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Excess Mortality Across Different Nations: Strengths and Limitations of Existing Measures

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Focus on:

The concept of 'excess mortality':

- observed deaths during catastrophic events, *e.g. COVID-19*, compared to the expected number of deaths at 'normal' times

based on different measures

Investigating demographic and cross-country patterns

- from January 2020 to 2024

What we have done:

- Focusing on all-cause mortality in 16 countries to

  . . . avoid discrepancies due to the reporting of COVID-19 deaths

  . . . examine the direct and indirect impacts of the pandemic

- Short-Term Fluctuations (STMF) data series

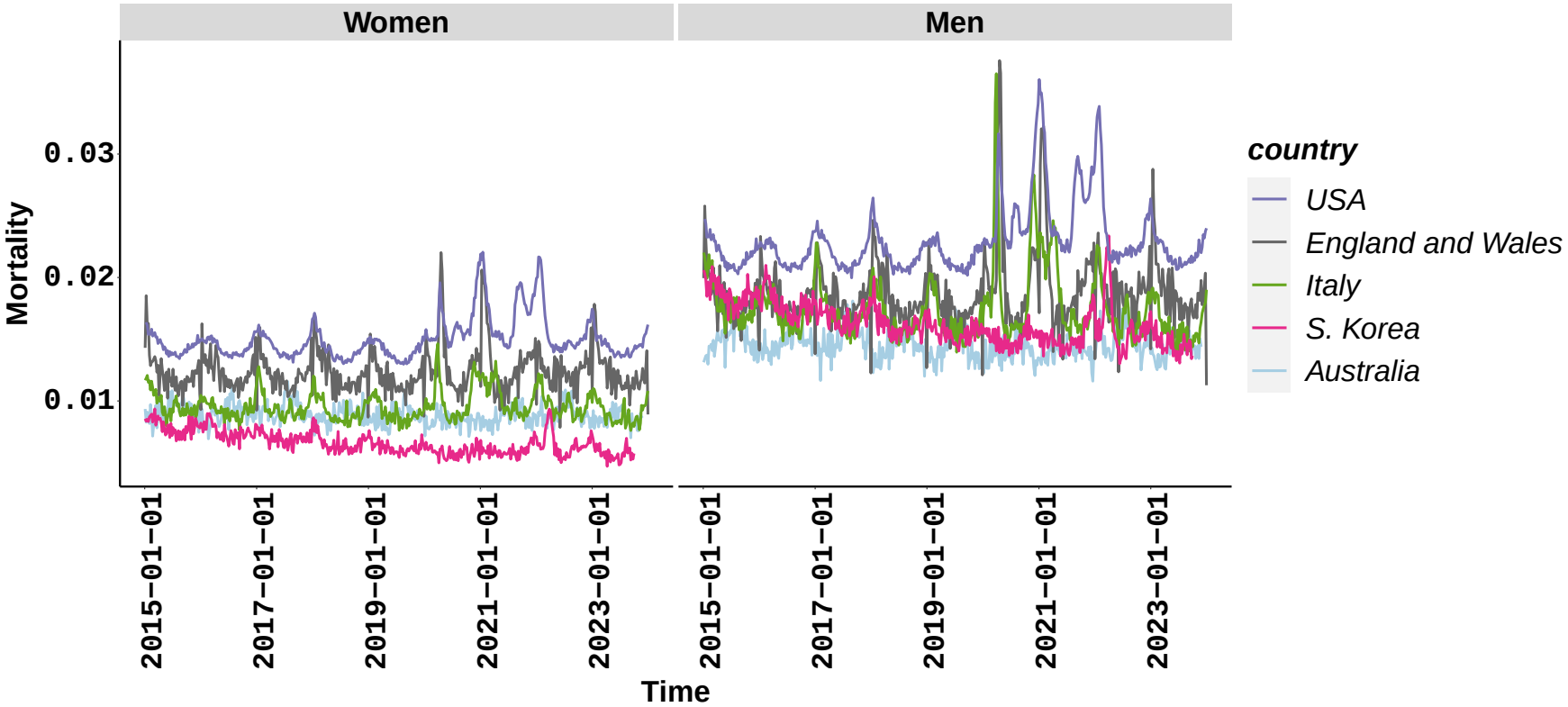
- Investigating excess mortality based on:
  - Proportional excess mortality (P-scores)
  - Relative age-standardised excess mortality (ASMR)
  - A methodological approach

STMF dataset

All-cause deaths data
STMF, Human Mortality Database (HMD)

- Age groups: 0–14, 15–64, 65–74, 75–84, 85+
- Gender
- Years: 2015–2023 (*weekly*)
- Country: Australia, Belgium, Canada, England and Wales, France, Germany, Hungary, Israel, Italy, Netherlands, Poland, South Korea, Spain, Sweden, Switzerland, and the USA

All-cause mortality: women & men aged 65–74



- Usual seasonal patterns: winter v. summer deaths

  . . . with a reversed cycle in Australia v. other countries

  . . . mortality peaks during winter time

- Sharp increases in (especially winter) mortality from 2020

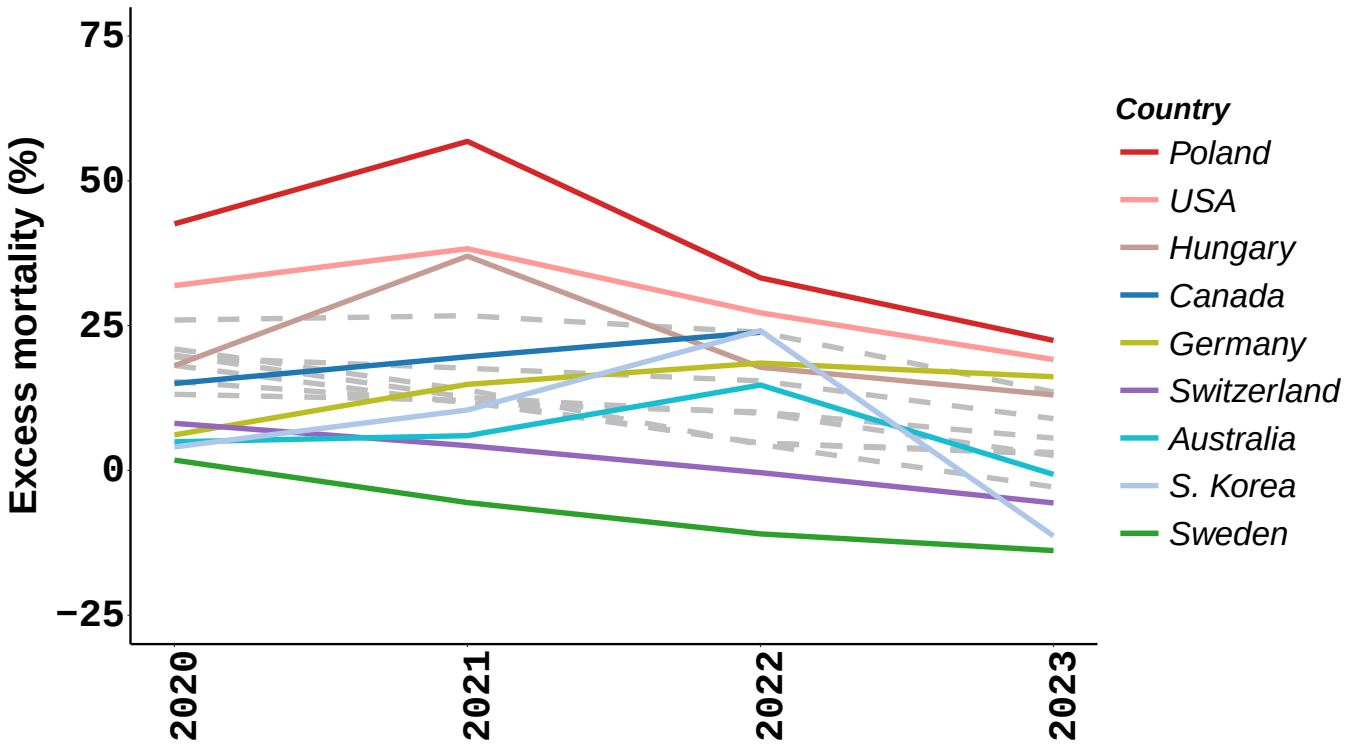
- At the time of this research: Deaths in 2023 were complete, apart from Australia (until Week 47), Canada (Week 30), South Korea (Week 39)

Excess mortality: P-scores

$$P_{a,c,g,y} = \frac{D_{a,c,g,y} - \overline{D}_{a,c,g,\text{reference year}}}{\overline{D}_{a,c,g,\text{reference year}}}$$

- $P_{a,c,g,y}$: P-scores, excess deaths (%) at *age-at-death a* for *gender g* in *country c* at a given *year y*
- $D_{a,c,g,y}$: all-cause (observed) number of deaths
- $\overline{D}_{a,c,g,\text{reference year}}$: average number of deaths during the reference year(s), e.g. 2015–2019

P-scores: men aged 65–74, relative to 2015–2019

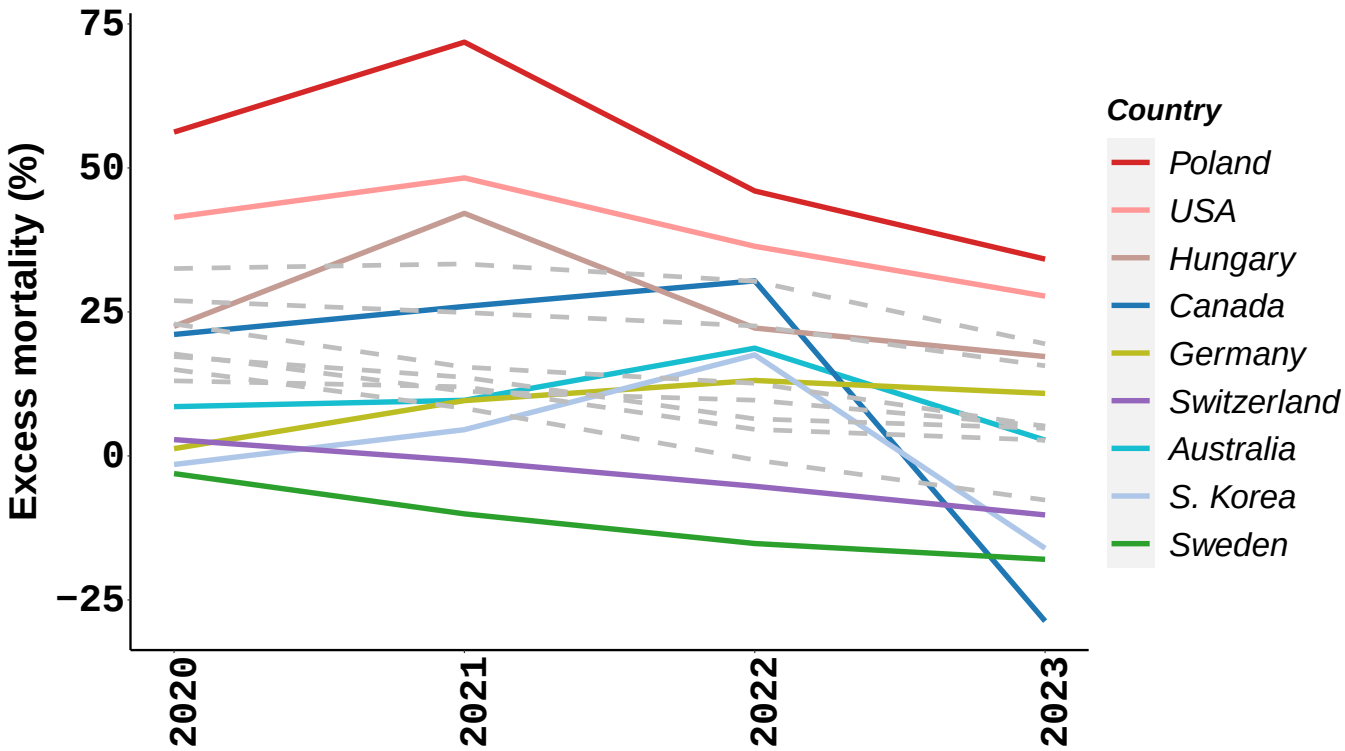


- The P-scores compared to the related average number of deaths bw 2015–2019
- Throughout 2020–2023

  . . . the USA and Poland are the most impacted

  . . . Sweden is the least impacted

P-scores: men aged 65–74, relative to 2019

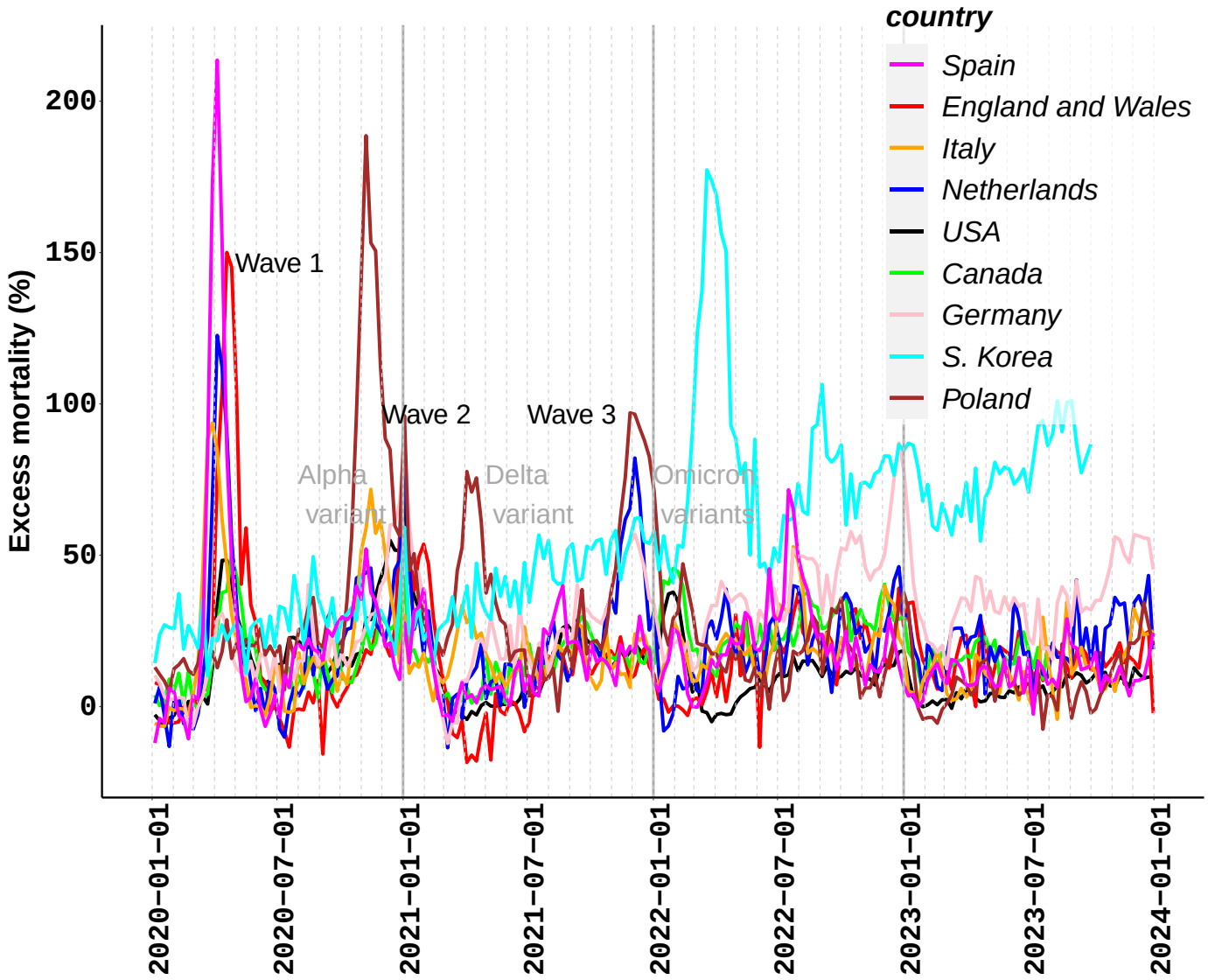


- The P-scores compared to the related number of deaths in 2019
- Mostly comparable results across different reference years

  . . . bigger changes

  . . . similar trends

P-scores: weekly, men aged 85+, relative to 2015–2019



– Wave 1: highly synchronous across countries, aligned with the pandemic phases in England

Excess mortality: relative ASMR

Relative change in ASMR:

$$\text{rASMR}_{c,g,w,y} = \frac{\text{ASMR}_{c,g,w,y} - \overline{\text{ASMR}}_{c,g,w,\text{reference year}}}{\overline{\text{ASMR}}_{c,g,w,\text{reference year}}}$$

$\overline{\text{ASMR}}_{c,g,w,\text{reference year}}$: average ASMR in week w during 2015–2019

$$\text{ASMR}_{c,g,w,y} = \frac{\sum_a \theta_{a,c,g,w,y} E_a^{\text{std}}}{\sum_a E_a^{\text{std}}}$$

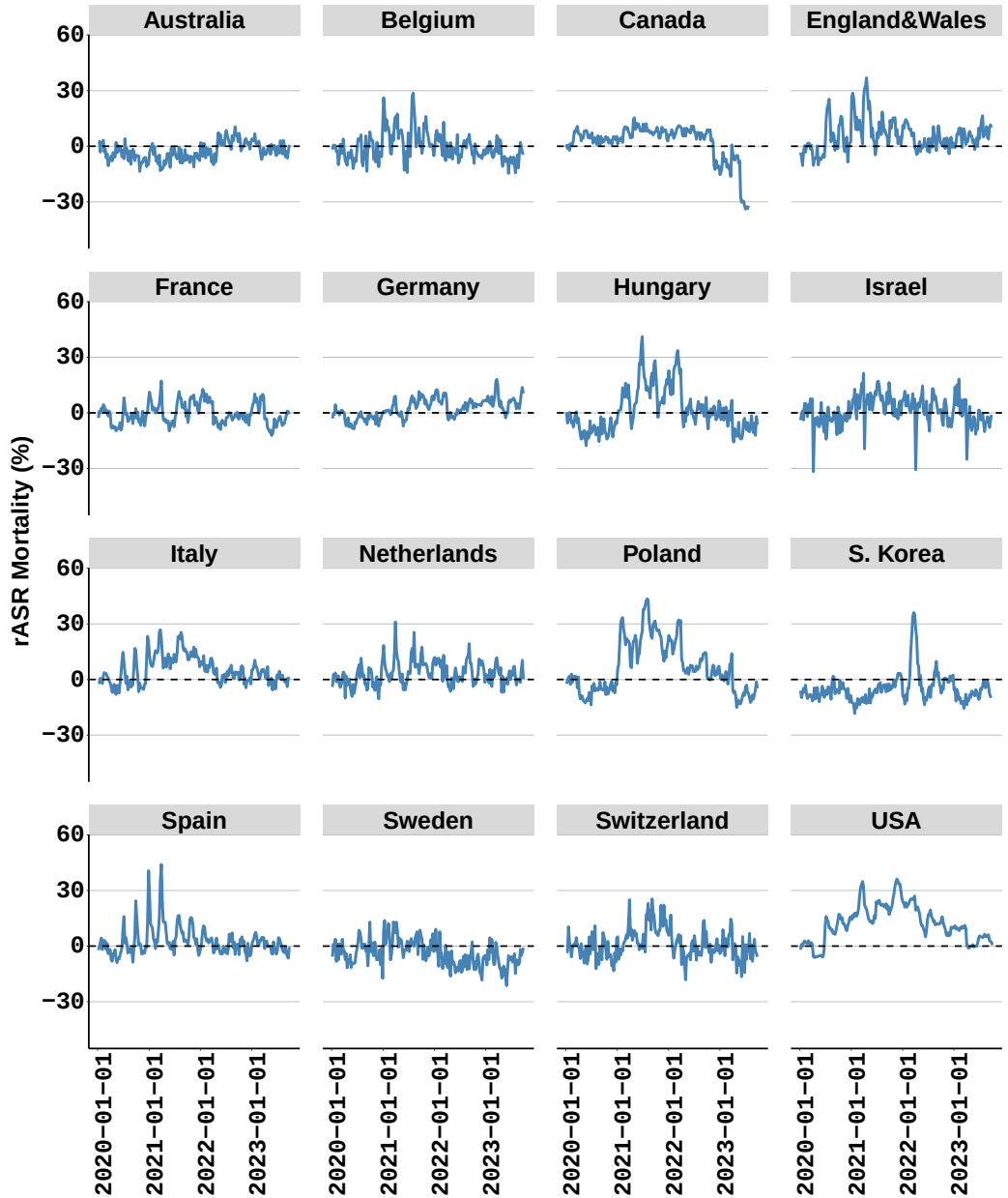
. . . E_a^{std} : standard population at age-at-death a

. . . $\theta_{a,c,g,w,y}$: mortality rates

. . . $E_{a,c,g,w,y}$: weekly population estimates

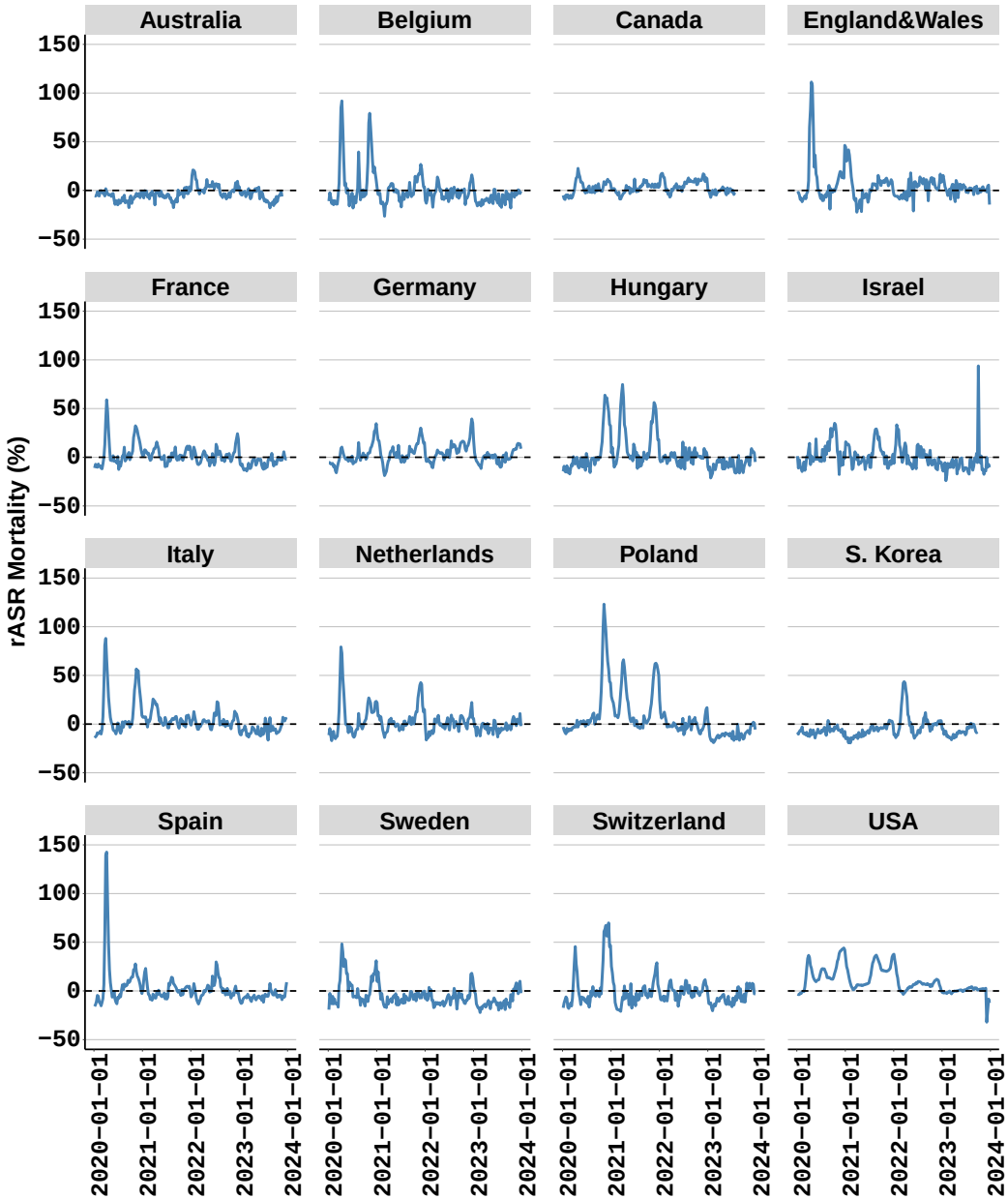
an interpolation method following the ONS (2022)

Relative ASMR: men, WHO standard population



- WHO Standard Population (2000–2025)
- Continuing high excess mortality in the USA
- A sharp peak in S. Korea in 2022
  - the Omicron variant?
  - age disparity?
- Negative excess trend in Canada since 2022
  - real or artefact?
- A shift in excess mortality in Australia since 2022
  - the Omicron variant?
  - re-opening of international borders?

Relative ASMR: men, ESP standard population



- European Standard Population 2013

. . . notably older than the WHO standard

- The excess in the USA is relatively much lower, with potential mortality gain
- No negative excess trend in Canada
- How appropriate is the standard we refer to for international comparisons?

Excess mortality: a methodological approach

- A simple linear regression model between 2015–2019
- Extrapolation of death counts to the post-pandemic years
- Reconciliation approach for extrapolated values

  Observed deaths in a group $= \sum$ Predictions in the same group
  following the study of Li et al. (2019)

A linear regression model

$$D_t^{\text{std}} = \alpha + \beta \times t + \epsilon_t$$

- D_t^{std} : age-, country- and gender-specific standardised deaths at time t

$$D_t^{\text{std}} = \frac{D_t - \mu_{t(w)}}{\text{sd}_{t(w)}}$$

  ... $\mu_{t(w)}$: average death over $w-1$, w, and $w+1$

  ... $\text{sd}_{t(w)}$: standard deviation over the same weeks

- ϵ_t : error term modelled through ARIMA(p, d, q)

Why does a simple model make sense?

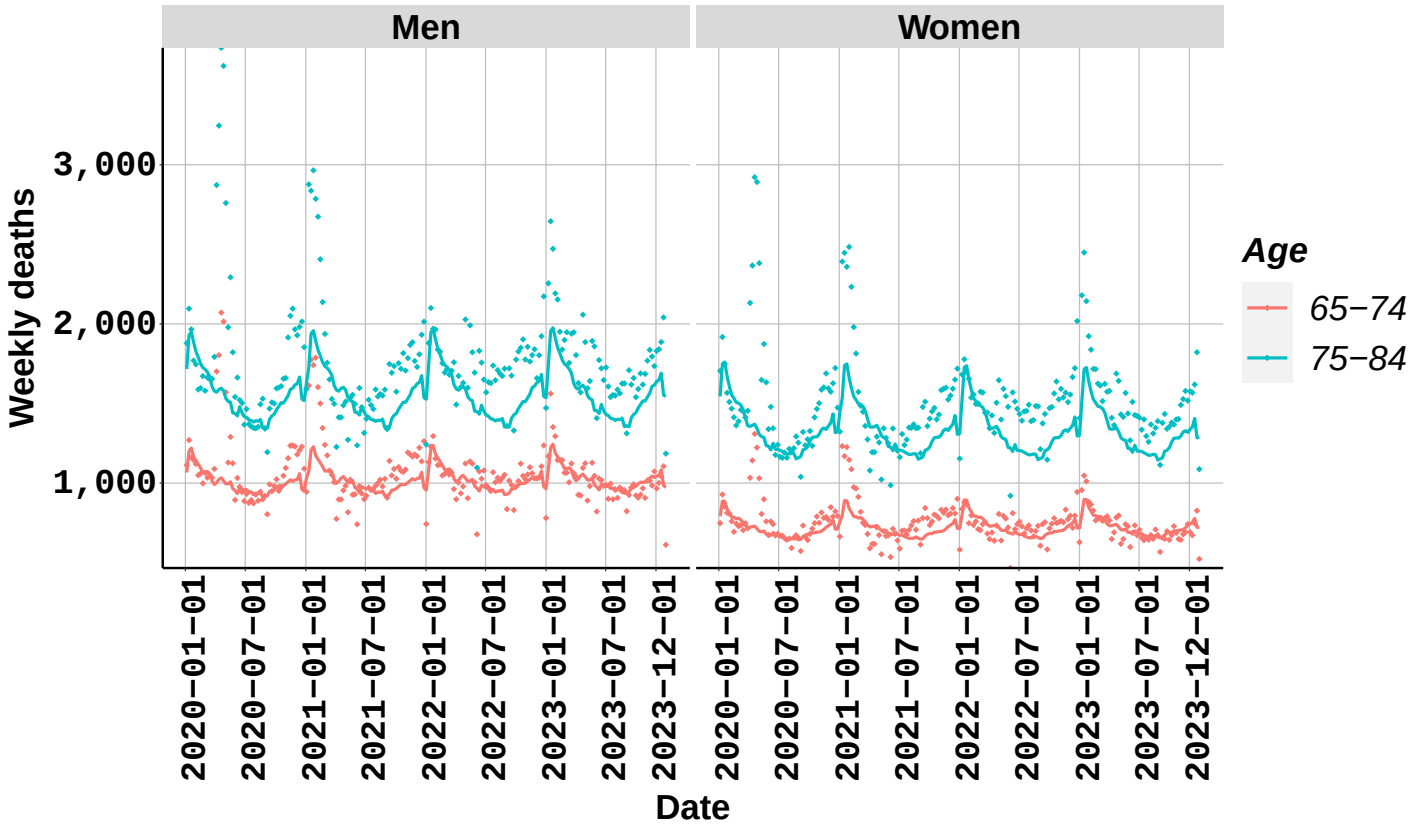
... seasonality?

... population size?

... different patterns in different countries?

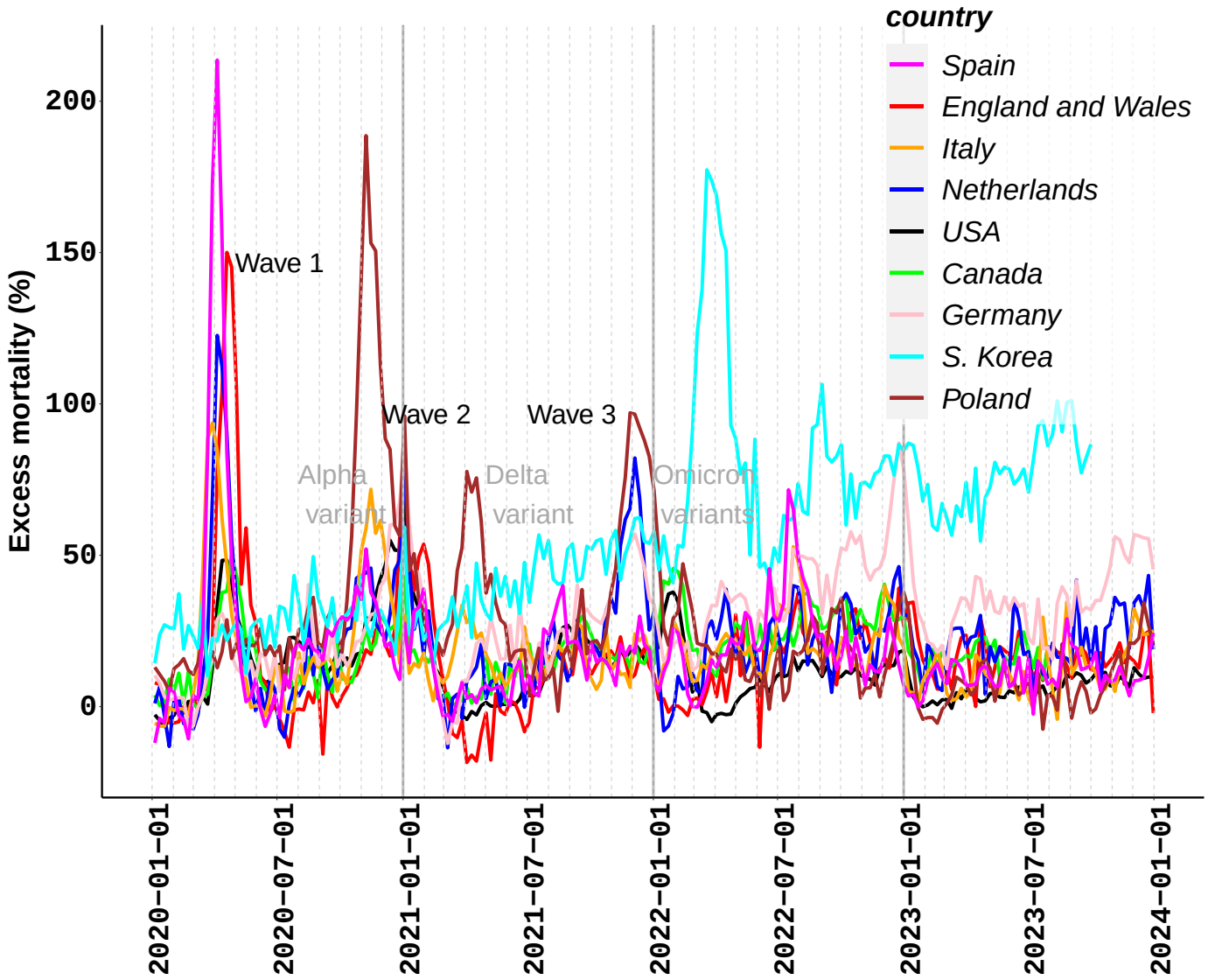
Regression model: observed v. estimated deaths

Observed **(dots)** and extrapolated **(solid lines)** deaths for men and women aged 65 to 84 in England and Wales



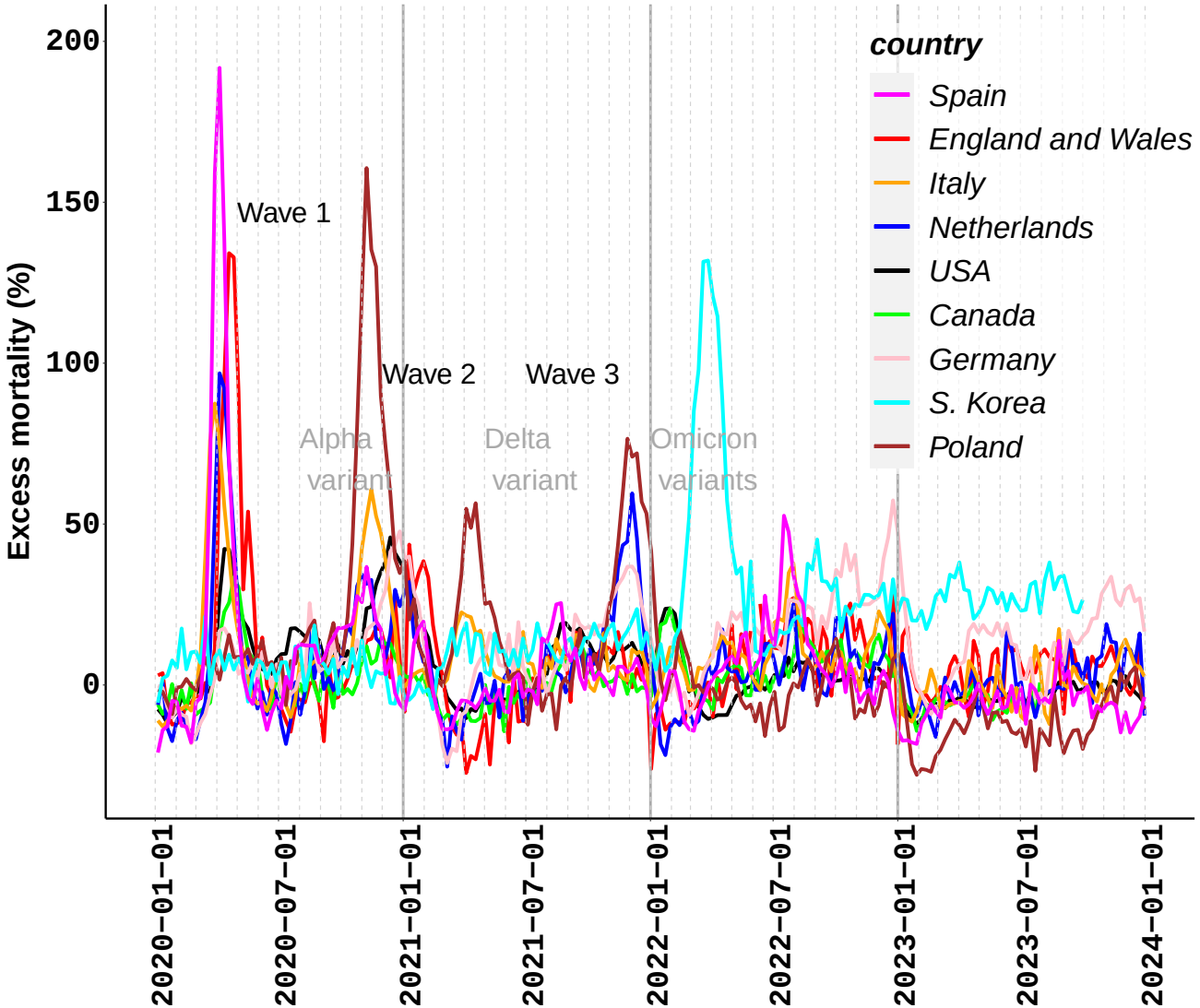
Excess deaths= Observed deaths -
Extrapolated deaths based on the trends in 2015–2019

P-scores: weekly, men aged 85+, relative to 2015–2019



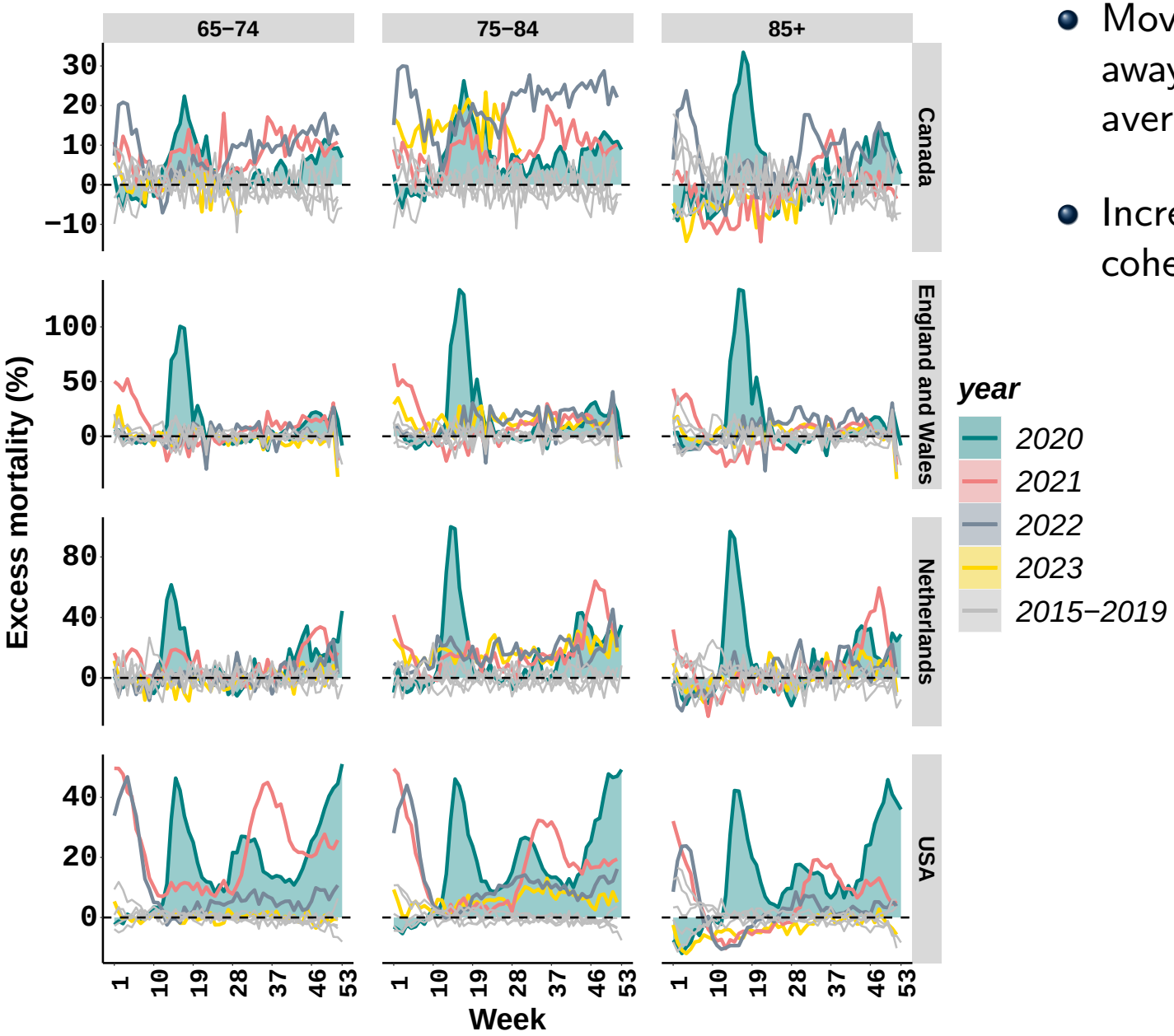
– Wave 1: highly synchronous across countries, aligned with the pandemic phases in England

Regression model, weekly, men aged 85+



- More substantial decline in excess mortality in recent years
- Previous upward trend(s) flattened, e.g. S. Korea

Regression model, pandemic peaks, men



- Moving away from averages
- Increasing coherence

Summary: Methodological approach v. P-scores

- Bigger variability in the rankings, compared to the P-scores, with some comparable results

  . . . the USA is among the most impacted

  . . . Sweden is among the least impacted

- Different trends over time

- Is the model too simple?

  . . . . . weekly v. annual?

Discussion

- Consistent findings across different measures

  . . . among the most impacted countries at the beginning of the pandemic

- Mostly comparable results by gender across different nations
- Over-generalisation should be avoided, e.g.

  . . . for younger age groups

  . . . in the most recent calendar years

- A more dynamic modelling structure?
- The impact of COVID-19 health measures on mortality?
- Cause-specific excess mortality in different population groups?

Thank you! Obrigado!

Questions?

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