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B2: Artifacts in Population Data

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PartnerRe

02 March 2015

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Artifact (or should it be Artefact?)



“an unintentional pattern in data, arising from processes of collection and management”

Where have all the men gone?



http://news.bbc.co.uk/2/hi/uk_news/magazine/3601493.stm

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Discussion Topics

- Projection Basics
- Smoothing
- Basis Risk
- Migration Impact
- International Comparison
- External Factors and Volatility



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Mortality Projections 101

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ertise
ponsorship
Thought leadership
Progress
Community
Sessional Meetings
Education
Working parties
Volunteering
Research
Shaping the future
Networking
Professional support
Enterprise and risk
Learned society
Opportunity
International profile
Journals
Support

The Basics

$$\text{Death Rate} = \frac{\text{Deaths}}{\text{Exposure to Risk}}$$

The Basics



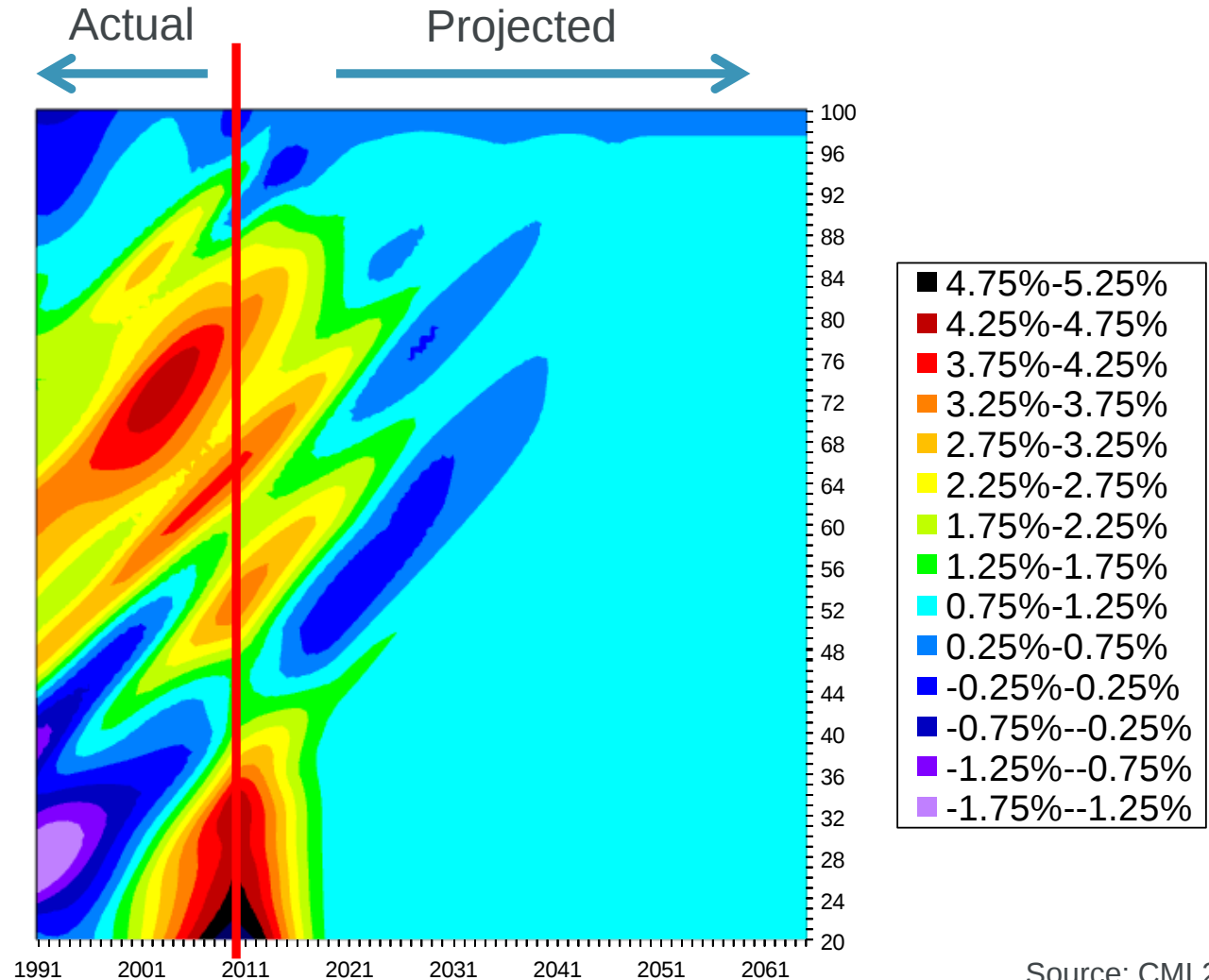
Death Rate

The Basics

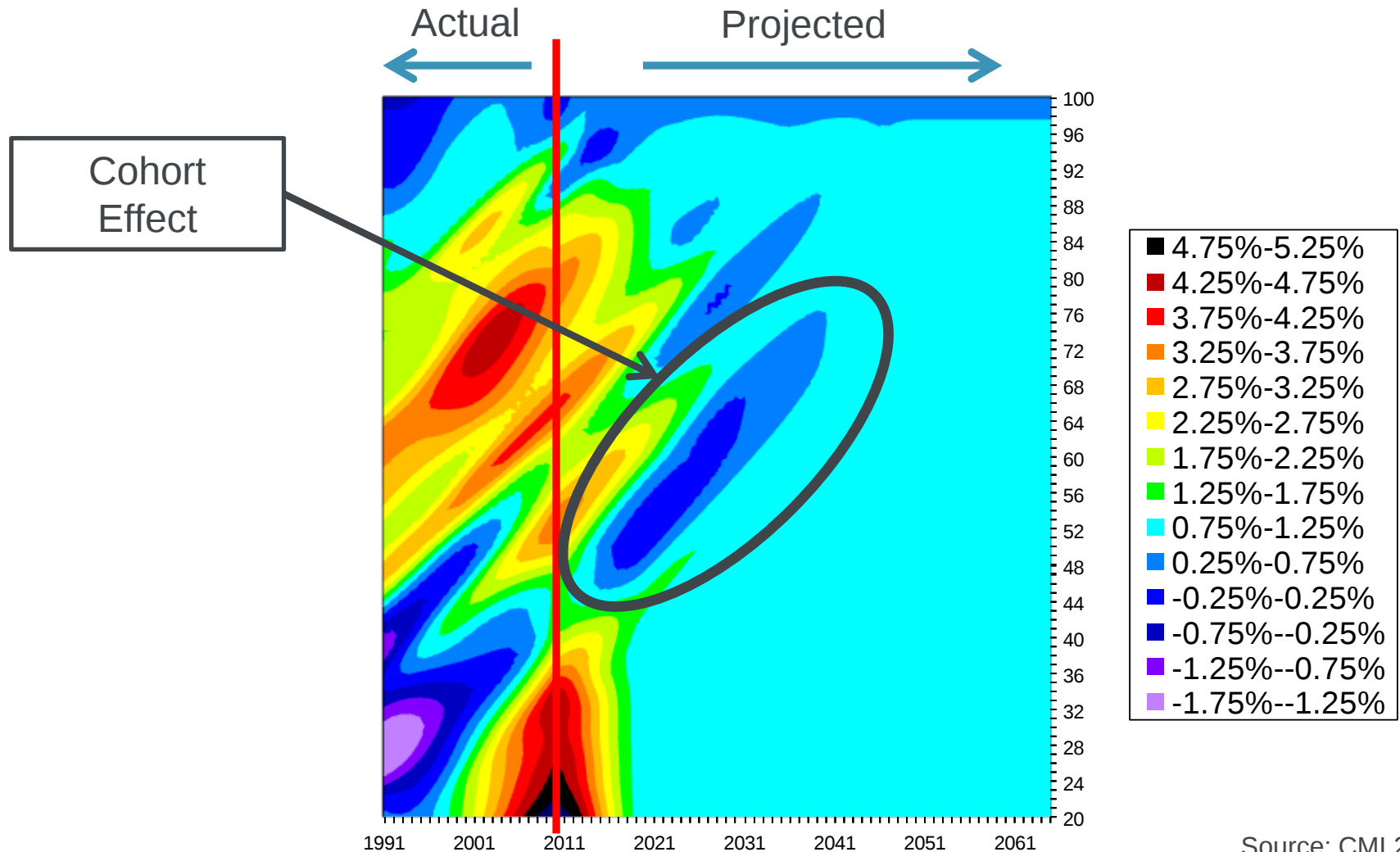


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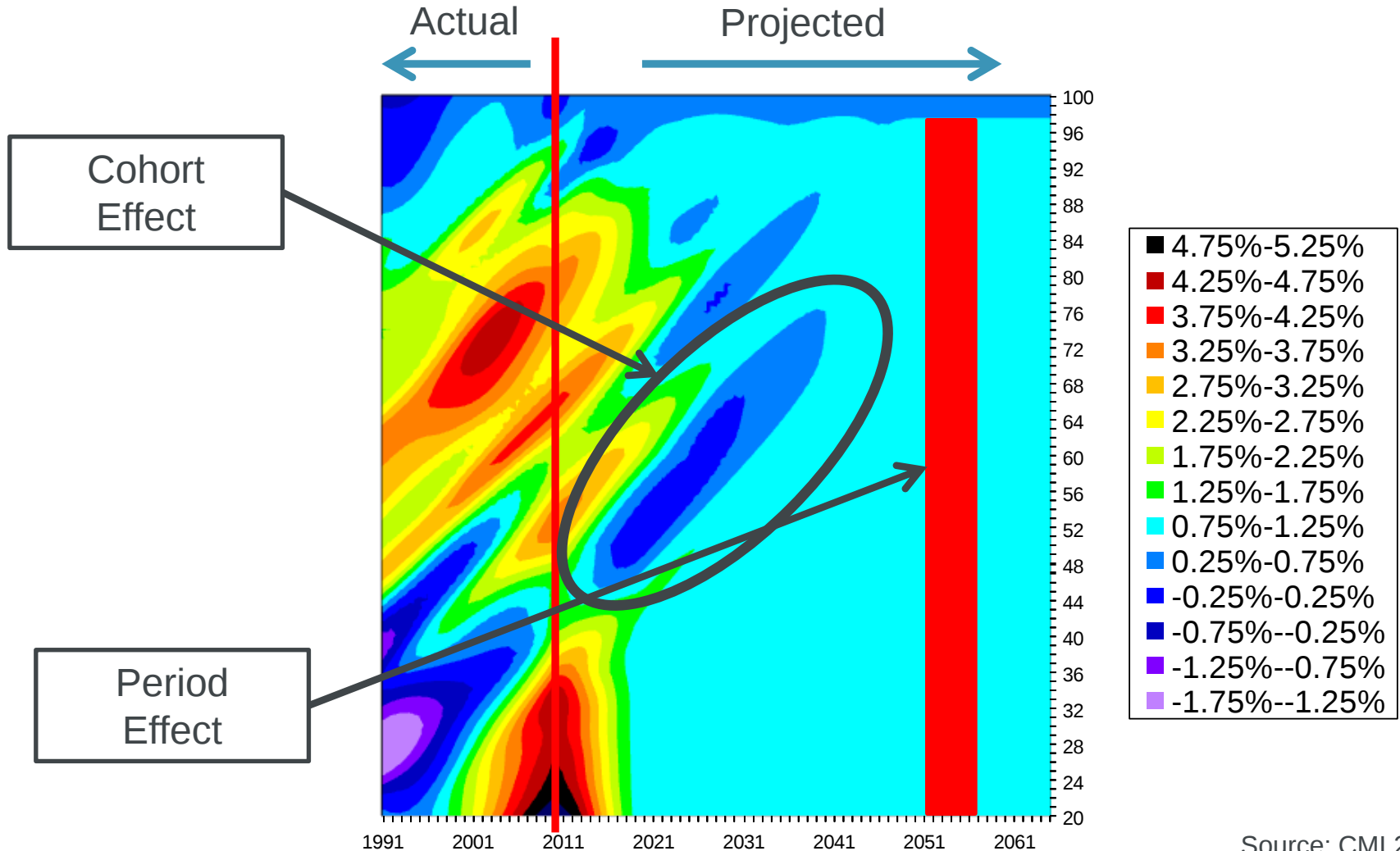
Heat Map



Heat Map



Heat Map



Source: CMI 2013

Potential Complications

$$E(x,t)$$

Potential Complications

$$E(x,t) \approx P\left(x, t + \frac{1}{2}\right)$$

Potential Complications

$$E(x, t) \approx P\left(x, t + \frac{1}{2}\right) \\ \approx 0.5 \times [P(x, t) + P(x, t + 1)]$$

What
assumptions are
we making here?



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To Smooth or not to Smooth?

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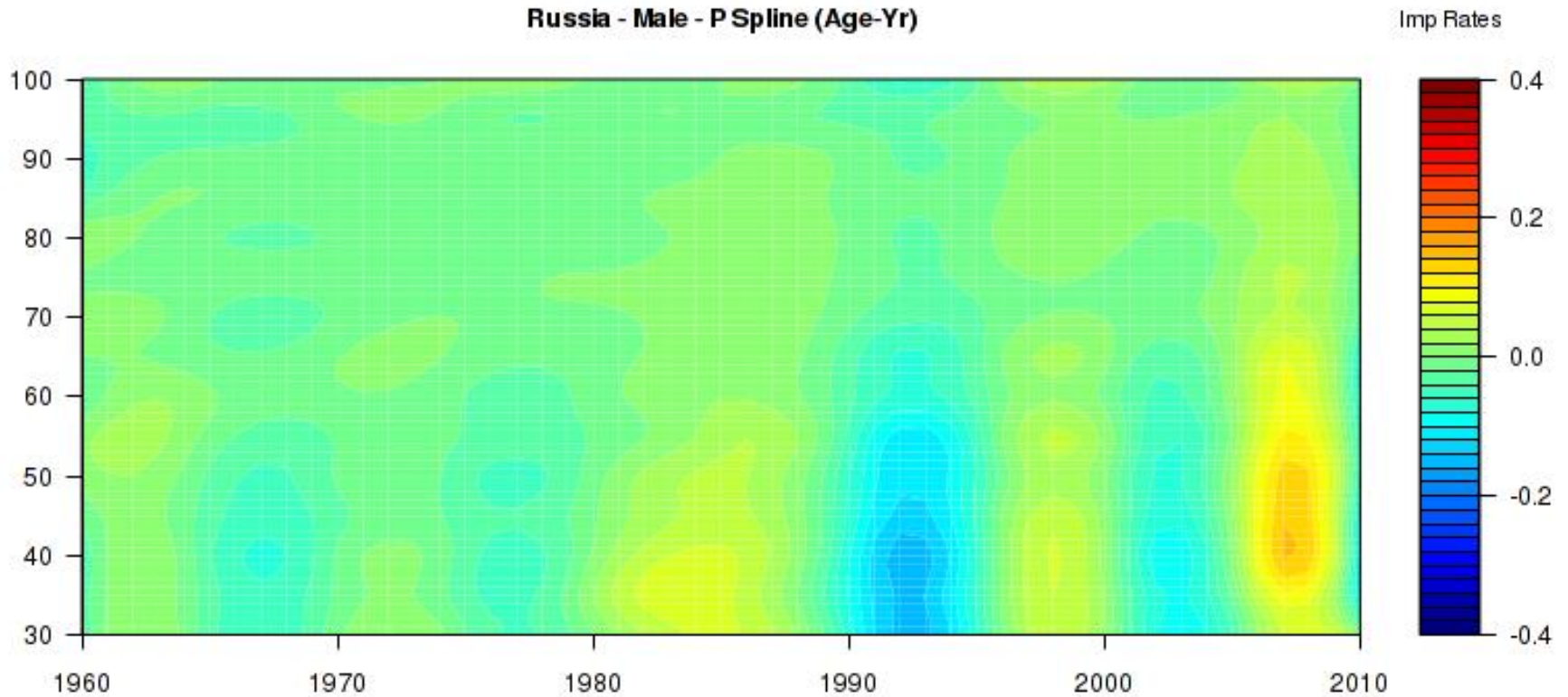
Potential Complications

Too
much
smoothing
???



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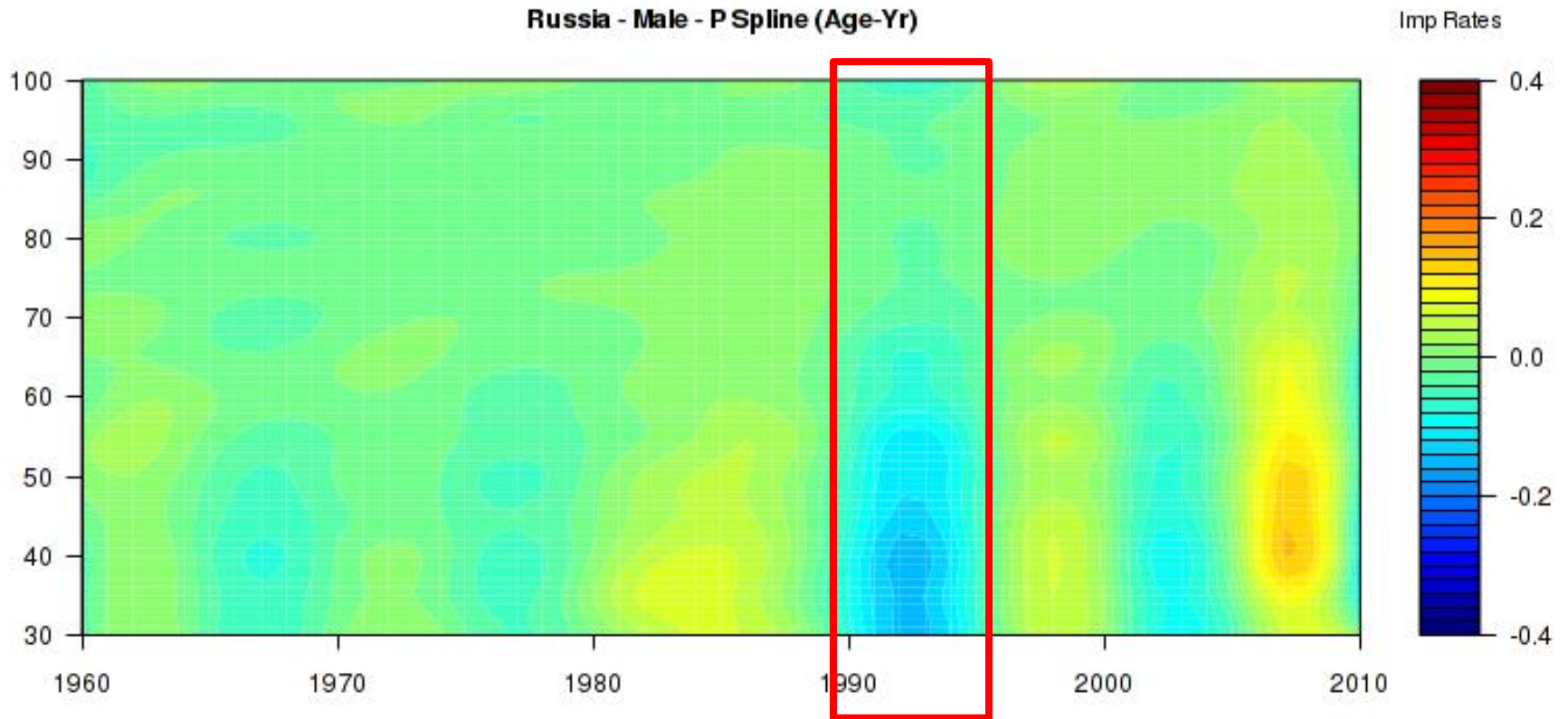
Russia Smoothed



Source of Data: Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de.

PartnerRe Own Calculations

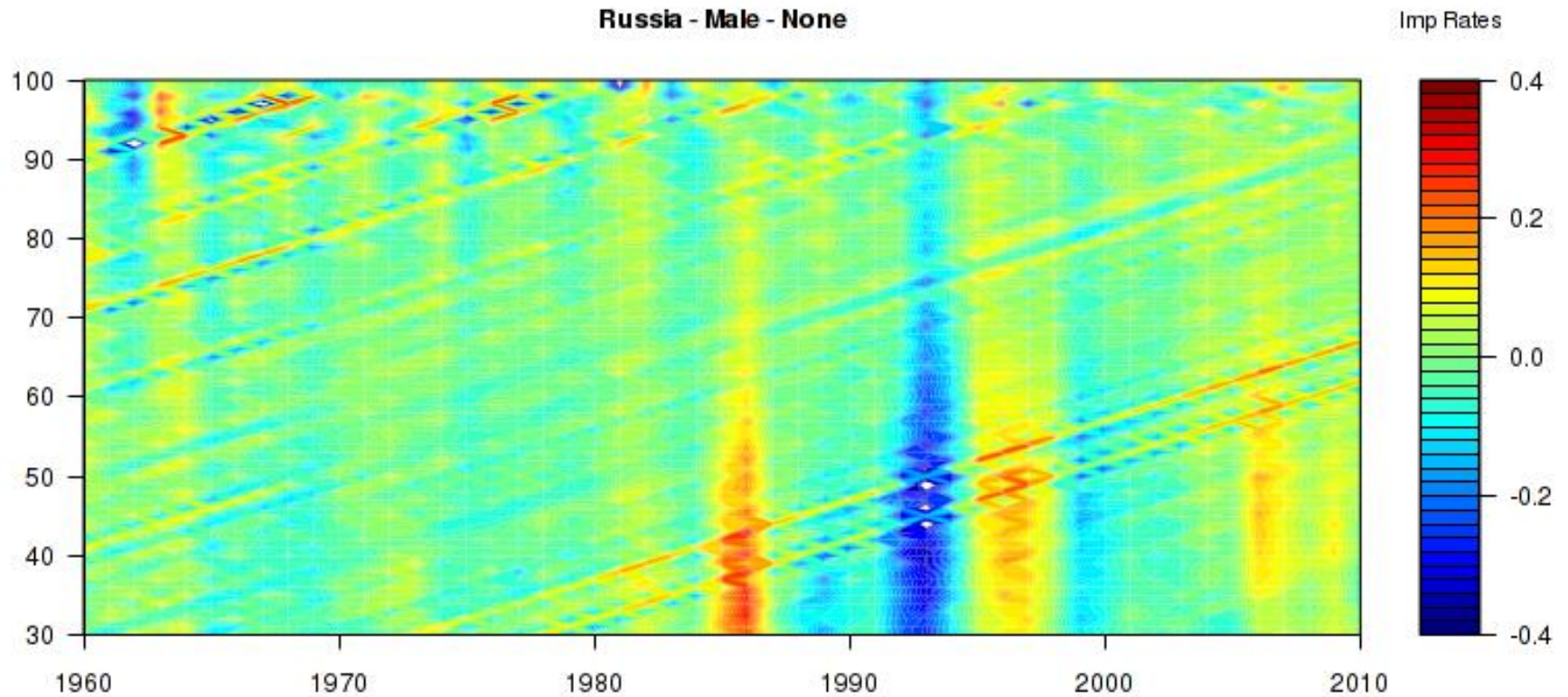
Russia Smoothed



Source of Data: Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de.

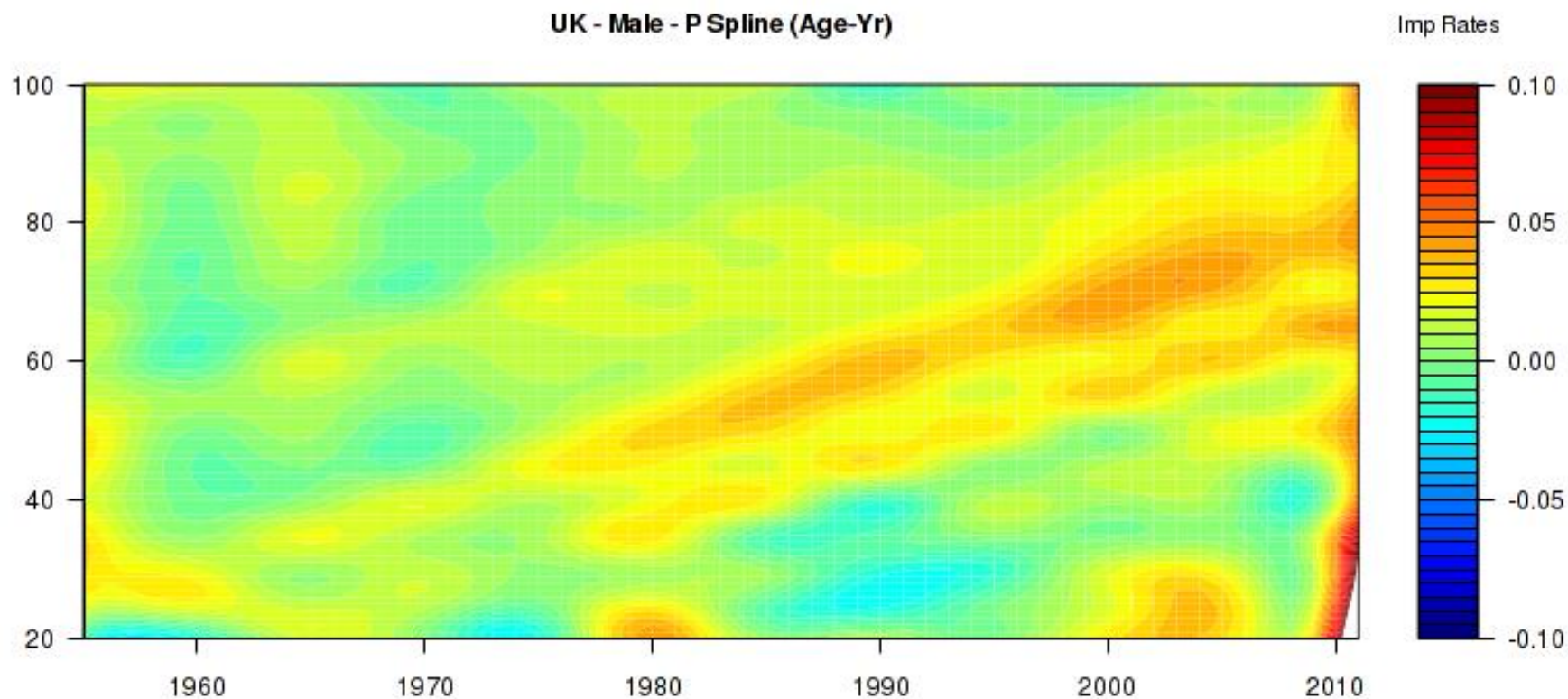
PartnerRe Own Calculations

Russia – No Smoothing



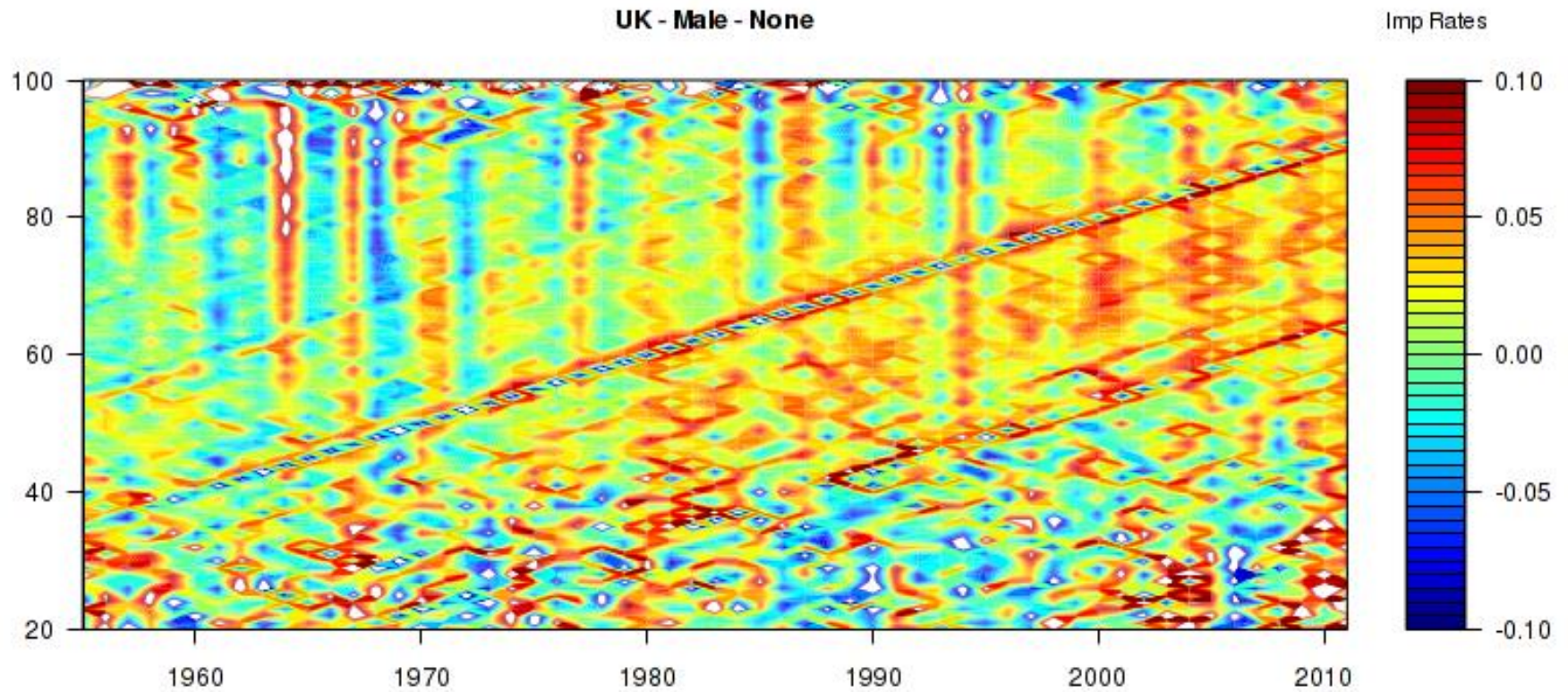
Source: HMD (own calculations)

UK - Smoothed



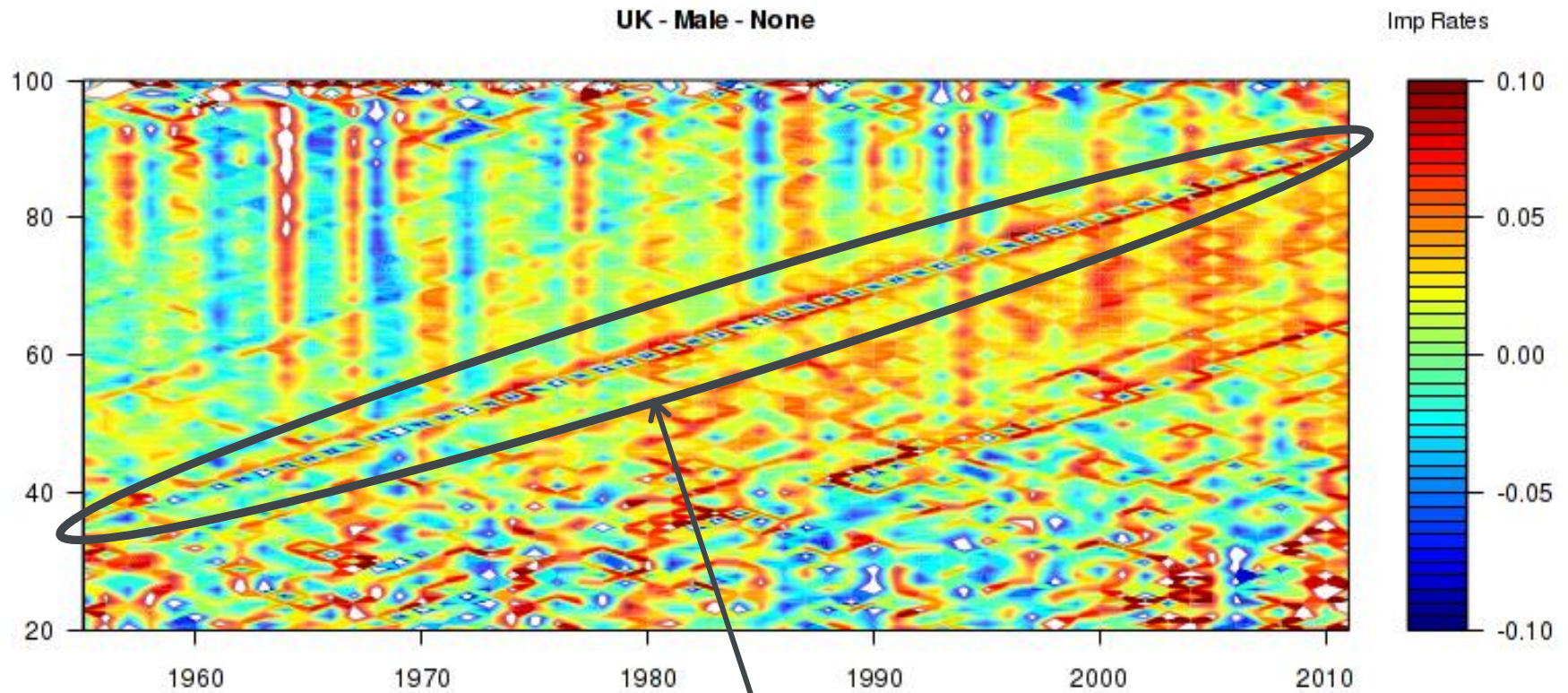
Source: HMD (own calculations)

UK – No Smoothing



Source: HMD (own calculations)

UK – No Smoothing



See Andrew Cairns' talk and paper for more on this

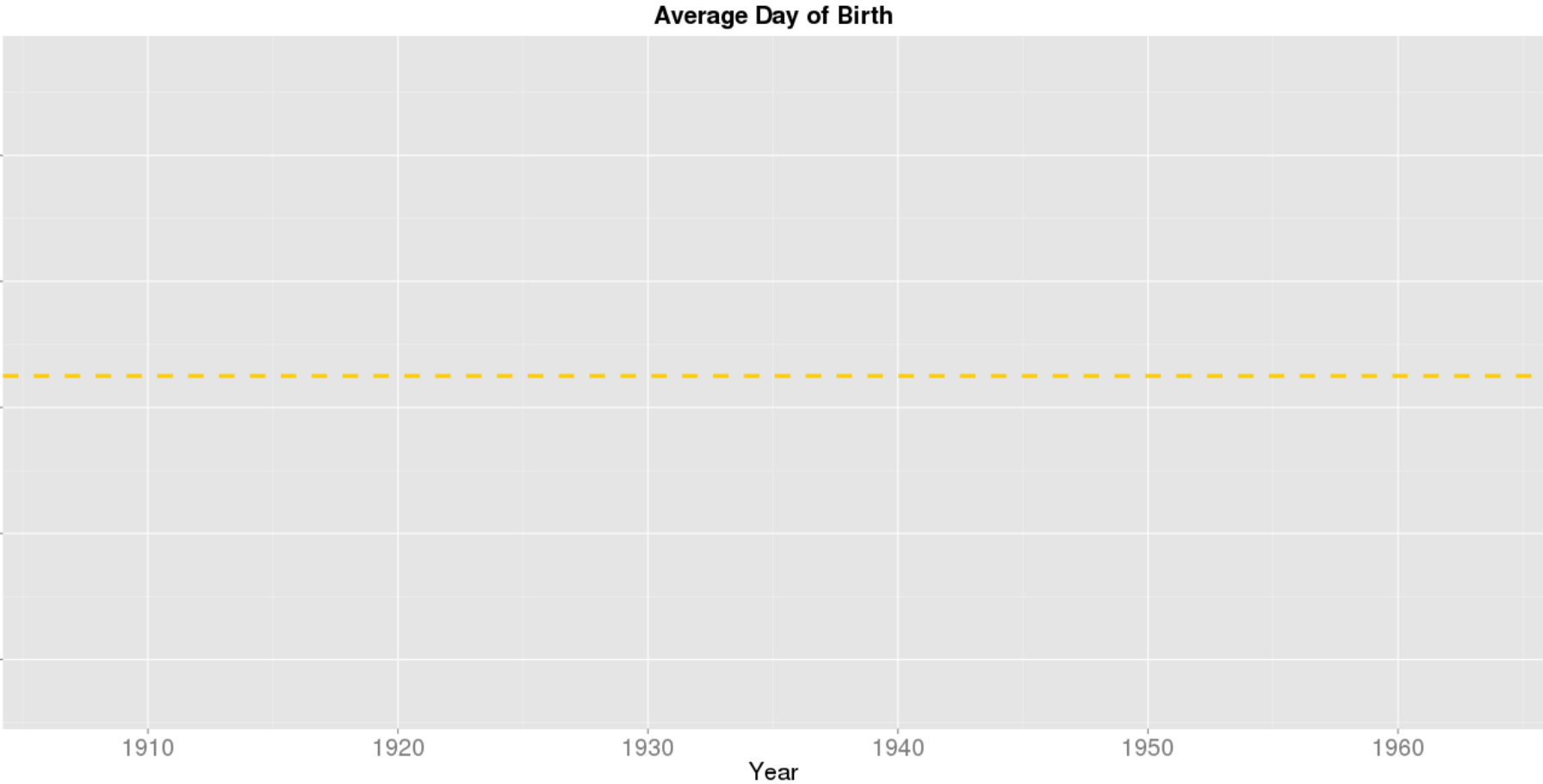
Source: HMD (own calculations)

Longevity Portfolio

- Over 1 million lives
- Gender differentiated
- Full date of birth available

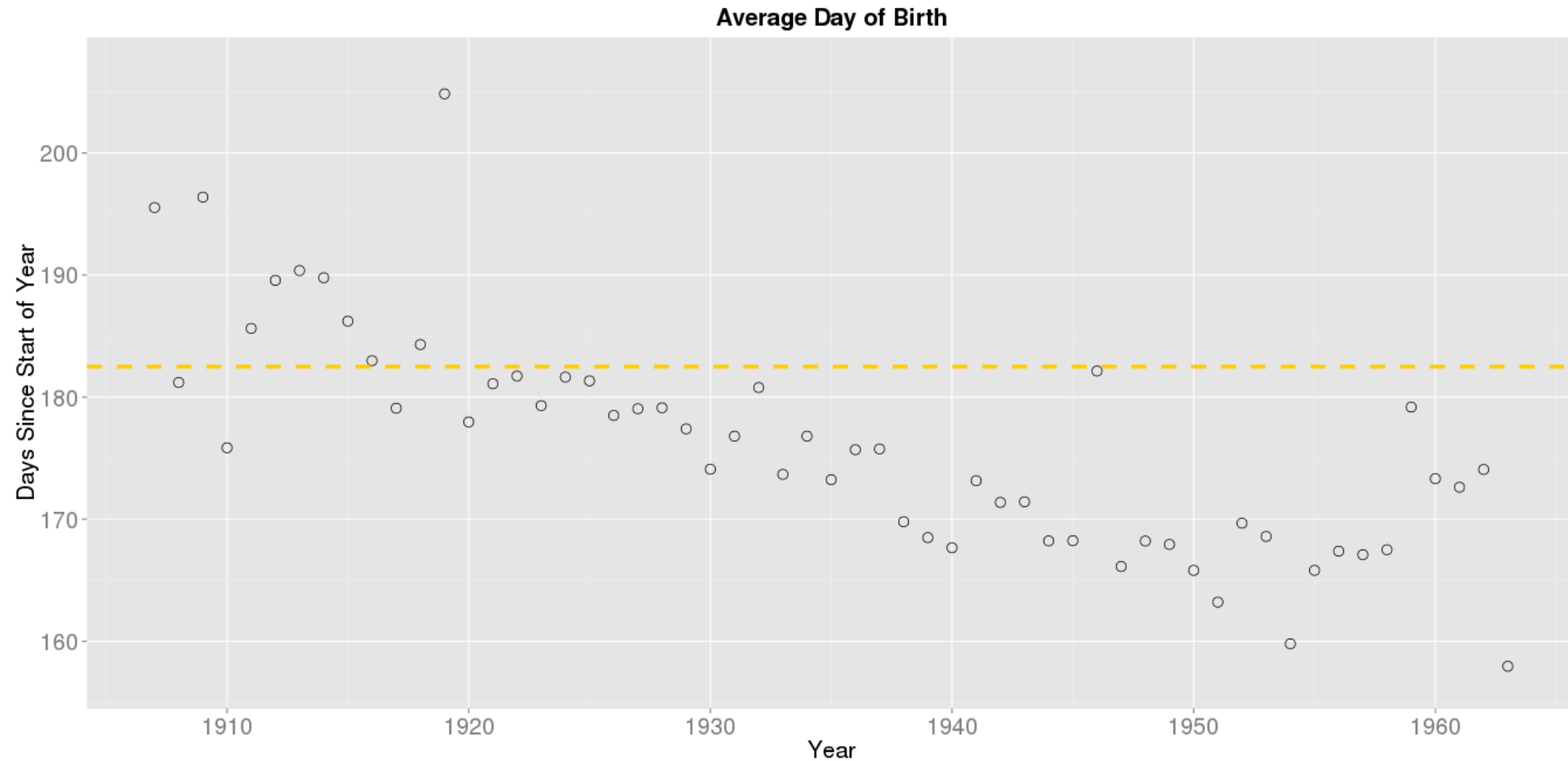
How are dates of birth distributed?

Longevity Portfolio



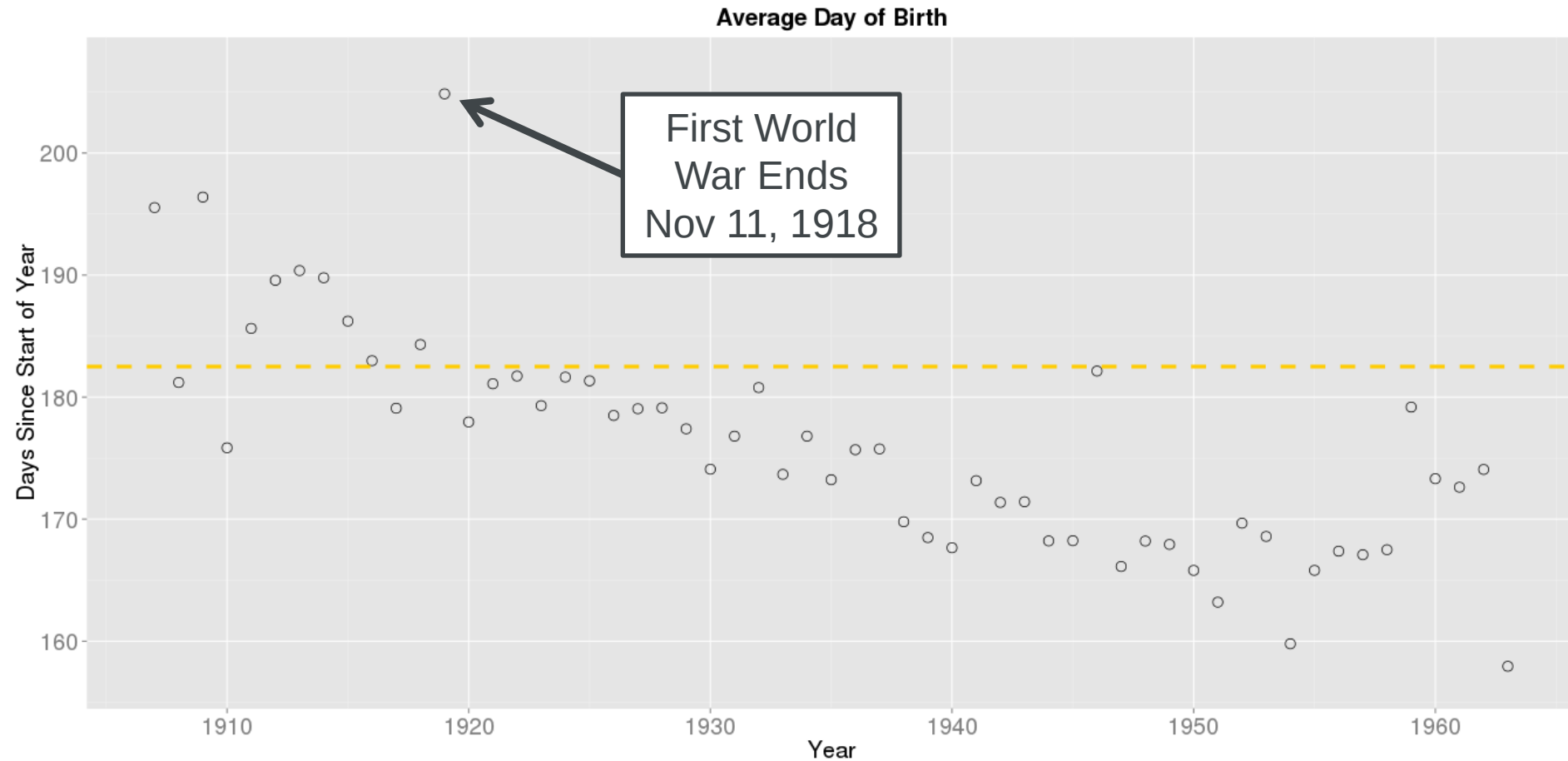
Source: PartnerRe

Longevity Portfolio



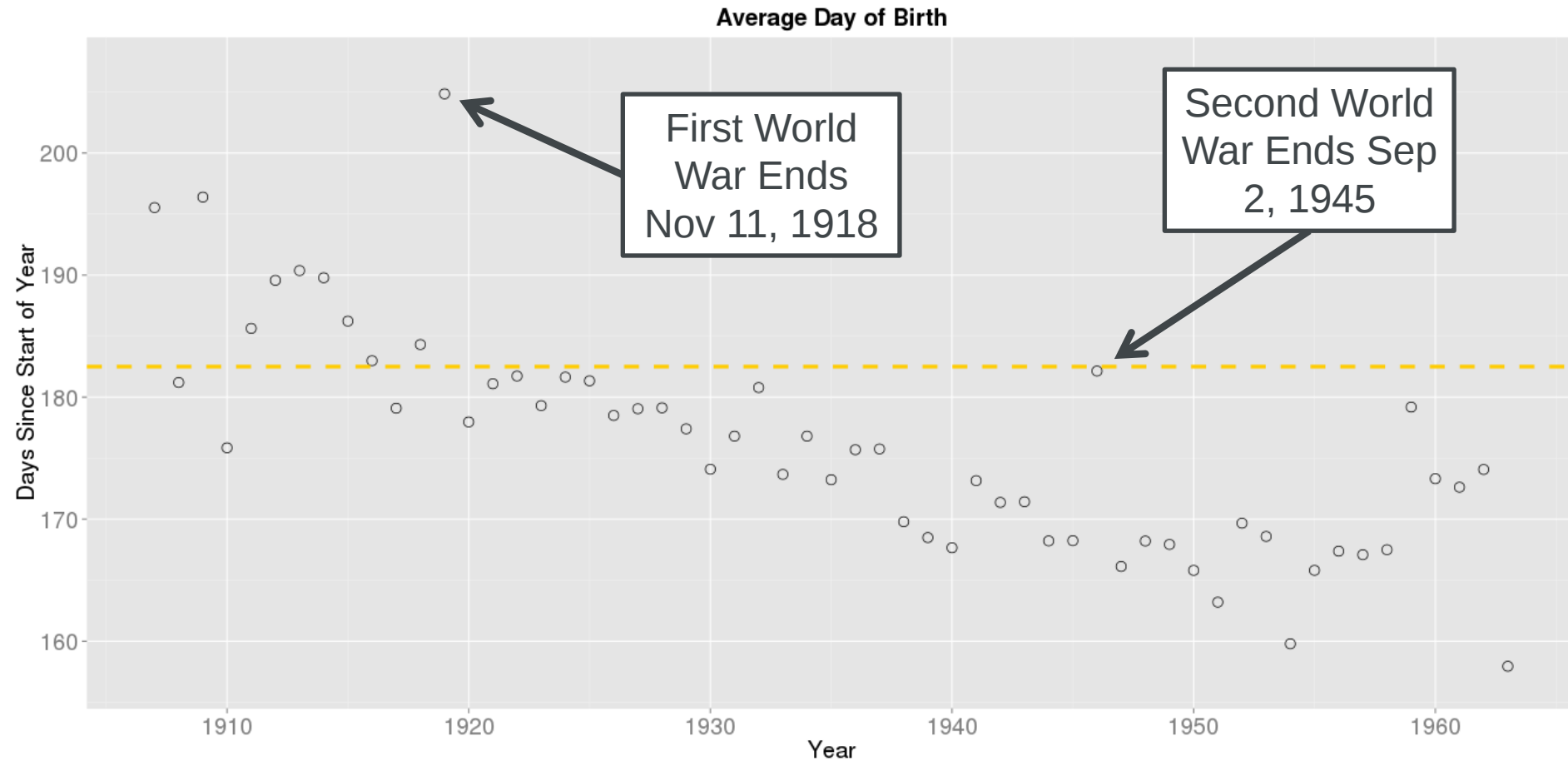
Source: PartnerRe

Longevity Portfolio



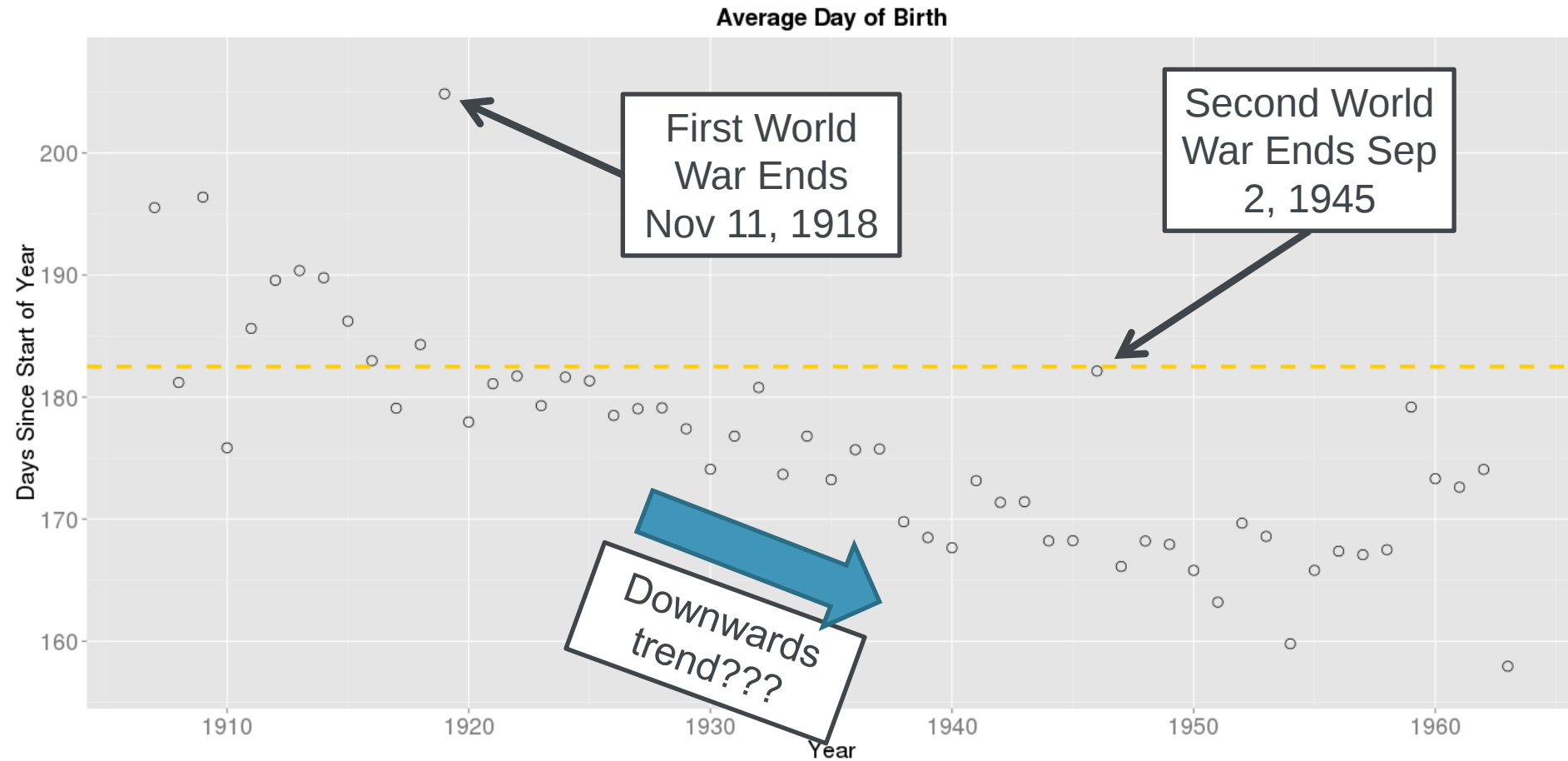
Source: PartnerRe

Longevity Portfolio



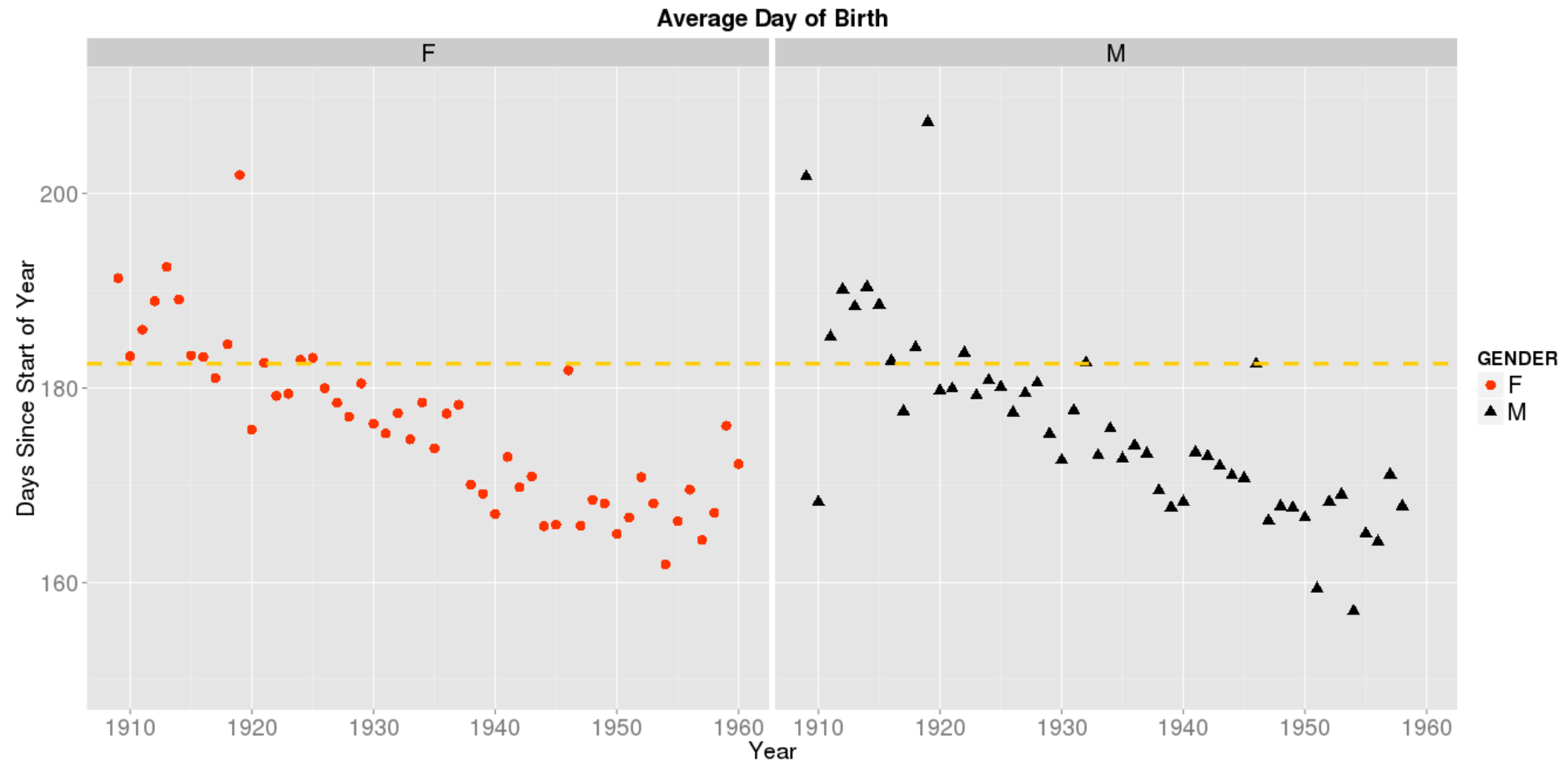
Source: PartnerRe

Longevity Portfolio



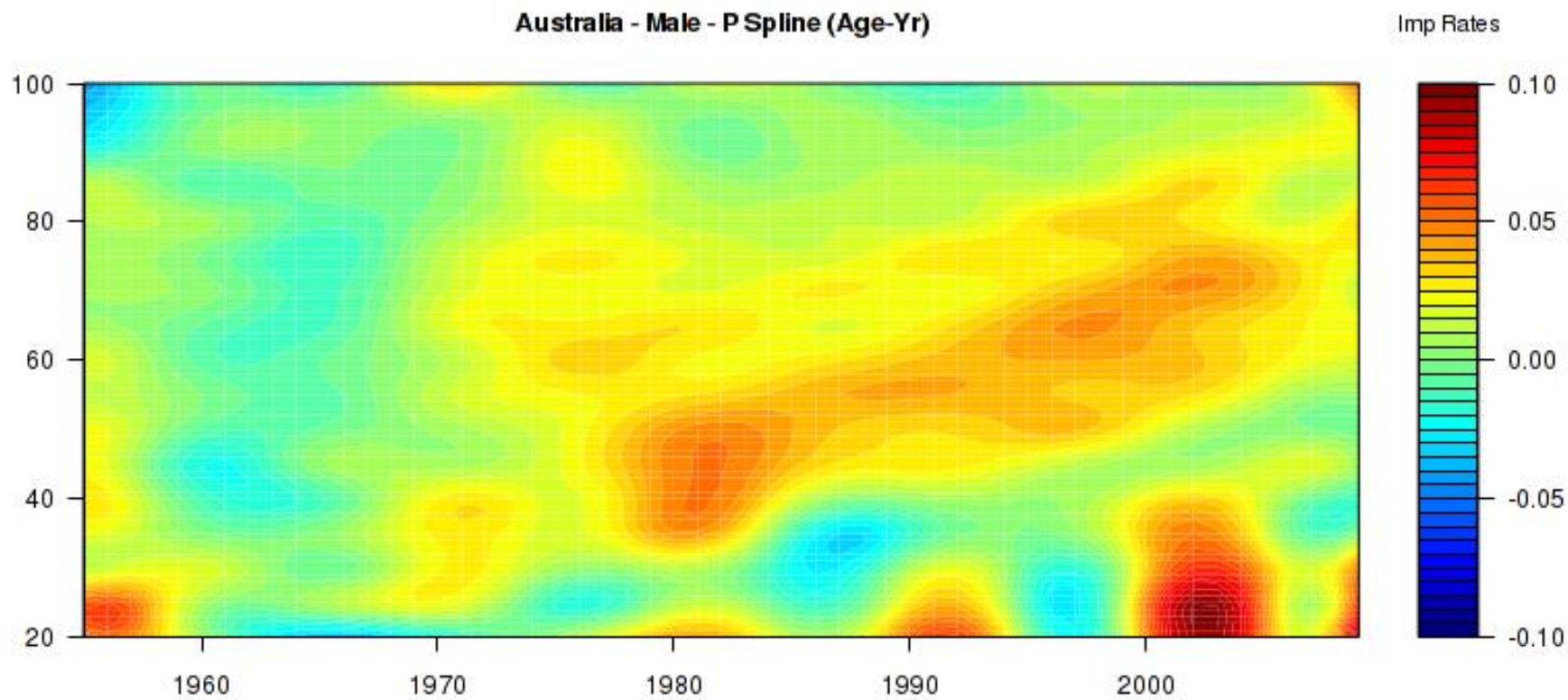
Source: PartnerRe

Longevity Portfolio - Gender



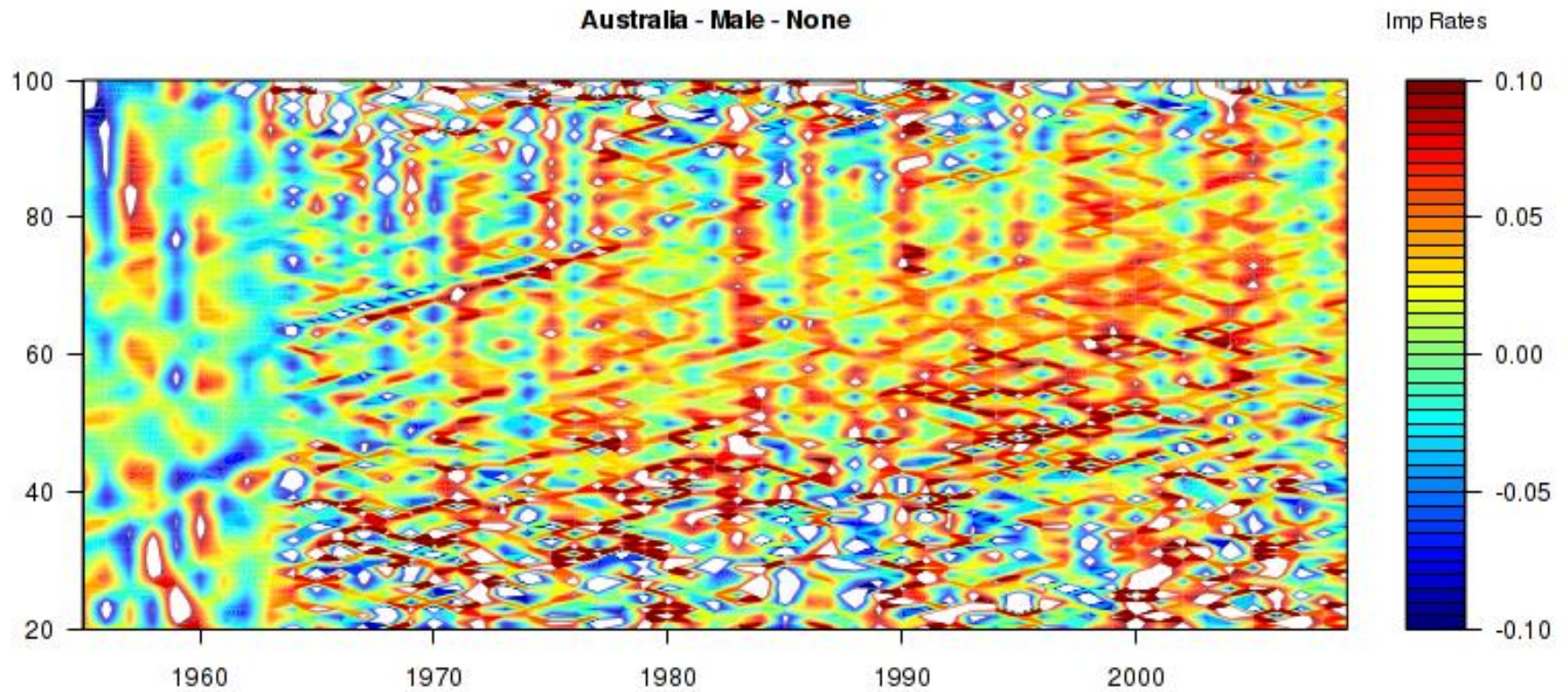
Source: PartnerRe

Australia Population



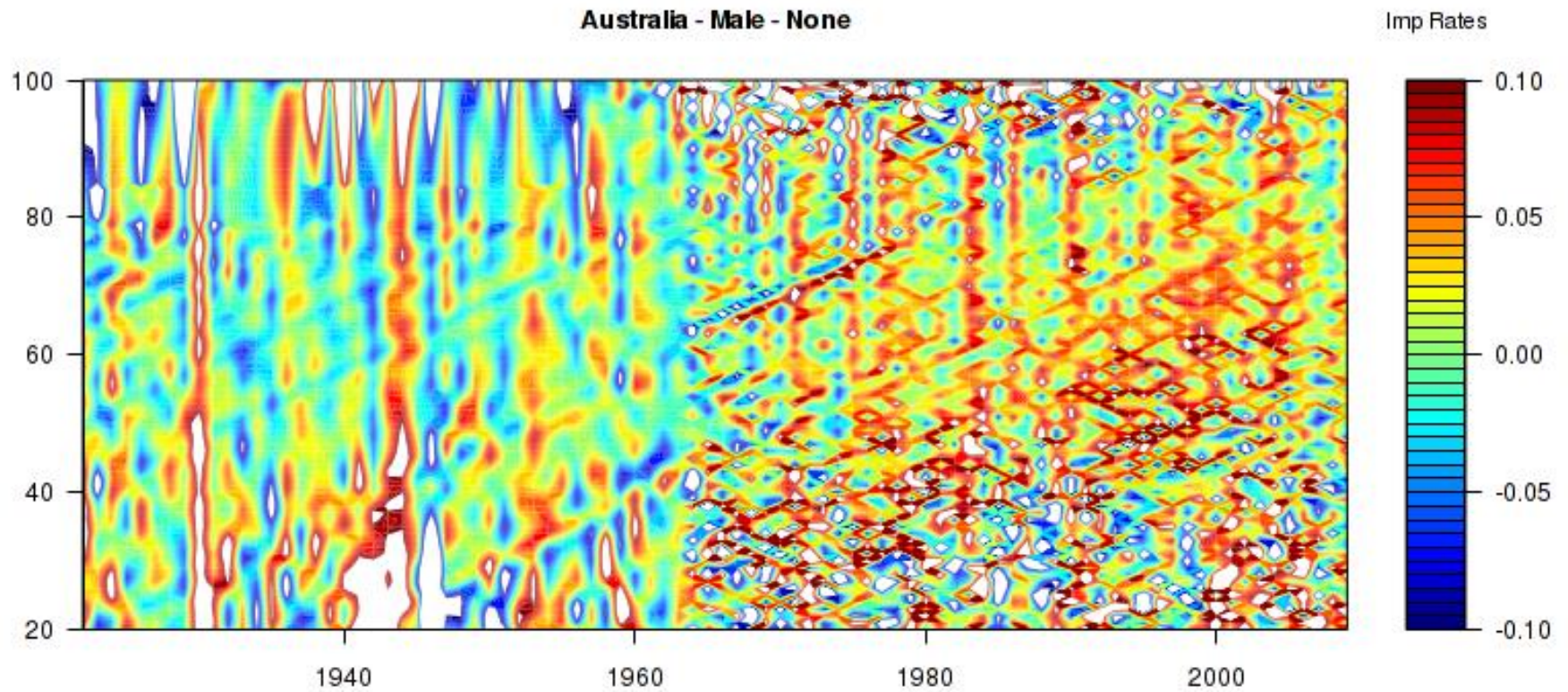
Source: HMD (own calculations)

Australia Population



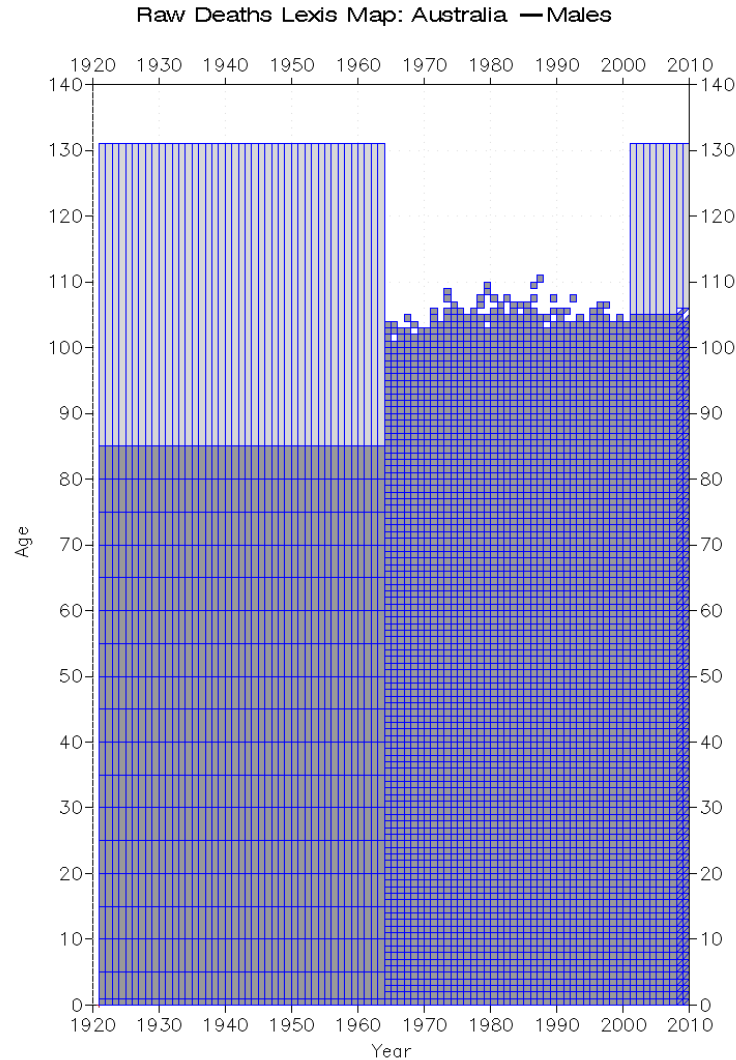
Source: HMD (own calculations)

Australia Population



Source: HMD (own calculations)

Raw Deaths



The background color of the lexis element reflects the nature of the age interval: A dark gray background indicates a closed, a light gray background indicates an open-ended age interval. The outline color of the lexis element is blue for ages of 130 or less, red otherwise.



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Basis Risk

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Basis Risk



Population

VS



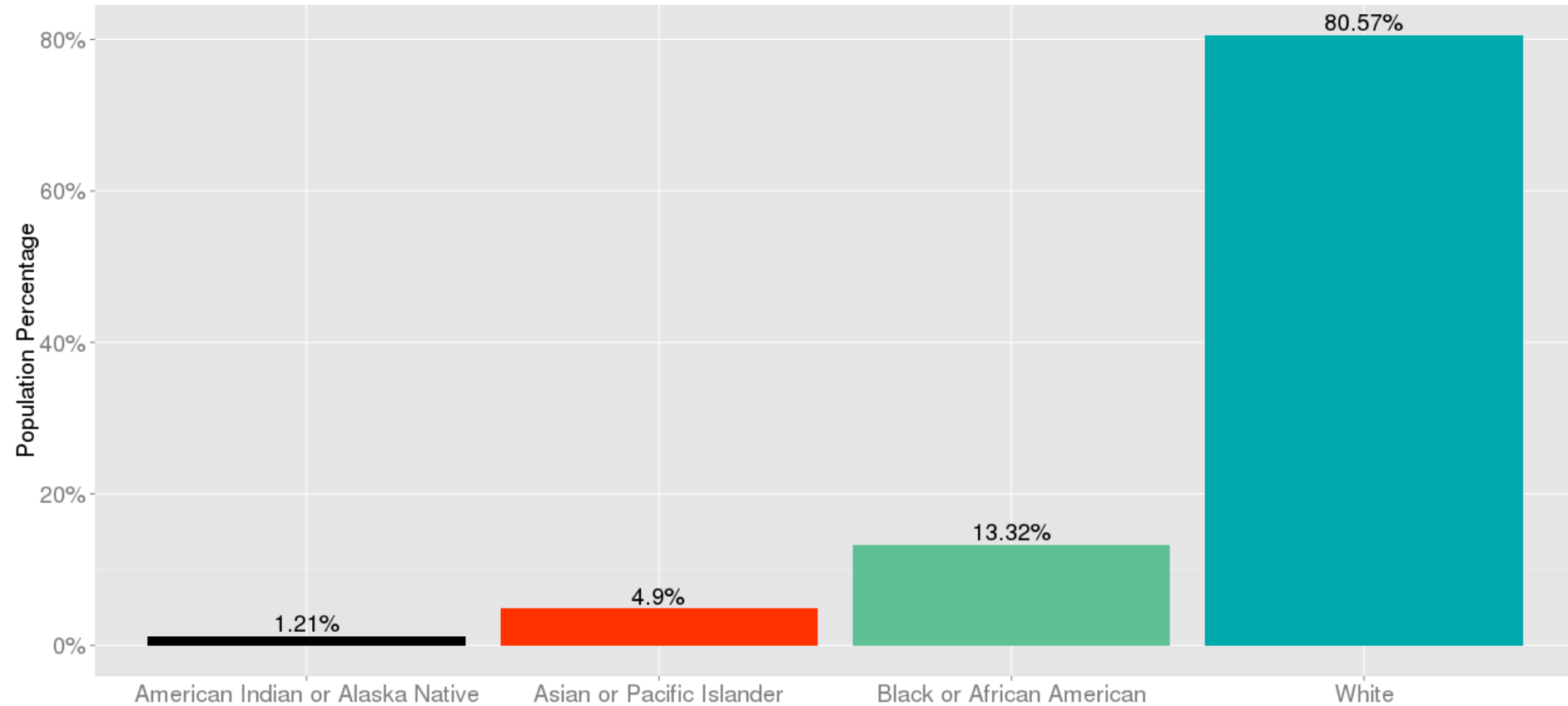
Portfolio

U.S. Example

- Consider data from the Centers for Disease Control and Prevention (CDC)
- Gender differentiated
- Individual Age
- Calendar Years 1999 – 2011
- ... also includes ethnic origin

U.S. Example

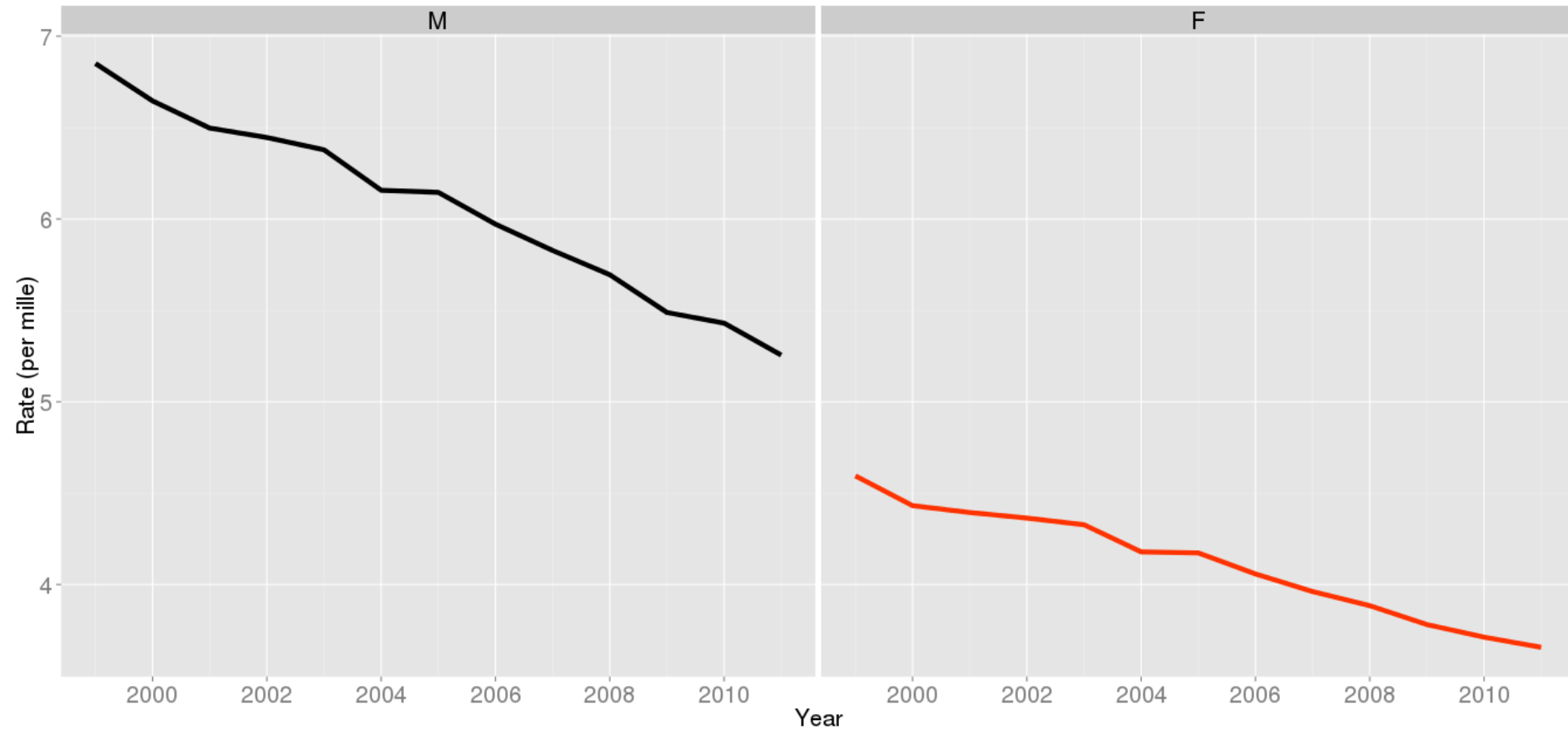
U.S. Population



Source: CDC - Accessed Oct 2014

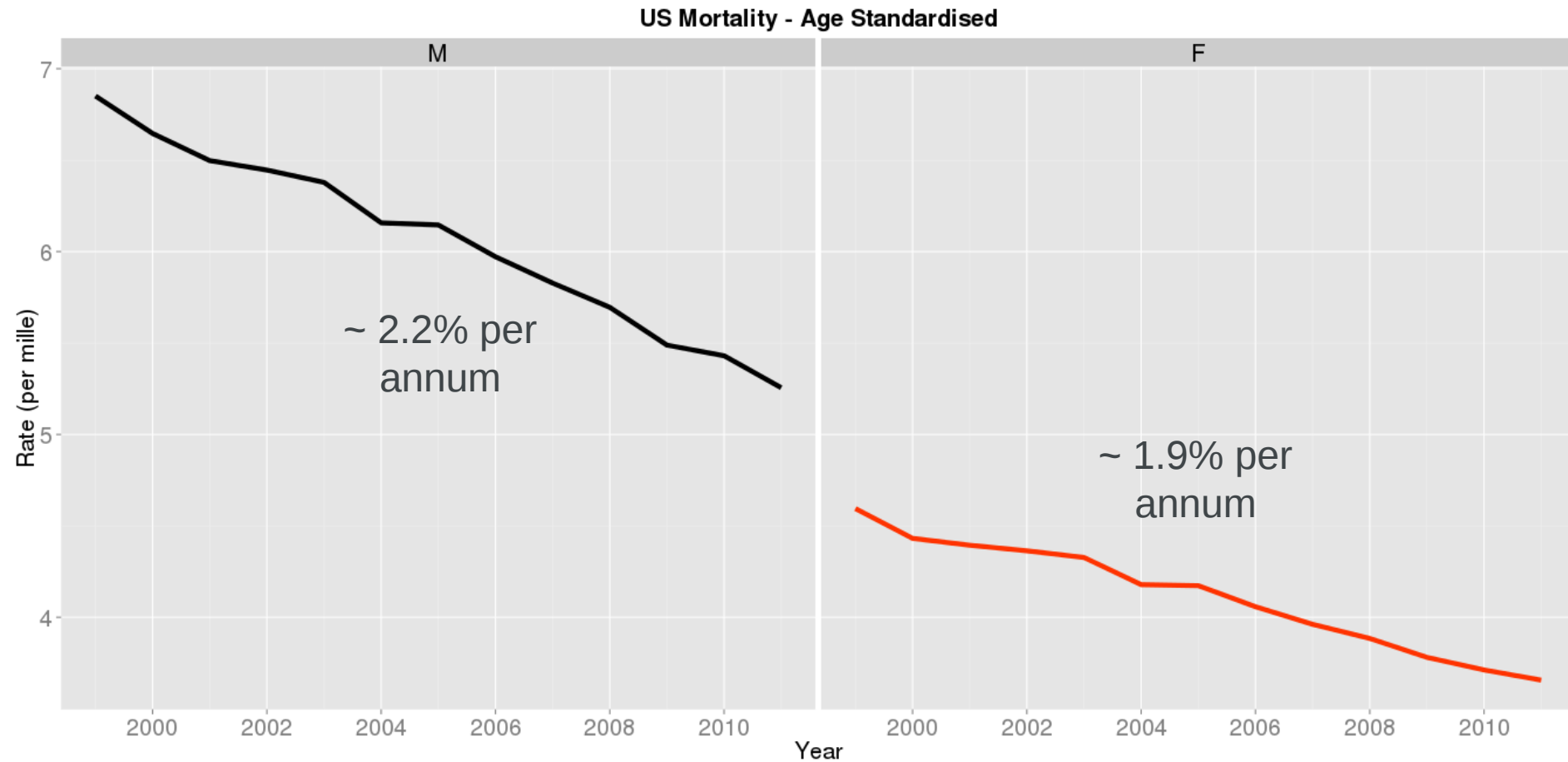
U.S. Example

US Mortality - Age Standardised



Source: CDC - Accessed Oct 2014

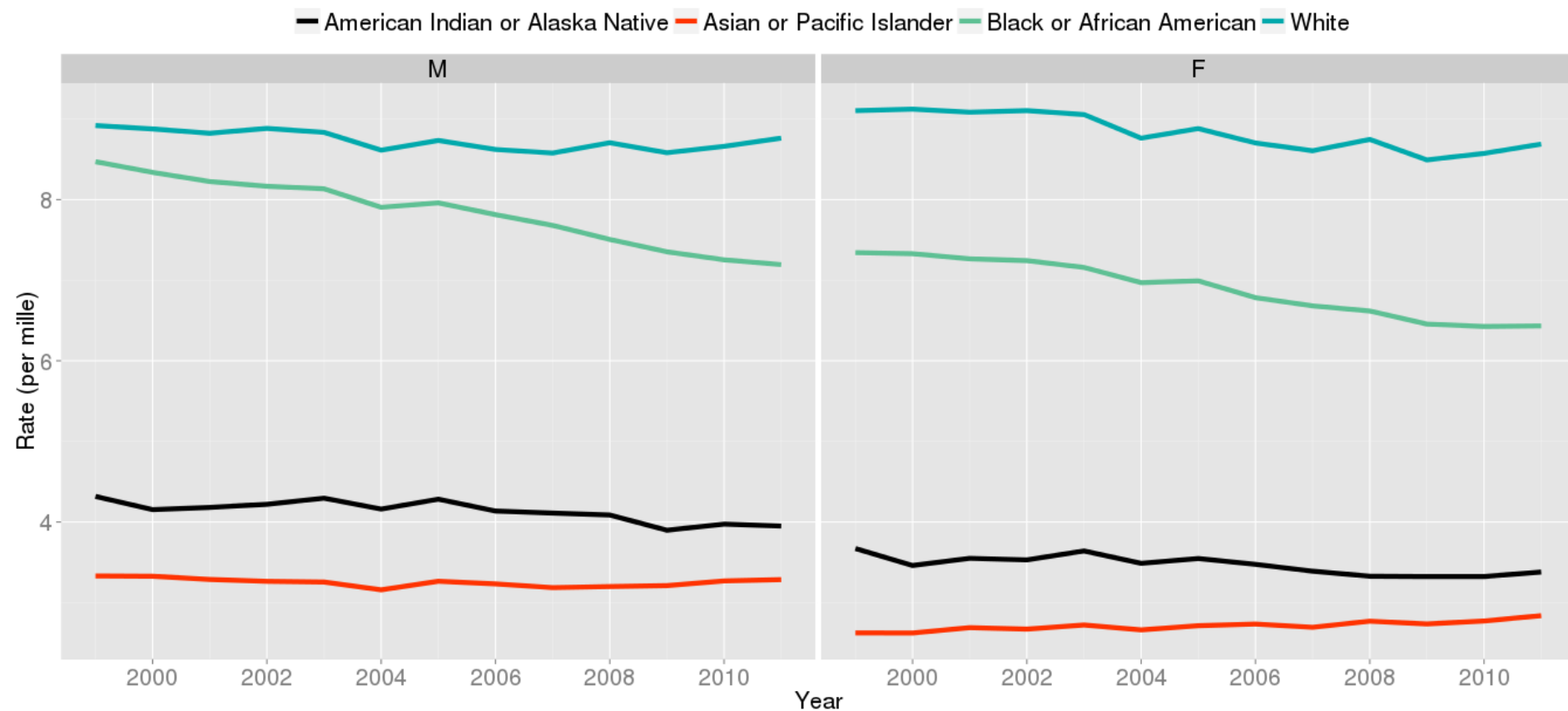
The U.S. Example



Source: CDC - Accessed Oct 2014

The U.S. Example

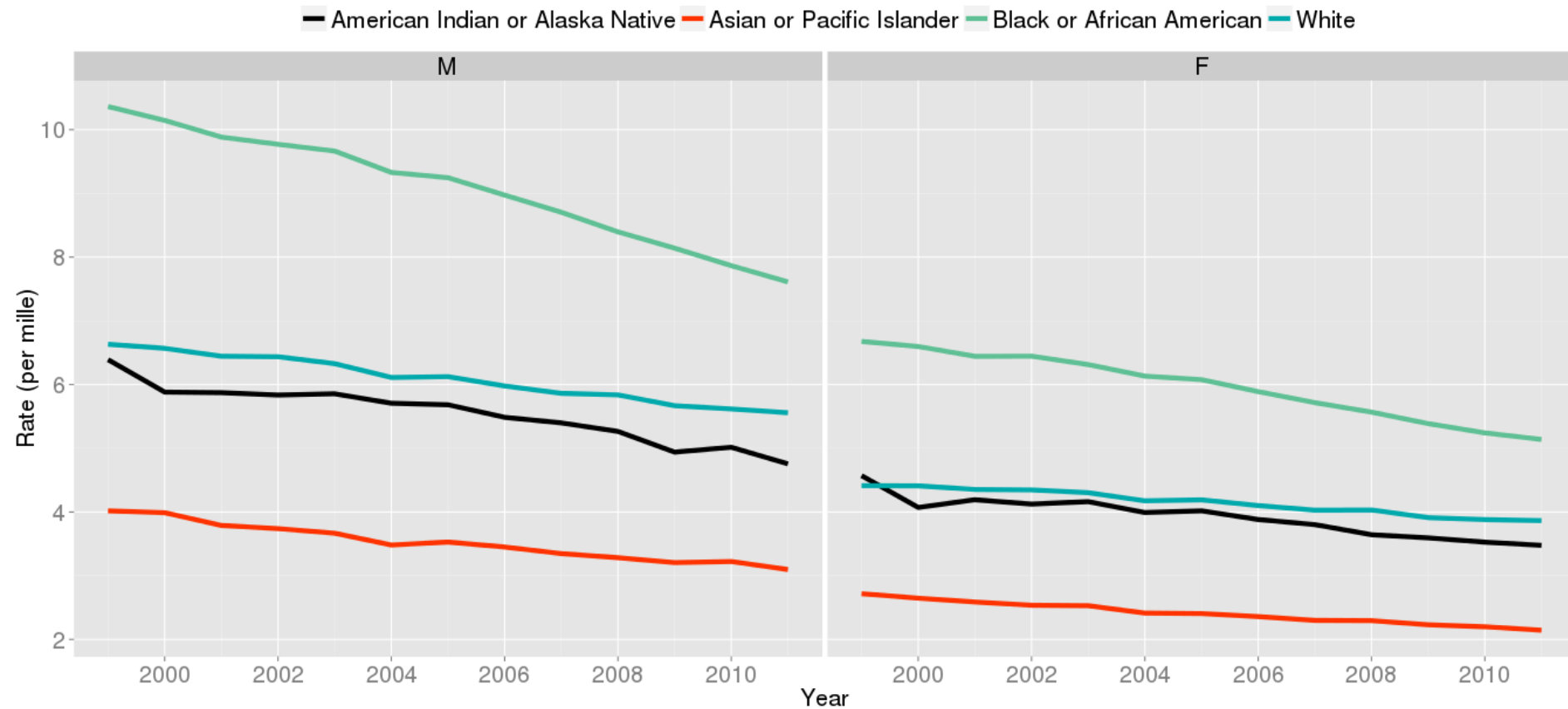
US Mortality - Not Standardised



Source: CDC - Accessed Oct 2014

U.S. Example

US Mortality - Age Standardised

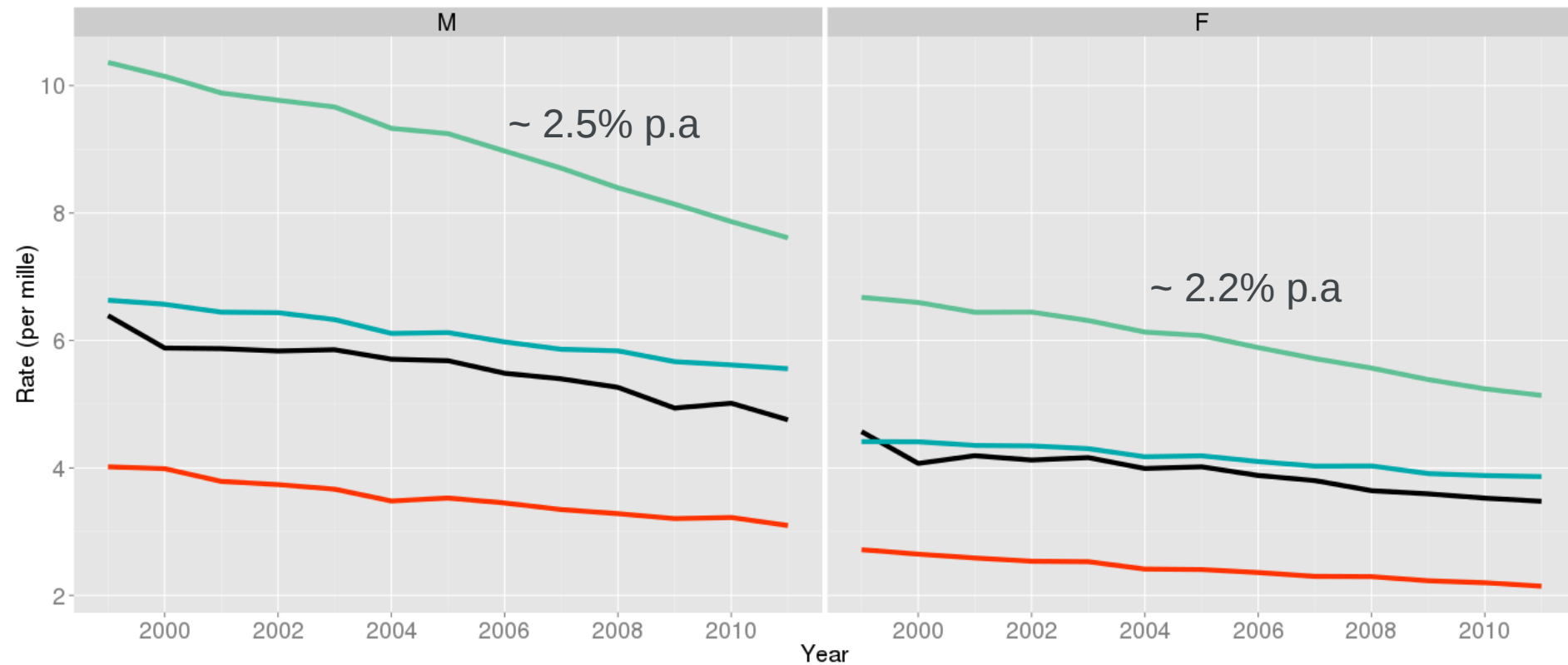


Source: CDC - Accessed Oct 2014

U.S. Example

US Mortality - Age Standardised

— American Indian or Alaska Native — Asian or Pacific Islander — Black or African American — White

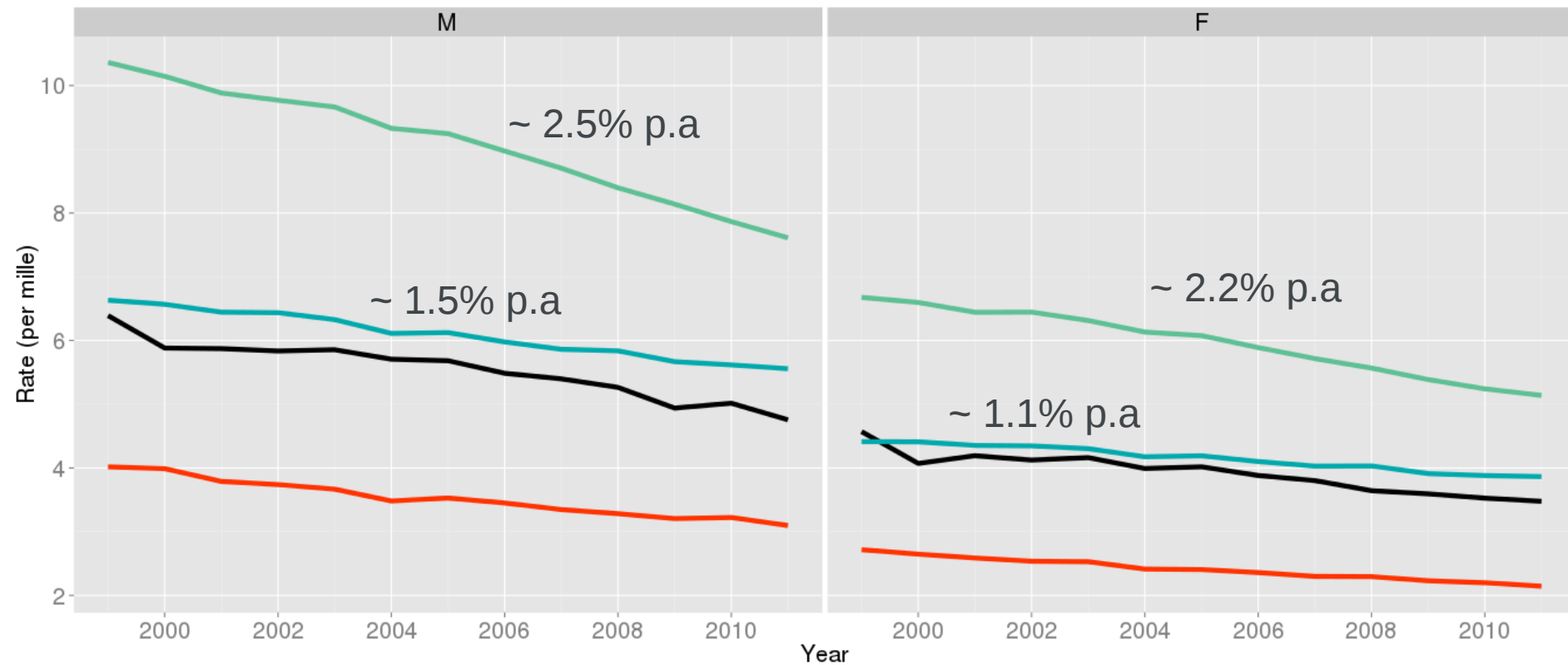


Source: CDC - Accessed Oct 2014

U.S. Example

US Mortality - Age Standardised

— American Indian or Alaska Native — Asian or Pacific Islander — Black or African American — White



Source: CDC - Accessed Oct 2014



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Migrations

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2 Populations



Cat Land
No mortality improvement

2 Populations



Cat Land
No mortality improvement



Dog Land
No mortality improvement

2 Populations



Cat Land
No mortality improvement



Dog Land
No mortality improvement
 $q(x)$ is 900% of that in Cat Land

Example 1

- Residents of Dog Land migrate to Cat Land
- 1% population growth
 - Per annum
 - Over 4 years
 - Over the age range 30 – 50
- Dogs don't trend to local mortality experience

Example 1

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
70	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
69	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
68	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
67	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
66	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
65	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%
64	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%
63	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%	-1.56%
62	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%	-1.56%	-2.50%
61	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%	-1.56%	-2.50%	-3.29%
60	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.52%	-0.87%	-1.56%	-2.50%	-3.29%	-4.28%
59	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.56%	-0.94%	-1.45%	-2.50%	-3.29%	-4.28%	-4.81%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.60%	-1.01%	-1.55%	-2.28%	-3.29%	-4.28%	-4.81%	-5.29%
57	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.64%	-1.07%	-1.65%	-2.42%	-2.94%	-4.28%	-4.81%	-5.29%	-5.03%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.68%	-1.14%	-1.75%	-2.56%	-3.10%	-3.77%	-4.81%	-5.29%	-5.03%	-4.49%
55	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.71%	-1.19%	-1.84%	-2.69%	-3.25%	-3.95%	-4.17%	-5.29%	-5.03%	-4.49%	-3.48%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.75%	-1.25%	-1.92%	-2.81%	-3.39%	-4.11%	-4.33%	-4.52%	-5.03%	-4.49%	-3.48%	-2.28%
53	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.78%	-1.30%	-2.00%	-2.92%	-3.52%	-4.26%	-4.48%	-4.67%	-4.17%	-4.49%	-3.48%	-2.28%	-0.52%
52	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.81%	-1.35%	-2.08%	-3.03%	-3.64%	-4.40%	-4.63%	-4.81%	-4.29%	-3.55%	-3.48%	-2.28%	-0.52%	0.48%
51	0.00%	0.00%	0.00%	0.00%	0.00%	-0.84%	-1.40%	-2.15%	-3.13%	-3.76%	-4.54%	-4.76%	-4.94%	-4.40%	-3.63%	-2.53%	-2.28%	-0.52%	0.48%	2.62%
50	0.00%	0.00%	0.00%	0.00%	-0.87%	-1.44%	-2.22%	-3.22%	-3.87%	-4.66%	-4.88%	-5.06%	-4.50%	-3.71%	-2.58%	-1.37%	-0.52%	0.48%	2.62%	3.58%
49	0.00%	0.00%	0.00%	0.00%	-1.53%	-2.34%	-3.38%	-4.76%	-4.79%	-5.00%	-5.18%	-4.60%	-3.79%	-2.63%	-1.40%	0.40%	0.48%	2.62%	3.58%	5.27%
48	0.00%	0.00%	0.00%	0.00%	-2.50%	-3.57%	-4.97%	-6.23%	-5.11%	-5.28%	-4.68%	-3.85%	-2.67%	-1.42%	0.41%	1.28%	2.62%	3.58%	5.27%	4.98%
47	0.00%	0.00%	0.00%	0.00%	-3.85%	-5.27%	-6.58%	-7.30%	-5.38%	-4.76%	-3.91%	-2.71%	-1.44%	0.41%	1.30%	3.34%	3.58%	5.27%	4.98%	4.61%
46	0.00%	0.00%	0.00%	0.00%	-5.69%	-7.08%	-7.86%	-8.49%	-4.84%	-3.97%	-2.75%	-1.46%	0.42%	1.31%	3.38%	4.19%	5.27%	4.98%	4.61%	4.19%
45	0.00%	0.00%	0.00%	0.00%	-7.84%	-8.70%	-9.23%	-9.01%	-4.02%	-2.78%	-1.47%	0.42%	1.33%	3.42%	4.24%	5.76%	4.98%	4.61%	4.19%	3.84%
44	0.00%	0.00%	0.00%	0.00%	-9.99%	-10.35%	-9.98%	-9.33%	-2.81%	-1.49%	0.43%	1.34%	3.46%	4.28%	5.83%	5.35%	4.61%	4.19%	3.84%	3.25%
43	0.00%	0.00%	0.00%	0.00%	-12.09%	-11.45%	-10.48%	-9.27%	-1.50%	0.43%	1.35%	3.49%	4.32%	5.89%	5.41%	4.90%	4.19%	3.84%	3.25%	2.26%
42	0.00%	0.00%	0.00%	0.00%	-13.73%	-12.19%	-10.54%	-9.08%	0.44%	1.37%	3.52%	4.37%	5.95%	5.47%	4.96%	4.41%	3.84%	3.25%	2.26%	1.50%
41	0.00%	0.00%	0.00%	0.00%	-14.78%	-12.37%	-10.35%	-8.10%	1.38%	3.55%	4.40%	6.00%	5.52%	5.01%	4.46%	3.98%	3.25%	2.26%	1.50%	0.86%
40	0.00%	0.00%	0.00%	0.00%	-15.07%	-12.14%	-9.38%	-7.98%	3.57%	4.44%	6.05%	5.57%	5.06%	4.51%	4.03%	3.35%	2.26%	1.50%	0.86%	0.00%
39	0.00%	0.00%	0.00%	0.00%	-14.64%	-11.09%	-8.98%	-6.30%	4.47%	6.10%	5.62%	5.11%	4.55%	4.08%	3.39%	2.32%	1.50%	0.86%	0.00%	0.00%
38	0.00%	0.00%	0.00%	0.00%	-13.33%	-10.23%	-7.22%	-5.55%	6.15%	5.67%	5.15%	4.60%	4.12%	3.43%	2.35%	1.52%	0.86%	0.00%	0.00%	0.00%
37	0.00%	0.00%	0.00%	0.00%	-11.73%	-8.31%	-6.13%	-3.56%	5.71%	5.19%	4.63%	4.15%	3.46%	2.37%	1.54%	0.87%	0.00%	0.00%	0.00%	0.00%
36	0.00%	0.00%	0.00%	0.00%	-9.54%	-6.76%	-4.12%	-3.20%	5.23%	4.67%	4.19%	3.49%	2.39%	1.55%	0.87%	0.00%	0.00%	0.00%	0.00%	0.00%
35	0.00%	0.00%	0.00%	0.00%	-7.40%	-4.69%	-3.34%	-2.64%	4.71%	4.22%	3.52%	2.41%	1.57%	0.88%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
34	0.00%	0.00%	0.00%	0.00%	-5.23%	-3.47%	-2.53%	-1.94%	4.26%	3.55%	2.44%	1.58%	0.89%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
33	0.00%	0.00%	0.00%	0.00%	-3.59%	-2.43%	-1.73%	-1.01%	3.58%	2.46%	1.60%	0.90%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
32	0.00%	0.00%	0.00%	0.00%	-2.37%	-1.58%	-0.93%	-0.21%	2.48%	1.61%	0.91%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	0.00%	0.00%	0.00%	0.00%	-1.48%	-0.88%	-0.10%	-0.11%	1.62%	0.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
30	0.00%	0.00%	0.00%	0.00%	-0.85%	-0.04%	-0.04%	0.00%	0.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Example 1

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
70	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
69	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
68	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
67	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
66	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
65	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
64	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%
63	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%	-1.56%
62	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%	-1.56%	-2.50%
61	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%	-1.56%	-2.50%	-3.29%
60	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.52%	-0.87%	-1.56%	-2.50%	-3.29%	-4.28%
59	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.56%	-0.94%	-1.45%	-2.50%	-3.29%	-4.28%	-4.81%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.60%	-1.01%	-1.55%	-2.28%	-3.29%	-4.28%	-4.81%	-5.29%
57	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.64%	-1.07%	-1.65%	-2.42%	-2.94%	-4.28%	-4.81%	-5.29%	-5.03%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.68%	-1.14%	-1.75%	-2.56%	-3.10%	-3.77%	-4.81%	-5.29%	-5.03%	-4.49%
55	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.71%	-1.19%	-1.84%	-2.69%	-3.25%	-3.95%	-4.17%	-5.29%	-5.03%	-4.49%	-3.48%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.75%	-1.25%	-1.92%	-2.81%	-3.39%	-4.11%	-4.33%	-4.52%	-5.03%	-4.49%	-3.48%	-2.28%
53	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.78%	-1.30%	-2.00%	-2.92%	-3.52%	-4.26%	-4.48%	-4.67%	-4.17%	-4.49%	-3.48%	-2.28%	-0.52%
52	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.81%	-1.35%	-2.08%	-3.03%	-3.64%	-4.40%	-4.63%	-4.81%	-4.29%	-3.55%	-3.48%	-2.28%	-0.52%	0.48%
51	0.00%	0.00%	0.00%	0.00%	0.00%	-0.84%	-1.40%	-2.15%	-3.13%	-3.76%	-4.54%	-4.76%	-4.94%	-4.40%	-3.63%	-2.53%	-2.28%	-0.52%	0.48%	2.62%
50	0.00%	0.00%	0.00%	0.00%	-0.87%	-1.44%	-2.22%	-3.22%	-3.87%	-4.66%	-4.88%	-5.06%	-4.50%	-3.71%	-2.58%	-1.37%	-0.52%	0.48%	2.62%	3.58%
49	0.00%	0.00%	0.00%	0.00%	-1.53%	-2.34%	-3.38%	-4.76%	-4.79%	-5.00%	-5.18%	-4.60%	-3.79%	-2.63%	-1.40%	0.40%	0.48%	2.62%	3.58%	5.27%
48	0.00%	0.00%	0.00%	0.00%	-2.50%	-3.57%	-4.97%	-6.23%	-5.11%	-5.28%	-4.68%	-3.85%	-2.67%	-1.42%	0.41%	1.28%	2.62%	3.58%	5.27%	4.98%
47	0.00%	0.00%	0.00%	0.00%	-3.85%	-5.27%	-6.58%	-7.30%	-5.38%	-4.76%	-3.91%	-2.71%	-1.44%	0.41%	1.30%	3.34%	3.58%	5.27%	4.98%	4.61%
46	0.00%	0.00%	0.00%	0.00%	-5.69%	-7.08%	-7.86%	-8.49%	-4.84%	-3.97%	-2.75%	-1.46%	0.42%	1.31%	3.38%	4.19%	5.27%	4.98%	4.61%	4.19%
45	0.00%	0.00%	0.00%	0.00%	-7.84%	-8.70%	-9.23%	-9.01%	-4.02%	-2.78%	-1.47%	0.42%	1.33%	3.42%	4.24%	5.76%	4.98%	4.61%	4.19%	3.84%
44	0.00%	0.00%	0.00%	0.00%	-9.99%	-10.35%	-9.98%	-9.33%	-2.81%	-1.49%	0.43%	1.34%	3.46%	4.28%	5.83%	5.35%	4.61%	4.19%	3.84%	3.25%
43	0.00%	0.00%	0.00%	0.00%	-12.09%	-11.45%	-10.48%	-9.27%	-1.50%	0.43%	1.35%	3.49%	4.32%	5.89%	5.41%	4.90%	4.19%	3.84%	3.25%	2.26%
42	0.00%	0.00%	0.00%	0.00%	-13.73%	-12.19%	-10.54%	-9.08%	0.44%	1.37%	3.52%	4.37%	5.95%	5.47%	4.96%	4.41%	3.84%	3.25%	2.26%	1.50%
41	0.00%	0.00%	0.00%	0.00%	-14.78%	-12.37%	-10.35%	-8.10%	1.38%	3.55%	4.40%	6.00%	5.52%	5.01%	4.46%	3.98%	3.25%	2.26%	1.50%	0.86%
40	0.00%	0.00%	0.00%	0.00%	-15.07%	-12.14%	-9.38%	-7.98%	3.57%	4.44%	6.05%	5.57%	5.06%	4.51%	4.03%	3.35%	2.26%	1.50%	0.86%	0.00%
39	0.00%	0.00%	0.00%	0.00%	-14.64%	-11.09%	-8.98%	-6.30%	4.47%	6.10%	5.62%	5.11%	4.55%	4.08%	3.39%	2.32%	1.50%	0.86%	0.00%	0.00%
38	0.00%	0.00%	0.00%	0.00%	-13.33%	-10.23%	-7.22%	-5.55%	6.15%	5.67%	5.15%	4.60%	4.12%	3.43%	2.35%	1.52%	0.86%	0.00%	0.00%	0.00%
37	0.00%	0.00%	0.00%	0.00%	-11.73%	-8.31%	-6.13%	-3.56%	5.71%	5.19%	4.63%	4.15%	3.46%	2.37%	1.54%	0.87%	0.00%	0.00%	0.00%	0.00%
36	0.00%	0.00%	0.00%	0.00%	-9.54%	-6.76%	-4.12%	-3.20%	5.23%	4.67%	4.19%	3.49%	2.39%	1.55%	0.87%	0.00%	0.00%	0.00%	0.00%	0.00%
35	0.00%	0.00%	0.00%	0.00%	-7.40%	-4.69%	-3.34%	-2.64%	4.71%	4.22%	3.52%	2.41%	1.57%	0.88%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
34	0.00%	0.00%	0.00%	0.00%	-5.23%	-3.47%	-2.53%	-1.94%	4.26%	3.55%	2.44%	1.58%	0.89%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
33	0.00%	0.00%	0.00%	0.00%	-3.59%	-2.43%	-1.73%	-1.01%	3.58%	2.46%	1.60%	0.90%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
32	0.00%	0.00%	0.00%	0.00%	-2.37%	-1.58%	-0.93%	-0.21%	2.48%	1.61%	0.91%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	0.00%	0.00%	0.00%	0.00%	-1.48%	-0.88%	-0.10%	-0.11%	1.62%	0.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
30	0.00%	0.00%	0.00%	0.00%	-0.85%	-0.04%	-0.04%	0.00%	0.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Period Effect
over 4 years

Example 1

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
70	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
69	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
68	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
67	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
66	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
65	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
64	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%
63	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%	-1.56%
62	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%	-1.56%	-2.50%
61	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%	-1.56%	-2.50%	-3.29%
60	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.52%	-0.87%	-1.56%	-2.50%	-3.29%	-4.28%
59	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.56%	-0.94%	-1.45%	-2.50%	-3.29%	-4.28%	-4.81%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.60%	-1.04%	-1.55%	-2.28%	-3.29%	-4.28%	-4.81%	-5.29%
57	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.64%	-1.07%	-1.65%	-2.42%	-2.94%	-4.28%	-4.81%	-5.03%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.68%	-1.14%	-1.75%	-2.56%	-3.10%	-3.77%	-4.81%	-5.29%	-5.03%	-4.49%	
55	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.71%	-1.19%	-1.84%	-2.69%	-3.25%	-3.95%	-4.17%	-5.29%	-5.03%	-4.49%	-3.48%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.75%	-1.23%	-1.92%	-2.81%	-3.39%	-4.11%	-4.33%	-4.52%	-5.03%	-4.49%	-3.48%	-2.28%
53	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.78%	-1.26%	-2.00%	-2.92%	-3.52%	-4.26%	-4.48%	-4.67%	-4.17%	-4.49%	-3.48%	-2.28%	-0.52%
52	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.81%	-1.35%	-2.08%	-3.03%	-3.64%	-4.40%	-4.63%	-4.81%	-4.29%	-3.55%	-3.48%	-2.28%	-0.52%	0.48%
51	0.00%	0.00%	0.00%	0.00%	0.00%	-0.84%	-1.40%	-2.15%	-3.13%	-3.76%	-4.54%	-4.76%	-4.94%	-4.40%	-3.63%	-2.53%	-2.28%	-0.52%	0.48%	2.62%
50	0.00%	0.00%	0.00%	0.00%	-0.87%	-1.44%	-2.22%	-3.22%	-3.87%	-4.66%	-4.88%	-5.06%	-4.50%	-3.71%	-2.58%	-1.37%	-0.52%	0.48%	2.62%	3.58%
49	0.00%	0.00%	0.00%	0.00%	-1.53%	-2.34%	-3.38%	-4.76%	-4.79%	-5.00%	-5.18%	-4.60%	-3.79%	-2.63%	-1.40%	0.40%	0.48%	2.62%	3.58%	5.27%
48	0.00%	0.00%	0.00%	0.00%	-2.50%	-3.57%	-4.97%	-6.23%	-5.11%	-5.28%	-4.68%	-3.85%	-2.67%	-1.42%	0.41%	1.28%	2.62%	3.58%	5.27%	4.98%
47	0.00%	0.00%	0.00%	0.00%	-3.80%	-5.27%	-6.58%	-7.30%	-5.38%	-4.76%	-3.91%	-2.71%	-1.44%	0.41%	1.30%	3.34%	3.58%	5.27%	4.98%	4.61%
46	0.00%	0.00%	0.00%	0.00%	-5.69%	-7.08%	-7.86%	-8.49%	-4.84%	-3.97%	-2.75%	-1.46%	0.42%	1.31%	3.38%	4.19%	5.27%	4.98%	4.61%	4.19%
45	0.00%	0.00%	0.00%	0.00%	-7.84%	-8.70%	-9.23%	-9.01%	-4.02%	-2.78%	-1.47%	0.42%	1.33%	3.42%	4.24%	5.76%	4.98%	4.61%	4.19%	3.84%
44	0.00%	0.00%	0.00%	0.00%	-9.99%	-10.35%	-10.06%	-9.33%	-2.81%	-1.49%	0.43%	1.34%	3.46%	4.28%	5.83%	5.35%	4.61%	4.19%	3.84%	3.25%
43	0.00%	0.00%	0.00%	0.00%	-12.09%	-11.45%	-10.48%	-9.27%	-1.50%	0.43%	1.35%	3.49%	4.32%	5.89%	5.41%	4.90%	4.19%	3.84%	3.25%	2.26%
42	0.00%	0.00%	0.00%	0.00%	-13.73%	-12.19%	-10.54%	-9.08%	0.44%	1.37%	3.52%	4.37%	5.95%	5.47%	4.96%	4.41%	3.84%	3.25%	2.26%	1.50%
41	0.00%	0.00%	0.00%	0.00%	-14.78%	-12.37%	-10.35%	-8.10%	1.38%	3.55%	4.40%	6.00%	5.52%	5.01%	4.46%	3.98%	3.25%	2.26%	1.50%	0.86%
40	0.00%	0.00%	0.00%	0.00%	-15.07%	-12.14%	-9.38%	-7.98%	3.57%	4.44%	6.05%	5.57%	5.06%	4.51%	4.03%	3.35%	2.26%	1.50%	0.86%	0.00%
39	0.00%	0.00%	0.00%	0.00%	-14.64%	-11.09%	-8.98%	-6.30%	4.47%	6.10%	5.62%	5.11%	4.55%	4.08%	3.39%	2.32%	1.50%	0.86%	0.00%	0.00%
38	0.00%	0.00%	0.00%	0.00%	-13.33%	-10.23%	-7.22%	-5.55%	6.15%	5.67%	5.15%	4.60%	4.12%	3.43%	2.35%	1.52%	0.86%	0.00%	0.00%	0.00%
37	0.00%	0.00%	0.00%	0.00%	-11.73%	-8.31%	-6.13%	-3.56%	5.71%	5.19%	4.63%	4.15%	3.46%	2.37%	1.54%	0.87%	0.00%	0.00%	0.00%	0.00%
36	0.00%	0.00%	0.00%	0.00%	-9.54%	-6.76%	-4.12%	-3.20%	5.23%	4.67%	4.19%	3.49%	2.39%	1.55%	0.87%	0.00%	0.00%	0.00%	0.00%	0.00%
35	0.00%	0.00%	0.00%	0.00%	-7.40%	-4.69%	-3.34%	-2.64%	4.71%	4.22%	3.52%	2.41%	1.57%	0.88%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
34	0.00%	0.00%	0.00%	0.00%	-5.23%	-3.47%	-2.53%	-1.94%	4.26%	3.55%	2.44%	1.58%	0.89%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
33	0.00%	0.00%	0.00%	0.00%	-3.59%	-2.43%	-1.73%	-1.01%	3.58%	2.46%	1.60%	0.90%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
32	0.00%	0.00%	0.00%	0.00%	-2.37%	-1.58%	-0.93%	-0.21%	2.48%	1.61%	0.91%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	0.00%	0.00%	0.00%	0.00%	-1.48%	-0.88%	-0.10%	-0.11%	1.62%	0.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
30	0.00%	0.00%	0.00%	0.00%	-0.85%	-0.04%	-0.04%	0.00%	0.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

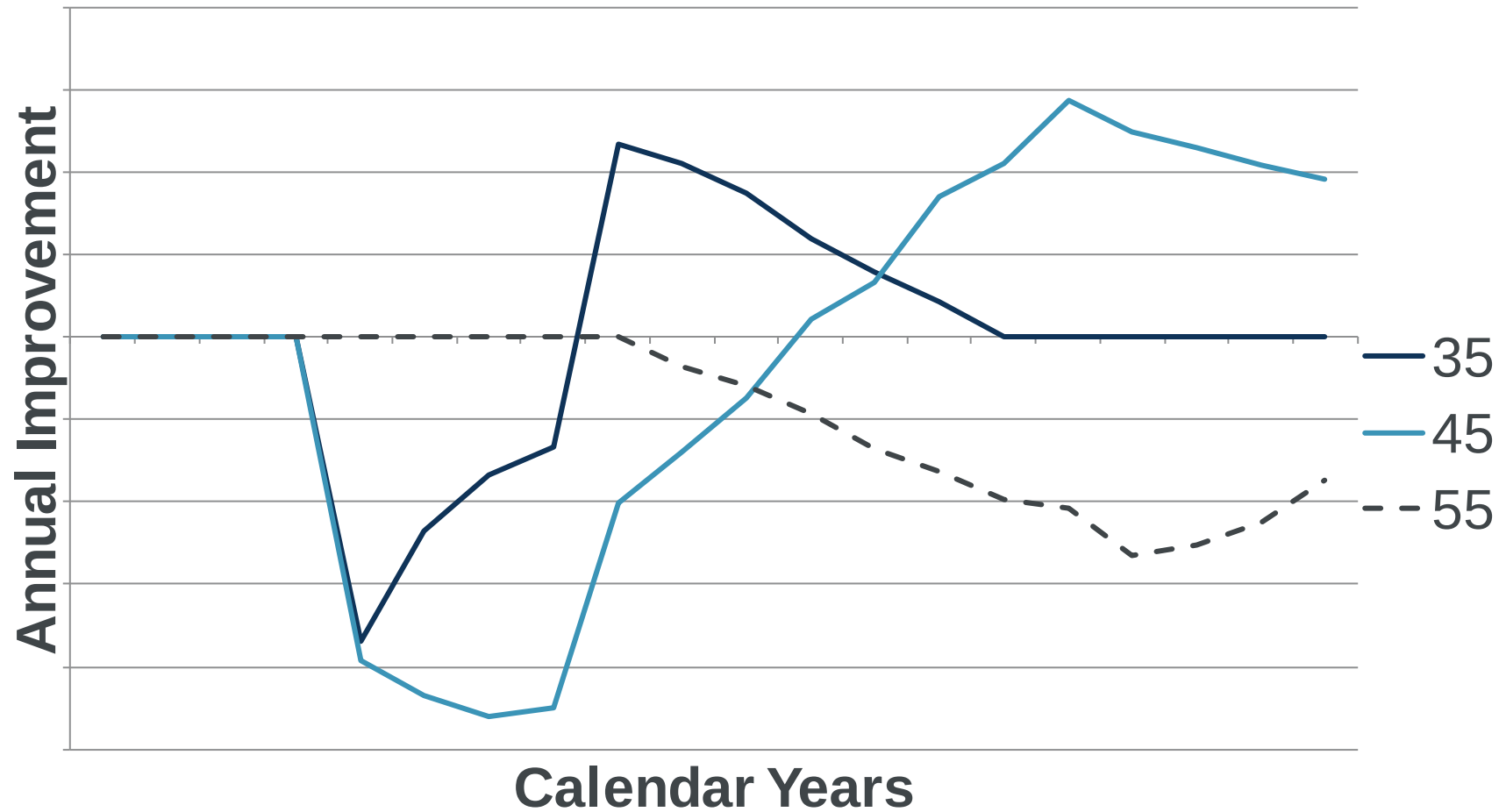
Leading edge cohort effect

Example 1

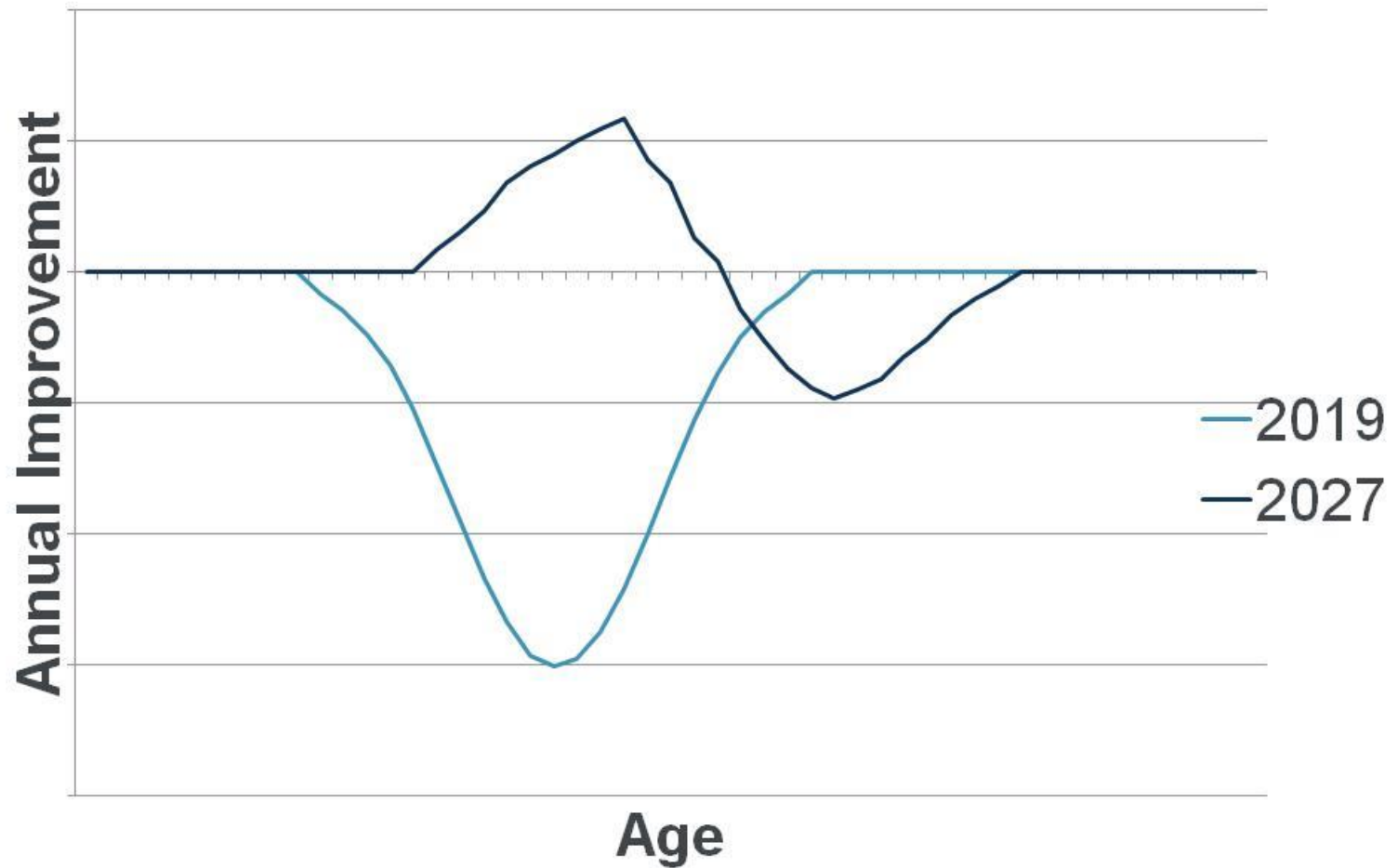
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
70	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
69	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
68	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
67	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
66	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
65	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
64	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
63	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
62	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
61	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.47%	-0.91%	-1.56%	-2.50%
60	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.52%	-0.87%	-1.56%	-2.50%	-4.28%
59	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.56%	-0.94%	-1.45%	-2.50%	-3.29%	-4.81%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.60%	-1.01%	-1.55%	-2.28%	-3.29%	-4.28%	-4.81%	-5.29%
57	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.64%	-1.07%	-1.65%	-2.42%	-2.94%	-4.28%	-4.81%	-5.29%	-5.03%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.68%	-1.14%	-1.75%	-2.56%	-3.10%	-3.77%	-4.81%	-5.29%	-5.03%	-4.49%
55	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.71%	-1.19%	-1.84%	-2.69%	-3.25%	-3.95%	-4.17%	-5.29%	-5.03%	-4.49%	-3.48%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.75%	-1.25%	-1.92%	-2.81%	-3.39%	-4.11%	-4.33%	-4.52%	-5.03%	-4.49%	-3.48%	-2.28%
53	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.78%	-1.30%	-2.00%	-2.92%	-3.52%	-4.26%	-4.48%	-4.67%	-4.17%	-4.49%	-3.48%	-2.28%	-0.52%
52	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.81%	-1.35%	-2.08%	-3.03%	-3.64%	-4.40%	-4.63%	-4.81%	-4.29%	-3.55%	-3.48%	-2.28%	-0.52%	0.48%
51	0.00%	0.00%	0.00%	0.00%	0.00%	-0.84%	-1.40%	-2.15%	-3.13%	-3.76%	-4.54%	-4.76%	-4.94%	-4.40%	-3.63%	-2.53%	-2.28%	-0.52%	0.48%	2.62%
50	0.00%	0.00%	0.00%	0.00%	-0.87%	-1.44%	-2.22%	-3.22%	-3.87%	-4.66%	-4.88%	-5.06%	-4.50%	-3.71%	-2.58%	-1.37%	-0.52%	0.48%	2.62%	3.58%
49	0.00%	0.00%	0.00%	0.00%	-1.53%	-2.34%	-3.38%	-4.76%	-4.79%	-5.00%	-5.18%	-4.60%	-3.79%	-2.63%	-1.40%	0.40%	0.48%	2.62%	3.58%	5.27%
48	0.00%	0.00%	0.00%	0.00%	-2.50%	-3.57%	-4.97%	-6.23%	-5.11%	-5.28%	-4.68%	-3.85%	-2.67%	-1.42%	0.41%	1.28%	2.62%	3.58%	5.27%	4.98%
47	0.00%	0.00%	0.00%	0.00%	-3.85%	-5.27%	-6.58%	-7.30%	-5.38%	-4.76%	-3.91%	-2.71%	-1.44%	0.41%	1.30%	3.34%	3.58%	5.27%	4.98%	4.61%
46	0.00%	0.00%	0.00%	0.00%	-5.69%	-7.08%	-7.86%	-8.49%	-4.84%	-3.97%	-2.75%	-1.46%	0.42%	1.31%	3.38%	4.19%	5.27%	4.98%	4.61%	4.19%
45	0.00%	0.00%	0.00%	0.00%	-7.84%	-8.70%	-9.23%	-9.01%	-4.02%	-2.78%	-1.47%	0.42%	1.33%	3.42%	4.24%	5.76%	4.98%	4.61%	4.19%	3.84%
44	0.00%	0.00%	0.00%	0.00%	-9.99%	-10.35%	-9.98%	-9.33%	-2.81%	-1.49%	0.42%	1.34%	3.46%	4.28%	5.83%	5.35%	4.61%	4.19%	3.84%	3.25%
43	0.00%	0.00%	0.00%	0.00%	-12.09%	-11.45%	-10.48%	-9.27%	-1.50%	0.43%	1.35%	3.49%	4.32%	5.89%	5.41%	4.90%	4.19%	3.84%	3.25%	2.26%
42	0.00%	0.00%	0.00%	0.00%	-13.73%	-12.19%	-10.54%	-9.08%	0.44%	1.37%	3.52%	4.37%	5.95%	5.47%	4.96%	4.41%	3.84%	3.25%	2.26%	1.50%
41	0.00%	0.00%	0.00%	0.00%	-14.78%	-12.37%	-10.35%	-8.10%	1.38%	3.55%	4.40%	6.00%	5.52%	5.01%	4.46%	3.98%	3.25%	2.26%	1.50%	0.86%
40	0.00%	0.00%	0.00%	0.00%	-15.07%	-12.14%	-9.38%	-7.06%	3.57%	4.44%	6.05%	5.57%	5.06%	4.51%	4.03%	3.35%	2.26%	1.50%	0.86%	0.00%
39	0.00%	0.00%	0.00%	0.00%	-14.64%	-11.09%	-8.98%	-6.30%	4.47%	6.10%	5.62%	5.11%	4.55%	4.08%	3.39%	2.32%	1.50%	0.86%	0.00%	0.00%
38	0.00%	0.00%	0.00%	0.00%	-13.33%	-10.23%	-7.22%	-5.55%	6.15%	5.67%	5.15%	4.60%	4.12%	3.43%	2.35%	1.52%	0.86%	0.00%	0.00%	0.00%
37	0.00%	0.00%	0.00%	0.00%	-11.73%	-8.31%	-6.13%	-3.56%	5.71%	5.19%	4.63%	4.15%	3.46%	2.37%	1.54%	0.87%	0.00%	0.00%	0.00%	0.00%
36	0.00%	0.00%	0.00%	0.00%	-9.54%	-6.18%	-4.12%	-3.20%	5.23%	4.67%	4.10%	3.49%	2.39%	1.55%	0.87%	0.00%	0.00%	0.00%	0.00%	0.00%
35	0.00%	0.00%	0.00%	0.00%	-7.40%	-4.69%	-3.34%	-2.64%	4.71%	4.22%	3.52%	2.41%	1.57%	0.88%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
34	0.00%	0.00%	0.00%	0.00%	-5.23%	-3.47%	-2.53%	-1.94%	4.26%	3.55%	2.44%	1.58%	0.89%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
33	0.00%	0.00%	0.00%	0.00%	-3.59%	-2.43%	-1.73%	-1.01%	3.58%	2.46%	1.60%	0.90%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
32	0.00%	0.00%	0.00%	0.00%	-2.37%	-1.58%	-0.93%	-0.21%	2.48%	1.61%	0.91%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	0.00%	0.00%	0.00%	0.00%	-1.48%	-0.88%	-0.10%	-0.11%	1.62%	0.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
30	0.00%	0.00%	0.00%	0.00%	-0.85%	-0.04%	-0.04%	0.00%	0.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Trailing edge cohort effect

Improvements by Calendar Year



Improvements by Age



Example 2

- Residents of Dog Land migrate to Cat Land
- 1% population growth
 - Per annum
 - Over 4 years
 - Over the age range 30 – 50
- Dogs take on cat characteristics over 10 years

Example 2

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
70	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
69	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
68	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
67	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
66	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
65	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
64	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
63	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
62	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
61	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.06%	0.06%	0.00%	0.00%	0.00%
60	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.12%	-0.05%	0.17%	0.00%	0.00%	0.00%
59	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.19%	-0.16%	-0.01%	0.36%	0.00%	0.00%	0.00%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.26%	-0.28%	-0.20%	0.07%	0.66%	0.00%	0.00%	0.00%
57	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.34%	-0.40%	-0.39%	-0.22%	0.28%	1.05%	0.00%	0.00%	0.00%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.42%	-0.53%	-0.58%	-0.51%	-0.09%	0.55%	1.56%	0.00%	0.00%	0.00%
55	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.51%	-0.67%	-0.79%	-0.81%	-0.46%	0.07%	0.98%	2.14%	0.00%	0.00%	0.00%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.60%	-0.82%	-1.00%	-1.11%	-0.84%	-0.41%	0.43%	1.48%	2.79%	0.00%	0.00%	0.00%
53	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.70%	-0.97%	-1.23%	-1.43%	-1.22%	-0.88%	-0.10%	0.85%	2.12%	3.43%	0.00%	0.00%	0.00%
52	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.81%	-1.14%	-1.46%	-1.76%	-1.60%	-1.35%	-0.62%	0.26%	1.50%	2.78%	4.00%	0.00%	0.00%	0.00%
51	0.00%	0.00%	0.00%	0.00%	0.00%	-0.84%	-1.40%	-1.71%	-2.10%	-2.00%	-1.82%	-1.13%	-0.30%	0.93%	2.20%	3.44%	4.44%	0.00%	0.00%	0.00%
50	0.00%	0.00%	0.00%	0.00%	-0.87%	-1.44%	-2.22%	-2.46%	-2.40%	-2.30%	-1.63%	-0.85%	0.39%	1.68%	2.96%	4.01%	4.73%	0.00%	0.00%	0.00%
49	0.00%	0.00%	0.00%	0.00%	-1.53%	-2.34%	-3.38%	-3.59%	-2.78%	-2.13%	-1.38%	-0.11%	1.19%	2.53%	3.65%	4.53%	4.77%	0.00%	0.00%	0.00%
48	0.00%	0.00%	0.00%	0.00%	-2.50%	-3.57%	-4.97%	-4.58%	-2.62%	-1.89%	-0.60%	0.75%	2.14%	3.33%	4.38%	4.69%	4.67%	0.00%	0.00%	0.00%
47	0.00%	0.00%	0.00%	0.00%	-3.85%	-5.27%	-6.58%	-5.16%	-2.39%	-1.06%	0.33%	1.79%	3.05%	4.26%	4.65%	4.90%	4.27%	0.00%	0.00%	0.00%
46	0.00%	0.00%	0.00%	0.00%	-5.69%	-7.08%	-7.86%	-5.83%	-1.50%	-0.06%	1.46%	2.80%	4.16%	4.63%	5.13%	4.65%	3.76%	0.00%	0.00%	0.00%
45	0.00%	0.00%	0.00%	0.00%	-7.84%	-8.70%	-9.23%	-5.92%	-0.44%	1.17%	2.58%	4.09%	4.63%	5.37%	5.01%	4.37%	3.03%	0.00%	0.00%	0.00%
44	0.00%	0.00%	0.00%	0.00%	-9.99%	-10.35%	-9.98%	-5.89%	0.89%	2.38%	4.03%	4.64%	5.60%	5.36%	4.95%	3.61%	2.38%	0.00%	0.00%	0.00%
43	0.00%	0.00%	0.00%	0.00%	-12.09%	-11.45%	-10.48%	-5.59%	2.20%	3.98%	4.67%	5.83%	5.71%	5.52%	4.17%	2.91%	1.80%	0.00%	0.00%	0.00%
42	0.00%	0.00%	0.00%	0.00%	-13.73%	-12.19%	-10.54%	-5.26%	3.95%	4.70%	6.05%	6.05%	6.06%	4.71%	3.44%	2.28%	1.30%	0.00%	0.00%	0.00%
41	0.00%	0.00%	0.00%	0.00%	-14.78%	-12.37%	-10.35%	-4.32%	4.73%	6.27%	6.37%	6.59%	5.24%	3.94%	2.75%	1.73%	0.86%	0.00%	0.00%	0.00%
40	0.00%	0.00%	0.00%	0.00%	-15.07%	-12.14%	-9.38%	-4.27%	6.49%	6.69%	7.10%	5.75%	4.44%	3.22%	2.16%	1.22%	0.49%	0.00%	0.00%	0.00%
39	0.00%	0.00%	0.00%	0.00%	-14.64%	-11.09%	-8.98%	-2.88%	7.00%	7.58%	6.26%	4.94%	3.68%	2.58%	1.57%	0.74%	0.25%	0.00%	0.00%	0.00%
38	0.00%	0.00%	0.00%	0.00%	-13.33%	-10.23%	-7.22%	-2.46%	8.06%	6.74%	5.42%	4.13%	3.00%	1.93%	0.98%	0.41%	0.09%	0.00%	0.00%	0.00%
37	0.00%	0.00%	0.00%	0.00%	-11.73%	-8.31%	-6.13%	-0.99%	7.21%	5.88%	4.58%	3.42%	2.29%	1.23%	0.57%	0.18%	0.00%	0.00%	0.00%	0.00%
36	0.00%	0.00%	0.00%	0.00%	-9.54%	-6.76%	-4.12%	-1.09%	6.34%	5.02%	3.84%	2.64%	1.47%	0.73%	0.27%	0.00%	0.00%	0.00%	0.00%	0.00%
35	0.00%	0.00%	0.00%	0.00%	-7.40%	-4.69%	-3.34%	-0.99%	5.46%	4.25%	3.00%	1.72%	0.89%	0.36%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
34	0.00%	0.00%	0.00%	0.00%	-5.23%	-3.47%	-2.53%	-0.70%	4.67%	3.36%	1.97%	1.05%	0.45%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
33	0.00%	0.00%	0.00%	0.00%	-3.59%	-2.43%	-1.73%	-0.17%	3.72%	2.23%	1.22%	0.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
32	0.00%	0.00%	0.00%	0.00%	-2.37%	-1.58%	-0.93%	0.29%	2.48%	1.39%	0.64%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	0.00%	0.00%	0.00%	0.00%	-1.48%	-0.88%	-0.10%	0.15%	1.56%	0.73%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
30	0.00%	0.00%	0.00%	0.00%	-0.85%	-0.04%	-0.04%	0.09%	0.83%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Example 2

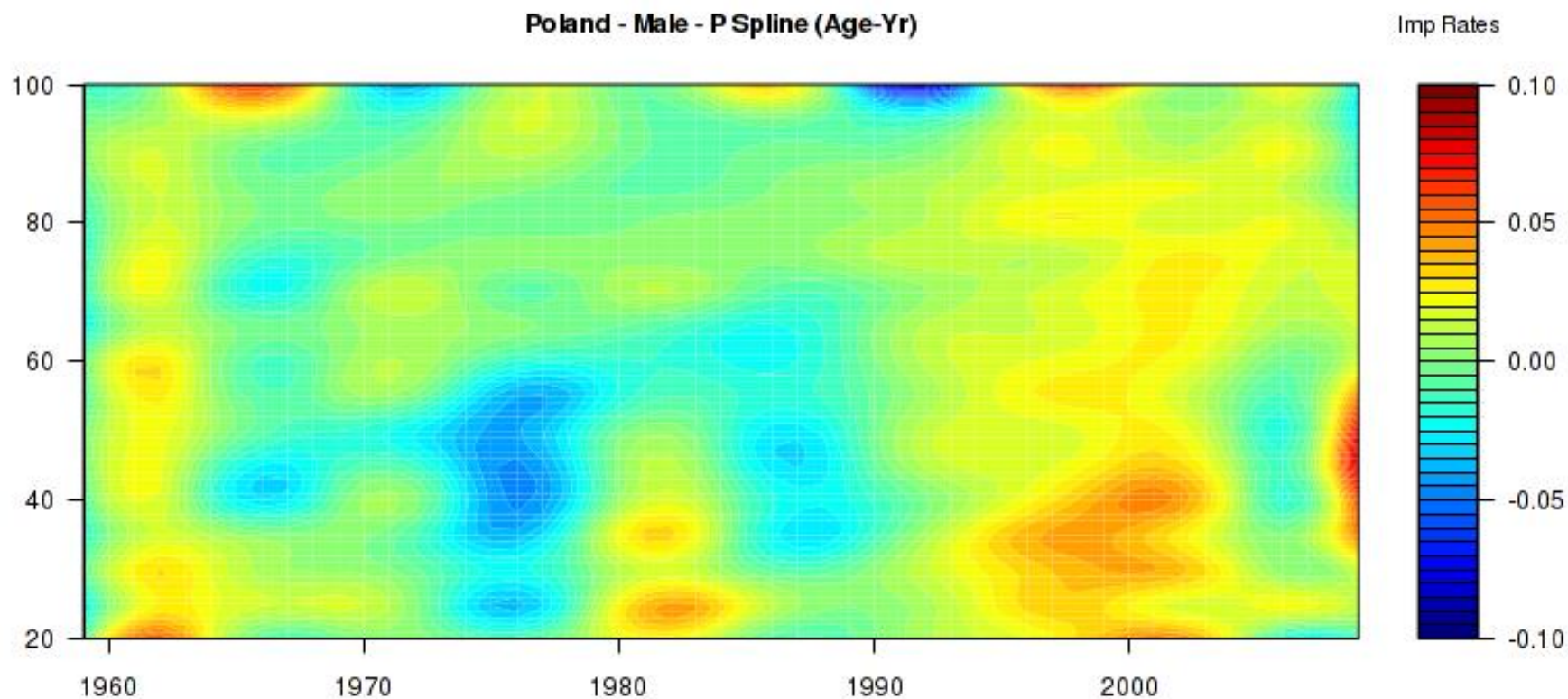
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
70	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
69	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
68	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
67	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
66	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
65	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
64	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
63	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
62	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
61	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.06%	0.06%	0.00%	0.00%	0.00%
60	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.12%	-0.05%	0.17%	0.00%	0.00%	0.00%
59	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.19%	-0.16%	-0.01%	0.36%	0.00%	0.00%	0.00%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.26%	-0.28%	-0.20%	0.07%	0.66%	0.00%	0.00%	0.00%
57	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.34%	-0.40%	-0.39%	-0.22%	0.28%	1.05%	0.00%	0.00%	0.00%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.42%	-0.53%	-0.58%	-0.51%	-0.09%	0.55%	1.08%	0.00%	0.00%	0.00%
55	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.51%	-0.67%	-0.79%	-0.81%	-0.46%	0.07%	0.98%	2.14%	0.00%	0.00%	0.00%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.60%	-0.82%	-1.00%	-1.11%	-0.84%	-0.41%	0.43%	1.18%	2.79%	0.00%	0.00%	0.00%
53	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.70%	-0.97%	-1.23%	-1.43%	-1.22%	-0.88%	-0.10%	0.85%	2.12%	3.43%	0.00%	0.00%	0.00%
52	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.81%	-1.14%	-1.46%	-1.76%	-1.60%	-1.35%	-0.62%	0.26%	1.30%	2.78%	4.00%	0.00%	0.00%	0.00%
51	0.00%	0.00%	0.00%	0.00%	0.00%	-0.84%	-1.40%	-1.71%	-2.10%	-2.00%	-1.82%	-1.13%	-0.30%	0.93%	2.20%	3.44%	4.44%	0.00%	0.00%	0.00%
50	0.00%	0.00%	0.00%	0.00%	-0.87%	-1.44%	-2.22%	-2.46%	-2.40%	-2.30%	-1.63%	-0.85%	0.39%	1.68%	2.96%	4.01%	4.73%	0.00%	0.00%	0.00%
49	0.00%	0.00%	0.00%	0.00%	-1.53%	-2.34%	-3.38%	-3.59%	-2.78%	-2.13%	-1.38%	-0.11%	1.19%	2.53%	3.65%	4.53%	4.77%	0.00%	0.00%	0.00%
48	0.00%	0.00%	0.00%	0.00%	-2.50%	-3.57%	-4.97%	-4.58%	-2.62%	-1.89%	-0.60%	0.75%	2.14%	3.33%	4.38%	4.69%	4.67%	0.00%	0.00%	0.00%
47	0.00%	0.00%	0.00%	0.00%	-3.85%	-5.27%	-6.58%	-5.16%	-2.39%	-1.06%	0.33%	1.79%	3.05%	4.26%	4.65%	4.90%	4.27%	0.00%	0.00%	0.00%
46	0.00%	0.00%	0.00%	0.00%	-5.69%	-7.08%	-7.86%	-5.83%	-1.50%	-0.06%	1.46%	2.82%	4.16%	4.63%	5.13%	4.65%	3.76%	0.00%	0.00%	0.00%
45	0.00%	0.00%	0.00%	0.00%	-7.84%	-8.70%	-9.23%	-5.92%	-0.44%	1.17%	2.58%	4.09%	4.63%	5.37%	5.01%	4.37%	3.03%	0.00%	0.00%	0.00%
44	0.00%	0.00%	0.00%	0.00%	-9.95%	-10.35%	-9.98%	-5.89%	0.69%	2.38%	4.03%	4.64%	5.60%	5.36%	4.95%	3.61%	2.38%	0.00%	0.00%	0.00%
43	0.00%	0.00%	0.00%	0.00%	-12.09%	-11.45%	-10.48%	-3.59%	2.20%	3.68%	4.67%	5.83%	5.71%	5.52%	4.17%	2.91%	1.80%	0.00%	0.00%	0.00%
42	0.00%	0.00%	0.00%	0.00%	-13.73%	-12.15%	-10.54%	-5.26%	3.95%	4.70%	6.05%	6.05%	6.06%	4.71%	3.44%	2.28%	1.30%	0.00%	0.00%	0.00%
41	0.00%	0.00%	0.00%	0.00%	-14.78%	-12.37%	-10.35%	-4.32%	4.73%	6.27%	6.37%	6.59%	5.24%	3.94%	2.75%	1.73%	0.86%	0.00%	0.00%	0.00%
40	0.00%	0.00%	0.00%	0.00%	-15.07%	-12.14%	-9.38%	-4.27%	6.49%	6.69%	7.10%	5.75%	4.44%	3.22%	2.16%	1.22%	0.49%	0.00%	0.00%	0.00%
39	0.00%	0.00%	0.00%	0.00%	-14.64%	-11.09%	-8.98%	-2.88%	7.00%	7.58%	6.26%	4.94%	3.68%	2.58%	1.57%	0.74%	0.25%	0.00%	0.00%	0.00%
38	0.00%	0.00%	0.00%	0.00%	-13.33%	-10.23%	-7.72%	-2.46%	8.06%	6.74%	5.42%	4.13%	3.00%	1.93%	0.98%	0.41%	0.09%	0.00%	0.00%	0.00%
37	0.00%	0.00%	0.00%	0.00%	-11.73%	-8.31%	-6.13%	-0.99%	7.21%	5.88%	4.58%	3.42%	2.29%	1.23%	0.57%	0.18%	0.00%	0.00%	0.00%	0.00%
36	0.00%	0.00%	0.00%	0.00%	-9.54%	-6.76%	-4.12%	-1.09%	6.34%	5.02%	3.87%	2.64%	1.47%	0.73%	0.27%	0.00%	0.00%	0.00%	0.00%	0.00%
35	0.00%	0.00%	0.00%	0.00%	-7.40%	-4.69%	-3.34%	-0.99%	5.46%	4.25%	3.00%	1.72%	0.89%	0.36%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
34	0.00%	0.00%	0.00%	0.00%	-5.23%	-3.47%	-2.53%	-0.70%	4.67%	3.36%	1.97%	1.05%	0.45%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
33	0.00%	0.00%	0.00%	0.00%	-3.59%	-2.43%	-1.73%	-0.17%	3.72%	2.23%	1.22%	0.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
32	0.00%	0.00%	0.00%	0.00%	-2.37%	-1.56%	-0.93%	0.29%	2.48%	1.39%	0.64%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	0.00%	0.00%	0.00%	0.00%	-1.48%	-0.88%	-0.10%	0.15%	1.56%	0.73%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
30	0.00%	0.00%	0.00%	0.00%	-0.85%	-0.04%	-0.04%	0.09%	0.83%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Example 2

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
70	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
69	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	Fully Integrated					0.00%	0.00%	0.00%	0.00%
68	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%						0.00%	0.00%	0.00%	0.00%
67	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%						0.00%	0.00%	0.00%	0.00%
66	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%						0.00%	0.00%	0.00%	0.00%
65	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
64	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
63	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
62	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
61	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.06%	0.06%	0.00%	0.00%	0.00%
60	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.12%	-0.05%	0.17%	0.00%	0.00%	0.00%
59	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.19%	-0.16%	0.01%	0.36%	0.00%	0.00%
58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.26%	-0.28%	-0.20%	0.07%	0.66%	0.00%	0.00%	0.00%
57	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.34%	-0.40%	-0.39%	-0.22%	0.28%	1.05%	0.00%	0.00%	0.00%
56	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.42%	-0.53%	-0.58%	-0.51%	-0.09%	0.55%	1.08%	0.00%	0.00%	0.00%
55	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.51%	-0.67%	-0.79%	-0.81%	-0.46%	0.07%	0.98%	2.04%	0.00%	0.00%	0.00%
54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.60%	-0.82%	-1.00%	-1.11%	-0.84%	-0.41%	0.43%	1.08%	2.79%	0.00%	0.00%	0.00%
53	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.70%	-0.97%	-1.23%	-1.43%	-1.22%	-0.88%	-0.10%	0.85%	2.12%	3.43%	0.00%	0.00%	0.00%
52	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.81%	-1.14%	-1.46%	-1.76%	-1.60%	-1.35%	-0.62%	0.26%	1.30%	2.78%	4.00%	0.00%	0.00%	0.00%
51	0.00%	0.00%	0.00%	0.00%	0.00%	-0.84%	-1.40%	-1.71%	-2.10%	-2.00%	-1.82%	-1.13%	-0.30%	0.93%	2.20%	3.44%	4.44%	0.00%	0.00%	0.00%
50	0.00%	0.00%	0.00%	0.00%	-0.87%	-1.44%	-2.22%	-2.46%	-2.40%	-2.30%	-1.63%	-0.85%	0.39%	1.68%	2.96%	4.01%	4.73%	0.00%	0.00%	0.00%
49	0.00%	0.00%	0.00%	0.00%	-1.53%	-2.34%	-3.38%	-3.59%	-2.78%	-2.13%	-1.38%	-0.11%	1.19%	2.53%	3.65%	4.53%	4.77%	0.00%	0.00%	0.00%
48	0.00%	0.00%	0.00%	0.00%	-2.50%	-3.57%	-4.97%	-4.58%	-2.62%	-1.89%	-0.60%	0.75%	2.14%	3.33%	4.38%	4.69%	4.67%	0.00%	0.00%	0.00%
47	0.00%	0.00%	0.00%	0.00%	-3.85%	-5.27%	-6.58%	-5.16%	-2.39%	-1.06%	0.33%	1.79%	3.05%	4.26%	4.65%	4.90%	4.27%	0.00%	0.00%	0.00%
46	0.00%	0.00%	0.00%	0.00%	-5.69%	-7.08%	-7.86%	-5.83%	-1.50%	-0.06%	1.46%	2.82%	4.16%	4.63%	5.13%	4.65%	3.76%	0.00%	0.00%	0.00%
45	0.00%	0.00%	0.00%	0.00%	-7.84%	-8.70%	-9.23%	-5.92%	-0.44%	1.17%	2.58%	4.09%	4.63%	5.37%	5.01%	4.37%	3.03%	0.00%	0.00%	0.00%
44	0.00%	0.00%	0.00%	0.00%	-9.95%	-10.35%	-9.98%	-5.89%	0.69%	2.38%	4.03%	4.64%	5.60%	5.36%	4.95%	3.61%	2.38%	0.00%	0.00%	0.00%
43	0.00%	0.00%	0.00%	0.00%	-12.09%	-11.45%	-10.48%	-3.59%	2.20%	3.68%	4.67%	5.83%	5.71%	5.52%	4.17%	2.91%	1.80%	0.00%	0.00%	0.00%
42	0.00%	0.00%	0.00%	0.00%	-13.73%	-12.15%	-10.54%	-5.26%	3.95%	4.70%	6.05%	6.05%	6.06%	4.71%	3.44%	2.28%	1.30%	0.00%	0.00%	0.00%
41	0.00%	0.00%	0.00%	0.00%	-14.78%	-12.37%	-10.35%	-4.32%	4.73%	6.27%	6.37%	6.59%	5.24%	3.94%	2.75%	1.73%	0.86%	0.00%	0.00%	0.00%
40	0.00%	0.00%	0.00%	0.00%	-15.07%	-12.14%	-9.38%	-4.27%	6.49%	6.69%	7.10%	5.75%	4.44%	3.22%	2.16%	1.22%	0.49%	0.00%	0.00%	0.00%
39	0.00%	0.00%	0.00%	0.00%	-14.64%	-11.09%	-8.98%	-2.88%	7.00%	7.58%	6.26%	4.94%	3.68%	2.58%	1.57%	0.74%	0.25%	0.00%	0.00%	0.00%
38	0.00%	0.00%	0.00%	0.00%	-13.33%	-10.23%	-7.02%	-2.46%	8.06%	6.74%	5.42%	4.13%	3.00%	1.93%	0.98%	0.41%	0.09%	0.00%	0.00%	0.00%
37	0.00%	0.00%	0.00%	0.00%	-11.73%	-8.31%	-6.13%	-0.99%	7.21%	5.88%	4.58%	3.42%	2.29%	1.23%	0.57%	0.18%	0.00%	0.00%	0.00%	0.00%
36	0.00%	0.00%	0.00%	0.00%	-9.54%	-6.76%	-4.12%	-1.09%	6.34%	5.02%	3.87%	2.64%	1.47%	0.73%	0.27%	0.00%	0.00%	0.00%	0.00%	0.00%
35	0.00%	0.00%	0.00%	0.00%	-7.40%	-4.69%	-3.34%	-0.99%	5.46%	4.25%	3.00%	1.72%	0.89%	0.36%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
34	0.00%	0.00%	0.00%	0.00%	-5.23%	-3.47%	-2.53%	-0.70%	4.67%	3.36%	1.97%	1.05%	0.45%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
33	0.00%	0.00%	0.00%	0.00%	-3.59%	-2.43%	-1.73%	-0.17%	3.72%	2.23%	1.22%	0.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
32	0.00%	0.00%	0.00%	0.00%	-2.37%	-1.56%	-0.93%	0.29%	2.48%	1.39%	0.64%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	0.00%	0.00%	0.00%	0.00%	-1.48%	-0.88%	-0.10%	0.15%	1.56%	0.73%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
30	0.00%	0.00%	0.00%	0.00%	-0.85%	-0.04%	-0.04%	0.09%	0.83%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

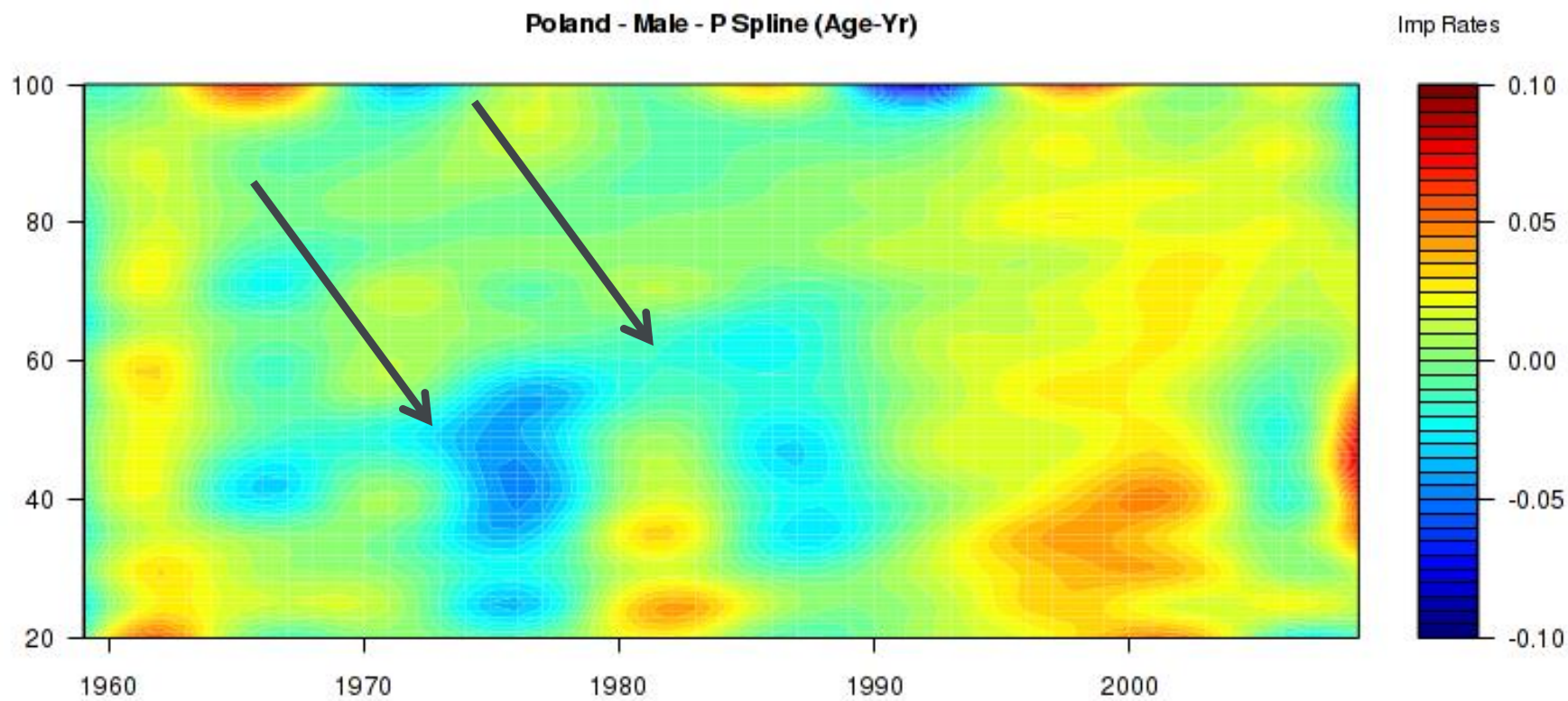
Real examples?

The Polish Example



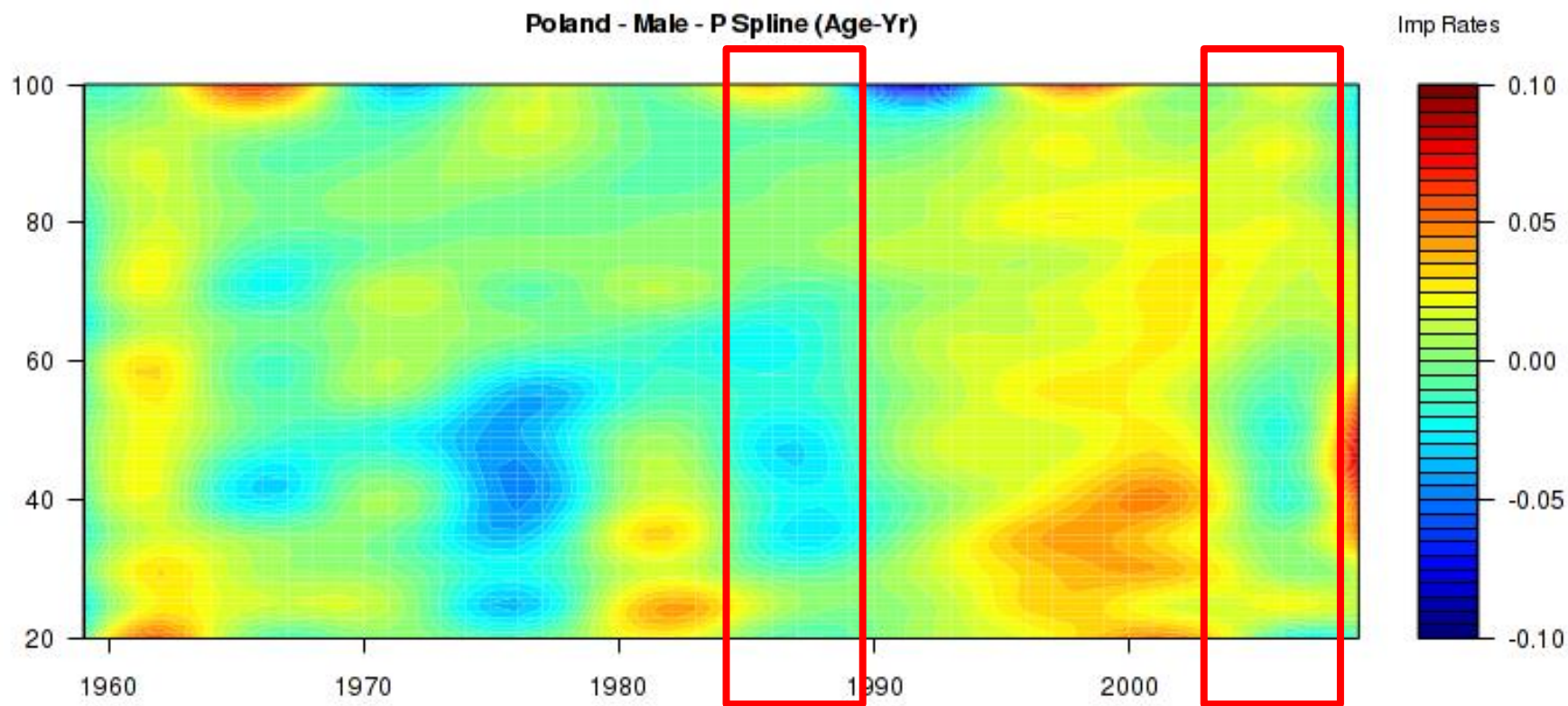
Source: HMD (own calculations)

The Polish Example



Source: HMD (own calculations)

The Polish Example



Source: HMD (own calculations)

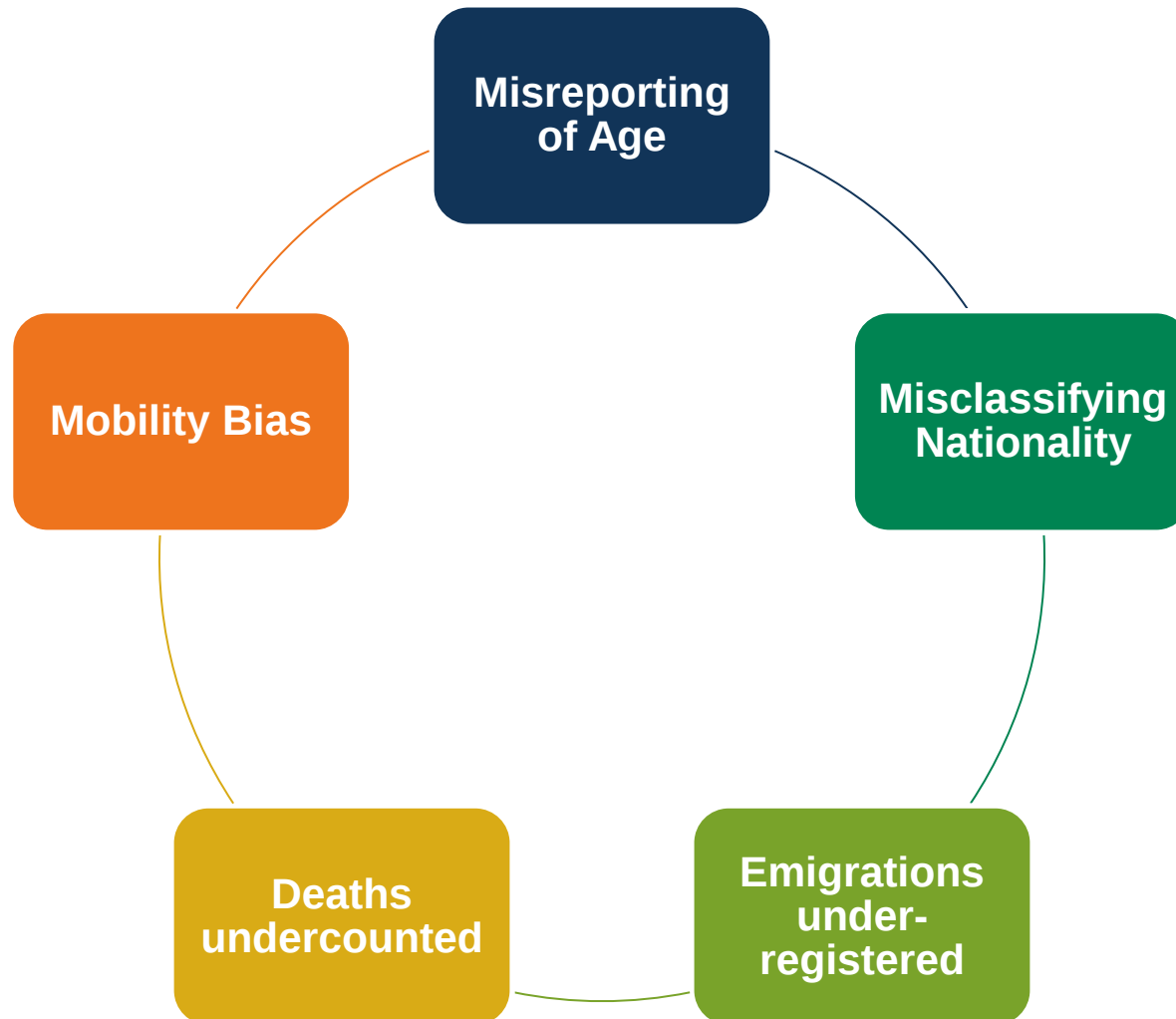
Low Immigrant Mortality or Data Artifact?

- Low mortality for most immigrant groups compared to natives in the host country¹
- Often attributed to beneficial health selection processes
- Could it be data artifacts?
- Explored in recent paper by Wallace and Kulu²

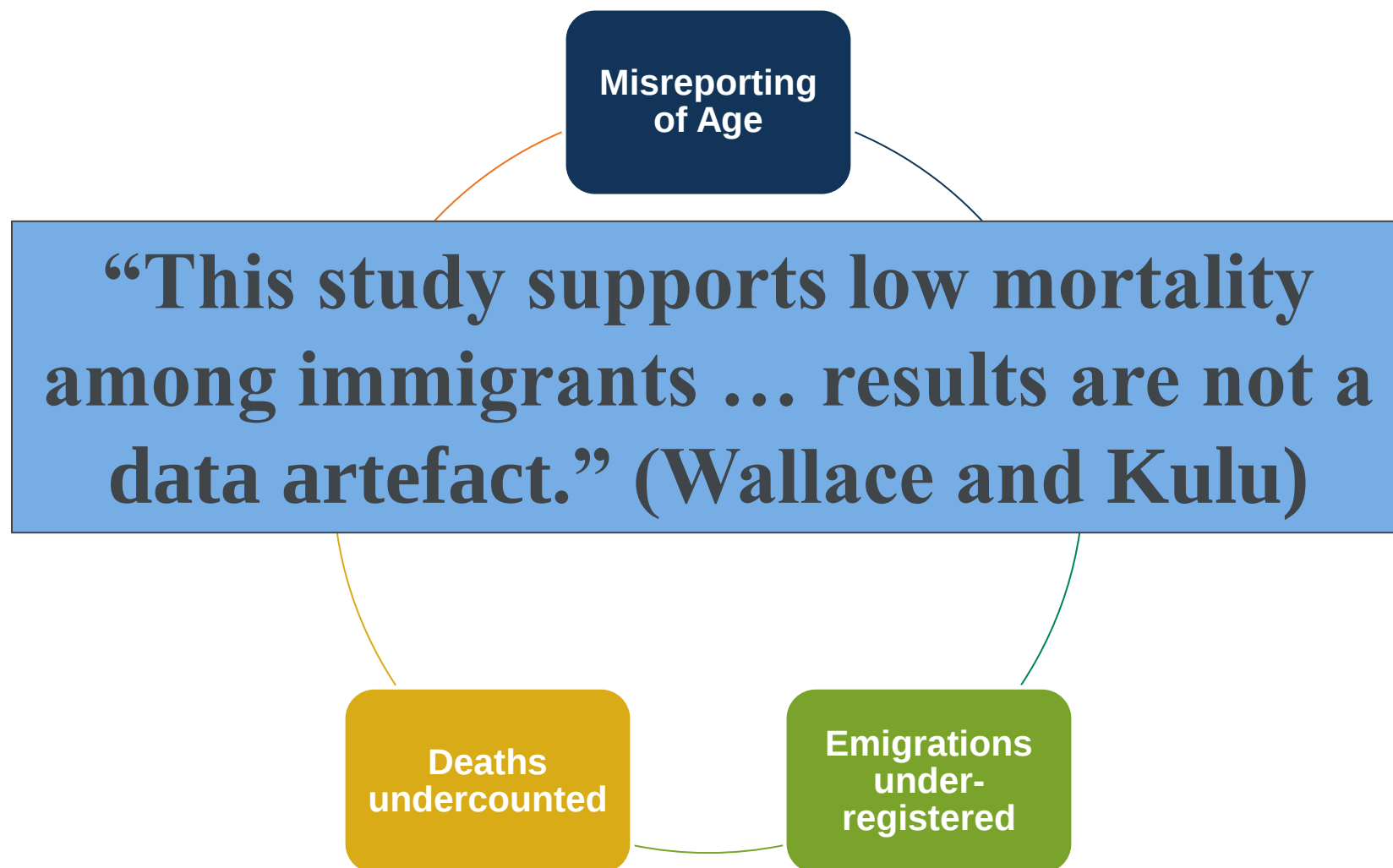
¹NZ - Hajat et al., 2010, U.S. - Abraido-Lanza et al., 1999; Palloni and Arias, 2004

²Wallace and Kulu, 2014

Potential Data Artifacts



Potential Data Artifacts





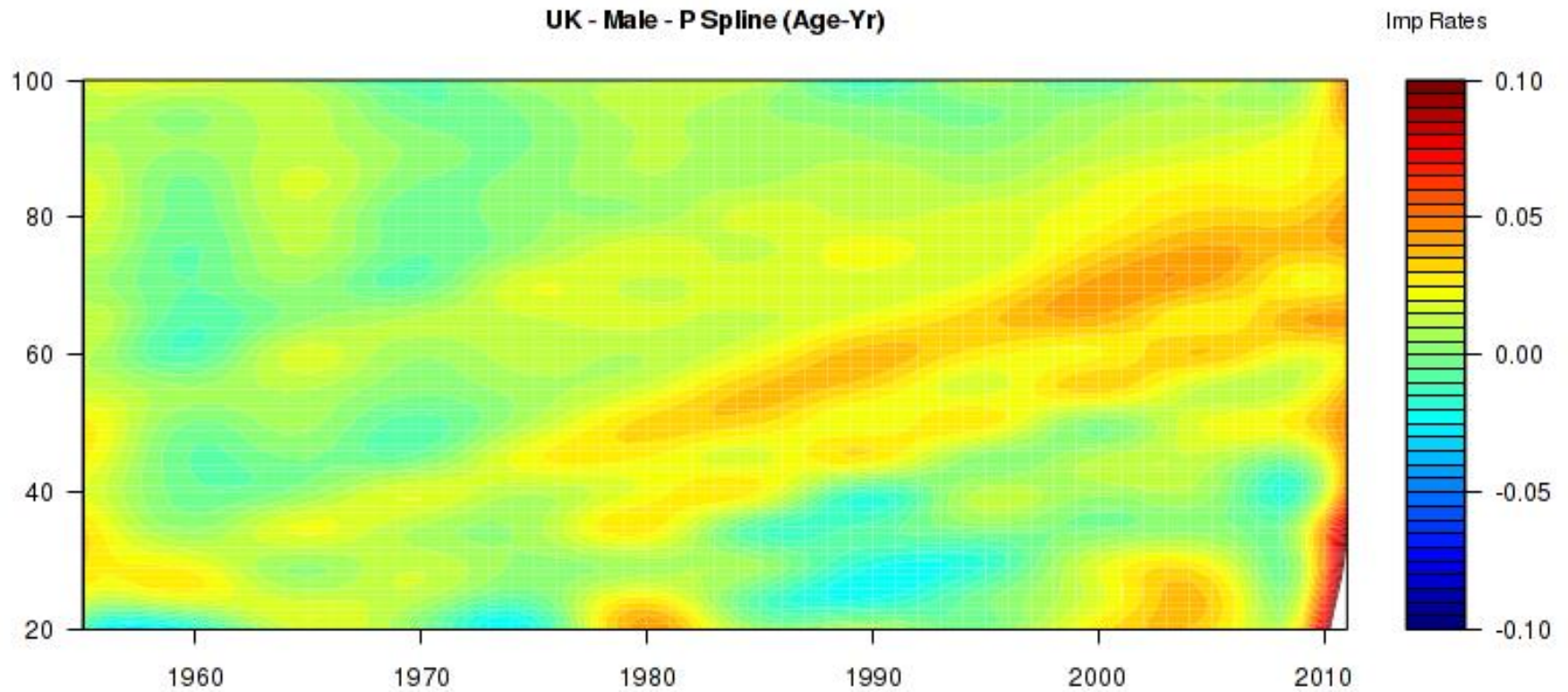
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One True History?

02 March 2015

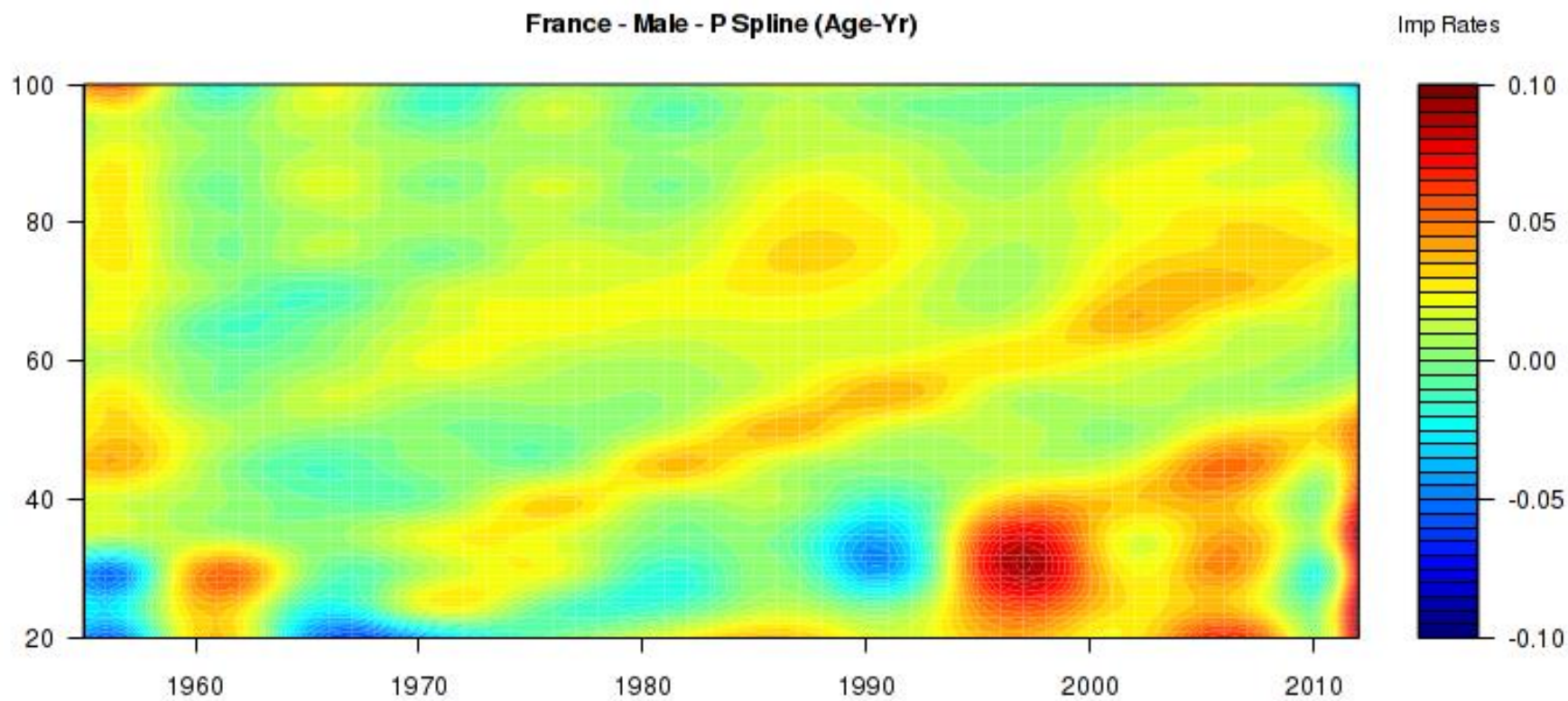
ertise
ponsorship
Thought leadership
Progress
Community
Sessional Meetings
Education
Working parties
Volunteering
Research
Shaping the future
Networking
Professional support
Enterprise and risk
Learned society
Opportunity
International profile
Journals
Support

UK Population



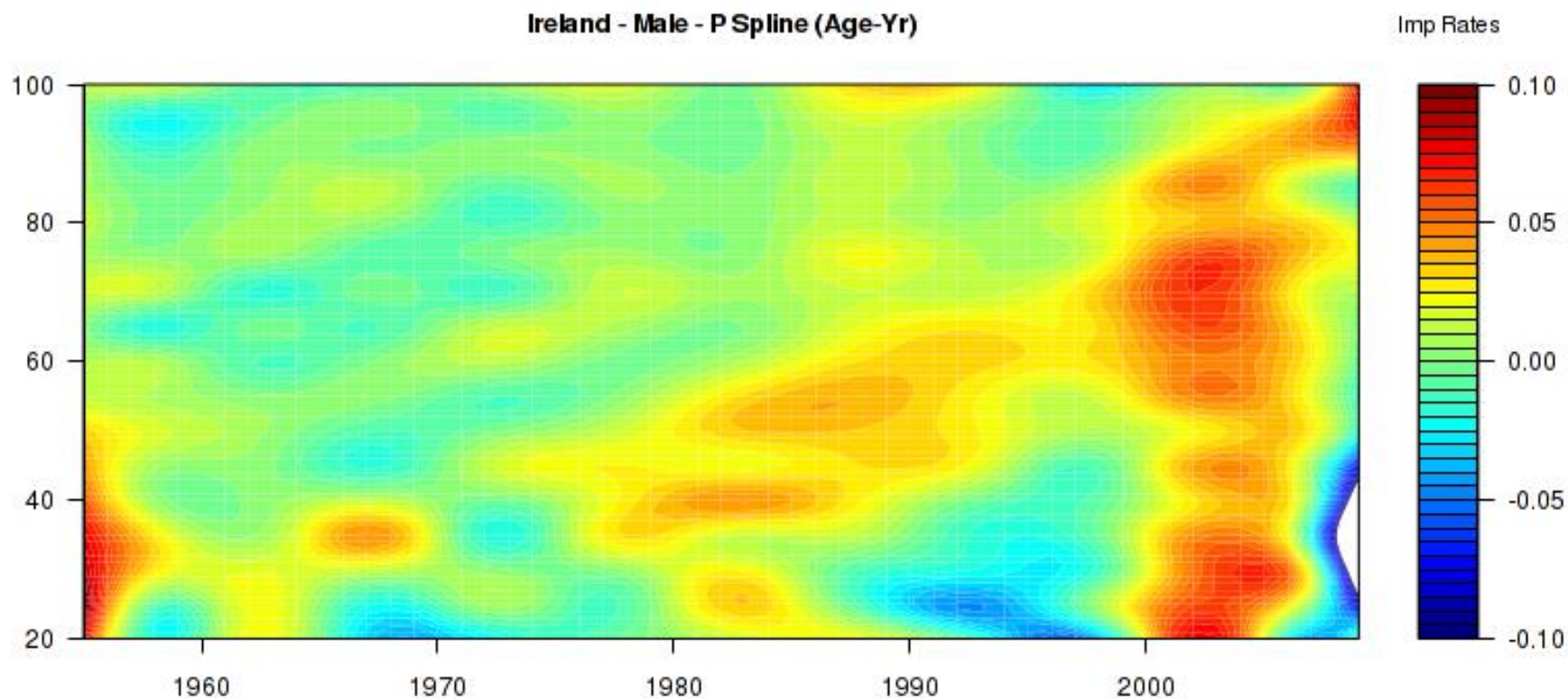
Source: HMD (own calculations)

France Population



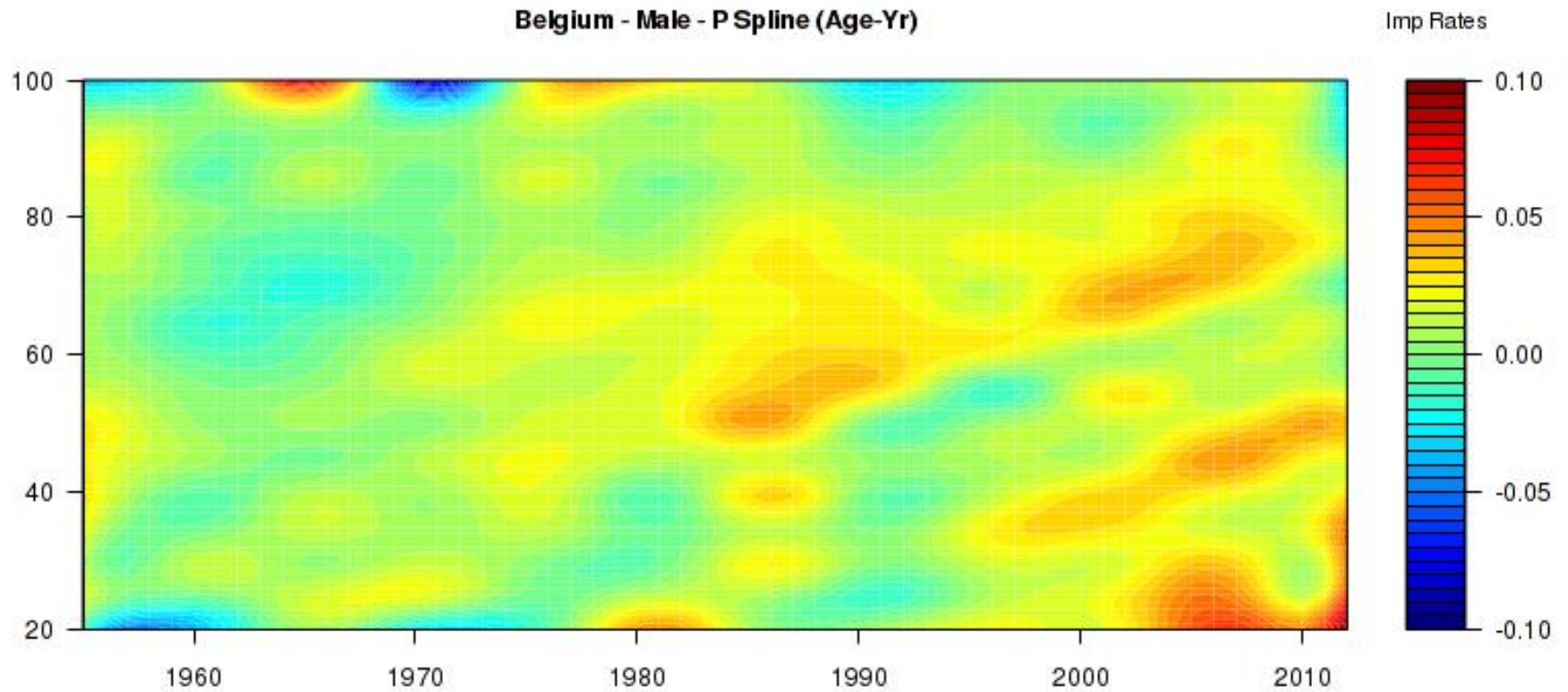
Source: Human Mortality Database

Ireland Population



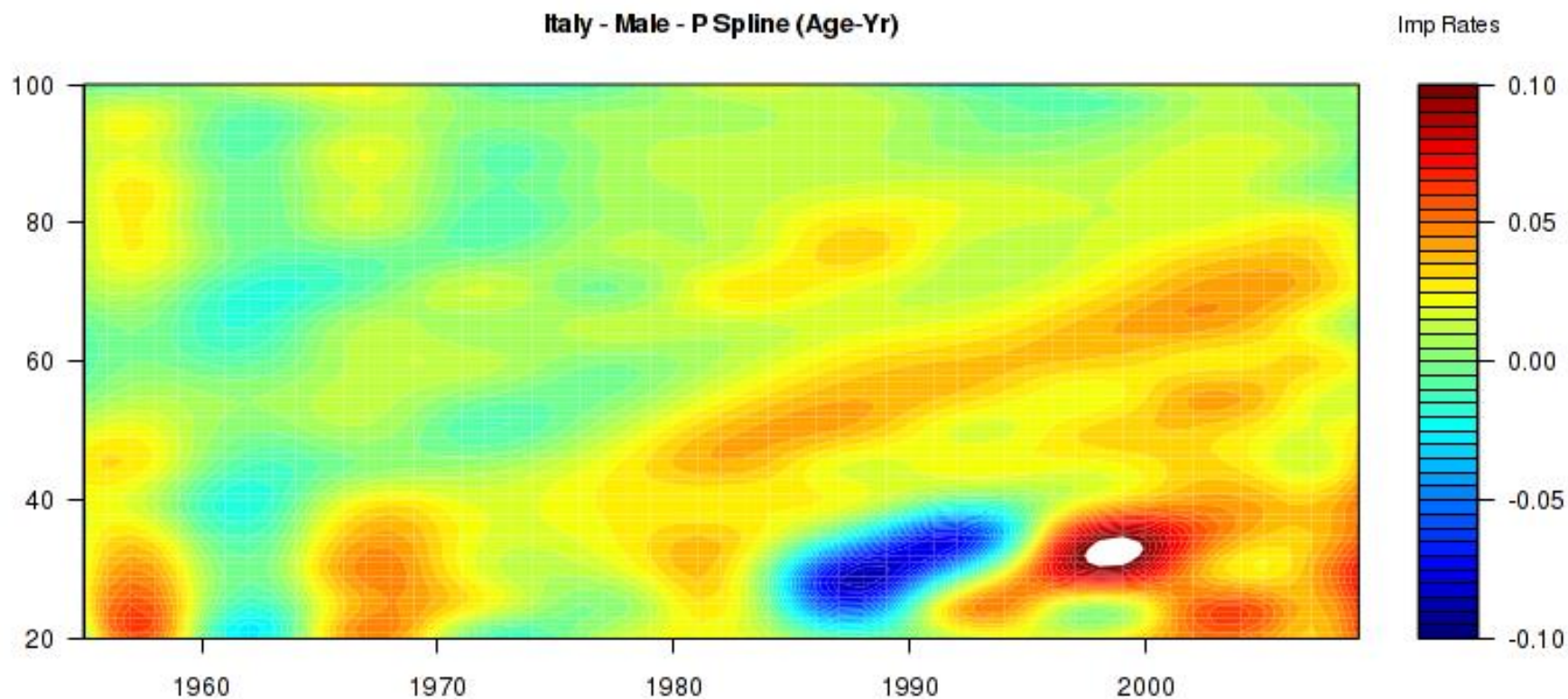
Source: HMD (own calculations)

Belgium Population



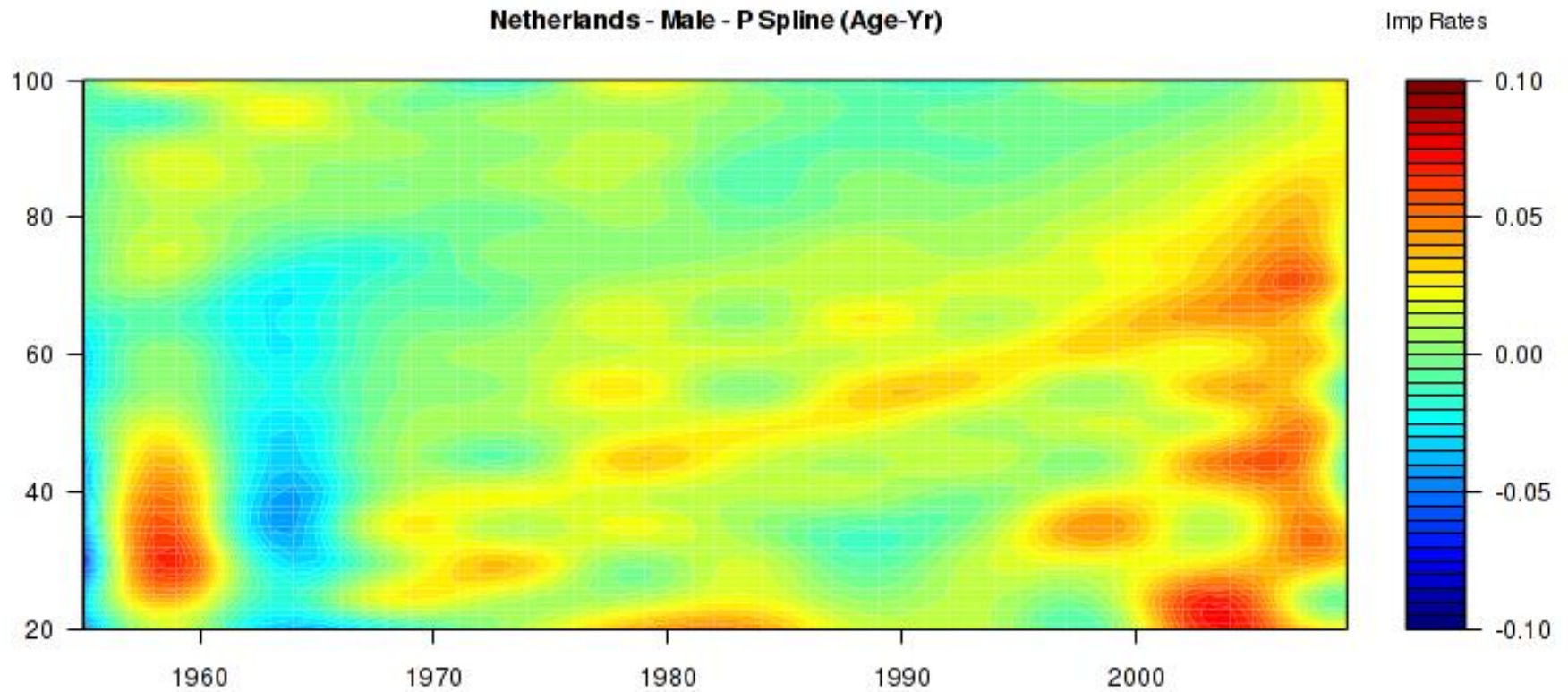
Source: Human Mortality Database

Italy Population



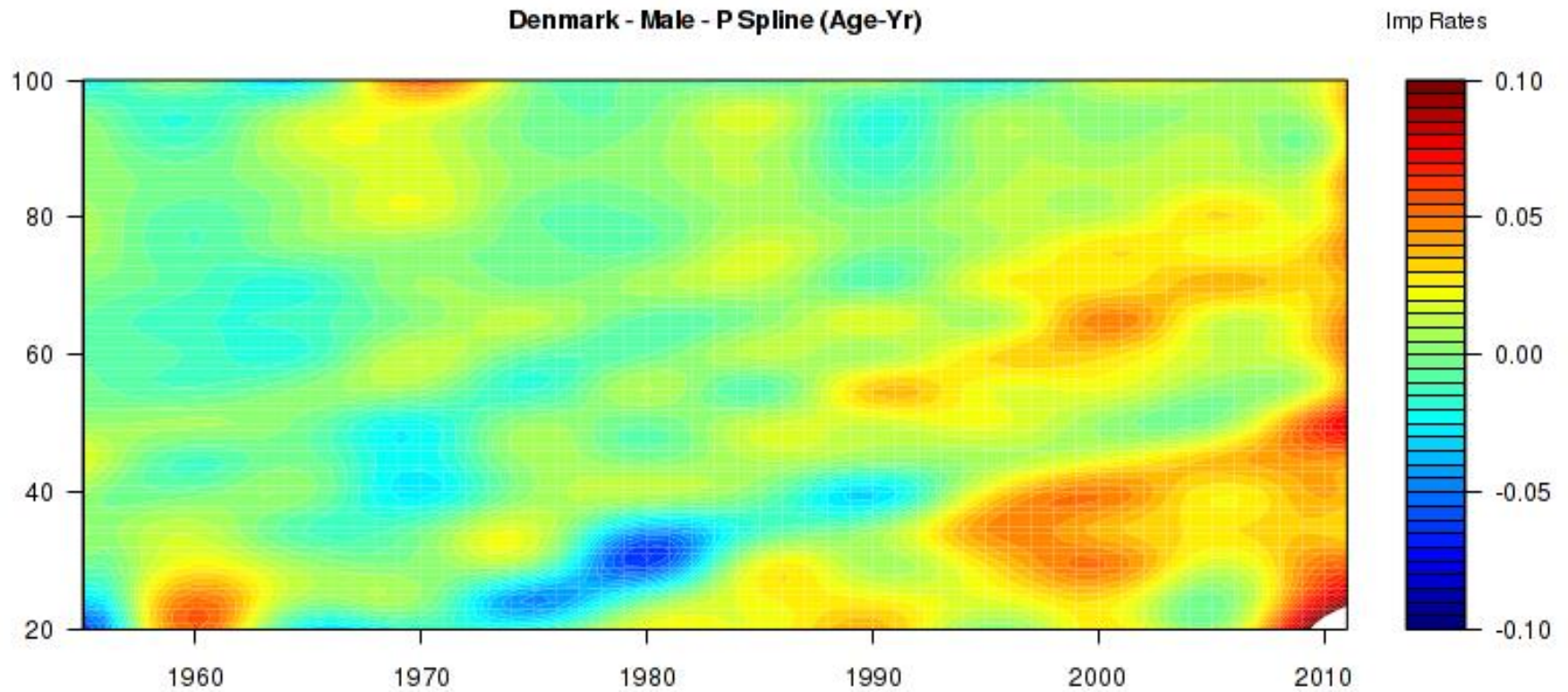
Source: HMD (own calculations)

Netherlands Population



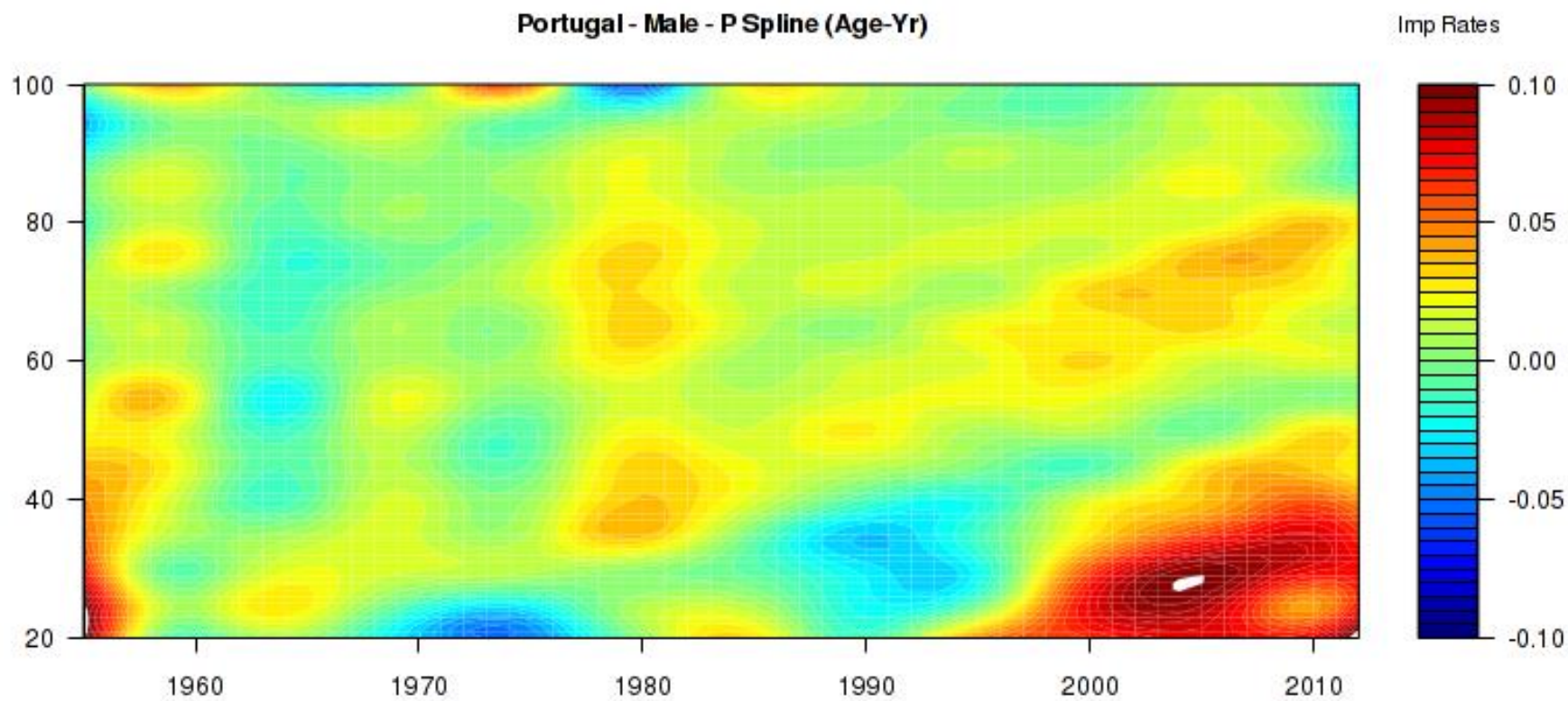
Source: Human Mortality Database

Denmark Population



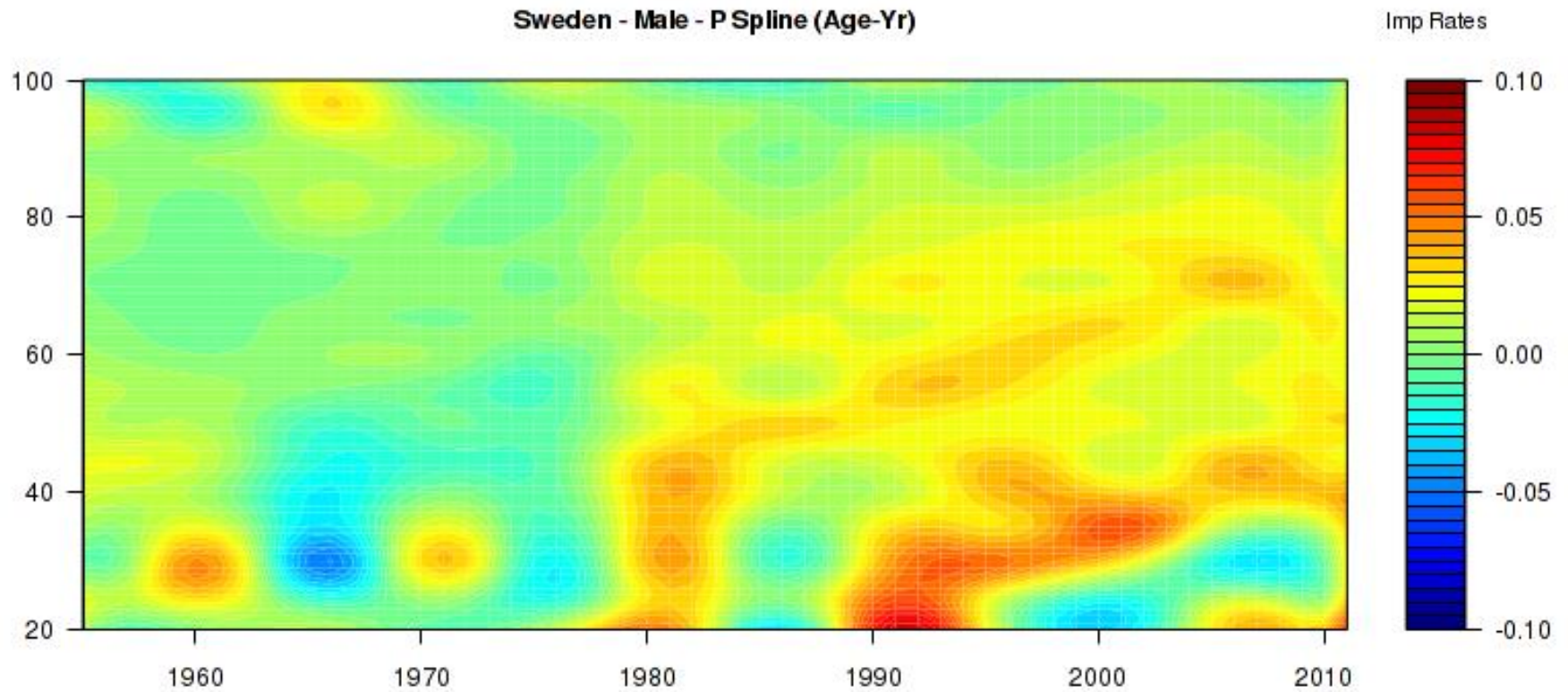
Source: Human Mortality Database

Portugal Population



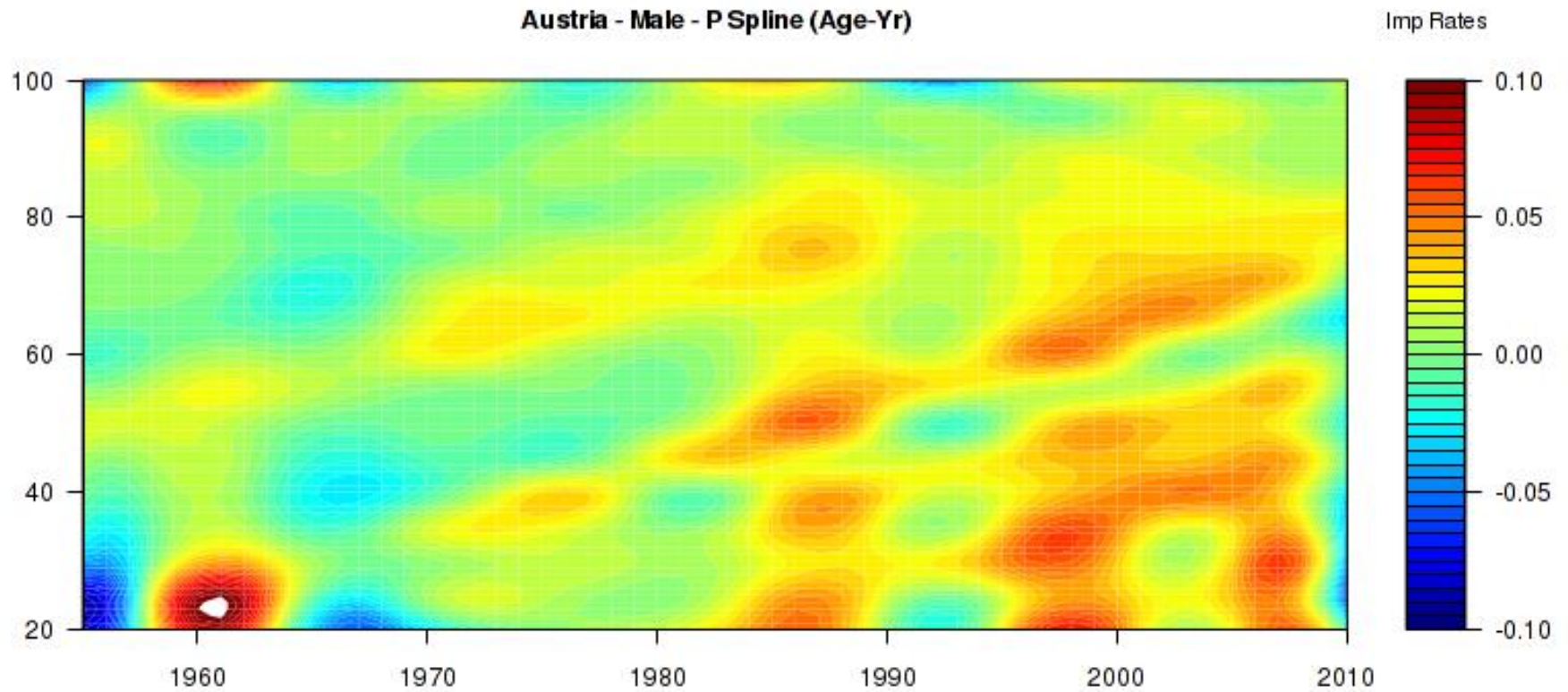
Source: Human Mortality Database

Sweden Population



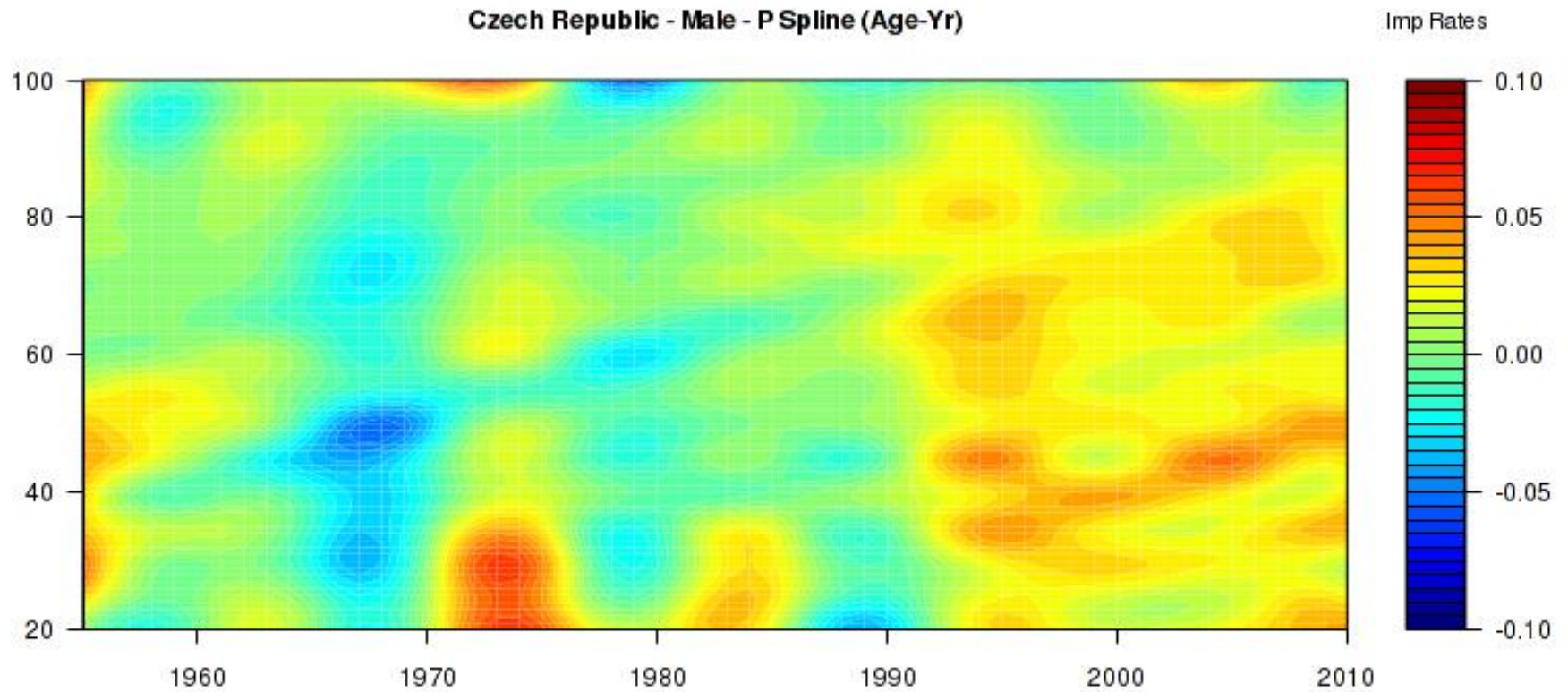
Source: Human Mortality Database

Austria Population



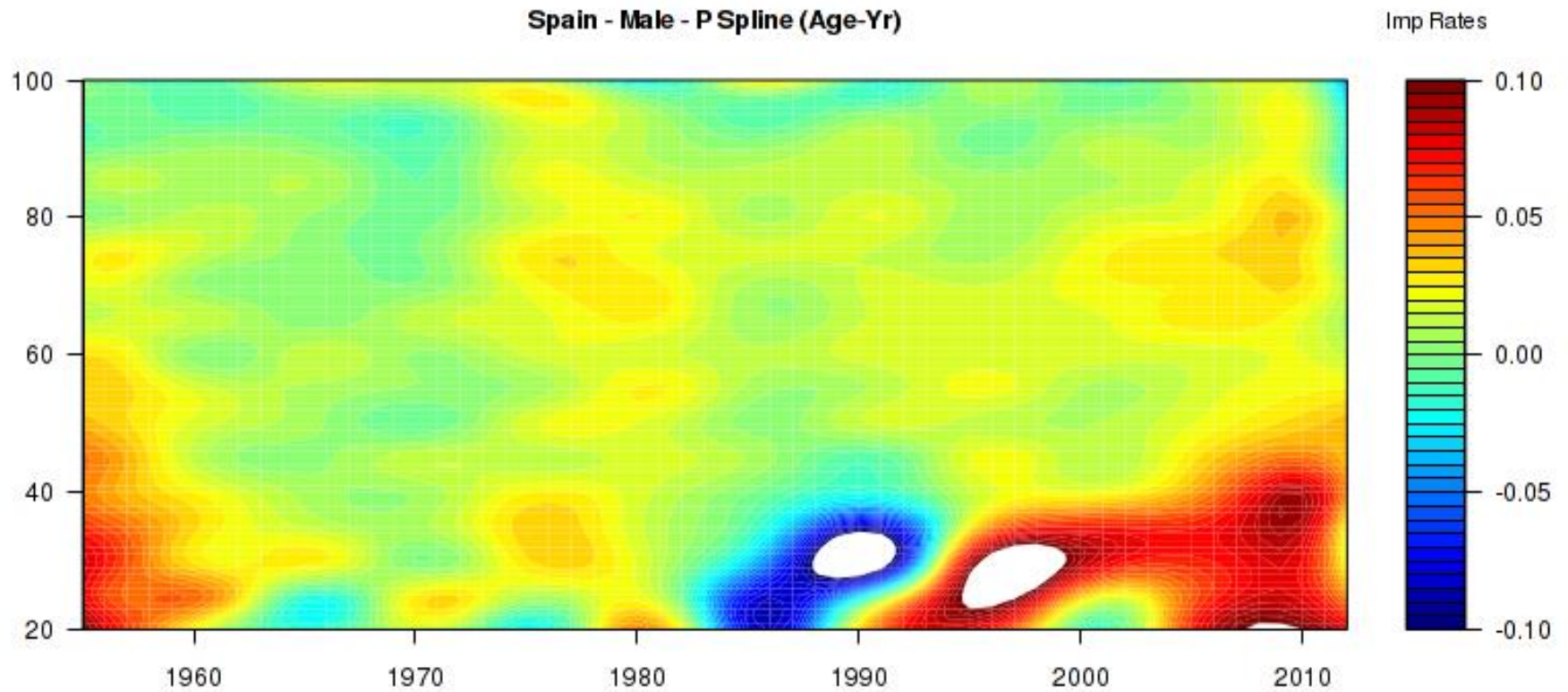
Source: Human Mortality Database

Czech Republic Population



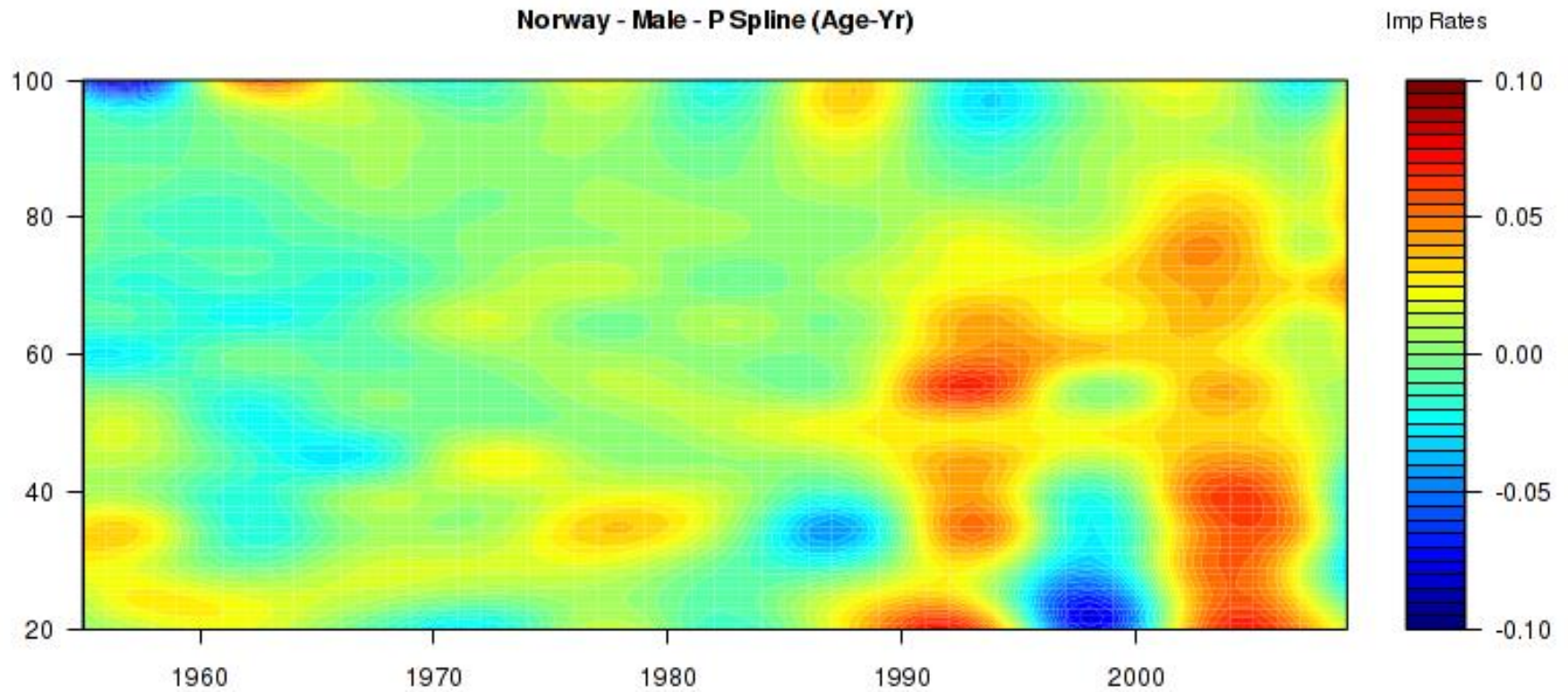
Source: Human Mortality Database

Spain Population



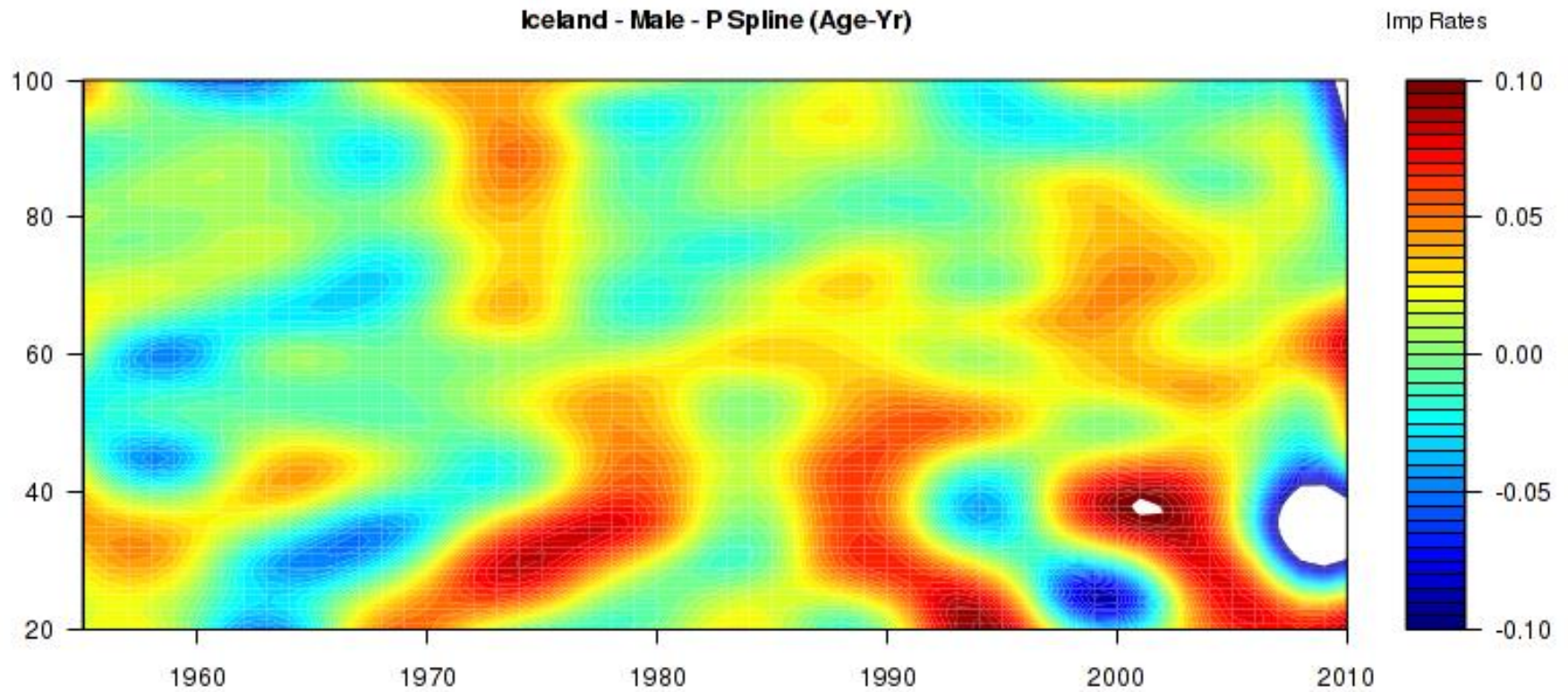
Source: Human Mortality Database

Norway Population



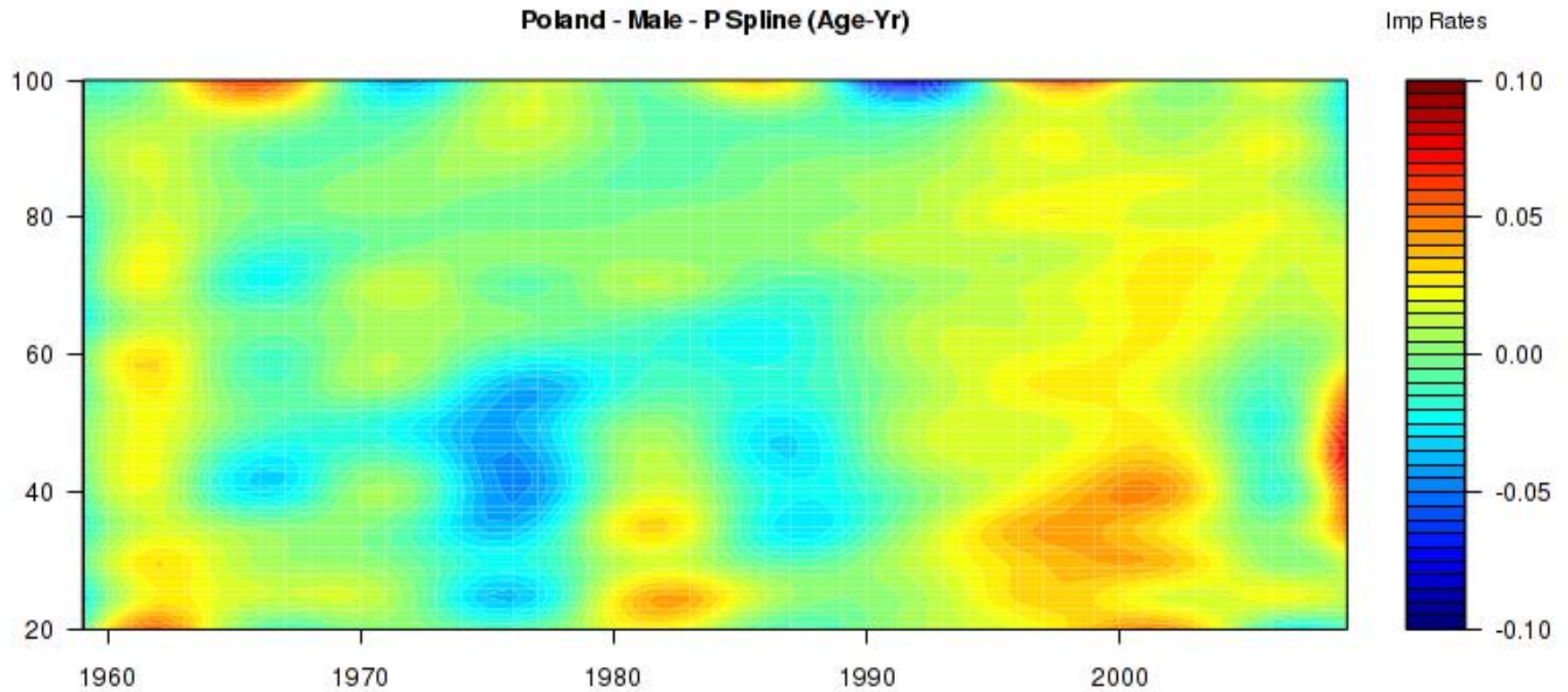
Source: Human Mortality Database

Iceland Population



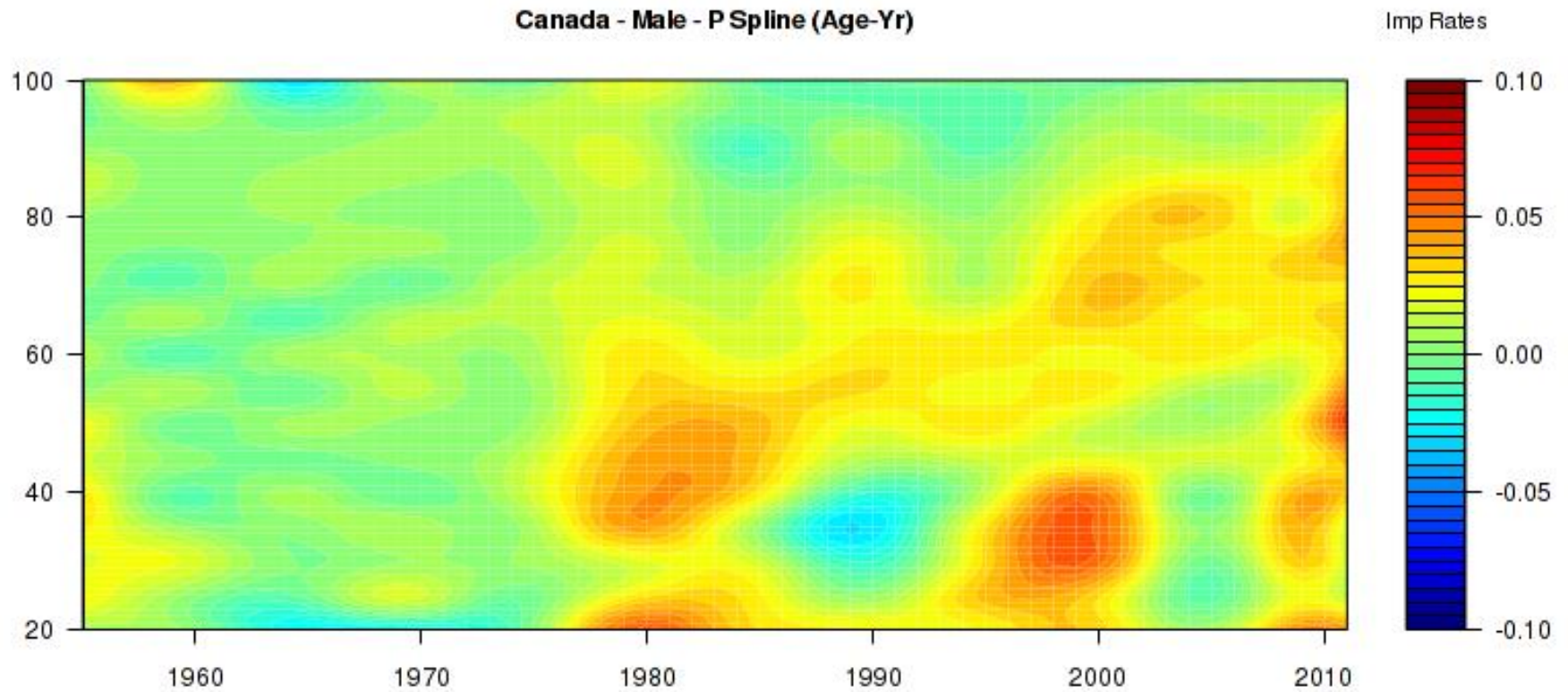
Source: Human Mortality Database

Poland Population



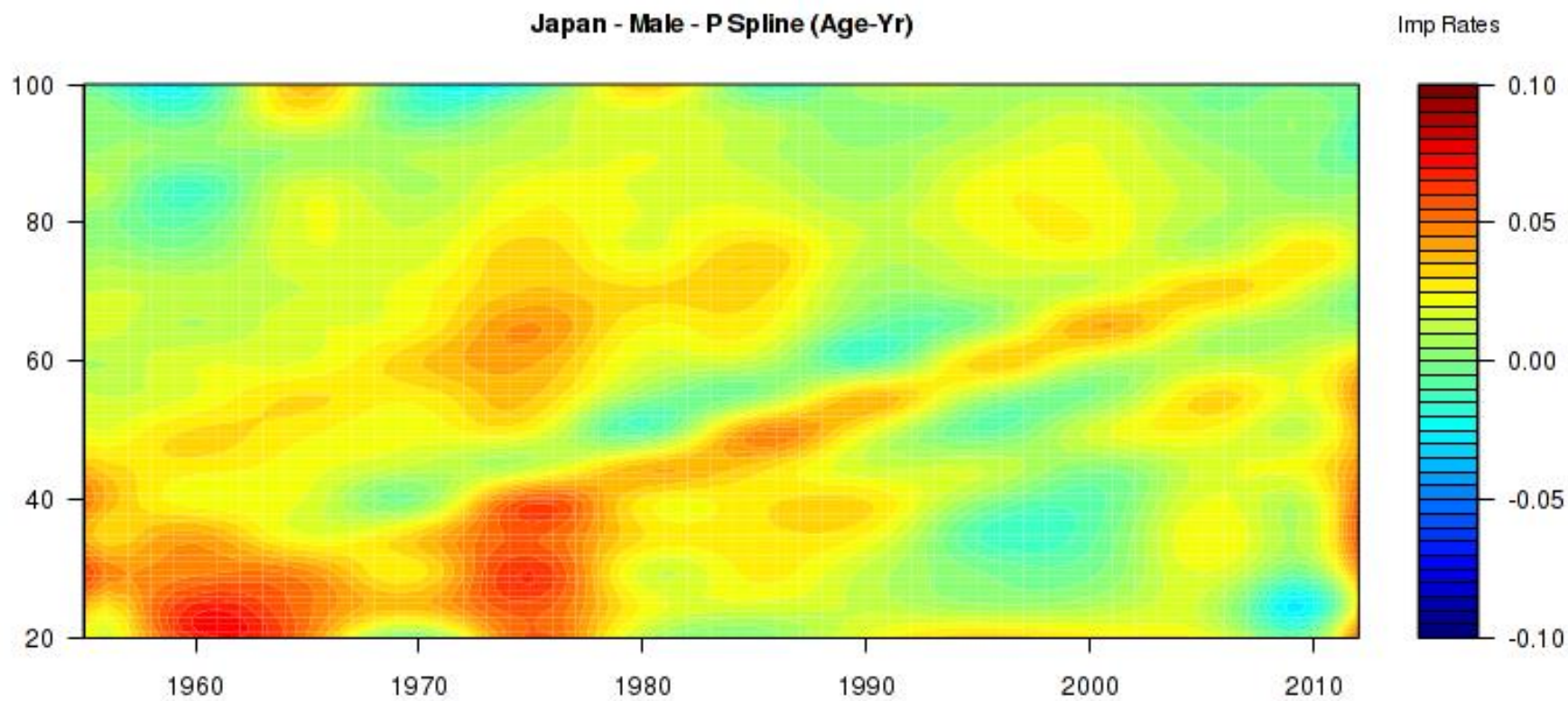
Source: Human Mortality Database

Canada Population



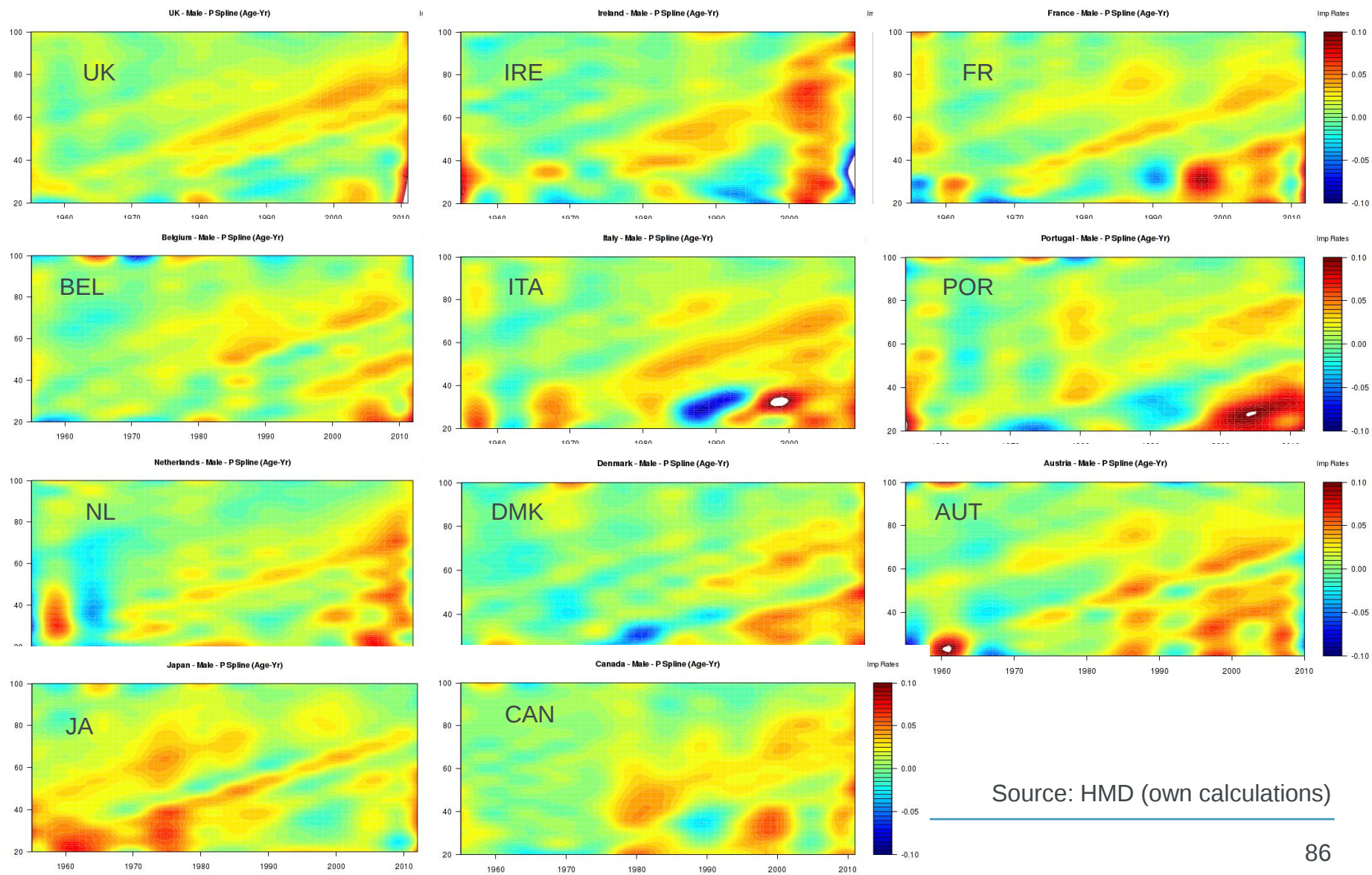
Source: Human Mortality Database

Japan Population



Source: Human Mortality Database

One true history?





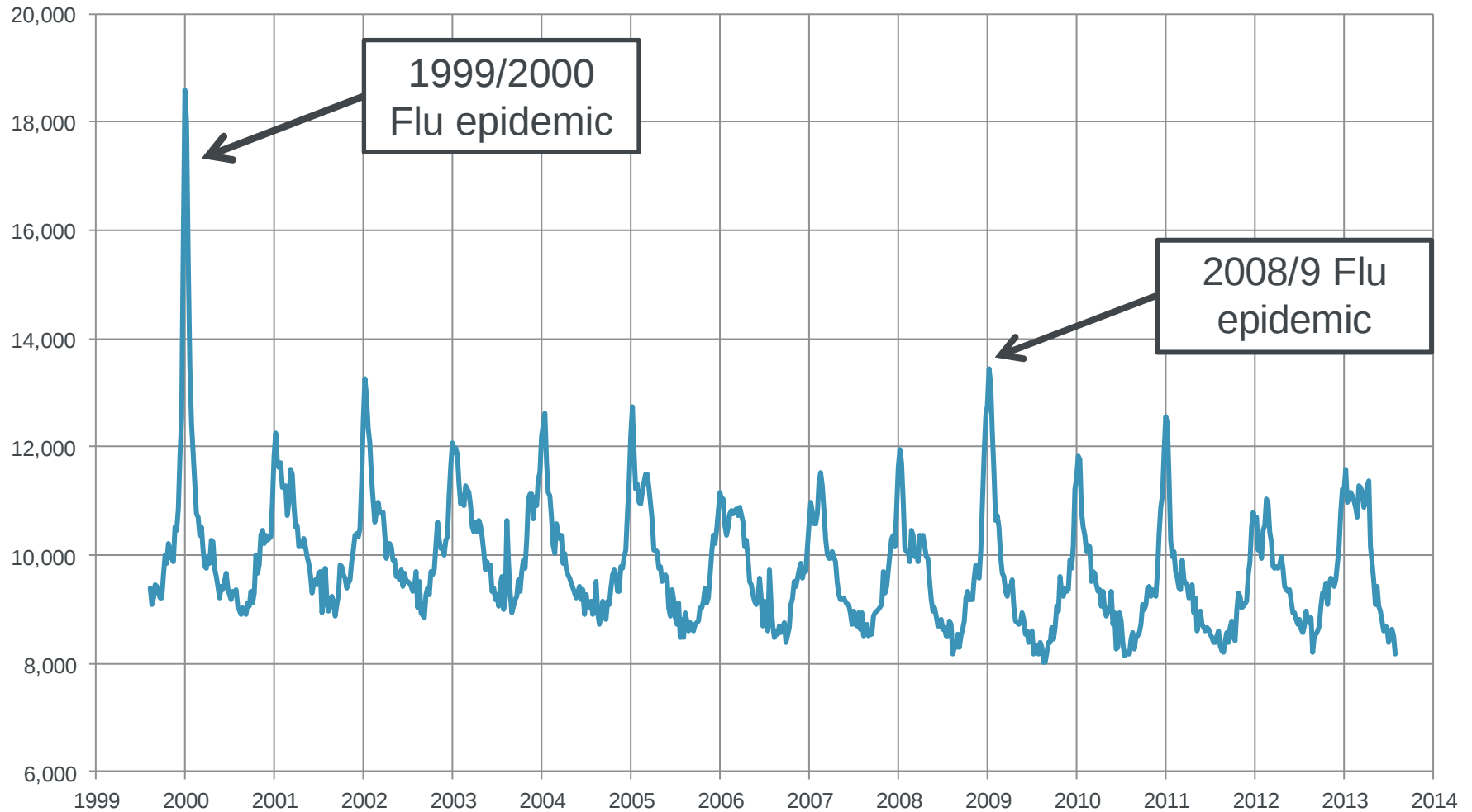
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The Changing Seasons

02 March 2015

ertise
ponsorship
Thought leadership
Progress
Community
Sessional Meetings
Education
Working parties
Volunteering
Research
Shaping the future
Networking
Professional support
Enterprise and risk
Learned society
Opportunity
International profile
Journals
Support

Seasonality – weekly death registrations



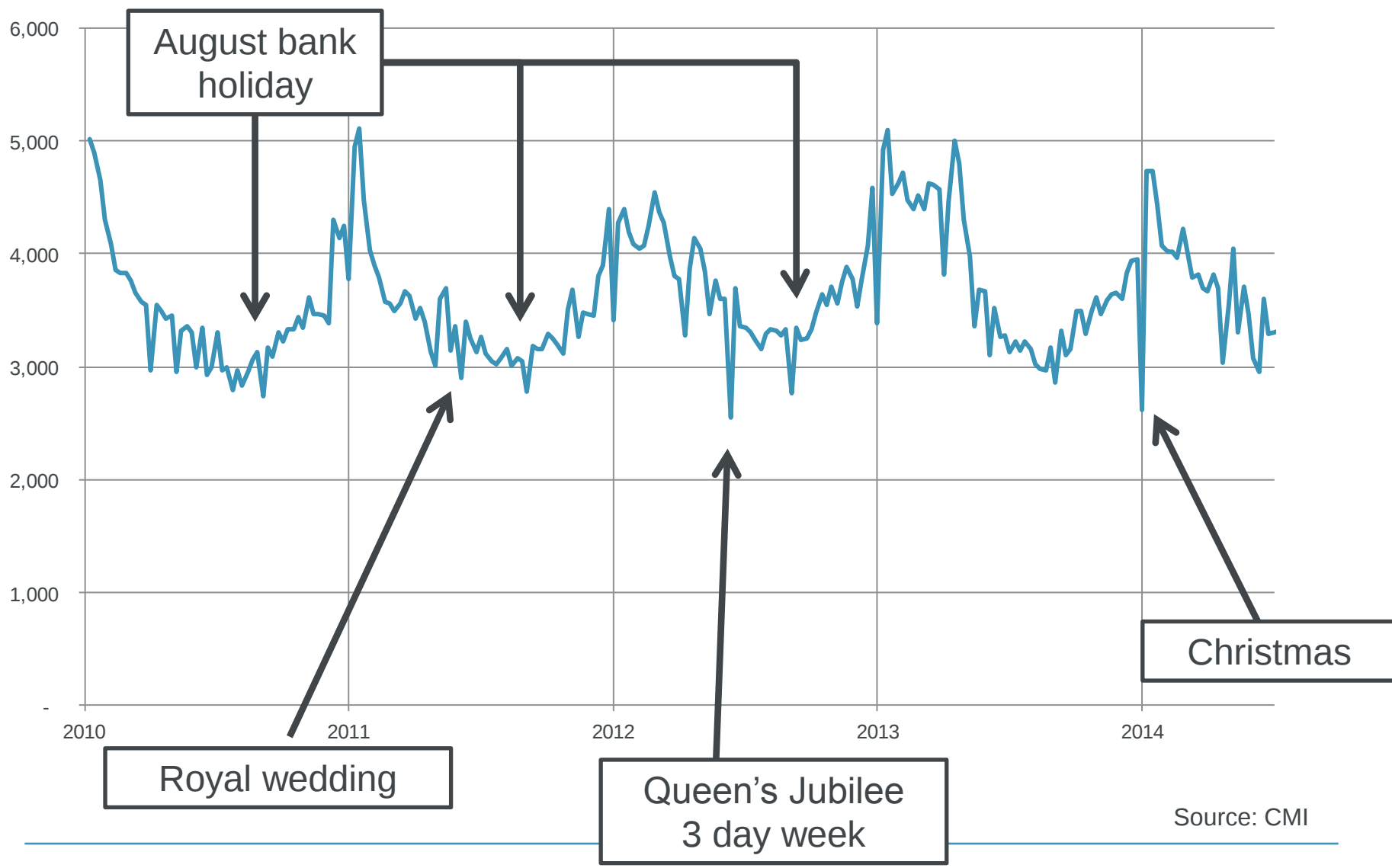
Source: ONS

Seasonality – Age 85+ (CMI)



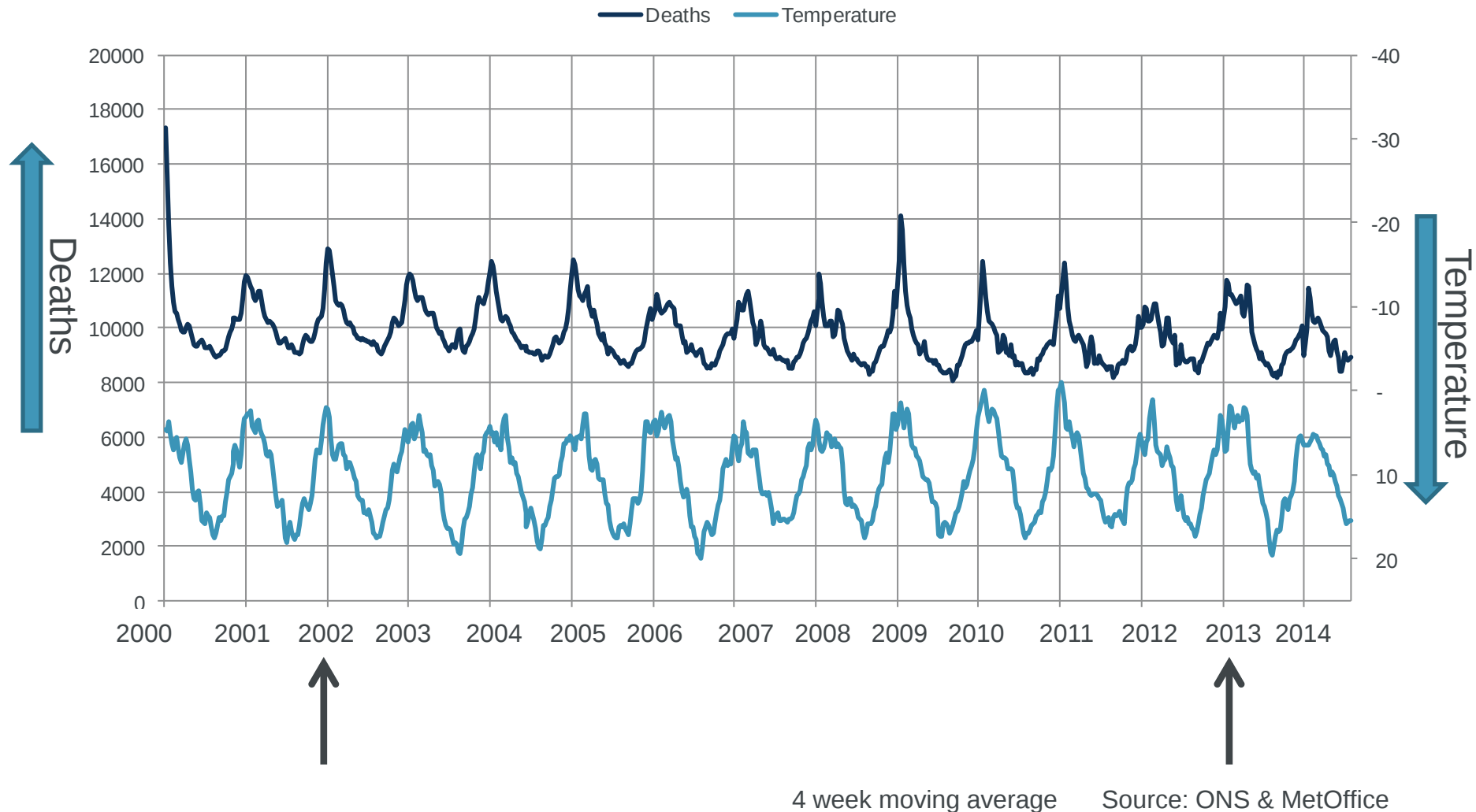
Source: CMI

Seasonality – bank holiday effect



Source: CMI

Seasonality – weekly death registrations



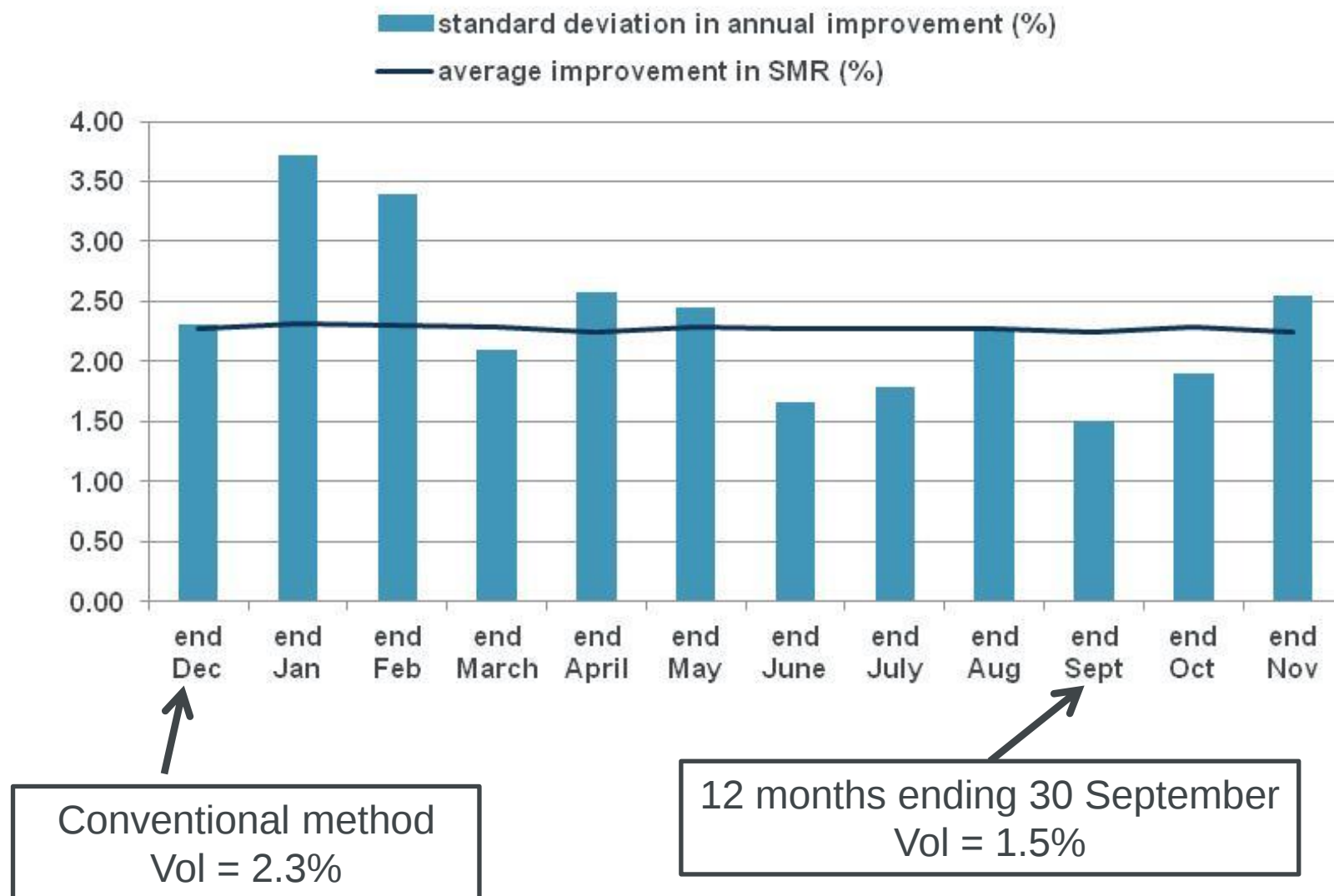
Seasonality – conventional approach

- Seasonality normally ignored
- Deaths by calendar year
- Mid-year population estimates

Interval	Average improvement in mortality	Standard deviation in annual improvement
12 months ending December	2.3%	2.3%

Ten year time series

Seasonality – choice of interval



Source: ONS data & own calculations

Seasonality – choice of interval

Interval	Average improvement	Standard deviation in annual improvement
12 months ending December	2.3%	2.3%
12 months ending September	2.3%	1.5%

- Calendar year interval overstates underlying volatility
- Stochastic models - Lee Carter, CBD, RH etc

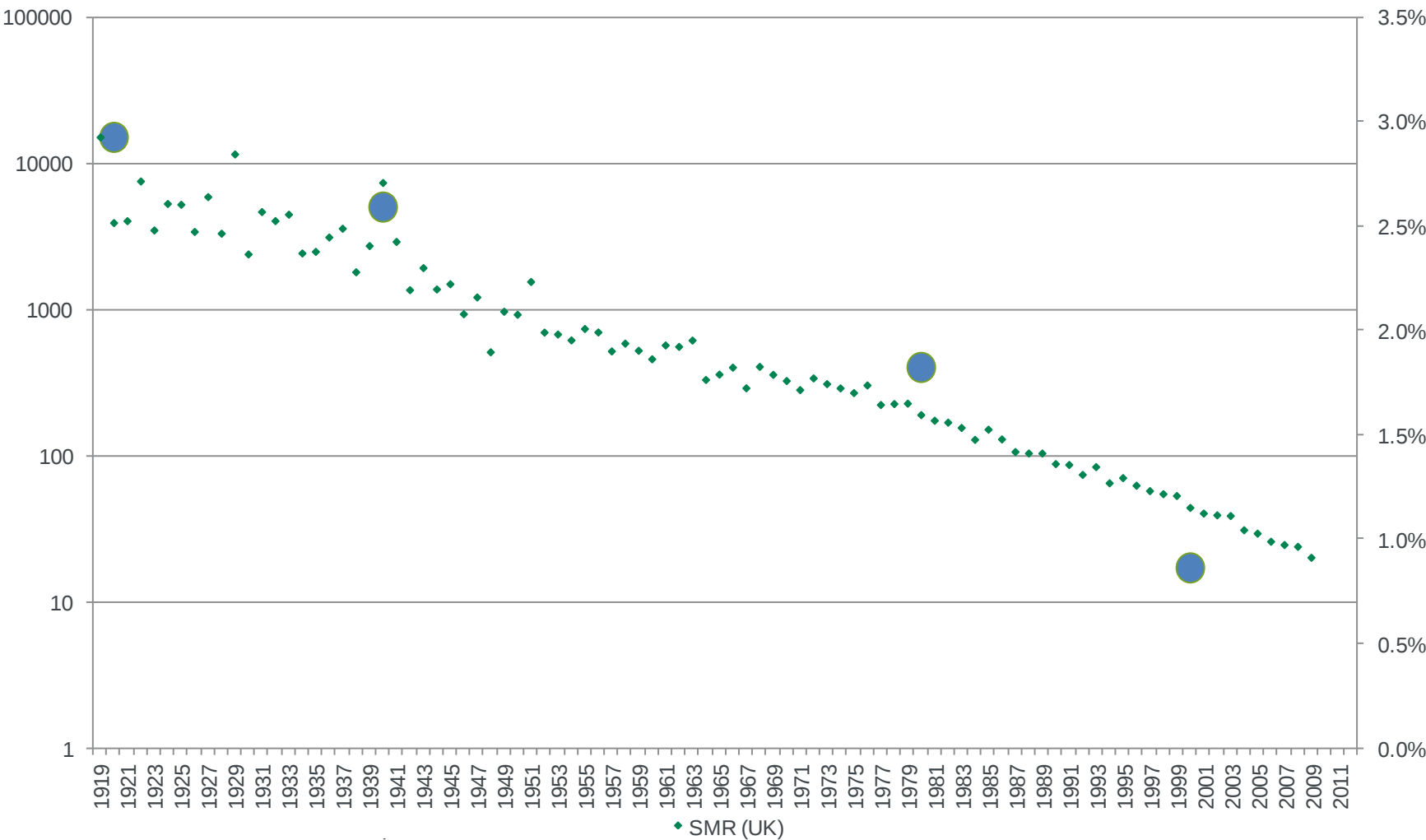
Source: ONS data & own calculations

Final Thoughts



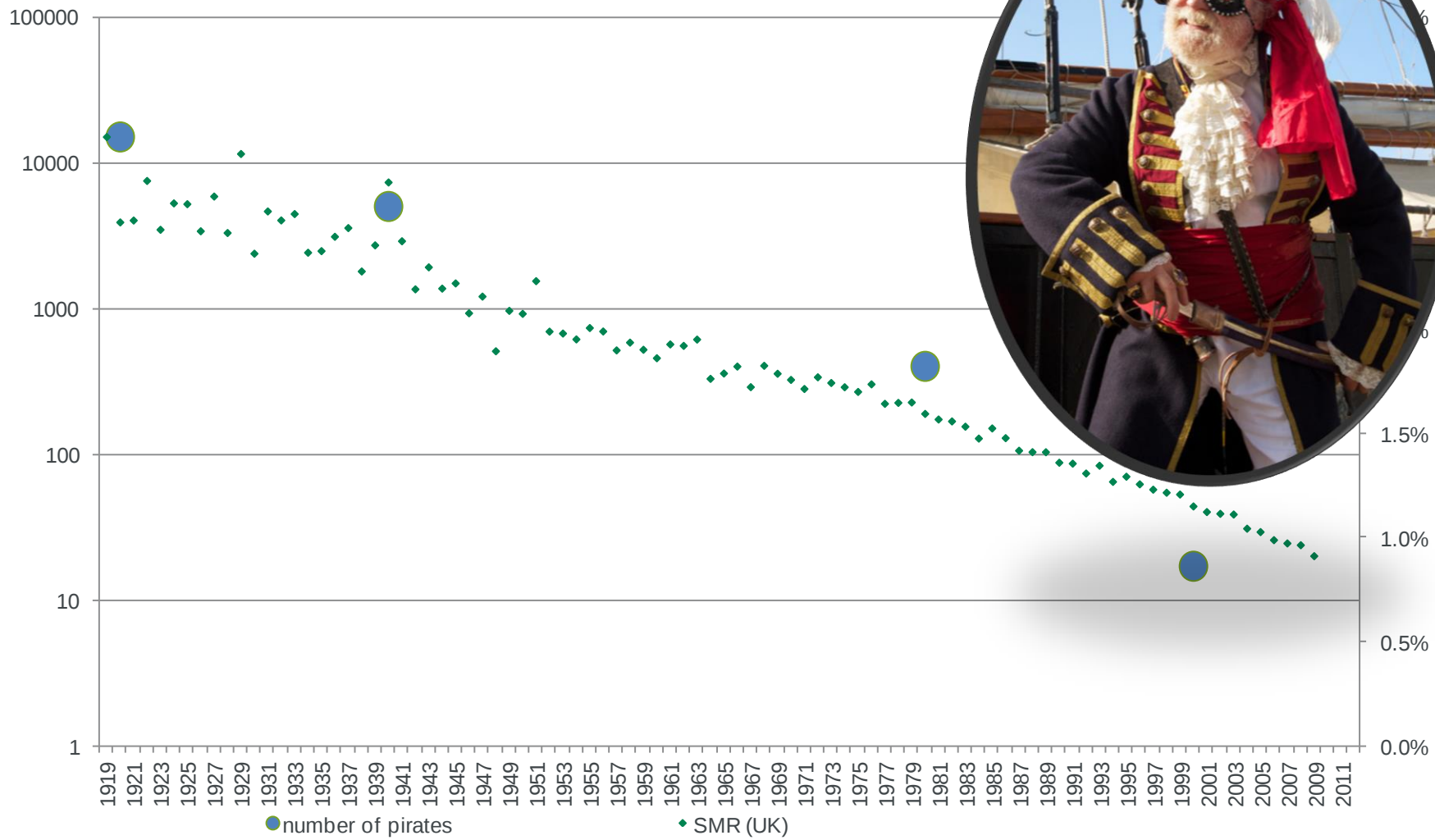
© Fotolia.com

Standardized mortality rate



Source: Wikipedia

Standardized mortality rate



Source: Wikipedia



Questions



Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

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



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Artifacts in Population Data

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