



**Continuous
Mortality Investigation**

Institute and Faculty of Actuaries



Mortality improvements in light of the pandemic

Discussion hosted by SIAS and the
CMI Mortality Projections Committee

13 April 2020

Staple Inn Hall, London

The views expressed in this presentation are those of the presenters and not necessarily those of their employers, the CMI or the Staple Inn Actuarial Society.

Agenda

- **Welcome and introduction**
 - Cobus Daneel, CMI
- **Recent mortality and CMI_2020**
 - Steve Bale, CMI
- **Mortality improvements in light of the pandemic**
 - Professor Michael Murphy, London School of Economics
 - Dr Chris Martin, Crystallise
 - Tim Gordon, Aon
 - Steve Leake, XPS
- **Discussion:** please submit questions using the “Chat” facility

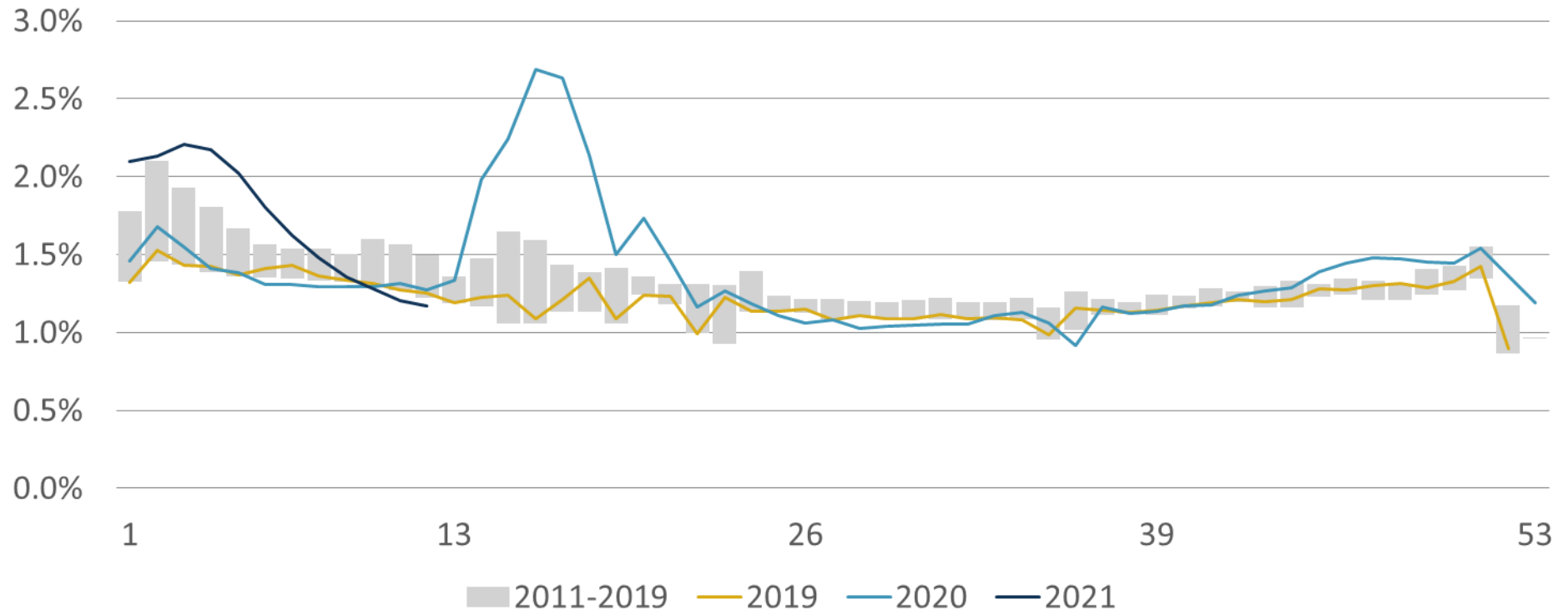
Recent mortality and CMI_2020

Steve Bale

CMI Mortality Projections Committee

Recent mortality

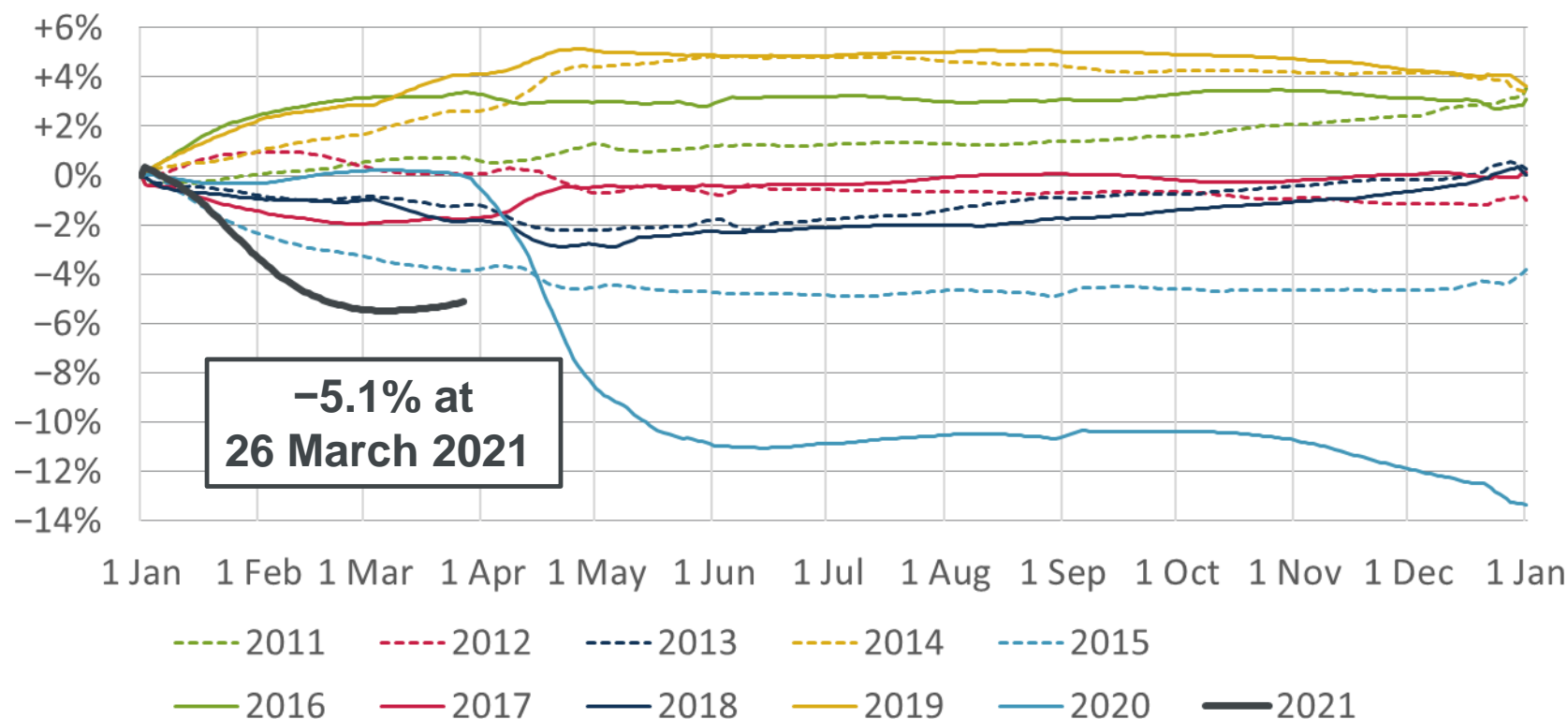
Standardised mortality rates by week number



Source: CMI calculations, to 26 March 2021, based on ONS provisional weekly deaths data for England & Wales

Recent mortality improvements

Cumulative annual standardised mortality improvements

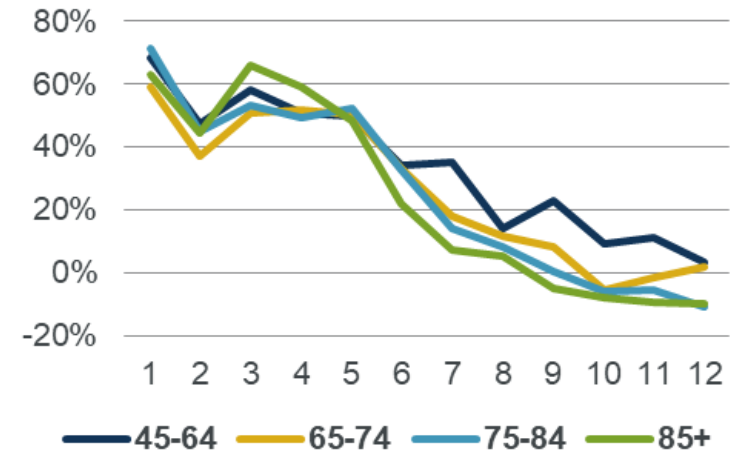


Source: CMI calculations, to 26 March 2021, based on ONS provisional weekly deaths data for England & Wales

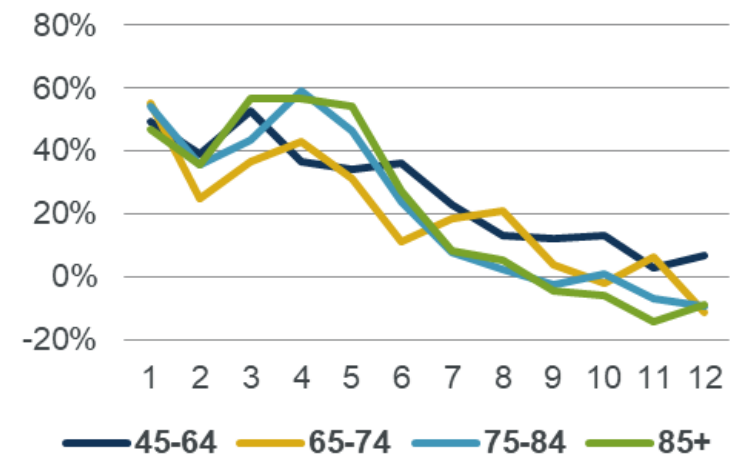
Mortality in 2021

- Excess mortality in weeks 1 to 9; but negative excess in weeks 10 to 12
- Excess deaths fell more rapidly at older ages – due to vaccination timetable?
- Possibility of future waves of COVID-19
- Possible variants of the virus
- Outcome for 2021 as a whole remains uncertain

Excess mortality – males



Excess mortality – females

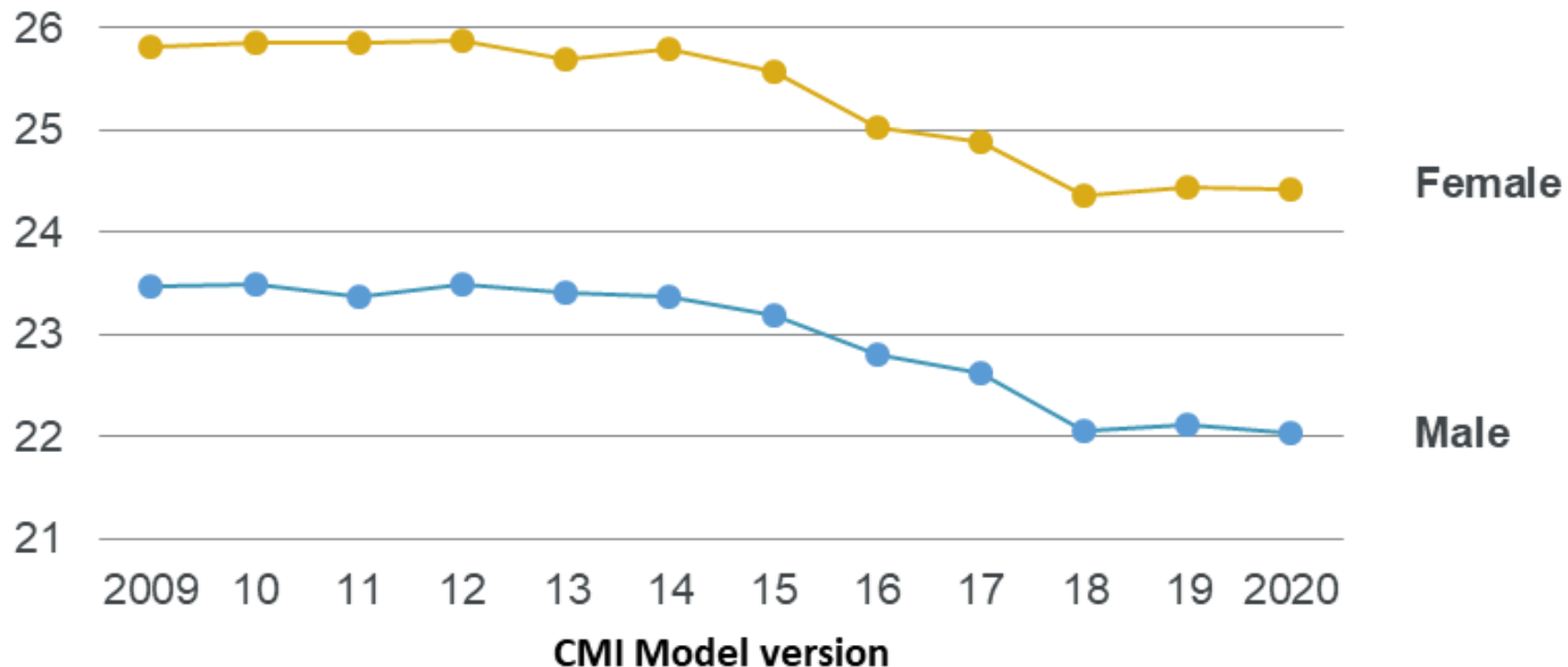


CMI_2020

- Not a “business as usual” update to the Model
 - That would have led to excessive falls in life expectancy
- CMI_2020 incorporates mortality data to 31 December 2020
- But 2020 data is given 0% weight in the Core version
 - Consultation showed broad support for this from users
- Overall impact is a modest reduction in life expectancies relative to CMI_2019 – four weeks for males and one week for females
- We encourage users to consider which parameters to use, particularly:
 - Long-term rate – and the impact of the pandemic on this
 - 2020 weight – to reflect the impact of the pandemic
 - Initial improvements – to reflect the composition of their population

Progression of cohort life expectancy

Age 65, CMI Model, S3PxA, illustrative long-term rate of 1.5% p.a.



Source: CMI calculations

Future plans

- Continue frequent mortality monitoring for the time being
- New survey, benchmarking use of the Model by insurers
 - Responses by 14 May 2021 please
- Annual “interim update” working paper, likely to include ongoing research on data quality and goodness of fit
- MPC will consider the weight to be applied to 2021 data in CMI_2021
 - We will communicate our preliminary view on this in the autumn
- Census 2021 – the ONS may revise population estimates as a result
 - We may modify the release date of CMI_2021 or CMI_2022 to reflect the new data in a timely manner

Mortality improvements in light of the pandemic

Professor Michael Murphy
London School of Economics

Mortality improvements in light of the pandemic

SIAS/CMI – Mortality improvements in light
of the pandemic

Mike Murphy School of Economics

So you've been asked to make annual COVID-linked forecasts!

- Refuse
- Accept with enthusiasm
- Accept with reluctance/ trepidation
- Ask a friend/colleague (ONS recent consultation)

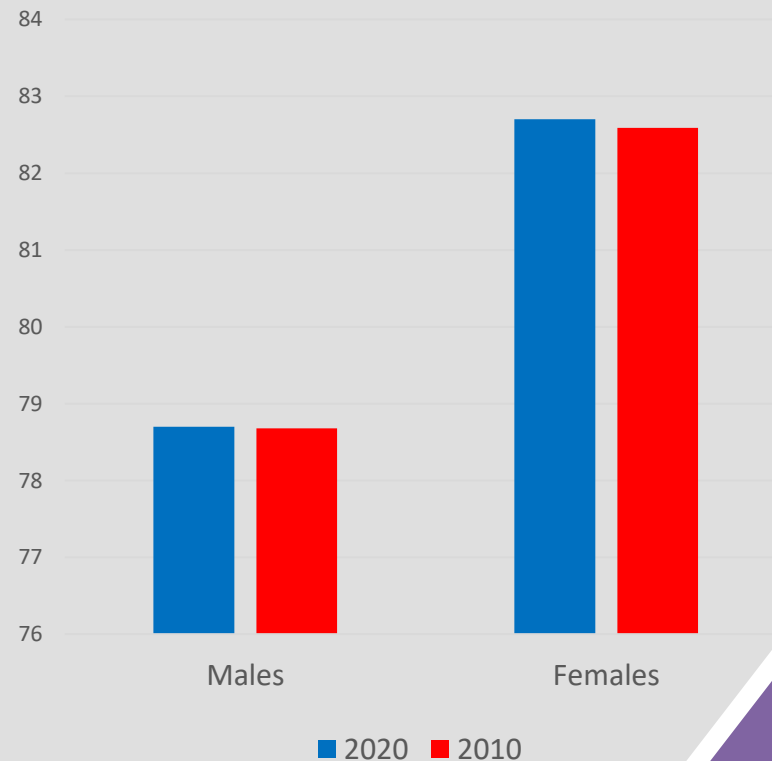
Why annual?

IF there is no substantial third wave, the period mid-March 2020 to February 2021 includes virtually all COVID-related deaths – the SDR in that 12-month period was 20% higher than the lowest value mid-2018-19.

2020 SDR (E&W) was 15% higher than low-point above
BUT only annual LE data are available...

Life expectancy
(e_0) 2020 back
to 2010 levels –
during in a
period of low
improvement.
Worst 12
months e_0
probably back to
around 2006
Source ONS & PHE

Life expectancy, England

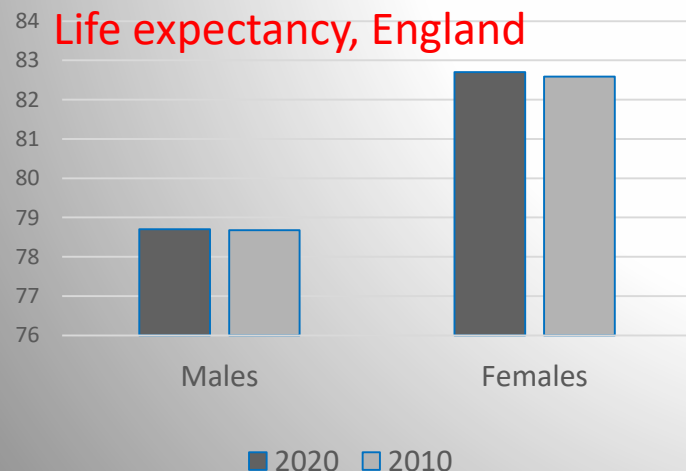


Period life expectancy

2010

Synthetic population with 2010
observed mortality throughout
life

Has same LE as 2020 pandemic
population



2020

Synthetic population with 2020
observed mortality throughout
life

Population experiences COVID-
19 pandemic for every year of
life up to highest age

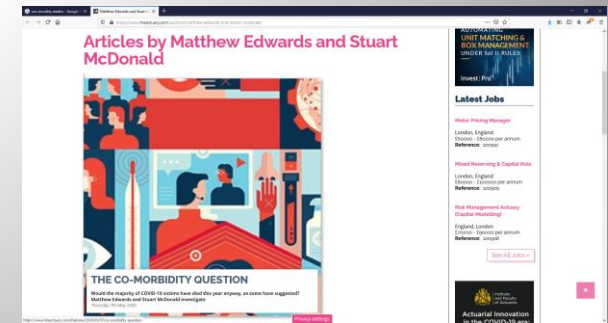
Population loses any immunity on
1st January (situation as on 1st
Jan. 2020)

Future period life expectancy

Life expectancy in 2020 about 1 year (1.3 M; 0.9 F)
less than the highest-ever value experienced in
2019

Where did the “missing year” go & the excess deaths
come from?

- Deaths brought forward from 2021 onwards (ignore reallocation within 2020, doesn't affect annual death total)
- Frailty (statistical) is crucial but highly confused by non-professional commentators



We all Bayesians now

Is there any consensus that there will be major long-term change in coronavirus mortality?

- Effective vaccinations/treatments exist
- New variants emerge as:
 - Minor inconvenience (“common cold”)
 - More lethal
- Behavioural change

Other mortality – COVID deaths additional c. 125K (total with no third wave?)

At risk population of 60 million person years per annum – need to ***specify priors***, especially uncertainty

Lesson from the past: The 1918-19 influenza pandemic

The most recent pandemic & share a number of important parallels with COVID-19:

1. Highly contagious, respiratory disease viruses
2. Spread across the globe in a matter of months
3. Non-pharmaceutical interventions main response to slow the spread since no immediate medical treatment

NBER WORKING PAPER SERIES: THE 1918 INFLUENZA PANDEMIC AND ITS LESSONS FOR COVID-19

Brian Beach, Karen Clay, Martin H. Saavedra

Working Paper 27673

<http://www.nber.org/papers/w27673>

Lesson from the past: The 1918-19 influenza pandemic

Long-term health impacts:

- *Limited, some speculations that may have affected CVD trends negatively*
- *Most work in pre-natal exposure, with some minor mortality implications*
- *Long-term mental health effects identified*

The Spanish Flu Pandemic and Mental Health: A Historical Perspective. Psychiatric Times. Greg Eghigian. Svenn-Erik Mamelund

Long-term indirect health impacts:

- *Limited impact on economy (mainly labour supply, unlike COVID-9)*
- *Little impact on health/mortality differentials*

Lesson from the past: Mortality following recessions

A **decrease** in mortality following recessions is a robust finding:

- *Limited financial pressures, lower work-related stress (among unemployed)*
- *Reductions in e.g. transport & occupational accidents, reduced lifestyle risks (all)*

Nature NEWS FEATURE 23 January 2019

How the next recession could save lives.

<https://www.nature.com/articles/d41586-019-00210-0>

But an **increase** in long-term mortality:

- *Cumulative financial hardship*
- *Stress*
- *Unhealth lifestyle*

What the current economic recession means for long-term health outcomes

Kristina Thompson

<https://ije-blog.com/2020/11/06/what-the-current-economic-recession-means-for-long-term-health-outcomes/>

Lesson from the past: mortality following seasonal influenza epidemics

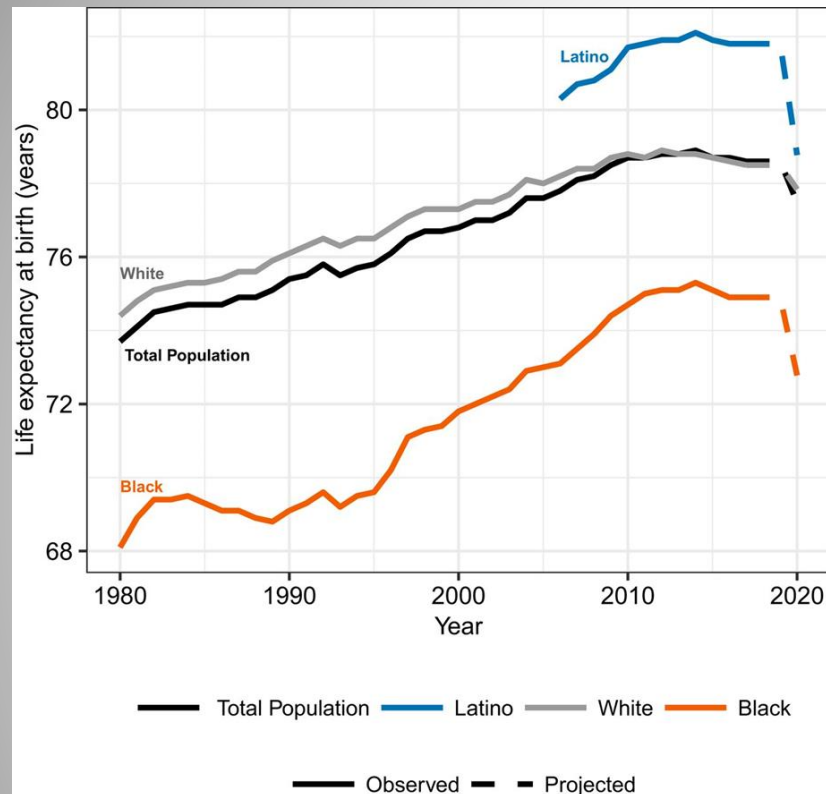
Selection & harvesting: COVID removes (“harvests”) the compromised (“frail”) disproportionately from the population & leaves a selected fit low-mortality subpopulation (US Black-White mortality cross-over)

Scarring: COVID leads to long-term health problems (physical and mental) with consequent long-term higher mortality

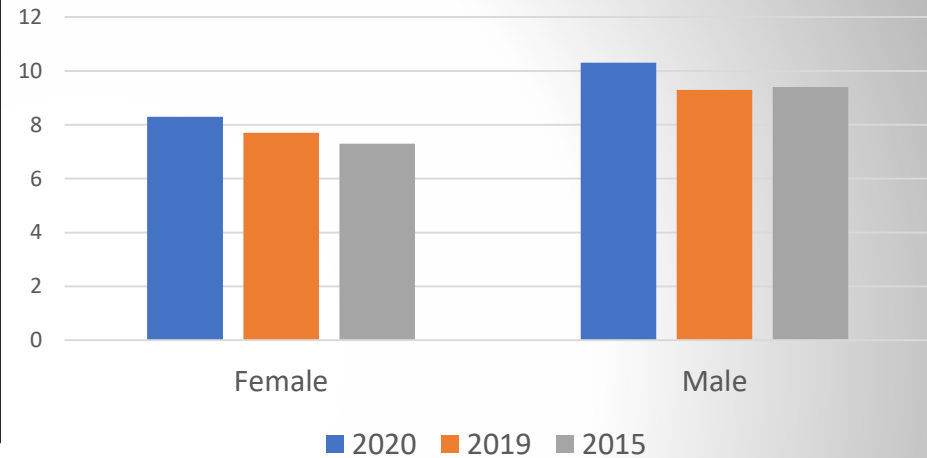
Immunity: COVID infection provides some immunity from disease

There is no clear evidence that any of these plausible mechanisms have had substantial impacts following flu epidemics.

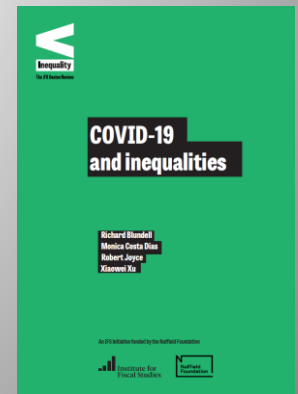
Mortality differentials: a sharp deterioration?



England Slope Index of Inequality



Reductions in 2020 US life expectancy due to COVID-19 and the disproportionate impact on the Black and Latino populations. PNAS
Theresa Andrasfay and Noreen Goldman



Conclusions

- The direct mortality implications, globally, nationally & locally, of the progression of the pandemic determined by biological, biomedical, political & socio-economic factors that are unclear at present.
- The effects of COVID-19 on mortality in future via other causes of death are likely to be considerably more substantial than recorded COVID deaths.
- The past may be less useful for making forecasts than in the past, especially overall mortality univariate time series

Thank you

Mortality improvements in light of the pandemic

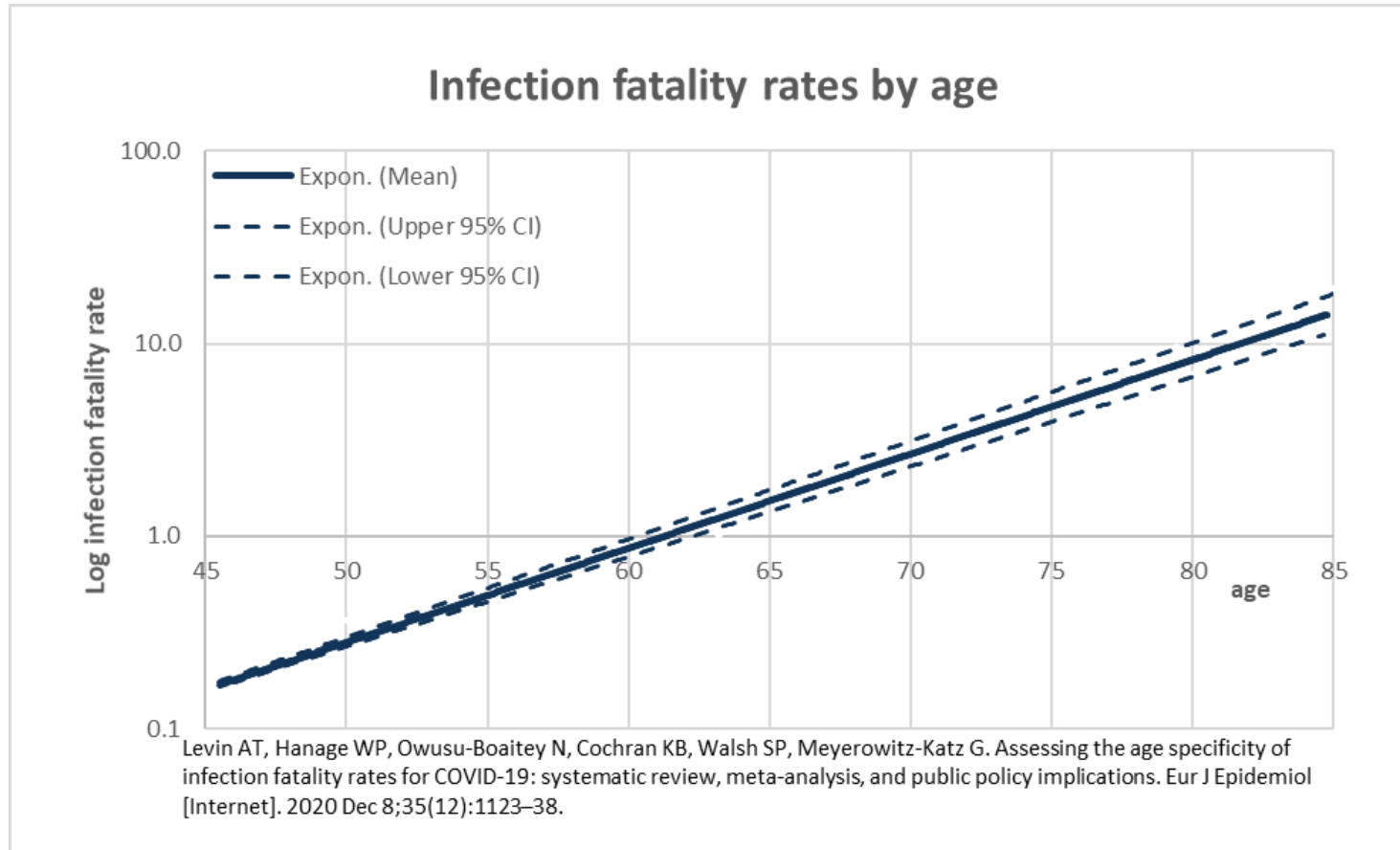
Dr Chris Martin
Crystallise

COVID-19 pandemic and mortality

- **Contemporary effects.**
 - Early case fatality rate.
 - Late case fatality rate & post-vaccination fatality rate.
- **Late effects.**
 - Frailty effects.
 - Long-term harms from COVID-19.
 - Direct effects of the virus.
 - Long-COVID, multisystem inflammatory syndrome (MIS).
 - Secondary effects.
 - CVD events. Acute kidney injury, PTSD.
 - Unknown unknowns.

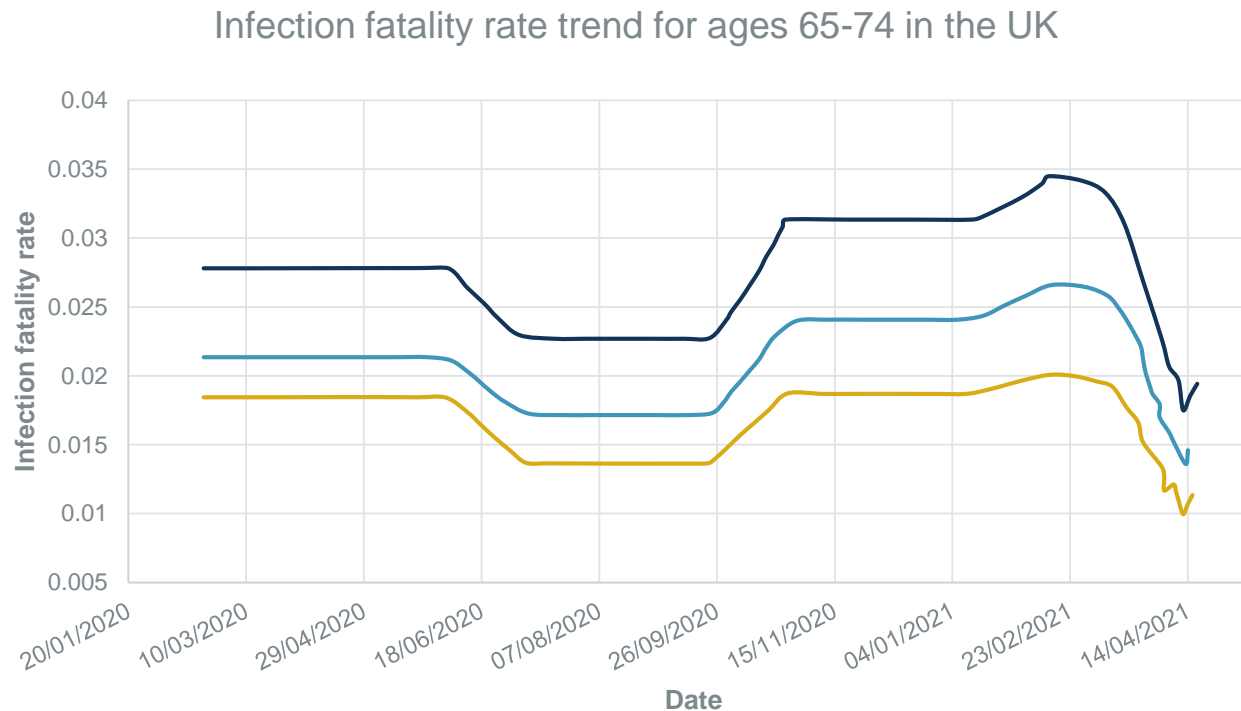
Contemporary effects

- Early pandemic case fatality rate.



Contemporary effects

- Changing case fatality rate over time.



Birrell P, Blake J, van Leeuwen E, De Angelis D. COVID-19: nowcast and forecast [Internet]. MRC Biostatistical Unit. 2021. Available from: <https://www.mrc-bsu.cam.ac.uk/nowcasting-and-forecasting-1st-april-2021/>

Contemporary effects

- COVID-19 is likely to remain in circulation permanently, but as an endemic / sporadic illness.
- The infection fatality rate (IFR) has been greatly attenuated already by improvements in treatment like pronation, dexamethasone and a optimisation of ventilation practice.
- Vaccination may not prevent all infection, but it will greatly reduce mortality.
- New variants of concern may escape existing immunity. However, as the pandemic declines the rate of emergence of new variants will decline. It is likely to take years rather than months for them to emerge.

Effect of comorbidity

- The impact of morbidities on the case fatality rate from COVID-19.

Source: Banerjee A, Pasea L, Harris S, Gonzalez-Izquierdo A, Torralbo A, Shallcross L, et al. Estimating excess 1-year mortality associated with the COVID-19 pandemic according to underlying conditions and age: a population-based cohort study. Lancet [Internet]. 2020;6736(20):1–11.

Case fatality rate

# comorbidities	Men							
>=3	4.63%	2.77%	7.04%	8.91%	12.22%	15.00%	19.41%	28.72%
2	1.54%	3.50%	3.50%	4.85%	5.86%	9.02%	14.65%	24.04%
1	0.61%	1.21%	1.77%	2.45%	3.43%	5.52%	10.10%	19.08%
0	0.12%	0.37%	0.64%	1.07%	1.71%	2.99%	5.96%	12.43%
	30-55	56-60	61-65	66-70	71-75	76-80	81-85	>85

	Men							
>=3	3.95%	6.53%	5.24%	8.08%	8.36%	10.73%	16.38%	26.01%
2	1.25%	1.06%	2.18%	3.12%	4.75%	6.71%	11.17%	20.41%
1	0.41%	0.91%	1.05%	1.74%	2.41%	3.80%	7.03%	17.14%
0	0.07%	0.25%	0.44%	0.66%	1.12%	2.14%	4.47%	11.97%
	30-55	56-60	61-65	66-70	71-75	76-80	81-85	>85

Relative impact of co-morbidity

- The impact of morbidities on the case fatality rate from COVID-19.

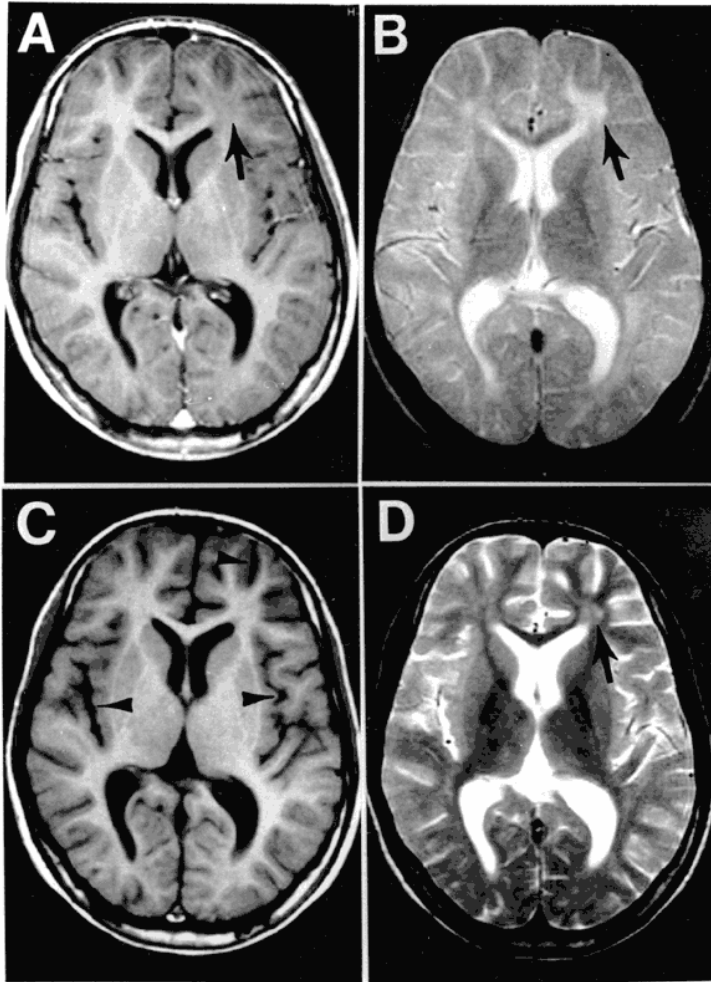
Source: Banerjee A, Pasea L, Harris S, Gonzalez-Izquierdo A, Torralbo A, Shallcross L, et al. Estimating excess 1-year mortality associated with the COVID-19 pandemic according to underlying conditions and age: a population-based cohort study. Lancet [Internet]. 2020;6736(20):1–11.

Relative mortality with comorbidities

# comorbidities	Women							
>=3	38.58	7.49	11.00	8.33	7.15	5.02	3.26	2.31
2	12.83	9.46	5.47	4.53	3.43	3.02	2.46	1.93
1	5.08	3.27	2.77	2.29	2.01	1.85	1.69	1.53
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	30-55	56-60	61-65	66-70	71-75	76-80	81-85	>85

	Women							
>=3	56.43	26.12	11.91	12.24	7.46	5.01	3.66	2.17
2	17.86	4.24	4.95	4.73	4.24	3.14	2.50	1.71
1	5.86	3.64	2.39	2.64	2.15	1.78	1.57	1.43
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	30-55	56-60	61-65	66-70	71-75	76-80	81-85	>85

Long term effects



Sub-acute sclerosing pan-encephalitis.

- Fatal progression brain inflammation.
- Caused by the measles virus.
- Affects 1:10,000 people infected.
- Appears typically 7 years after the measles infection.

Image source: Bonthius D, Stanek N, Grose C/ CDC - Bonthius D, Stanek N, Grose C (2000). "**Subacute sclerosing panencephalitis, a measles complication, in an internationally adopted child**". Emerg Infect Dis 6 (4): 377-81. [PMID 10905971](https://pubmed.ncbi.nlm.nih.gov/10905971/). Public domain

Long-term effects

It is possible that COVID-19 will cause late effects.

This may include neurological, cardiovascular, respiratory or diseases including cancer.

Infectious agent	Illness	Late effect	Delay
Varicella zoster virus	Chicken-pox	Shingles	Lifelong
Measles morbillivirus	Measles	Sub-acute sclerosing pan-encephalitis	Typically ~7 years
Epstein-Barr virus	Glandular fever	Burkitt's lymphoma, nasopharyngeal carcinoma	Decades
Treponema pallidum	Syphilis	Tertiary syphilis. Neurosyphilis. Aortic aneurysm.	Decades
Hepatitis B or virus	Hepatitis B or C	Liver cirrhosis, liver cancer	Decades
Human papilloma virus	Genital warts	Cervical or vulval carcinoma	Decades
Streptococcus pyogenes	Tonsillitis, scarlet fever	Rheumatic heart disease. Sydenham's chorea.	Decades weeks-months

Indirect harms from COVID

- COVID-19 can be a multisystem disorder. In particular, causing widespread tendency to clotting of blood which increases the risk of heart attacks and strokes.
- Some COVID-19 victims will be left with the long-term consequences of strokes, heart attacks and other 'injuries'.

One-year risks	Population	COVID patients	Ratio
Major adverse cardiovascular events	16.2%	1.360%	11.90
Diabetes	13.1%	1.460%	8.94
Chronic kidney disease	5.6%	0.570%	9.84
Chronic liver disease	1.2%	0.040%	29.50

SMR for survivors of acute MI is about 2.2.

Plakht Y, Gilutz H, Shiyovich A. Excess long-term mortality among hospital survivors of acute myocardial infarction. Soroka Acute Myocardial Infarction (SAMI) project. Public Health [Internet]. 2017 Feb;143:25–36.

Source. Office for National Statistics. The prevalence of long COVID symptoms and COVID-19 complications [Internet]. 2020 [cited 2021 Jan 19]. <https://www.ons.gov.uk/news/statementsandletters/theprevalenceoflongcovidssymptomsandcovid19complications>. Data supplement Table 5

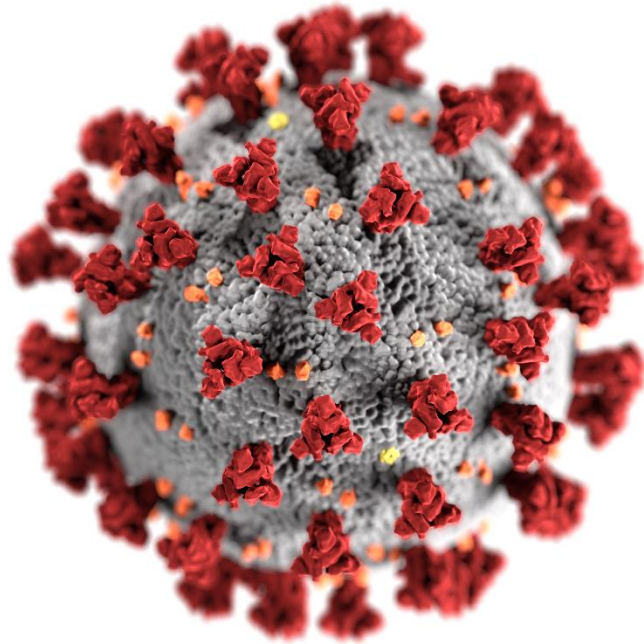
Messages

There are counterfactual drivers of mortality improvement / disimprovement that will emerge. The scale of these and the resulting balance between them is not yet known.

- COVID-19 will become a sporadic / endemic condition like the seasonal flu. The **IFR will be lower** as a consequence of vaccination, partial immunity and better treatment.
- **Short-term mortality improvements** (1-2 years) resulting from a reduction in frailty in the population, particularly in the elderly.
- A **cohort of people harmed** by COVID-19 that will bear a permanent increased mortality rate as a consequence of injury (lung fibrosis, CVD, kidney and liver disease).
- **Unknown unknowns:** long-term consequences to SARS-CoV-2 infection that impact mortality rates in the future.

Mortality improvements in light of the pandemic

Tim Gordon
Aon



Presentation to CMI / SIAS

Mortality improvements in light of the pandemic

Tim Gordon, Head of Demographic Horizons™

13 April 2021

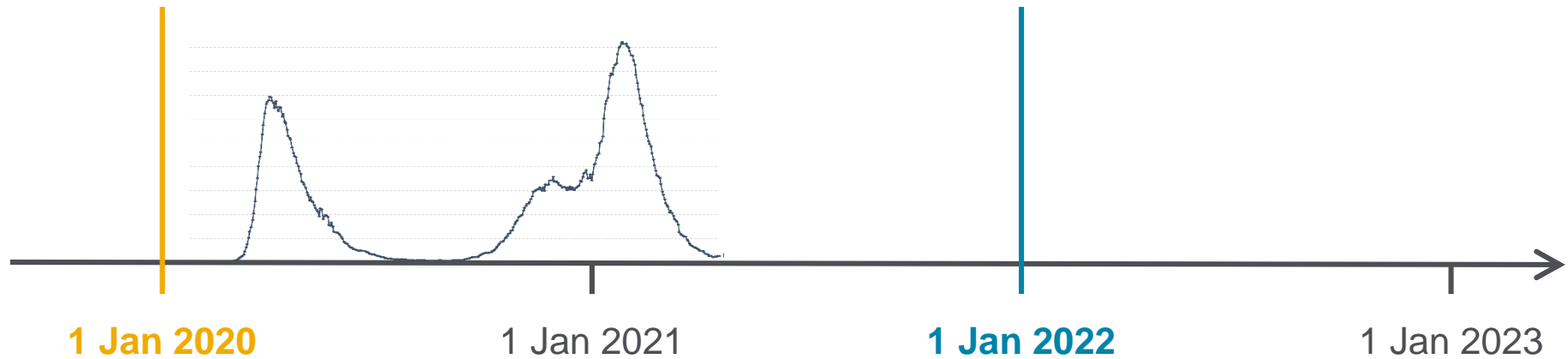
1 Longevity forecast uncertainty is *large*

2 Multiple drivers with complex interaction
– the *emergent* impact is hard to predict

3 The pandemic could be *positive* or
negative for future longevity

This is about the future, *not* the pandemic to date

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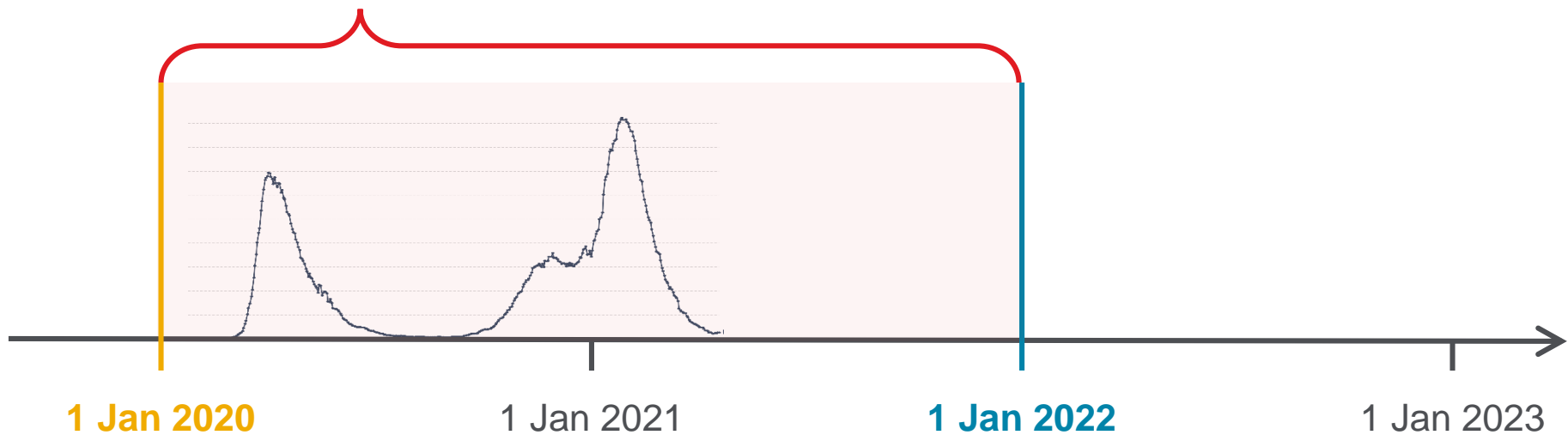


This is about the future, *not* the pandemic to date



Not included

- Mortality vs expected *during the pandemic* to date
- *Mostly a matter of fact*
- Impact < 1% of pension liabilities



This is about the future, *not* the pandemic to date



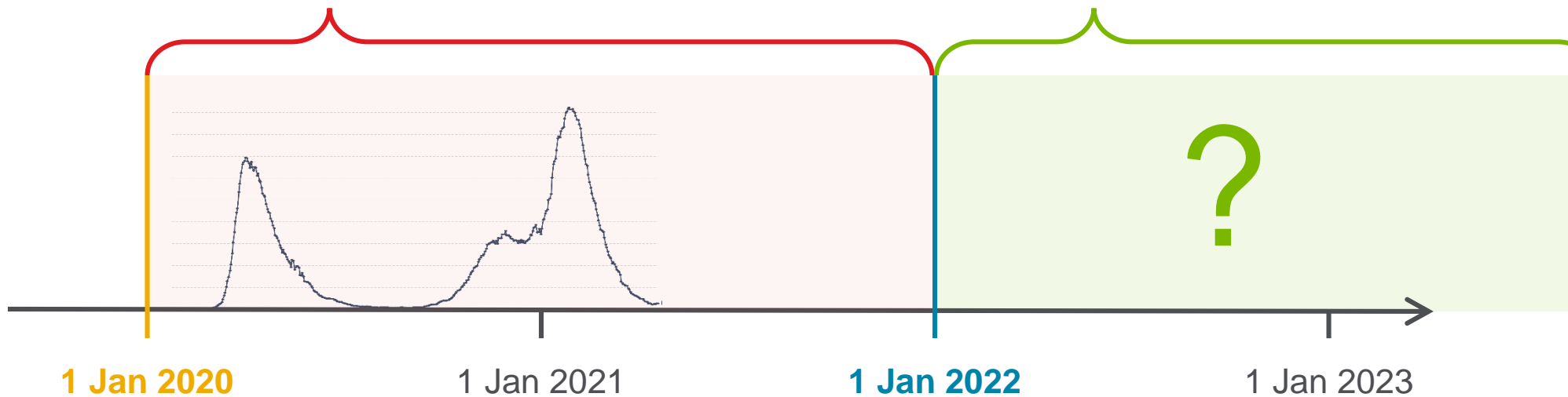
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Included

- Compared with view as at **1 Jan 2020**
- Actual mortality from **1 Jan 2022**



This is about the future, *not* the pandemic to date



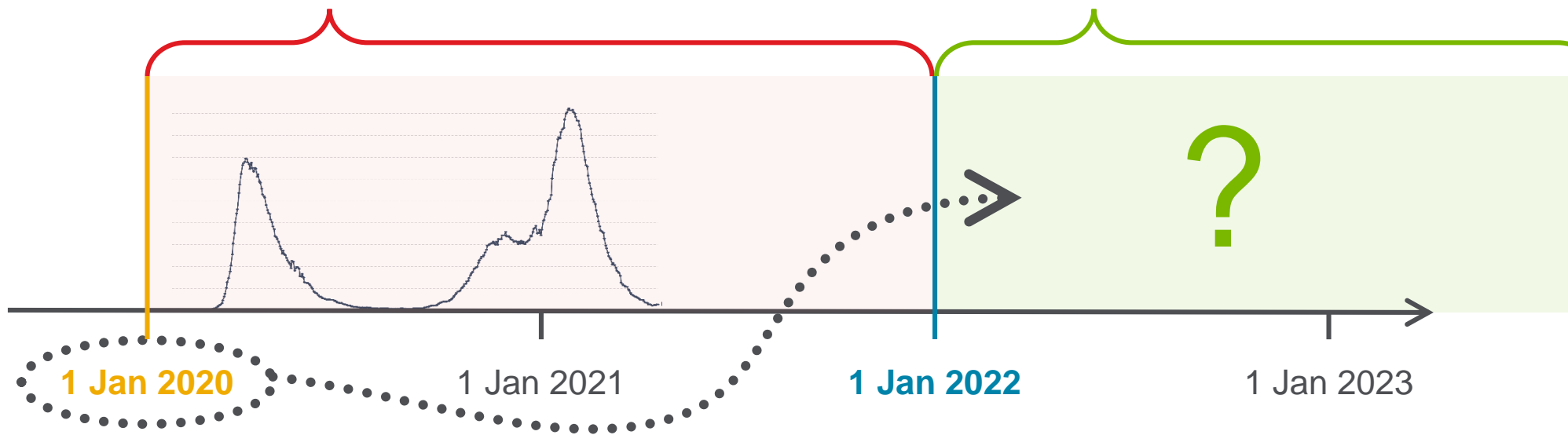
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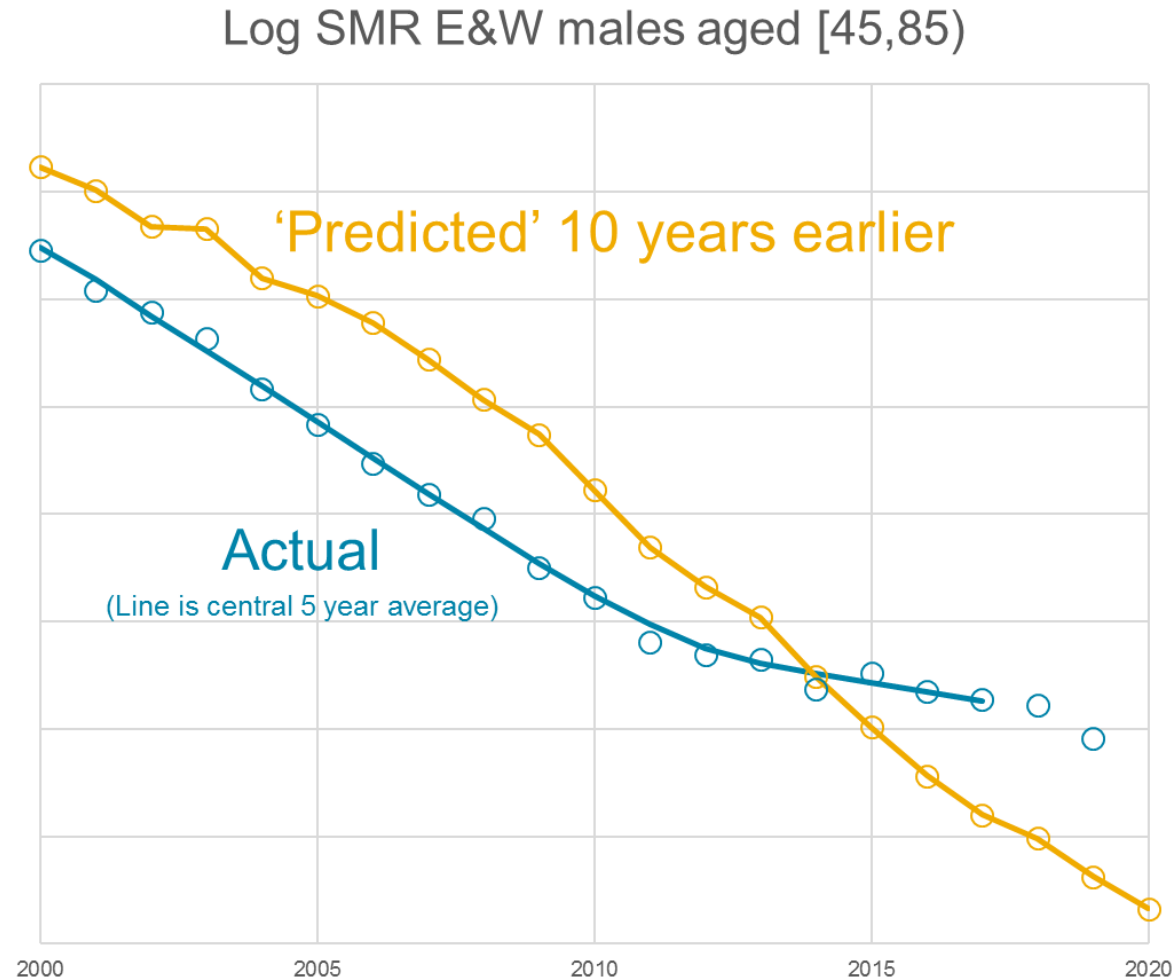
Included

- Compared with view as at **1 Jan 2020**
- Actual mortality from **1 Jan 2022**



Forecast uncertainty

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Illustration

- E&W males (HMD/ONS data)
- Apply CMI Core Model (CMI_2019)
- LTR from historical (smoothed) 60 year average improvements
- SMR aged [45,85) (standardised using 2013 Euro pop)

Plotted

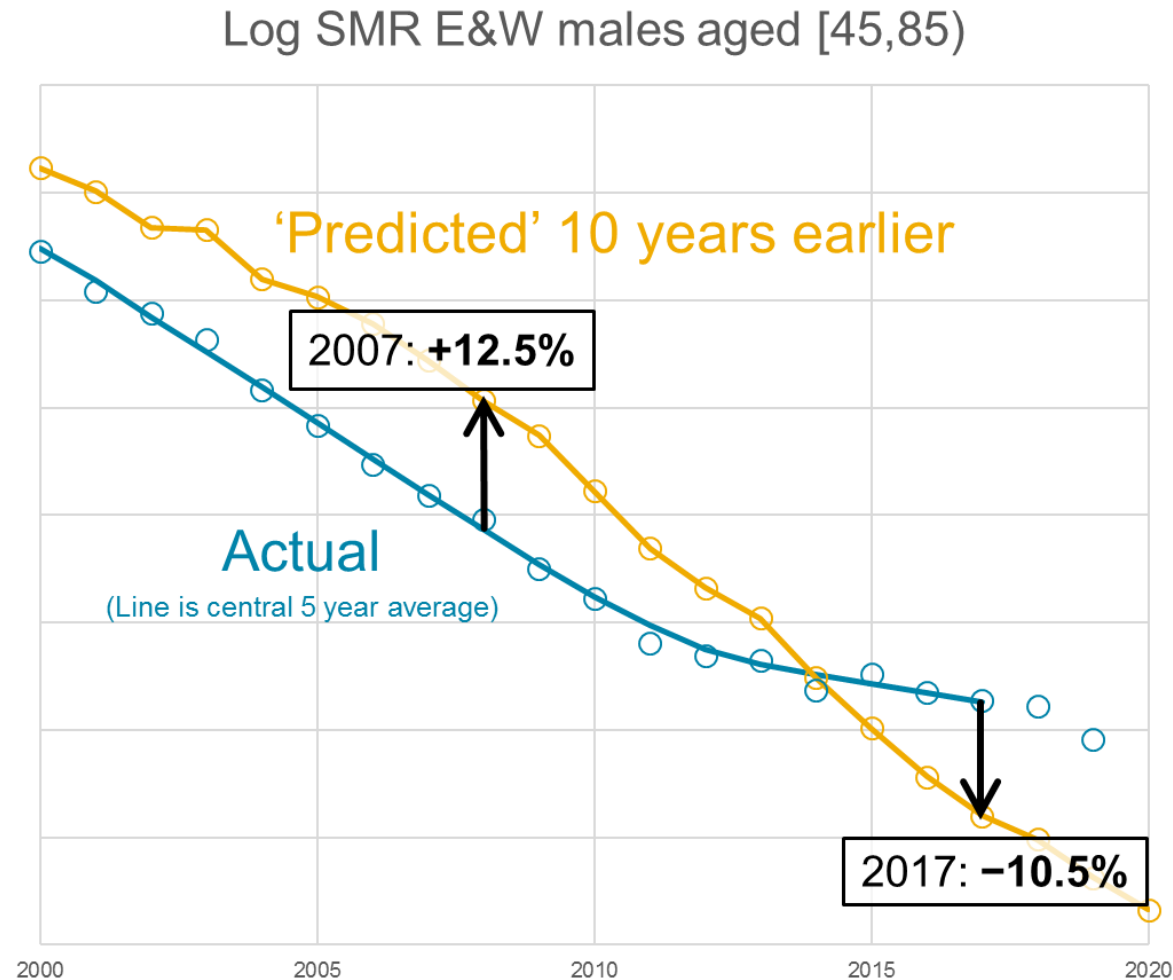
- Smoothed actual
- 'Predicted' from 10 years before

Source: HMD, ONS and CMI plus Aon calculations

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Forecast uncertainty

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Illustration

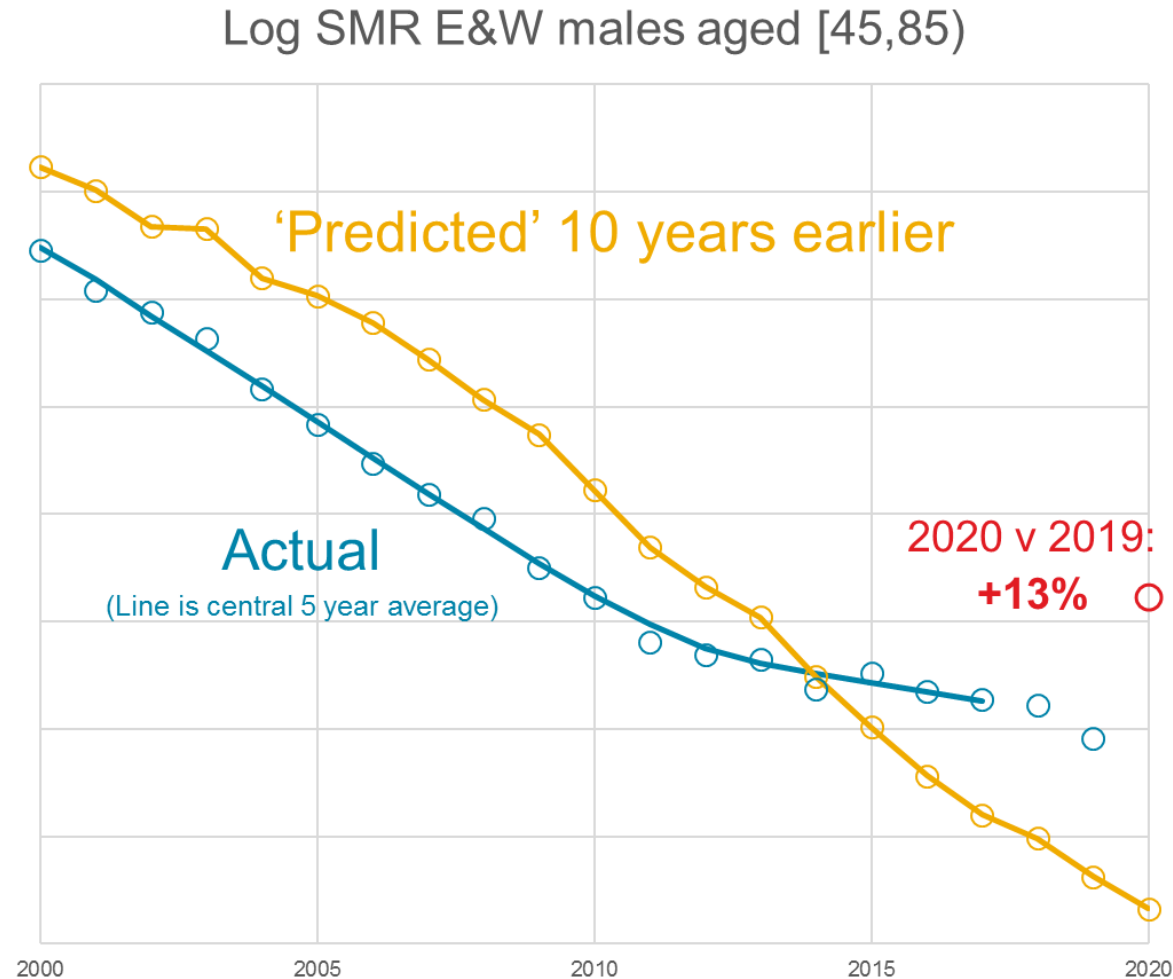
- E&W males (HMD/ONS data)
- Apply CMI Core Model (CMI_2019)
- LTR from historical (smoothed) 60 year average improvements
- SMR aged [45,85) (standardised using 2013 Euro pop)

Plotted

- Smoothed actual
- 'Predicted' from 10 years before

Even over just ten years, mortality forecasts can be wrong by $\pm 10\%$

Magnitude of shock



2020 was a huge shock

- On this log SMR measure, 2020 has been the biggest one year hit since 1929 (comparable)
- Two year hit was worse in 1940

But

- It *does not automatically* follow that 2020 is predictive
 - It is clearly an outlier
 - Humans adapt

Graphic to indicate *incidence* of driving factors

Base graphic

Quadrants indicate whether likely impact of the driving factor will be affected

- **positively** or **negatively** compared with pre-pandemic best estimates
- in the **shorter** or **longer** term

Potential incidence	
Positive Short term	Positive Long term
Negative Short term	Negative Long term

Example A

A driving factor that

- is **positive**
- is **shorter** term

Potential incidence	
Positive Short term	

Example B

A driving factor that

- could be **positive** or **negative**
- is **longer** term

Potential incidence	
	Positive Long term
	Negative Long term

Example C

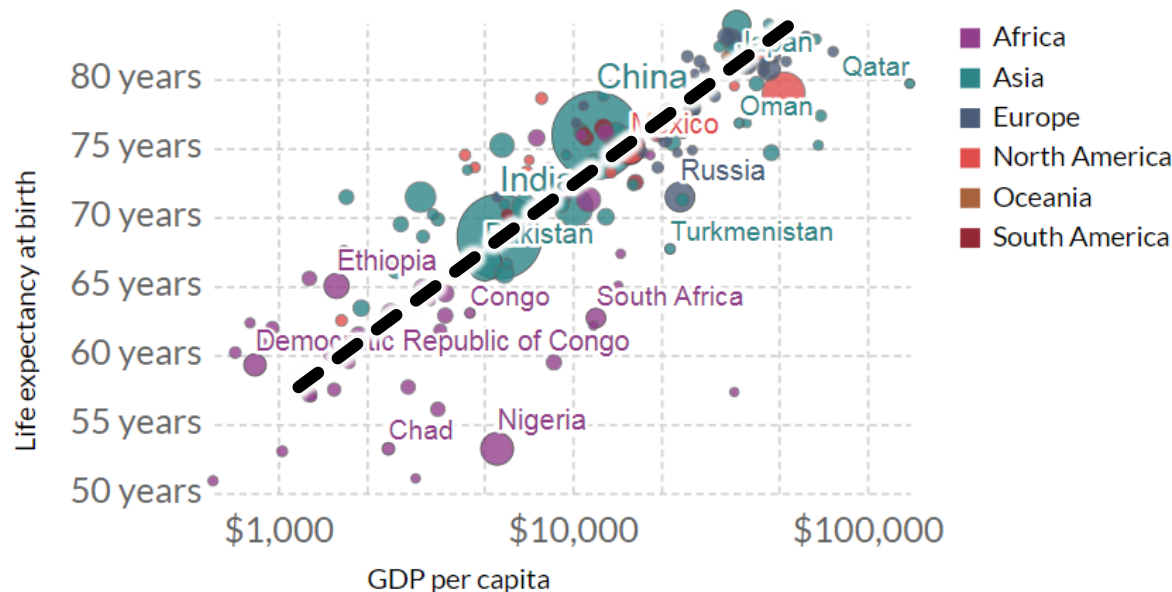
A driving factor that is

- is **positive**
- is **shorter** and **longer** term

Potential incidence	
Positive Short term	Positive Long term

Impact of recessions on mortality

At a global level, life expectancy is correlated with GDP per capita¹



And so the obvious narrative is that recessions must surely be negative for longevity, but **the data do not bear this out**

“[the link between recessions and lowered death rates is] almost as strong as the evidence that cigarette smoking is bad for health”

Granados²

1. As at 2015. GDP per capita is measured in 2011 international dollars, which corrects for inflation and cross-country price differences. Source: Our World in Data based on estimates by James C. Riley, Clio Infra, and the United Nations Population Division. <https://ourworldindata.org/grapher/life-expectancy-vs-gdp-per-capita>

2. Quoted in Nature 565, 412-415 (2019) doi: <https://doi.org/10.1038/d41586-019-00210-0>

Potential incidence

Positive Short term	
	Negative Long term

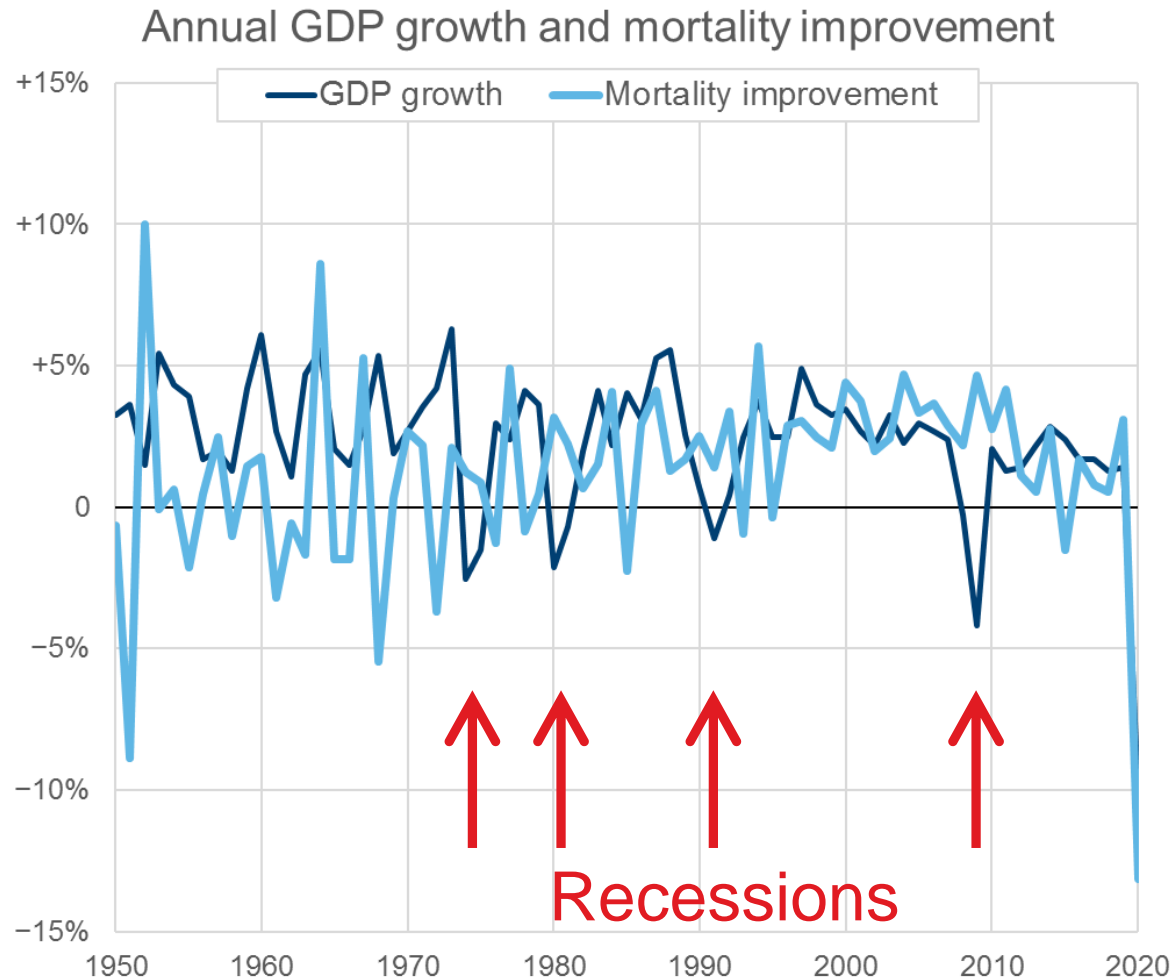
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- The overall impact of recessions on mortality is (notoriously) unclear
- This is not new – positive impact of recession on longevity observed 100 years ago in the US
- *Short-term* impact can be positive
 - Lower levels of smoking, drinking
 - Lower levels of pollution
- Potentially worse *longer-term*
- Public spending, *especially on health and social care*, is critical

UK GDP growth v mortality improvement

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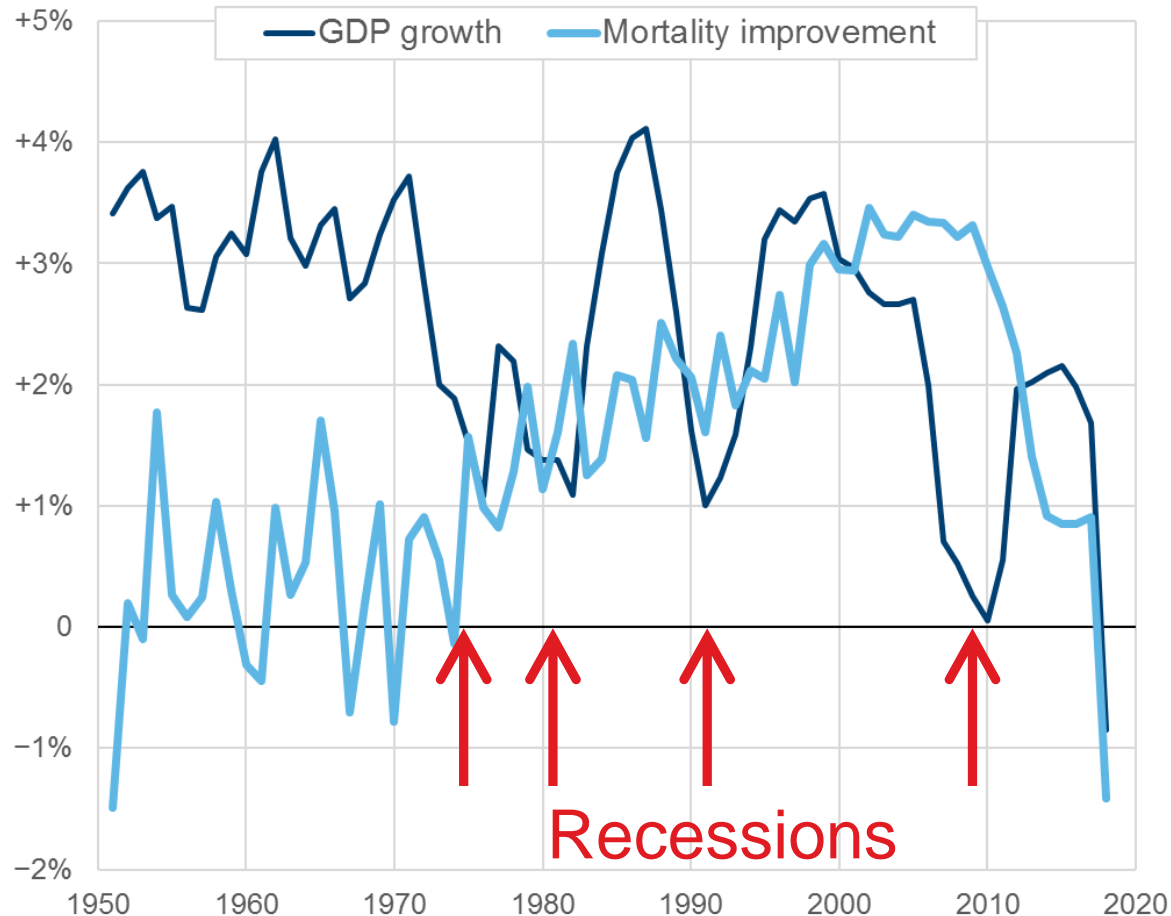
What do the data show?



UK GDP growth v mortality improvement

Smoothed (5 year central average)

Annual GDP growth and mortality improvement



What do the data show?

- The data are unclear – we cannot draw reliable conclusions as to correlation, let alone causality
- But we can say that recessions are *not* necessarily followed by falls in mortality improvement
- In **3 of the 4** cases on the left, recessions were followed by an *acceleration* of mortality improvement

Source: HMD, ONS and CMI plus Aon calculations. Mortality improvements are derived from male E&W log SMRs.

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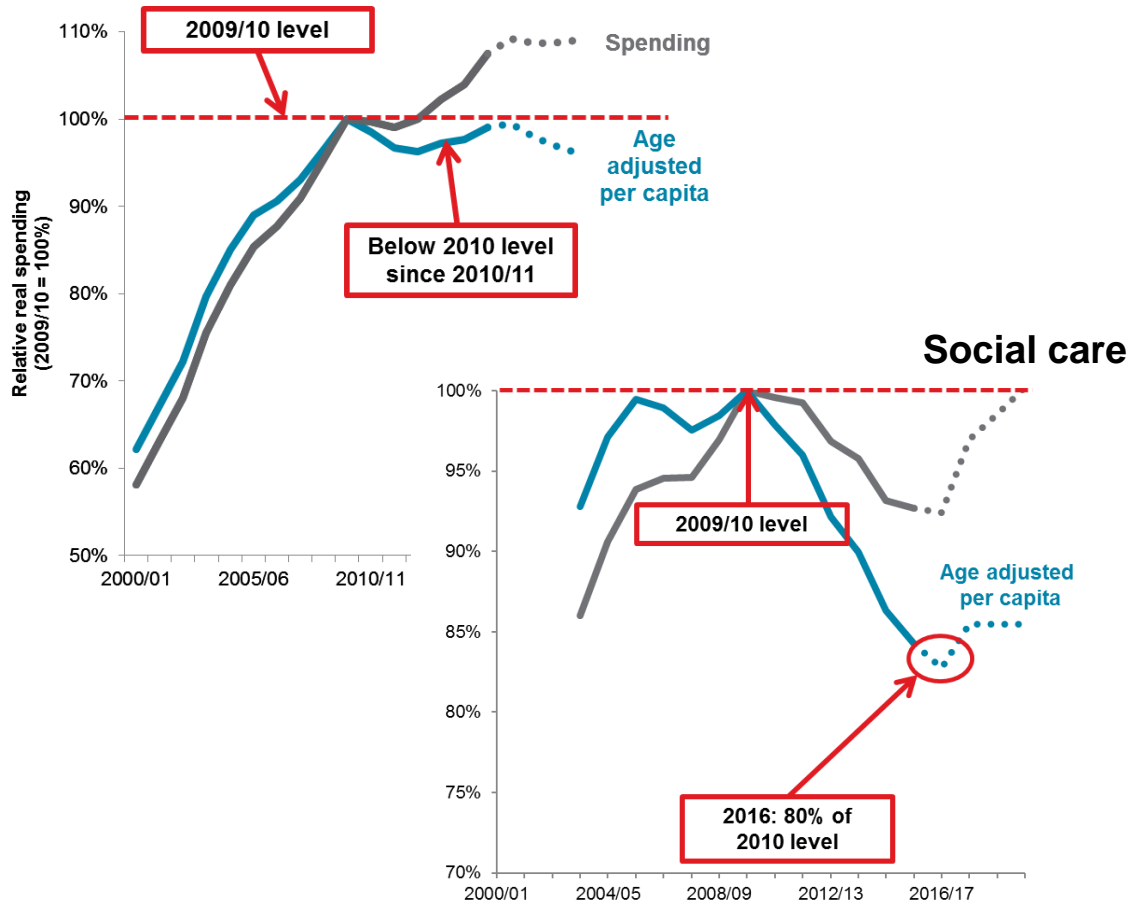
Increased health and social care spending

Potential incidence

Positive Short term	Positive Long term

50

NHS



- Important to allow for population, age distribution and costs by age
- 2000-2010 high improvement coincided with high annual increases in longevity
- Post 2010 very low mortality improvements coincided with almost nil health and social care spending increases
- Correlation vs causation – falls in improvements in the 2010s were also seen in countries without such falls in healthcare spending
- Could we see appetite for a large post-COVID increase in spending?

Source: HMD, ONS and CMI plus Aon calculations

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AON

Potential incidence of other factors – positives

Positive Short term	Positive Long term

Lifestyle / pollution

- Reduced smoking
- Higher exercise during lockdown
- NOx levels 20-30% lower than pre-lockdown

Positive Short term	Positive Long term

Effectiveness of vaccines

- Strongly positive real-world data from e.g. Israel and UK

Positive Short term	Positive Long term
Negative Short term	

Influenza deaths

- Almost no 2020/21 'flu deaths
- More positive attitude to preventative measures
- Concerns over immunity and make-up of the next flu vaccine

Positive Short term	Positive Long term

mRNA vaccines

- COVID-19 is first approved use of mRNA vaccines
- Manifold medical applications, e.g. cancer treatment
- Will receive more funding

Positive Short term	

Frailty effect

- Some pandemic deaths would have died in the next few years
- Short-term positive impact on mortality (already visible?)

	Positive Long term

Systems hardening

- Expect UK to be hardened to future pandemics
- Better monitoring, resourcing and planning

Potential incidence of other factors – negatives

Negative Short term	Negative Long term

Endemic COVID-19

- Eradication seems unlikely
- Long-COVID is a concern – estimated 1 million cases in UK

Negative Short term	Negative Long term

Fall in elective care

- Higher mortality from delays in cancer diagnoses and treatments
- But impact expected to be small if care is postponed not cancelled
- SAGE estimate: 6 month delay in cancer diagnoses leads to 1,500 excess deaths for 5 years

Negative Short term	Negative Long term

Vaccine escape / immunity

- Mutation has *already* occurred, e.g. UK (B.1.1.7), South Africa (B.1.351), Brazil (P1 / B.1.1.28)
- Persistence of immunity unclear

Negative Short term	Negative Long term

Bio warfare / terrorism

- Effectiveness of viral pandemic at shutting down the developed world has been proven
- Pandemic will stimulate spread of knowledge



Pre-pandemic best estimate projected mortality remains broadly reasonable

- There are positive as well as negative impacts – in particular, recession is *not necessarily negative* for longevity
- Don't forget that we were starting from an historically low base



Traps for the unwary

- Giving *any* weight to the 2020 outlier (*mortality projections*) – other adjustments are preferable
- Not accounting for geographical and other mortality variation in 2020 (*base mortality experience*)

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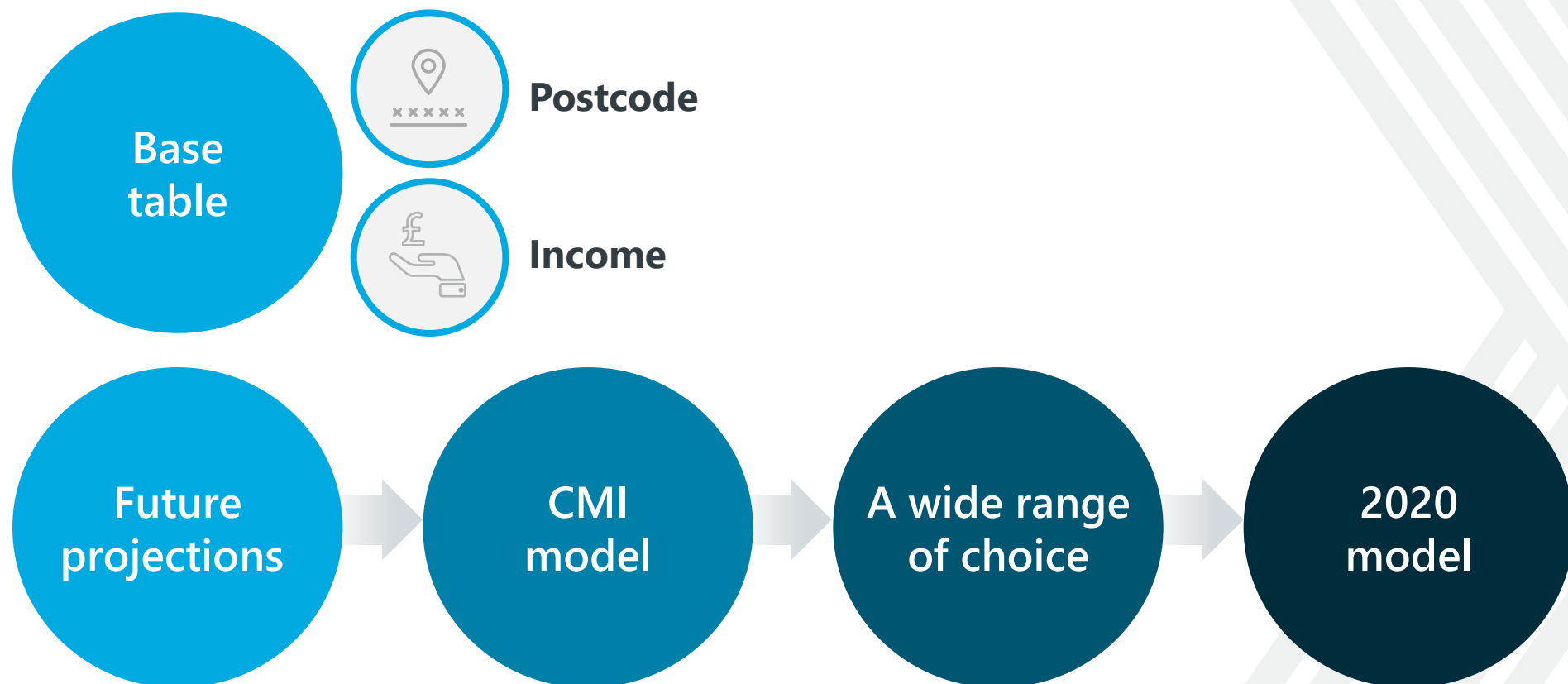


Mortality improvements in light of the pandemic

Steve Leake
XPS

CMI Update - Mortality improvements in light of the pandemic

Scheme specific life expectancy



Forward looking model

**Socio-economic
and Demographic**



**Forward
looking
model**



**Vulnerability
Analysis**



**Range of
Scenarios**



**Investment
Scenarios**



**CMI model
calibration**

Building the model

Probability of catching COVID-19



Location



Age



Gender



Occupation

Impact on life expectancy from catching COVID-19



Hospital
services



Age



Gender



Current
health



Levels of
deprivation



Interruption of
health services



COVID-19
severity

Impact on life expectancy from second order factors



Hospital
services



Impact of
recession



Levels of
deprivation



Interruption of
health services



Healthcare
spending



Lifestyle
changes

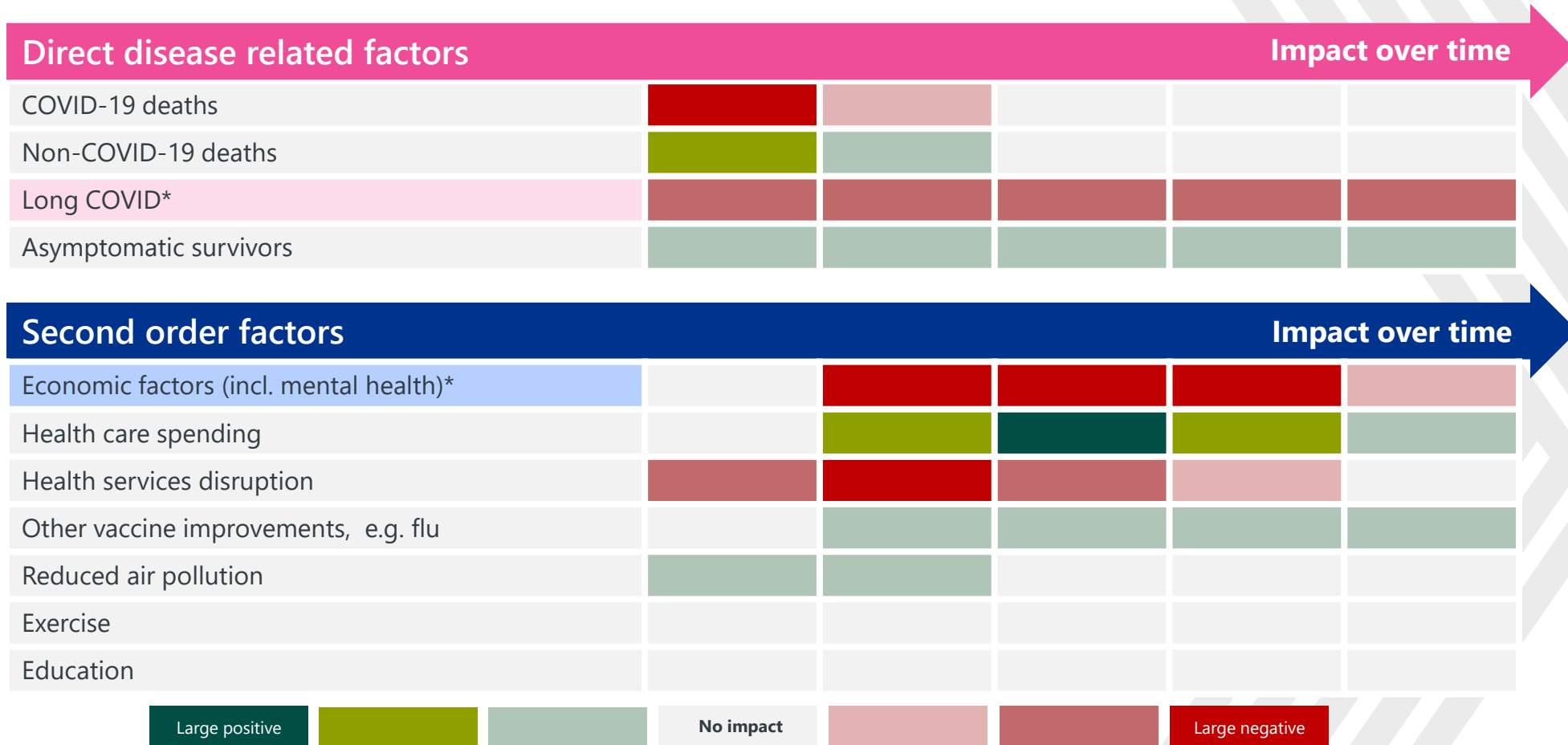


Environmental
factors

Scenarios

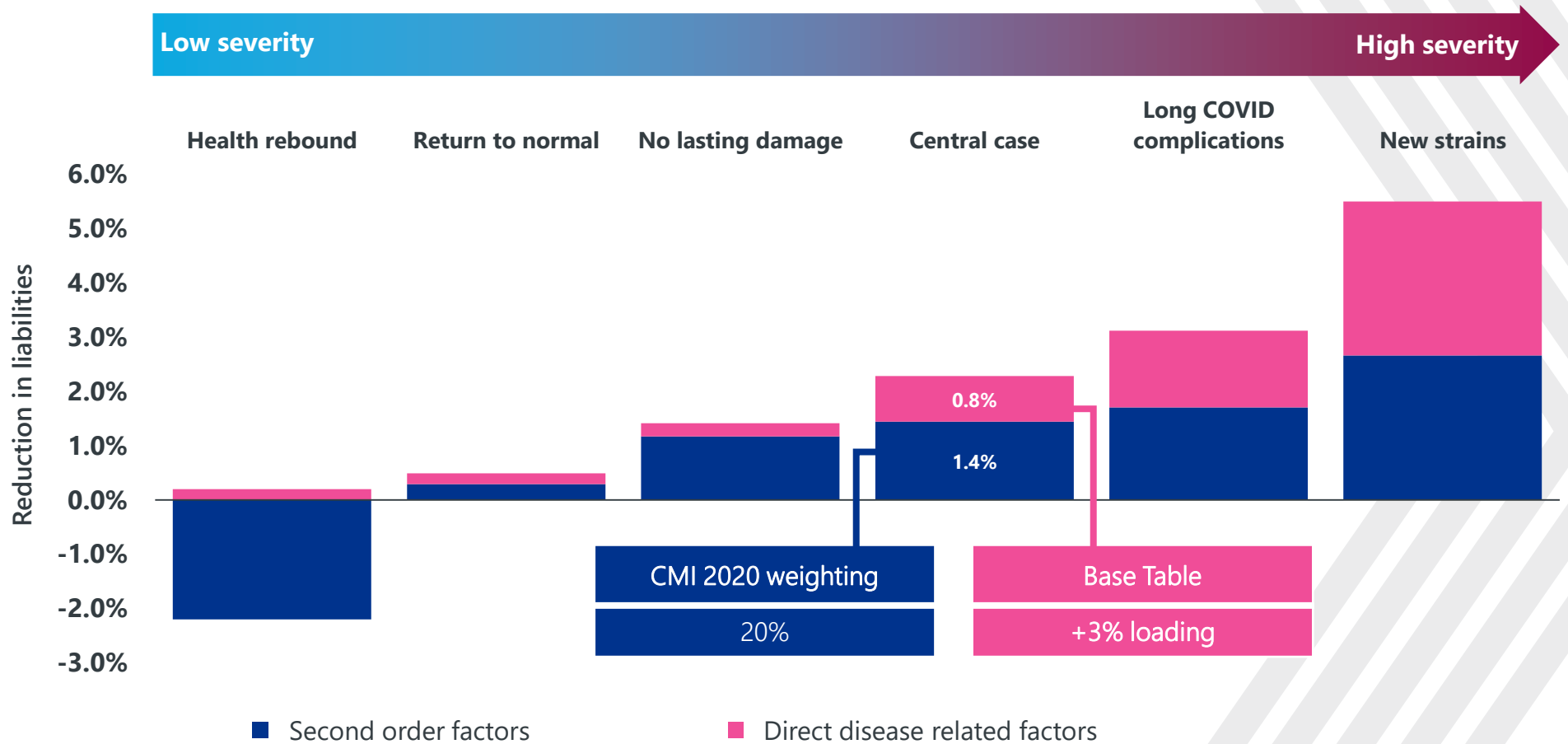


Central case

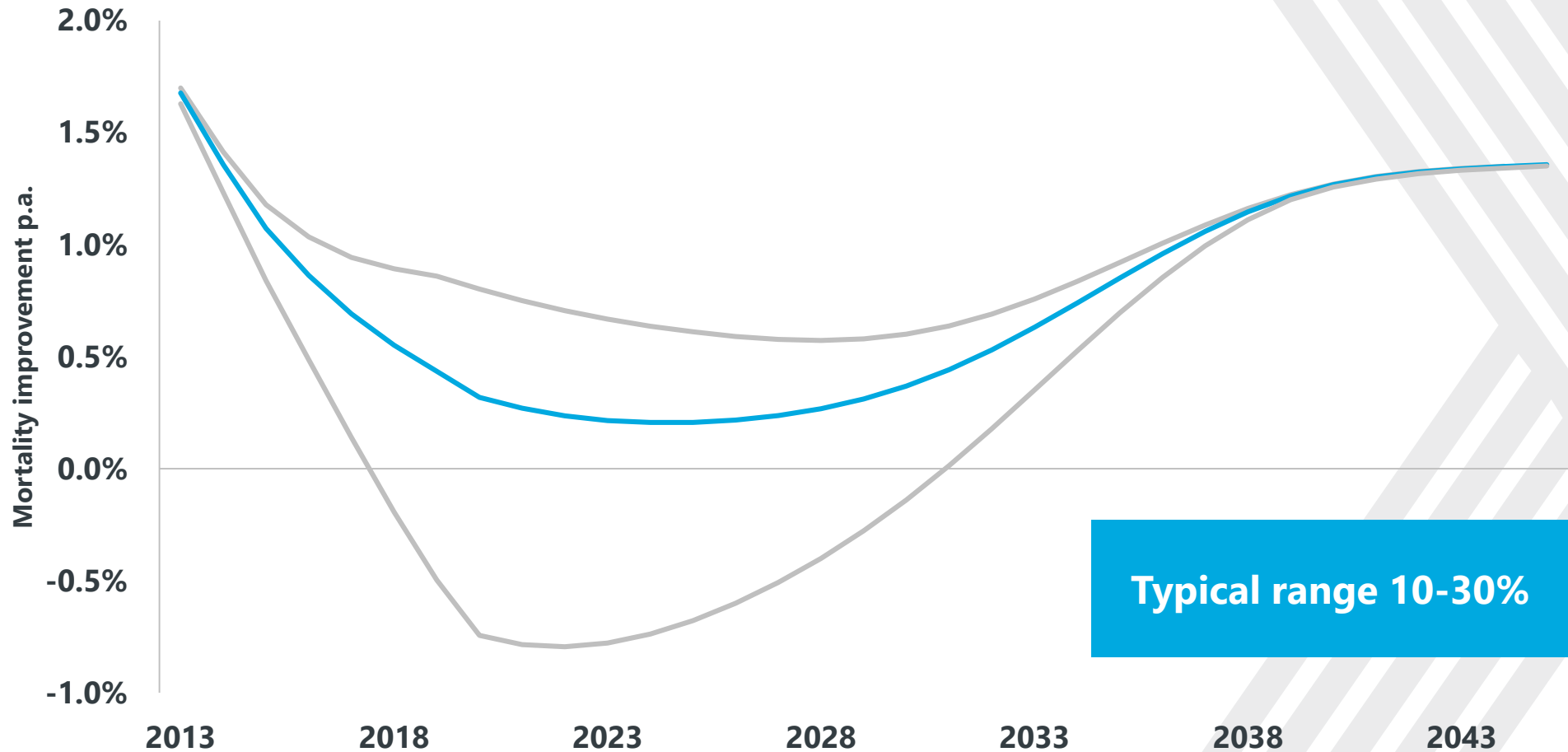


*Subject to the most uncertainty and are stressed in our scenarios

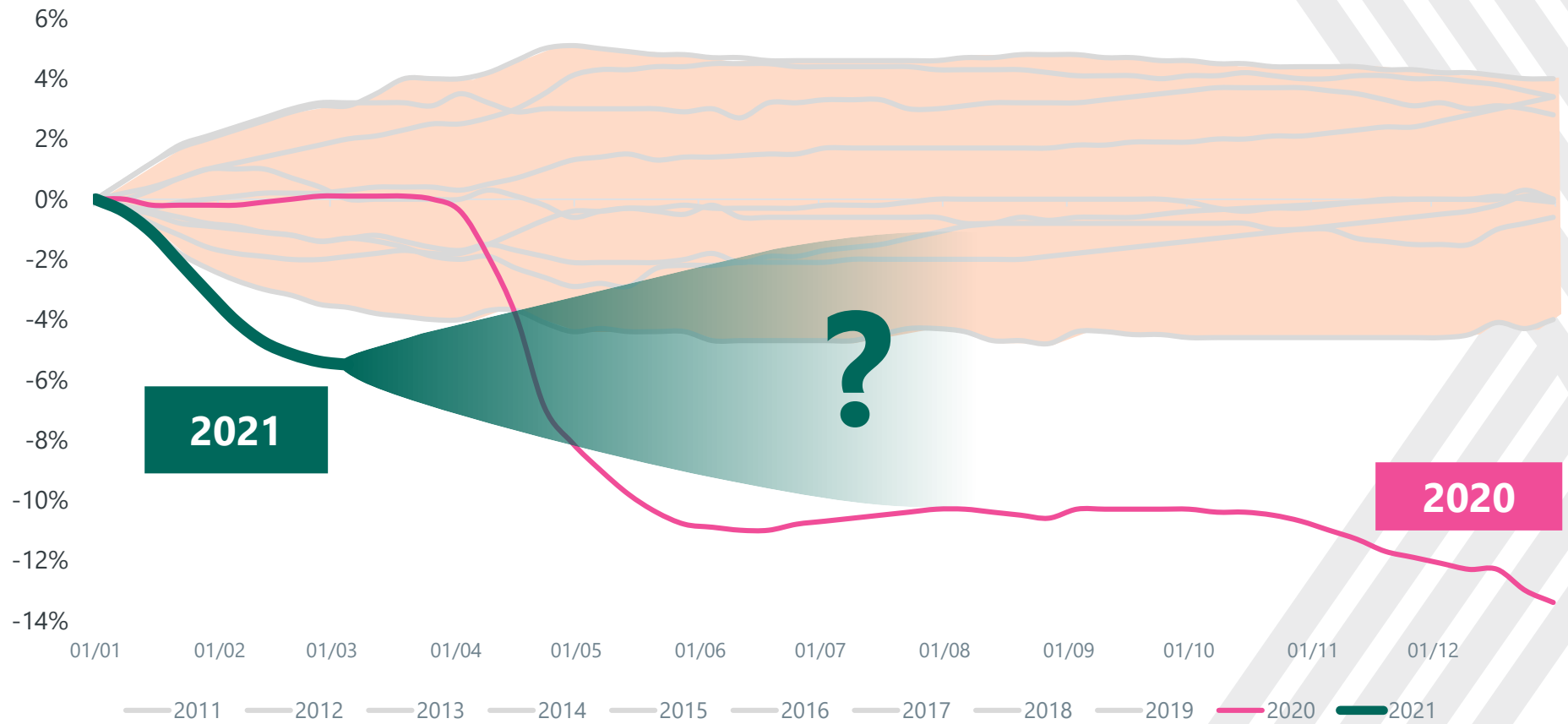
Outputs



Scheme specific weighting



2021 so far...





Questions



Comments

The views expressed in this presentation are those of the presenter.



Continuous Mortality Investigation

Institute and Faculty of Actuaries

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