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Impact of the COVID-19 pandemic on cohort life expectancy

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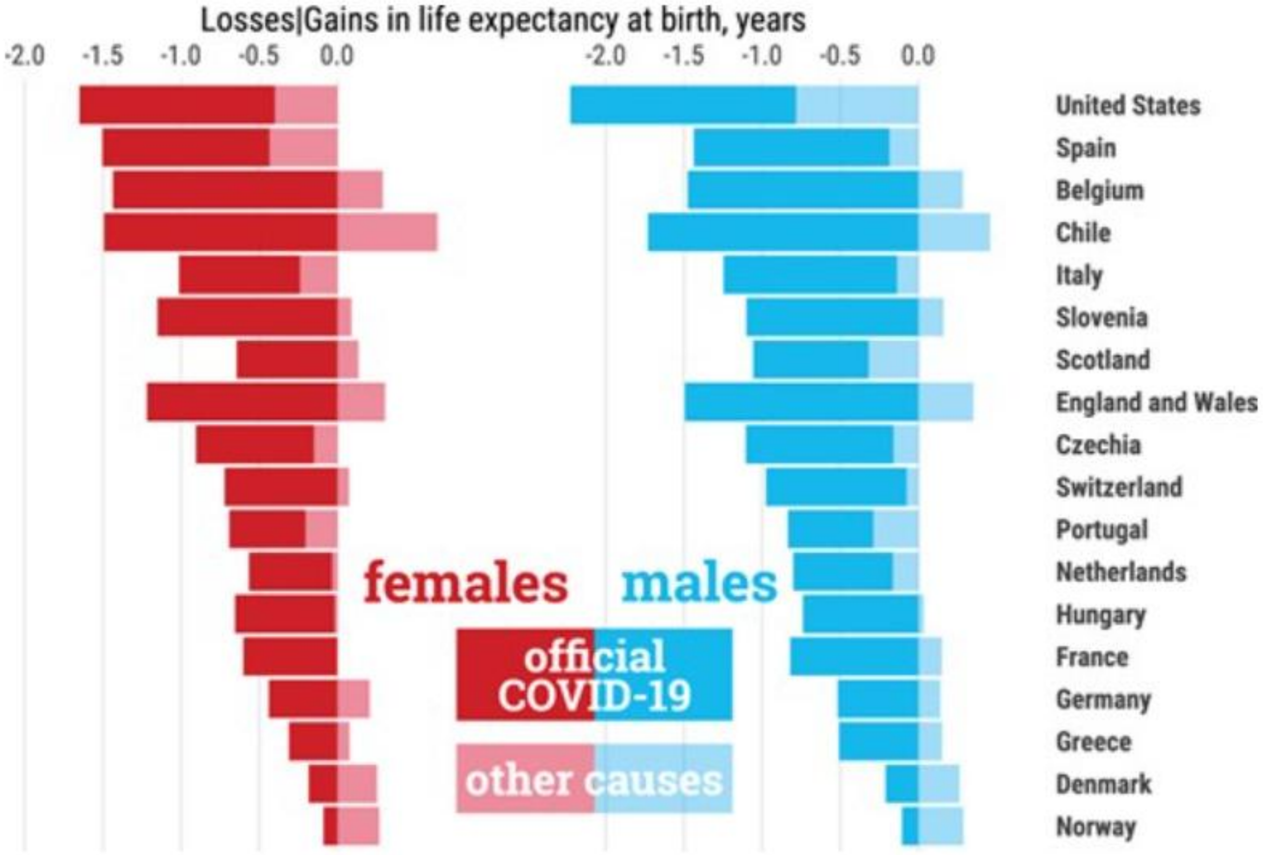
Background - Mortality due to the COVID-19 pandemic

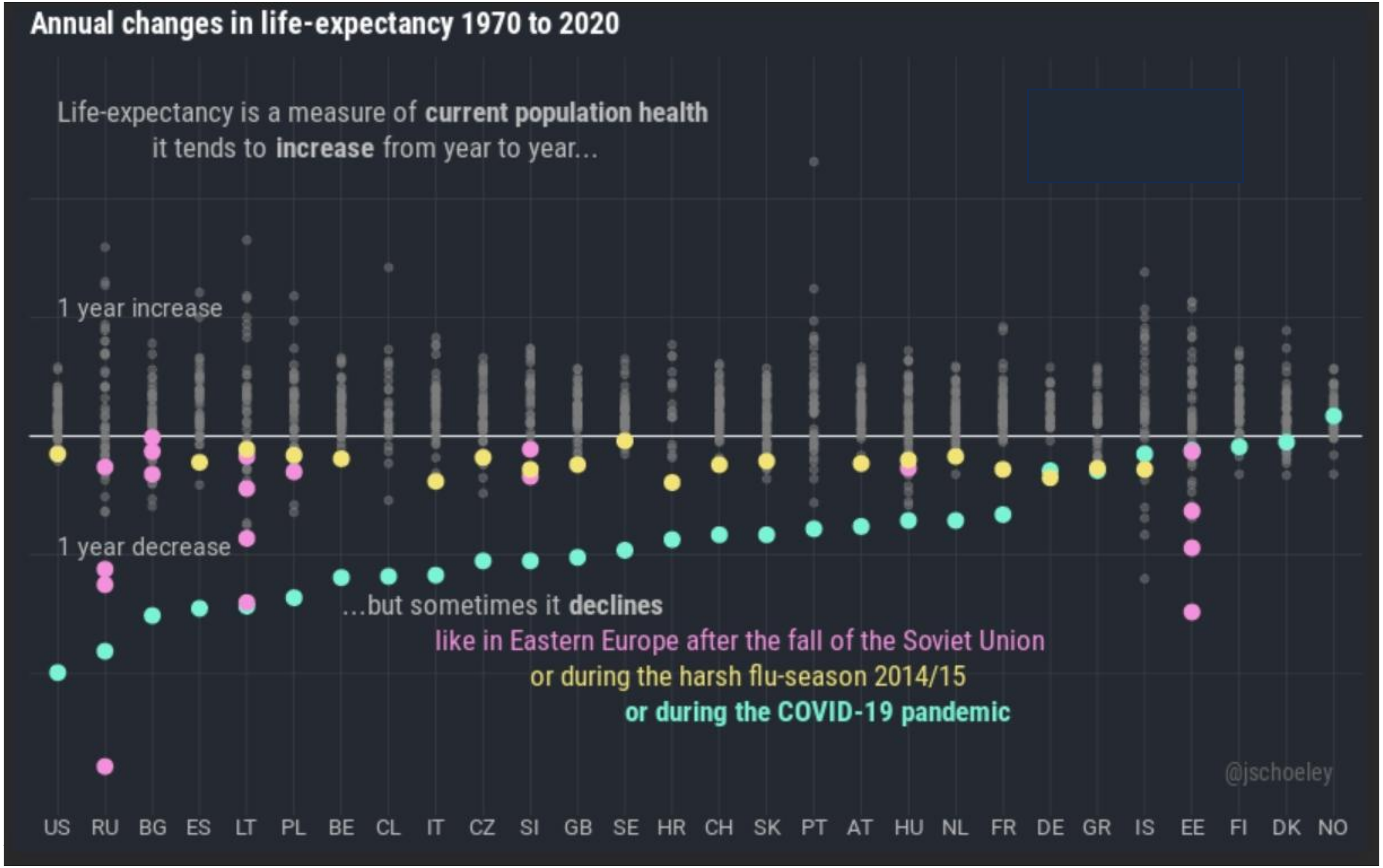
- **What we know**: short-term impact of the COVID-19 pandemic on mortality.
  - Remarkable **increase in mortality** between 2020 and 2023 with geographic and demographic variations due to the COVID-19 pandemic.
  - The pandemic wiped out nearly a decade of progress in improving **period life expectancy** within just two years. Between 2019 and 2021, global life expectancy dropped by 1.8 years to 71.4 years (back to the level of 2012) *(WHO Statistics, 2024).*
  - Similarly, global **healthy life expectancy** dropped by 1.5 years to 61.9 years in 2021 (back to the level of 2012) *(WHO Statistics, 2024).*

Background – Period life expectancy changes between 2019 and 2020



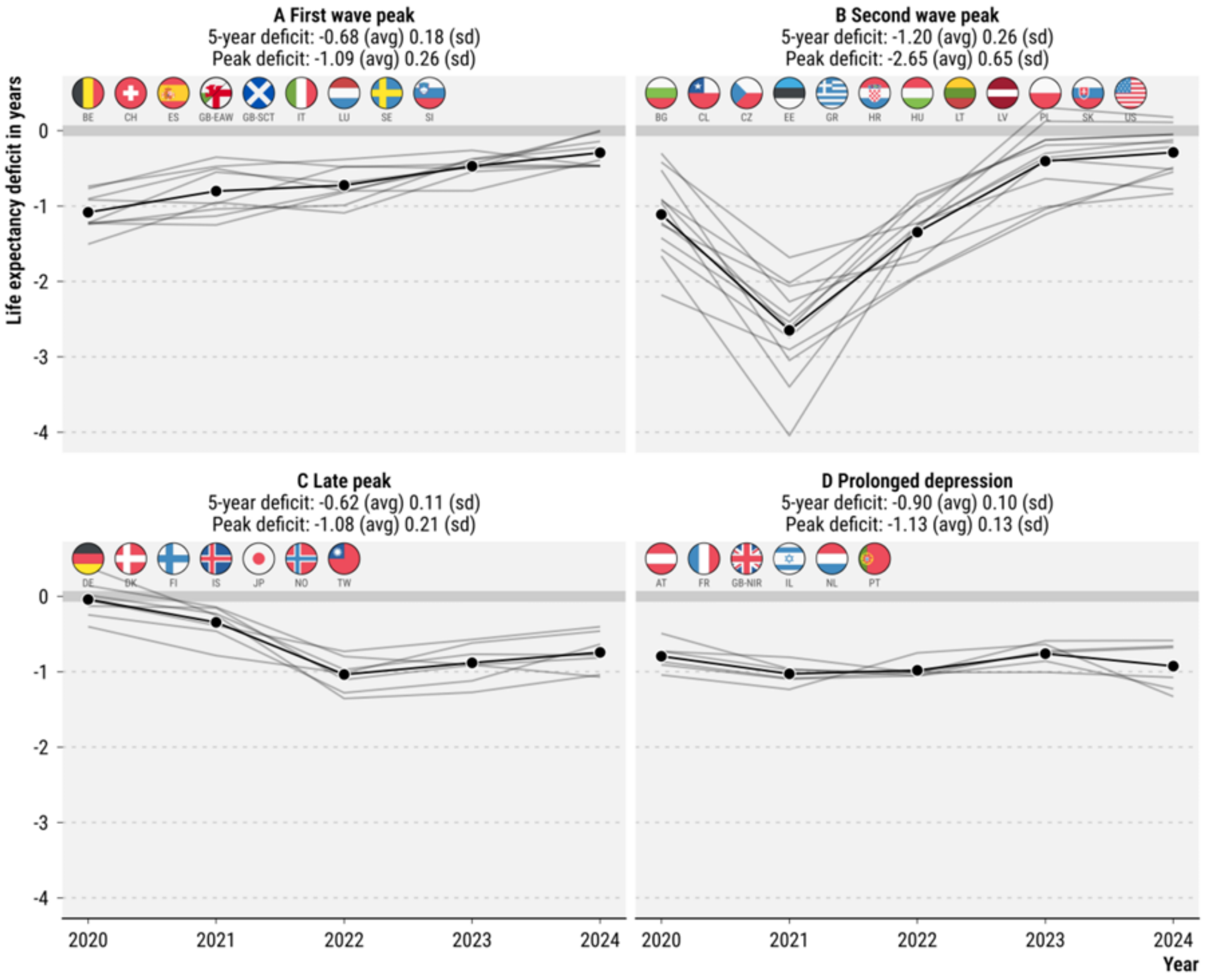
Period life expectancy exibited a drop in most of the Western countries - e.g., 2.2 years for males in one year in the US. Reductions were mostly attributable to increased mortality above age 60 years and to official COVID-19 deaths *(Aburto et al., 2021).*

Background – Period life expectancy changes between 1970 and 2020



Source: Aburto et al., 2021

Background – Period life expectancy changes between 2020 and 2024



Five years after the pandemic's onset, **recovery remains incomplete** in most high-income countries.

Notably, those with the largest early life expectancy losses were more likely to return to pre-pandemic trends by 2024. *(Dowd et al., 2026)*.

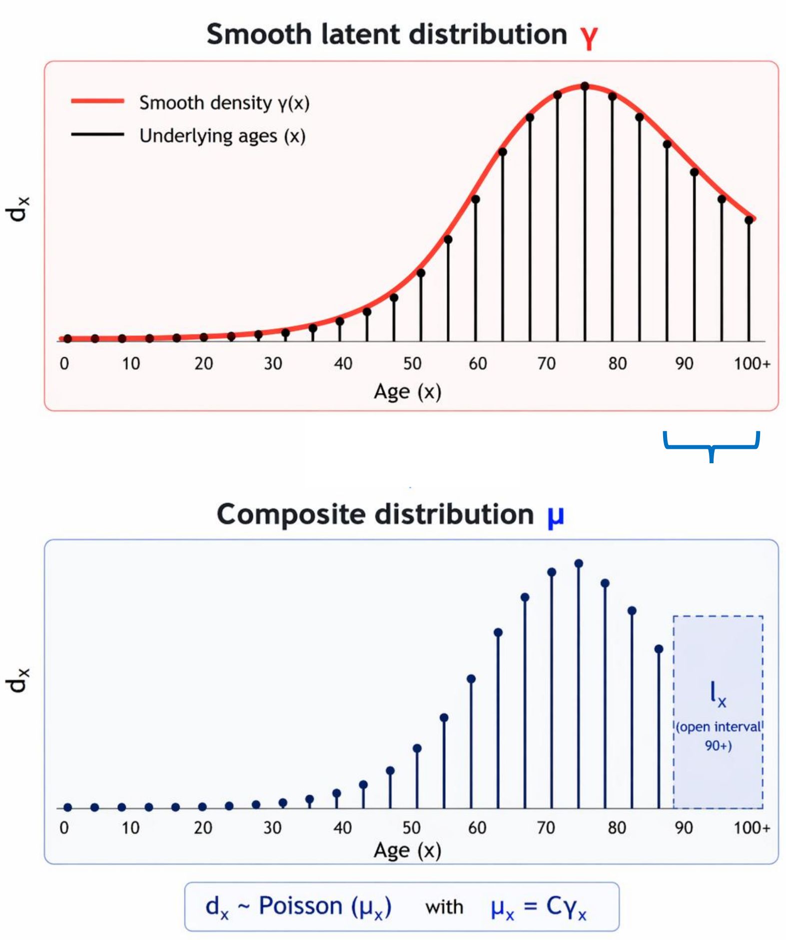
Aim – Long-term consequences due to the COVID-19 pandemic

- **What we do not know**: long-term consequences of the COVID-19 pandemic on mortality.
  - What will the actual **life expectancy of cohorts** not yet extinct be?
- Early attempt to answer this question presented by Miranda et al. at PAA 2025
  - Two methods used: 1: The World Population Prospects (WPP) 2024 forecats 2. Smooth Lee-Carter
  - In general, no significant changes found in cohort life expectancy.
- General context on cohort life expectancy *(Andrade et al., 2025)*:
  - The pace of life expectancy gains for cohorts born between 1939 and 2000 is slowing dramatically with projections suggesting that none of these cohorts will reach a life expectancy of 100 years.
  - Cohorts born before 1939 experienced decades of rapid mortality decline, despite living through major mortality crises such as the Spanish influenza pandemic and the World Wars.
  - Reason of slow down: stalled progress in reducing mortality at very young ages.
- **What we want to do**: forecast the mortality trajectories for incomplete cohorts under two scenario:
  - 1. Accounting for the Covid-19 pandemic;
  - 2. Not accounting for the Covid-19 pandemic (counterfactual)
  - Target cohorts: 1920-1960.

Approach – A Penalized Composite Link Model (PCLM) to Forecast Not Extinct Cohorts (I)

The number of survivors from a given birth cohort at the age of truncation can be considered as a coarsely grouped death count not yet observed. The remaining deaths can be ungrouped (forecast) by age using the PCLM:

- Cohort deaths d_x assumed to be Poisson distributed with $E(d_x) = \mu$.
- Vector μ results from grouping the observed counts such that $\mu = C\gamma$.
- Vector γ to be estimated is assumed to be smooth.
- Estimation by penalized maximum likelihood *(Eilers, 2007).*

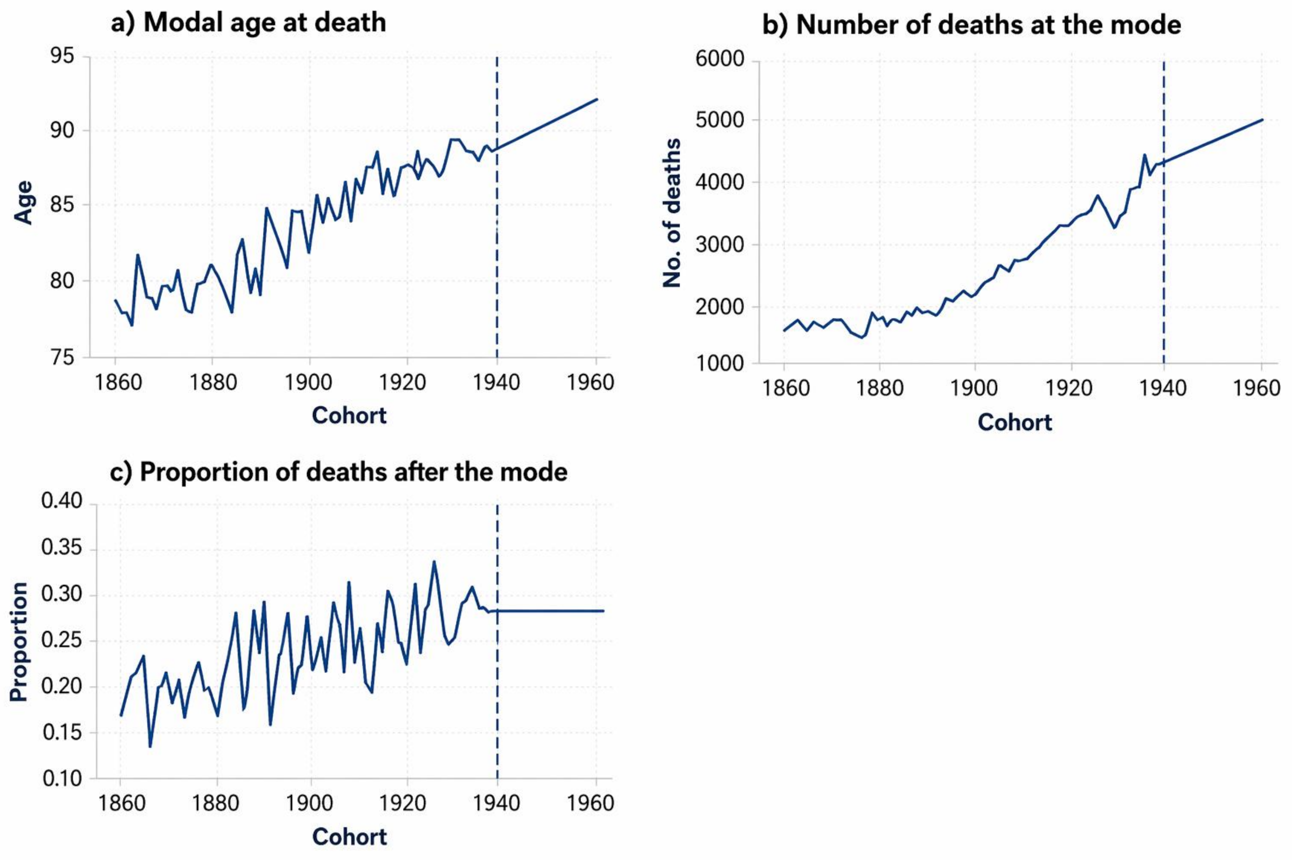


Approach – A Penalized Composite Link Model (PCLM) to Forecast Not Extinct Cohorts (II)

Incorporation in the model of demographic information to estimate younger cohorts (ie,1940-1960):

- Forecast of the (a) modal age at death and (b) the number of deaths at the mode with a random walk with drift model (RWD);

- Forecast of the (c) proportion of deaths after the mode with an autoregressive moving average (ARMA) model.



Data and Application – Human Mortality Database

- **Cohort death rates** life tables from the Human Mortality Database (HMD).
- For illustration purposes we show **Swedish males 1920 − 1960**.
- **Forecast** cohort age-at-death distributions with the penalized composite link mode PCLM *(Rizzi et al., 2021).*

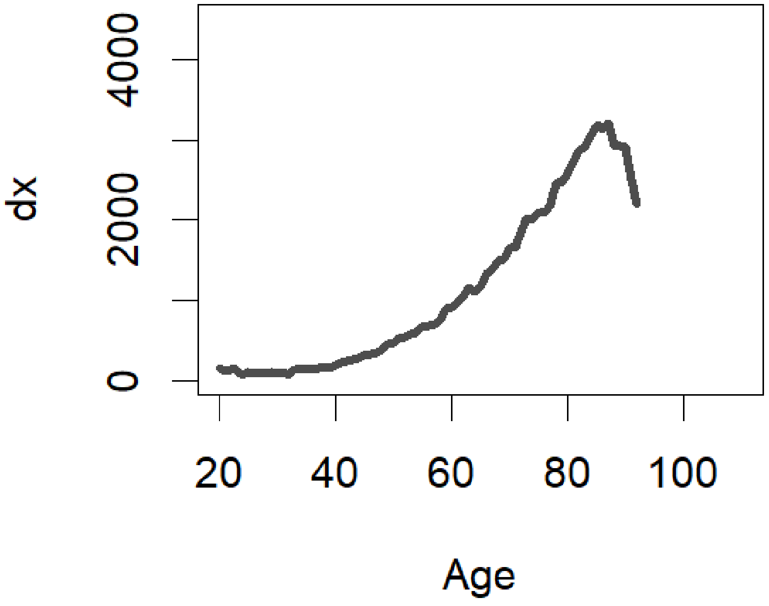
Method applied to data **pre- and post- COVID-19** pandemic:

- Forecast cohort *dx*, *mx* and e_0 using data up to and including 2019 (counterfactual)
- Forecast cohort *dx*, *mx* and e_0 using data up to 2024.

→ Changes in cohort life expectancy due to the COVID-19 as the difference between counterfactual e_0 and e_0 using data up to 2024.

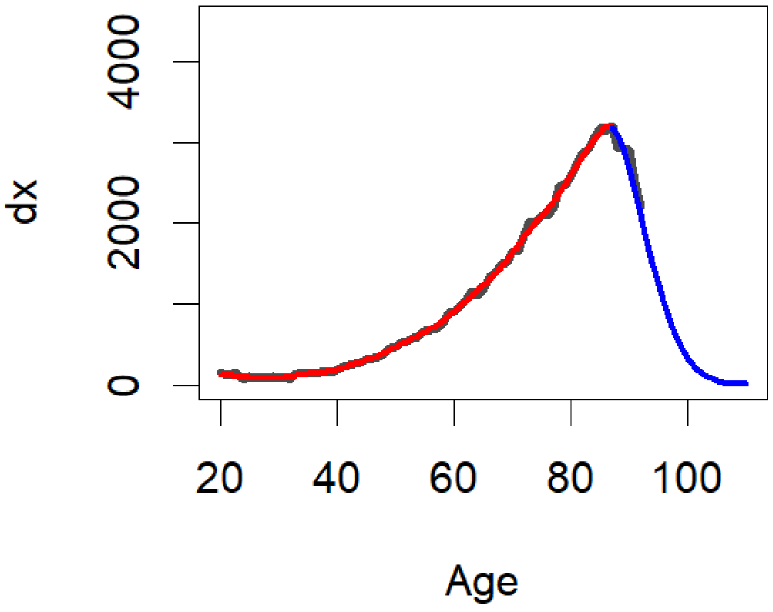
Results – Age at death forecasts: Birth cohort 1930 example

A. Cohort 1930
Observed



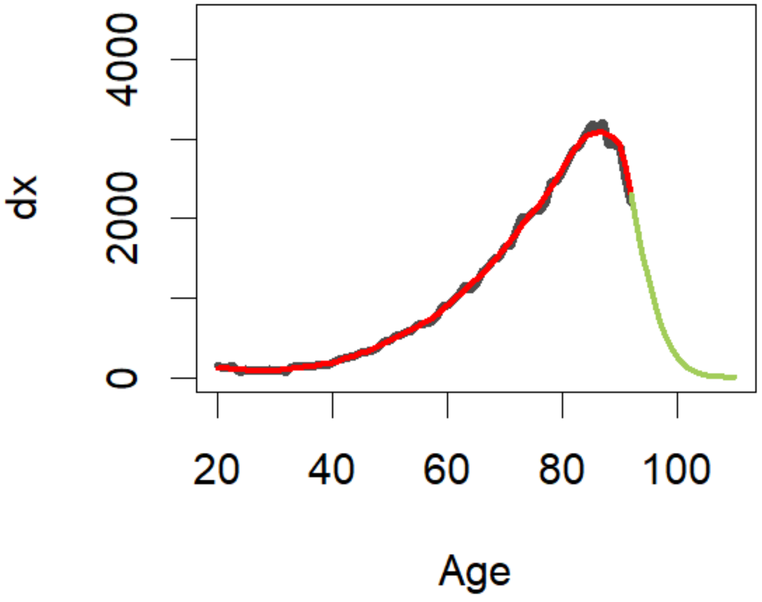
Raw data: gray line

B. Cohort 1930
Counterfactual



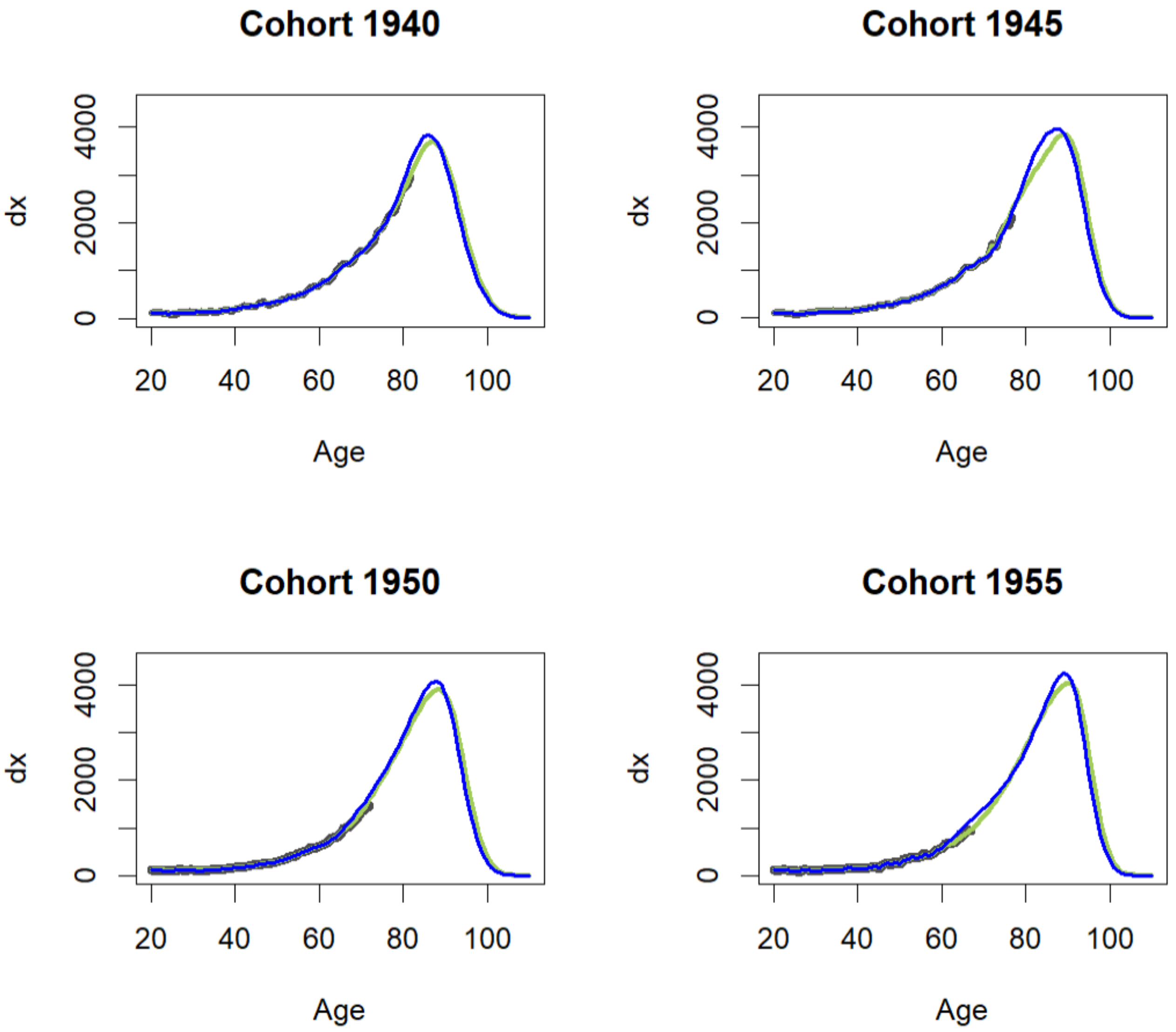
Training set data: red line
Counterfactual forecast: blue line

C. Cohort 1930
Actual post-Covid



Training set data: red line
Actual post-Covid forecast: green line

Results – Age at death counterfactual vs actual scenarios for selected birth cohorts



Raw data: gray line
Counterfactual scenario
Actual post-Covid scenario

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Results – Log mortality counterfactual vs actual scenario for selected birth cohorts

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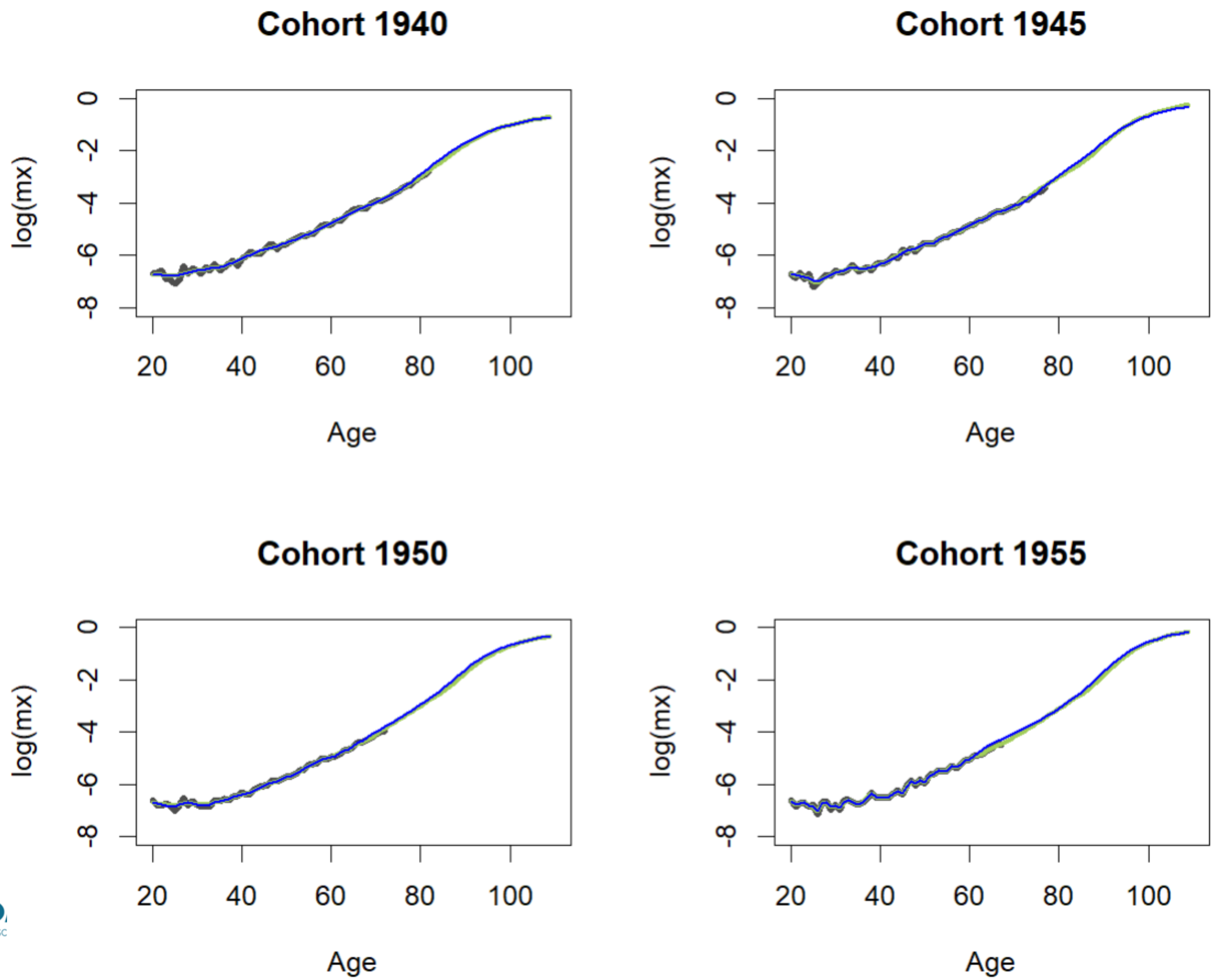
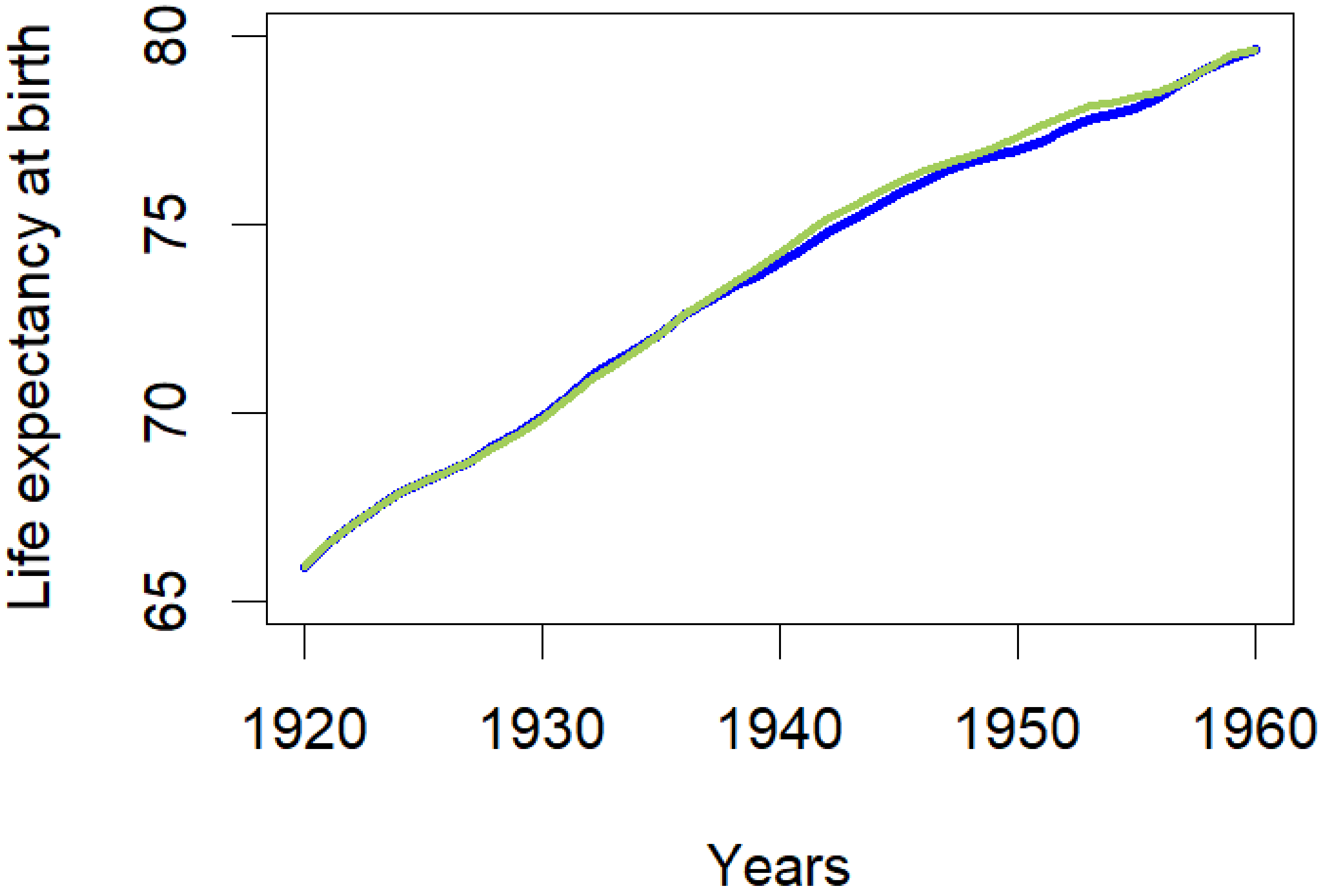


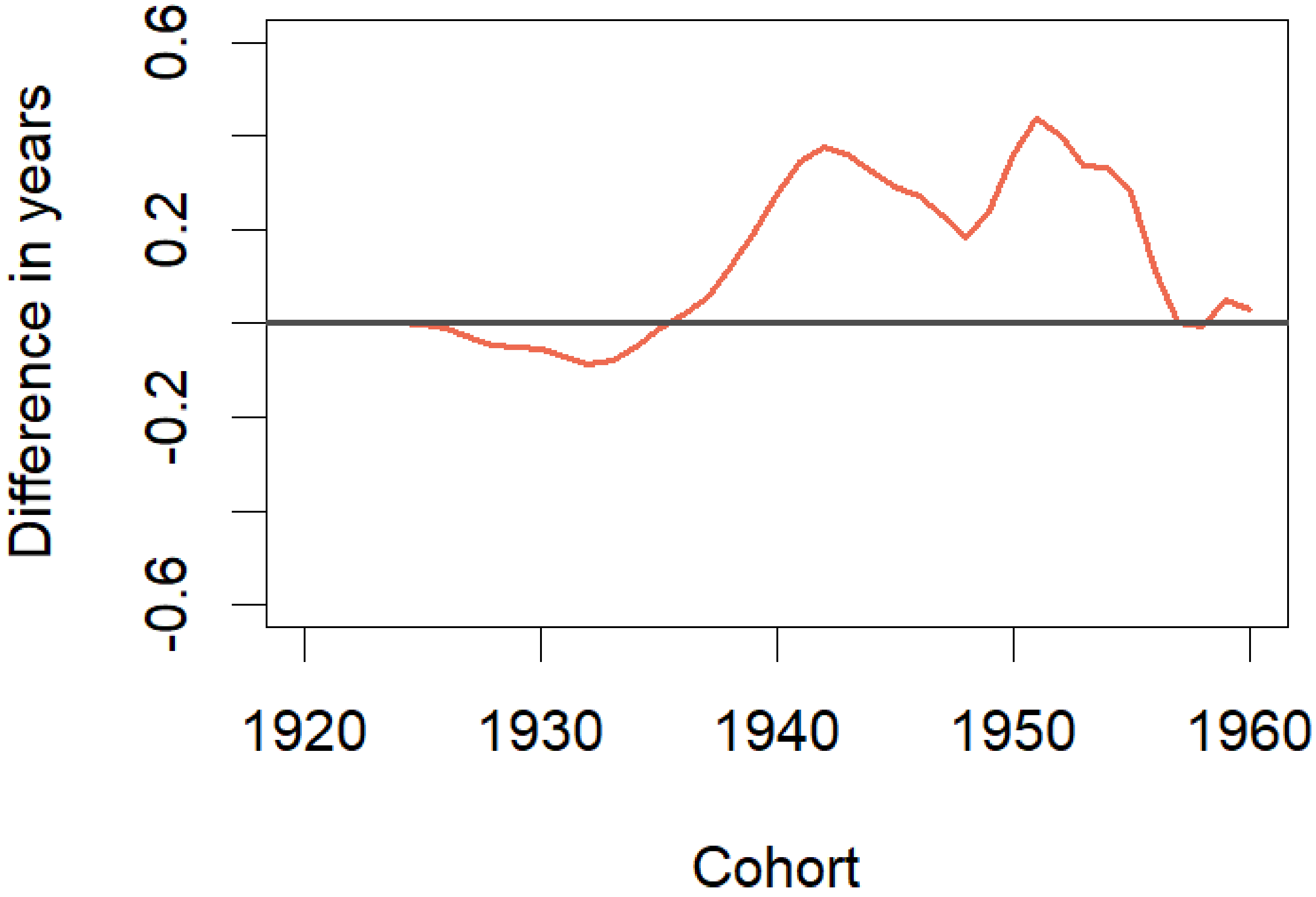
Raw data: gray line
Counterfactual scenario
Actual post-Covid scenario

Results – Cohort life expectancy forecast for Swedish males: Counterfactual forecast using pre-COVID-19 data vs Actual forecast using post-COVID-19 data



Counterfactual scenario
Actual post-Covid scenario

Results – Cohort life expectancy at birth differences for Swedish males: Actual forecast - Counterfactual forecast



Conclusion

- Investigating the long-term impact of a mortality shock, such as the COVID-19 pandemic, is essential.
- We propose a data driven method to forecast cohort mortality in the context of the COVID-19 pandemic.
- Across high-income countries (Denmark [late peak] and Italy, Spain and Sweden [first wave peak]), **our method does not detect any evidence for a lasting effect of COVID-19** on cohorts that went through the pandemic.
- However, no evidence for younger cohorts (after 1960) and in utero exposure.
- Our results are in line with existing literature
  - No lasting impact of COVID-19 on cohorts *(Miranda et al., 2025).*
  - No long-term implications of older adults affected by previous viruses and pandemics (Oeppen and Vaupel, 2002).

Next steps

- Extend analysis to US (second wave peak) and France (prolonged depression).
- Extend analysis to Danish National Registry data with socio-economic stratification.
- Possibility to forecast in two dimensions: all cohorts 1910-1960 to be completed simulatenoulsy rather than independently (2D PCLM).

Thank you.

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