A Comprehensive Analysis of the Patterns of Worldwide Mortality Evolution

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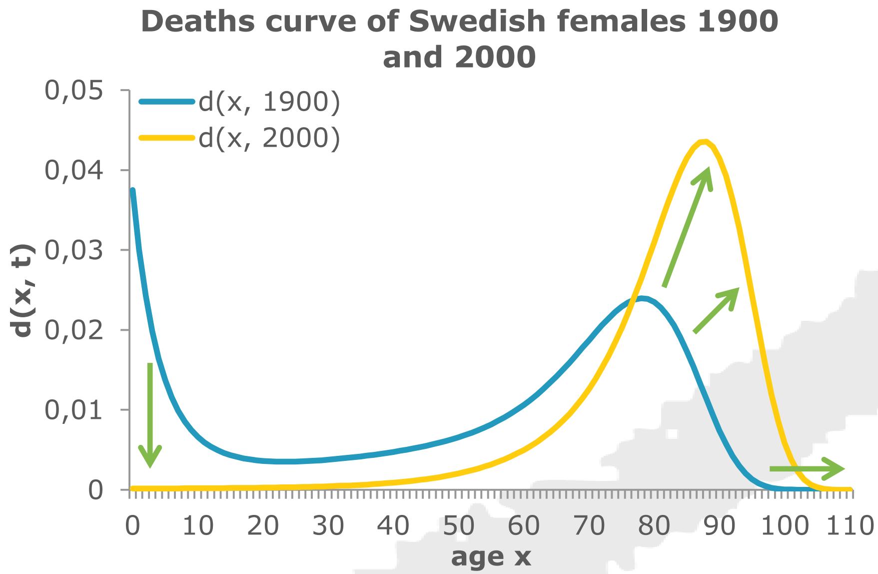
Motivation

- Life expectancy has been increasing in most countries all over the world.
- But changes in life expectancy (and other typically used statistics) are only a **consequence of the underlying change of the age distribution of deaths**.



- **Questions:**
  - How does the shape of the deaths curve **change over time** and how can we **classify** that?
  - Are there **different evolutions for different countries**? And are there any **common patterns** and/or **exceptions**?

Data and Methods
An Overview

- We use data from the **Human Mortality Database (HMD)** for **males and females**.
- We compute time series of deaths curves for **two different starting** ages:
  - Deaths curves with the starting age 0 capture the mortality structure of the entire age range.
  - Deaths curves with the starting age 60 capture the mortality of the age range of retirement.
- We use the **classification framework** of Börger et al. (2016) in order to find trends in the evolution of the age distribution at death for both starting ages. This framework…
  - … gives a clear definition for each scenario,
  - … explicitly allows for mixed scenarios,
  - … uniquely classifies any kind of change in the age distribution of deaths,
  - … is based on 4 statistics.

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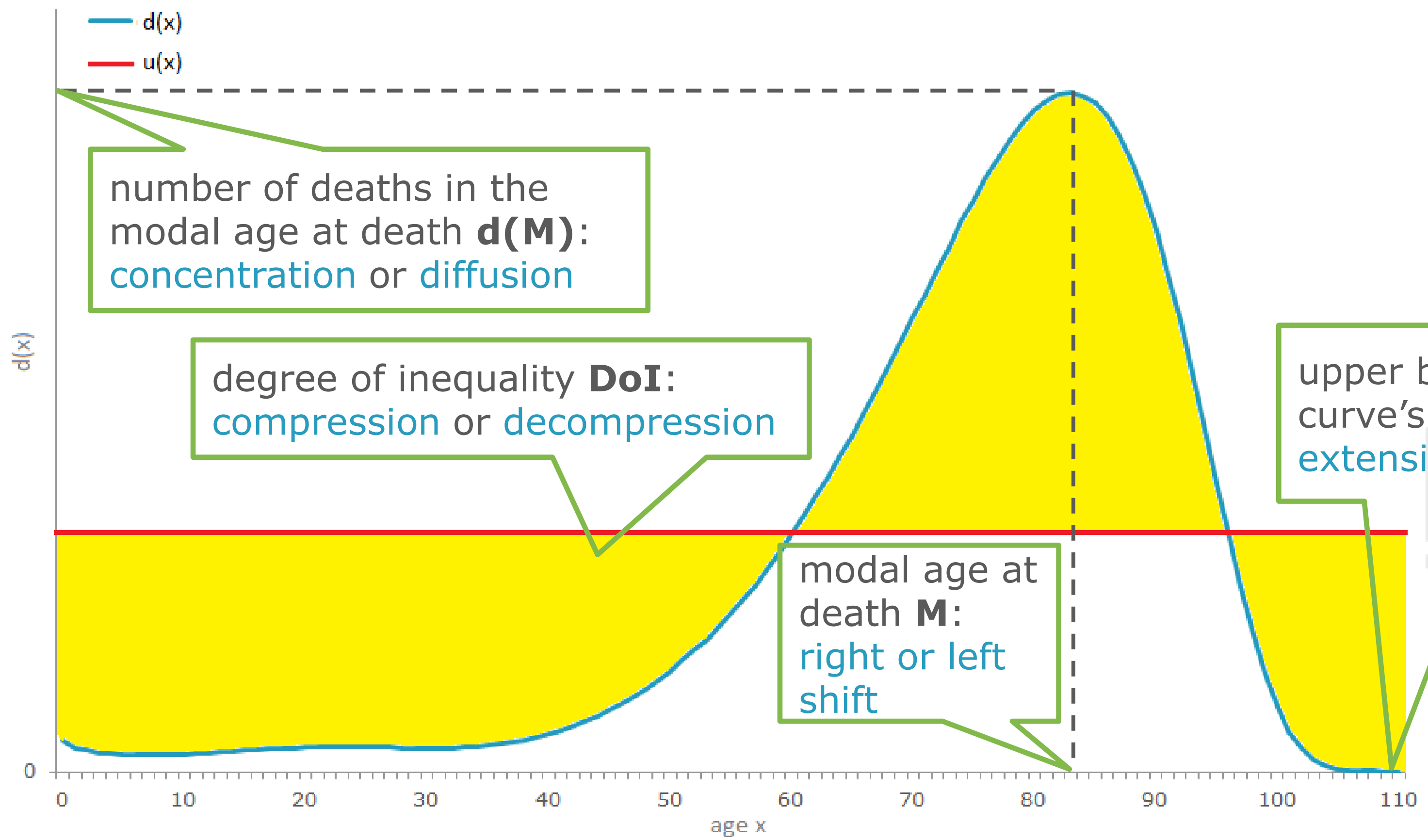
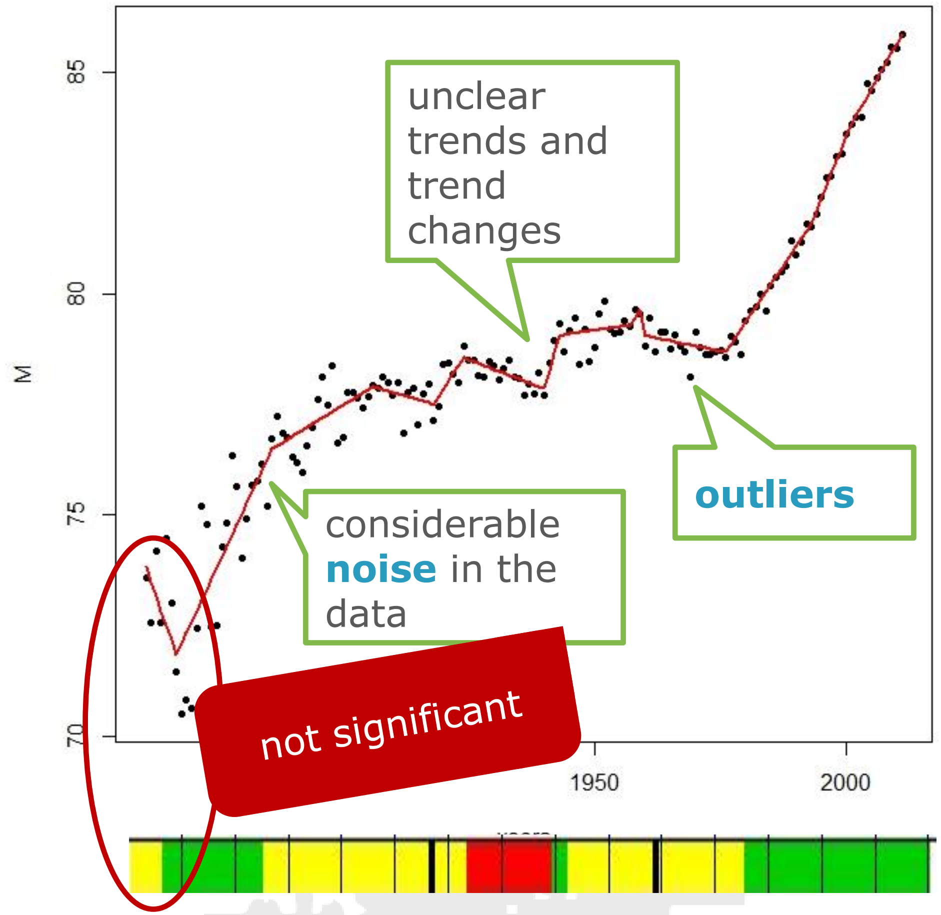
Data and Methods: The Classification Framework



- Each scenario is defined by a **4-dimensional vector** where each component can have three specifications (increasing, neutral, decreasing)
- The components **measure different phenomena** and we must always **consider them jointly** to capture the changes in the deaths curve's shape over time.

Data and Methods: Detection of Trends

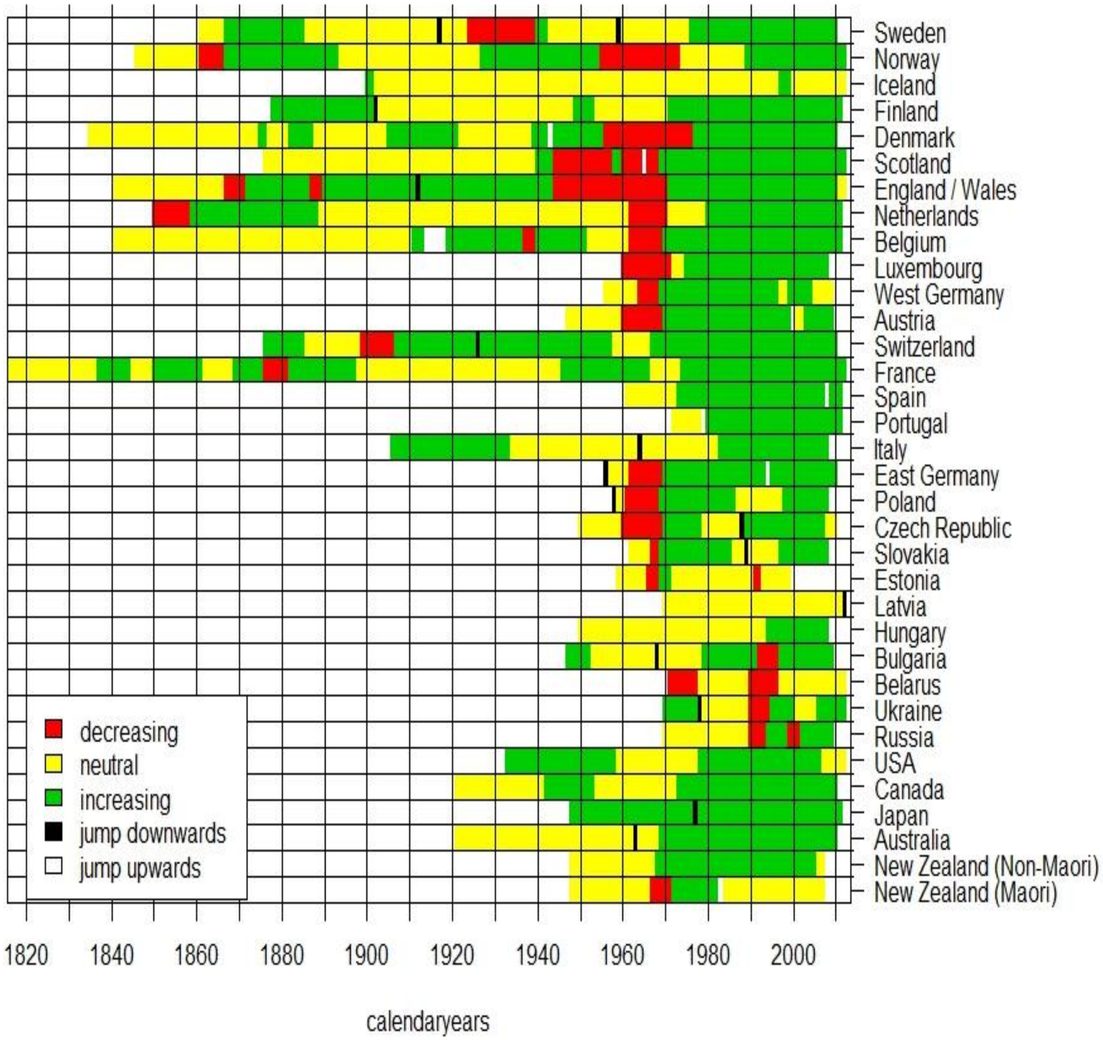
Example: M for Swedish males, starting age 0



- The time series for each statistic and each population…
  - … are "**noisy**" → We need to eliminate the noise.
  - … have **outliers** → We need to eliminate the outliers.
  - … in parts have **unclear trends** → We need a method to identify periods of stable trends.
- We fit a continuous polygonal curve to the data. Thus we achieve a decomposition of the time range into periods, where the time series follows a linear trend.
- For each period we detect whether a trend is **increasing**, **neutral**, or **decreasing** using a statistical test.
- We plot these trends per population over time.

Results

Males, starting age 0, M



left-shift

neutral

right-shift

- There is an obvious difference between the trends of Eastern European populations and the rest of the world.
- We observe a "plateau effect" in the 1960s followed by an almost global increase. This is a significant vertical pattern.
- Right shift evolves to be a global trend in the most recent years with single exceptions (e.g. Iceland, New Zealand (Maori), Eastern Europe).

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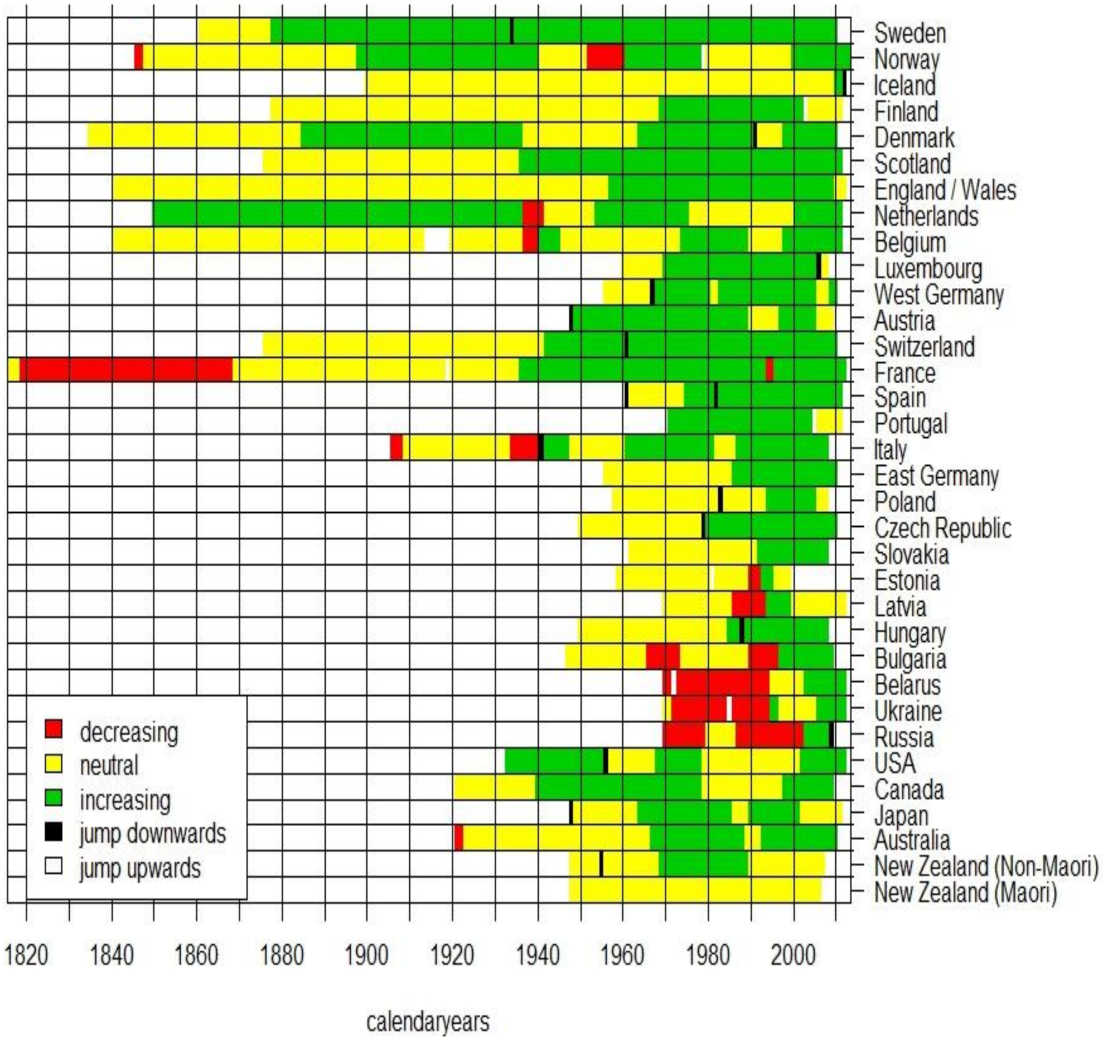
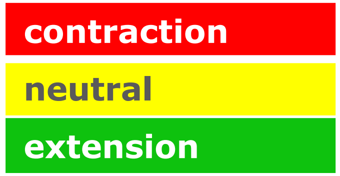
Results

Males, starting age 0, UB

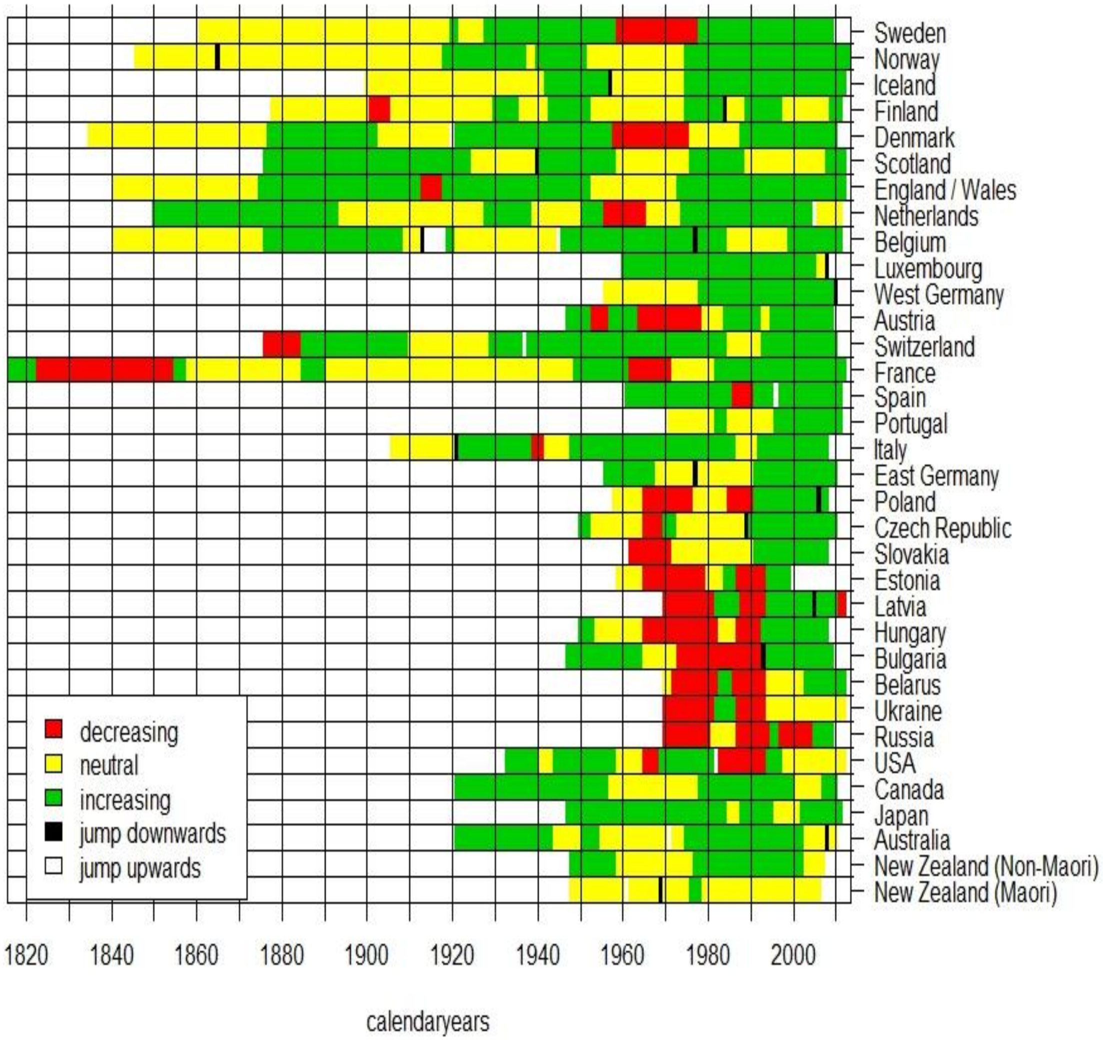




- Again we detect an obvious difference between the trends in Eastern European populations and the rest of the world.
- There is some heterogeneity in the trends within the Eastern European cluster ("the more eastern, the less long-term extension").
- There is no plateau and (apart from Eastern Europe) only few "vertical patterns" e.g. in the 1980s and 1990s in USA and Canada.
- During the most recent years, we observe an increase in UB (i.e. extension) in many populations but this is less comprehensive than for M.

Results

Males, starting age 0, DoI



decompression

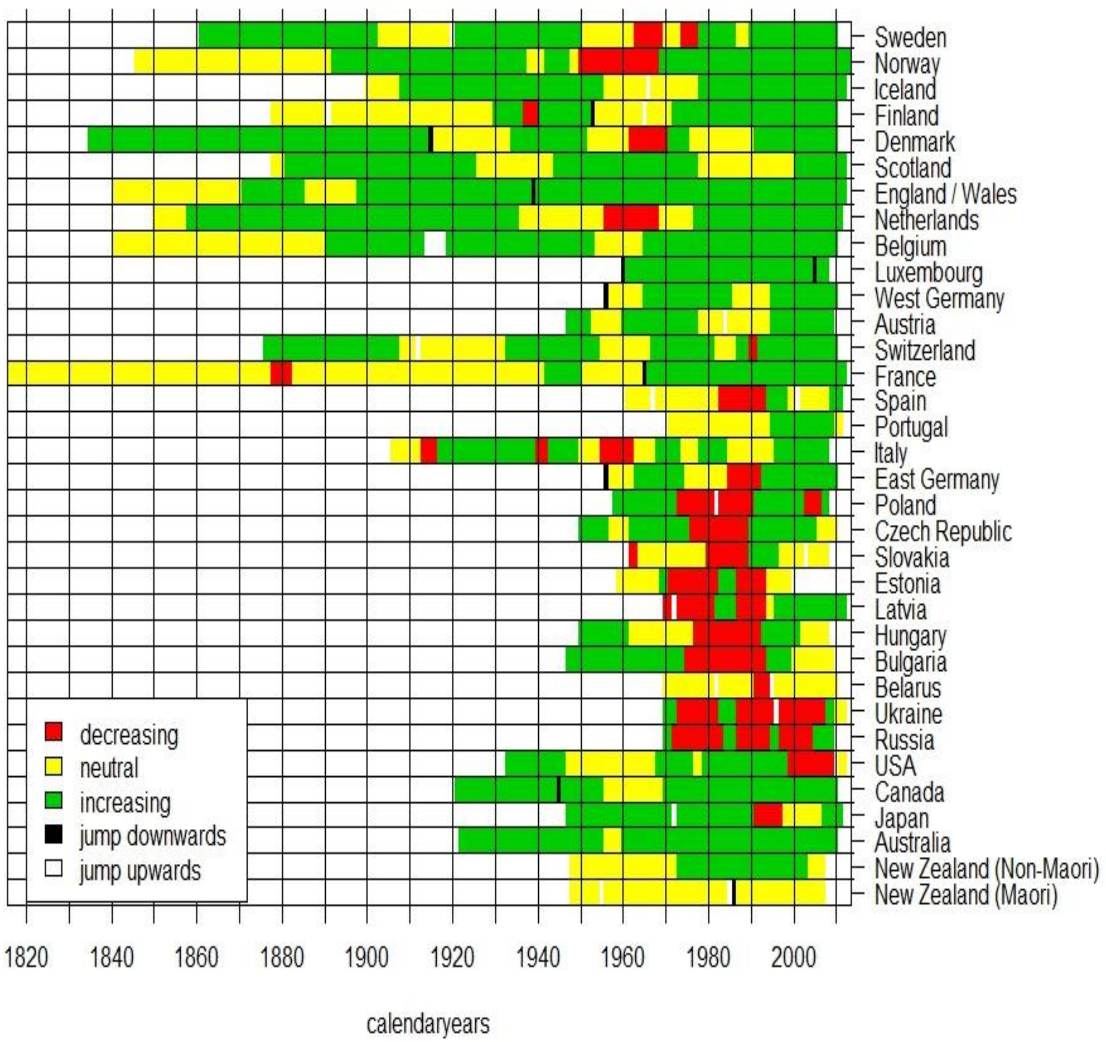
neutral

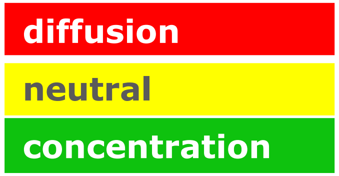
compression

- We see very explicit vertical patterns e.g. in Eastern Europe but also in North-Western Europe during the 1960s.
- The heterogeneity within the Eastern European populations is less pronounced than for UB.
- In the most recent years we observe compression almost all over the world, but there are few exceptions (especially outside Europe).

Results

Males, starting age 0, d(M)



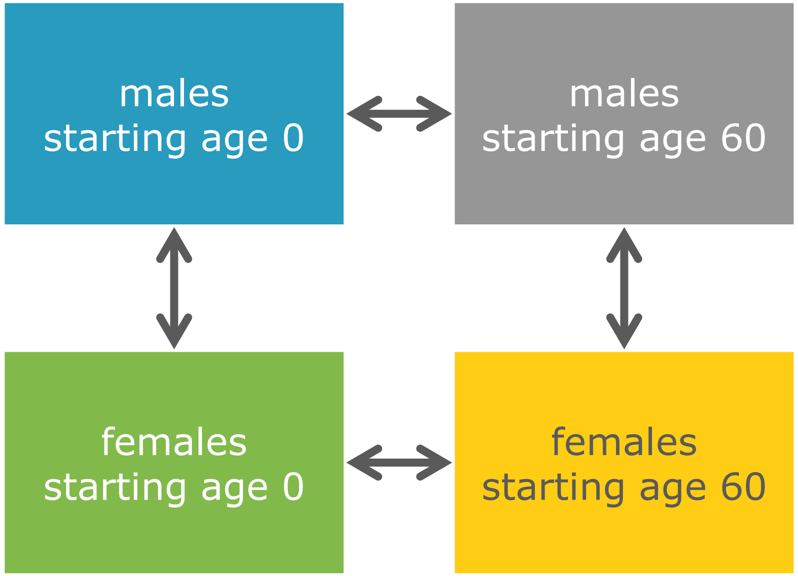


- The trends in $d(M)$ appear to be very similar to those of DoI. However, there are differences in the details, which underlines that these figures indicate different phenomena.
- Compared to DoI the plateau in the 1960s / 70s is less pronounced here (but there is a plateau!).

Results

Comparing males with starting age 0 to starting age 60 and females

Overview



We observe…

- … significant differences between sexes,
- … that differences between starting ages are larger for males than for females, and
- … that the differences between sexes and between starting ages vary over global regions.

Thus, the evolution of the age distribution at death **differs between sexes and starting ages** which should therefore be chosen according to the question at hand.

Summary

What have we seen?

- We discussed a **classification framework for mortality evolution patterns**, which…
  - … gives a clear definition for each scenario,
  - … explicitly allows for mixed scenarios,
  - … uniquely classifies any kind of change in the age distribution of deaths,
  - … is based on 4 statistics.
- We get time series for each of the four statistics of the framework and we briefly discussed methods for the detection of the **direction of the trends in these time series** (increasing, neutral, decreasing).
- We discussed the results for males with the starting age 0 and found **multiple supra-regional patterns** in the trends of the deaths curves' evolution over time but **also differences between (groups of) populations**.
- Comparing the trends of the deaths curves of males with starting age 0 to the other sex / starting age combinations, we found **significant differences between males and females and between the starting ages.** These differences differ by (global) regions.

Thank you for your attention!

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Literature

Genz, M. (2016). *A Comprehensive Analysis of the Patterns of Worldwide Mortality Evolution.* Working Paper, ifa Ulm and Ulm University.

Börger, M., Genz, M., and Ruß, J. (2016). *Extension, Compression, and Beyond – A Unique Classification System for Mortality Evolution Patterns.* Working Paper, ifa Ulm and Ulm University. http://www.ifa-ulm.de/fileadmin/user_upload/download/forschung/2016_ifa_Boerger-Genz-Russ_Extension-Compression-and-Beyond.pdf