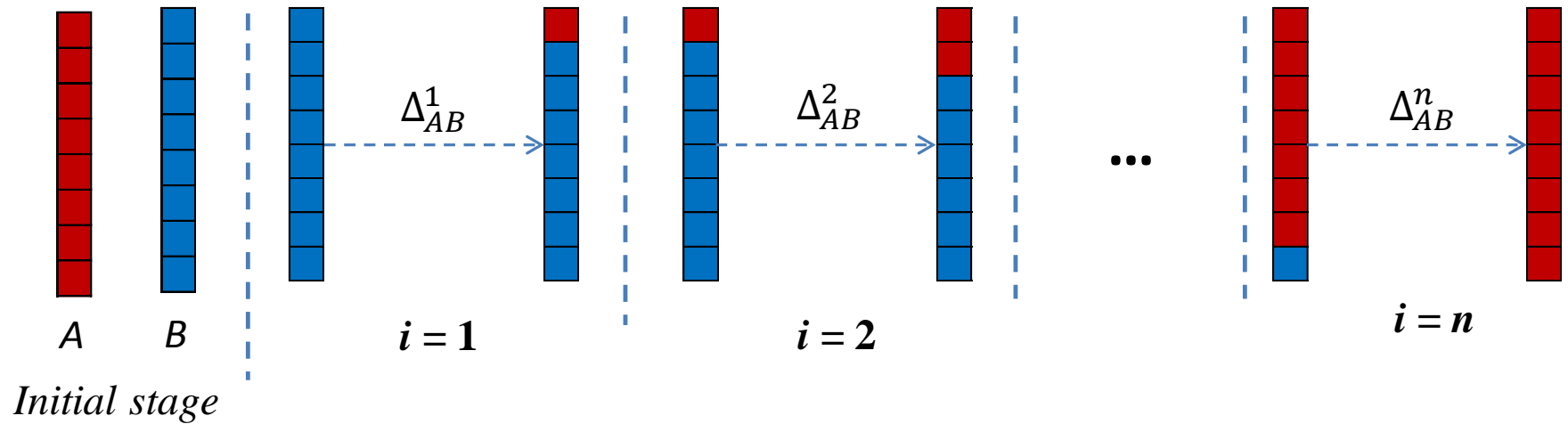
Thus, the primary requirement is that at every age the sum of the initial and the trend components is equal to the total age-specific component:



$$\begin{aligned} \Delta_{AB} &= \sum_{i=1}^n (Initial^i + Trend^i) \\ &= \sum_{i=1}^n (\Delta_{ab|AB}^i + \delta_{ab|AB}^i), \end{aligned}$$

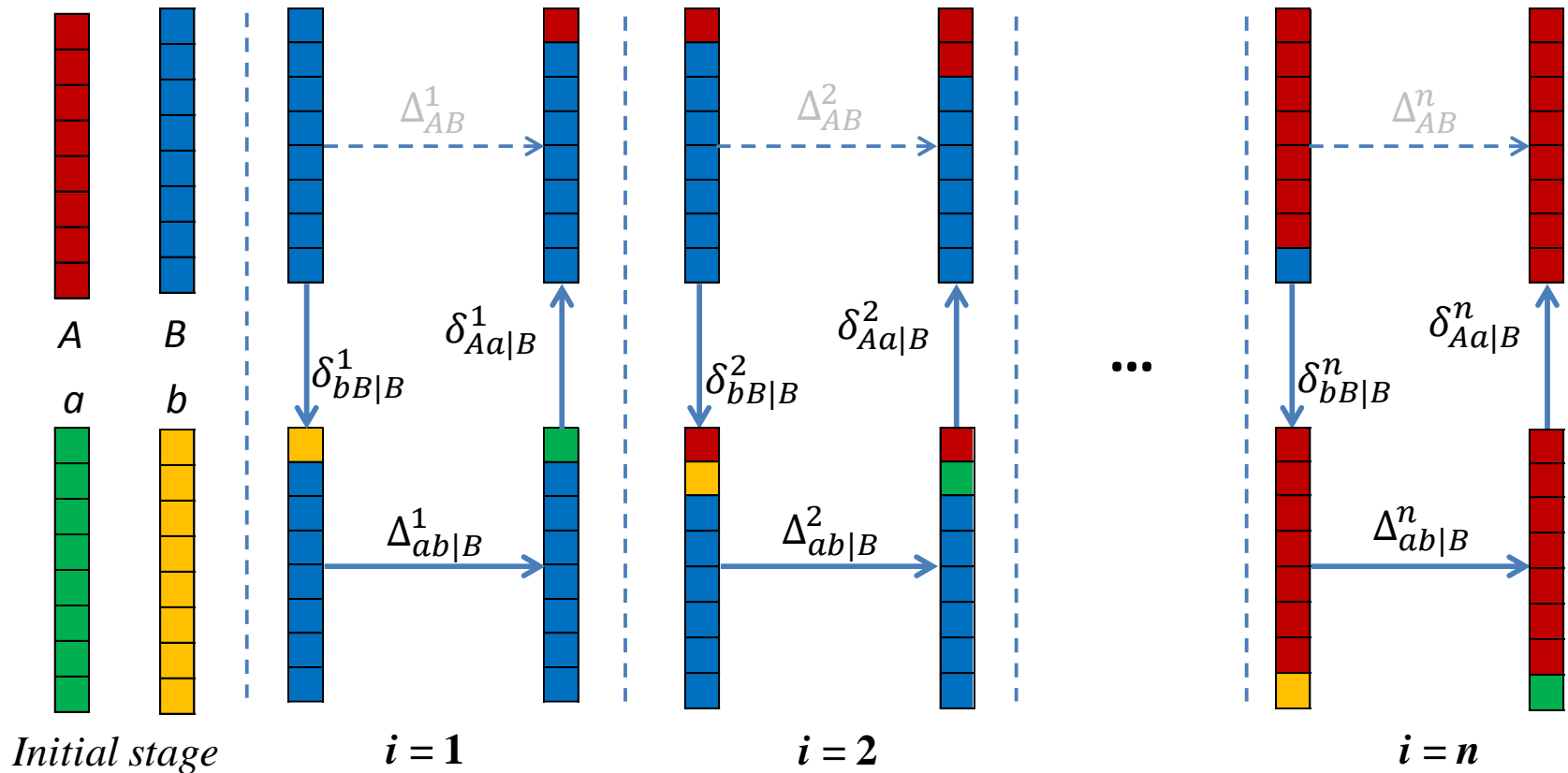
$$\begin{aligned} Initial^i + Trend^i &= \Delta_{ab|AB}^i + \delta_{ab|AB}^i = \Delta_{AB}^i, \\ i &= 1, \dots, n \end{aligned}$$

# Stepwise replacement: one-dimensional problem



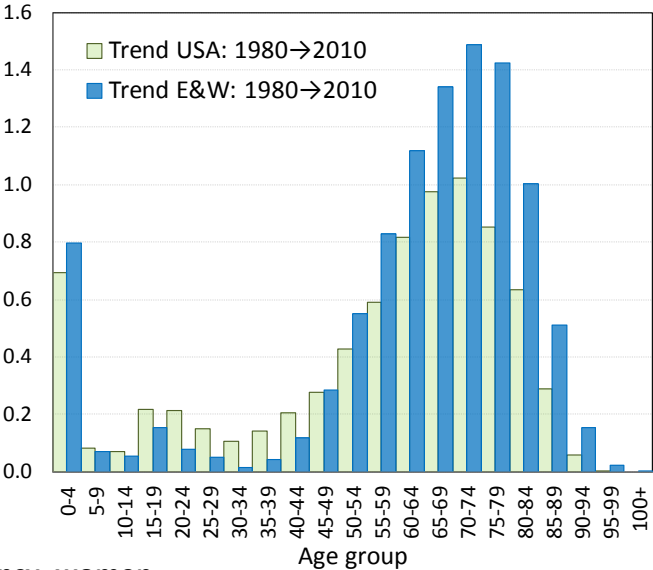
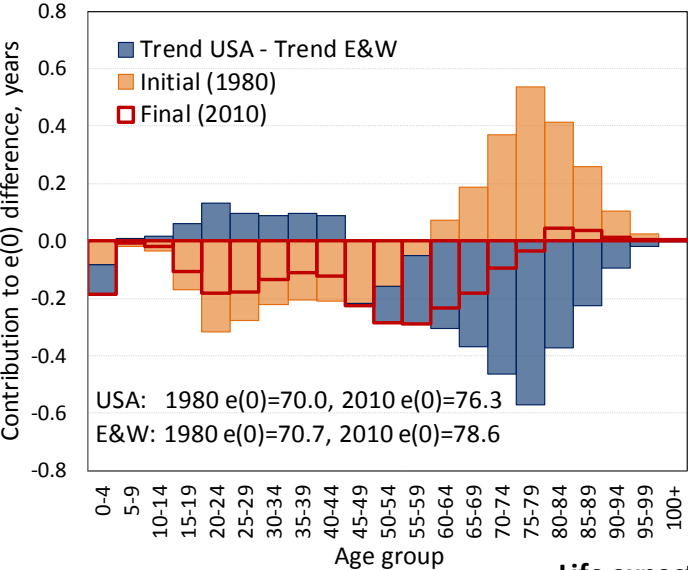
# Contour replacement

The sequence of element replacement in the four vectors in direction  $B \rightarrow b \rightarrow a \rightarrow A$



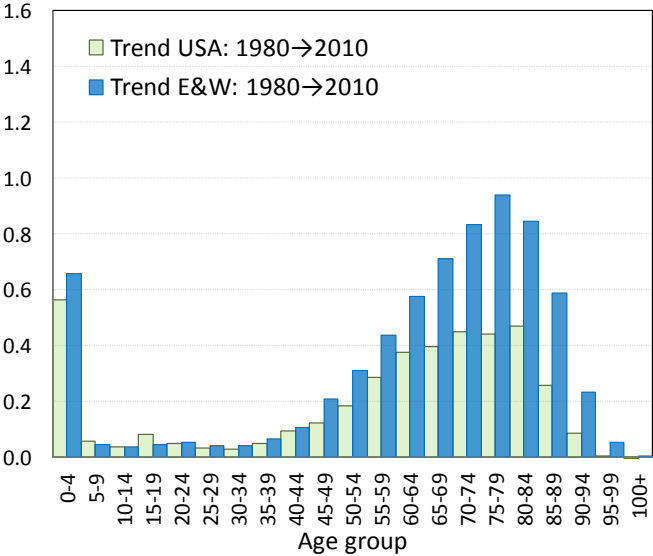
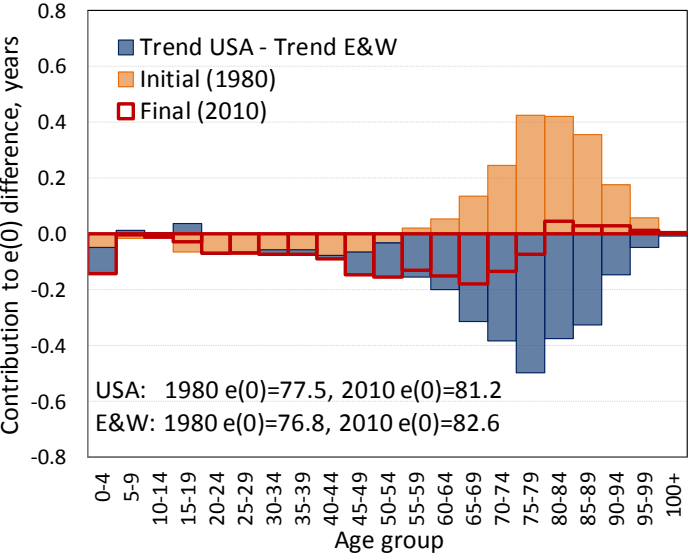
# Empirical example: USA and England and Wales, 1980-2010

Life expectancy, men



Initial component:  
**-0.10**  
 Trend Component:  
**-2.21**  
 Conventional  
 Decomposition  
 in 2010:  
**-2.30**

Life expectancy, women



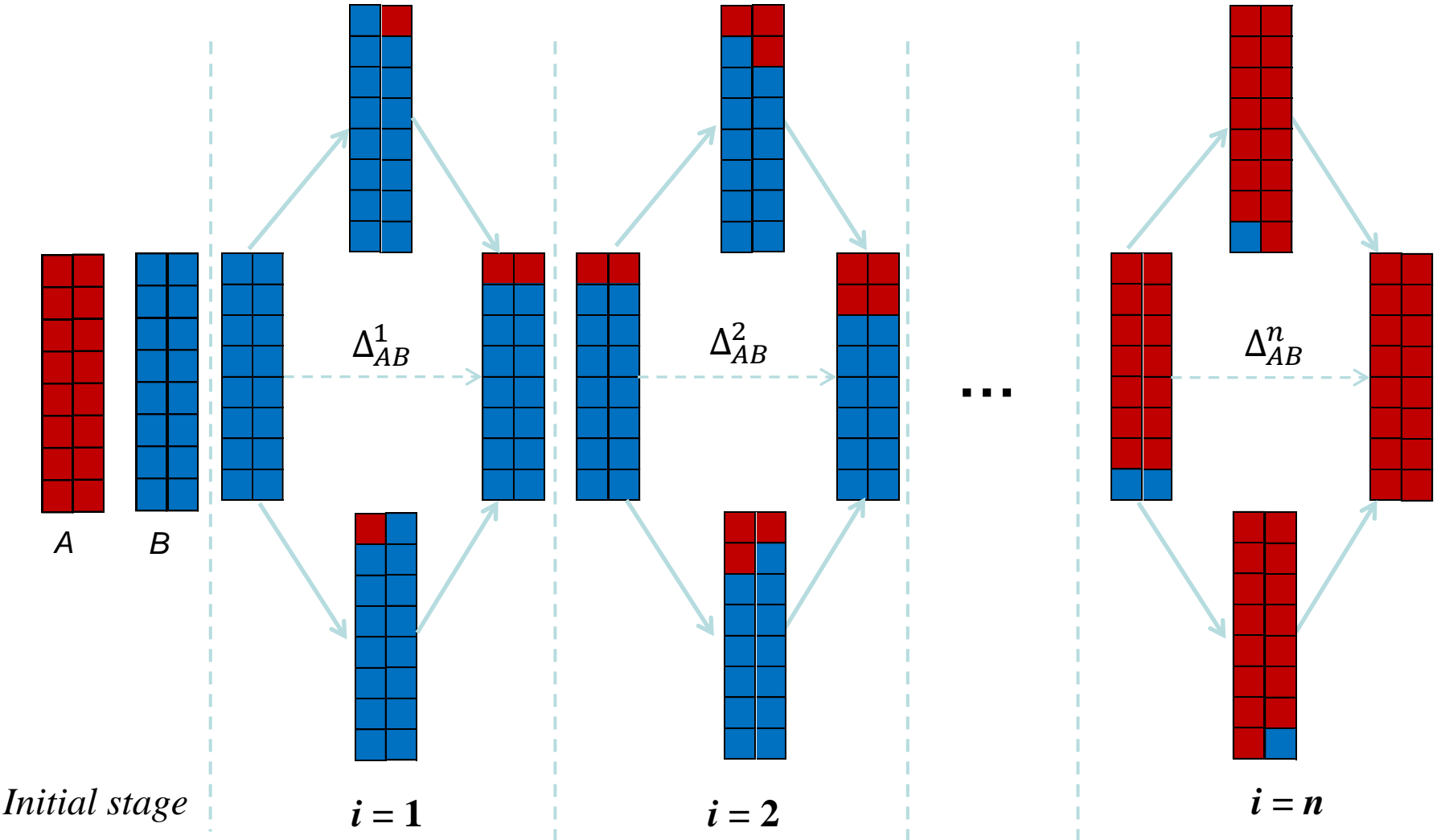
Initial component:  
**1.26**  
 Trend Component:  
**-2.67**  
 Conventional  
 Decomposition  
 in 2010:  
**-1.41**



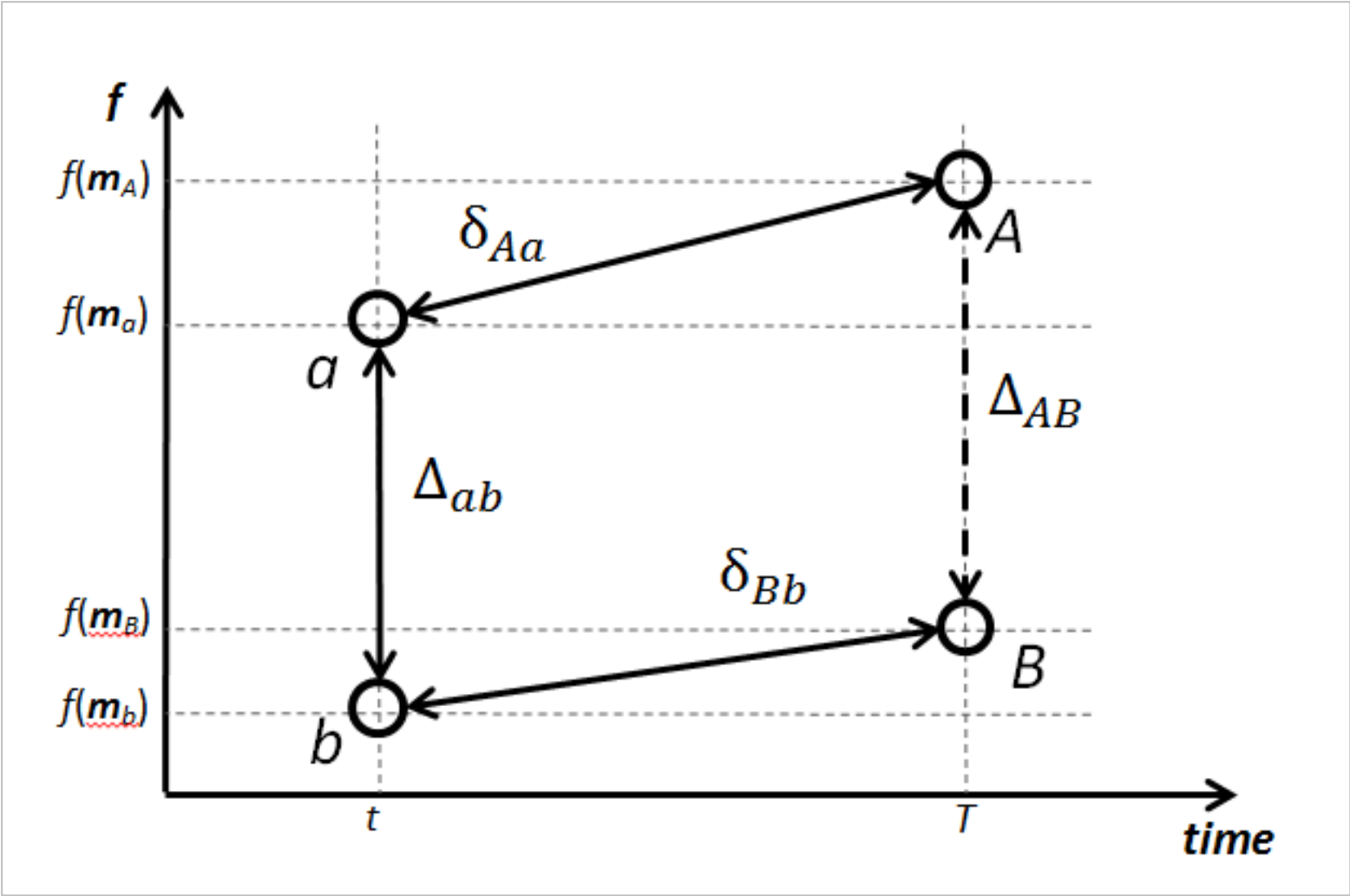


# Causes of death

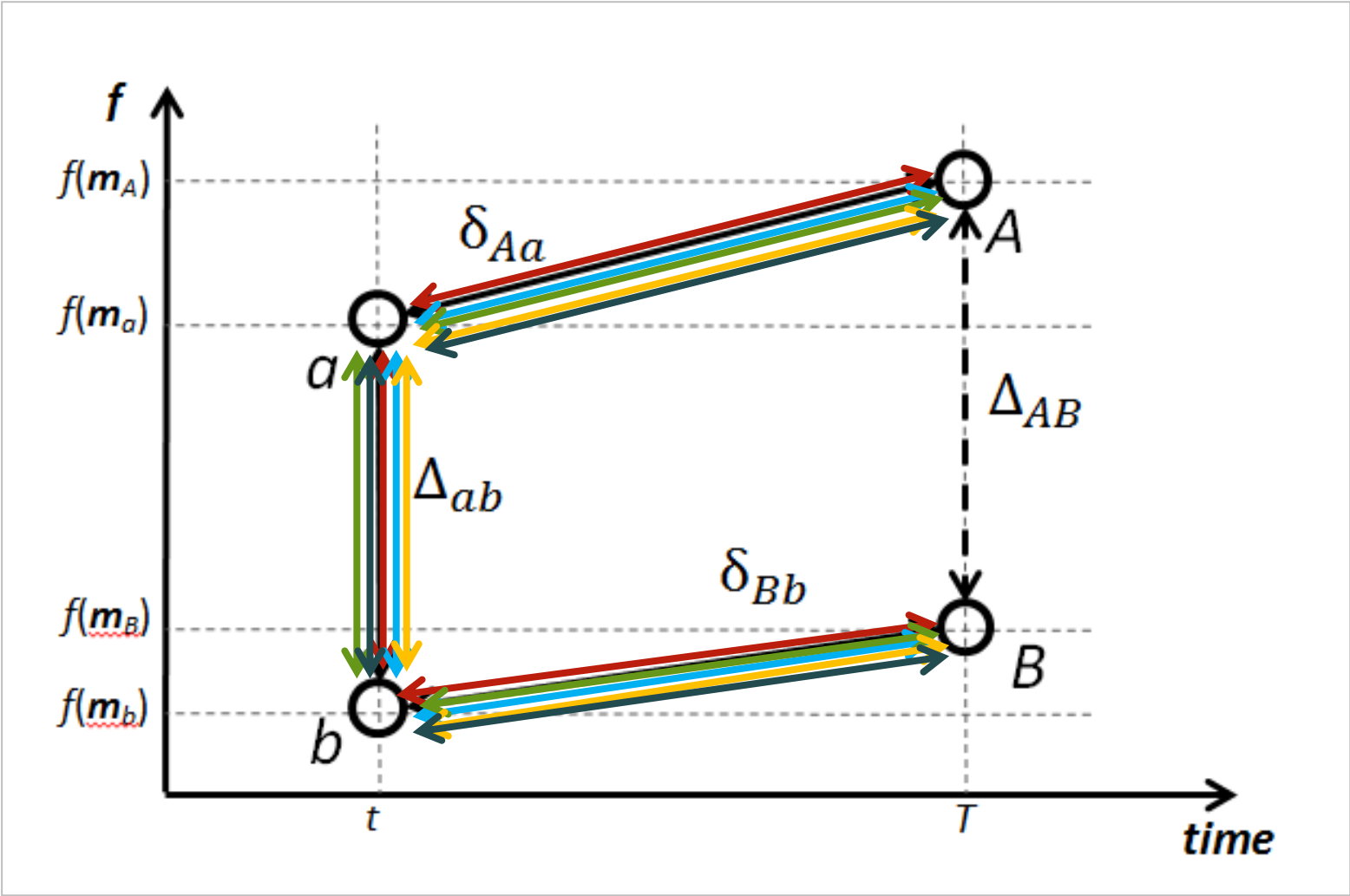
# Stepwise replacement: two-dimensional problem (age + CoD)



# Contour decomposition by age and cause of death

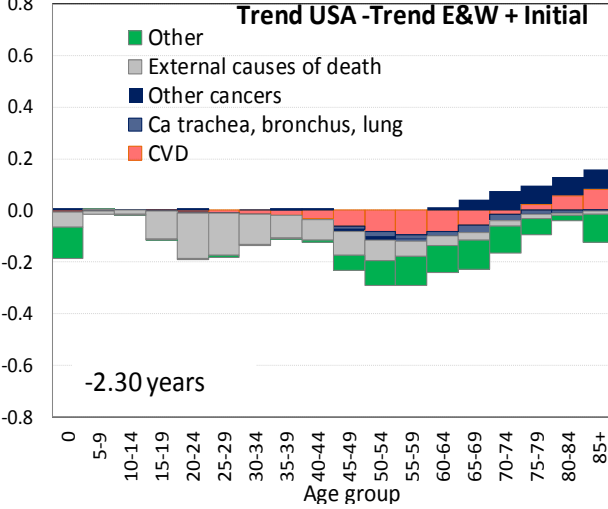
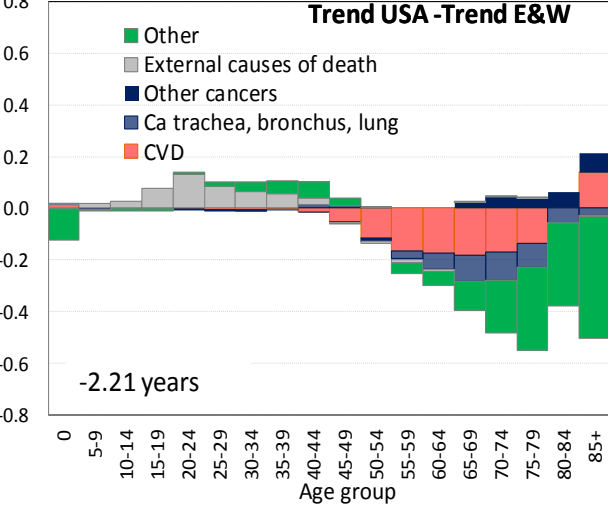
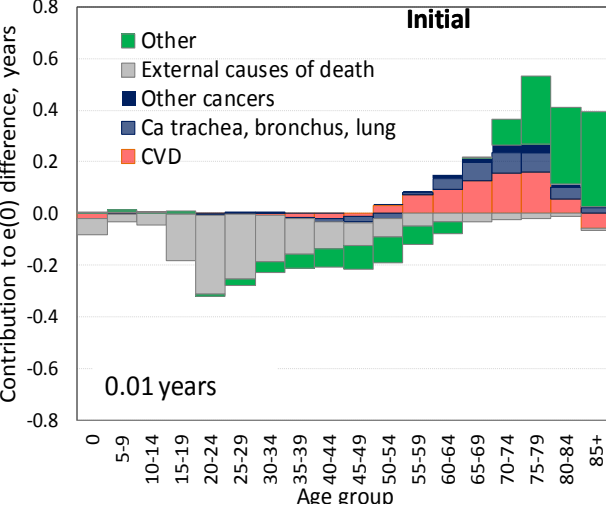
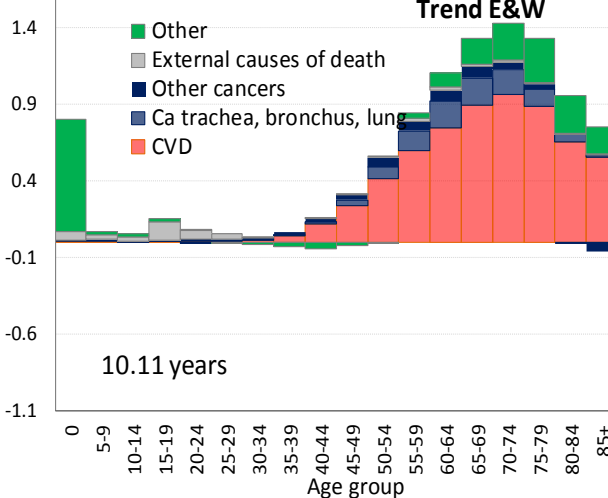
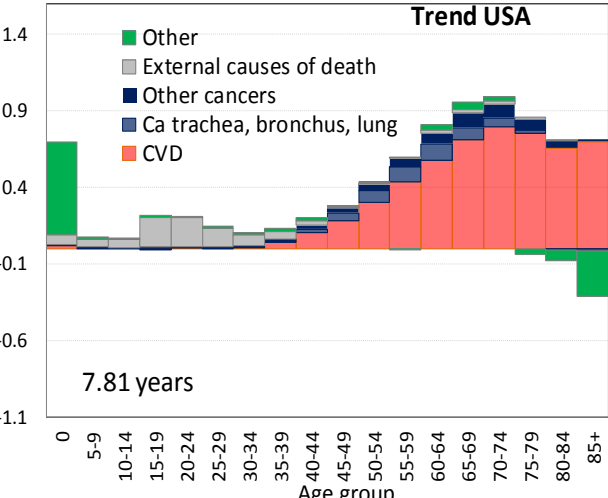
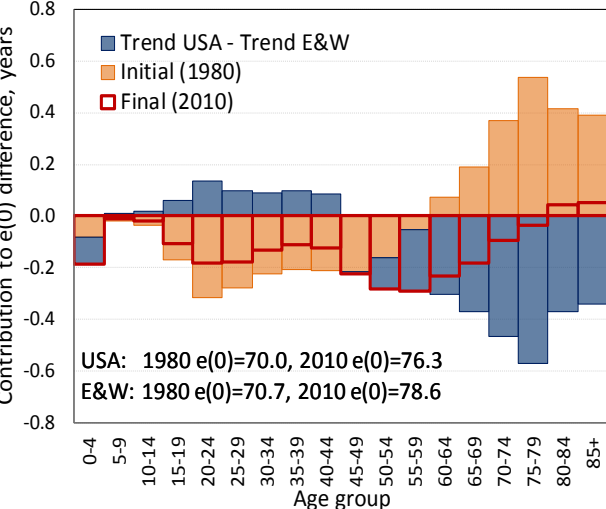


# Contour decomposition by age and cause of death



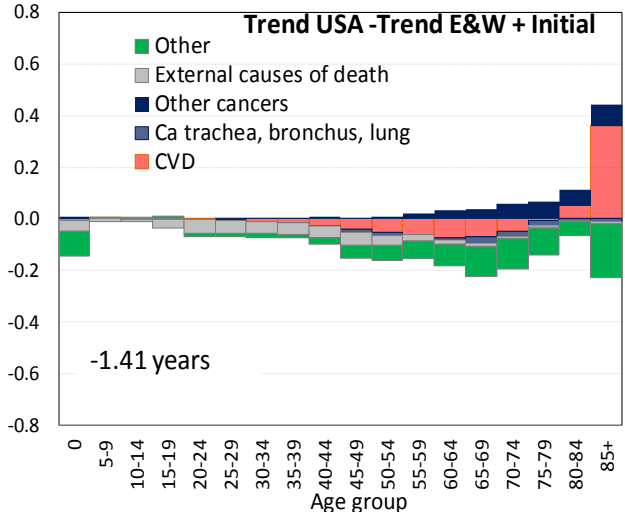
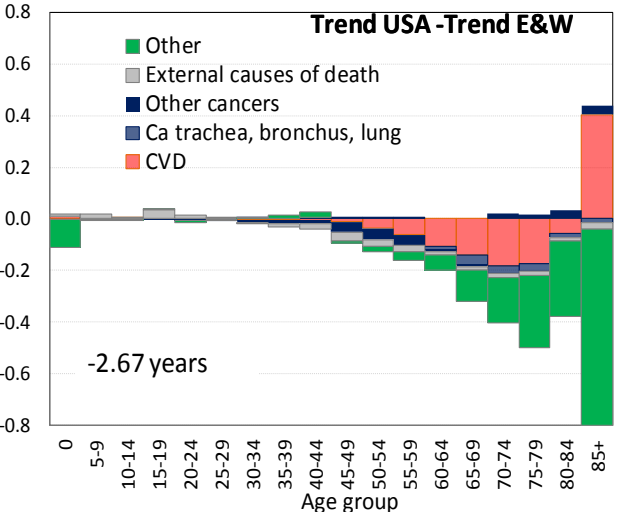
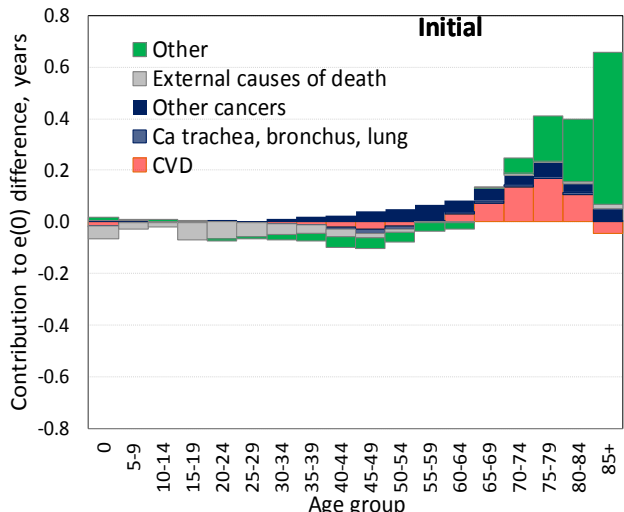
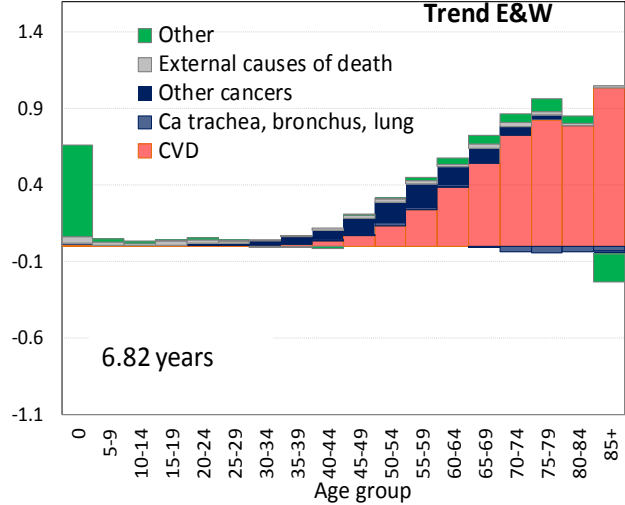
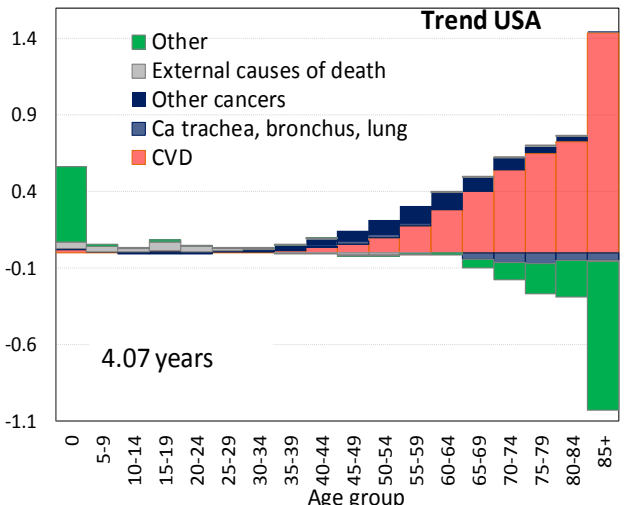
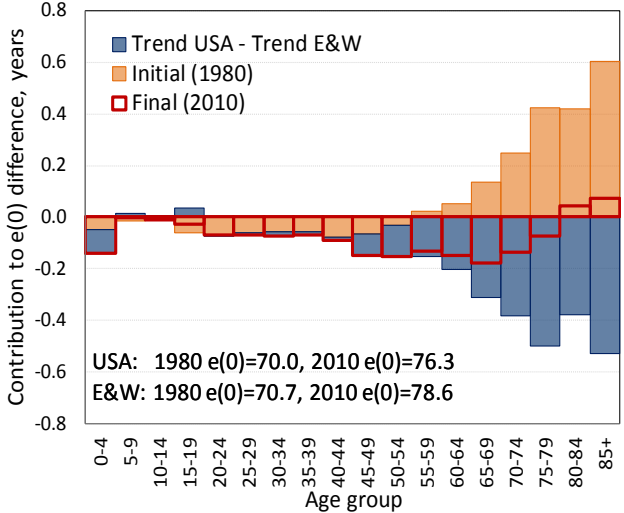
# Empirical example: USA and England and Wales, 1980-2010

## Life expectancy, men



# Empirical example: USA and England and Wales, 1980-2010

## Life expectancy, women



# References

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## Method (without CoD)

Jdanov, D. A.; Shkolnikov, V. M.; Van Raalte, A. A.; Andreev, E. M.:  
Decomposing current mortality differences into initial differences and differences in  
trends: the contour decomposition method  
*Demography* (forthcoming).

## Scripts (R)

Jdanov D.A. and Shkolnikov V.M. 2014. An R-script for the assessment of the  
cross-sectional and the longitudinal components of a difference between two  
values of an aggregate demographic measure by contour replacement. *MPIDR  
Technical Report TR-2014-003*. Available at [www.demogr.mpg.de](http://www.demogr.mpg.de)

**Thank you!**