Session 025: Post Level Term: Lapse and Mortality Risk Considerations

SOA Antitrust Compliance Guidelines
SOA Presentation Disclaimer

2019 ANNUAL MEETING & EXHIBIT

Session 25: Post Level Term: Lapse and Mortality Risk Considerations

Katherine McLaughlin, FSA, MAAA
Aisling Bradfield, FIA
Patrick Davidson, ASA, CERA
Laura Muse, FSA, MAAA

October 28, 2019

SOCIETY OF ACTUARIES®

SOCIETY OF ACTUARIES
Antitrust Compliance Guidelines

Active participation in the Society of Actuaries is an important aspect of membership. While the positive contributions of professional societies and associations are well-recognized and encouraged, association activities are vulnerable to close antitrust scrutiny. By their very nature, associations bring together industry competitors and other market participants.

The United States antitrust laws aim to protect consumers by preserving the free economy and prohibiting anti-competitive business practices; they promote competition. There are both state and federal antitrust laws, although state antitrust laws closely follow federal law. The Sherman Act, is the primary U.S. antitrust law pertaining to association activities. The Sherman Act prohibits every contract, combination or conspiracy that places an unreasonable restraint on trade. There are, however, some activities that are illegal under all circumstances, such as price fixing, market allocation and collusive bidding.

There is no safe harbor under the antitrust law for professional association activities. Therefore, association meeting participants should refrain from discussing any activity that could potentially be construed as having an anti-competitive effect. Discussions relating to product or service pricing, market allocations, membership restrictions, product standardization or other conditions on trade could arguably be perceived as a restraint on trade and may expose the SOA and its members to antitrust enforcement procedures.

While participating in all SOA in person meetings, webinars, teleconferences or side discussions, you should avoid discussing competitively sensitive information with competitors and follow these guidelines:

- Do not discuss prices for services or products or anything else that might affect prices
- Do not discuss what you or other entities plan to do in a particular geographic or product markets or with particular customers.
- Do not speak on behalf of the SOA or any of its committees unless specifically authorized to do so.
- Do leave a meeting where any anticompetitive pricing or market allocation discussion occurs.
- Do alert SOA staff and/or legal counsel to any concerning discussions
- Do consult with legal counsel before raising any matter or making a statement that may involve competitively sensitive information.

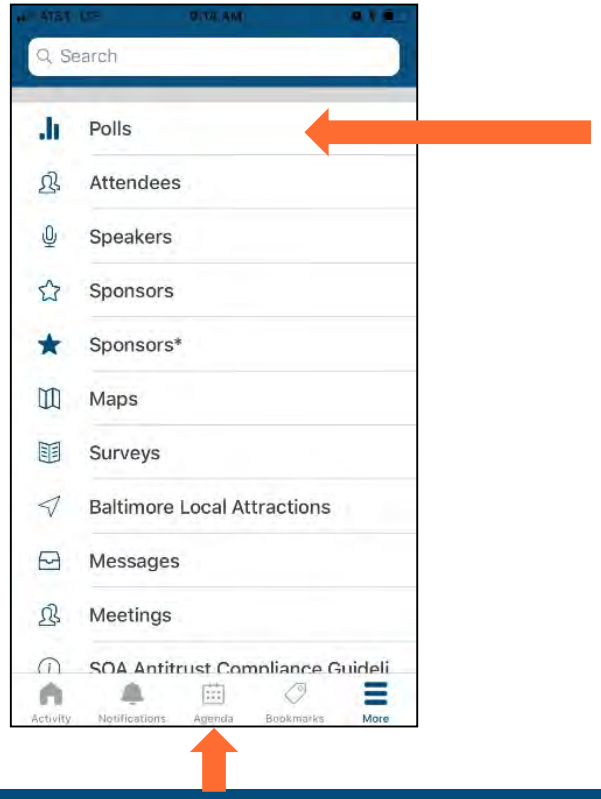
Adherence to these guidelines involves not only avoidance of antitrust violations, but avoidance of behavior which might be so construed. These guidelines only provide an overview of prohibited activities. SOA legal counsel reviews meeting agenda and materials as deemed appropriate and any discussion that departs from the formal agenda should be scrutinized carefully. Antitrust compliance is everyone's responsibility; however, please seek legal counsel if you have any questions or concerns.

Presentation Disclaimer

Presentations are intended for educational purposes only and do not replace independent professional judgment. Statements of fact and opinions expressed are those of the participants individually and, unless expressly stated to the contrary, are not the opinion or position of the Society of Actuaries, its cosponsors or its committees. The Society of Actuaries does not endorse or approve, and assumes no responsibility for, the content, accuracy or completeness of the information presented. Attendees should note that the sessions are audio-recorded and may be published in various media, including print, audio and video formats without further notice.

To Participate, look for Polls in the SOA Event App or visit **annual.cnf.io** in your browser

Find The Polls Feature Under **More** In The Event App or Under This Session in the Agenda



or

Type **annual.cnf.io** In Your Browser

Live Content Slide

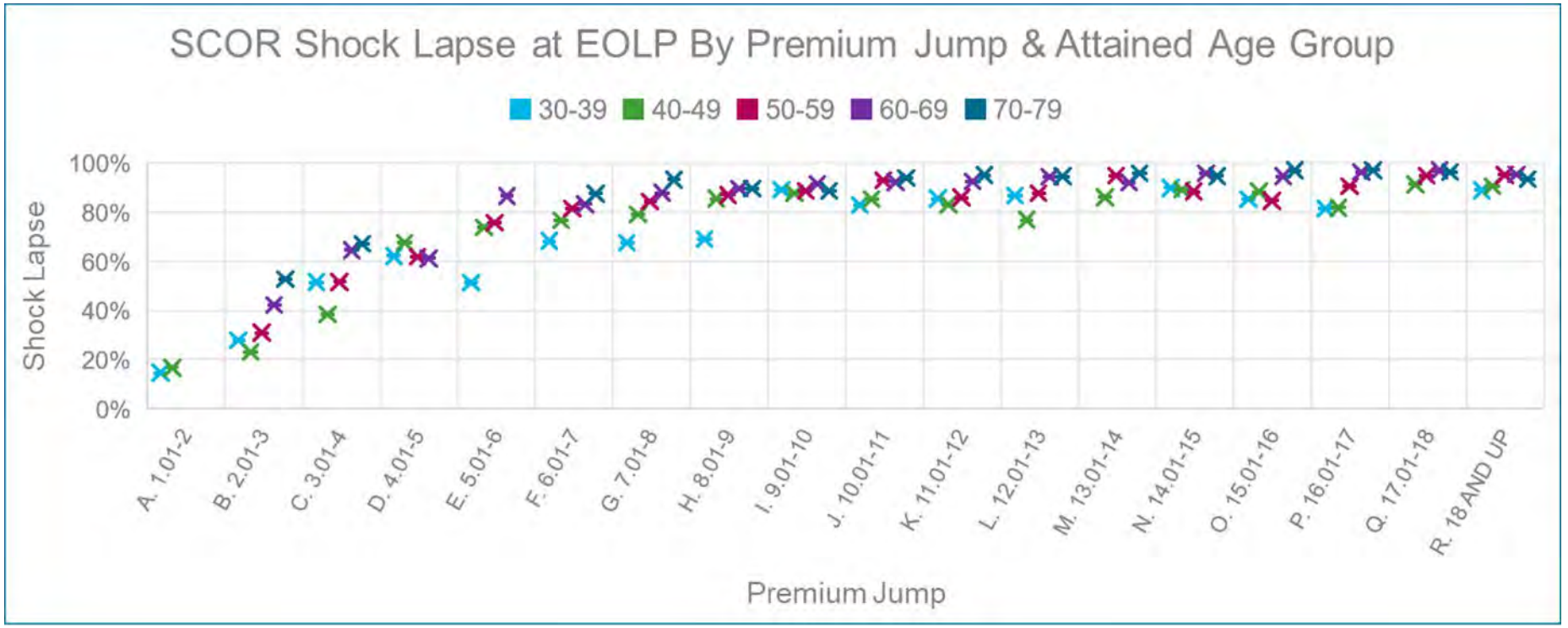
When playing as a slideshow, this slide will display live content

Poll: Who's in the room?

Statistical Modelling for PLT Lapse & Mortality

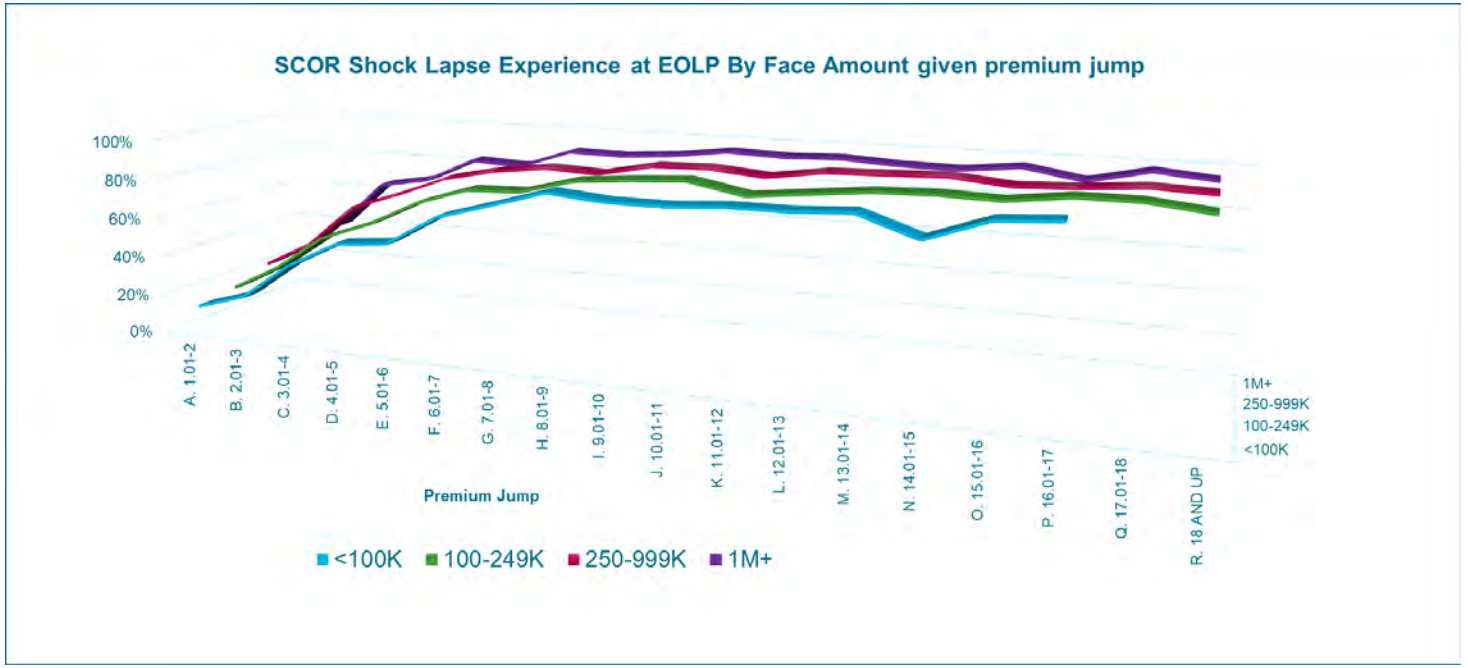
- Shock lapse modelling using GLM
- Subsequent PLT lapse modelling
- Considerations when modelling PLT Graded structures
- Advanced Analytics and alternative approaches to lapse modelling
- PLT mortality modelling

Shock lapse at end of term



- Higher shock lapse for higher premium jump
- Increasing pattern by age
- Significant age variation at lower premium jumps

Shock lapse at end of term



- Face amount variation evident even within premium jump groups
- Higher shock lapse for higher face amount policies
- Larger dollar increase for the same relative jump

Identified potential to vary the PLT assumptions by more factors, in addition to premium jump

Shock Lapse Variable Selection

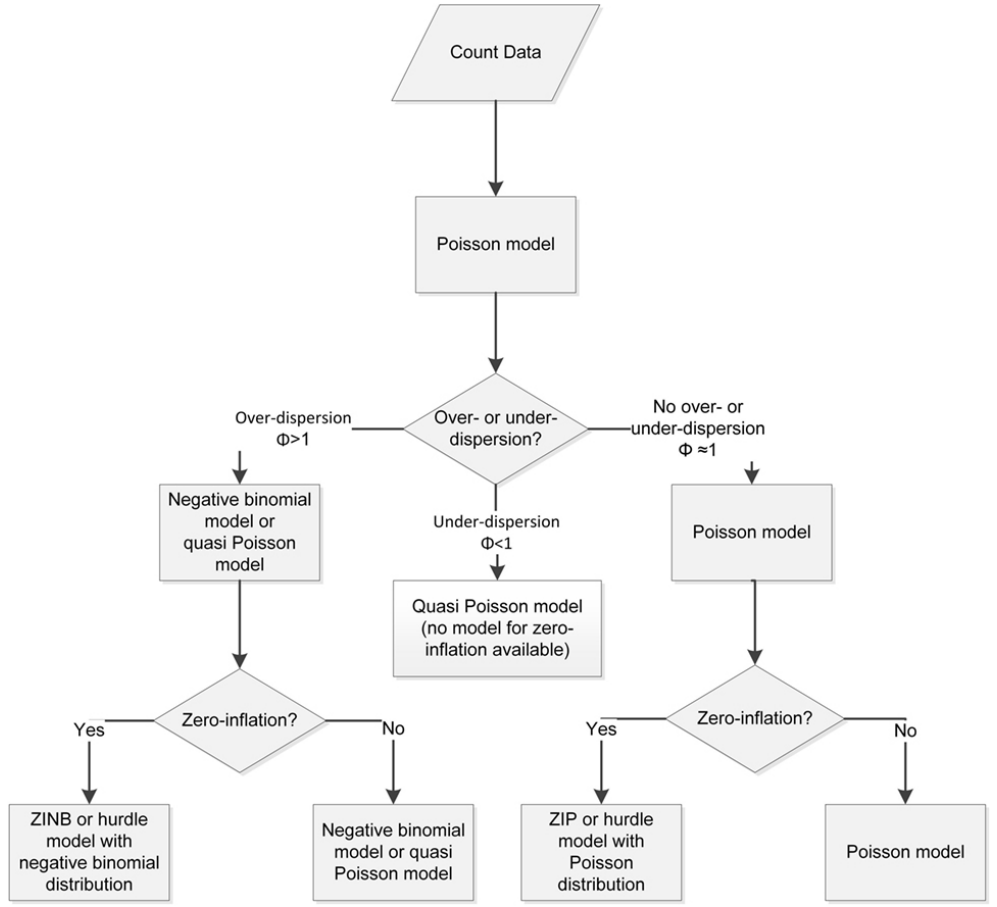
- Variable selection for “best” subset of predictors
- Mallows Cp criterion is minimized to find the most precise model
- Premium jump ratio is the most significant variable
  - Does not provide the full picture
- Also important :
  - Attained age
  - Face Amount
  - Risk Class
- Interaction terms with premium jump are considered
  - Gender is more significant as an interaction term

Interaction terms form the proxy for absolute premium jump in USD terms

Building a Predictive Model

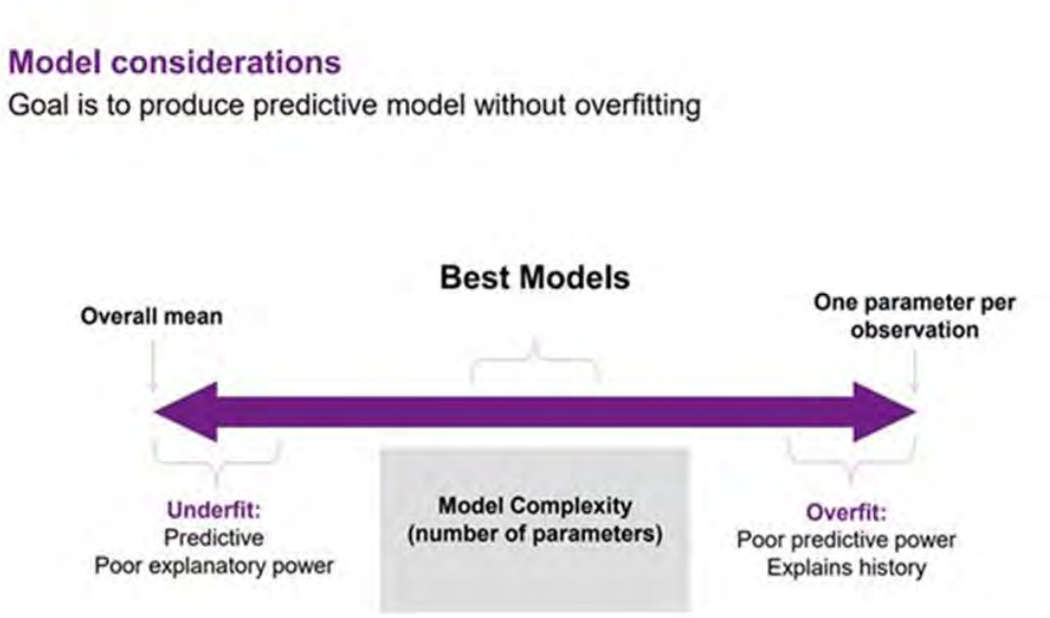
Predictive Model for Shock Lapse at PLT

- Using shock lapse experience data on counts basis, a GLM predictive model is built
- Generalized Linear Model (GLM)
- Poisson model suitable for counts
- Overdispersion: the variance of the response variable exceeds the mean
- Quasi Poisson Regression Model is used



Source: A Comparative Approach to Identify an Appropriate Regression Model for Count Data: https://pdfs.semanticscholar.org/8ab1/829f559b869eeb48e38f15c5d94dc957a0f5.pdf

Optimal model



Quality measures for statistical models

- Consider additional variable until all shock lapse variation is explained
- Akaike information criterion (AIC) and Bayesian Information Criterion (BIC) are useful tools
  - The model with the lowest AIC/BIC is the best fit
  - If adding an additional variable does not reduce AIC/BIC, the variable does not add further explanation of the lapse rates.
- Iterations required to find the optimal model

Predictive Model – Autoregression for later durations

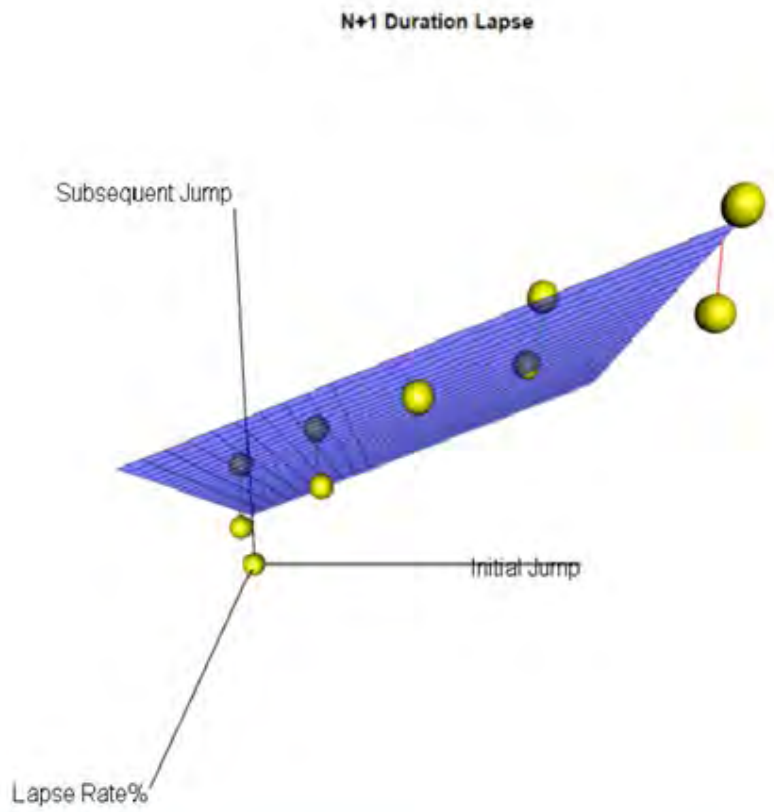
- Premium jump at end of term becomes less relevant at later durations
  - Yet initial jump still accounts for the most significant portion of premium
  - Subsequent increase are annual age-rated increases
- At later durations, credibility by premium jump bucket is reduced
  - Especially for higher premium jumps, higher initial shock lapse
- Autoregressive model was built where the initial shock lapse is an explanatory variables

AR(1) process (**AutoRegressive**):

$$X_t = \phi X_{t-1} + W_t, \qquad \{W_t\} \sim WN(0, \sigma^2)$$

- The auto-regressive model predicts lapse at each subsequent duration in PLT
  - Lapse rates at N+1, N+2, etc.

Subsequent lapse rates and premium jumps



- For other structures the subsequent premium increases are more important
- For Graded PLT structures, subsequent jumps tested as an explanatory variable
- For a Graded structure the subsequent duration lapses are significant, often the lapse in the first duration in PLT (N+1) can be almost as substantial as the end of term shock lapse
- The significant subsequent premium increase is a factor but also the initial premium increase remains an important aspect.
- Shown is a snapshot of lapses in N+1 duration and how this varies by initial and subsequent jump

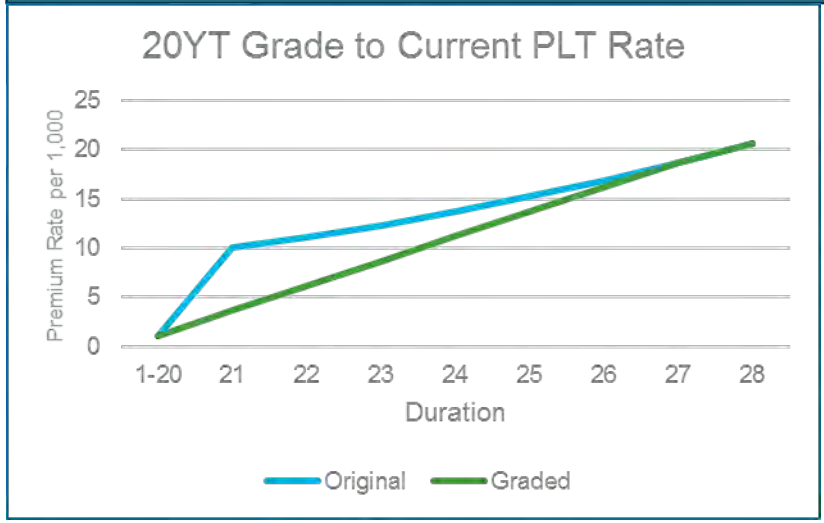
Live Content Slide

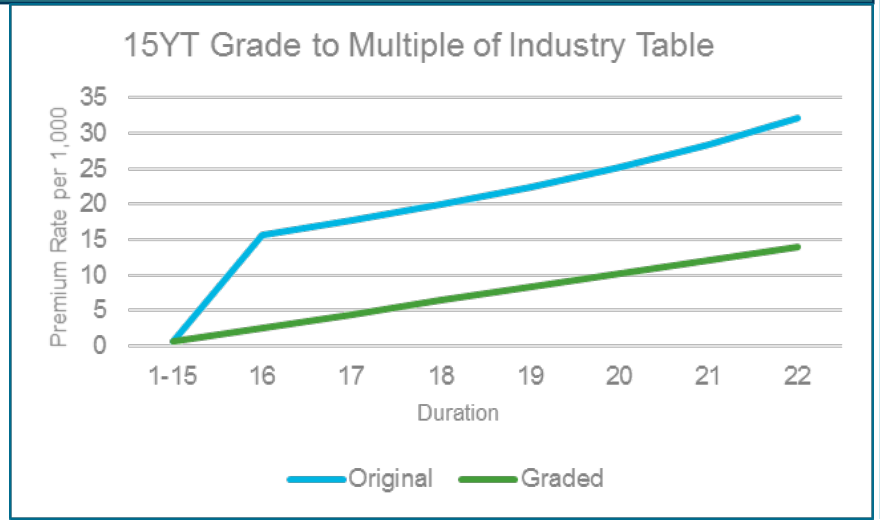
When playing as a slideshow, this slide will display live content

Poll: How would you describe your company's PLT strategy?

Modelling considerations for PLT Graded Structures

Switching from Jump to ART to Graded PLT





Various approaches

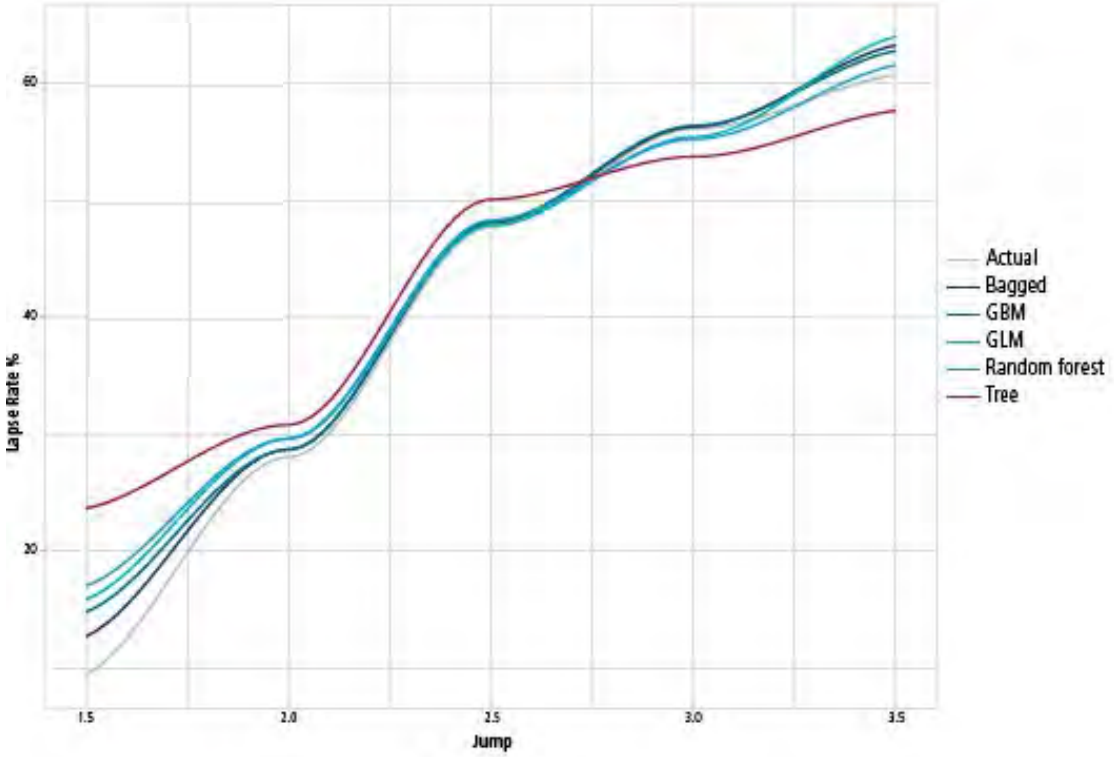
- Grading to original PLT rates
- Grade to multiple of industry table
- Number of years of grading vary 5 to 10years
- Jump to ART PLT rates were smoker/non-smoker; Graded PLT rates vary by UW class

- All of these factors impact the initial and subsequent premium jumps
- Lapse modelling may require additional variables, e.g., subsequent premium jumps
- Reassess relative importance of other factors

More advanced analytics for Shock Lapse Modelling

Decision tree algorithms

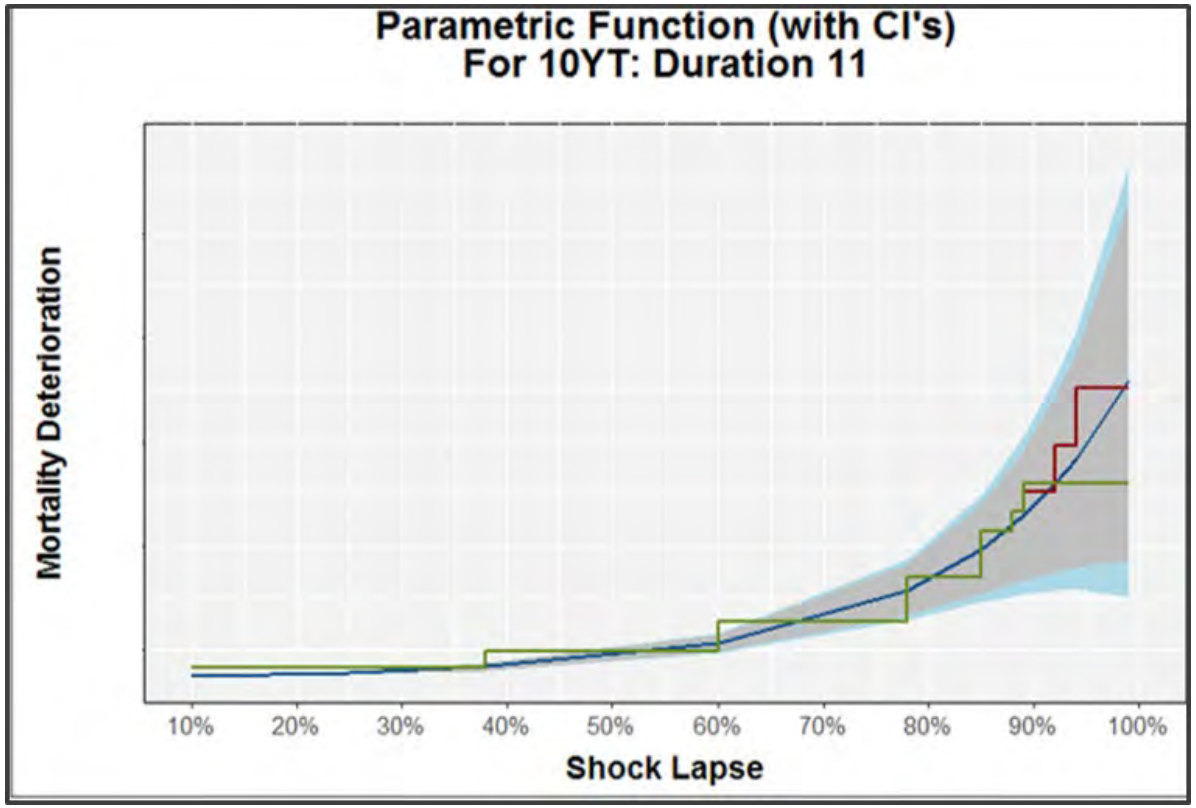
- CART classification and regression trees
- Recursive partitioning
- Main advantage is the flow chart like structure
  - Interpretability
- Risk of overfitting/overlearning
- **Tree-based ensemble** may overcome disadvantage
  - Bagging - Bootstrap AGGregatING
  - Random forests
  - GBM - Gradient Boosting Machine algorithm
- Interpretability is lost
  - Prediction path on a single tree is no longer possible



GLM and tree-based models seems to work comparably

Quantitative measures - the predictive performance and the computational time
Qualitative measures - interpretability and implementation

SCOR Mortality PLT Mortality Modelling



Difficulties with PLT mortality

- At highest shock lapses, note a wider confidence interval
  - Less claims, less credibility
- Mortality assumptions by premium jump groupings creates a stepped assumption
- Judgement required in setting the groupings
  - Does deterioration continue to step up after 90% shock lapse?
  - Green Vs Red line

Advantages of parametric function

- A continuous function – blue line example
- Links to shock lapse model

Mortality Deterioration Function Development

PLT mortality modelling & wear-off pattern

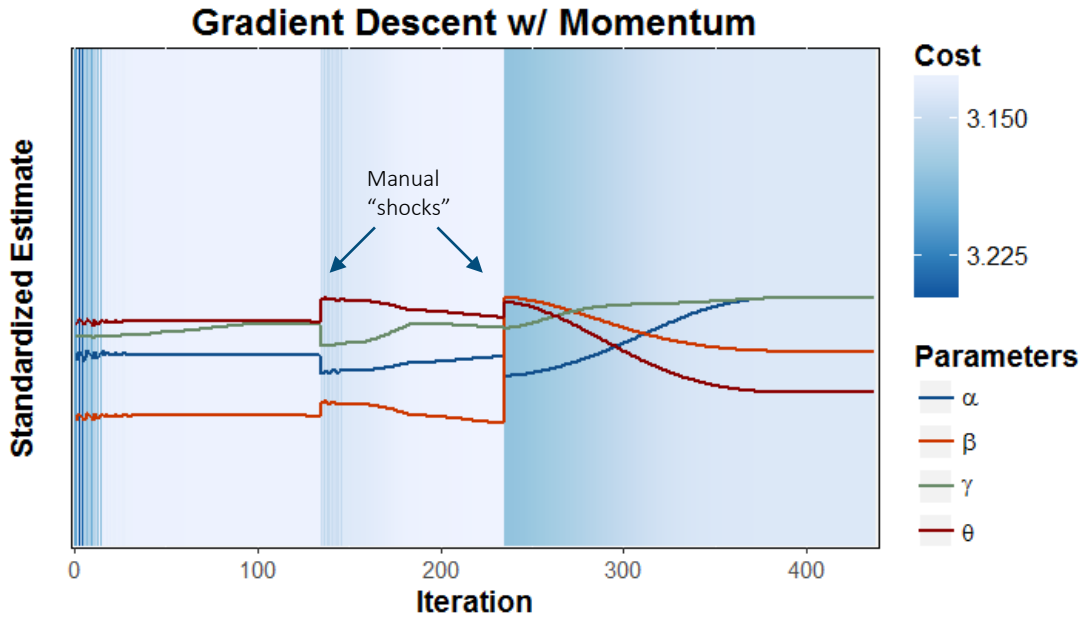
- Investigate PLT mortality by 2 variables: shock lapse rate and post level duration
- A non-linear pattern in the mortality behavior emerges
  - Traditional regression would not work

Parameter Estimation: Gradient Descent with Momentum

- Calibrated a function that fit the data using only the two input variables

Advantages:

- Strength for estimation on noisy parameter space
- Produces a continuous spectrum of outcomes
- Allows to model the fringes more accurately
- Momentum component allows the algorithm to search for multiple local minimums, an optimal parameter vector is more likely to be found



Source: http://distill.pub/2017/momentum

2019 ANNUAL MEETING & EXHIBIT

Post Level Term assumptions setting with Dukes-MacDonald

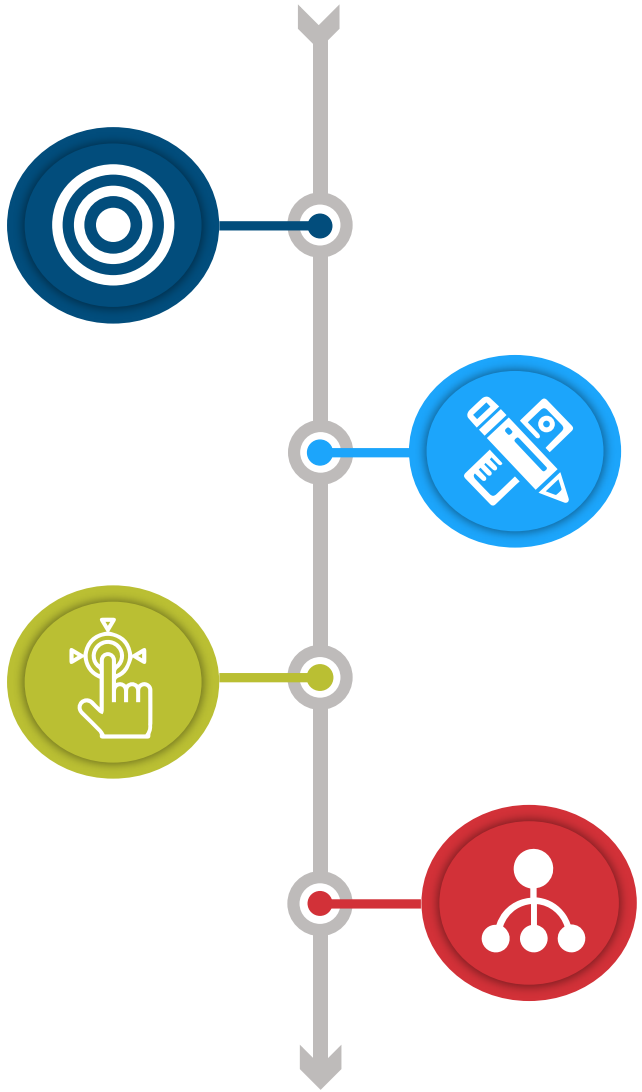
Patrick Davidson, ASA, CERA

Oliver Wyman

October 26, 2019

SOCIETY OF ACTUARIES®

Contents



Live Content Slide

When playing as a slideshow, this slide will display live content

Poll: Which PLT mortality deterioration methodology is used at your company?

Overview of Dukes-MacDonald mortality assumption

SOCIETY OF ACTUARIES®

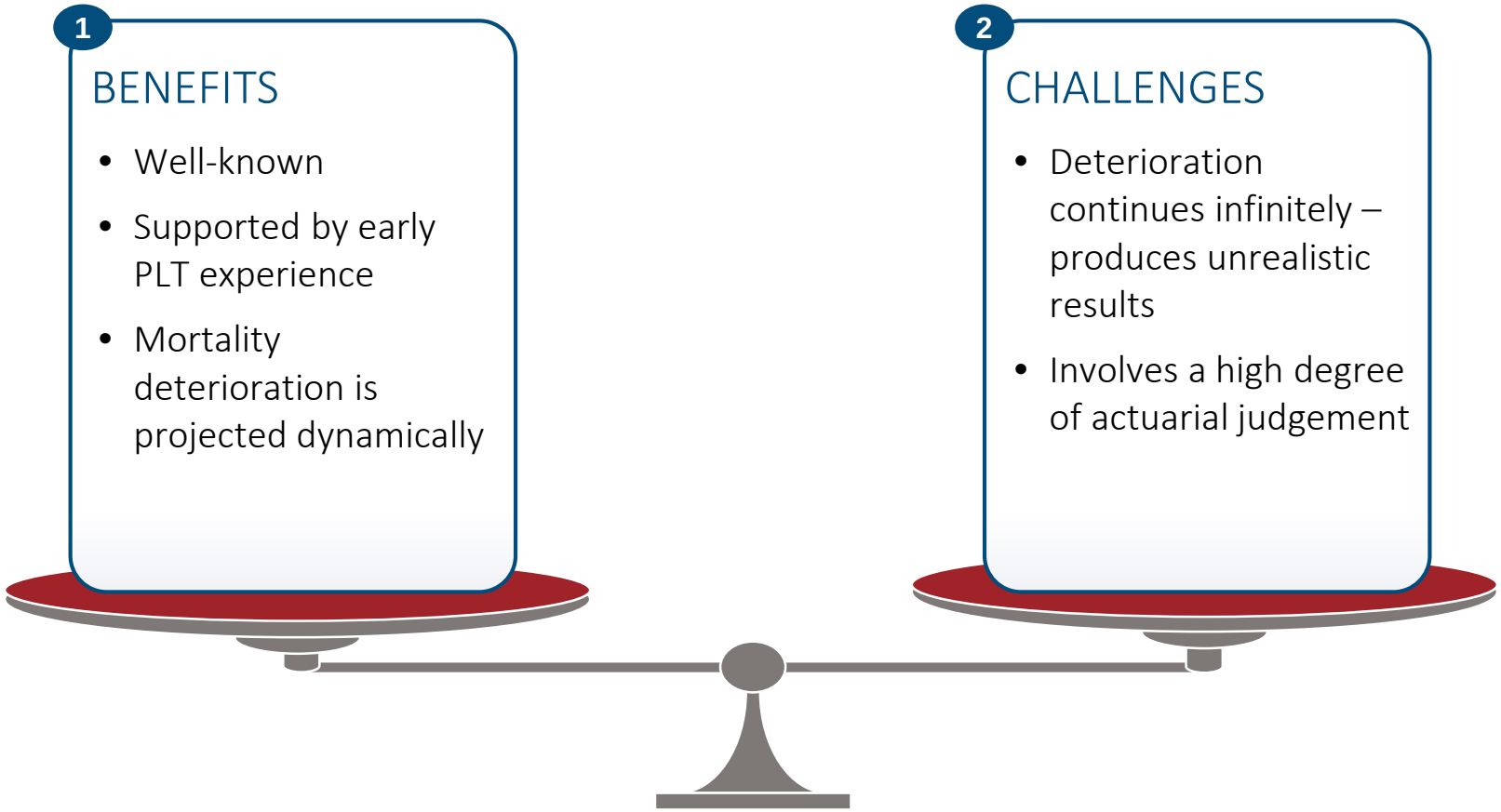
Dukes-MacDonald (D-M) mortality assumption

- Developed in 1980 by Jeffrey Dukes and Andrew M. MacDonald
- Mortality is deteriorated according to the principle of **conservation of deaths**
- Original methodology assumed that **100% of lapses** other than underlying are selective (D-M Type 1)
- Newer variations use the concept of **effectiveness**, i.e. some additional lapses are not selective (D-M Type 2)

Dukes-MacDonald framework

- Four groups of remaining lives in the PLT period:
  - Those who lapse with underlying mortality **("reverters")**
  - Those who lapse with newly select mortality **("effective lapsers")**
  - Those who lapse with average mortality **("non-effective lapsers")**
    - Ignored under Type 1 D-M
  - Those who don't lapse **("persisters")**
- Solve for the mortality of the persisters using **conservation of deaths**
  - Affected by:
    - Size of initial shock lapse
    - Effectiveness factor
    - D-M Type 1 versus D-M Type 2

Benefits and challenges



Illustrative examples of Dukes-MacDonald mortality deterioration

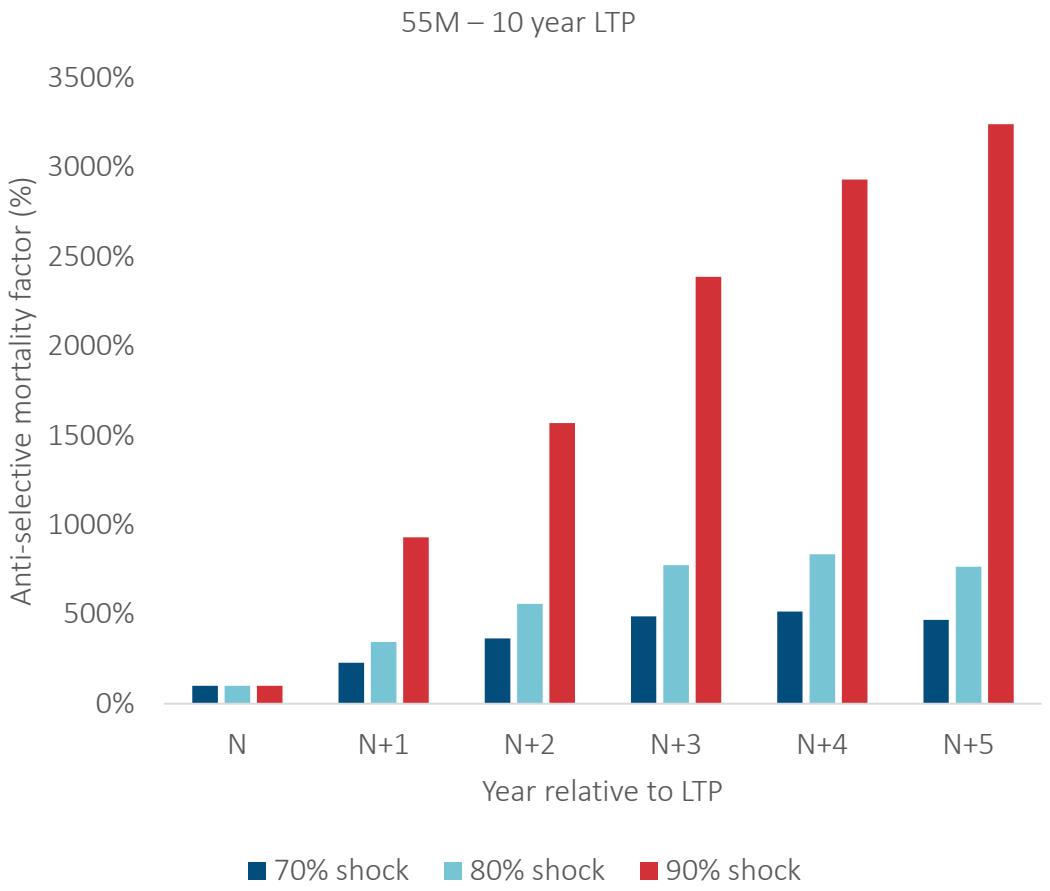
SOCIETY OF ACTUARIES®

Assumptions

- 55 year old male
- 10 year LTP
- Base mortality is 100% of 2015 VBT
- Base lapse rate of 5%
- 4-year excess shock lapse pattern of 70%/50%/30%/10%
- D-M Type 1
- 70% effectiveness factor

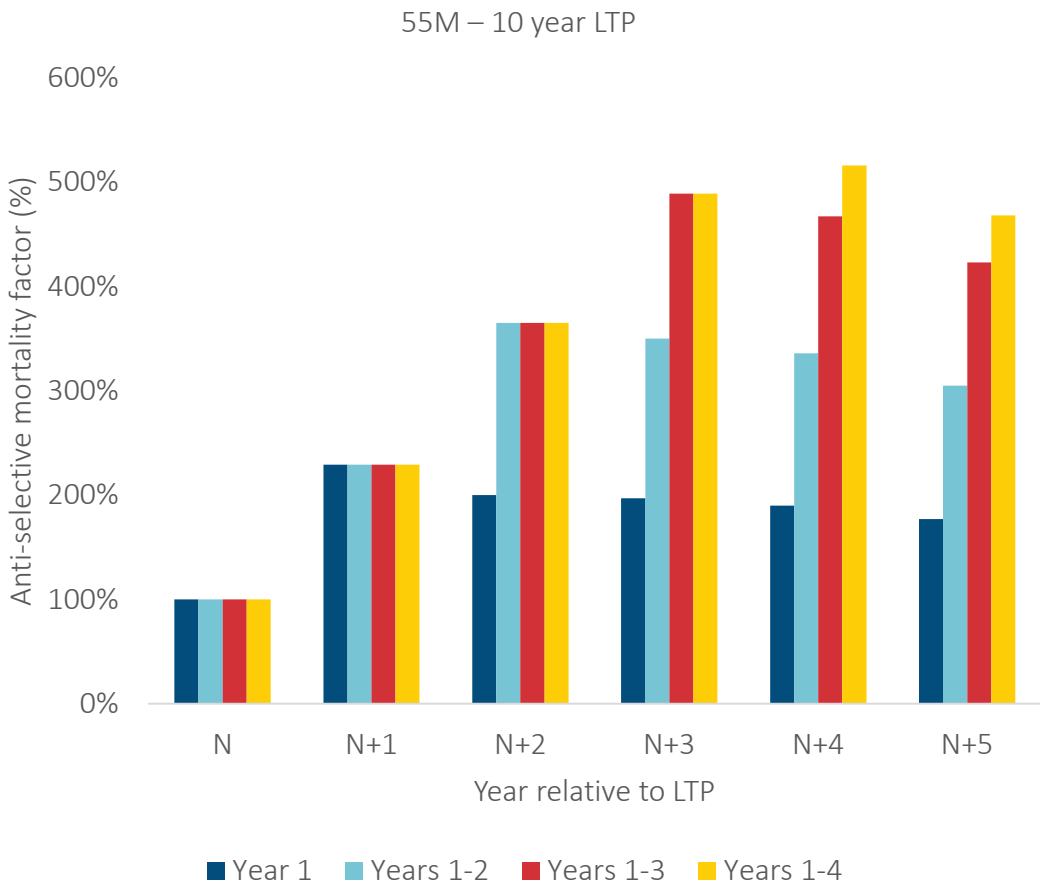
Size of shock lapse

- Mortality deterioration highly correlated with size of initial shock lapse
  - Secondary and tertiary shocks have smaller impacts
- Assumption should be set **holistically** in conjunction with size of premium jump and length of level term period



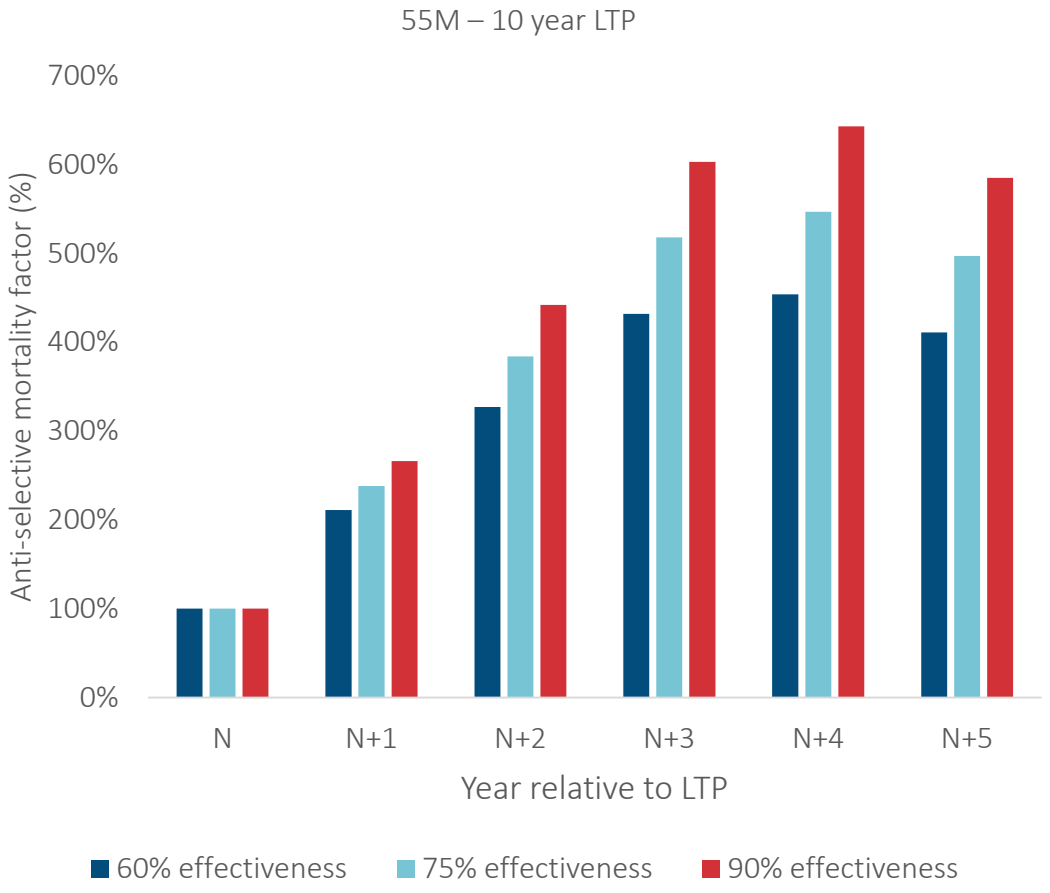
Infinite deterioration

- Caused by cumulative impact of shock lapses in PLT period
- Expected pattern is exhibited by initial shock lapse
  - Highest % difference in year n + 1
  - Grades down in later years
- Each future shock lapse in excess of the underlying lapse increases the amount of deterioration

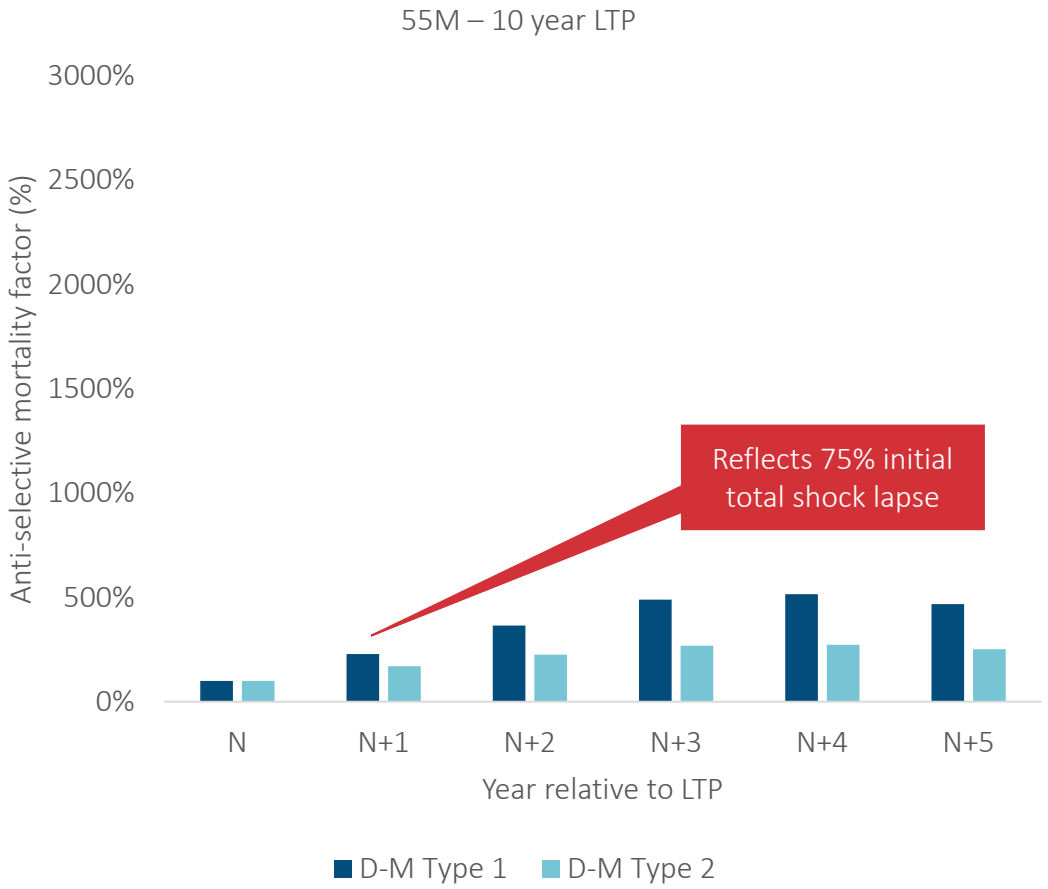


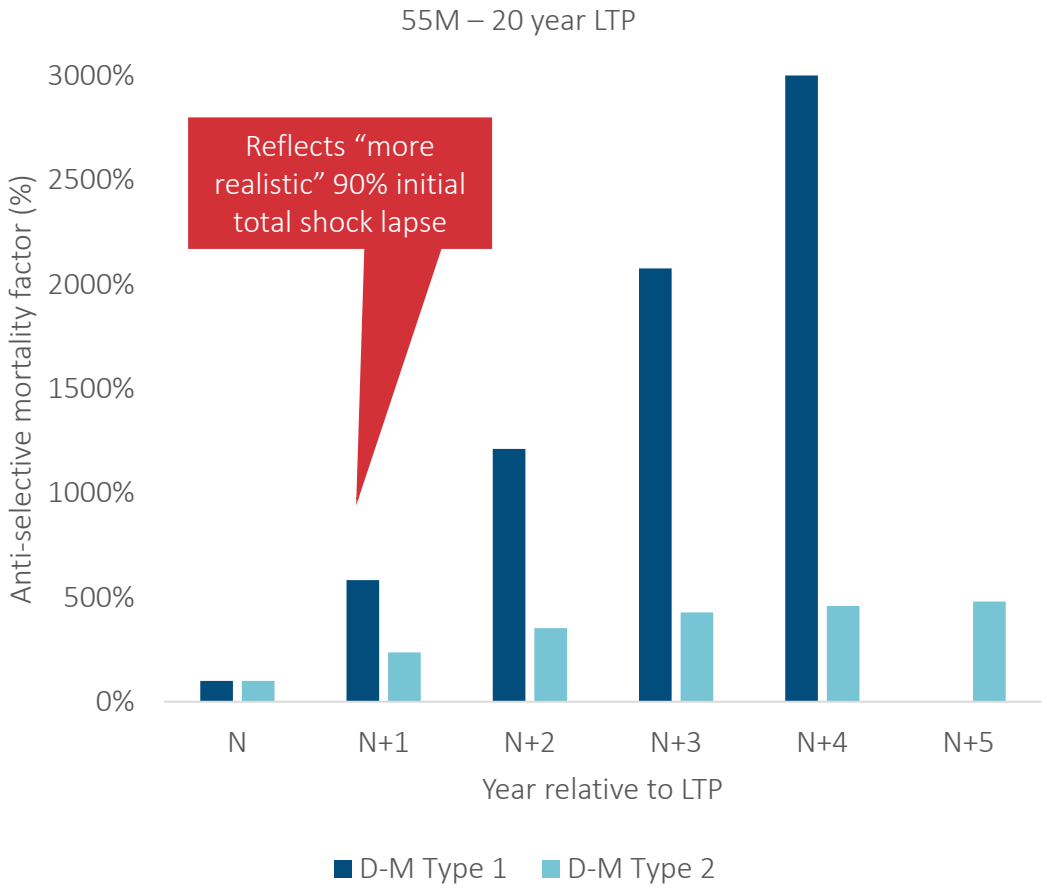
Effectiveness factor

- Factor provides implicit view on policyholder behavior
  - 100% effectiveness = all remaining policyholders are unhealthy
  - In reality, other factors contribute to policyholder persistency
    - Automatic premiums
    - Size of premium jump
    - Availability of similar products
    - Imperfect information
    - Irrational behavior



Type 1 versus Type 2 assumption

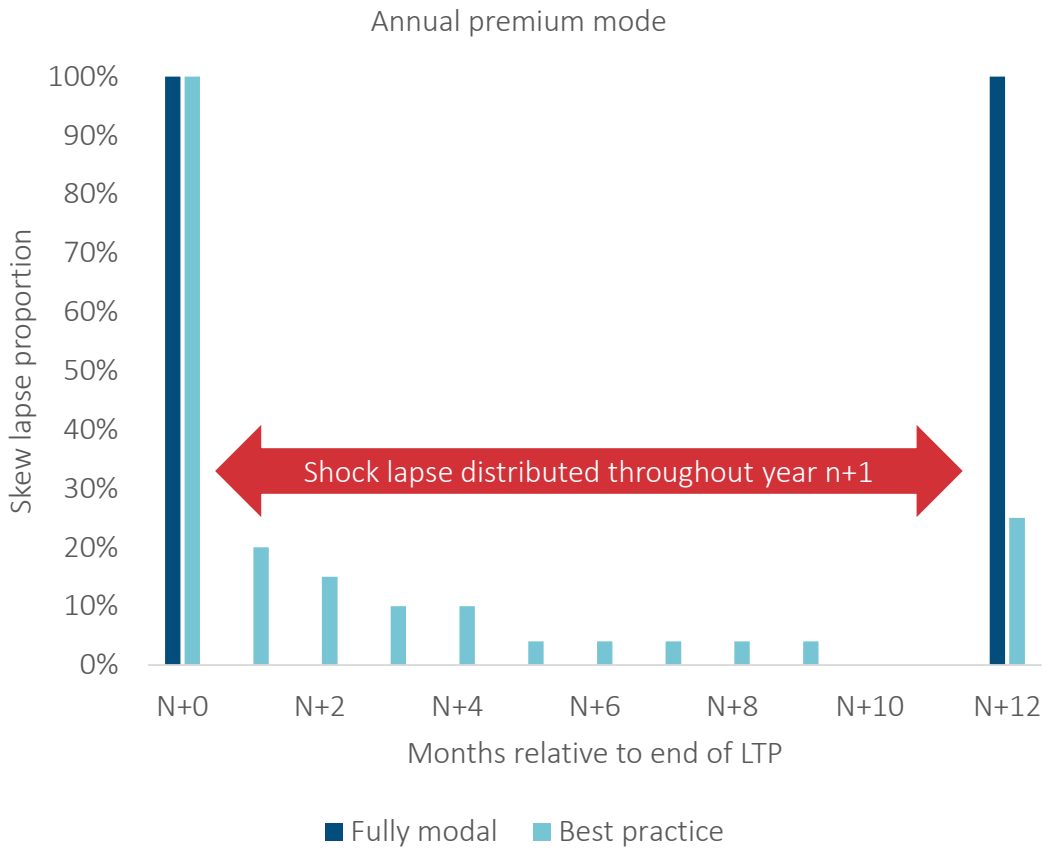


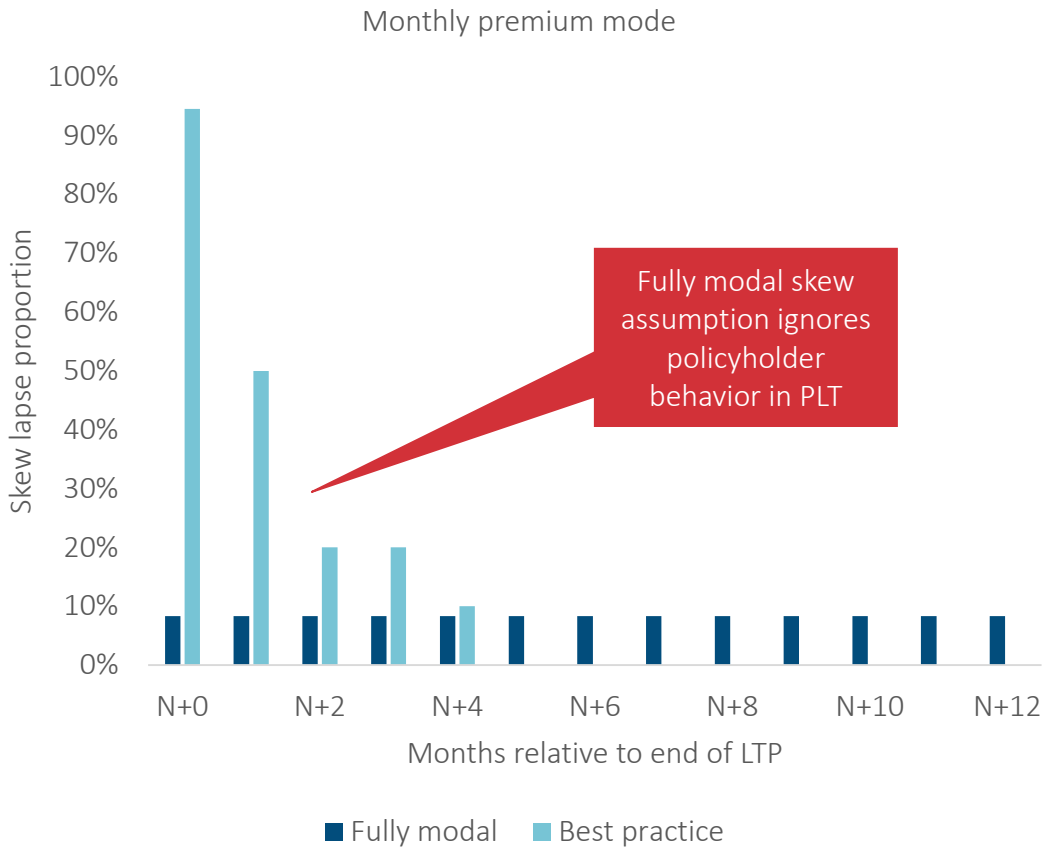


Modeling and analytical considerations

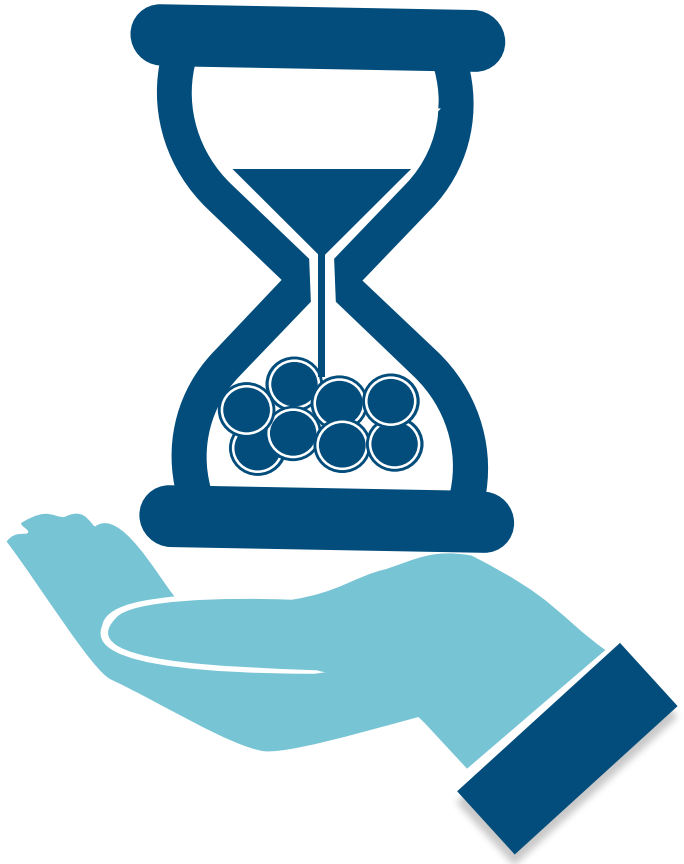
SOCIETY OF ACTUARIES®

Skew lapse pattern in years ‘N’ and ‘N+1’





Mortality deterioration in the grace period



- PLT modeling methods **were not** created with a grace period in mind
- In periods of high lapses, excess mortality during the grace period can be understated by 6-12%
  - Important for A/E analysis

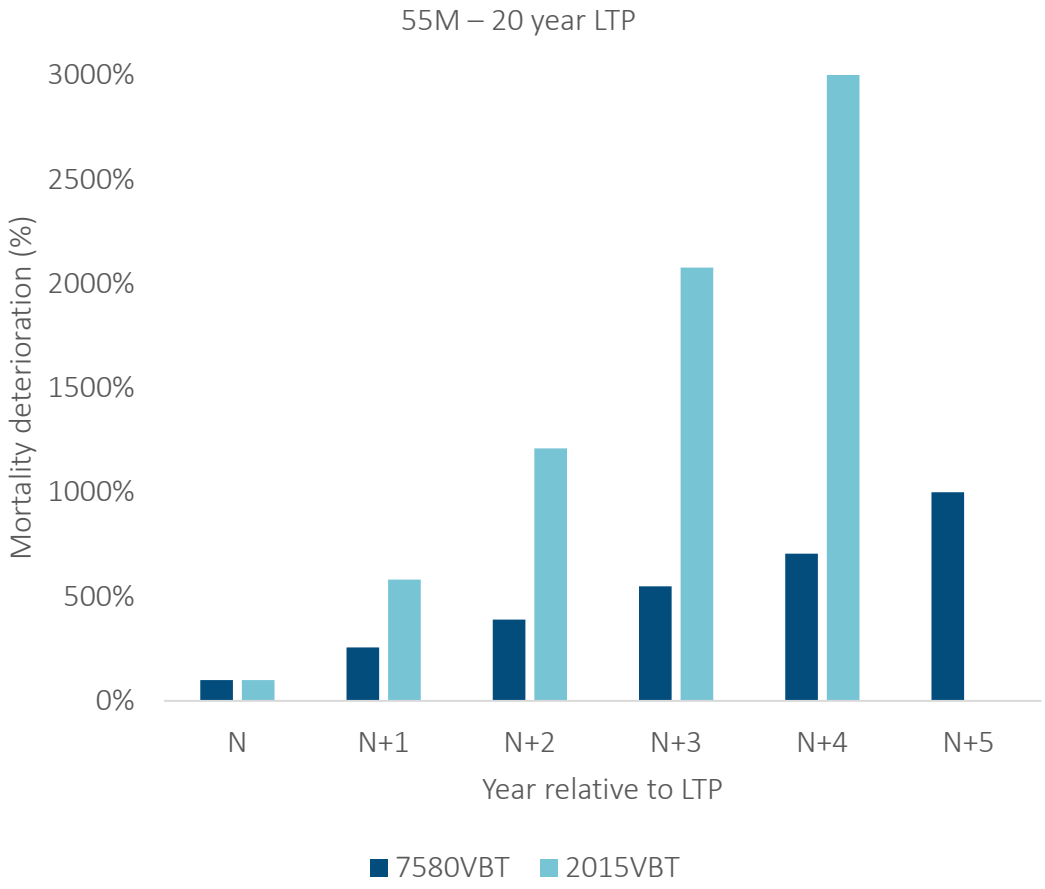
$$\frac{\left[S * q_{[x+t]} + (A+U) * q'_{[x]+t}\right] * [Grace\ Period]}{\frac{365}{[1-T]}}$$

Newly select lives – pricing or best estimate?

- Important to understand treatment of “compound” mortality tables within actuarial software
- Depends on view of mortality
  - Pricing – retain original underwriting multiples
  - Valuation – reflect best estimate assumptions
- Consider timing of future mortality improvement and applicability

Shape of underlying mortality table

- Level and run-off pattern of excess mortality is **highly** dependent on the shape of the underlying mortality table
  - Different select periods
  - Underlying preferred wear off
  - Old age grading

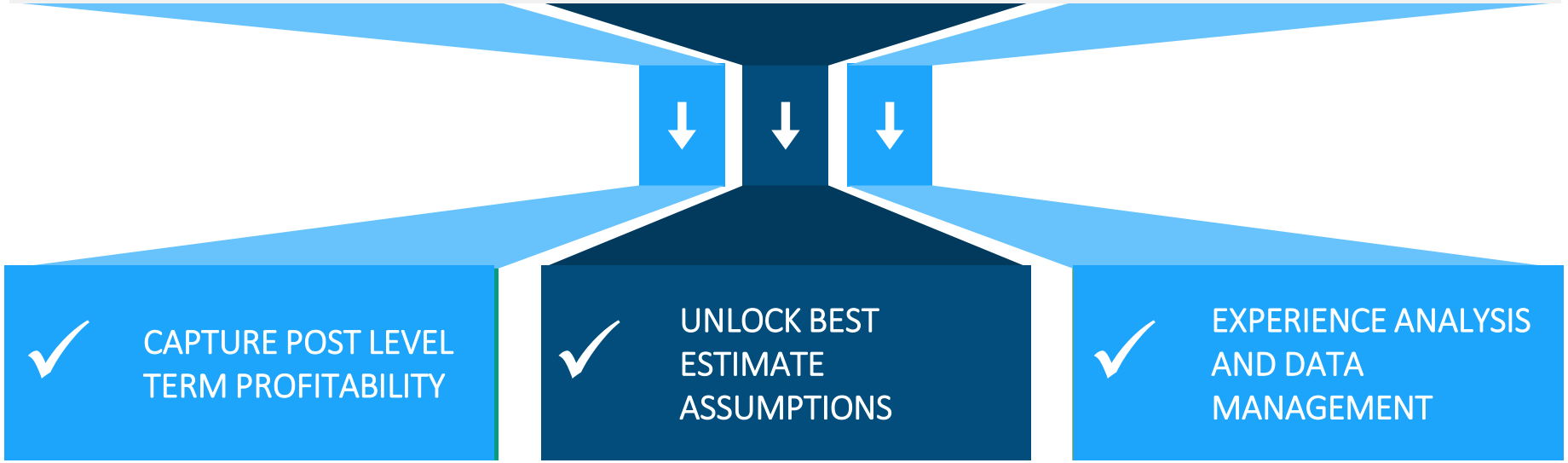


Emerging regulatory considerations

SOCIETY OF ACTUARIES®

PLT assumption treatment 2020 & beyond

Principles-Based Reserving and ASU 2018-12 (LDTI) have the potential to reshape the way companies handle statutory and US GAAP reserving for Term blocks



2019 ANNUAL MEETING & EXHIBIT

Post Level Term: Lapse and Mortality Risk Considerations

Laura Muse

October 28, 2019

SOCIETY OF ACTUARIES®

LCN: 2785983-102119

Post Level Term (PLT)
Direct Company Considerations - Agenda

- Overview of In-force Actions
- Considerations other than lapse and mortality assumptions
- Currently priced products and alternative designs

Overview of Term Design & Company Action

Common design

- Level premium paid for term period (10, 15, 20 years)
- Premiums change to a Yearly Renewal Term (YRT) scale that increases annually in PLT period

10-20+ years ago

- PLT premiums were set to/close to maximum allowed
- Resulted in premium jump after level period of 20-30 x level premium
- Lower premium jump results in lower shock lapse and more value to company

Company action

- Change scales of products reaching the end of level period to more favorable premium design

Live Content Slide

When playing as a slideshow, this slide will display live content

Poll: Has your company implemented a change to PLT premiums?

Identify Term Blocks for Action

Identify blocks approaching first cross-over date

Evaluate premium jump at end of level period

Review shock lapse and resulting mortality assumptions

Model a revised scale

- Perform sensitivity tests, Evaluate several discount rates

In-Force PLT Rate Change Considerations

Timeline

Reinsurance Considerations

Administrative Systems

Communications

Reinsurance Considerations

- Navigating a pool of reinsurers
- Recapture and retain or Recapture and recede options
- Is the change favorable to reinsurers? Invoke their support for modeling
- Coinsurance vs. YRT
- Financial Reinsurance/Capital solutions: are changes allowed?

Administrative Considerations

Does the cost to change administrative systems outweigh premium/mortality benefit?

- Policy administrative systems
- Reinsurance systems and treaty amendments
- Illustration systems, if illustrated

Quantify the cost into dollars and include in analysis

Communication Considerations

Messaging to Policyholders

- Do you normally notify policies at end of level period?
- Is this an illustrated policy form? If not, how do you show new scale?

Messaging to Agent

- Provide general update regarding a particular product
- Ability to provide list of impacted policies
- Orphan policies and upstream agencies

Live Content Slide

When playing as a slideshow, this slide will display live content

Poll: Has your company received much feedback after implementing a change to PLT premiums?

Live Content Slide

When playing as a slideshow, this slide will display live content

Poll: Have your revised lapse assumptions been accurate after changing the PLT premiums?

Live Content Slide

When playing as a slideshow, this slide will display live content

Poll: Have your revised mortality assumptions been accurate after changing the PLT premiums?

New Product Pricing Considerations

Set current PLT premiums at currently assumed optimal levels

File as indeterminant premium product – can't assume policyholder behavior won't change in future

Alternative designs

- Decreasing face amount, level premiums
- Start new level premium period
- No PLT period

Live Content Slide

When playing as a slideshow, this slide will display live content

Poll: How do your currently sold products compare to the design of years ago?

Conclusion

To Change or Not to Change?

- Impact of more favorable premium persistency and mortality
- IT/Implementation costs
- Communication materials or customer service support
- Impacts from unadjusted reinsurance treaties

Today's Product Development

- Improvements in modeling techniques and credible assumptions give a good starting point for future product development.
- Eliminate the need for in-force actions in the future

2019 ANNUAL MEETING & EXHIBIT

Questions?

SOCIETY OF ACTUARIES®