LIVING *to* 100

SOCIETY OF ACTUARIES
INTERNATIONAL SYMPOSIUM

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Lake Buena Vista, FL

5C – Teaching Session: Long Term Care Modeling

2020 Living to 100 Symposium

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5C: Teaching Session: Long Term Care Modeling
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Purpose of this teaching session

- Emphasize the importance of cross-expertise collaboration
- Make the case for more research on impaired mortality
- Illustrate the above via a real-life insurance product example

Living longer meets living benefits

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Cross-expertise collaboration

- Although Life and Health are often used conjointly, the paths of their respective actuaries do not often cross within an insurer
- Separate insurers, separate divisions, separate conferences, separate exams, separate policies, etc.
- Yet globally more and more products have and continue to emerge in which collaboration is necessary but not often seen:
    - Disability income insurance riders on life insurance products
    - Impaired annuities
    - Enhanced annuities based on qualifying medical conditions
    - Combination products (life and LTC, annuity and LTC)
    - Accelerated Death Benefits for terminal, chronic or critical illnesses
    - Viatical settlements
    - Etc.
- Collaboration is not widespread and yet critical for such products

The case for impaired mortality research

- Mortality research to date has been primarily focused on:
  - Healthy insured lives and
  - General population
- Focus of insurance data:
  - Healthy individuals at policy issue and their journey through time
  - Substandard mortality cases are smaller in number and not homogeneously defined
  - Continued use of "health gadgets" and may allow longitudinal analysis of impaired mortality
- Population data is often not refined enough to allow data parsing
- As populations age, products are/will be catered to individual needs with diverse medical conditions
  - Pre-existing conditions on new insurance (any protection)
  - Change in experience pattern, in product options when an existing insured goes from healthy to impaired

The case for impaired mortality research

- Current data sources include studies on:
  - Disability income
  - Long-term care mortality
  - Medical claims
  - Viatical settlement
  - Pension mortality
  - Life insurance and annuity
  - Etc.
- Problems with using such studies:
  - Linkage to contractual definitions
  - Underlying products focus on other risks and decrements
- New products introduce new risk factors and behavioral patterns
- What about mortality improvement
  - Are healthy individuals getting healthier?
  - Do those with medical conditions afforded a longer life?

Longevity in impaired health

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The insurance need and available products

- As individuals age, various health conditions may occur
  - Exposing them to higher medical or personal care expenses
  - Leading to questions about paying for such expenses
- More traditional products to respond to such needs in the USA include:
  - Medical insurance (individual/group insurance, medicare)
  - Disability income insurance (working years only)
  - Critical illness insurance (limited in scope, face amount and availability)
  - Long term care insurance
- LTC sales in the USA have been on the decline due to various factors

" …only 70,000 stand-alone policies were sold in 2017, but over 750,000 had been sold back in 2000."

– 2018/10/10 Forbes.com

"Between 2012 and 2016, stand-alone LTCI's share of the overall LTC planning products market that LIMRA tracks fell to 5.3%, from 17%." *– 2017/11/09 Thinkadvisor.com*

The insurance need and available products

- Conversely, sales of « hybrid » products have been on the rise

  “ New premiums from life-LTC hybrids increased 18% over 2017 levels, to $4.1 billion, [LIMRA] institute analysts report.

  The number of policies sold increased 5%, to about 260,000.
  […]
  In 2017, about 25% of all new U.S. life insurance premiums paid for life products that offer LTC or chronic illness benefits.”

  – 2018/07/05 Thinkadvisor.com

  “ [in 2016] New sales of individual stand-alone LTCI fell 13%, to $228 million, but sales of individual annuities that offer LTC benefits increased 2.1%, to $480 million.

  Sales of individual life-LTC hybrid products increased 16%, to $3.6 billion.”

  – 2017/11/09 Thinkadvisor.com

The insurance need and available products

- Why?
  - LTC has had its share of highly publicized problems
    - Underpricing
    - Exit of carriers
    - Concerns from investment community
    - Etc.
  - Hybrid products on the other hand are
    - New(ish)
    - New enough to have limited reported experience
    - Offering a limit the total payouts
    - Easier to explain/sell to insurance prospects
    - Subject to different regulation in some cases than LTC

The insurance need and available products

- Hybrid products include:
  - Accelerated Death Benefits (ADB) for Chronic Illness
  - ADB for Terminal Illness
  - ADB for Critical Illness
  - Life/Long Term Care Insurance (LTCI) Accelerated Benefits
  - Life/LTCI Linked-Benefit Plans
  - Annuity/LTCI Linked-Benefit Plans
  - Annuity Enhanced Payout Benefits triggered by a qualifying health condition
- For more details on these products, please consult:
  - https://www.soa.org/globalassets/assets/files/research/projects/research-2015-04-considerations-for-insurers.pdf

The Case Study: Accelerated Death Benefits (ADB) for Chronic Illness

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Case study: ADB for Chronic Illness

- Three common types:
  - Discounted Death Benefit Approach:
    - Insurer pays a discounted death benefit of the face amount being accelerated.
  - Lien Approach:
    - Payment of accelerated benefits is considered a lien against the death benefit of the policy or rider and access to the cash value is restricted to any excess of the cash value over the sum of any other outstanding loans and the lien.
  - Dollar-for-Dollar Benefit Reduction (4BR) Approach:
    - When accelerated death benefit is payable, there is a dollar-for-dollar reduction in the death benefit and a pro rata reduction in the cash value based on the percentage of death benefits accelerated.

Case study: ADB for Chronic Illness

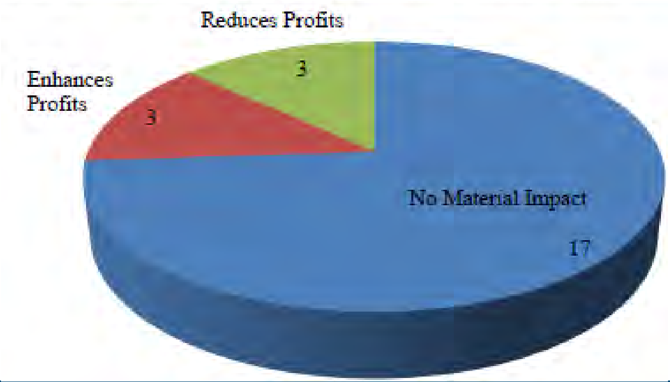
- SOA survey found (19 respondents):

Impact of Including the Chronic Illness Benefit on Mortality	Number of Plans
No Impact	7
Minimal	7
Increase	1
Not Evaluated	1
No Results Available	1
Negative	1
Assume Conservation of Mortality	1

Impact of Including the Chronic Illness Benefit on Policyholder Optionality/Anti-Selection	Number of Plans
No Impact	8
Minimal Impact	7
Slight Increase	1
Not Evaluated	1
No Results Available	1
No Assumption	1

Impact of Including the Chronic Illness Benefit on Policy Persistency	Number of Plans
No Impact	7
Minimal Impact	7
Lower Lapses/Higher Persistency	2
Not Evaluated	1
No Results Available	1
Unknown	1

Figure 20: Impact of Including the Chronic Illness Benefit on Profits



Source: https://www.soa.org/globalassets/assets/files/research/projects/research-2015-04-living-benefit-riders.pdf

Case study: ADB for Chronic Illness

- Key actuarial assumptions include:
  - Incidence of morbidity and persistency of medical conditions
  - Mortality of active lives (« Healthy »)
  - Mortality of lives with medical conditions (« Impaired »)
  - Mortality improvement for Healthy and Impaired lives
  - Lapse assumption for Healthy and Impaired lives
  - Interest rate assumption
  - Waiver of premium assumption

Which assumptions do you think have more impact on 4BR ADB?

Data sources

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Morbidity: Incidence and claim persistency

- Need to consider benefit triggers

Figure 11: Benefit Payment Triggers

Trigger	Number of Plans		
	Use	Use Always	Use Sometimes
LHCP	18	12	1
2 of 6 ADLs or Cognitive Impairment	18	11	2
Permanent Nursing Home Confinement	7	4	1
2nd Opinion of Other LHCP	6	0	6
Plan of Care	3	1	1
Written Notice of Claim	2	2	
2 of 6 ADLs or Severe Cognitive Impairment	1	1	
Severe Cognitive Impairment	1		1
Requires Substantial Supervision to Protect such Individuals from Threats to Health and Safety Due to Severe Cognitive Impairment	1		1

14/23 plans require that the condition be expected to be permanent

Source: https://www.soa.org/globalassets/assets/files/research/projects/research-2015-04-living-benefit-riders.pdf

Morbidity: Incidence and claim persistency

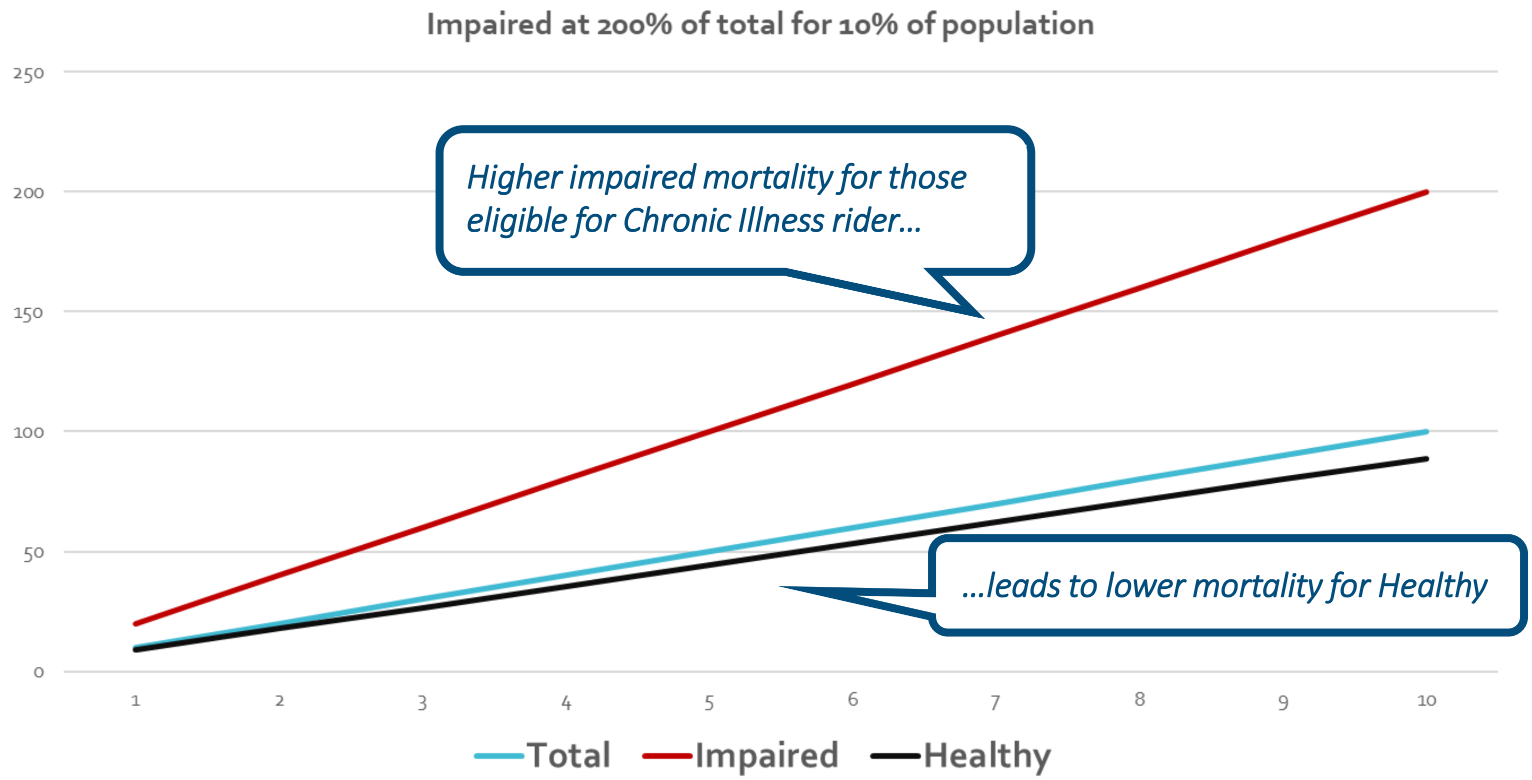
- North American studies
  - SOA LTC Studies
    - Based on 2/6 activities of daily living or cognitive impairment
    - Condition does not need to be permanent
    - Monitors time on claim with subsequent recovery or death
  - CIA Critical Illness Basis Development
    - Offers incidence rates for Loss Of Independent Existence (LOIE)
    - Developed based on Canadian, US and international studies
    - LOIE is based on 2/6 activities of daily living or cognitive impairment
    - Requires condition to be permanent and pays a lumpsum
    - Could be used for ABD based on Critical Illness

Sources: https://www.soa.org/resources/experience-studies/2015/2000-2011-ltc-experience-basic-table-dev/
https://www.cia-ica.ca/docs/default-source/2012/212059e.pdf
https://www.cia-ica.ca/publications/publication-details/212059T

Mortality

- Total Mortality
  - Assuming no anti-selection at issue, total mortality should be the same on otherwise equivalent products with and without the ADB Chronic Illness rider
- Impaired Mortality
  - Most studies focus on the mortality of disabled lives or LTC-dependent lives
  - We will examine this in more detail
- Healthy Mortality
  - This assumption will be derived by taking out the Impaired lives with their associated impaired mortality from the total cohort

Mortality


Impaired at 200% of total for 10% of population
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
Higher impaired mortality for those eligible for Chronic Illness rider…
…leads to lower mortality for Healthy
Total
Impaired
Healthy

Impaired Mortality

- If we assume the LTC incidence assumption is correct, then the impaired mortality is bounded
- Impaired mortality = total mortality
  - Benefit payments are paid earlier
  - Assuming a waiver of premium is in effect, no lapse on impaired lives
  - Worse case scenario, higher premium
  - ➢ One can conclude the claim trigger is likely too loose and incidence rates may be higher than expected
- Impaired mortality is multiple times the total mortality (close to terminal illness trigger)
  - LTC payment stream is short, full face amount is paid earlier, but close to expected date of death
  - The remaining, non-LTC insureds are healthier
  - Best case scenario, lower premium
  - ➢ Claim trigger is likely too strict, focused on those in worse health, incidence rates will likely be lower than expected

Mortality Improvement

- Mortality improvement for Healthy and Impaired lives
  - Not aware of studies looking at mortality improvement by health status
  - The WHO has derived an analysis of Healthy Adjusted Life Expectency (HALE) which can provide some general guidance which can be compared to Life Expectancy
- Health Adjusted Life Expectancy (HALE)
  - HALE is a measure of population health that takes into account mortality and morbidity. It adjusts overall life expectancy by the amount of time lived in less than perfect health. This is calculated by subtracting from the life expectancy a figure which is the number of years lived with disability multiplied by a weighting to represent the effect of the disability.

Total Life Expectancy vs HALE

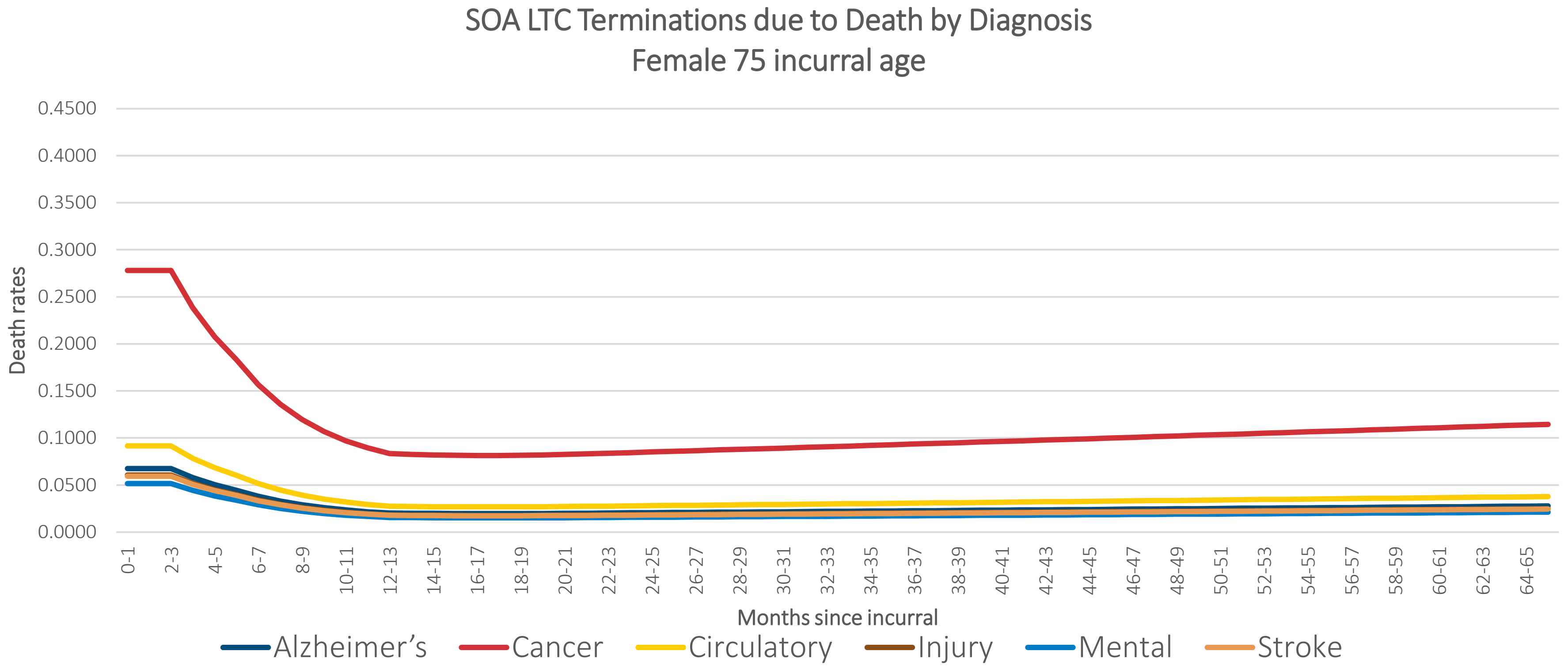
Source: WHO		Life expectancy at birth (years)			Life expectancy at age 60 (years)			Healthy life expectancy (HALE) at birth (years)			Healthy life expectancy (HALE) at age 60 (years)		
	Increase	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
	over period	MF-LE@0	M-LE@0	F-LE@0	MF-LE@60	M-LE@60	F-LE@60	MF-HALE@0	M-HALE@0	F-HALE@0	MF-HALE@60	M-HALE@60	F-HALE@60
CANADA	2016 - 2000	3.5	4.2	2.9	3.0	3.5	2.4	2.8	3.3	2.2	2.4	2.9	2.0
FRANCE	2016 - 2000	3.8	4.6	3.0	2.7	3.2	2.4	3.1	3.8	2.3	2.2	2.6	1.8
GERMANY	2016 - 2000	2.9	3.7	2.3	1.8	2.4	1.6	2.4	3.1	1.9	1.5	1.9	1.3
UK	2016 - 2000	3.5	4.2	3.0	2.8	3.4	2.4	2.9	3.5	2.5	2.3	2.7	2.0
USA	2016 - 2000	1.6	1.8	1.5	1.7	2.0	1.6	1.1	1.3	1.0	1.1	1.3	1.0

Source: WHO		Life expectancy at birth (years)			Life expectancy at age 60 (years)			Healthy life expectancy (HALE) at birth (years)			Healthy life expectancy (HALE) at age 60 (years)		
	Growth rate	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
	over period	MF-LE@0	M-LE@0	F-LE@0	MF-LE@60	M-LE@60	F-LE@60	MF-HALE@0	M-HALE@0	F-HALE@0	MF-HALE@60	M-HALE@60	F-HALE@60
CANADA	2016 - 2000	0.27%	0.33%	0.22%	0.78%	0.98%	0.58%	0.24%	0.29%	0.19%	0.78%	1.02%	0.61%
FRANCE	2016 - 2000	0.29%	0.37%	0.22%	0.69%	0.91%	0.56%	0.27%	0.34%	0.20%	0.71%	0.92%	0.54%
GERMANY	2016 - 2000	0.23%	0.30%	0.18%	0.50%	0.73%	0.41%	0.21%	0.28%	0.16%	0.53%	0.73%	0.43%
UK	2016 - 2000	0.28%	0.34%	0.23%	0.77%	1.00%	0.62%	0.26%	0.32%	0.22%	0.80%	1.00%	0.66%
USA	2016 - 2000	0.13%	0.15%	0.12%	0.47%	0.60%	0.42%	0.10%	0.12%	0.09%	0.40%	0.51%	0.34%

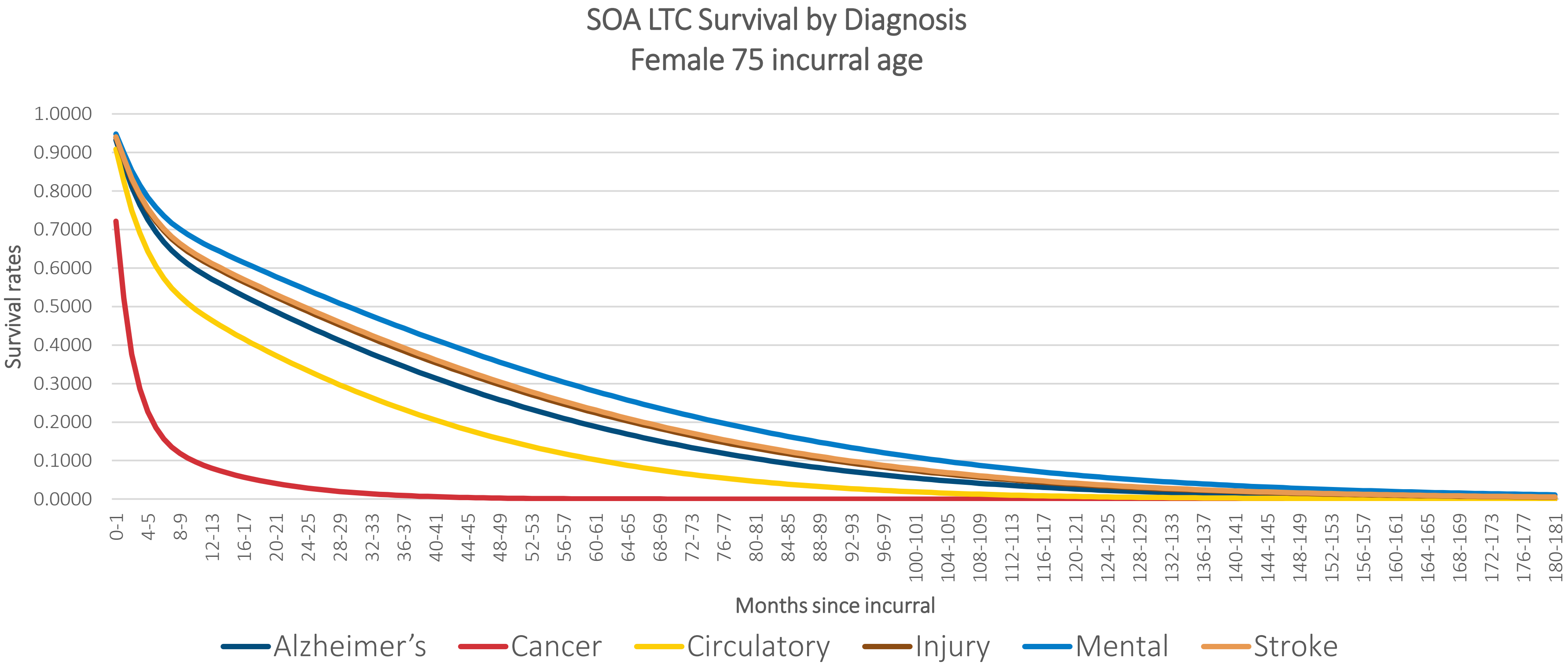
Additional Considerations

- Any model can be further enhanced by including additional splits in each mortality/morbidity assumption
  - By risk classes
  - By major medical conditions (e.g., cvd, dementia, cancer)
  - By income and education levels
  - Preferred mortality classes
  - Traditional variables such as age, gender, state, etc.
  - Etc.

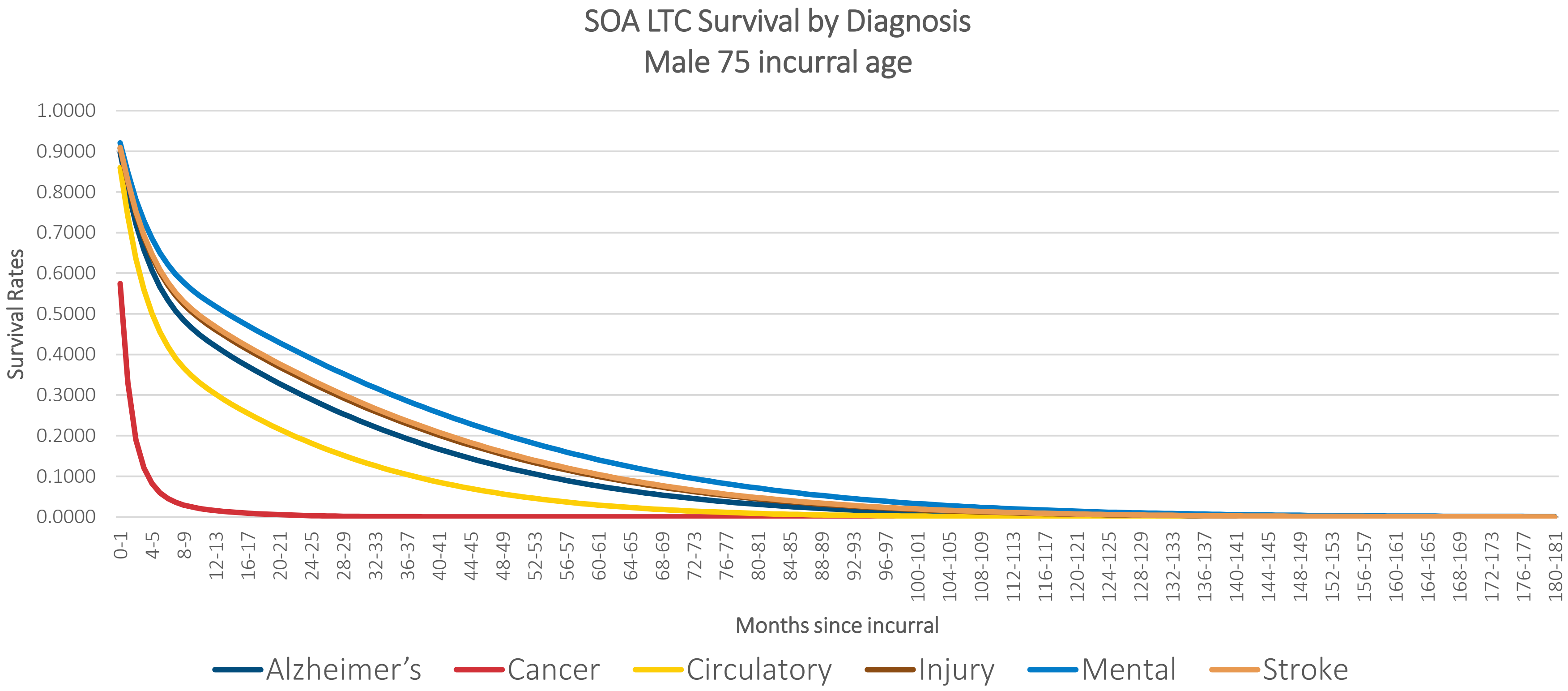
Variations by Medical Condition: Death



Variations by Medical Condition: Survival



Variations by Medical Condition: Survival



Modelling – Mortality in the presence of morbidity

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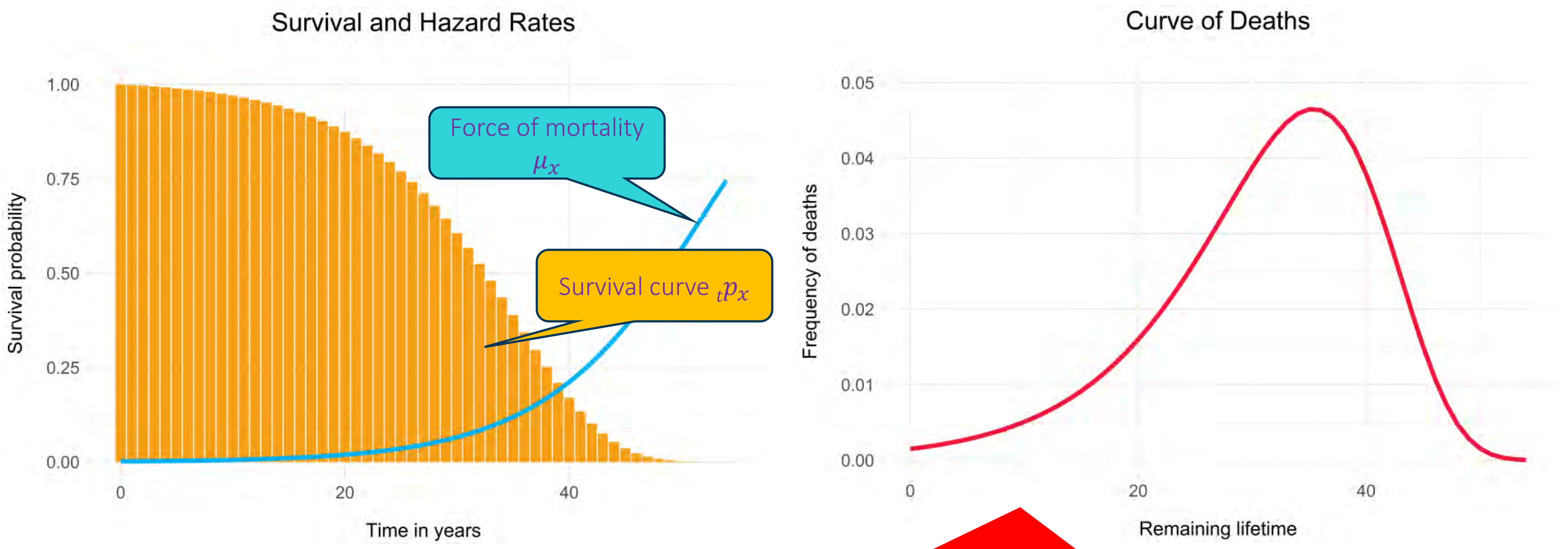
Survival Models



Probability density function ${}_tp_x\mu_{x+t}$
= likelihood for one observation

Parametric Survival Models using Maximum Likelihood Estimation

Maximum likelihood estimation used to estimate parameter values, life tables are readily derived with these parameters.

Survival for t years: $S_t = {}_tp_x = e^{-H_x(t)} = exp\left(-\int_0^t h_{x+s} ds\right)$

Hazard rate function: $h_x = h_x(\theta)$

Hazards can be force of mortality μ_x, intensity of incidence rate of disability i_x, lapse w_x, or reactivation r_x

Say force of mortality $\mu_x = \mu_x(\theta)$

Probability of surviving one year: $p_x = exp(-\int_0^1 \mu_{x+s} ds) = exp(-H_x(1))$

Probability of dying within one year: $q_x = 1 - p_x$

Likelihood of observing the survival time for all individuals: $L(\theta) = \prod {}_tp_x \, \mu_{x+t} d$

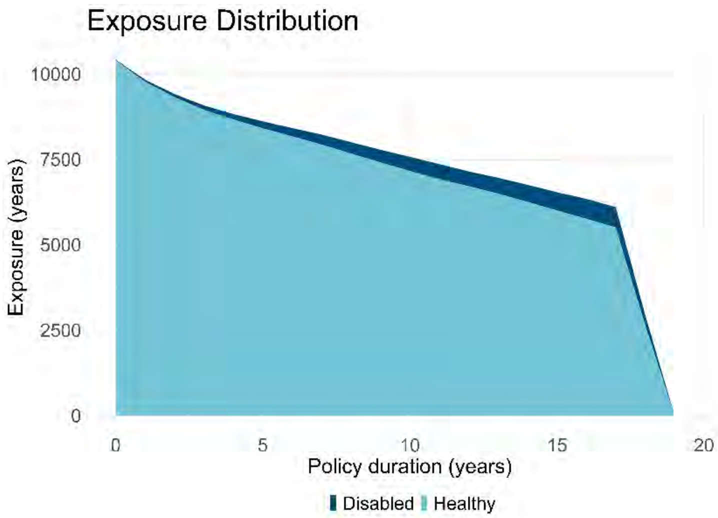
And this is the function we need to maximize: $log(L(\theta)) = -\sum_i H_{x_i}(t_i) + \sum_i d_i log(\mu_{x_i+t_i})$

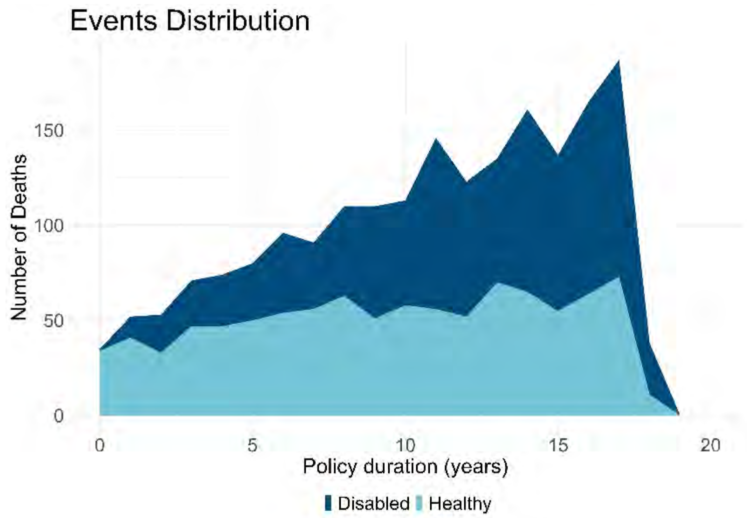
Where $d_i = \begin{cases} 1 \text{ Death } of\ i \\ 0 \text{ Otherwise} \end{cases}$

LTC Portfolio Modelled

Experience data is used to calibrate models

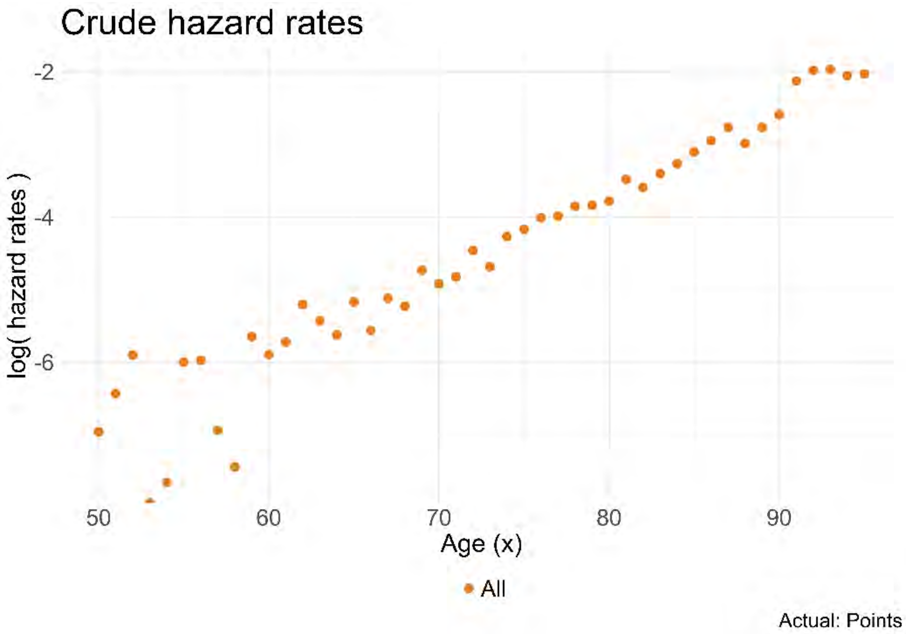
- 15+ years of experience data and thousands of observed deaths → reasonable credibility





Crude Death Rates

Crude death rates indicate log-linear mortality hazard

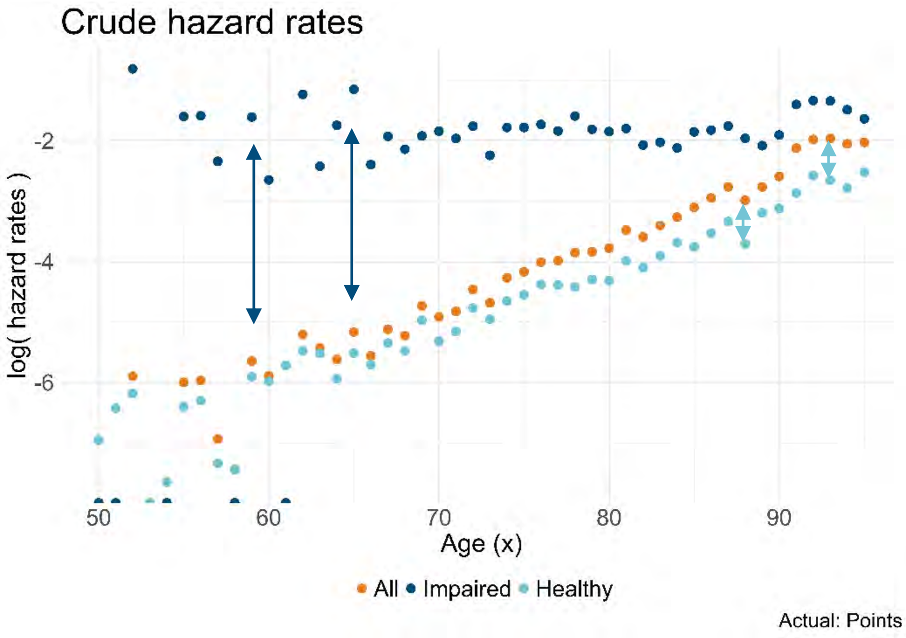


Hazard Rates:

$$m_x = {Deaths_x}/{E_x^{central}}$$

Crude Death Rates

Mortality of impaired markedly higher



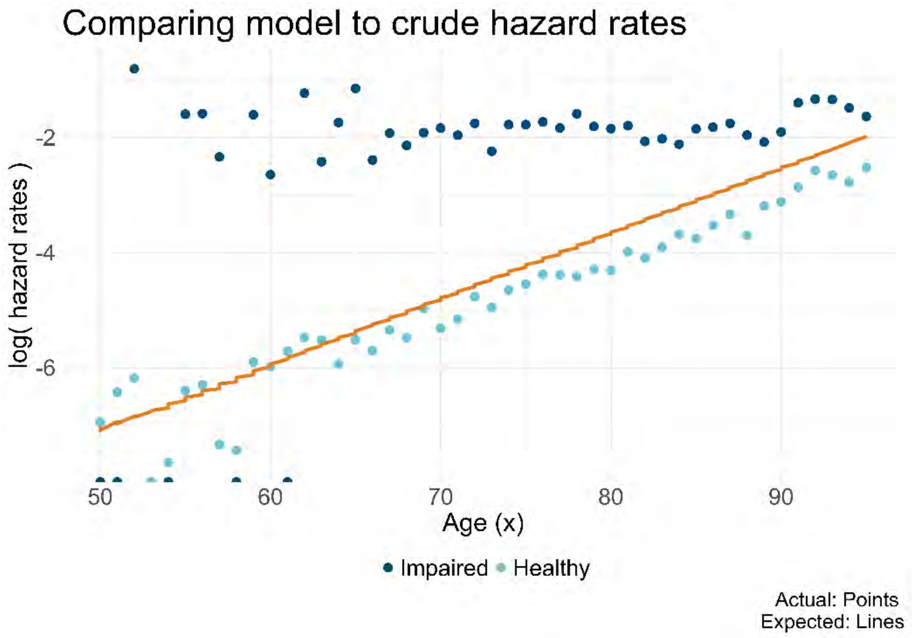
Hazard Rates:

$$m_x = {Deaths_x}\Big/{E_x^{central}}$$

$$I_{disabled} = \begin{cases} 1 & \text{Impaired} \\ 0 & \text{Healthy} \end{cases}$$

Proposed Model (1)

A single model misses sub-populations of healthy/disabled



Hazard Rates:

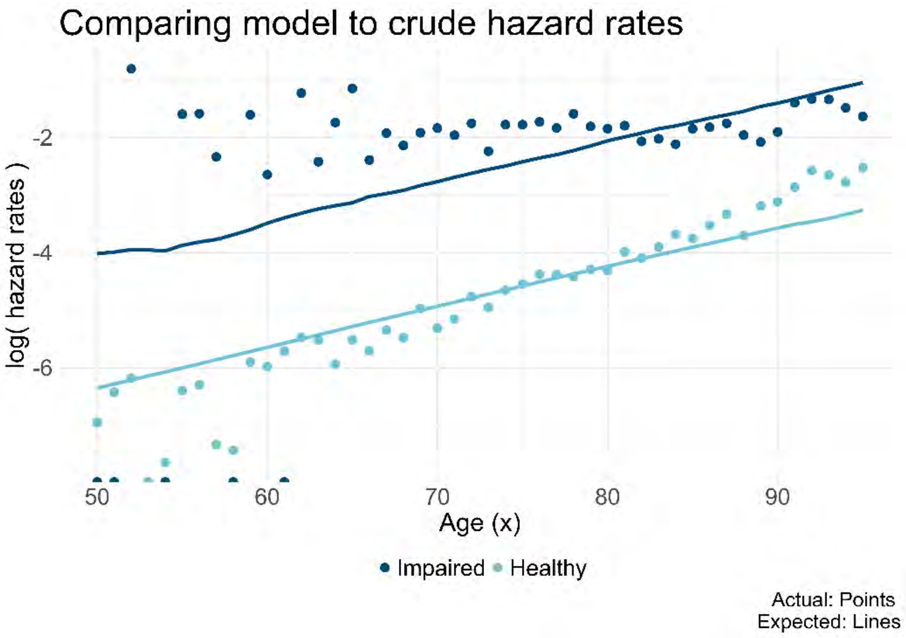
$$m_x = \frac{Deaths_x}{E_x^{central}}$$

$$m_x = e^{\alpha + x*\beta}$$

$$\ln(m_x) = \alpha + x*\beta$$

Proposed Model (2)

Separate mortality for sub-populations – improves fit



Model with main effect:

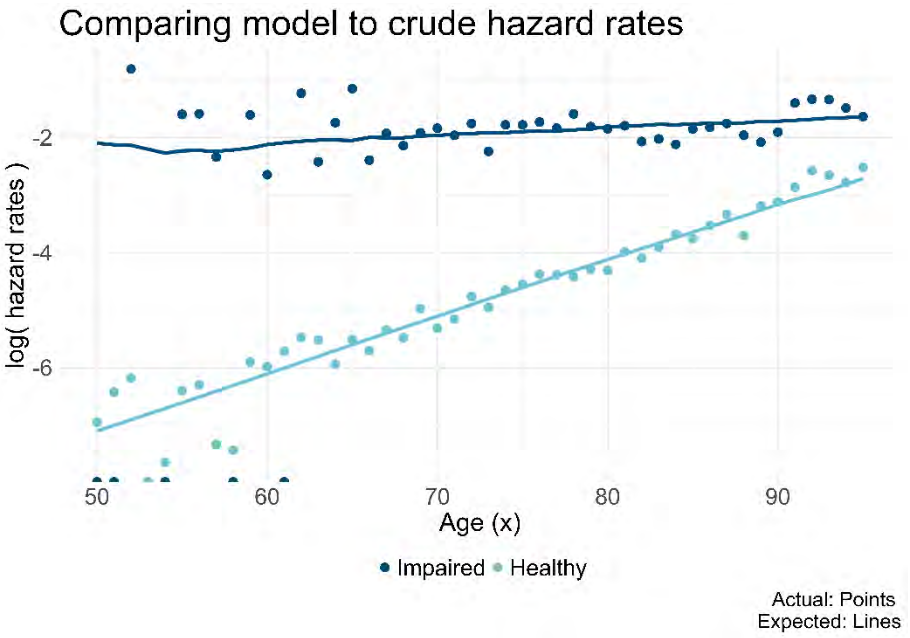
$$\ln(m_x) = \alpha + x * \beta$$

$$+ \alpha_{disabled} * I_{disabled}$$

Where $I_{disabled} = \begin{cases} 1 & \text{Impaired} \\ 0 & \text{Healthy} \end{cases}$

Proposed Model (3)

Best fitting model – separates for sub-populations

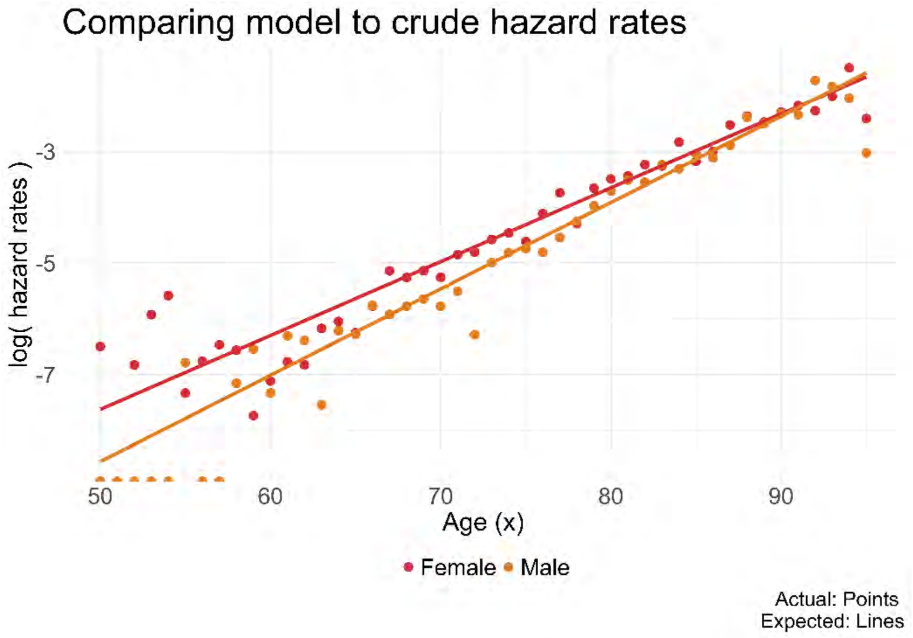


Model with main effect and age interaction:

$$\ln(m_x) = \alpha + x * \beta + (\alpha_{disabled} + x * \beta_{disabled}) * I_{disabled}$$

Disability Incidence Rate Modelling

Similar model is fitted to morbidity incidence



Hazard Rates:

$$i_x = {Disablements_x}/{E_x^{central}}$$

$$\ln(i_x) = \alpha + \alpha_{male} I_{male}$$
$$+ (\beta + \beta_{male}\, I_{male})x$$

Where $I_{male} = \begin{cases} 1 & \text{Male} \\ 0 & \text{Female} \end{cases}$

Worked Case Study & Results

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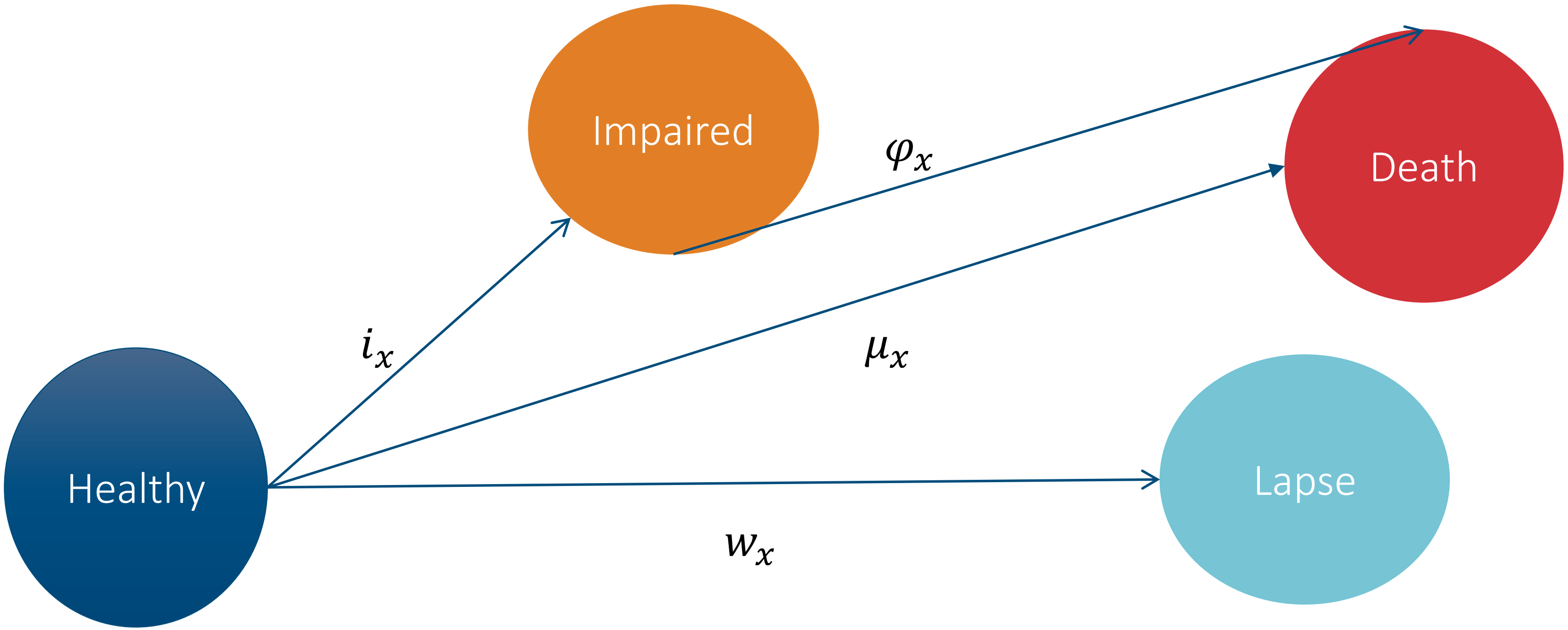
Multiple Decrement Model

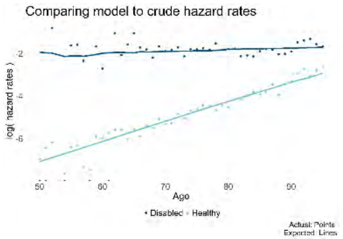


ADB Projected Benefit Cost

Key Assumptions

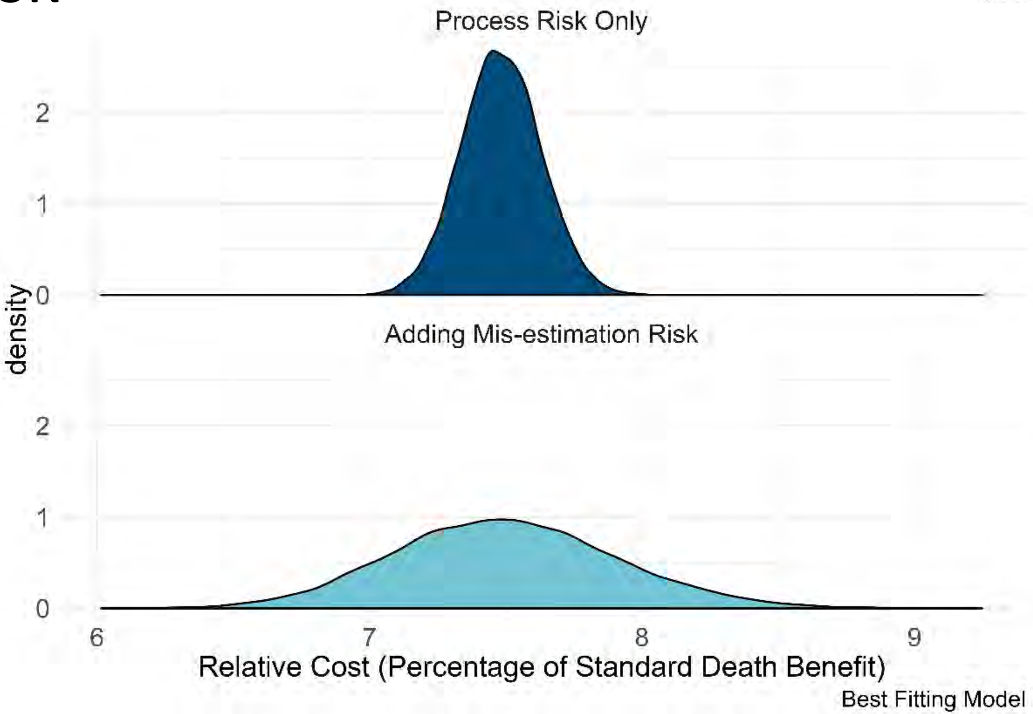
- ADB on a 4BR basis → cost of rider reflects the average time that benefits are accelerated for impaired lives
- 3% interest rate
- Incidence of morbidity
- Mortality of healthy lives
- Mortality of disabled lives
- Lapses
- Portfolio of LTC policies modelled

Multi-State Modelling & Simulations – "Best Model"

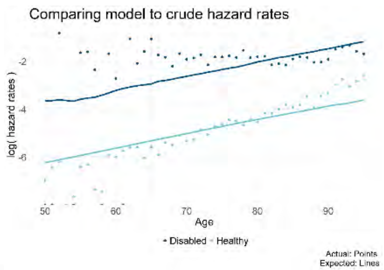


Process & Parameter Risk

- The preferred approach relies on detailed data to calibrate models
- We get a range for the relative cost of the rider
- A wider range results when allowing for the credibility of portfolio specific experience data

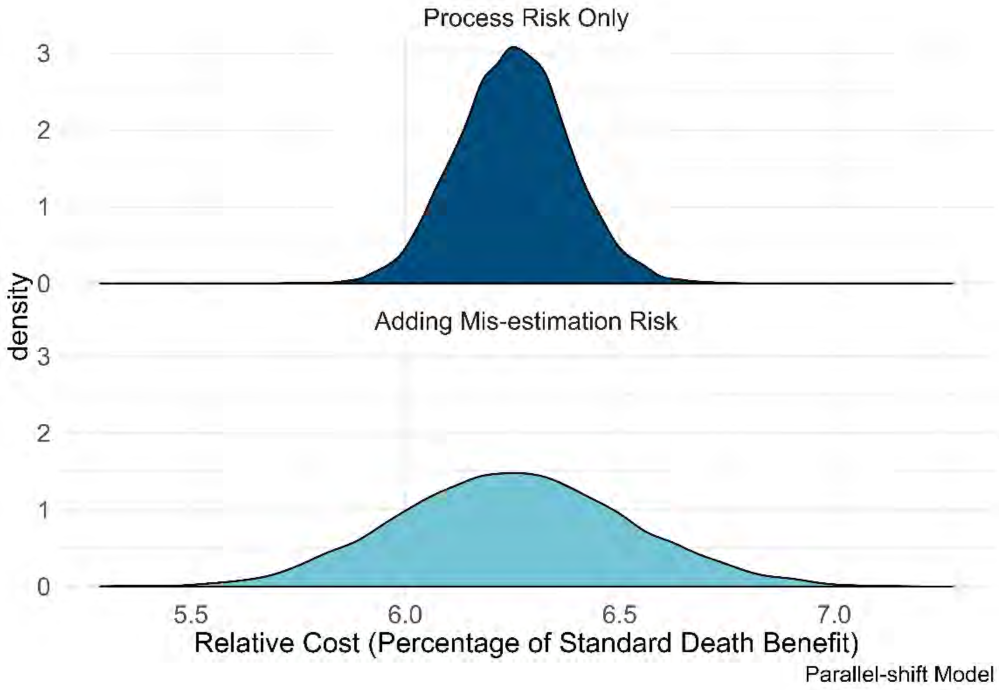


Multi-State Modelling & Simulations – “Intermediate Model”



Process & Parameter Risk & Model risk (1)

- The estimated relative cost of the benefit is lower than the best fitting model
- Actuarial judgement for model selection is a key determinant of the relative cost of this benefit
- The model that is a poorer fit to the experience data is more likely to result in underpricing of the ADB ~ less accurate



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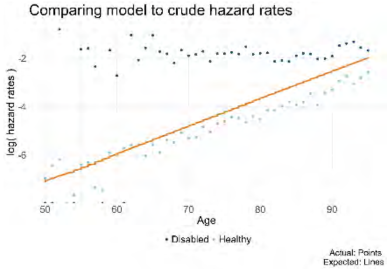
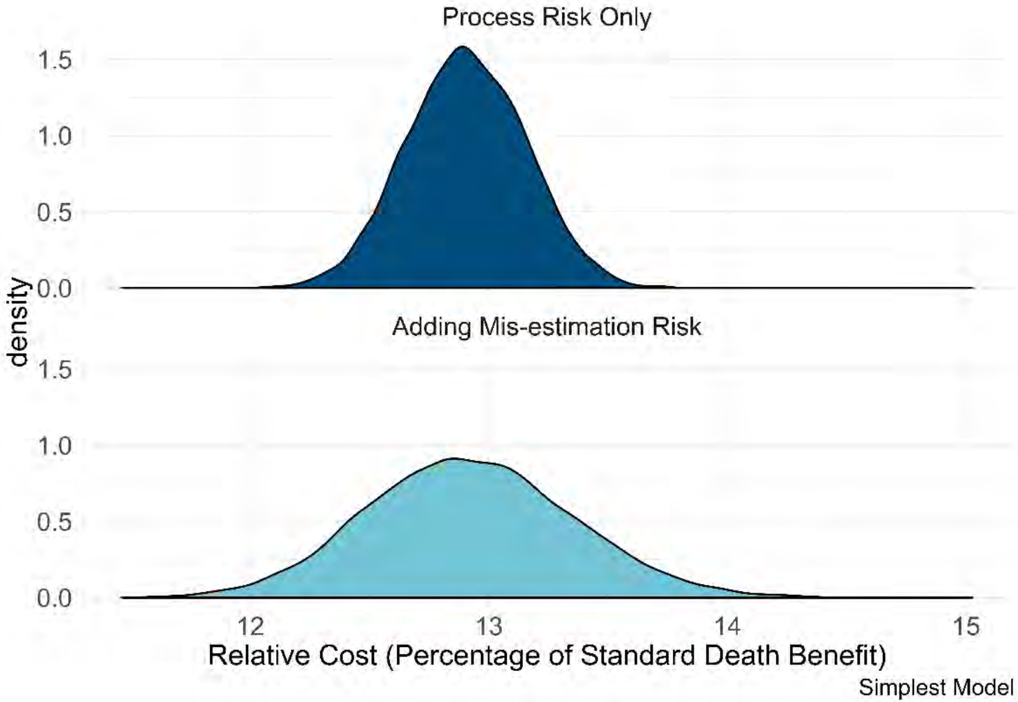
Multi-State Modelling & Simulations – “Inadequate Model”



Process & Parameter Risk & Model risk (2)

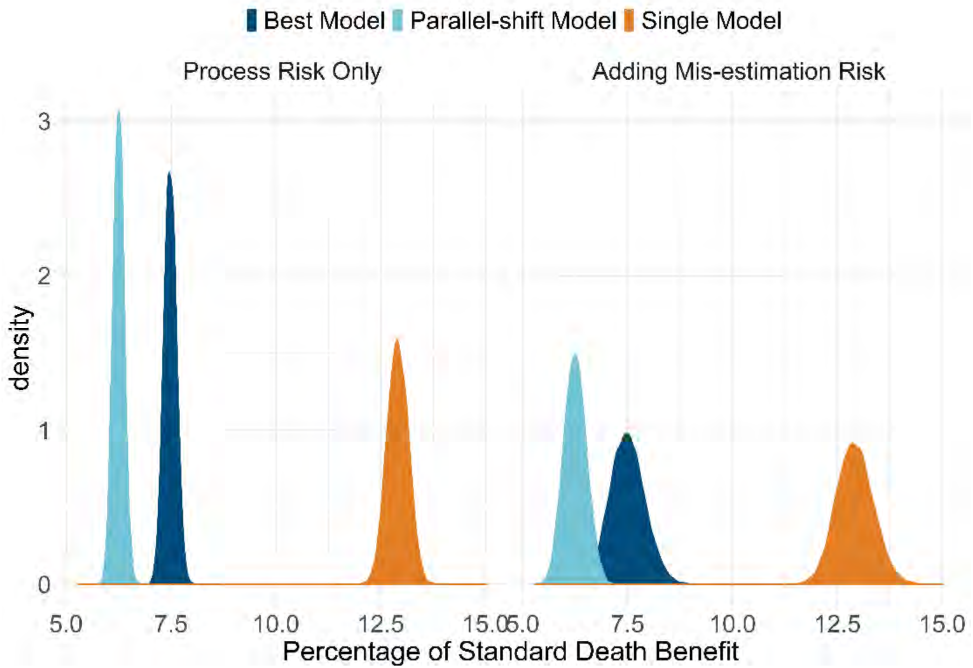
- Estimated relative cost for rider is markedly higher
- Highlighting the importance of appropriate judgement in model selection
- This judgement is informed by the availability of credible data and relevant research



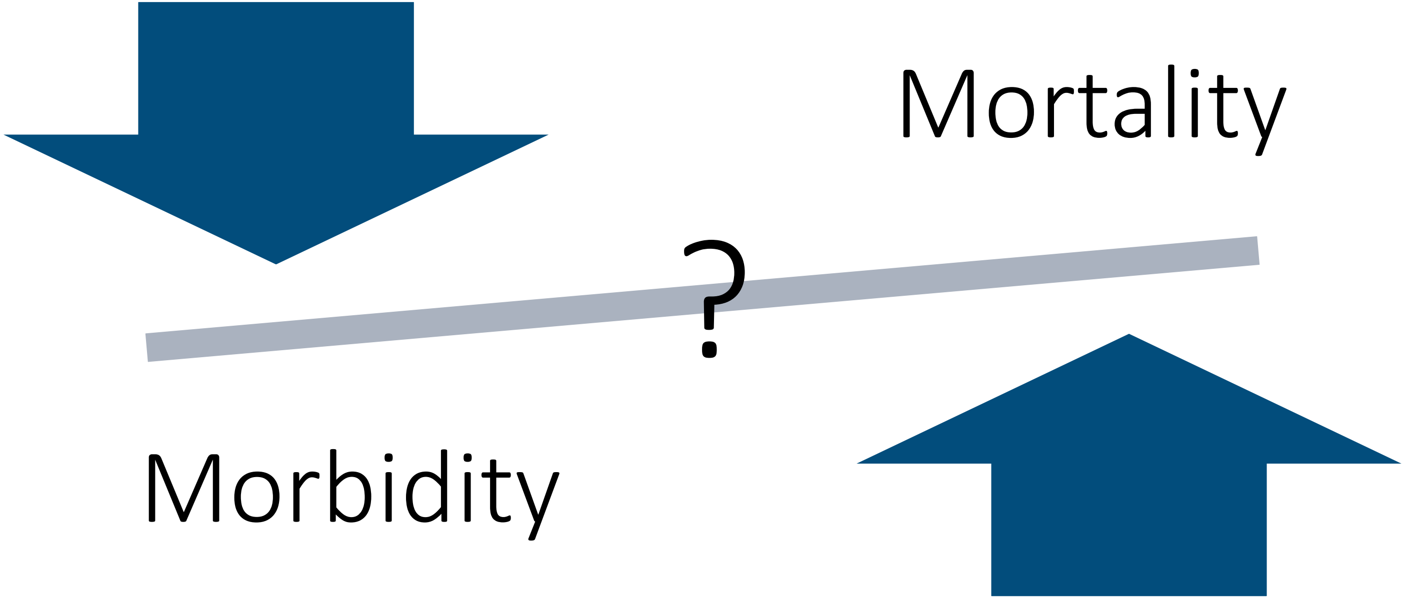
Process & Parameter Risk & Model risk (3)

- In summary → better fitting models will give more accurate pricing result

- Model selection → data/research inform appropriate model selection



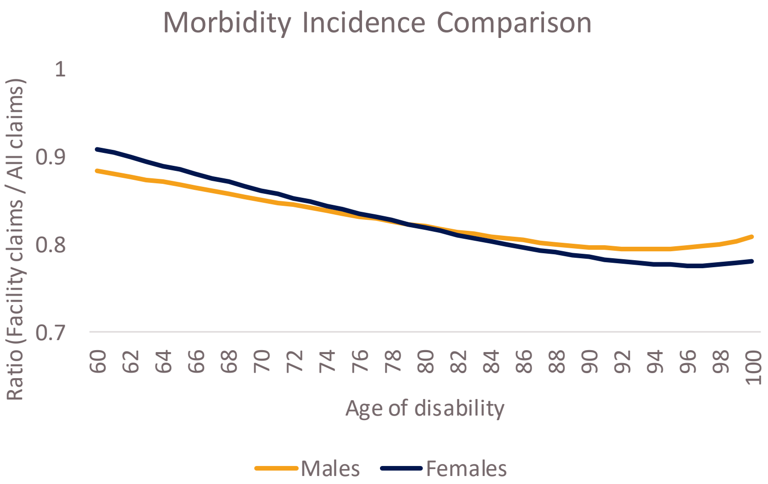
Consistent Basis

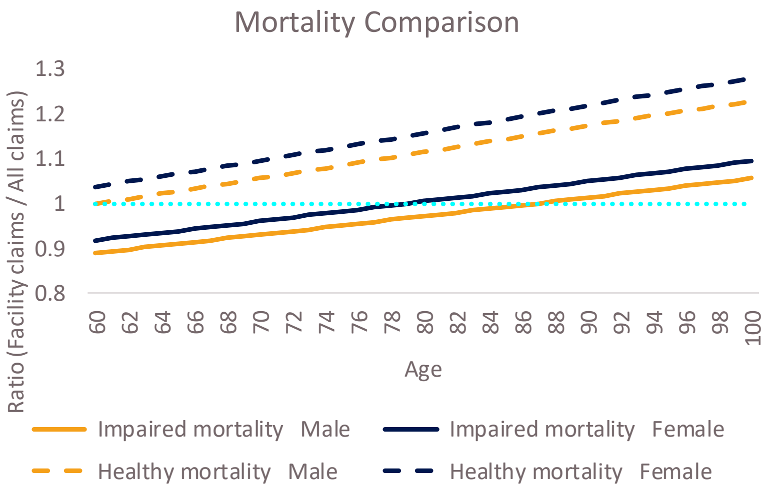


Mortality and morbidity are associated

Stricter morbidity definition reduces incidence

- Limiting to only facility claims lowers the incidence of morbidity
- Impact on mortality varies by age and for the healthy vs. impaired

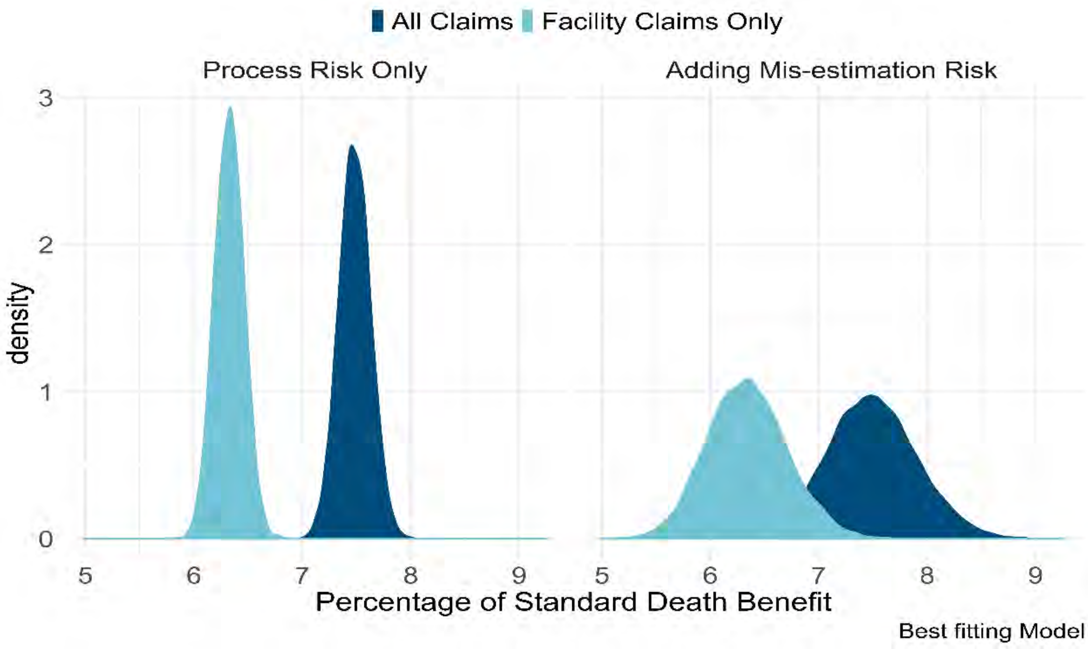




Impairment definitions vary and impact incidence of morbidity and mortality

Altering impairment definition consistently - experience data

- Effect on mortality is mixed across ages
- 4BR benefit sensitive to incidence of morbidity



ADB Projected Benefit Cost

Key Assumptions Using Industry Data

- ADB on a 4BR basis
- 3% interest rate
- Incidence of morbidity → SOA LTC 2015 study
- Standard Mortality Basis → Unismoke VBT 2015 Mortality Rates
- Mortality of disabled lives → Standard Mortality Basis - with a percentage loading
- Mortality of healthy lives → Solved to conserve the number of deaths at each age, given the above
- Lapses → Whole Life Insurance Lapse Experience (Experience Period 2009-2013)
- Portfolio of LTC policies modelled

Modelling Conserved Deaths

Varying Impaired Mortality

- Increasing the impaired mortality has limited impact on the total benefits paid to impaired lives (under fixed incidence assumption) **timing of payment
- The concomitant decrease in the healthy mortality results in lower cost of providing the benefit to modelled healthy lives

→ Supposing that total mortality is conserved requires a dynamic link between mortality the incidence of morbidity for consistency

→ This requires large/credible data to model the dynamic interactions realistically

Impaired Mortality Loading	Relative Cost of ADB Rider
None	16.8%
200%	11.2%
500%	9.7%

***Based on the portfolio of lives from the worked example

Modelling Conserved Deaths

Varying Incidence & Impaired Mortality

- Simply reducing the incidence by 20% reduces the relative cost of the rider to 6.6% (or by 32%)

  → This highlights that the 4BR structure is sensitive to the incidence assumption

  → The interaction between the impaired mortality loading and the incidence assumption is apparent

Impaired Mortality Loading	Relative Cost of ADB Rider			Change in Cost
	SOA Study Incidence	Incidence reduced to 90% of SOA Study	Incidence reduced to 80% of SOA Study	Based on 20% Incidence Reduction
None	16.8%	15.4%	14.0%	-16.7%
200%	11.2%	9.8%	8.5%	-24.1%
500%	**9.7%**	8.1%	**6.6%**	**-32.0%**

Modelling Conserved Deaths

Mortality Trends

- Mortality of the impaired depends on the definition of morbidity
- Trends in mortality of impaired may deviate from those of the population (**more research required to inform consistent assumption basis)

Thank you!
Questions?

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