

2019 **LIFE &
ANNUITY**

SYMPOSIUM

May 20–21 • Tampa, FL



Session 64: Utilizing Predictive Analytics to Set Assumptions

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Session 64: Utilizing Predictive Analytics to Set Assumptions

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May 21, 2019



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Business Case for Analytics

Michelle Rosel

Actuary

Why should we consider Predictive Analytics for Setting Assumptions?

- Considers more factors than traditional actuarial practices
- Identify variables of significance
- Competitive Advantage
- Financial Integrity
- Provides better insights => better decisions
- Efficient manner to understand large volumes of data
- Becoming necessary to compete

Business Case for Analytics

Which Assumptions can be enhanced?

Anything with a decrement:

- Policyholder behavior
 - Surrenders/lapses
 - Liquidity
 - Optionality
- Mortality/Mortality Improvement
- Disability Incidence Rates
- Cause of Disability
- Underwriting/Claims Considerations
- Operational Considerations

Advantages of using Predictive Analytics

Powerful

**Game
Changing**

Must Do

Challenges of using Predictive Analytics



Complicated



**Can be
Approached
Incorrectly**



**“Throw-Away”
Work**

Pitfalls to be careful of:

- Data Quality
- Credibility
- Don't just "jump in" to a project. Need to be thoughtful...
- Interaction between variables
- Over-fitting the model
- Modeling without an understanding of the business
 - If Data Scientist doesn't understand the business, business partners must be more involved
- Does your model's results pass a gut check??
 - Does it make sense?
 - Are you seeing something that seems irrational?

Outset of a Project:

Need to be thoughtful...

- How will the model be used?
- How could it be implemented?
- Involve IT partners or others that may need to be involved with the implementation early on

Often great work is done, but it becomes wasted work because you can't put it into action at the end of the day. Thoughtfulness can prevent that.

Business Case for Analytics

Outset of a Project:

Need to be thoughtful...

- Data
 - Is your data good??
 - Is it clean?
 - If not...what are you going to do to address that?
- Are there ways to add value to your data??
 - Could a data field be bucketed or mapped to add insight?
 - Could external data be paired with the data to add insight?
 - Should the data be transformed?
 - Should it be thought of as Discrete, Continuous, etc.?
 - Various uses of a variable will provide different levels of value.

Learnings from projects...

**Define the
Question Well**

**Data Scientist
Must
Understand
the Business**

**Can't Partner
with IT "Too
Soon"**

**Begin with the
End in Mind**

Begin with the end in mind...



GOAL

What is your goal?



PROCESS

How will you apply this work to the "PROCESS"?



STRUCTURE

How does the work need to be **STRUCTURED** to fit into existing process?

Thank you

Rosel.Michelle@principal.com



Predictive Analytics for Assumption Setting

Thomas Naraindas

NOT IF, BUT HOW

Munich RE 

Where can we apply predictive analytics



Mortality/Longevity



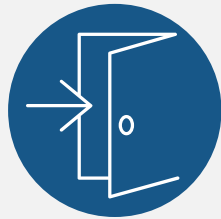
Claim Termination



Incidence



Mortality Improvement



Lapse/Surrenders



Funding



Utilization

Fit multiple factors

- ✓ Fit multiple covariates simultaneously
- ✓ Handles correlations and interactions

Automation

- ✓ Assumption setting can be partially automated using statistical programming

Smoothness

- ✓ Smooth fit against actual experience

New data sources

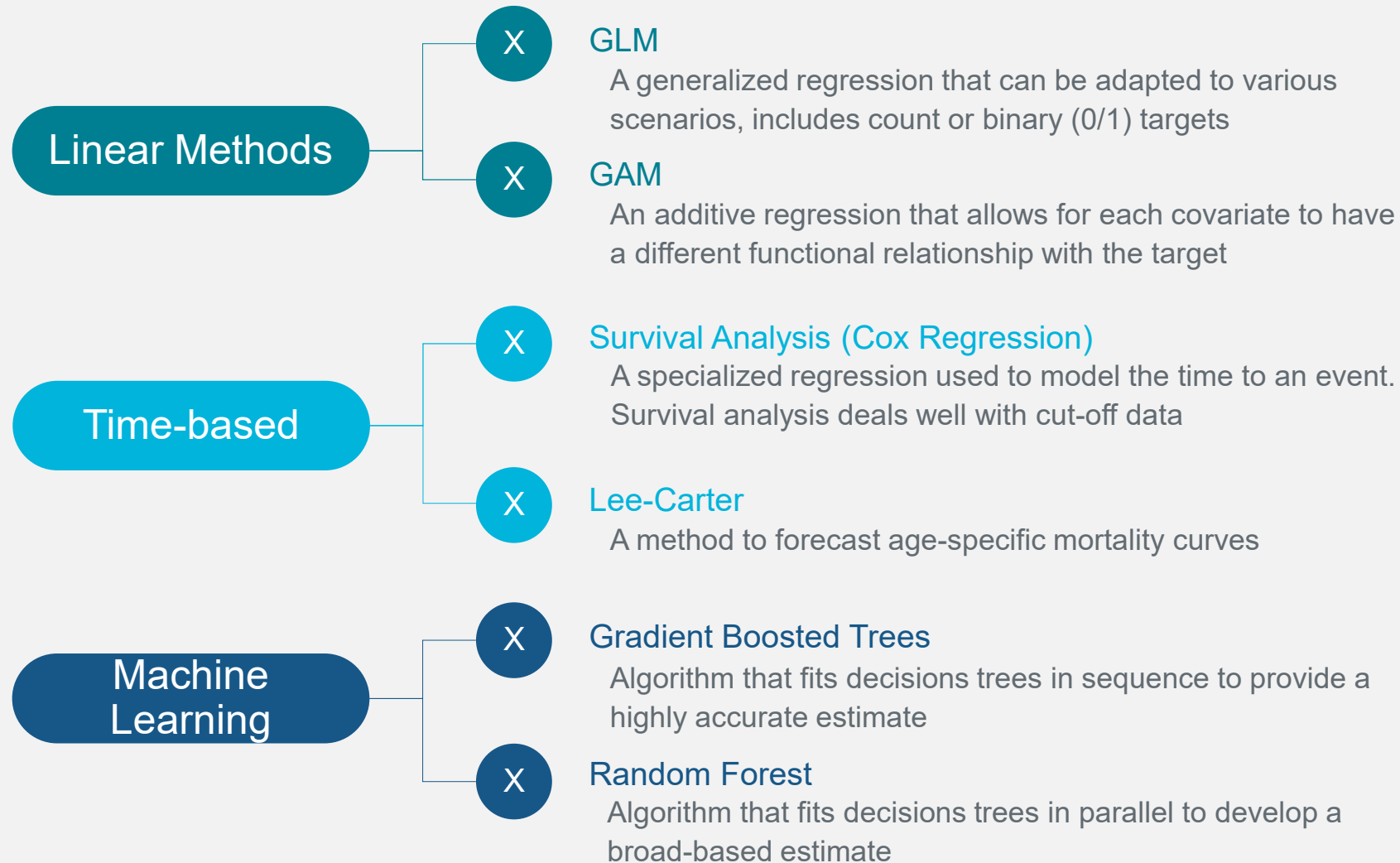
- ✓ Quantitatively assess the predictive power of new attributes

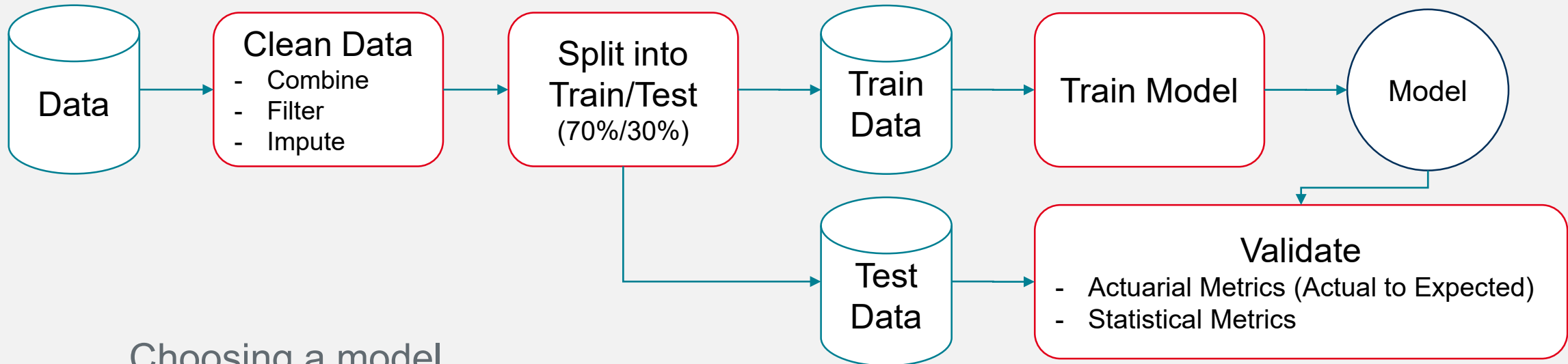
Validation

- ✓ Statistical metrics to validate fit
- ✓ Validation on hold-out data

Data efficiency

- ✓ Data can be “shared” between cells, allowing for estimates to be made with less data





Choosing a model

- What are you modelling and how will it fit into the current assumption framework?
- What does the available data look like?
- Are there any special considerations?

Validation Considerations

- The train-test split is stratified by target to ensure similar distributions in both sets
- Cross-validation can also be used to test models across different subsets of the data

Building a Poisson GLM

```
glm(Actual ~ Gender + Smoker + fa_band + attained_age + duration + Gender:attained_age,  
    data = X, family = poisson, offset = log(exposure))
```

Factors

Offset

Target

| | Coeff | Multiplier: exp(coeff) |
|----------------------|--------|---------------------------|
| (Intercept) | 0.040 | 1.04 |
| Gender[Male] | 0.107 | 1.11 |
| Gender[Female] | -0.158 | 0.85 |
| Smoker[Non Smoker] | 0.068 | 1.07 |
| Smoker[Smoker] | -0.007 | 0.99 |
| fa_band[100K-249K] : | 0.091 | 1.09 |
| fa_band[250K-499K] | -0.088 | 0.92 |
| fa_band[500K-999K] | -0.034 | 0.97 |
| fa_band[1M+] | -0.012 | 0.99 |
| fa_band[<100K] | 0.052 | 1.05 |

| Approach | Target | Offset |
|------------|---------------------|-------------------|
| Count (dx) | Count | None |
| Rate (qx) | Count | Exposure |
| Rate (qx) | Amount (FA or NAAR) | Exposure (amount) |
| A/E | Count | Expected |

How to choose what variables to use?

Manual

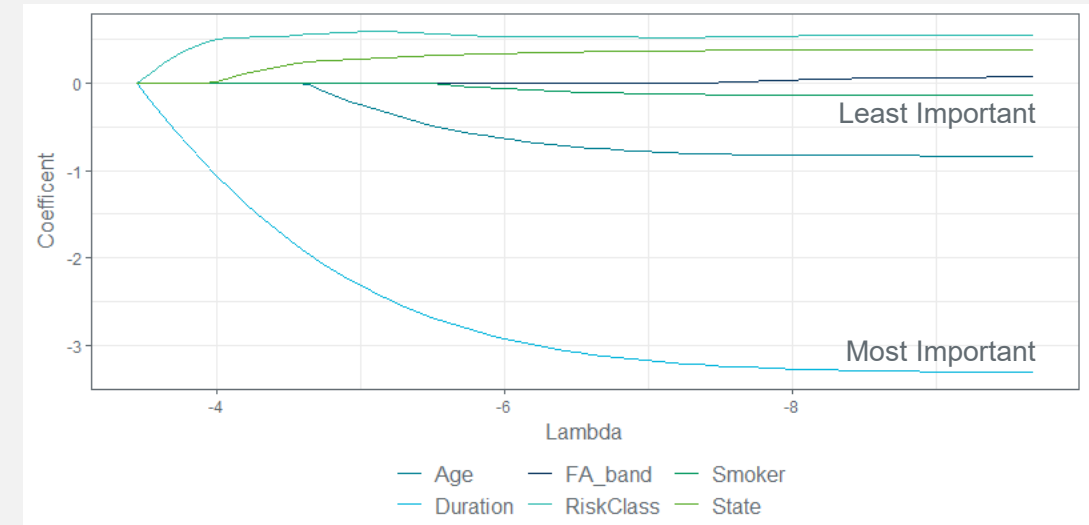
Coefficients:

| | Estimate | Std. Error | z value | Pr(> z) | |
|---------------------|-----------|------------|---------|----------|-----|
| (Intercept) | -1.375807 | 0.086134 | -15.973 | < 2e-16 | *** |
| Smokers | -0.105378 | 0.040945 | -2.574 | 0.010064 | * |
| GenderMale | -0.060402 | 0.038140 | -1.584 | 0.113263 | |
| Duration | -0.026679 | 0.001196 | -22.306 | < 2e-16 | *** |
| IssueAge | -0.012323 | 0.001704 | -7.232 | 4.76e-13 | *** |
| FA_band1 | 0.215766 | 0.077438 | 2.786 | 0.005331 | ** |
| FA_band2 | 0.163387 | 0.047679 | 3.427 | 0.000611 | *** |
| FA_band3 | 0.063077 | 0.041014 | 1.538 | 0.124066 | |
| GenderMale:FA_band1 | 0.130287 | 0.085374 | 1.526 | 0.126993 | |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

A combination of actuarial knowledge and statistical tests can identify important covariates to use in a predictive model

Automated



Automated statistical techniques like stepwise regression and LASSO can process a large number of covariates simultaneously

Cross validation on unseen data



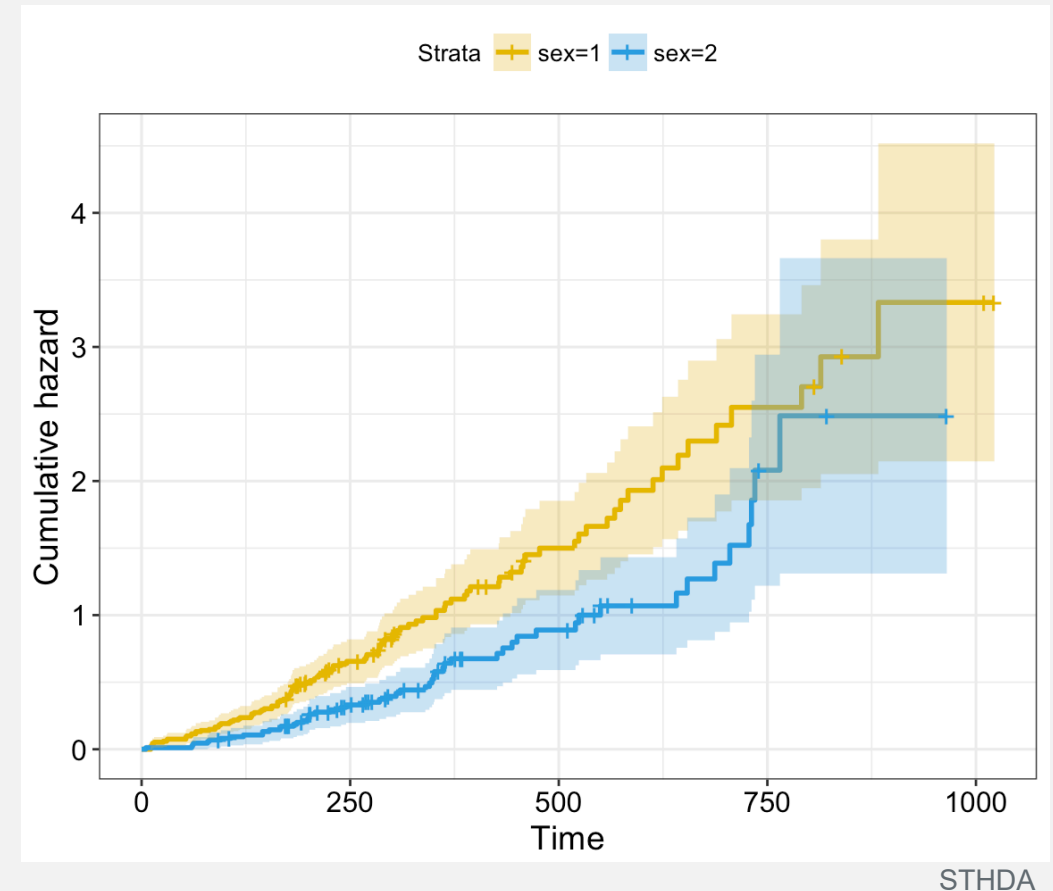
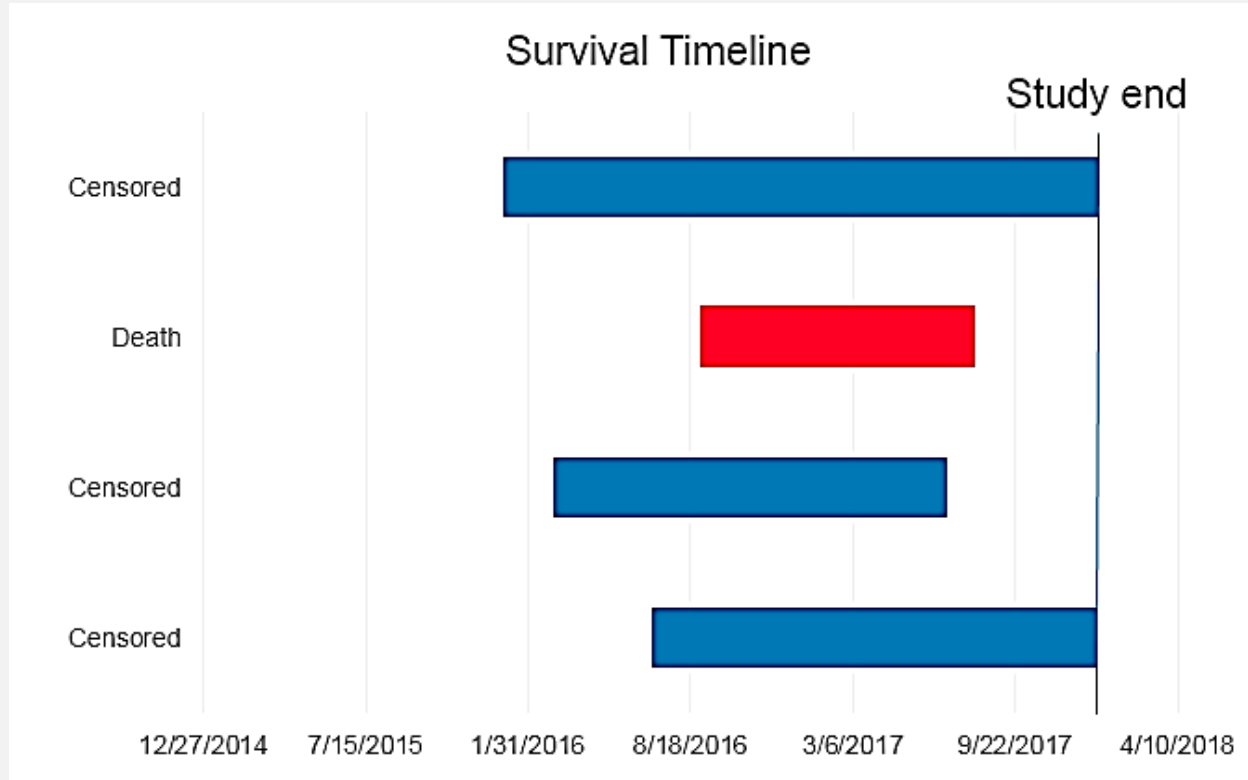
Procedure

3-fold cross validation:

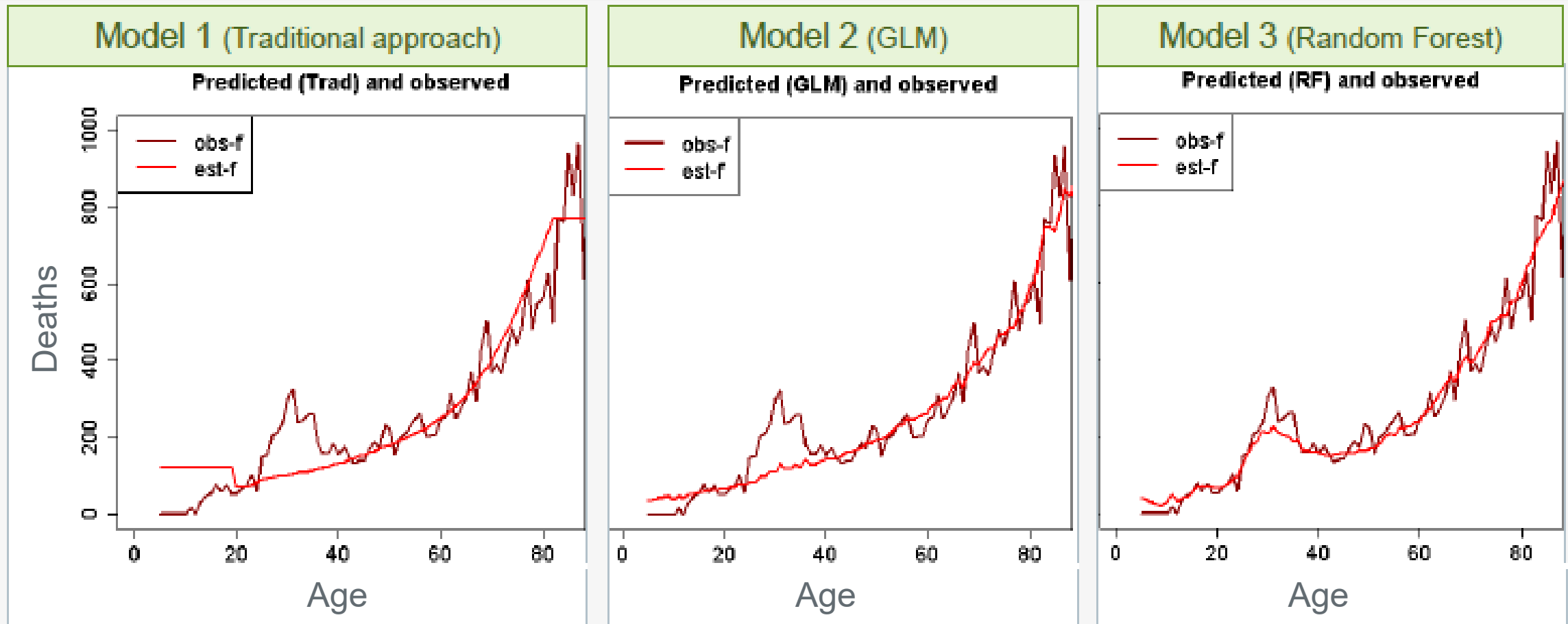
- split data into 3 subsets
- train model on first 2 subsets (67% of data)
- test on the last subset (33% of data)
- repeat 2 more times, testing on each subset
- evaluate actual / predicted ratios for each test subset (fold)

- Assess the ability of the model to predict on new data that was not used to develop the model
- This allows us to determine whether the model will generalize to new data

Time-varying assumptions: survival analysis



- Survival analysis is used to construct assumptions based on the probability of surviving until a given time
- “Survival” is a generic term, and can be used for the length of time a policy is active (lapse) or time a claim is open (termination)



Accuracy & Automation 

SOA Life and Annuity Symposium
May 21, 2019

Predictive Analytics for Assumption Setting

Kendrick Lombardo, FSA, MAAA



Agenda:

Market Drivers

Industry Trends

Annuity Case Study

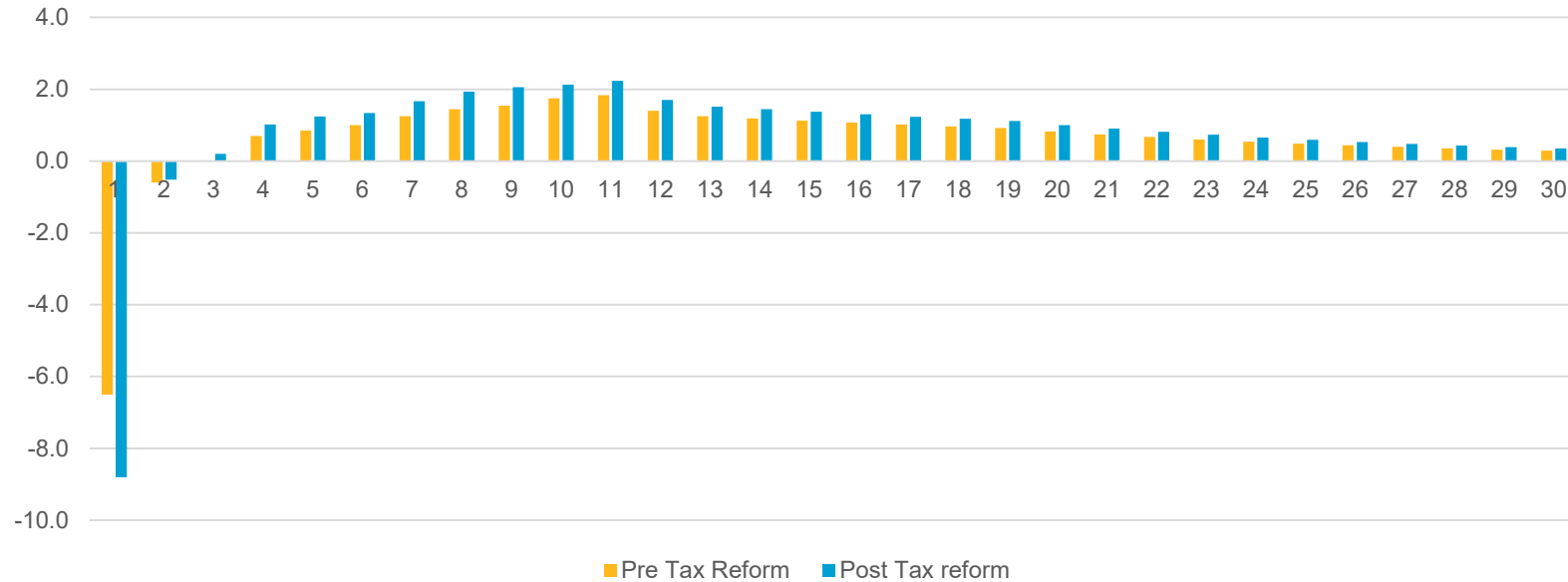
Market Drivers

Regulatory Market Drivers

- Principles Based Reserving (VM-20)
 - Life Products
- International Financial Reporting Standards (IFRS-17)
 - For most with outside US ownership
- Annuity Reserving Working Group – VM-22
 - PBR method for Non-Variable Annuities, consistent with AG 43/VM21, target GMWBs
- GAAP Targeted Improvements
 - Moving GMDB, GMWB and GMIB Reserves to market based methods
- Quantitative Impact Studies I & II
 - Refinements and Harmonization of AG43 and C3P2

Tax Reform Impacts

Illustrative Distributable Earnings Cash Flows
Before and After Tax Reform



- Assumption Setting: More effort will be made
 - Larger impact (more volatility) from A/E deviations
 - More important than ever to set assumptions well, monitor / notice
 - Balance between model / assumption structure complexity vs. accuracy
 - May push towards more structural accuracy

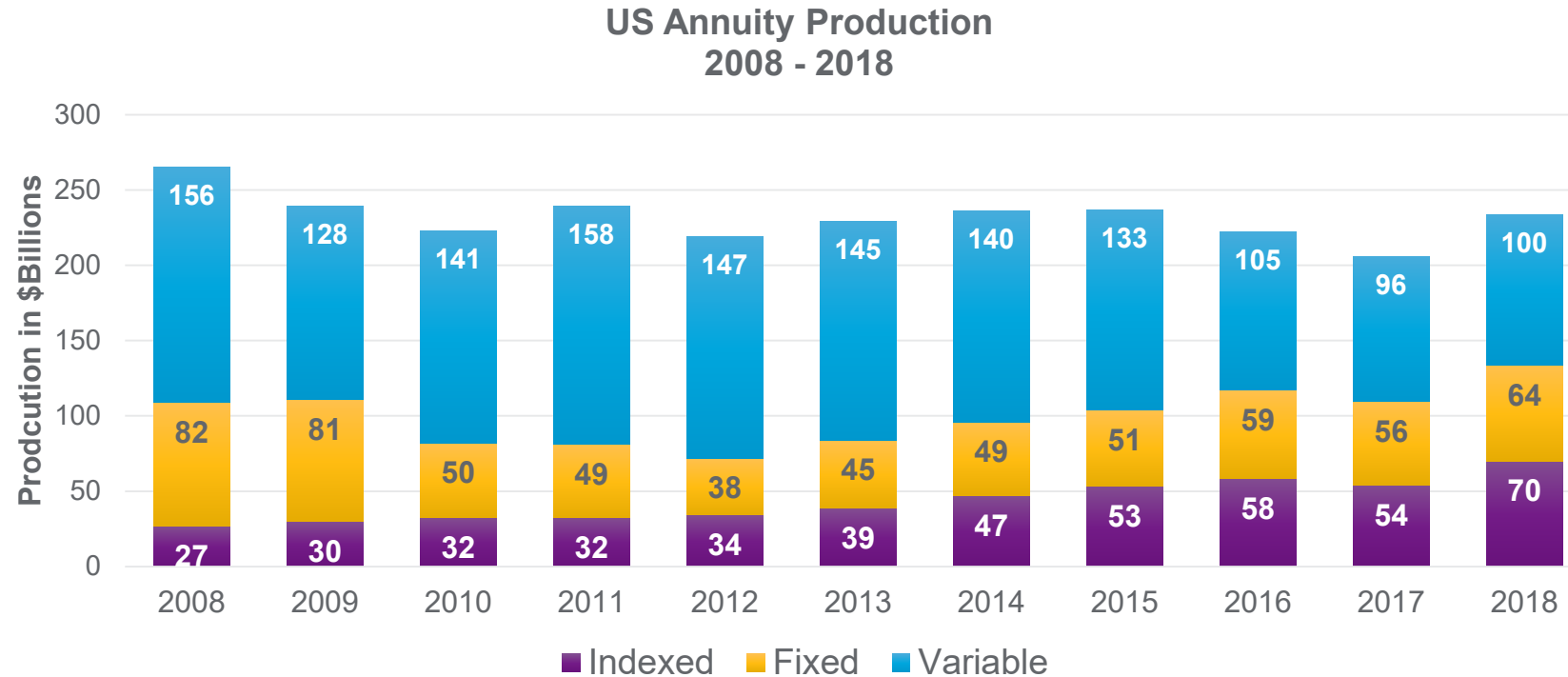
Expected Impacts of Regulatory Changes

- What are the key changes?
 - Moving GMDB, GMWB and GMIB reserves to market based methods for GAAP
 - More market sensitive for Statutory for VA and eventually FIA, with AG43 and VM-22
- Expected impacts?
 - Business more sensitive to equity and interest rate movements
 - Behavior more important, more leveraged on behavior
 - May need to refresh policyholder behavior assumptions to help rethink product and hedge strategy
 - More emphasis on the potential variability of assumptions, including alternative assumptions and range of possibilities
 - Expect companies to hedge more in general
 - With more hedging, more risk of over hedging (SOP 03-1 generally suggested some under hedging)

GAAP Targeted Improvements Impacts

- What is changing?
 - Moving all GMDB, GMWB and GMIB Reserves to market based methods
 - More sensitive to equity and interest rate movements
 - Behavior more important, more leveraged on behavior
- Expected impacts
 - Need to refresh PHB assumptions to be able rethink product and hedge strategy
 - More emphasis on the potential variability of assumptions, alternative and range of possibilities
 - Overall, more risk of over hedging (SOP 03-1 generally suggested some under hedging)

Annuity Sales have started to increase . . .



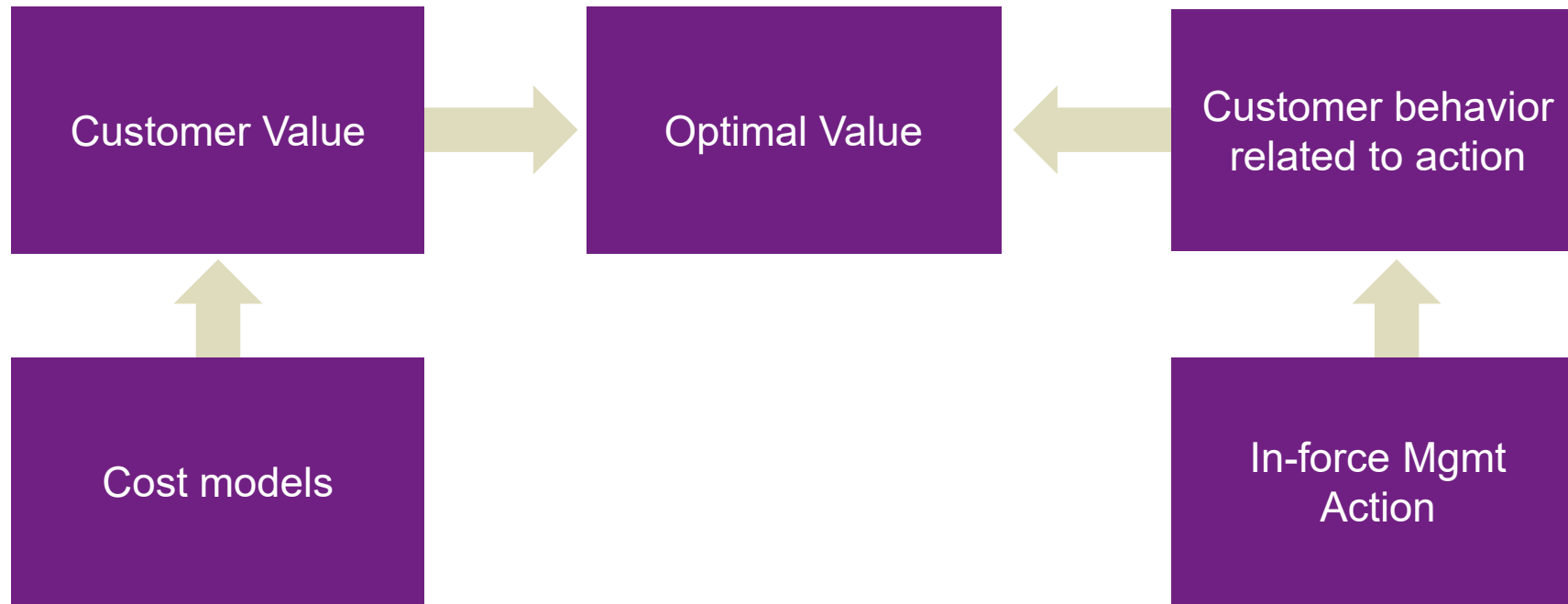
- U.S. individual annuity sales have generally been increasing over the last several years, with a slight decline for 2017
 - Decline likely due to the Department of Labor fiduciary rule (also evidence in decline in variable annuity sales in 2017)
- 2018 has shown a rebound in sales and 2019 had started strong

** Source: LIMRA Data Bank

Industry Trends

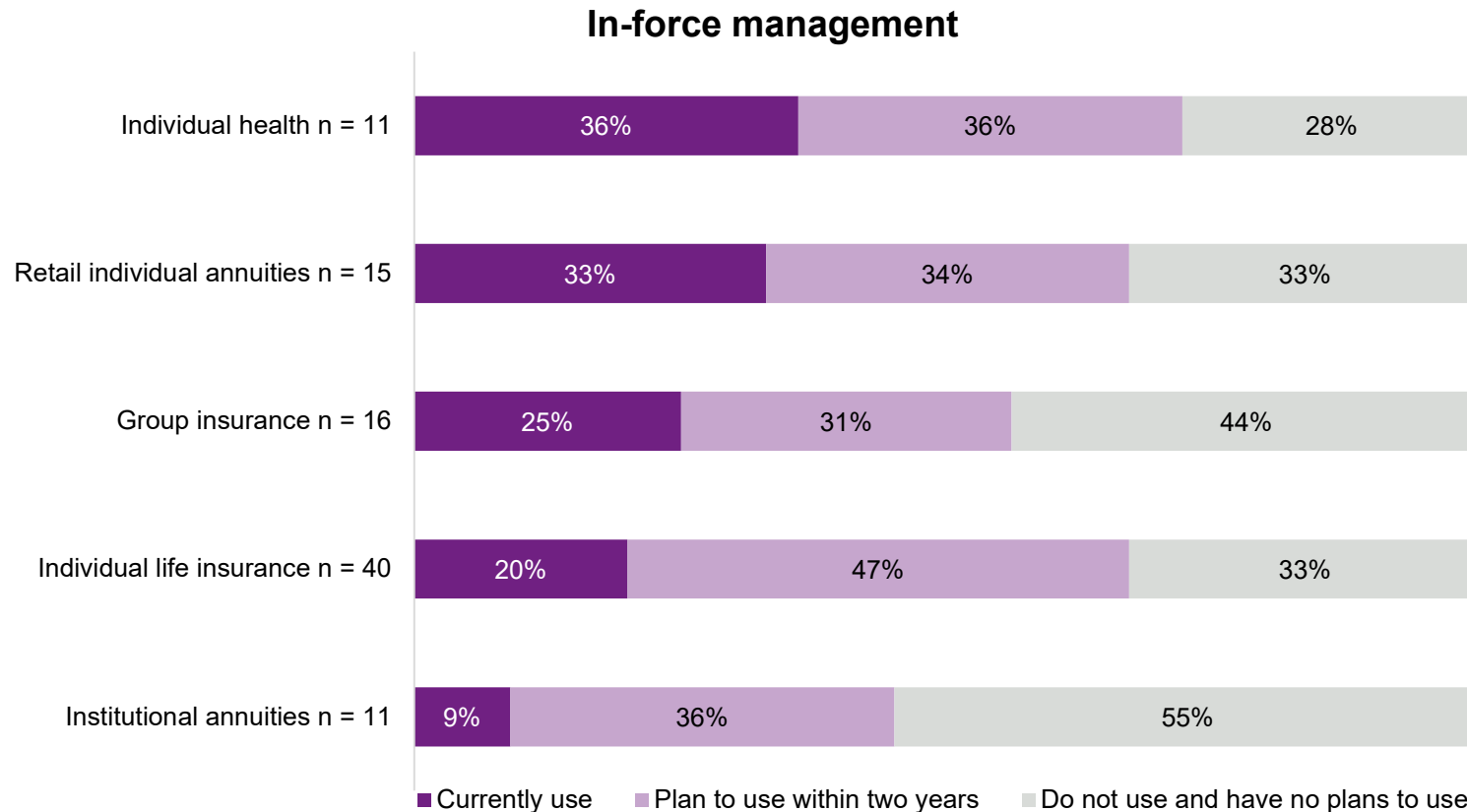
In-force management is a hot topic in the life insurance industry

Understanding customer value can inform in-force management



Key components of this are understanding customer value, using appropriate analytical tools and accessing appropriate software tools

In order to best understand the impact and interplay of various factors, predictive analytic techniques are being used with increasing frequency within the industry



Source: 2018 Willis Towers Watson Life Predictive Analytics Survey

Companies are considering in-force management actions

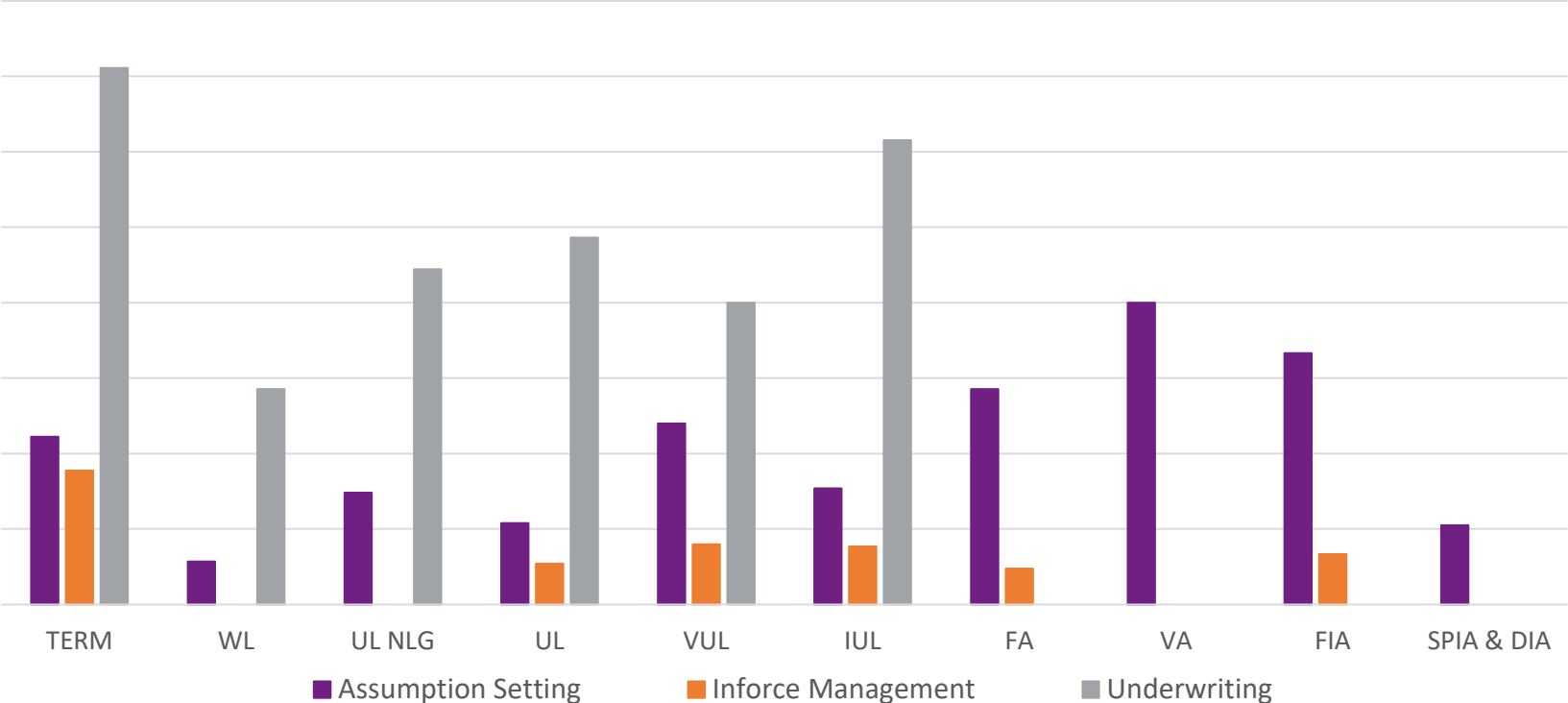
Increasing value on in-force business

- Route them to more qualified (i.e., better) customer service reps
- Buy-outs
- Cross-sell / up-sell opportunities
- Non-guaranteed elements – fees/charges, rates, renewals, etc.
- Sending personalized messages
- Review of contract communications – suspension of reminder notifications about contractual options (e.g., resets)
- Agent/representative person visit tracking and correlation analysis

Need to determine how customers will react to actions
and to see how actions will impact profitability

Predictive analytics was most frequently used in underwriting and assumption setting, with some growing inforce management use

Use of Predictive Analytics



InsureTech & Advanced Analytics

- Marketing/Sales
 - Consumer Messaging
 - Direct consumer marketing
 - Carefully crafted e-app
 - Post-sale followup & service
 - Regulatory compliance
 - Reduced NIGO and associated cost
 - Acceptance rates analysis
- Life Underwriting Methodologies
 - Minimal losses in value over traditional methods expected
- Predictive Analytics & Machine Learning
 - Identifies sub-trends and sub-factors within data
 - Refinement of policyholder behavior
 - Validation is critical

Case Study

Variable Annuity in-force block

- **Block:** VA business written over past 10 years with guaranteed benefits – richness of which varies over time. Sold through multiple distribution outlets
- **Data elements to analyze:**
 - Issue age
 - Duration
 - Gender
 - Policy size
 - Richness of XB
 - Time of first withdrawal
 - Amount of withdrawal(s)
 - PV of guarantee
 - Benefit Base
 - Distribution outlet
 - Fund mix
 - Share class
- **Baseline:** Develop a GLM based predictive model for base and dynamic lapses

Solution

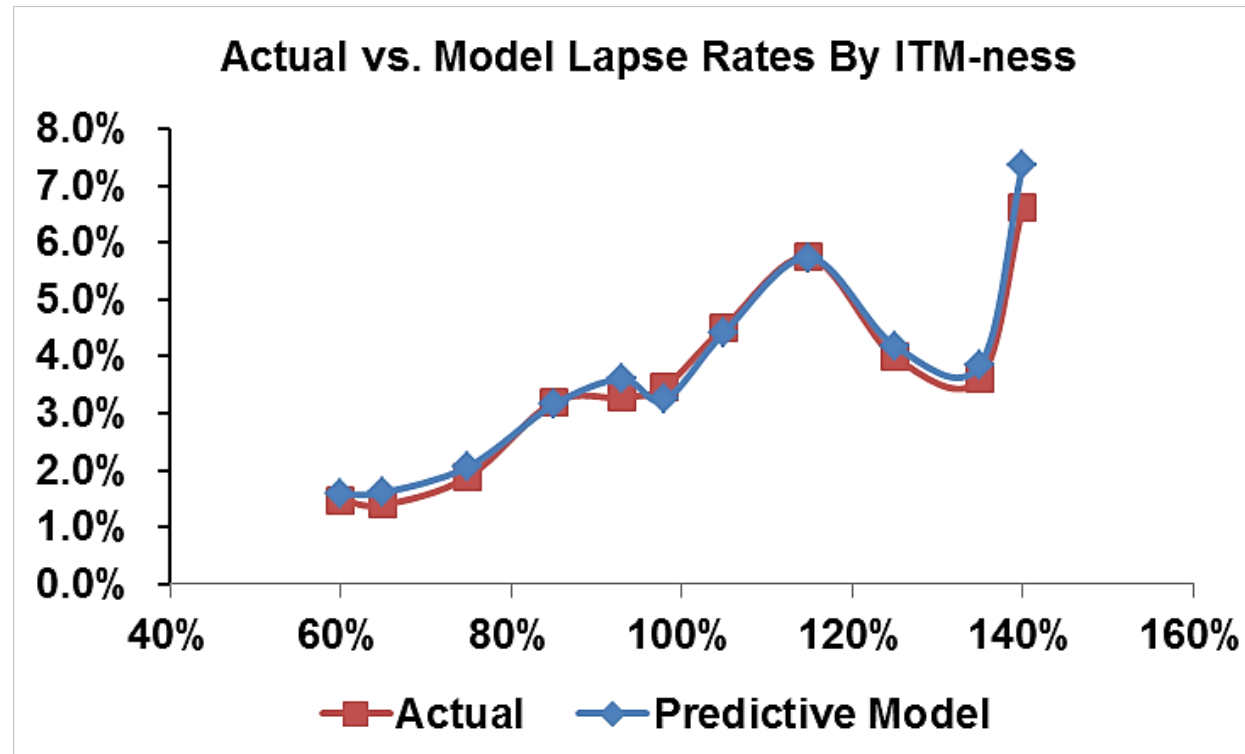
Below illustrates the form of the predictive lapse model developed, a multiplicative model:

- Several factors were considered, with the best predictors of lapses selected (those that correlated the highest and could be explained)
- Several interaction effects were also analyzed to determine which warranted inclusion in the model, balancing sophistication with predictive power
- Actual models typically include other factors, some specific to the company (product and rider groups) and some other general indicators of lapses (state and activity based, such as starting LB income, prior excess withdrawals, tax status, policy size, gender, commission option)
- Other potential factors : zip code data and macro-economic factors

$$\begin{array}{l} \text{Lapse Rate} = \text{Base Lapse (Share Class, Duration)} \times \text{Dynamic Factor (Size, Surrender Charge)} \times \text{Policy Month Factor} \times \text{Attained Age Factor} \\ \text{Lapse Rate} = 10\% \times 50\% \times 90\% \times 120\% = 5.4\% \end{array}$$

Predictive Model Validation

- Projecting lapses with the full predictive model fits the experience very well
- The predictive model anticipates the odd dips in the experience seen in the raw data



What went wrong?

- Post surrender charge data
 - Predominately older designs with lower rider charges, lower fees in total and a 3.0% fixed account available
- Surrender charge variation
 - Data was grouped by surrender charge length, but the slope of the wear off varied dramatically by product series
- Income factors
 - Income factor slope varies by product age, with more economic designs in older products and reduced older ages factors in new products; post surrender charge experience was all for designs with more economic income factors
- Interaction effects across assumption sets
 - Excess withdrawals correlating with excess surrenders

Final Thoughts

Final Thoughts

- Regulation continues to create drive change in the industry with significant impacts coming to the industry
- Annuity sales have recovered after DOL fears reduced, which should help allow for companies to invest in their businesses, but expense pressure should continue as well
- We have more and more data we can leverage, with more companies using predictive analytics, but also more risk of model gaps
- Variation in judgement still continues, on how to apply, adjust and supplement what more technical exercises can produce
- Predictive analytics usage continues to grow across assumptions, underwriting and inforce management, with benefits on expenses, predictive power and sales

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Questions & Comments



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