2020 VALUATION ACTUARY
VIRTUAL SYMPOSIUM

Mortality Improvement Practices and Future Projection Modeling

Session 4C

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September 1, 2020

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SOA Mortality and Longevity Initiatives

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SOA Longevity Task Force

- SOA Board level task force established in 2012
- Task force charged to consider:
  - What actions SOA should take in response to the rapidly changing science
  - How can the SOA be more proactive in serving the needs of key stakeholders (members, public, policy-makers, regulators)
- Longevity Advisory Group ("LAG")
  - July 2014 initial meeting
  - Nine members
  - Seven sub-projects
    - Mortality modeling standardization
    - Research on drivers of mortality
    - Webcast series designed to keep membership current on these topics
    - WILL (Workable Innovations for Living Longer) Contest

SOA Mortality & Longevity Strategic Research

- The SOA Board authorized in October 2017 an expanded research strategy placing increased focus on key strategic research programs.
- Program Steering Committee – www.soa.org/programs/mortality-longevity
  - Initiating new research projects and assessing the value of repackaging previously completed projects in a new structure to support the goals in the Program.
  - Using dissemination and communications methods to ensure a "continuous release and dissemination" approach to research so that the Program stays top of mind as a highly active and focused SOA Program for members, stakeholders, and the public; and
  - Evaluating the success of the Program and providing an annual report of Program impact to the Research Executive Committee.

SOA Mortality & Longevity Strategic Research

- 2019 Projects
  - Economic Impact of Opioid Abuse
  - Actuaries Longevity Illustrator (Jointly with American Academy of Actuaries)
- 2020 Projects
  - Living to 100 Symposium
  - Public Perceptions of Longevity
  - Women's Longevity Issues
  - Obesity Trends
  - Consistent Mortality Improvement Framework
- Experience Studies
- Partnerships
  - IFOA, HMD, CIA, Club Vita

2020 VALUATION ACTUARY VIRTUAL SYMPOSIUM

Mortality Improvement Research

Session 4C

Larry N Stern, FSA, MAAA

September 1, 2020

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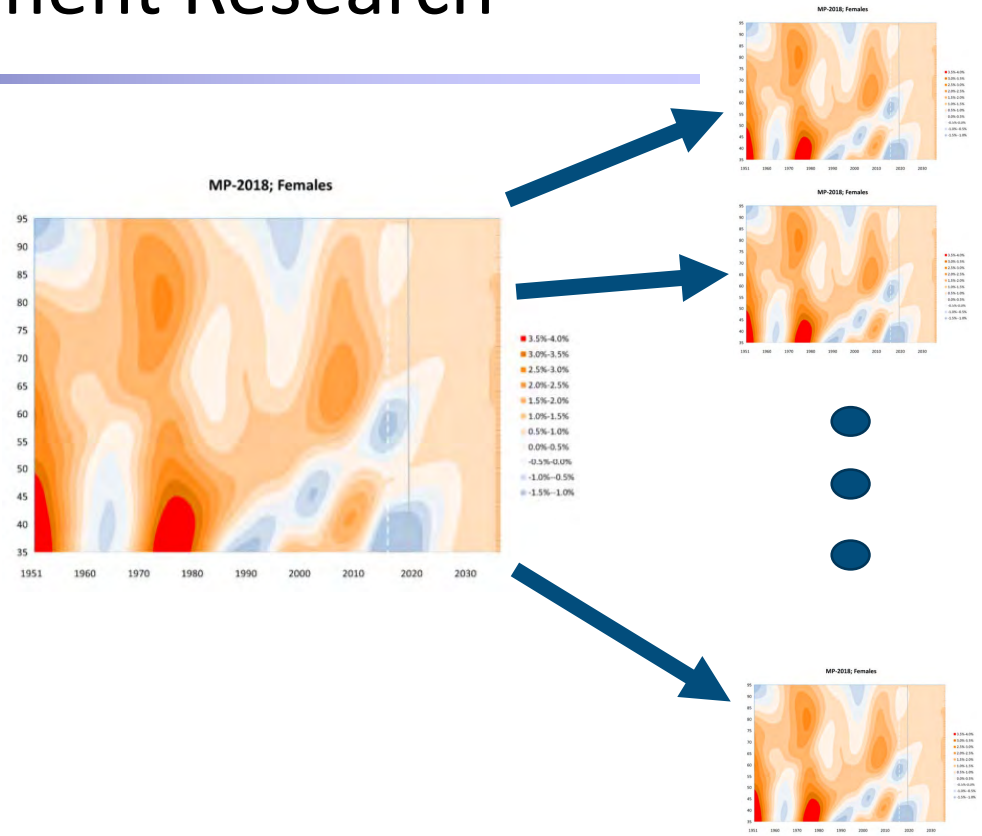
Mortality Improvement Research

- Consistent Mortality Improvement Framework
- Decomposition of US Population into Socioeconomic Categories

Preliminary Subject to Change



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Consistent Mortality Improvement Framework V1.0

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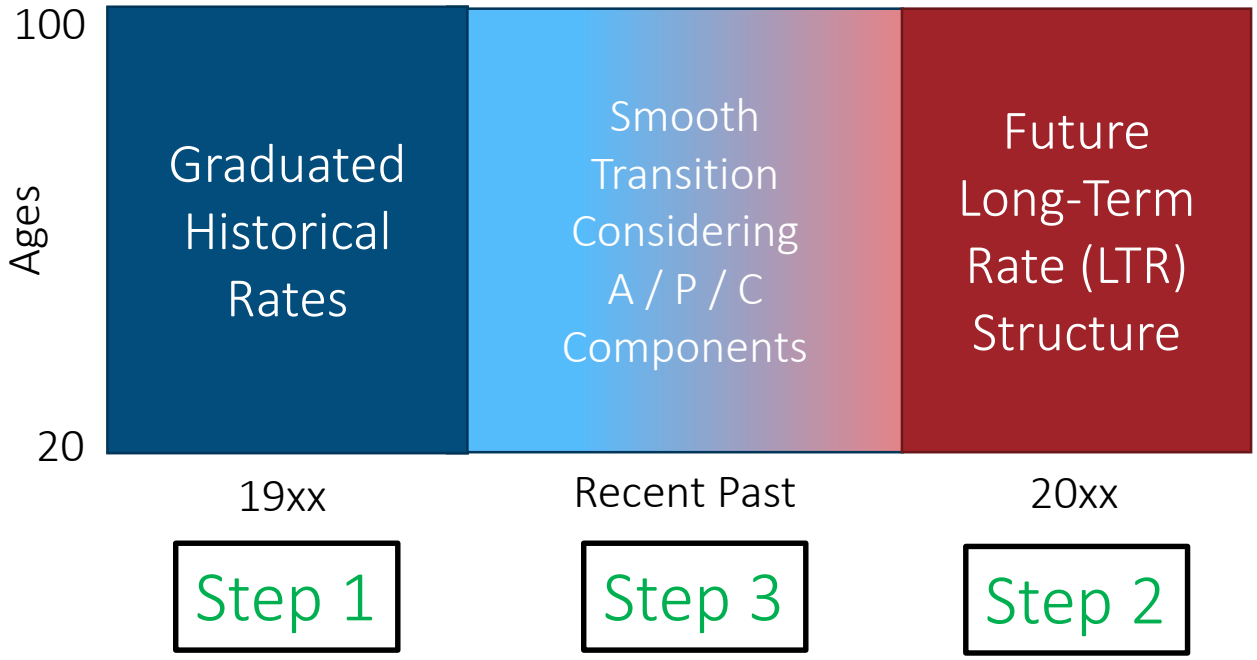
Consistent Mortality Improvement Framework

- The purpose of this project is to develop a tool for practicing actuaries to model mortality improvement like the approaches used by RPEC and CMI
  - Life insurance
  - Annuities
  - Retirement

Consistent Framework…RPEC Methodology



Consistent Framework V1.0…Key Decision Points

- Step 1: Graduated historical rates
  - From what underlying population should historical mortality rates be derived?
    - If anything other than US general population, is the dataset sufficiently robust?
    - SOA Experience Studies
  - Graduation methodology and “set-back” years
    - Whittaker-Henderson
    - GAM
  - How to determine A/P/C splits for underlying population
    - Cohort 45˚ diagonal
    - A/P horizontal

Consistent Framework V1.0…Key Decision Points

- Step 2: Future long-term rate (LTR)
  - What is long term – is it the same for age-period and cohort effects?
  - Should the SOA framework specify any “default” LTR structure?
    - No – need to provide additional education/guidance
    - Yes – how should the default be structured?
  - What roles played by---
    - Cause of death research – input from Forum; CoD POG
    - Historical long-term US population MI trends
    - Known unknowns
    - SSA long-term assumptions

Consistent Framework V1.0…Key Decision Points

- Step 3: Smooth transition (considering A/P/C components)
  - Think in terms of subdividing transition period
    - 3a is period from end of usable historical data to the jumping off year
    - 3b is the period from jumping off year to first year of LTR Structure
  - How to connect from last year of historical data to first year of LTR structure
    - RPEC used cubic spline
      - The first year or two of period 3 the progress toward LTR is slow
      - Around year 3 the transition accelerates
      - Near end of period 3, the transition decelerates
      - Creates a zero slope at both ends
    - Could consider linear
  - To what extent should CoD research influence Step 3 interpolations
    - Especially for 3a period because historical CoD is known

Consistent Framework - Data

- The MP2018 calculation process uses historical Social Security mortality data to estimate the initial improvement rates
- For insured data, initial attempt was to use historical SOA mortality experience for NS and SM categories
  - Not enough data to achieve credible results
  - Has led to the project to decompose US population data into socioeconomic categories to “mimic” insured data

Version 1.0 of the Mortality Improvement Tool

Current Capabilities as of May 2020:

- Can replicate the MP2018 forward interpolation process
- Can perform variations of this process:
  - Either linear interpolation or the default cubic spline approach
  - Weight on cohort effects can be varied from 0% to 100%
  - Speed of convergence to long term rates can be varied
- User can enter their own set of initial rates and long-term rates (or simply use the MP2018 values)

Version 1.0 of the Mortality Improvement Tool

What is not included in version 1.0?

The MP2018 calculation process uses historical Social Security mortality data to estimate the initial improvement rates. The mortality data is first subjected to a complex graduation process. We decided for v1.0 this complex process is best left out of the model. Therefore, v1.0 offers no built-in capability for a user to smooth or graduate their own data.

Version 1.0 of the Mortality Improvement Tool

Features we would like to add:

In addition to permitting users to use MP2018 initial rates or enter their own rates, we have discussed estimating smoker versus non-smoker improvement rates from individual life data and providing those rates within the Tool. However, an initial attempt to implement this idea has led to some questions about whether we have enough data to achieve credible results.

How Much Data is Needed to Reliably Estimate Improvement Rates?

Credibility increases as a function of:

- The number of lives covered by the data
- The number of years of data available
- The level of mortality rates -- in other words, it is easier to achieve credible results for older age cohorts than for younger age cohorts that have low mortality rates

Datasets – Credibility Example

	Cohort Size At Age 60	Years of Data
Social Security	2,000,000	65
Individual Life: Non-Smokers	200,000	7
Individual Life: Smokers	20,000	7

Preliminary Subject to Change

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Mortality by Socioeconomic Category in the United States

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Mortality by Socioeconomic Category Project

- The purpose of this project is to study trends in mortality by socioeconomic category in the United States since the 1980s
  - Start with county-level mortality information
  - Work to find ways to associate each county in each year with some form of socioeconomic score
  - Use the score to group the counties into some form of deprivation/propensity/socioeconomic ranking
  - Create mortality estimations for each year for each decile
  - Ensure when aggregating back across deciles, result reasonably estimates the full population mortality

Methodology - approach, data and sources

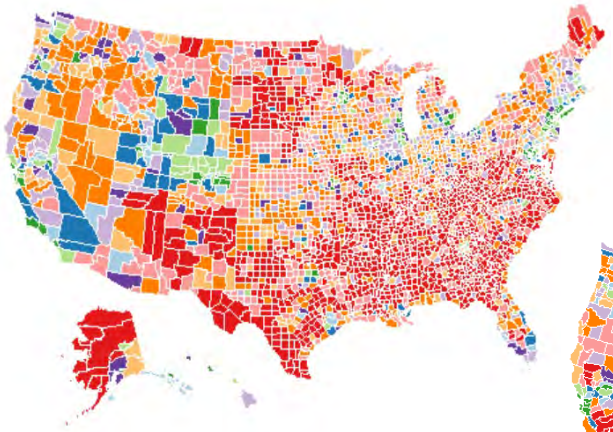
- Construction of lifetable series for years 1982-2018 for all US counties grouped into 10 categories based on their population-level socioeconomic characteristics
- Socioeconomic variables (by county)
  - 1980, 1990 and 2000 Census
  - American Community Survey (5yr) 2007-2016
- Mortality (1982-2018)
  - Individual death records (NCHS)
    - With exact dates of birth and deaths, sex, age at death and county/State of residence
  - July 1st population estimates (Census Bureau)
    - By sex, age and county/State

Methodology - approach, data and sources (revised)

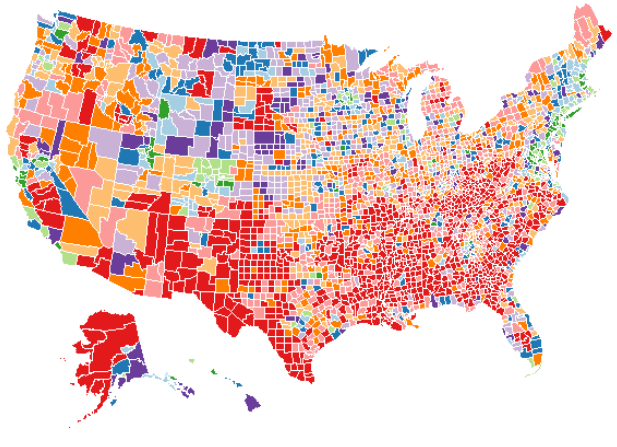
- IHME => Mortality values from statistical modeling for all US counties 1980-2014
  - Life expectancy at birth
  - Probabilities of dying (at ages 0-5, 5-25 25-45, 45-65, 65-85 years)
- Summary NCHS data for 2005-2017
  - Mortality rates by single year of age up to 85+ years for each county decile
- Mortality
  - 2005-2017 complete life tables up to 85+
  - 1982-2014 e(0), ${}_5q_0$, ${}_{20}q_5$, ${}_{20}q_{25}$, ${}_{20}q_{45}$, ${}_{20}q_{65}$
- Socioeconomic categories
  - Single socioeconomic score for each US county and every year (1980, 1990, 2000, 2007-2016)

US counties by socioeconomic decile

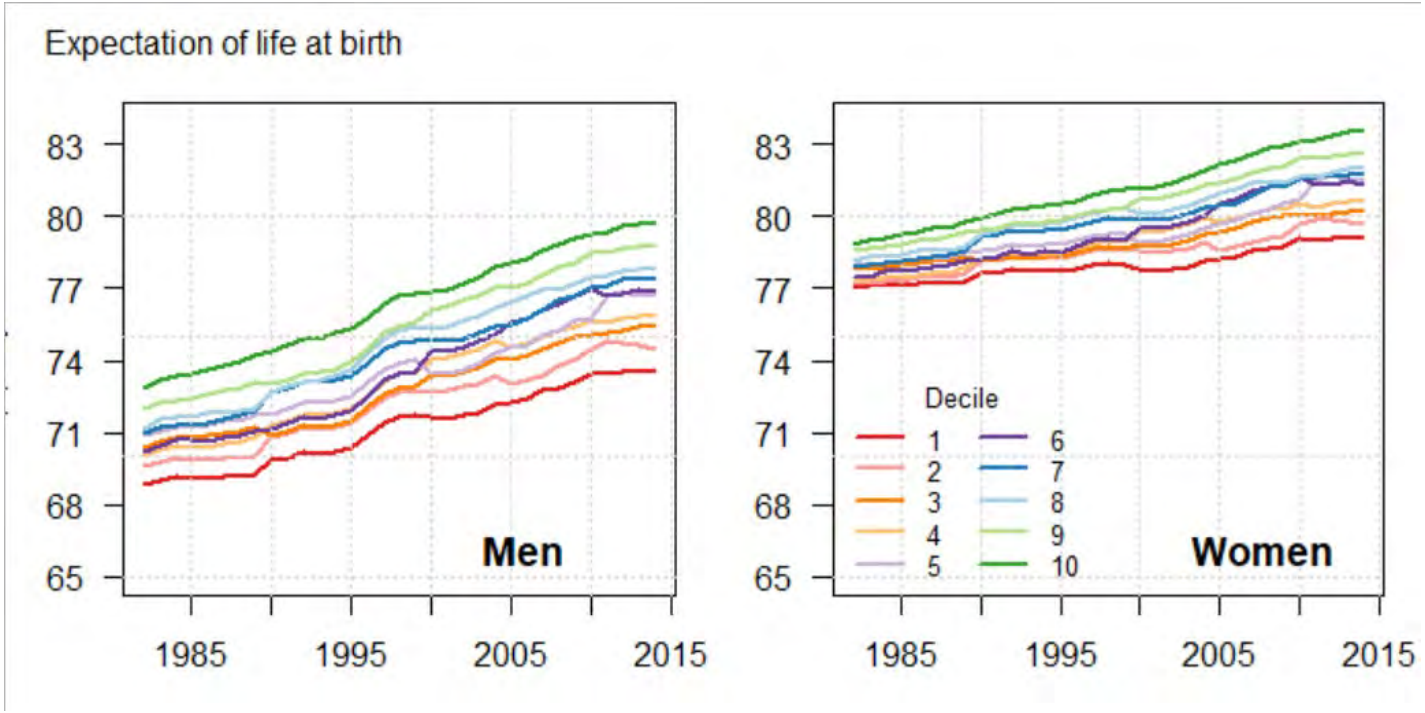
1980



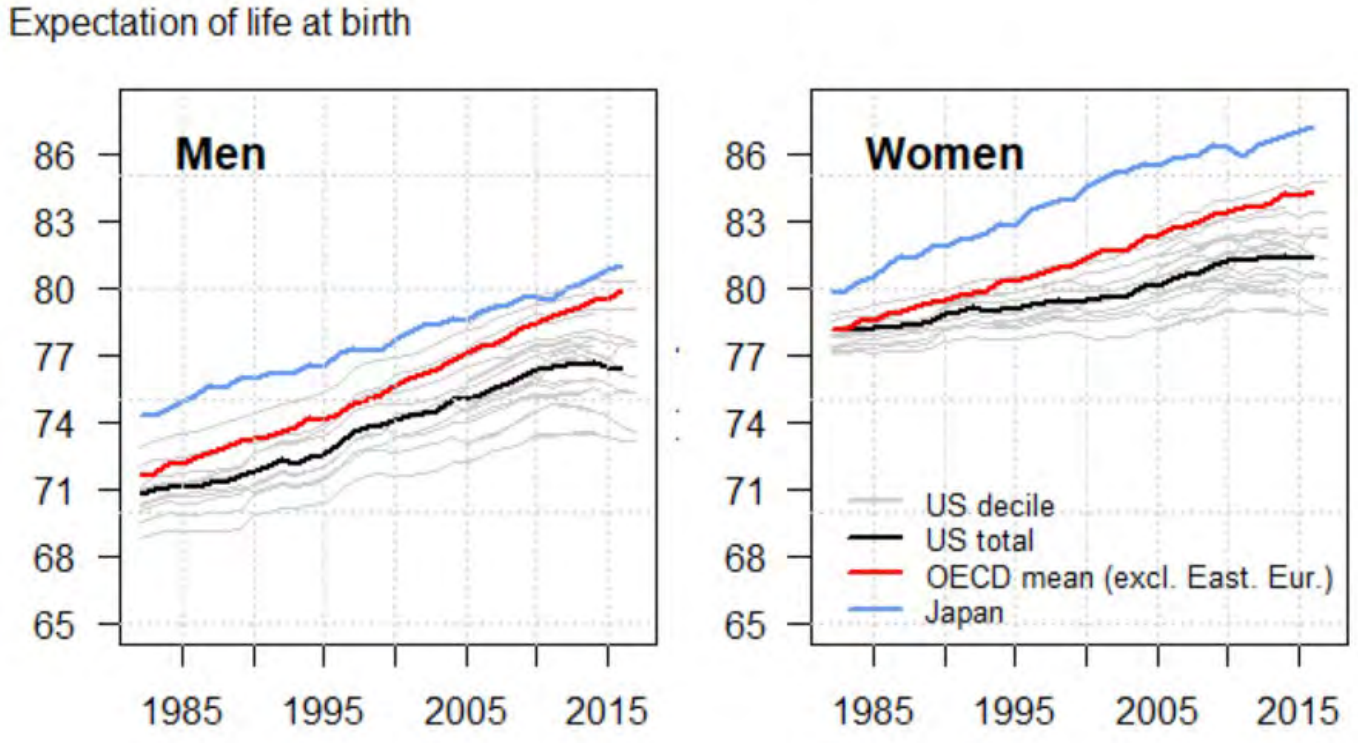
2018



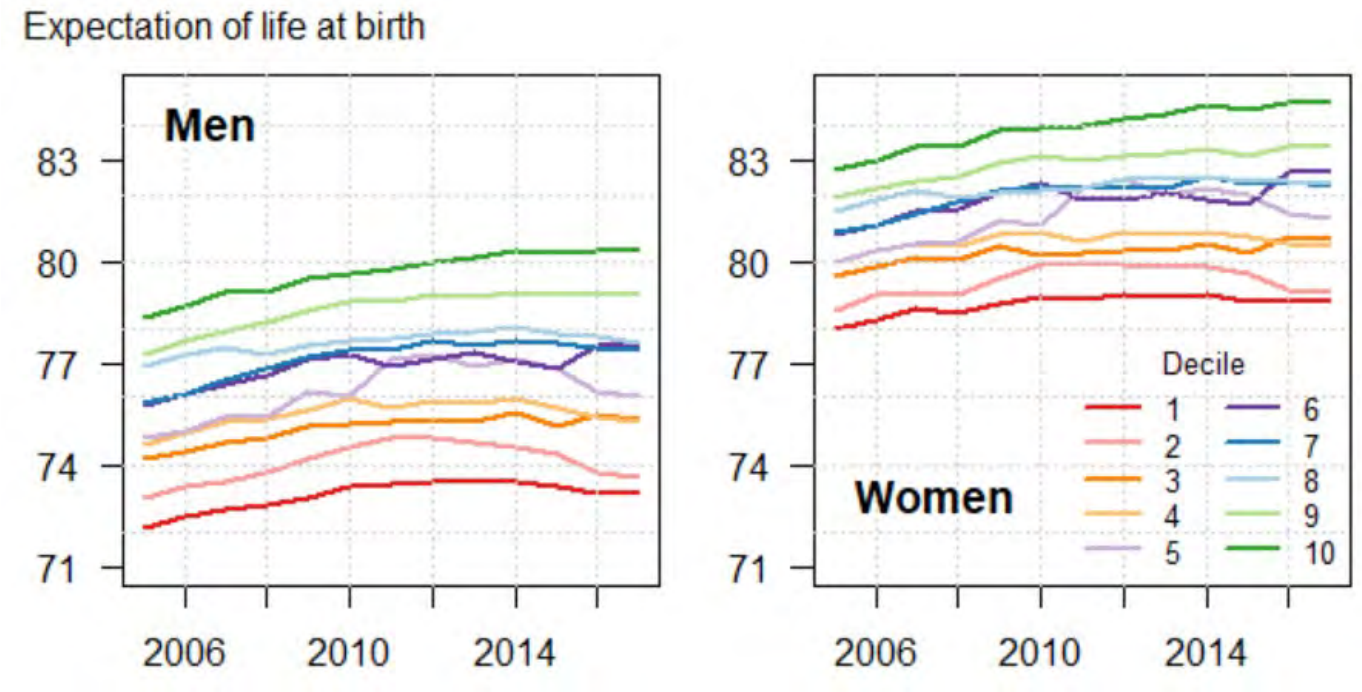
Mortality by decile, 1982-2014



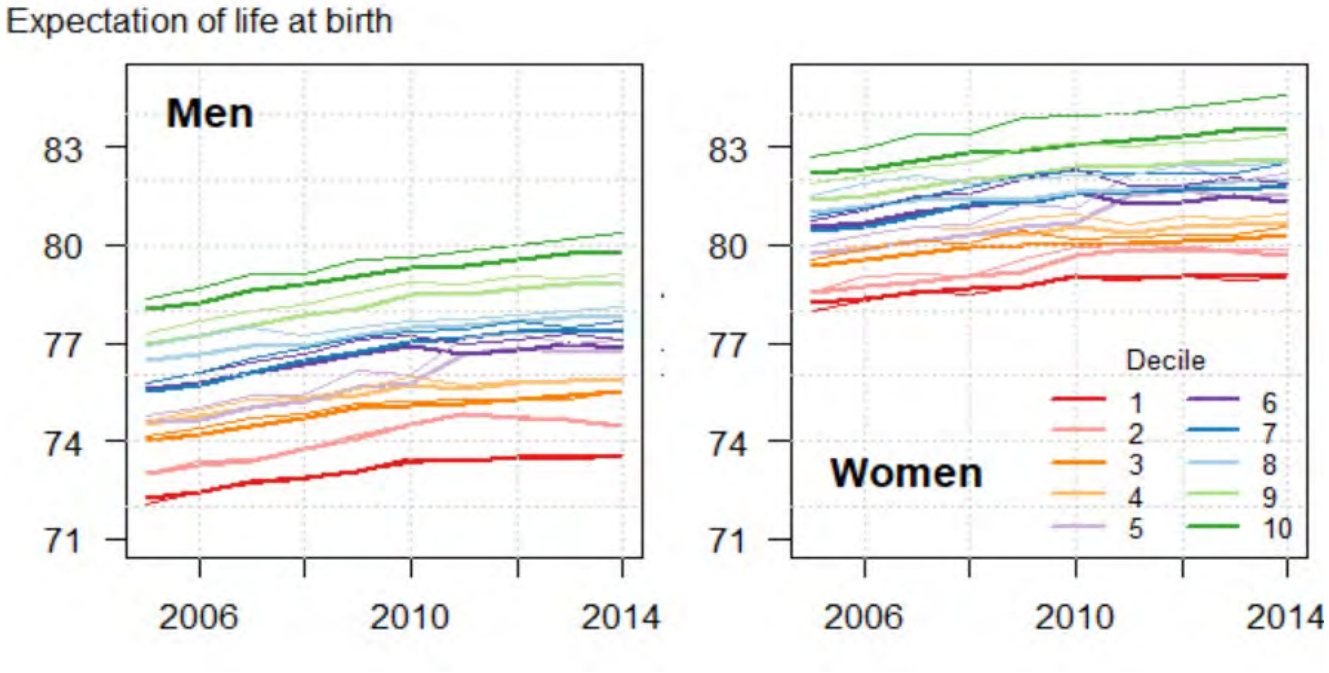
International comparisons



Mortality by decile, 2005-2017

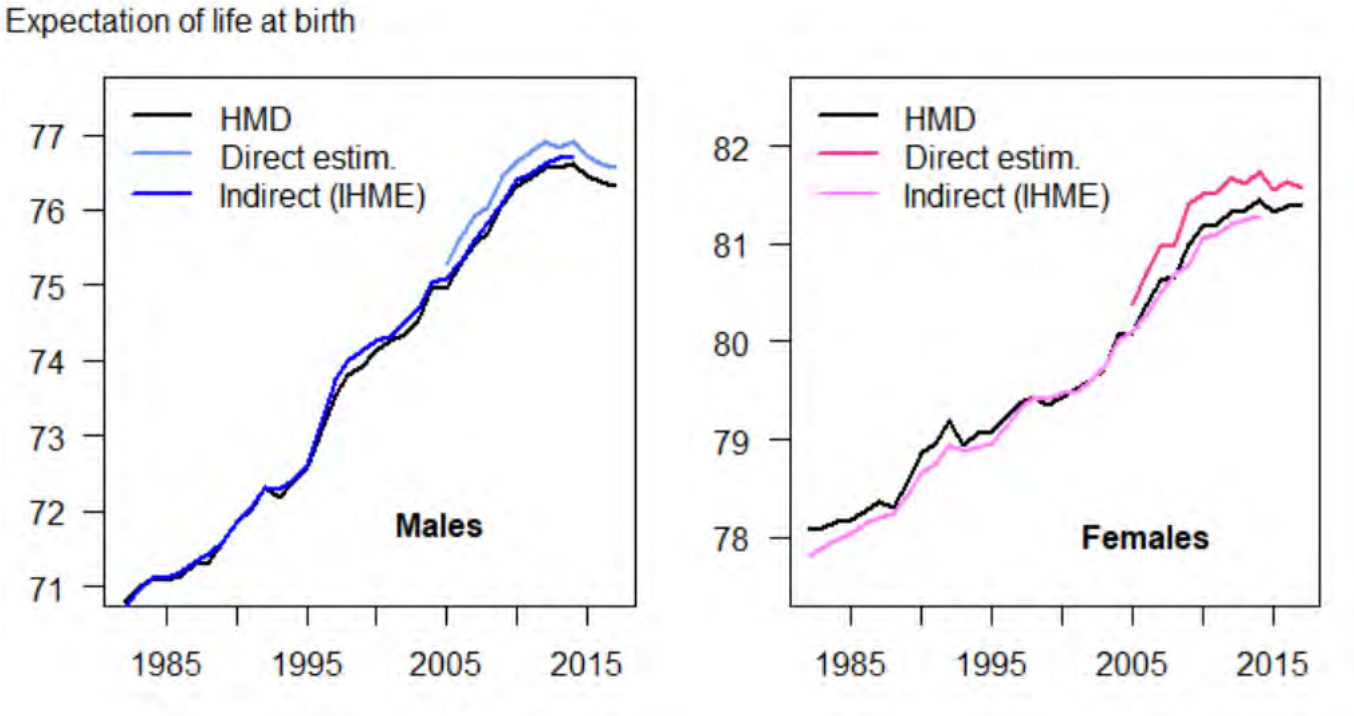


Mortality by decile, 2005-2014

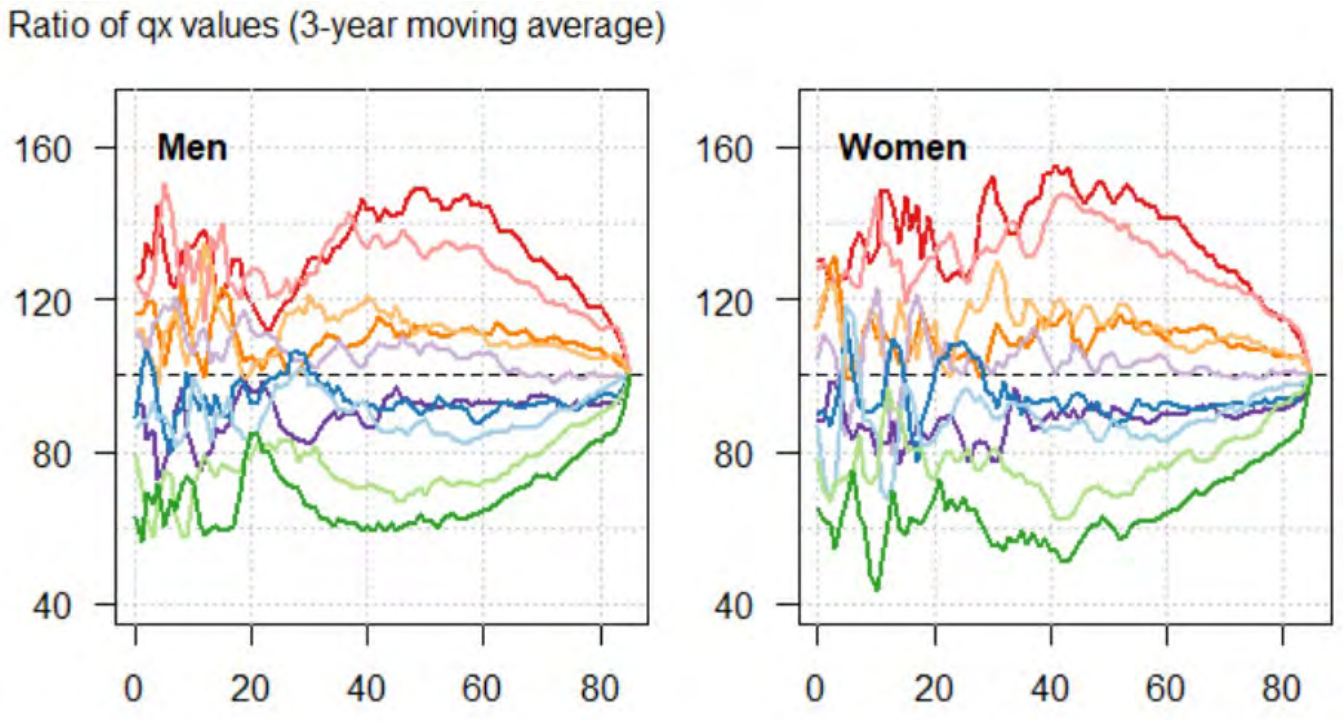


Thin lines = direct estimation ; thick lines = IHME (modeling)

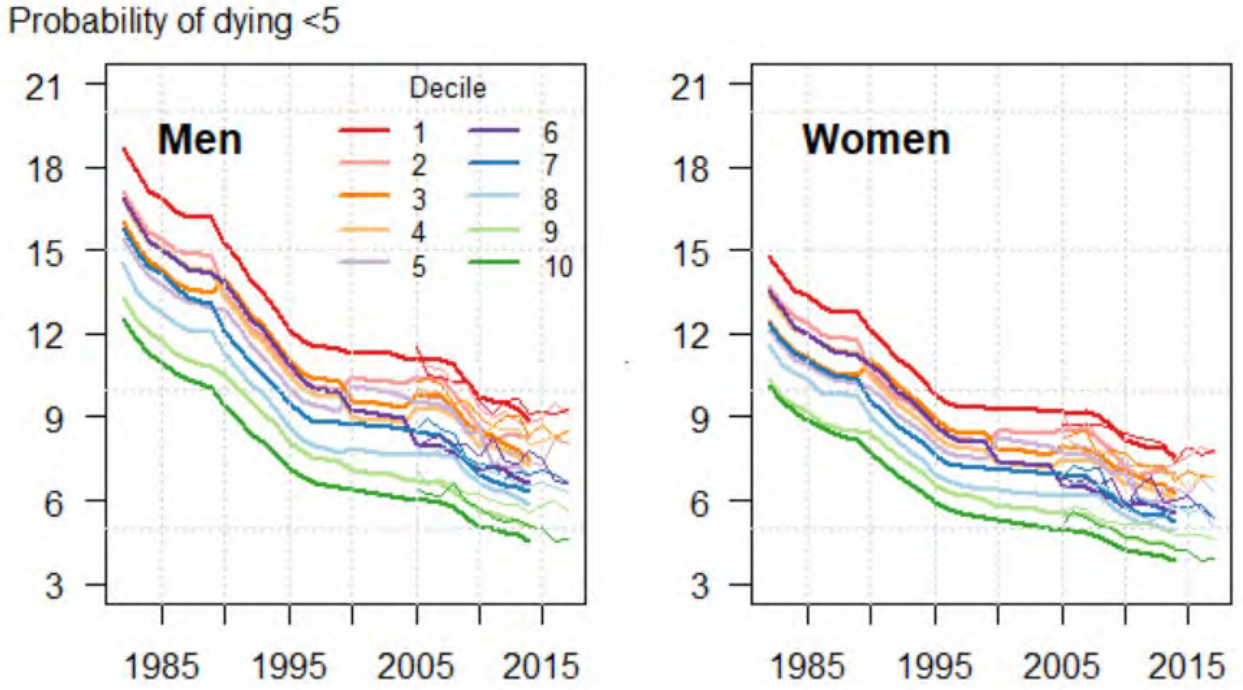
Validation test



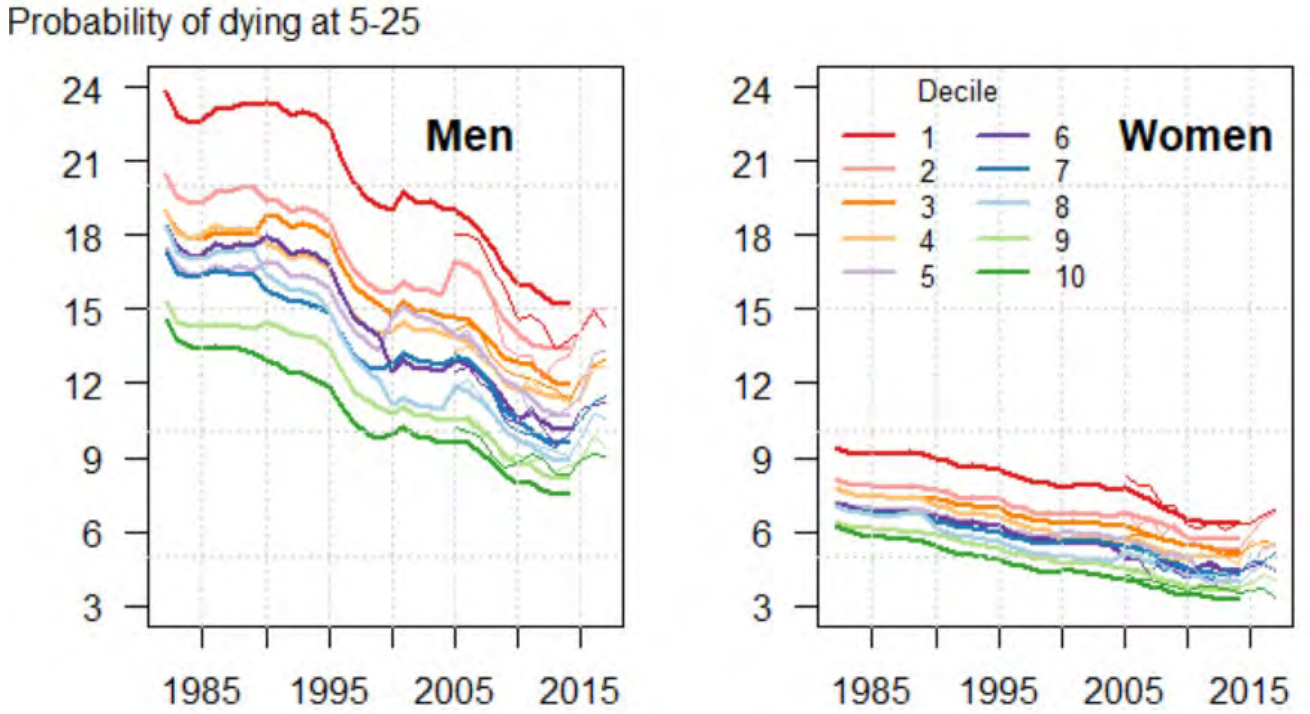
Ratio of qx in each decile to US average, each sex, 2017 (%)



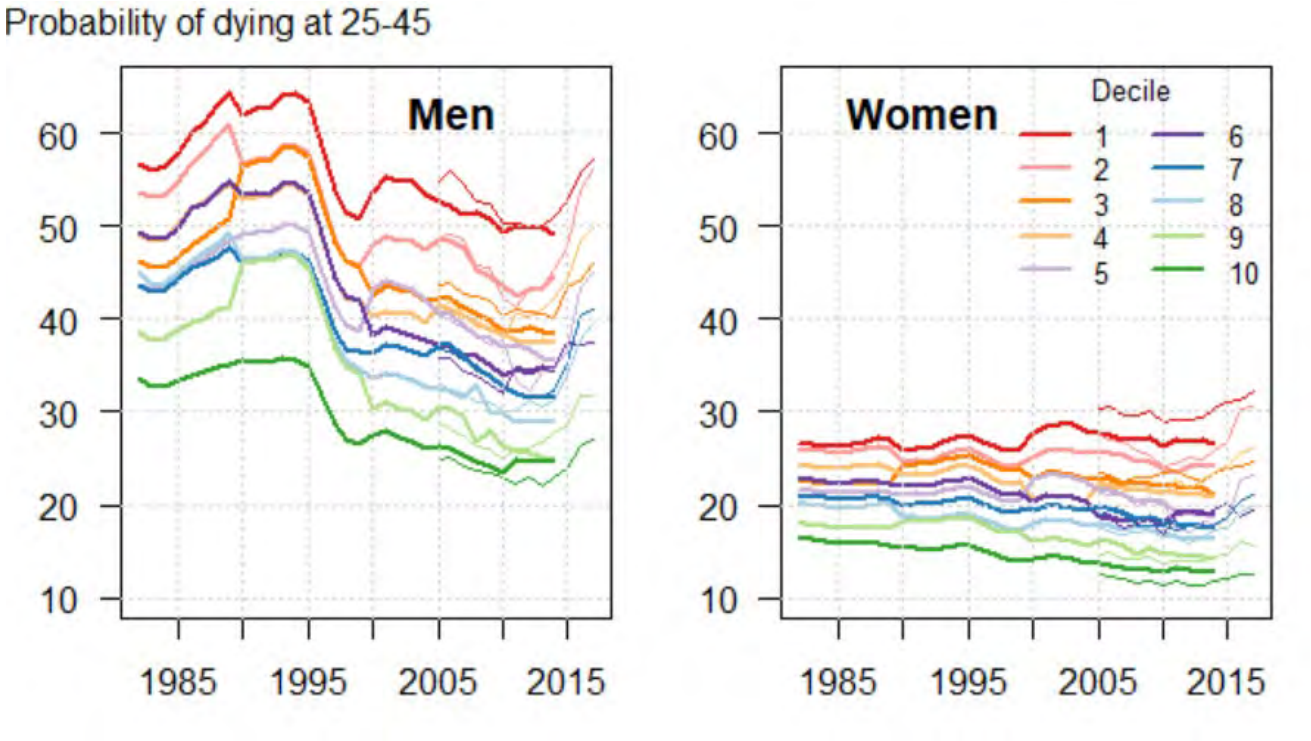
Mortality below age 5



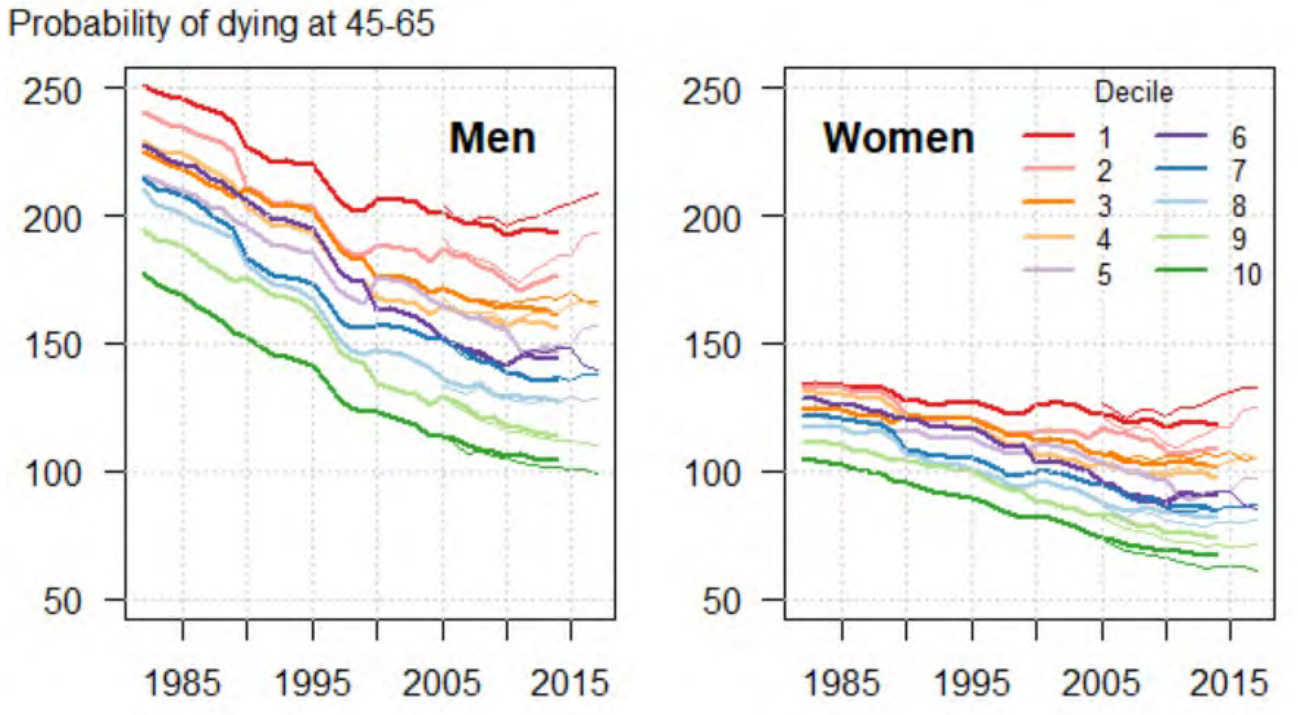
Mortality at ages 5 to 25 years



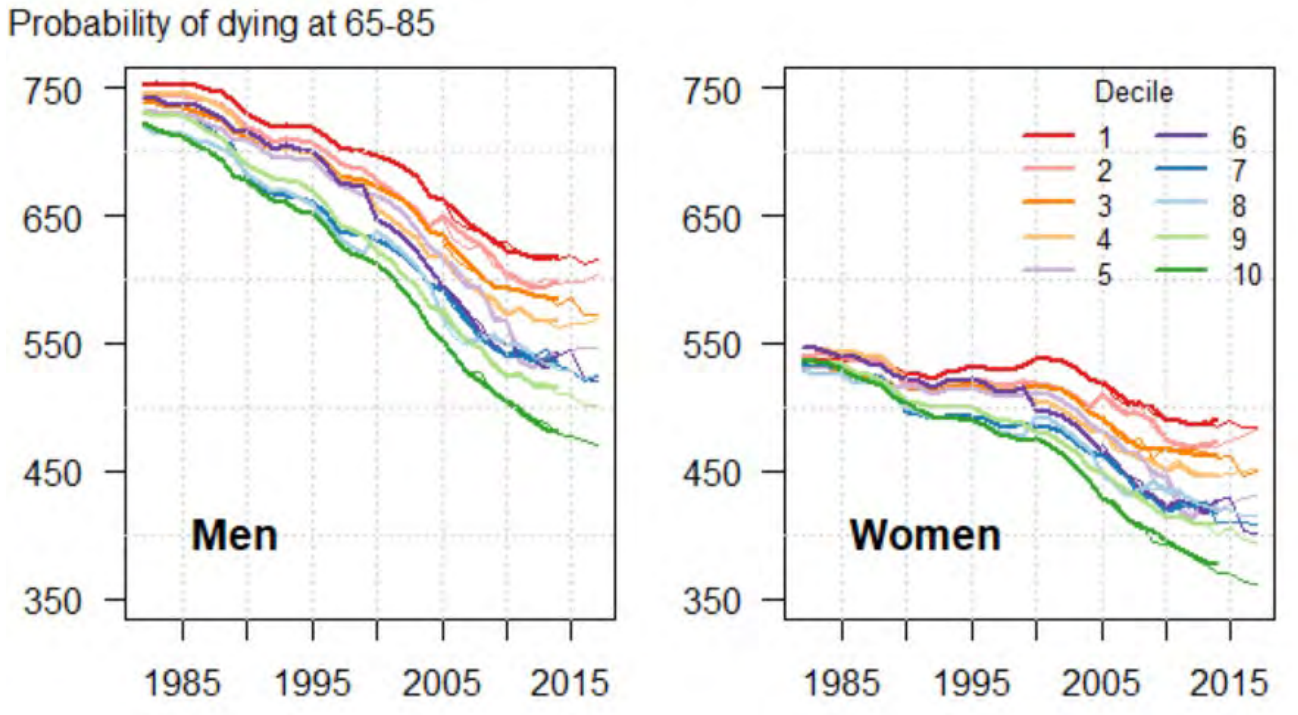
Mortality at ages 25 to 45 years



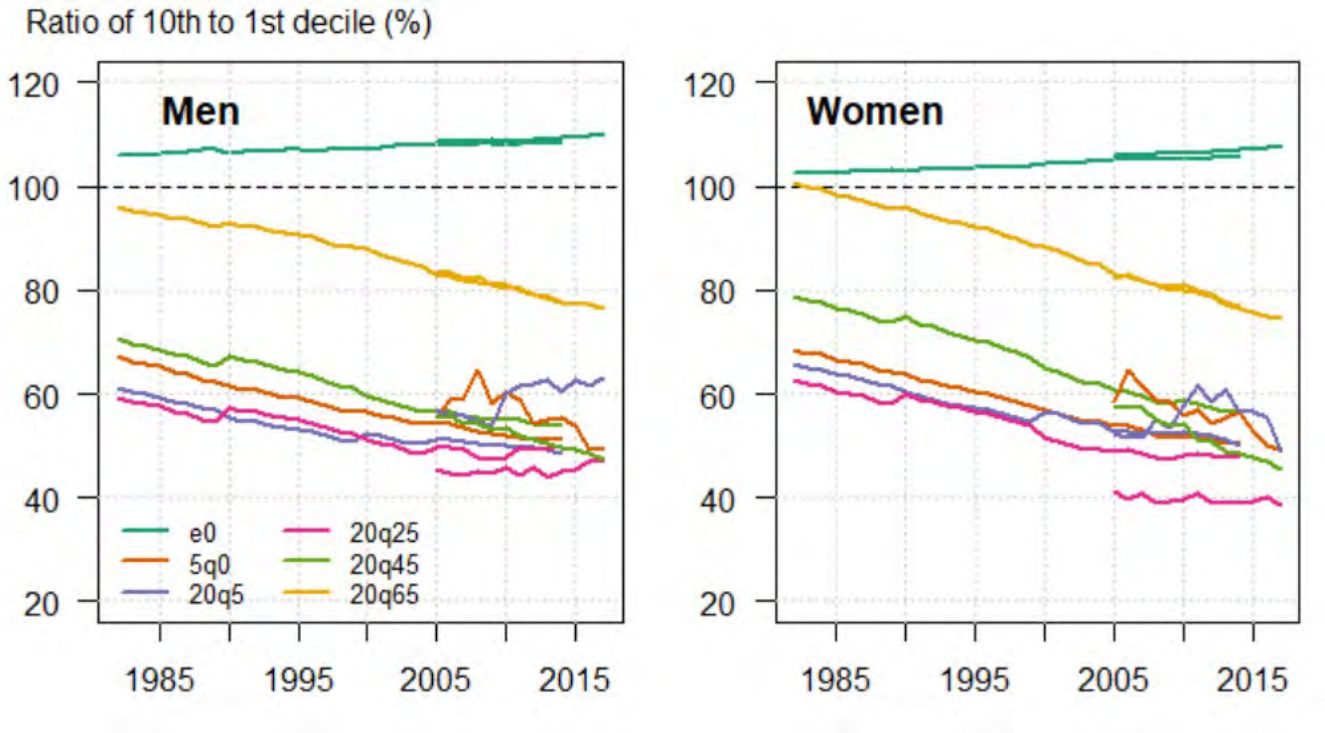
Mortality at ages 45 to 65 years



Mortality at ages 65 to 85 years



Ratio of 10th to 1st deciles



Conclusions

- Clear socioeconomic gradient in life expectancy at birth and other mortality values
- Increasing inequalities over time
- Larger disparities for men than for women
- Larger inequalities below age 45 years than above
- Only the least deprived American women have longer lives than the average women in other high-income democracies

Possible extensions

- Compute lifetable series by county decile for 1982-2018 using detailed NCHS data and HMD methods
- Compare inter- and intra-decile disparities in mortality
- Investigate differences in cause-of-death structure by decile (Covid-19 in particular)
- Concentrate on mortality variations across deciles for specific categories (racial/ethnic, foreign born, urban/rural, etc…)

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Appendix

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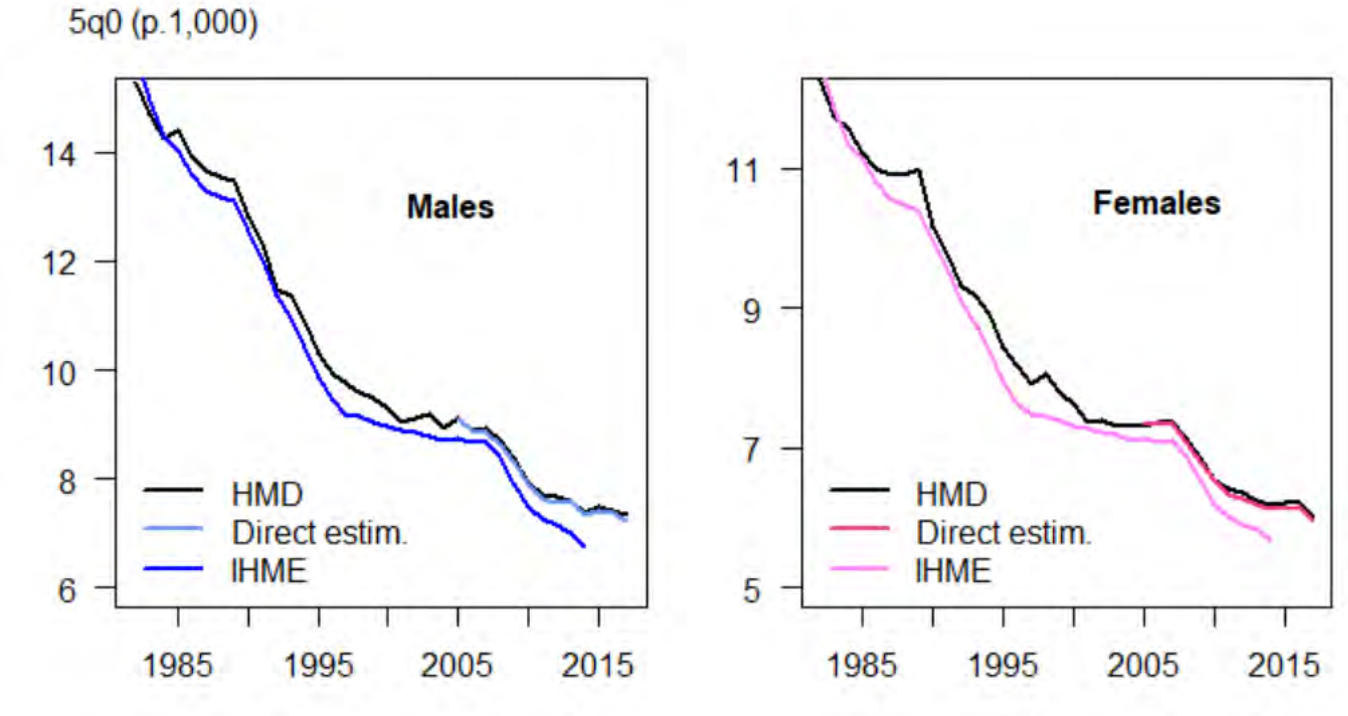
Validation test



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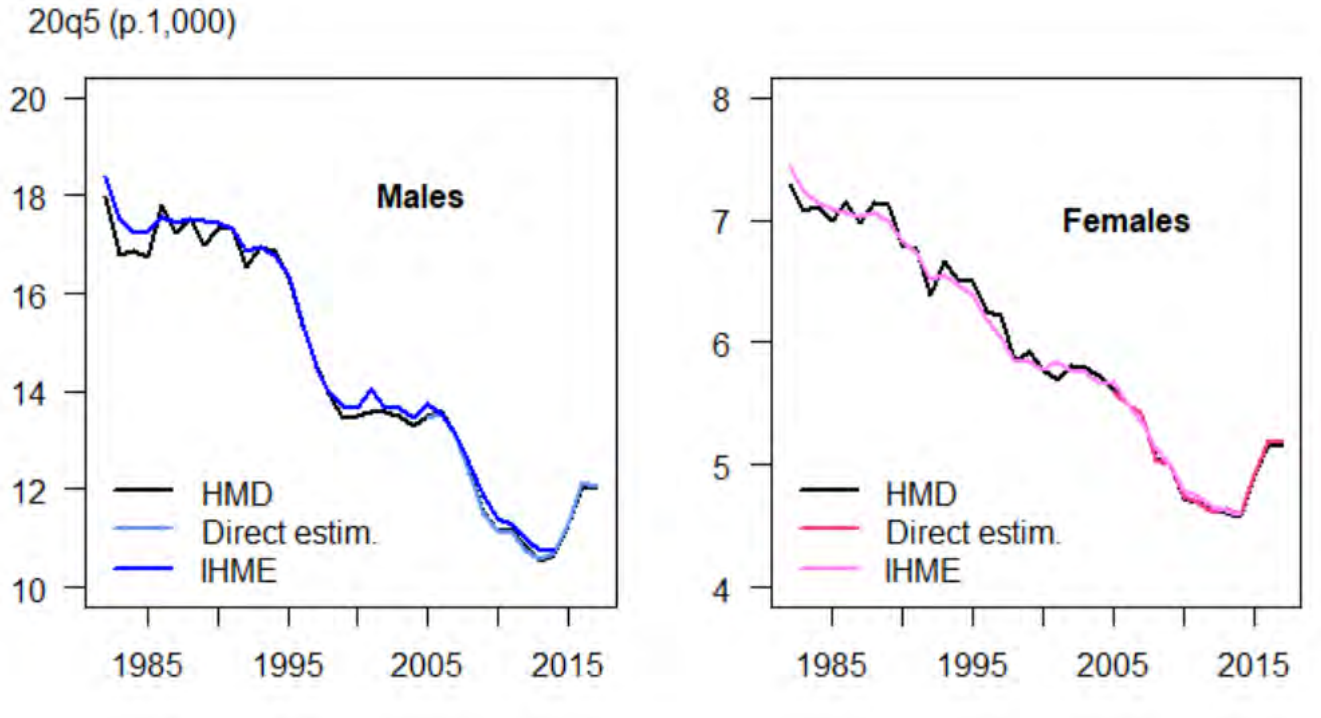

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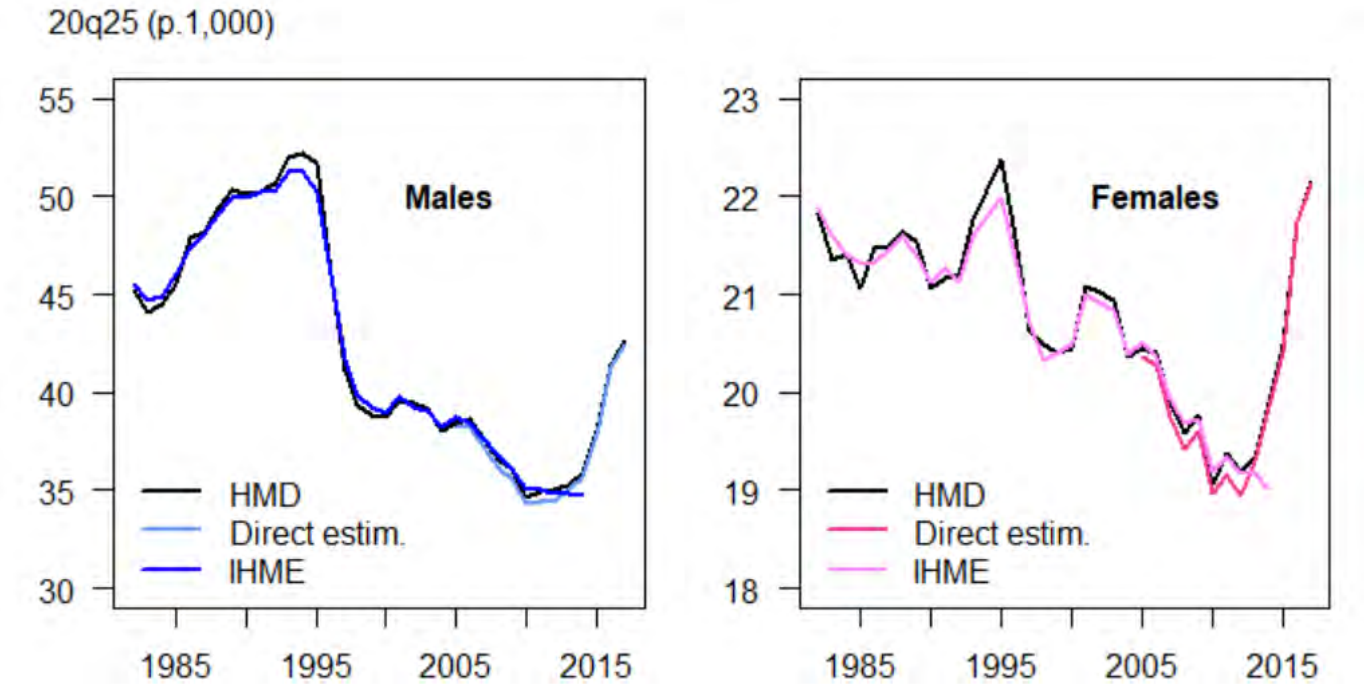

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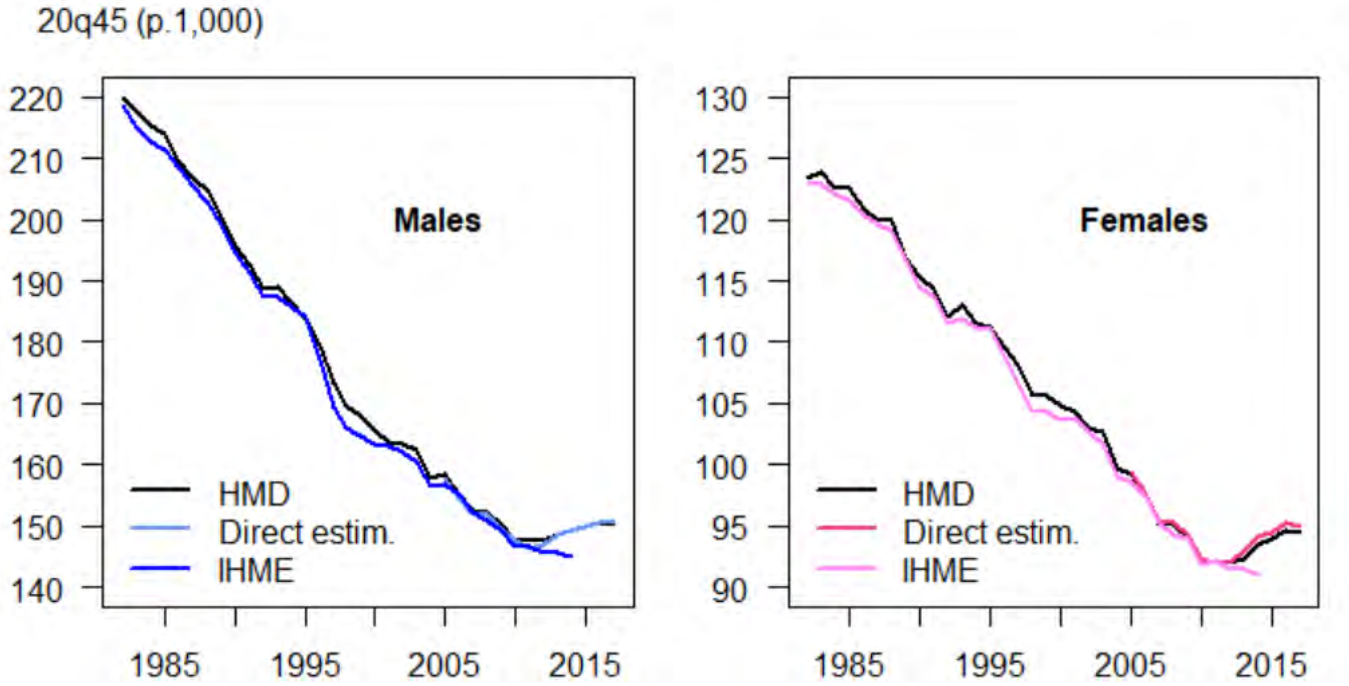

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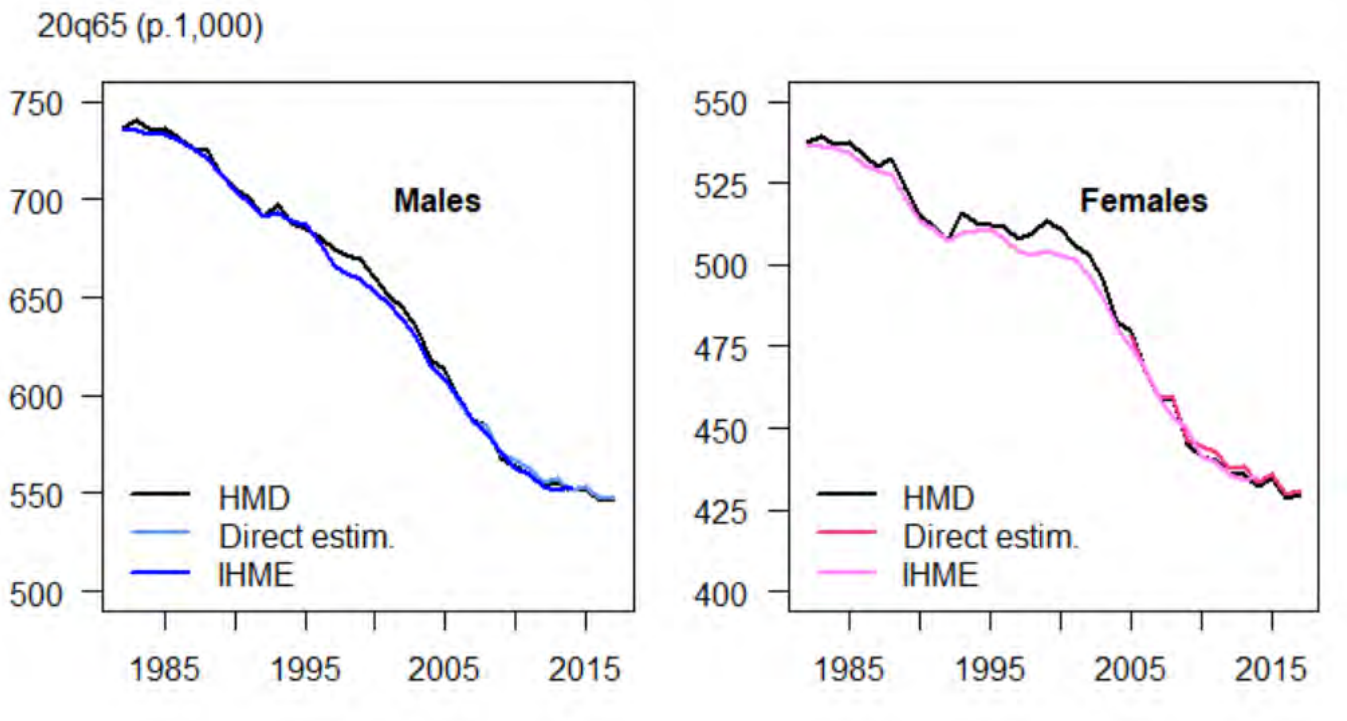

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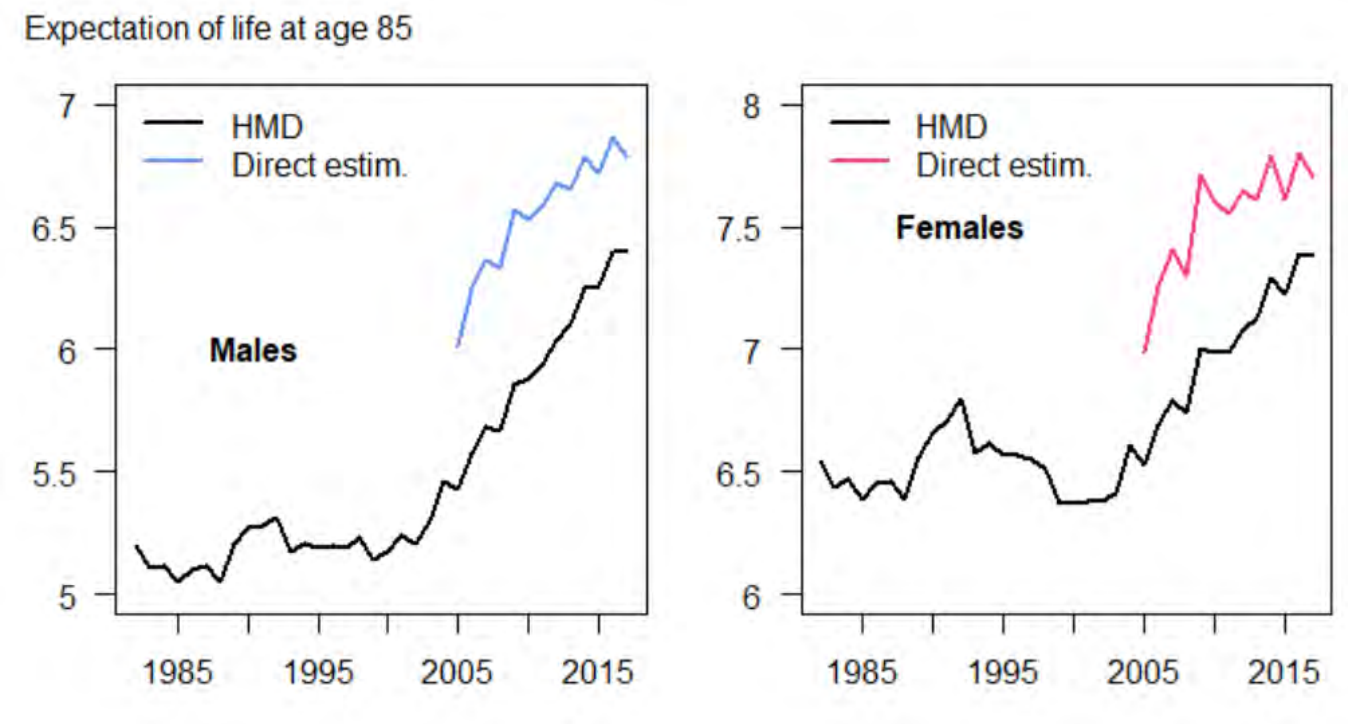


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2020 VALUATION ACTUARY
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Mortality Improvement Practices of Life Insurance Companies and Reinsurers in Canada and the U.S.

CONNIE DEWAR, FSA, FCIA

September 1, 2020

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Agenda

1. Background and Overview
2. Durational Mortality Improvement Practices
3. Drivers of Future Mortality Improvement and Deterioration
4. Durational Mortality Improvement Rates
5. Concluding Thoughts

Background

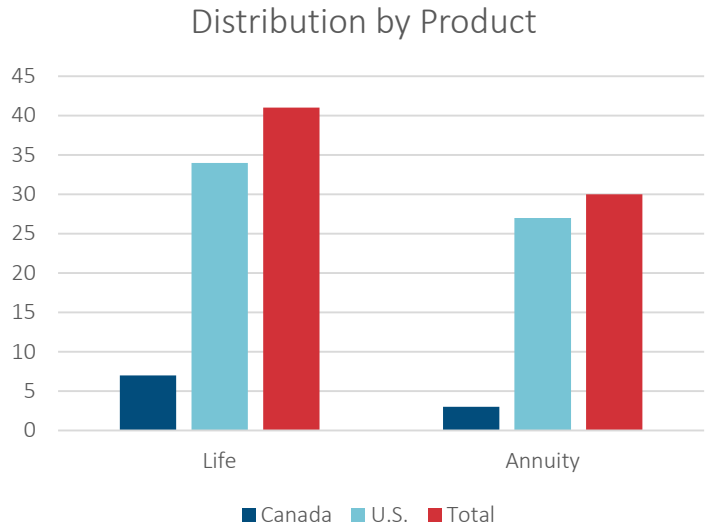
- SOA conducted a survey on mortality improvement practices and rates in early 2019
- Survey was conducted by a subcommittee of the Mortality and Underwriting Survey Committee of the SOA
- Survey Subcommittee:
  - Al Klein, Chair, U.S. Actuary
  - Connie Dewar, Canadian Actuary
  - Mark Dion, U.S. Underwriter
  - David Wylde, U.S. Actuary
- Others to recognize for their help with this project:
  - Hannah Lobbezoo
  - Cindy MacDonald
  - Pete Miller
  - All of the participants

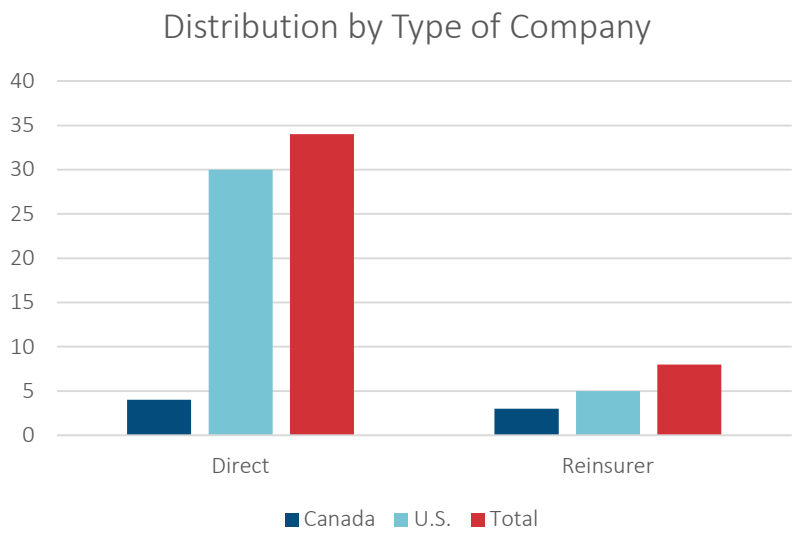
Overview

- 42 companies responded, results will be split by:
  - Country (Canada and U.S.)
  - Company type (Direct and Reinsurer)
  - Product (Life and Annuity)
  - Projection type (Pricing and Financial Projections)
- Company opinions were also asked on a number of items
  - Some will be covered here
  - Full report will provide more details and some other items, e.g., opinions on the future of e-cigarettes, and accelerated underwriting
- Results presented here are preliminary and final results in paper will likely be slightly different

Distribution By Product, Type and Country

- 42 companies responded





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Durational Mortality Improvement Practices

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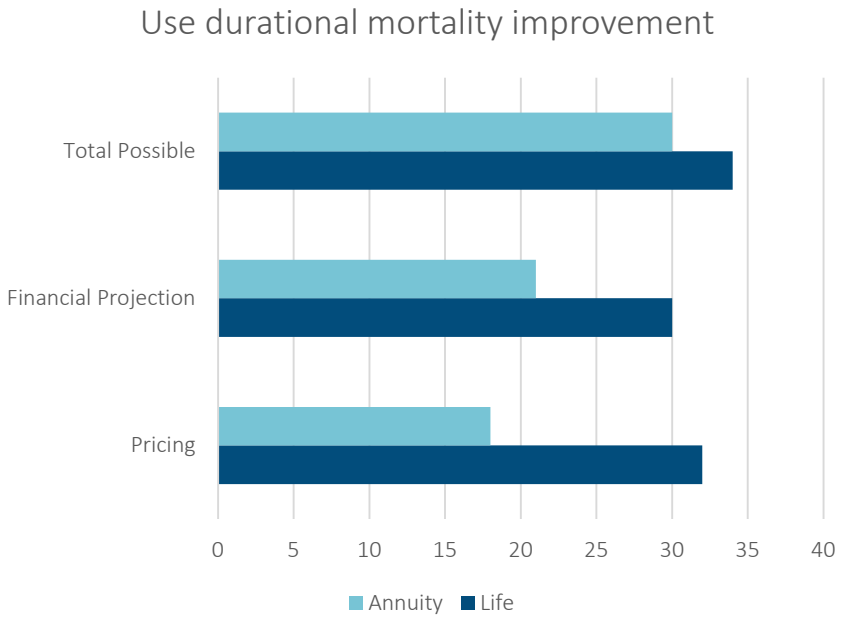
Durational Mortality Improvement

“Durational mortality improvement describes the process of projecting the current era’s mortality into the future. As a cohort proceeds in time from policy year to policy year, the mortality rates applicable in each year may be lower than defined by the base mortality table selected for the project. Durational mortality improvement is a way of keeping the annual mortality rate of a cohort up-to-date by applying future trends or expectations for mortality improvement.”

Distribution and Characteristics

- Of the 42 companies that responded, 34 use durational mortality improvement

- Key characteristics used in mortality improvement program:
  - Attained age
  - Gender
  - Duration
  - Smoking Status



Limits on Durational Mortality Improvement Program

ATTAINED AGE				
MEASURE	LIFE PRICING	LIFE PROJECTION	ANNUITY PRICING	ANNUITY PROJECTION
Minimum				
Low	0	0	0	0
Average	9.6	10.4	3.8	3.2
High	35	35	20	20
Most common	0 (10)	0 (8)	0 (8)	0 (10)
Maximum				
Low	89	89	99	99
Average	102.0	102.4	109.3	110.7
High	121	121	150	150
Most common	100 (5)	100 (4)	103, 104 (3 ea.)	103, 104 (3 ea.)

Limits on Durational Mortality Improvement Program

MAXIMUM NUMBER OF YEARS USED				
MEASURE	LIFE PRICING	LIFE PROJECTION	ANNUITY PRICING	ANNUITY PROJECTION
Low	15	15	10	20
Average	17.1	18.5	57.7	75.9
High	125	125	104	125
Most common	20 (12)	20 (10)	All unique	All unique
Total Respondents	21	17	6	7

Source of Data and Resources

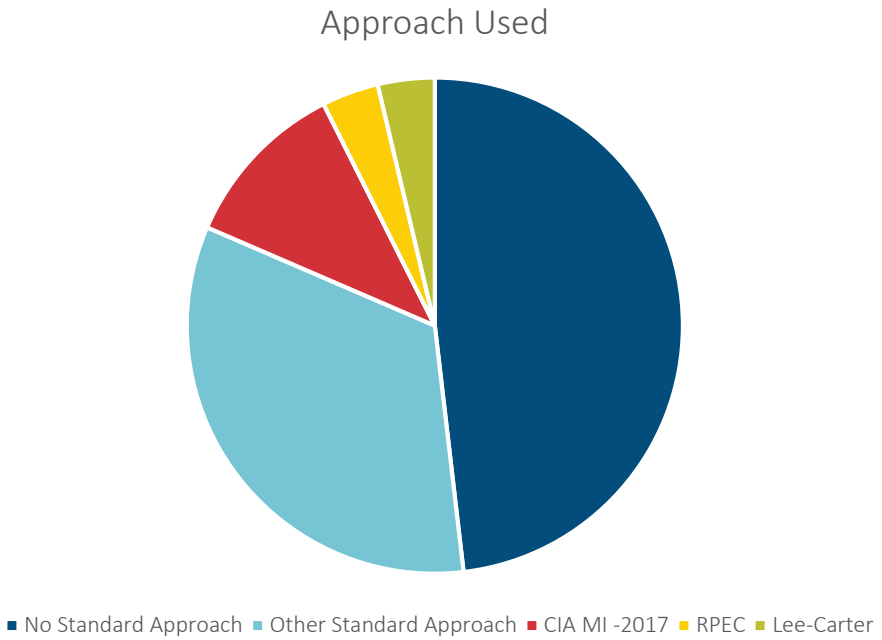
SOURCES	RESOURCES	INTERNAL RESOURCES
Population Data	Internal	Actuary(ies)
Industry Data	Reinsurer/Retrocessionaire*	Committee
Company's Data	Consultant	Senior Officer(s)
Government Data		Medical Director(s)
		Data Scientist(s)*
		Underwriter(s)

*Only used for life insurance

Standard Approaches Used to Develop Durational Mortality Improvement Assumptions

- Standard approaches include CIA, CMI projection models and RPEC mortality improvement scales

- Most insurers use a non-standard approach or a different standard approach



Changes, Validation and Review of Mortality Improvement Assumptions

Validation of Durational Mortality Improvement Assumptions	• Most validate life assumptions and most do not validate annuity assumptions
How often Durational Mortality Improvement Assumptions are Reviewed	• Every year • Over 1 and up to 3 years • As needed • As product is priced and repriced

Challenges to Setting Mortality Improvement Assumptions

- Uncertainty of the magnitude of future trends
- Availability of appropriate data
- Uncertainty in duration of future trends
- Differences in underwriting over time
- Determining age, period, cohort effects
- Limited resources
- Difficulty in back-testing models
- Modeling uncertainty

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Drivers of Future Mortality Improvement and Deterioration

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Common Drivers of Future Mortality Improvement

Short-Term Drivers

1. Reductions in mortality from cancer
2. Reductions in mortality from cardiovascular diseases
3. Medical advances (life)
4. Access to healthcare/medical care (annuity)

Long-Term Drivers

1. Reductions in mortality from cancer
2. Medical advances
3. Advances in understanding of genetics

Common Drivers of Future Mortality Deterioration

Short-Term Drivers

1. Opioids
2. Obesity
3. Diabetes
4. Lifestyle behaviors

Long-Term Drivers

1. Obesity
2. Antibiotic resistant organisms
3. Lifestyle behaviours
4. Mental health/depression

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Durational Mortality Improvement Rates

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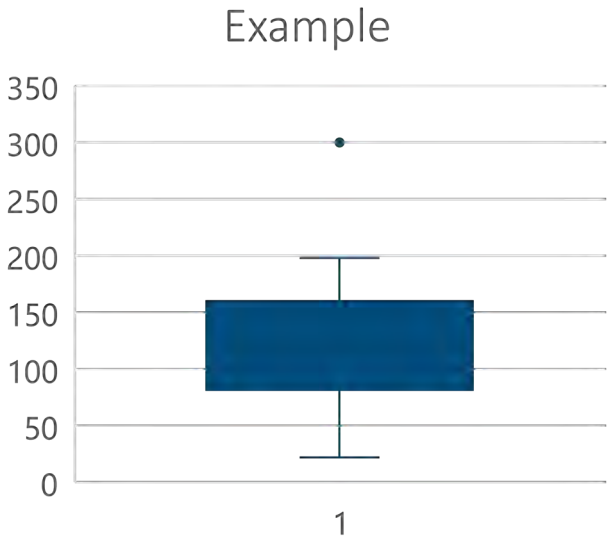
Durational Mortality Improvement Rates Requested

- Attained ages: 35, 55, 75, 95
- Products: Life, Annuities
- Type: Pricing, Financial Projections
- Period:
  - For pricing: Short-term, Long-term
  - For financial projections: Year 1, Year 21
- Category:
  - For life: Male and Female best preferred NS and residual standard NS
  - For annuities: Male and Female

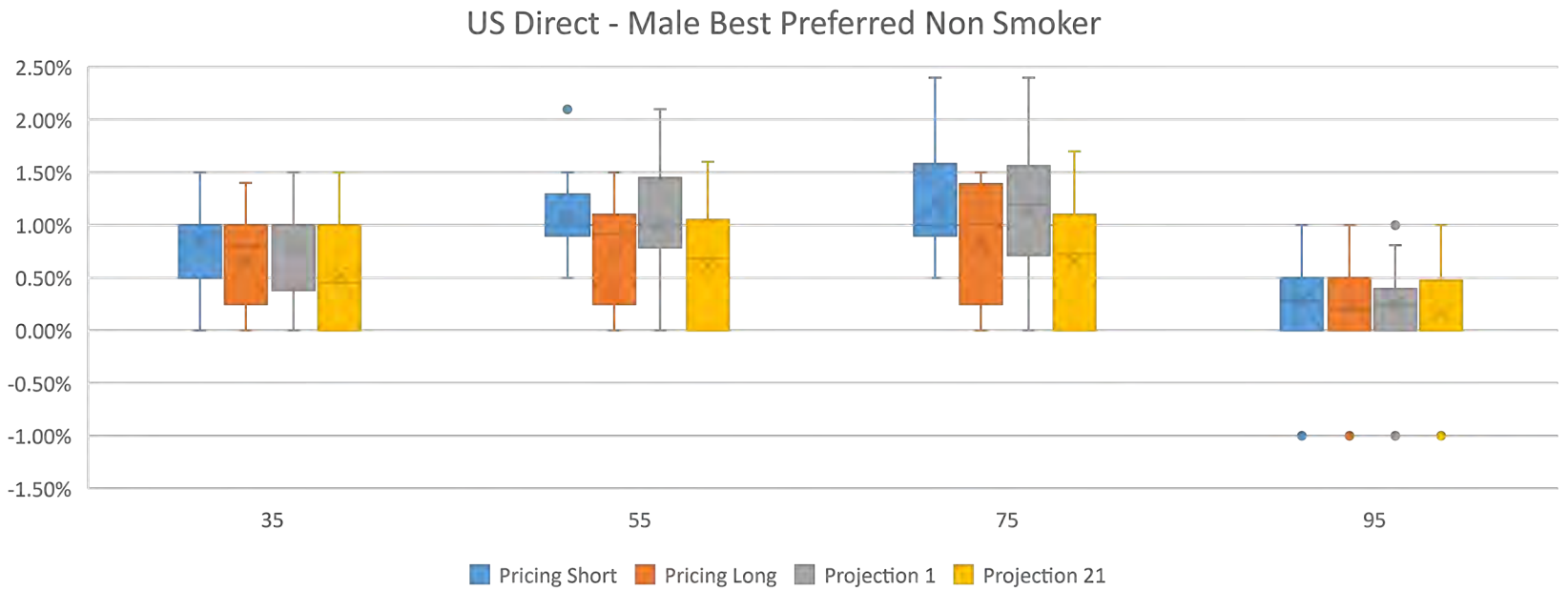
Durational Mortality Improvement Rates Shown

- "Box and Whiskers" graphs show:
  - x represents average
  - Lines represent maximum, median, and minimum
  - Box shows top of 2nd quartile and bottom of 3rd quartile
  - Dots are outliers, i.e., values that lie more than 1 ½ times the length of the box from top or bottom
- Data shown:
  - Life best preferred NS and annuity
  - For all ages and pricing and financial projection periods
  - Separately for males and females



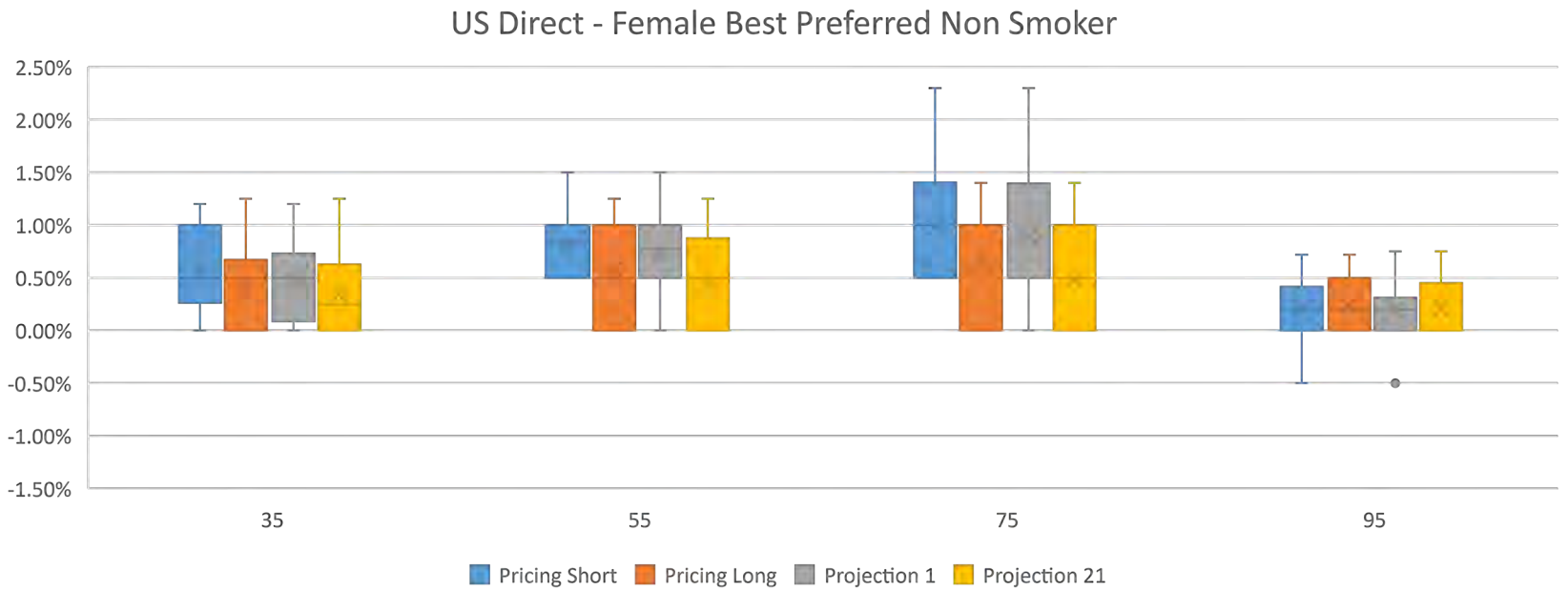
US Direct Insurance

Part 1 – Male



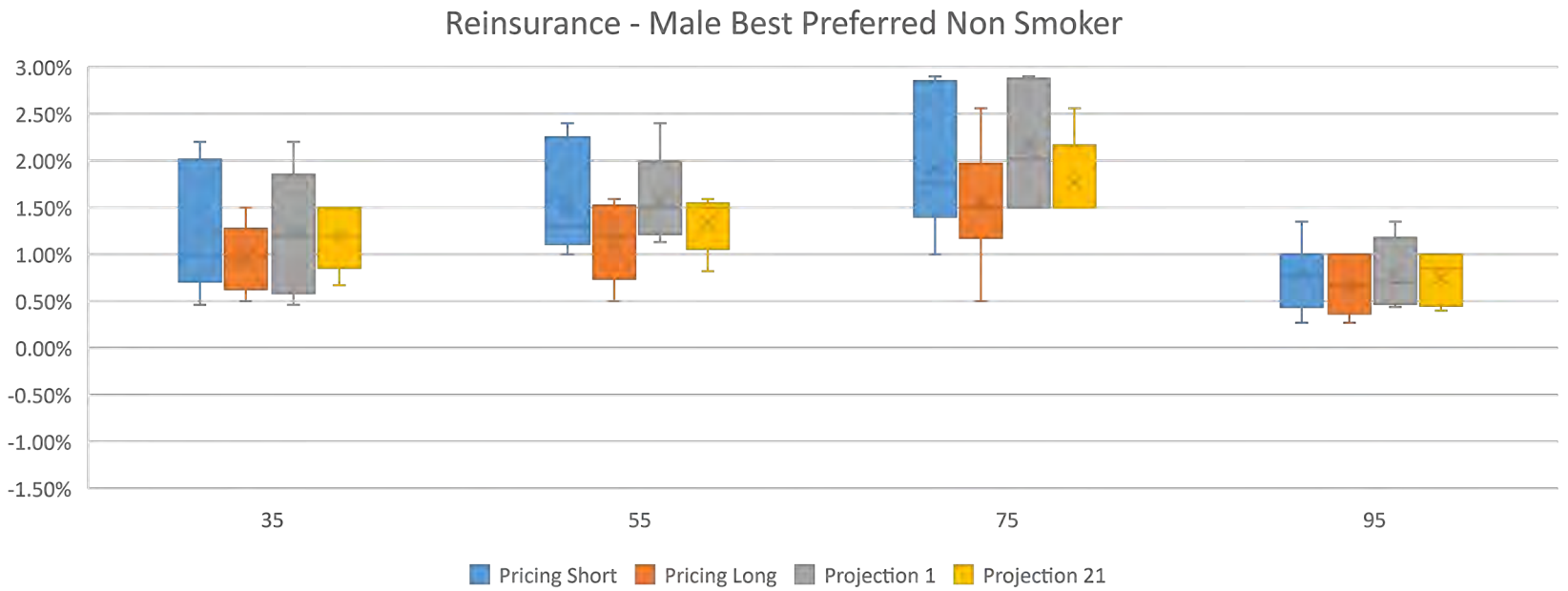
US Direct Insurance

Part 2 - Female



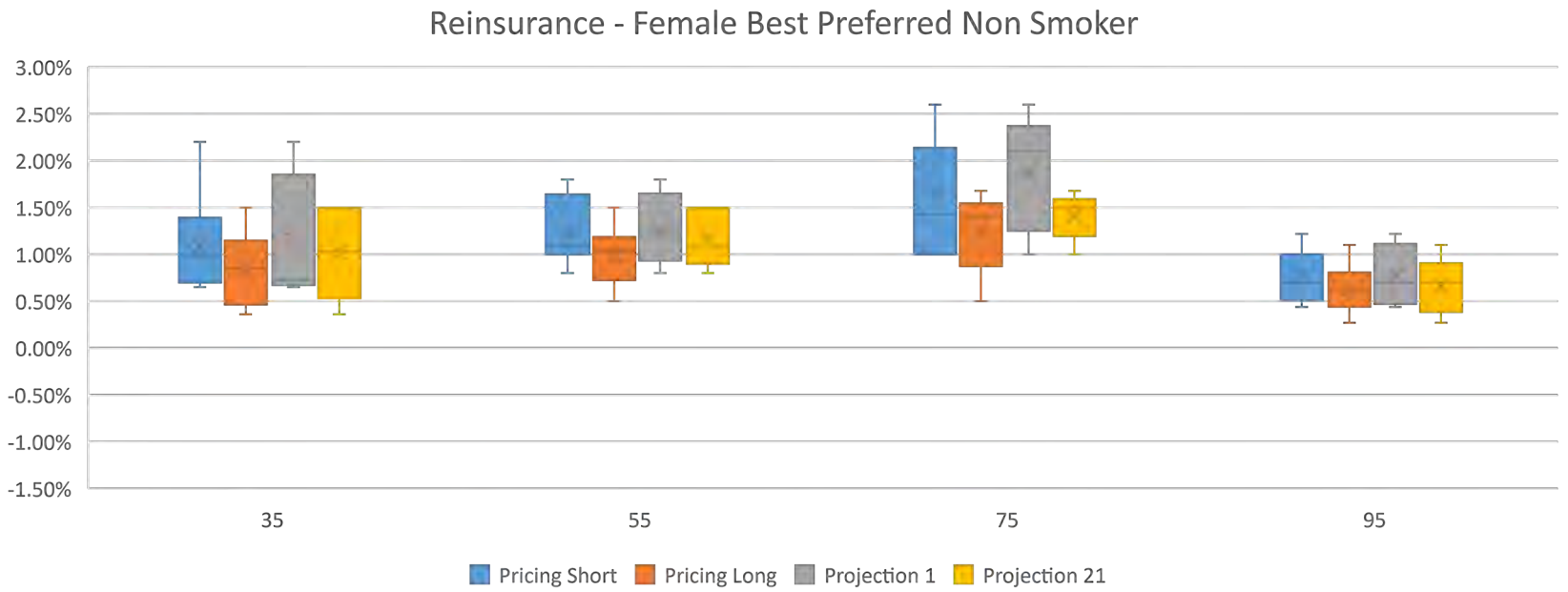
US Reinsurance

Part 1 – Male



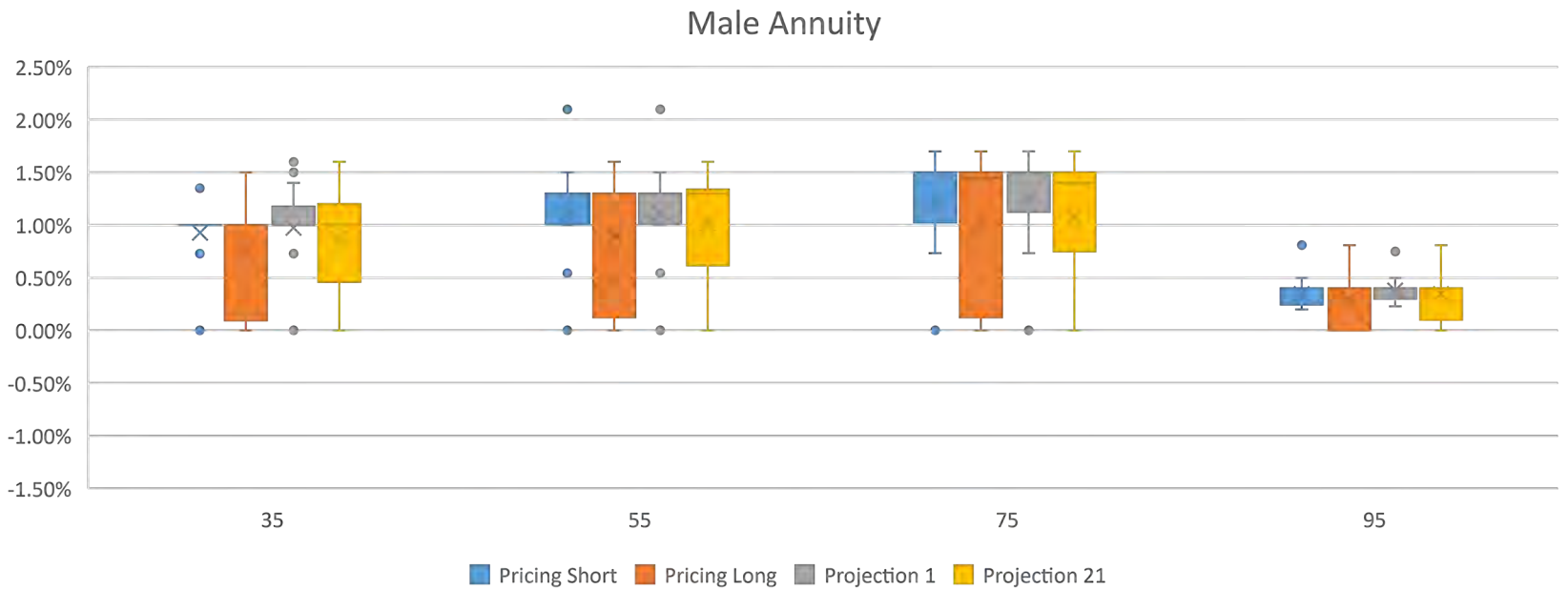
US Reinsurance

Part 2 – Female



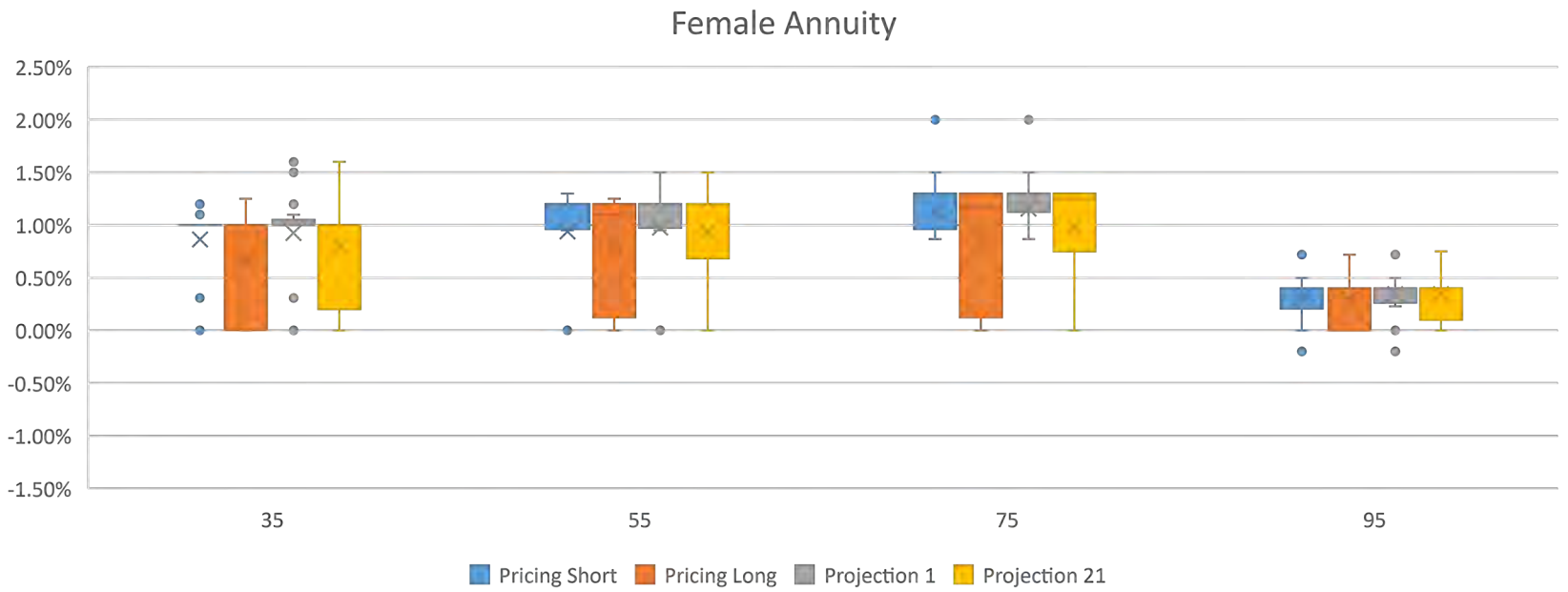
Annuities

Part 1 – Male



Annuities

Part 2 – Female



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Concluding Thoughts

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Concluding Thoughts

- Development, validation and assessment of mortality improvements assumptions continue to advance
- Will mortality improvement continue?
  - 75% of respondents indicated they thought a slow down in mortality improvements would continue short term, less so in the long term
- How will assumptions change now in light of COVID-19?
  - Level and/or length of change will depend on any lingering affects due to COVID, whether there will be a second wave of additional COVID-19 infections