England & Wales' **demographics** and **state pension** system under different **COVID-19** scenarios

Agnes Werpachowska

CeMPA
Centre for Microsimulation and Policy Analysis

AVERISERA
MATHEMATICAL INVESTIGATIONS OF REALITY

Motivation

- COVID-19 as **leading cause of death** from 11/2020-2/2021
  - Mortality rising sharply with age
  - Differences in mortality and vaccine hesitancy among ethnic groups
- Impact of lockdown on international migration

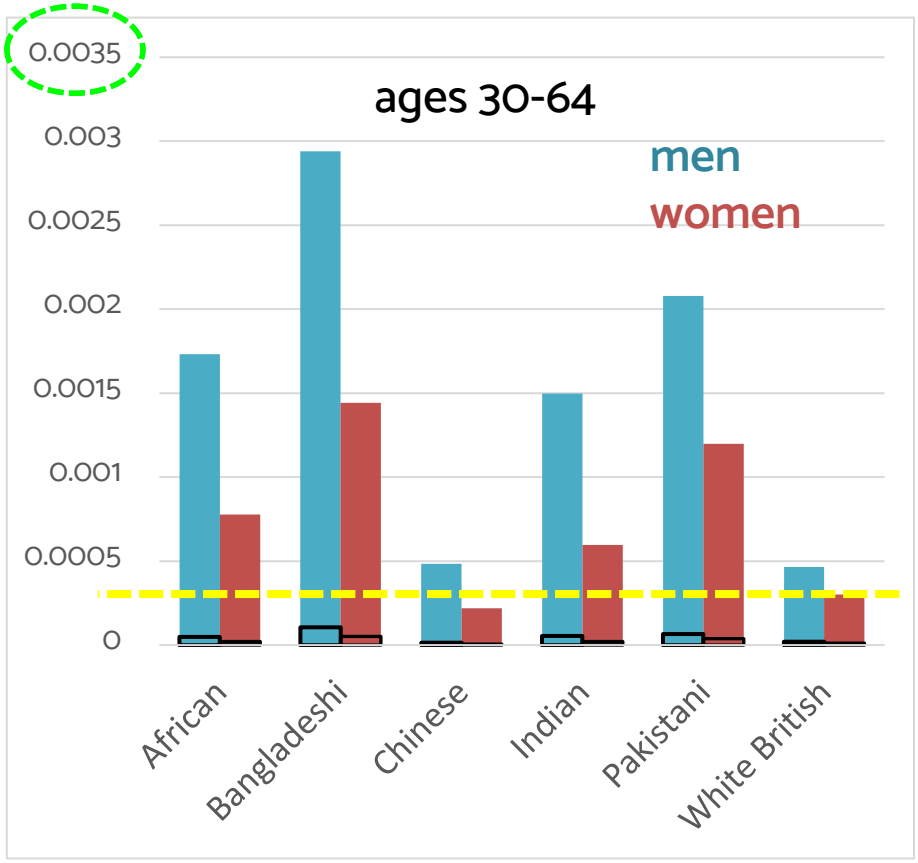
Use microsimulations to evaluate the impact of **COVID-19, lockdown and vaccines** on England & Wales' **demographic structure** and **state pension system**

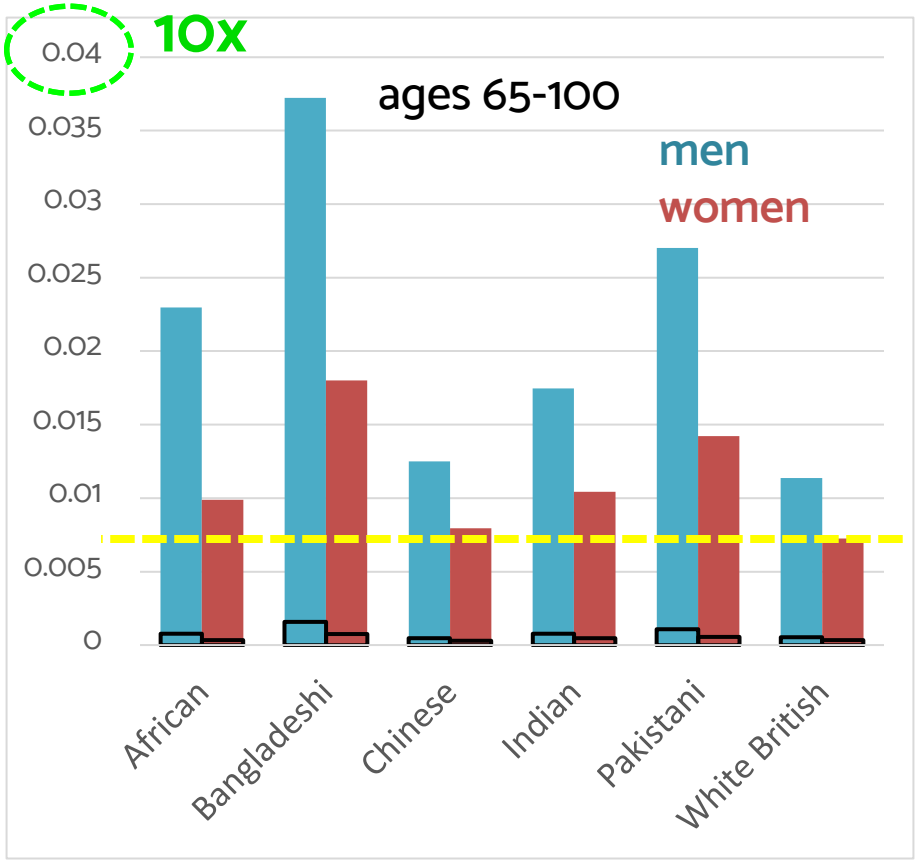
revisiting IMA WC 2017 & 2018 results:
"Microsimulations of demographic changes in England and Wales under different EU referendum scenarios", *Int. J. of Microsimulation*, 10(2), 2017
"Forecasting the impact of state pension reforms in post-Brexit England and Wales using microsimulation and deep learning", *IMA World Congress 2018; Proceedings of PenCon 2018*

Motivation

- COVID-19 as **leading cause of death** from 11/2020-2/2021
  - Mortality rising sharply with age
  - Differences in mortality and vaccine hesitancy among ethnic groups

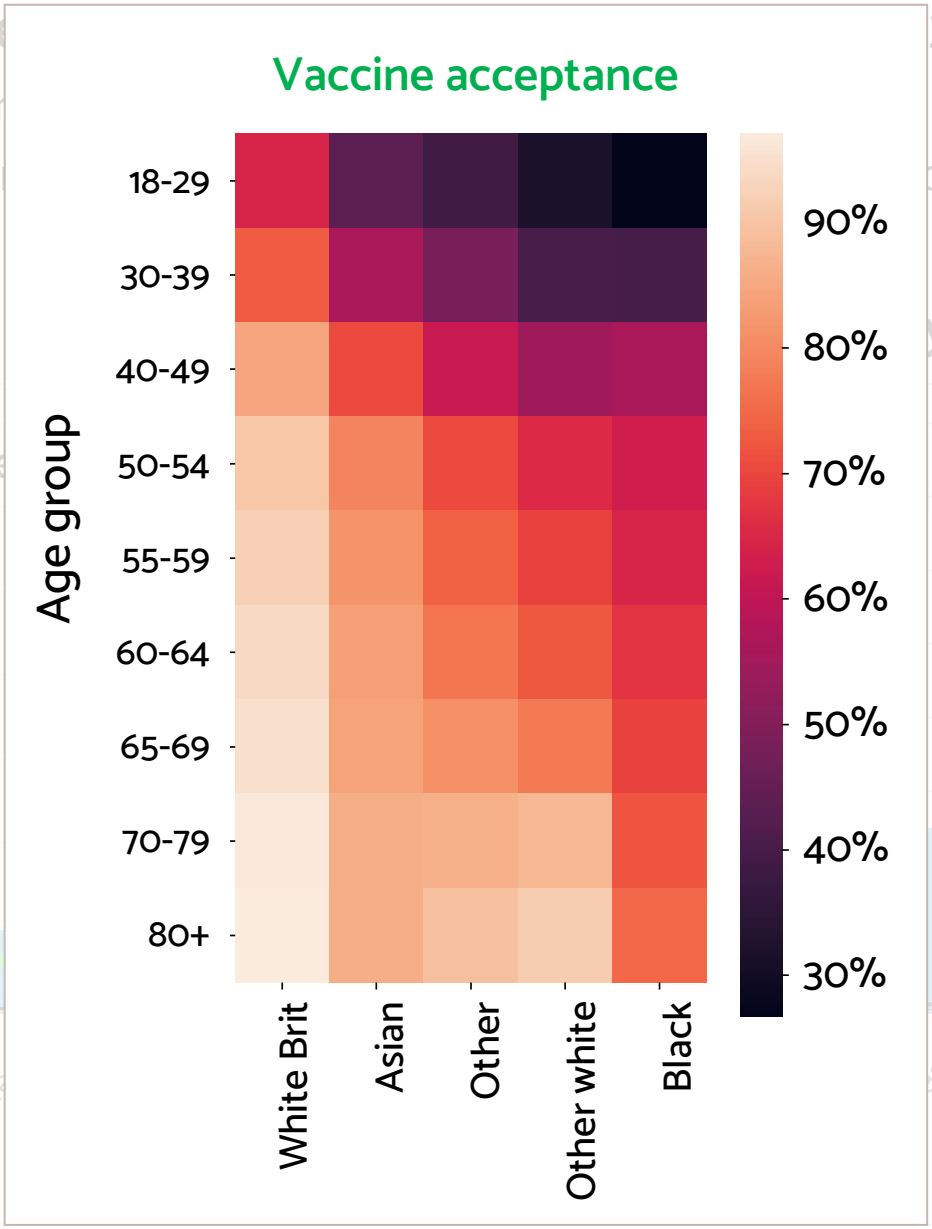
Pre- and post-vaccine COVID-19 mortality





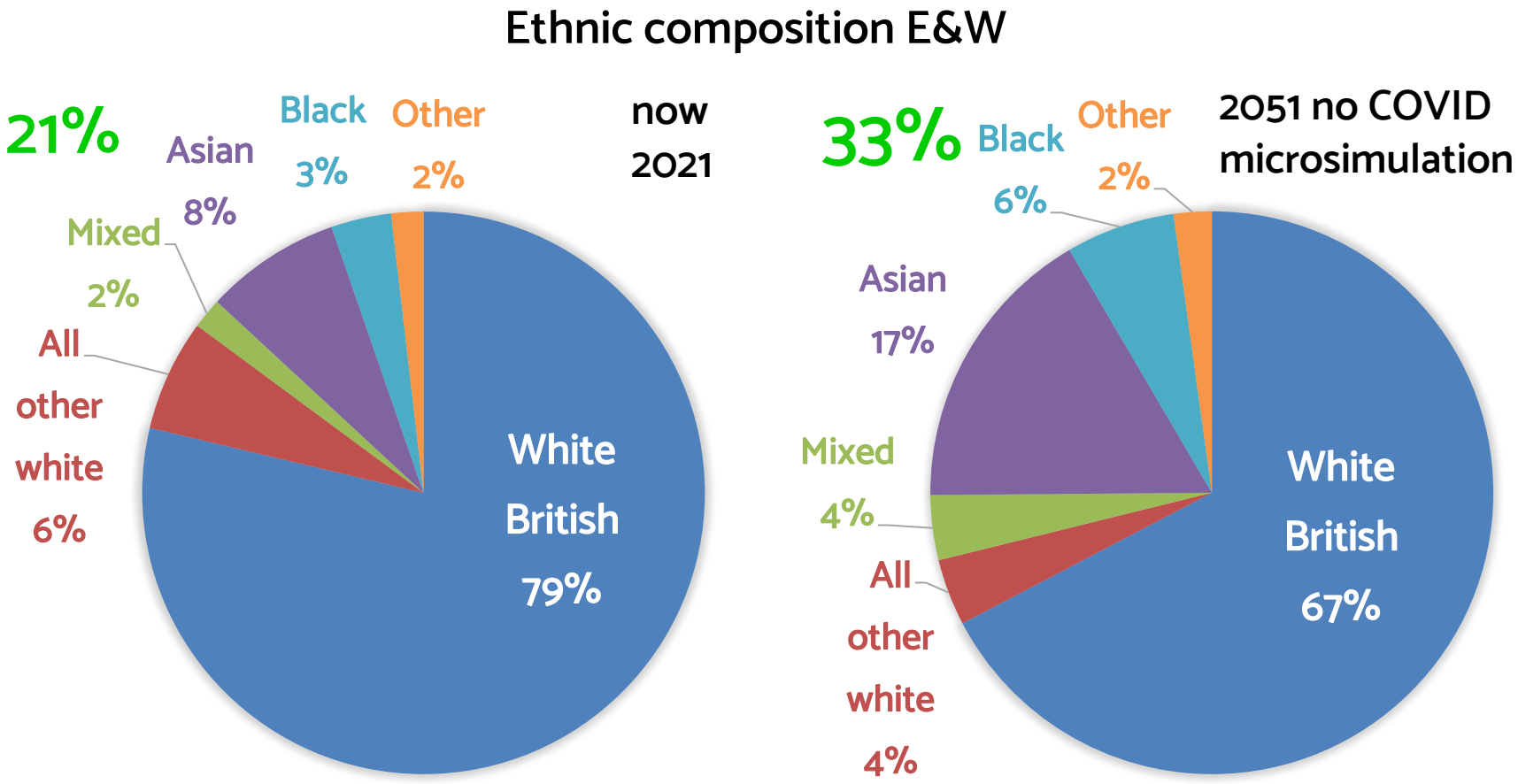
OpenSAFELY COVID-19 Vaccine Coverage Report / NHS

Motivation


Vaccine acceptance
Age group
18-29
30-39
40-49
50-54
55-59
60-64
65-69
70-79
80+
White Brit
Asian
Other
Other white
Black
90%
80%
70%
60%
50%
40%
30%

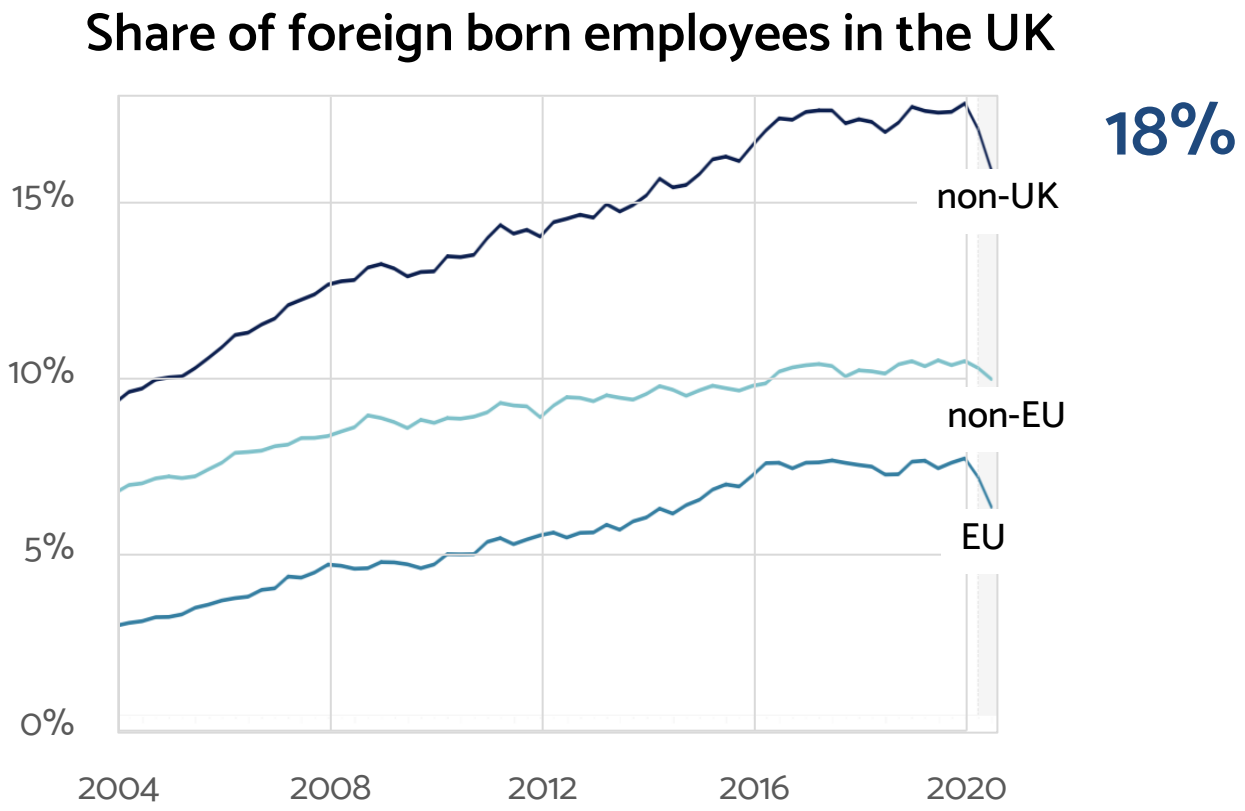
Motivation

- COVID-19 as **leading cause of death** from 11/2020-2/2021
  - Mortality rising sharply with age
  - Differences in mortality and vaccine hesitancy among ethnic groups



Motivation

- COVID-19 as **leading cause of death** from 11/2020-2/2021
  - Mortality rising sharply with age
  - Differences in mortality and vaccine hesitancy among ethnic groups
- Impact of lockdown on international migration



Microsimulation

PERSON

- age (date of birth DD/MM/YYYY)
- sex (male or female)
- pregnancy history, multiplicity (9M + 3M postpartum infertility)
- mother-children links (< 15-year-old migrating with mother)
- history of **international migration** → **Brexit**
- ethnicity ("inherited" from mother)
- **mortality** & fertility (**RNN** forecasts [IJM paper])

Microsimulation

COVID-19

- <u>mortality:</u> counterfactual baseline RNN forecast 2019+

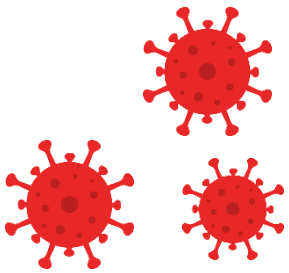
  1. + COVID-19 deaths *ONS COVID mortality*

     - vaccination coverage by SAE with 95% protection from death

     OpenSAFELY COVID-19 Vaccine Coverage Report

  2. + excess deaths *ONS death statistics by age and sex*

- <u>international migration:</u> Brexit + lockdown, reduced by 90% *ONS:LFS&IPS*



Brexit scenarios

"Microsimulations of demographic changes in England and Wales under different EU referendum scenarios", *International Journal of Microsimulation*, 10(2), 2017

"Bremain"

"Soft"

30%

2017-2020

30%

"Hard"

30%

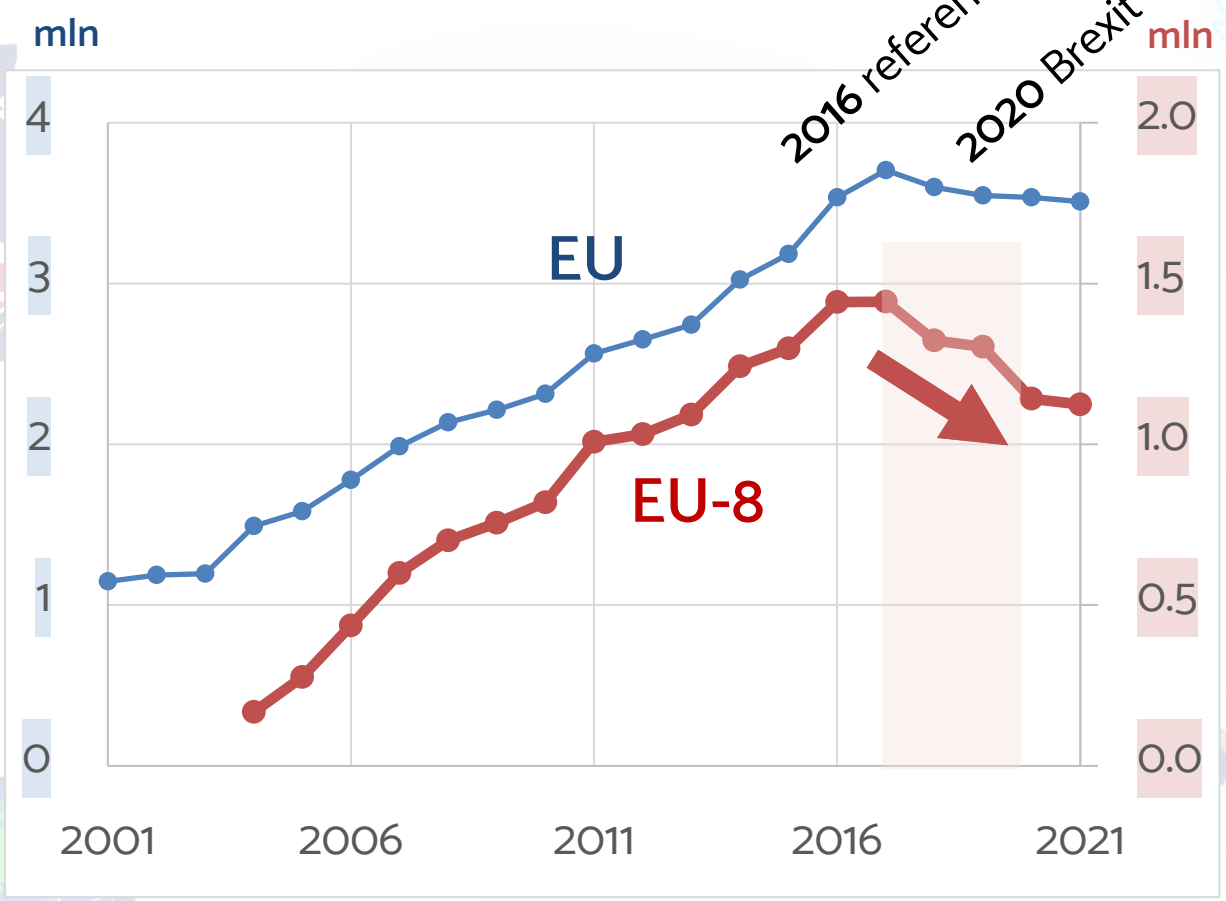
pre-2004

"Exodus"

"Hello World!"

Hard Brexit + lockdown

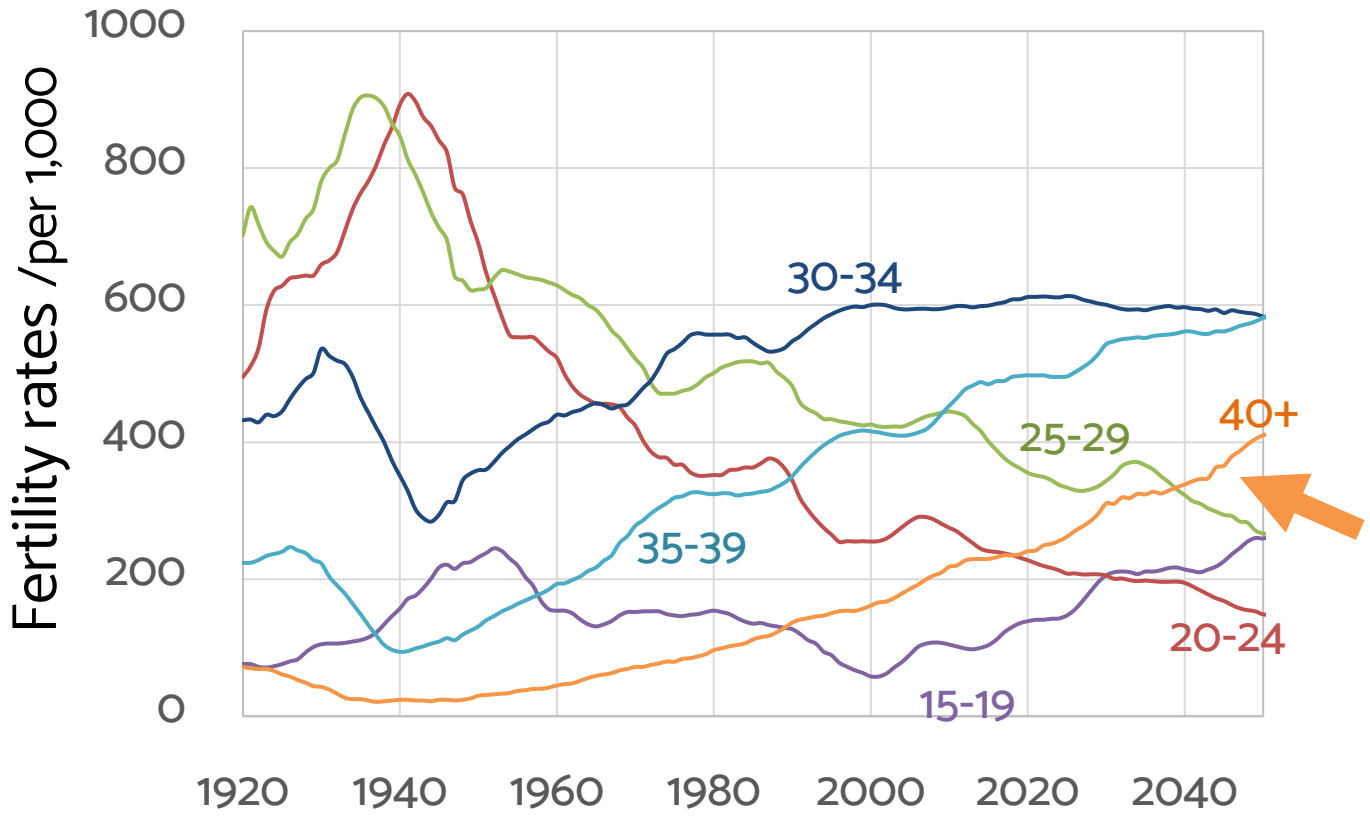
"Microsimulations of demographic changes in England and Wales under different EU referendum scenarios", *International Journal of Microsimulation*, 10(2), 2017



Exodus
of 30%
of simulated
EU immigration

& migration flows reduced by 90%

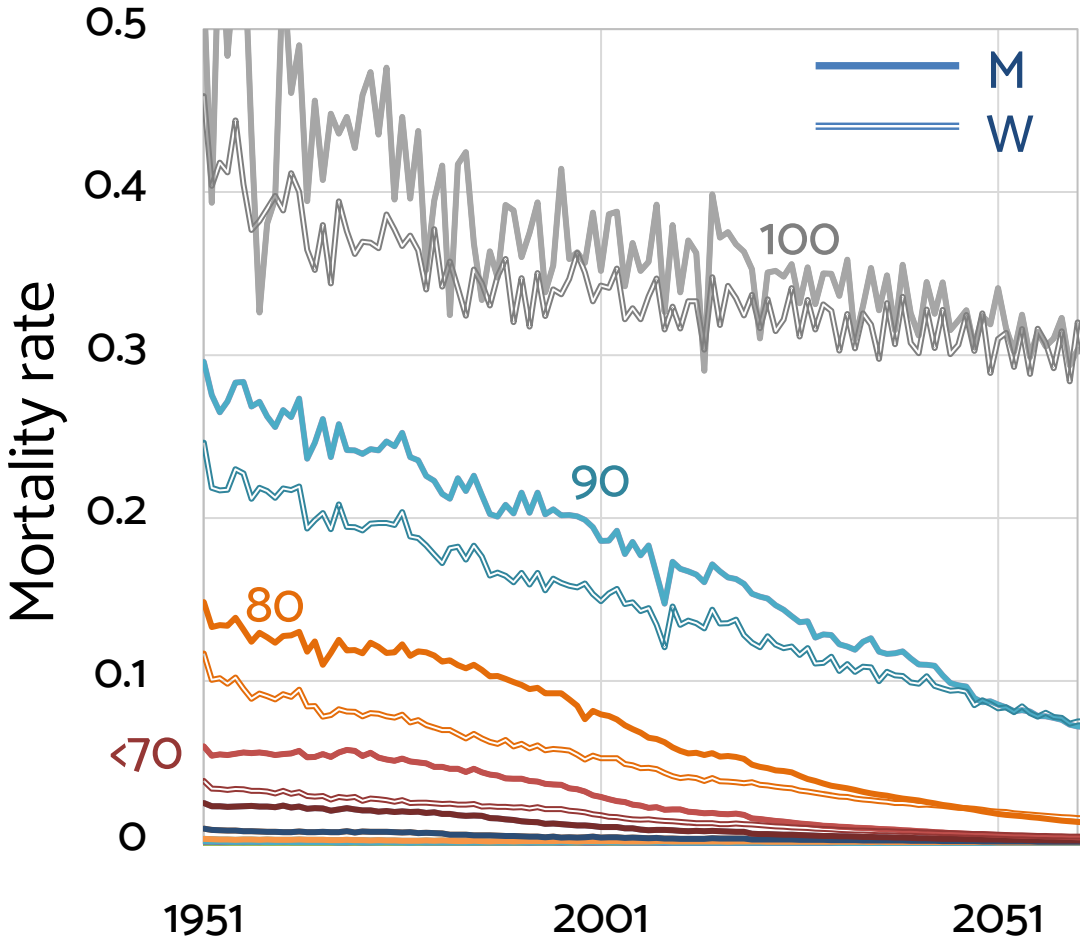
Fertility rate modelling



Like in the SP work IMA 2018 (w/o COVID) with updated data:

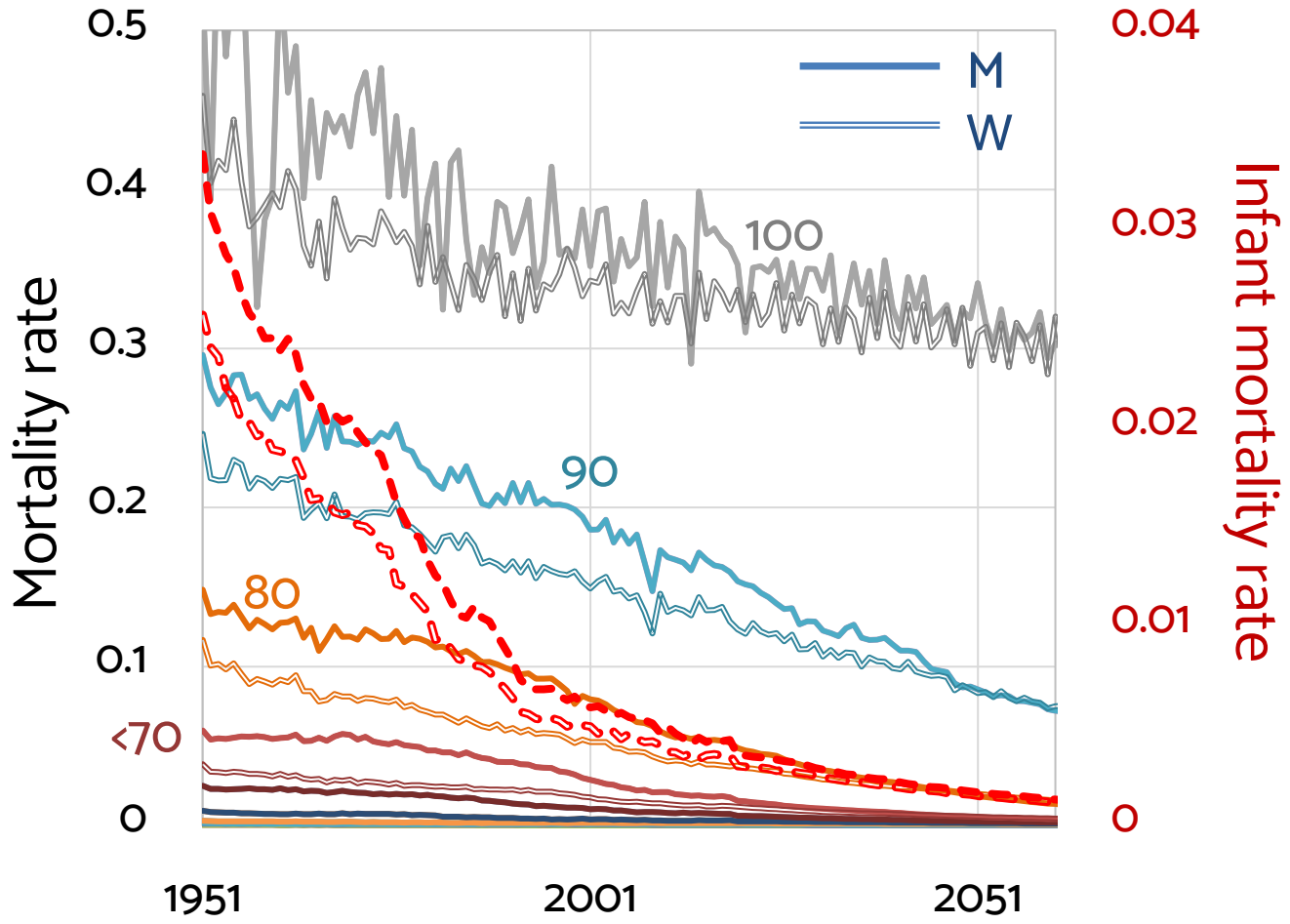
- **cohort fertility rates** extrapolated using **RNN** past 2018
- **birth sex ratios** extrapolated flat past 2020
- **birth multiplicities** extrapolated flat past 2019
- **TFR by ethnicity** enhanced by new data for 2011-2018 & extrapolated flat

Baseline mortality rate modelling



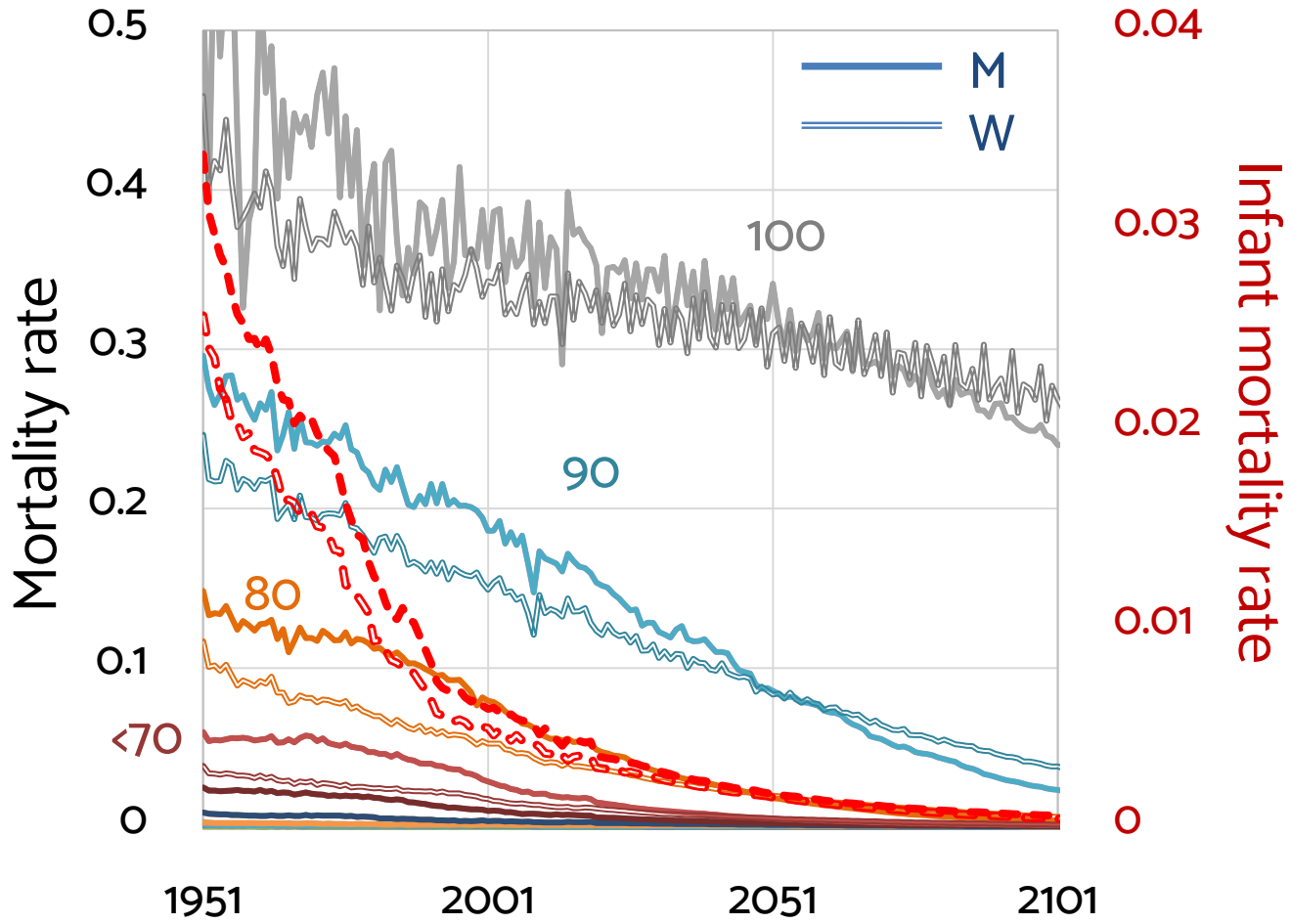
RNN extrapolation of ONS mortality rates until and including 2019
(2020 excluded to ignore the COVID & lockdown related mortality)

Baseline mortality rate modelling



RNN extrapolation of ONS mortality rates until and including 2019
(2020 excluded to ignore the COVID & lockdown related mortality)

Baseline mortality rate modelling



- ONS (2014): "There is a long-running trend since the 1970s for male life expectancy to catch up with female…"
- PHE (2014) "In some areas of the UK men are beginning to outlive females by as much of 13 years."

COVID-19 mortality

baseline mortality adjusted by:

Setup 1: COVID deaths

- in 2020: actual historical mortality rates
- from 2021: **+ pre-vaxx COVID mortality** rates by SAE (data until 31/3/2021)
- from April 2021: **- vaccine protection** (95%) against death in **fully vaccinated** (data by SAE from 11/2021)

Excess deaths

Excess mortality rate per 100,000

age	female	male
0-1	-14	-13
1-14	-2	-1
15-44	4	3
45-64	39	82
65-74	118	243
75-84	365	677
85+	1503	2153

< COVID-19 mortality

Setup 2: Excess deaths to estimate total demographic effect of epidemic

excess mortality rate = mortality rate 2020 - avg mortality rate 2017-2019

by sex and age groups (0-1, 1-14, 15-44, 45-64, 65-74, 75-84, 85+)

COVID-19 mortality vs Excess deaths

baseline mortality adjusted by:

Setup 1: COVID deaths

- in 2020: actual historical mortality rates
- from 2021: **+ pre-vaxx COVID mortality** rates by SAE (data until 31/3/2021)
- from April 2021: **- vaccine protection** (95%) in fully vaccinated (data by SAE from 11/2021)

Setup 2: Excess deaths to estimate total demographic effect of epidemic

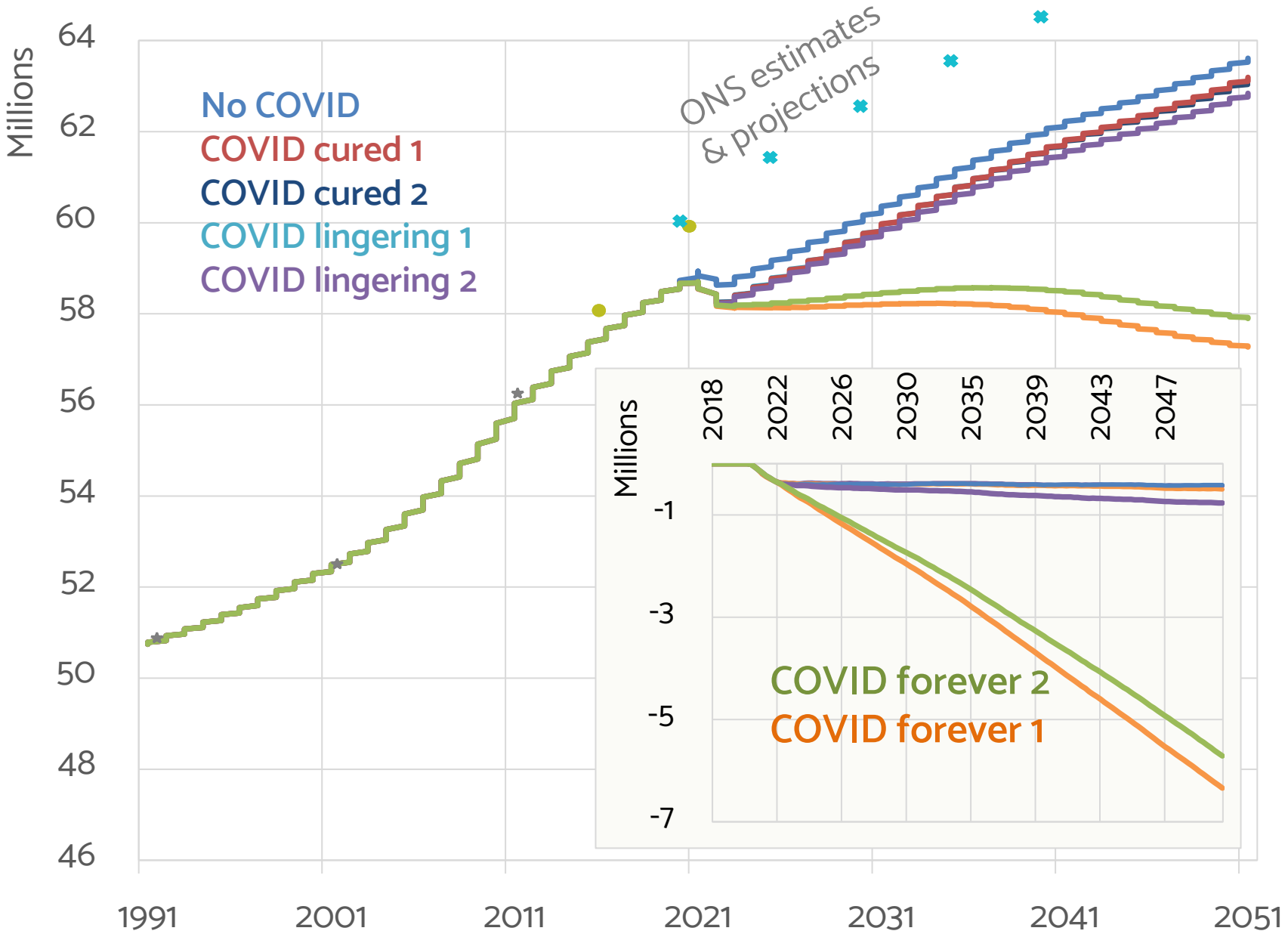
excess mortality rate = mortality rate 2020 - avg mortality rate 2017-2019

by sex and age groups (0-1, 1-14, 15-44, 45-64, 65-74, 75-84, 85+)

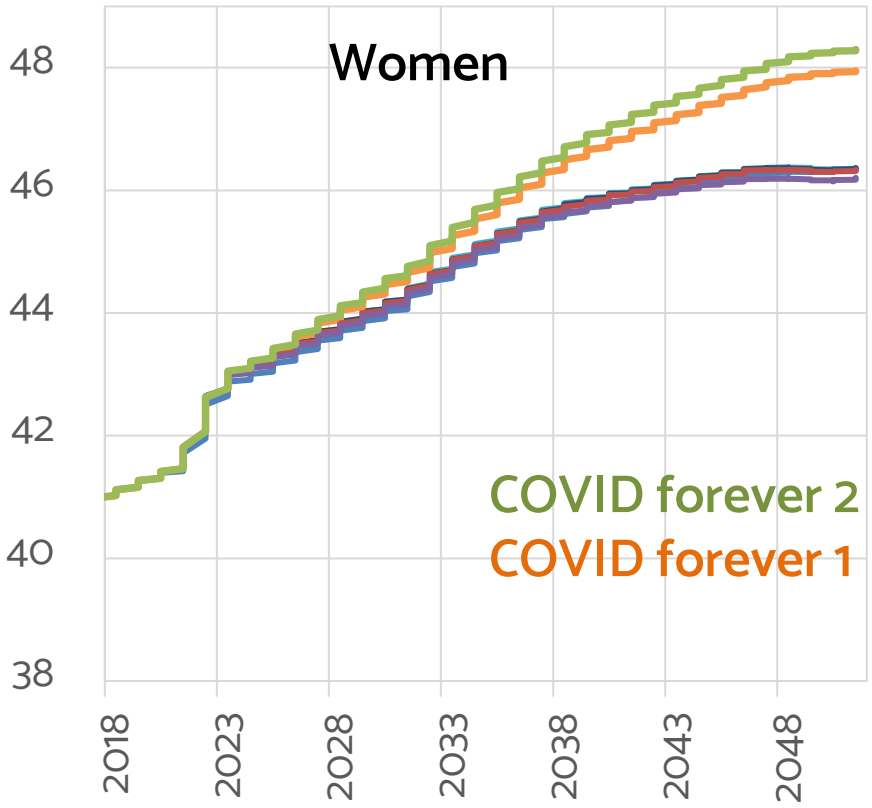
Microsimulation scenarios

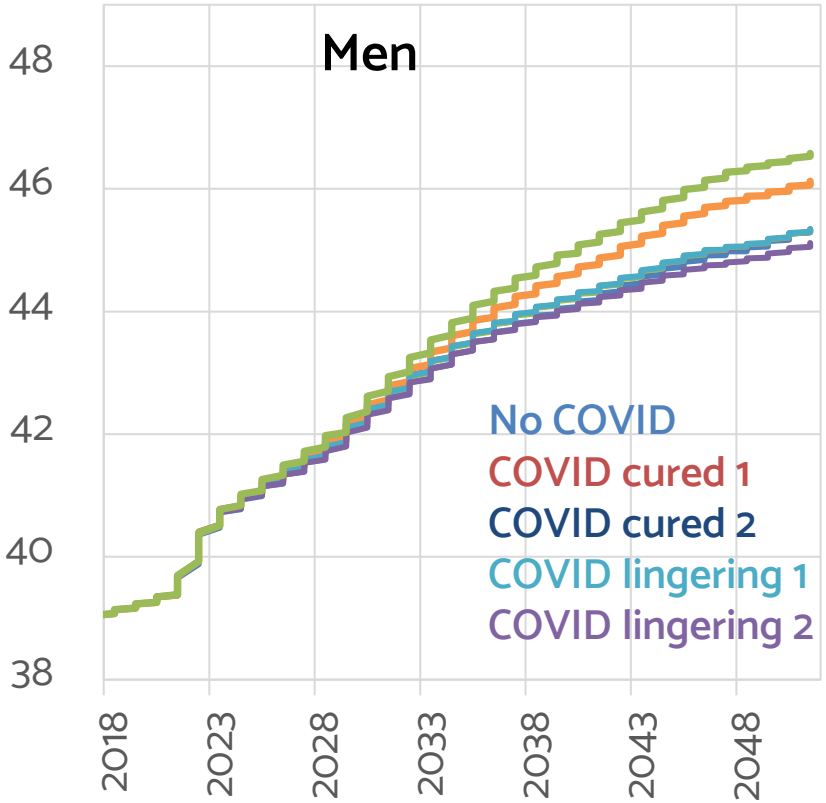
- **No COVID** counterfactual scenario assuming that the pandemic never happened (baseline mortality & "Hard" Brexit migration)
- **COVID cured** epidemic is extinguished and life goes back to pre-Covid baseline situation in 2022
- **COVID lingering** epidemic turns into endemic with lasting but four times weaker Covid impact, controlled by efficient vaccines (95% protection), migration returns to baseline in 2022
- **COVID forever** dystopian scenario – epidemic and lockdown (migration flows reduced by 90%) remain in full force as vaccine protection diminishes (to 20%)

Results: Total population size



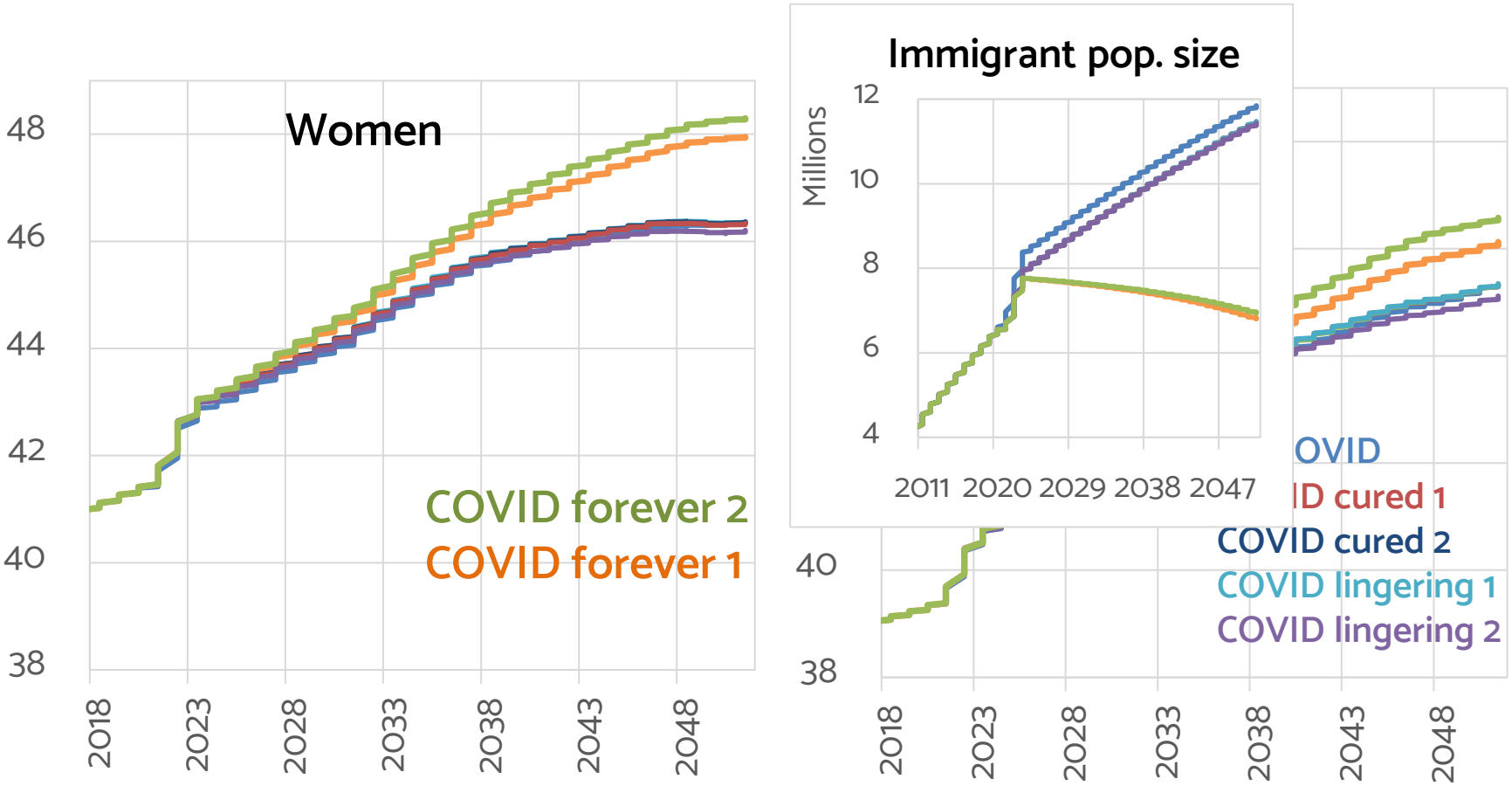
Results: Median age





- Population **still ageing because of to limited immigration**
- More prominent for women (young women are major part of immigration)

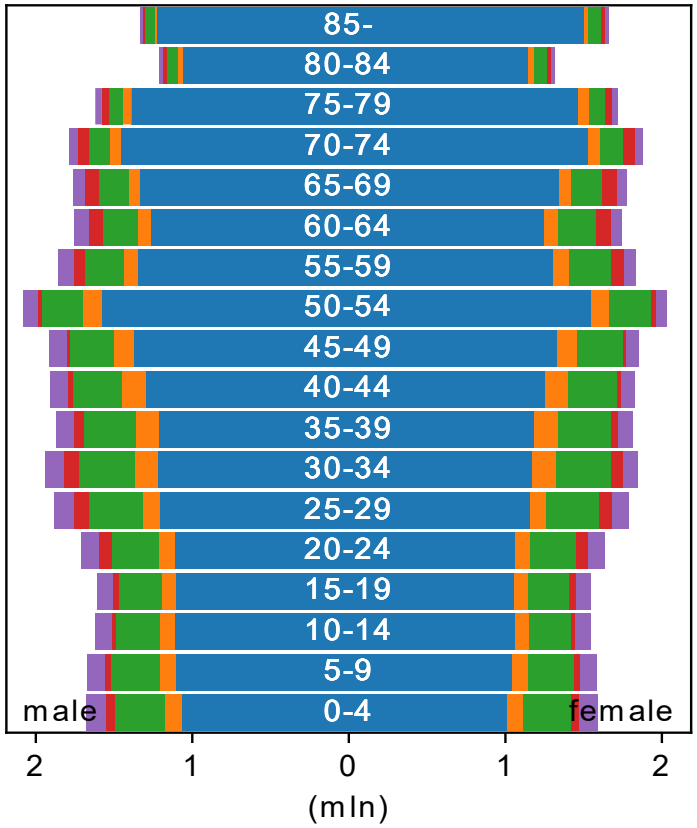
Results: Median age



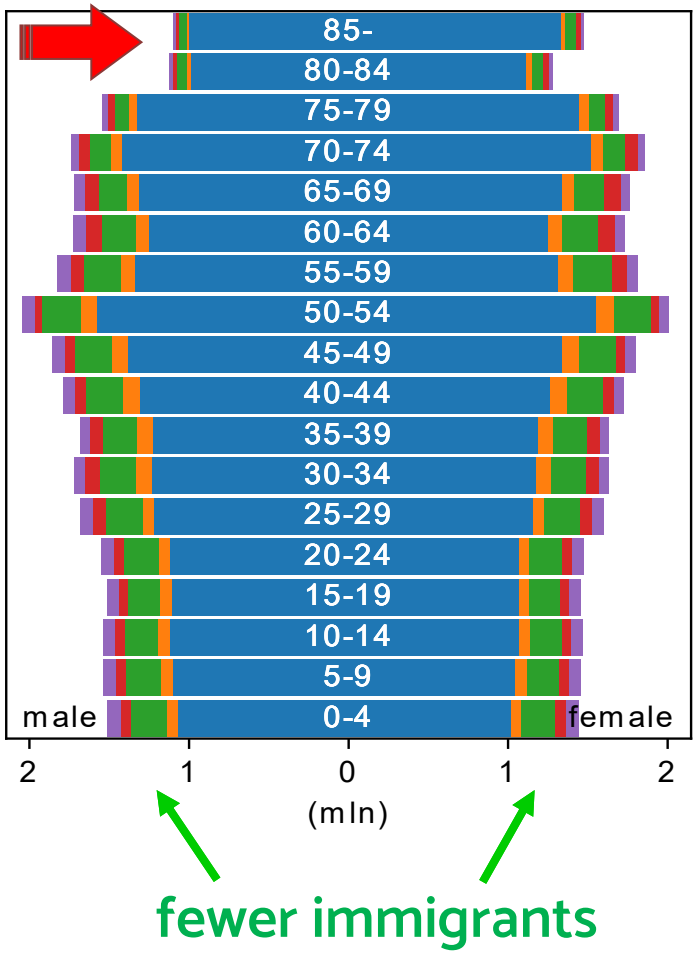
- Population **still ageing because of to limited immigration**
- More prominent for women (young women are major part of immigration)

Results: Population pyramids

no COVID, 2041



COVID forever 2, 2041

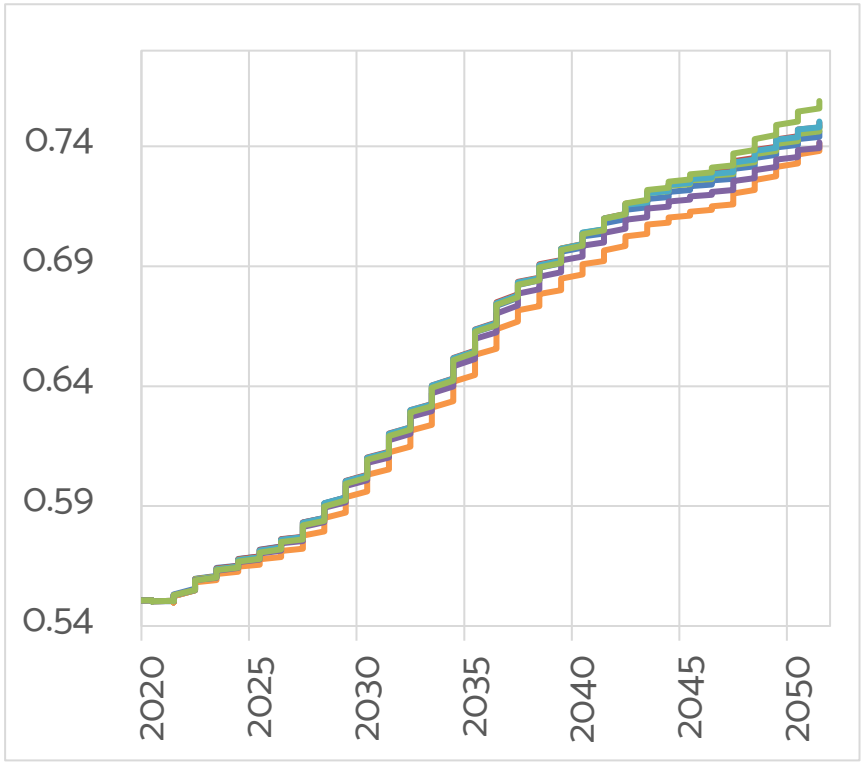


- Shrinking oldest groups, **especially male**
- Significantly reduced immigrant population

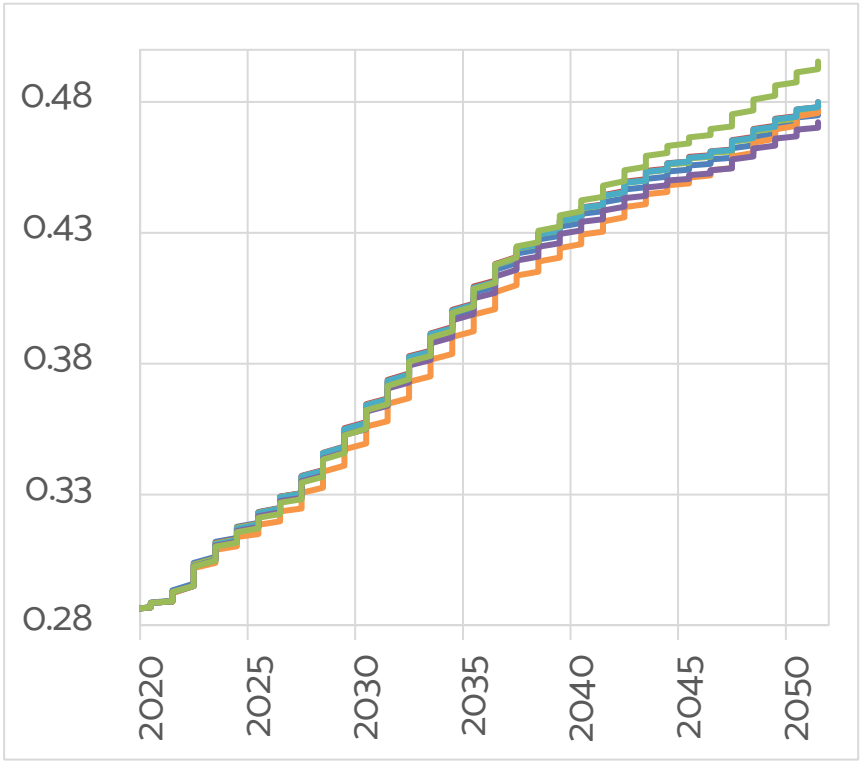
Results: Dependency ratios

$$\frac{\text{dependants (elderly \& children)}}{\text{working-age (15-64)}}$$

Dependency ratio



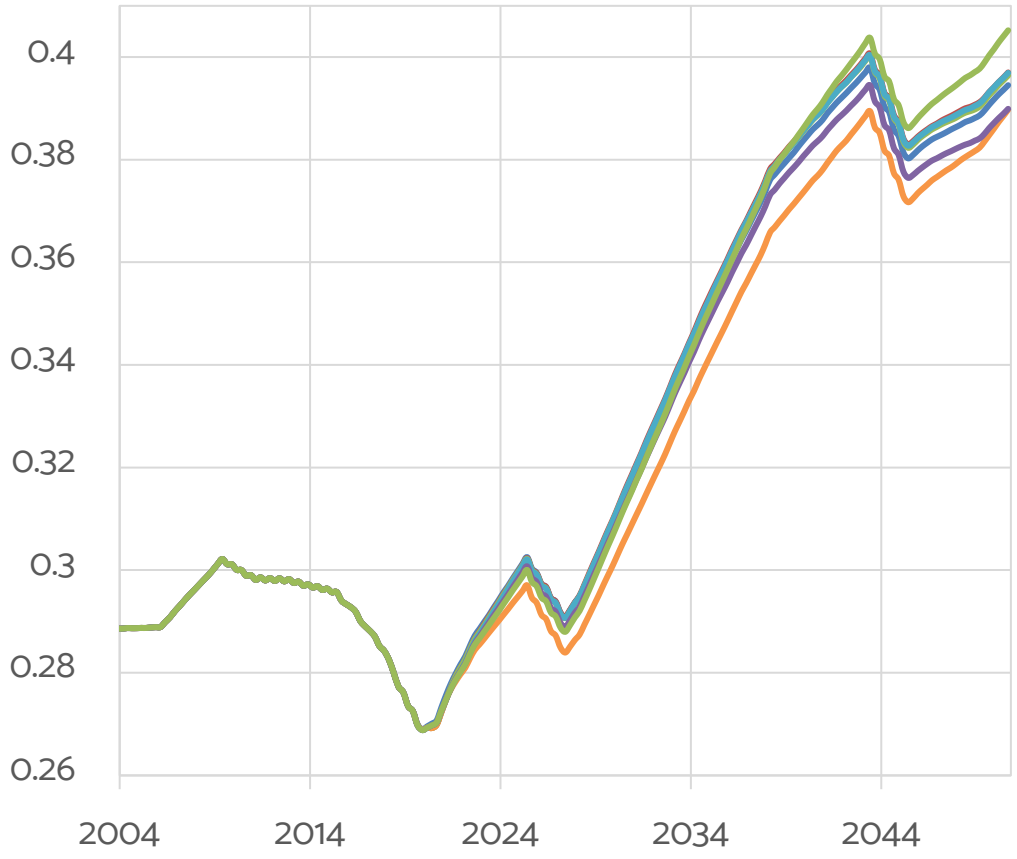
Old age-dependency ratio

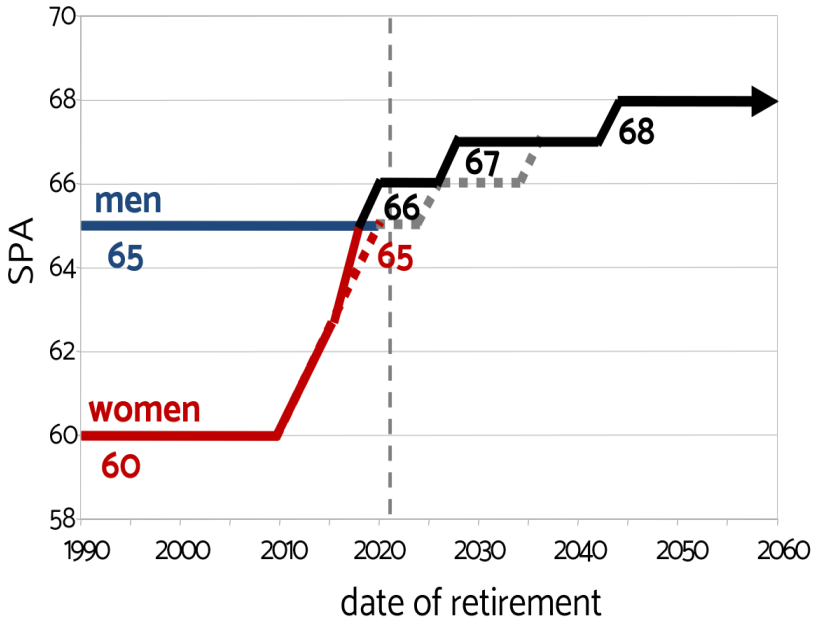


- As a consequence of the population ageing and lockdown, the dependency ratios are sharply growing

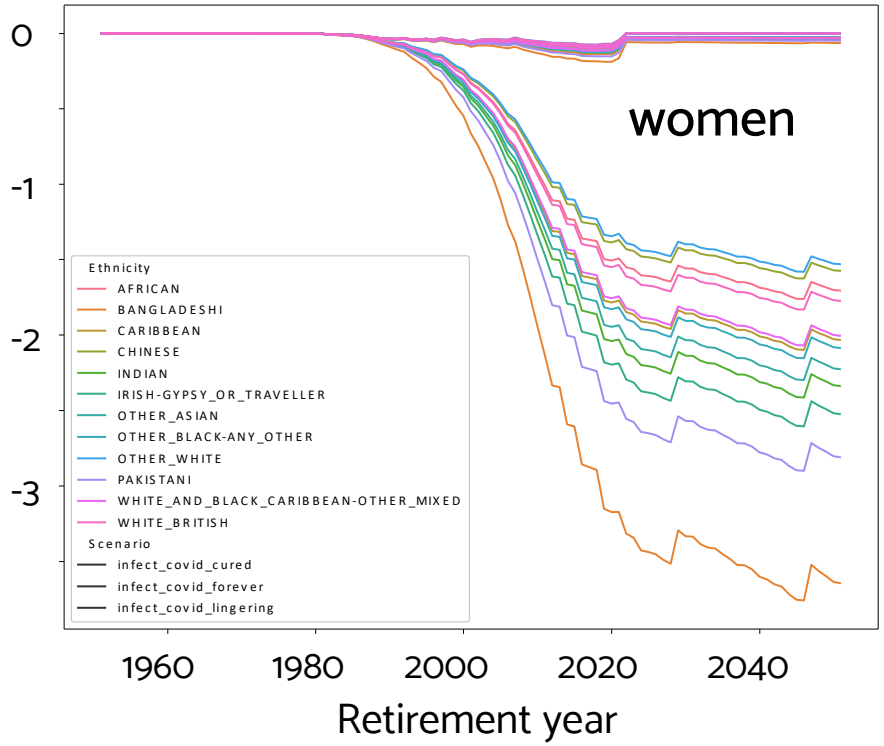
Results: Pension-cost dependency ratio

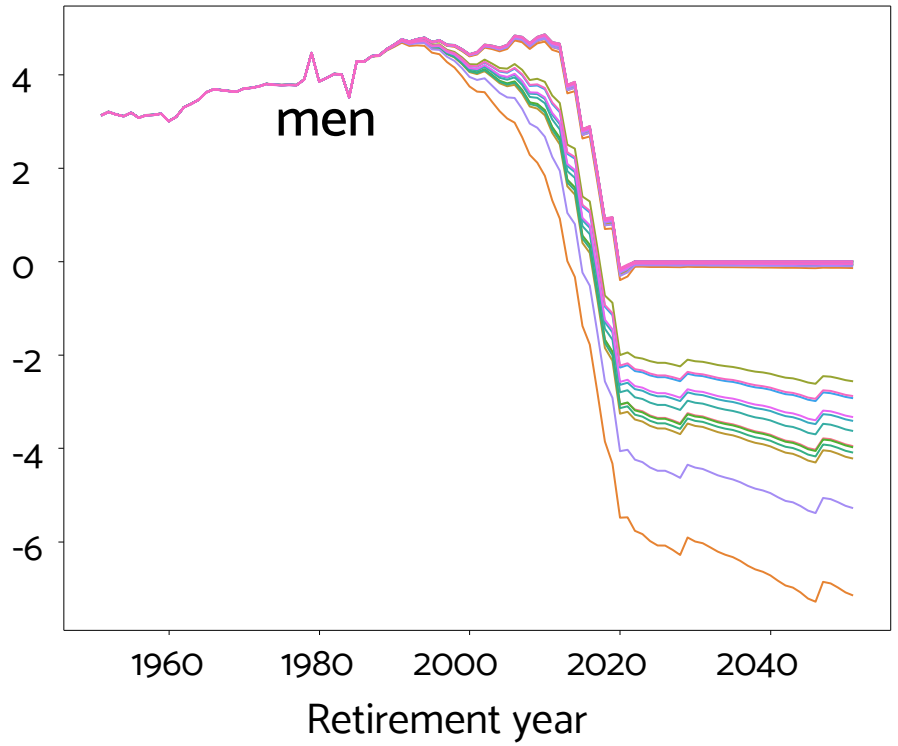
$$\frac{\text{people at or above the current retirement age}}{\text{people between ages 15 and that retirement age}}$$





Results: Life expectancy at SPA





STRONG ETHNIC DISPARITIES

- Bangladeshi men can lose over 7 years life expectancy at SPA to Covid
- other strongly affected groups: Pakistani men (over 5 yrs) and Indian men (4 yrs); White British men lose less than 3 yrs
- similar reductions for women, but weaker

Summary & Conclusions

- microsimulations of different COVID-19 scenarios evaluating its impact on the demographic structure of E&W, and consequences for state pension system
- scenarios included two different mortality settings: COVID-19 vs excess deaths (to estimate total demographic impact of the epidemic), vaccination effectiveness and lockdown-reduced migration flows
- the lasting **full force epidemics with low vaccine protection leads to shrinking E&W population**, however it **doesn't stop its ageing** – the effects caused mostly by harsh lockdown **restrictions on immigration**
- COVID-19 mortality or excess deaths data, alongside higher vaccine hesitancy among major ethnic groups reveal striking **disparities in life expectancy at SPA** and significantly slows down the growth of their share in the **ethnic structure of E&W's population**

Thank you for your attention!