# Select Birth Cohorts

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- Introduction: Motivation and Literature Review

- Identifying Select Cohorts

- The Fortunate Generations – Analysis of Historical Data

- Outlook and Summary

- Common observation for many countries:

    - reduction of death rates (**"mortality improvement"**) *(Wilmoth, 1998)*

    - **"ageing of mortality improvement"** *(Willets et al., 2004)*

- Consequence: increasing life expectancies (**"longevity trend"**) *(Wilmoth, 1998)*, i.e. subsequent generations tend to live longer

    - fiscal risk for pension providers; already forced to implement DB  DC transitions, reduced benefits, more conservative pricing

- "Longevity improvements" of particular interest; estimates of cost of pension provision and detection of long-term problems beneficial

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**Introduction: Motivation**

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Relative rates of mortality improvement - Males - United States
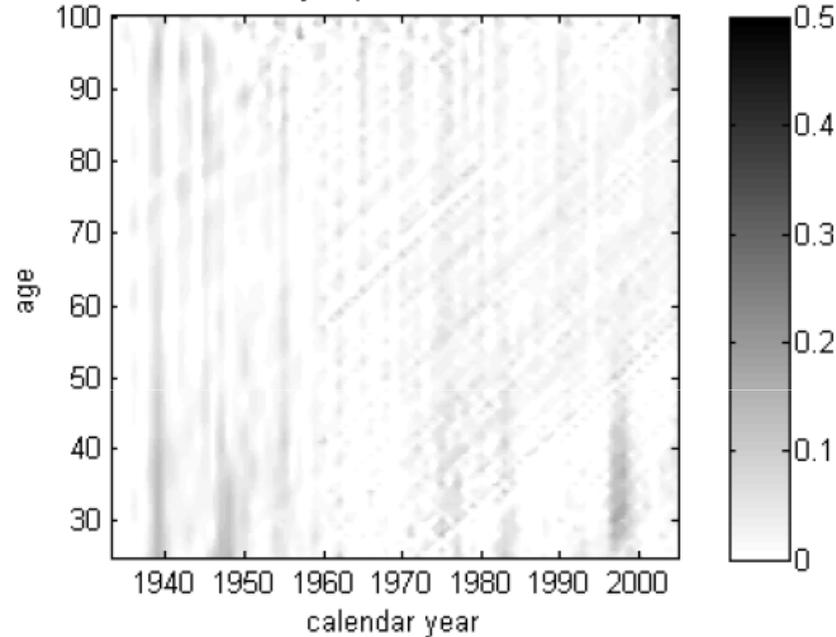
Relative rates of mortality improvement - Females - United States
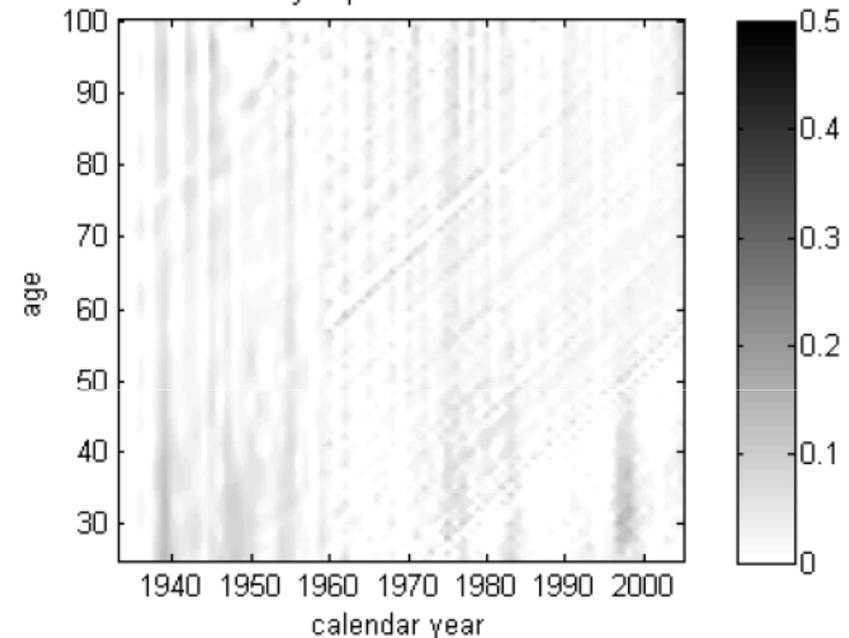
- Dominance of vertical (**"period effects"**) vs. diagonal patterns (**"cohort effects"**) – not clear which prevail for the US

- A cohort experiencing lower mortality will be quite a shock for a pension system upon retiring – thus of particular interest here

**Introduction: Literature Review**

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- Straightforward to investigate mortality data in a two-dimensional way – less so which axes to use (age, period, cohort)

- Surprisingly sparse discussion in an insurance context
  *(Derrick, 1927; Kermack et al., 1934; Ryder, 1965; Hobcraft et al., 1982)*

  - Tendency for diagonal patterns

  - Cohort perspective more consistent for projections

  - E.g. wars and pandemics have different (persistent) impacts on different ages

- *Richards/Kirkby/Currie (2006)* find that an age-cohort model better explains UK mortality over the past 40 years than age-period models

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**Introduction: Literature Review**

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Relative rates of mortality improvement - Males - England & Wales
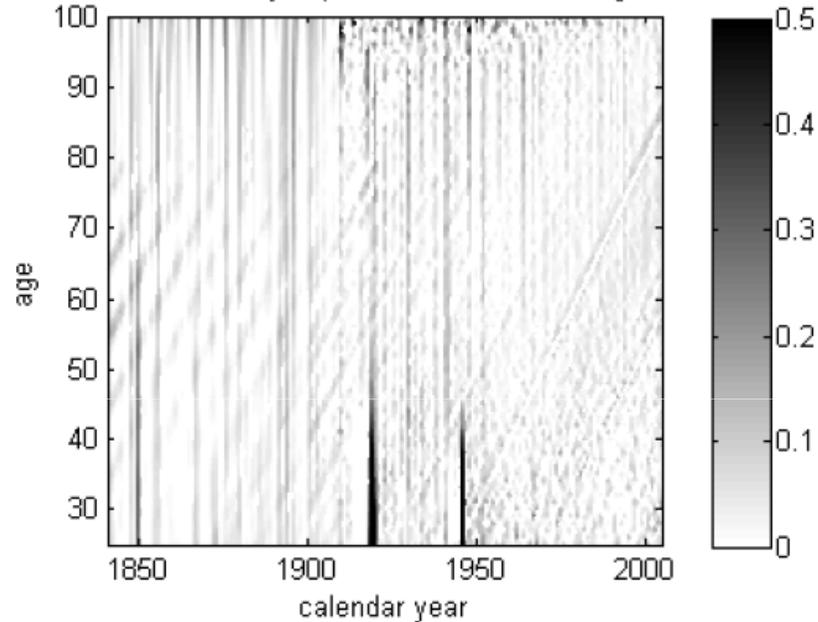
Relative rates of mortality improvement - Females - England & Wales
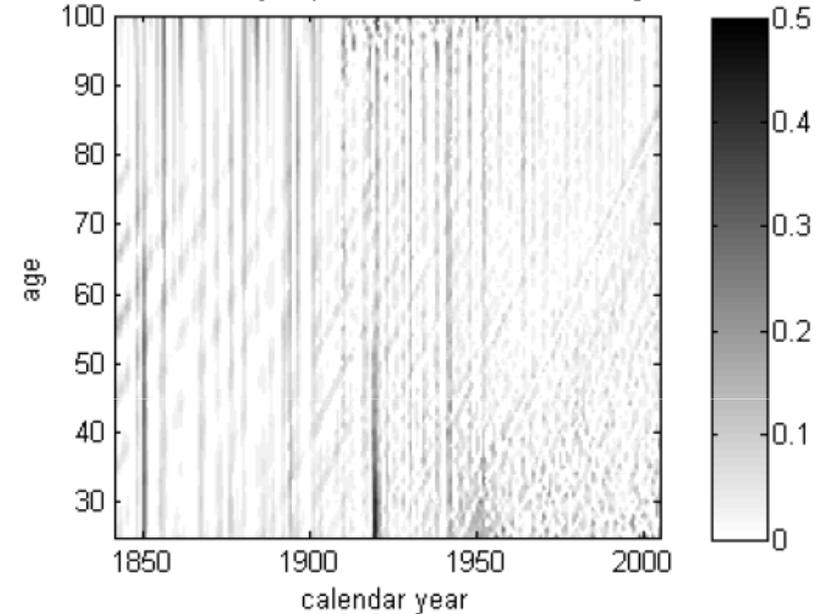
- *Willets (1999)* identifies stronger mortality improvements in the UK for 1925-1945 generations than adjacent generations

- Reasons for cohort effect include participation in WW hostilities, availability of vaccinations, varying nutrition quality, etc.; driving factor: smoking prevalence *(Willets, 2004)*

**Introduction: Literature Review**

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- Previous attempt to identify "select" birth cohorts by *Willets (2004)*

  - **Smoothed** mortality improvement rates tabularized

  - Only "strong" values shown, i.e. if in excess of threshold – determined by comparing different cohorts at **different** ages

- Results fragile to changes in smoothing band (±2 or ±1 years vs. ±4 years), choice of threshold based on comparison of **same** ages

  - Abstain from smoothing procedures

- Suitable to assess impact on public pension systems at one point in time, ill-suited to identify single birth cohorts as "select"

  - Conduct cohort-by-cohort investigation

- Establishing a **formal** criterion almost entirely neglected so far, rather focusing on **graphical** representations

- Several criteria proposed and further analyzed in previous work *(MacMinn et al., 2004)*; no criterion could integrate observations

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- Define relative mortality improvement rate at age *x* for cohort *z* as

$$^{z}i_{x} = -\left( \frac{^{z}m_{x} - {}^{z-1}m_{x}}{^{z-1}m_{x}} \right) = 1 - \frac{^{z}m_{x}}{^{z-1}m_{x}}$$

where $^{z}m_{x}$ central death rate at age *x* for the cohort born in *z*

- Cohorts exhibiting **stronger** mortality improvements than adjacent cohorts – **for numerous ages** – are of special interest

- Generation born in year *z* is a **select cohort** if for *k* [percent] of ages *x* mortality improvement rates exceed those of the adjacent cohorts, i.e.

$$\frac{\#\left\{ x \mid {}^{z}i_{x} > \max\left\{ {}^{z-1}i_{x}, {}^{z+1}i_{x} \right\} \right\}}{\#\{x\}} > k$$

- Mortality data taken from HMD (Human Mortality Database)

- Only largest data sets considered due to required age span (25-100 years); only 11 countries suitable – with varying data coverage

- Threshold parameter $k$=0.50 requires significant strength, but number of select cohorts varies greatly – also in their strength

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**The Fortunate Generations – Analysis of Historical Data**

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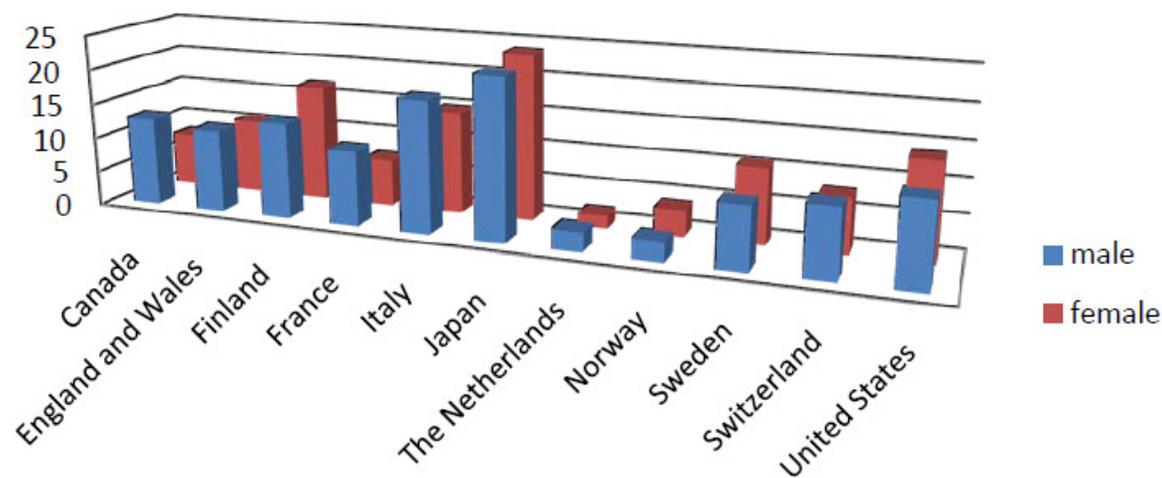
| Canada | | | United States | | |
|:---:|:---:|:---:|:---:|:---:|:---:|
| **M** | **F** | **B** | **M** | **F** | **B** |
| 1831 | 1829 | 1835 | 1871 | 1899 | 1887 |
| 1835 | 1869 | 1869 | 1902 | 1902 | 1899 |
| 1837 | 1902 | 1879 | 1909 | 1909 | 1902 |
| 1849 | 1912 | 1881 | 1919 | 1912 | 1909 |
| 1869 | 1934 | 1889 | 1921 | 1919 | 1912 |
| 1887 | 1944 | 1891 | 1929 | 1921 | 1919 |
| 1891 | 1954 | 1899 | 1934 | 1929 | 1921 |
| 1902 | 1979 | 1902 | 1942 | 1931 | 1929 |
| 1919 | | 1909 | 1944 | 1934 | 1931 |
| 1929 | | 1919 | 1946 | 1944 | 1934 |
| 1948 | | 1934 | 1948 | 1946 | 1942 |
| 1979 | | 1948 | 1987 | 1948 | 1944 |
| 1981 | | 1977 | | 1970 | 1946 |
| | | 1979 | | 1974 | 1948 |
| | | 1981 | | | |

*Shaded select cohorts determined based on only 11-20 years of age – i.e. tentative select cohort.*

- Select birth cohorts do not seem to be correlated across countries nor follow a cyclical pattern.

## Relative Rates of Mortality Improvement for U.S. Males
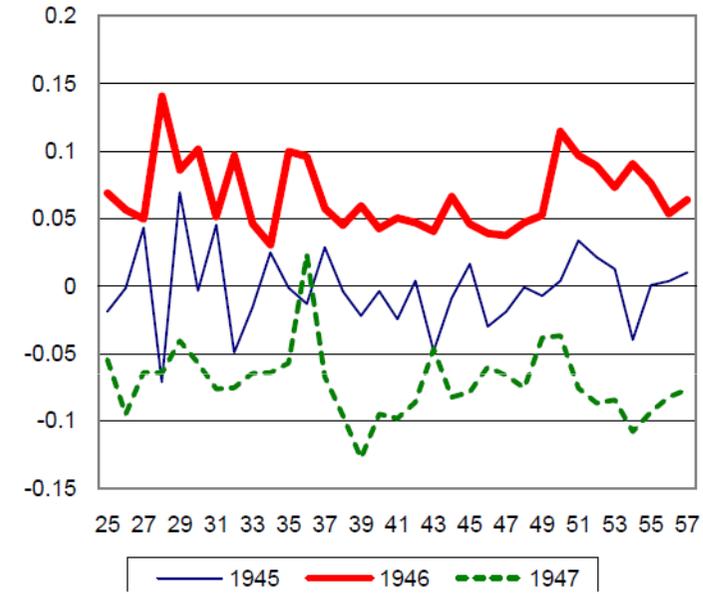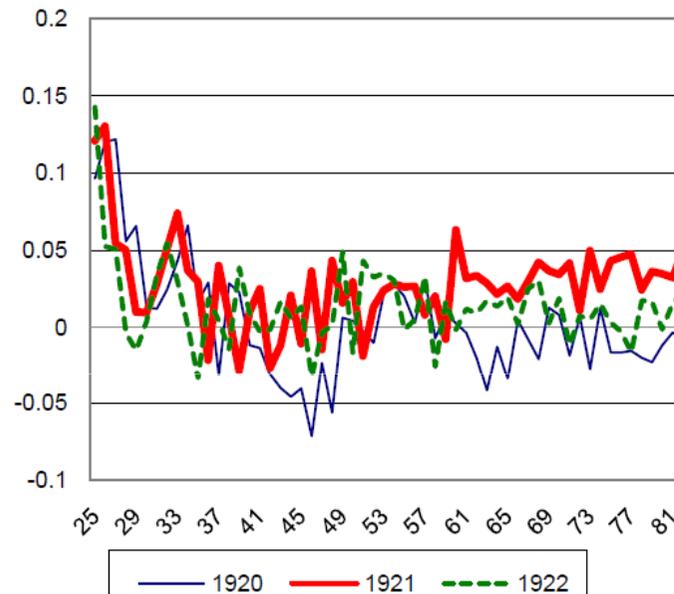


- **Left**: greatest improvements at younger ages, 1921 cohort distinguished by further improvements at higher ages (60+)

- **Right**: 1946 cohort: on average 7% excess improvement ("super" select cohort)

- Predicting extraordinary long lives of special interest for pension providers – preferably long before entering retirement

**Percentage Change in Life Annuity Value for U.S. Males**
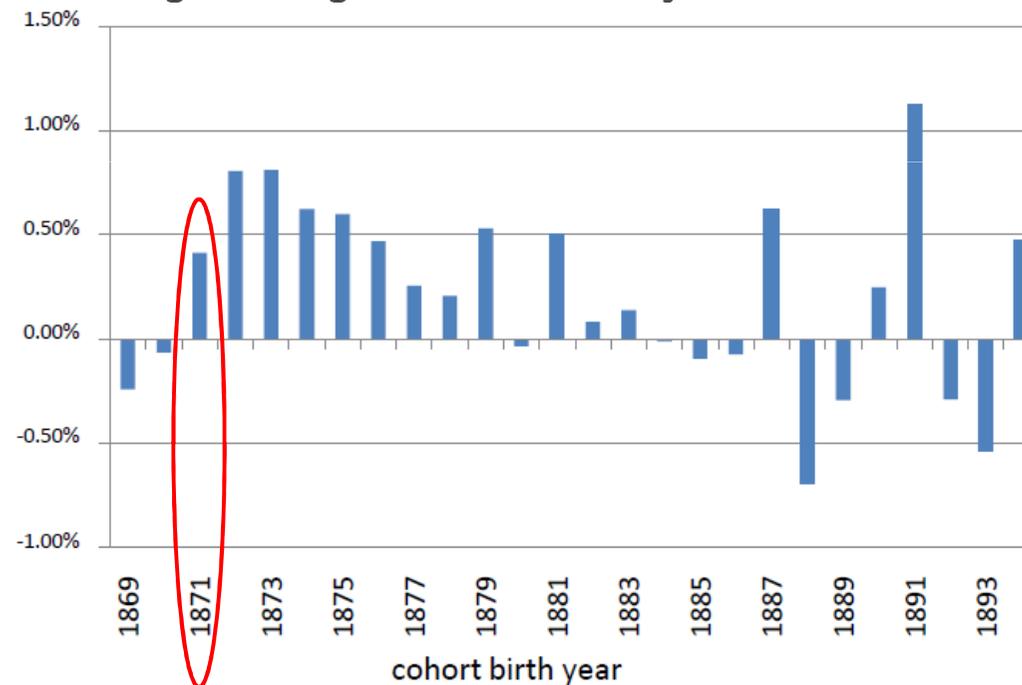
- Dominance of **period/cohort effects varies** across countries

- "Select" birth cohorts **exist** in several countries; **not so common**

- **No** evidence of **correlation** across countries; no **cyclical pattern**

- While measure of **mortality improvement** consistent in the literature, further discussion of **formal select cohort criteria** necessary

- Analysis and **early diagnosis** of (super) select cohorts prudent and possibly value-enhancing for providers as **risk management** option
  - possibly combined with projection of mortality

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