Session 52PD: Financial Analysis: Impairment, Stress Testing and Predictive Modeling for Health Companies

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2017 Valuation Actuary Symposium

Session 52

Financial Analysis: Impairment, Stress Testing, and Predictive Modeling for Health Companies

August 29, 2017

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Problems and objectives

- Financial impairment due to under reserving, underpricing, and excessive growth

- What can we learn from stress testing and predictive modeling to alter future behavior?

- Objective:
  - Understand modeling future financial performance
  - Assess results from complex systems for future decisions

How will we accomplish?

- Predictive modeling and experience studies
  - Missy Gordon, Milliman Minneapolis
- The actuarial timeline
  - Roger Loomis, Actuarial Resources Corporation
- Q&A

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Reducing financial risk using predictive modeling with experience studies

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Milliman, Minneapolis

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Ways predictive analytics can reduce risk

Identifying insureds for preventative care

Flagging miscoded or fraudulent claims

Evaluating new preventative care or treatments

Experience studies

Risk scores and underwriting

Agenda

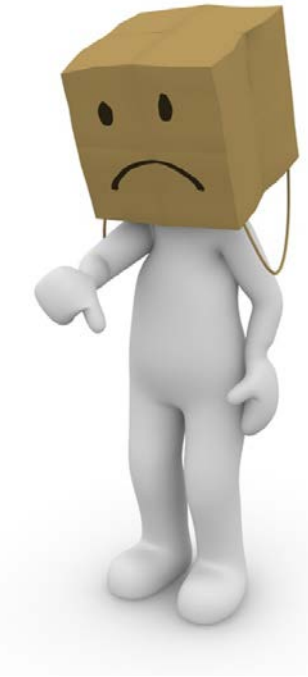
- Traditional A:E and its financial risks
- Predictive modeling and how it reduces financial risk
- Communicating complex results

Traditional A:E method

- Starting expectation
  - Prior assumption
  - Industry data or benchmark
- A:E adjustments with judgement
  - Amount of weight to give data
  - Variable selection and interactions
- Iteratively adjust and re-normalize

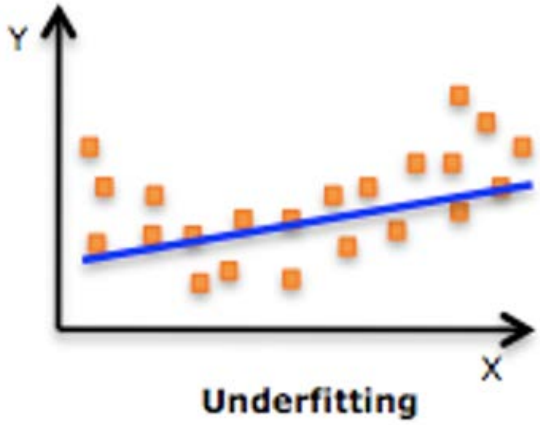
Traditional A:E method risks

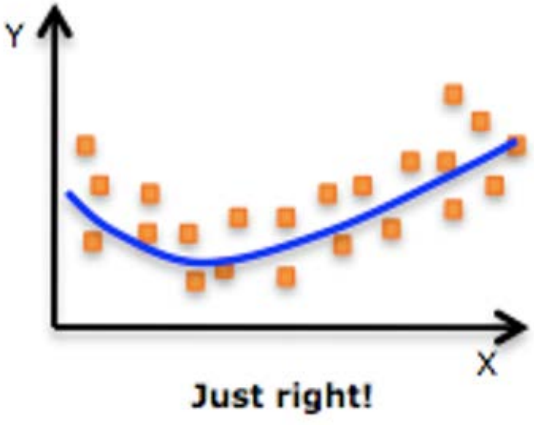
- A:E can mask offsetting errors
- Does not tell us if works on unseen data
- Judgement decisions
  - Variable selection
  - Interactions/slices
  - Weight given to data

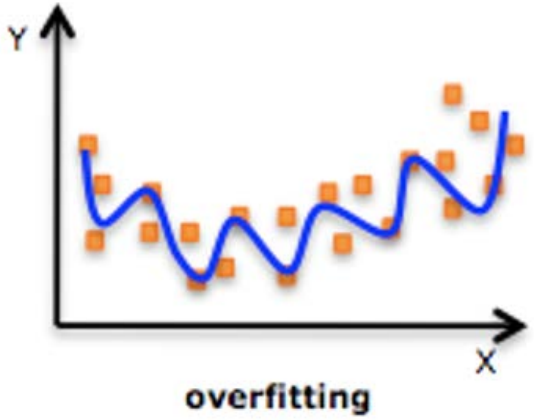


Traditional A:E method risks

Judgement to traverse the bias-variance tradeoff







High bias
Low variance
Low data weight
Aggregate

High variance
Low bias
High data weight
Granular

How can predictive modeling reduce financial risk with experience studies?

Many possible predictive modeling methods….

Penalized GLM is a nice stepping stone

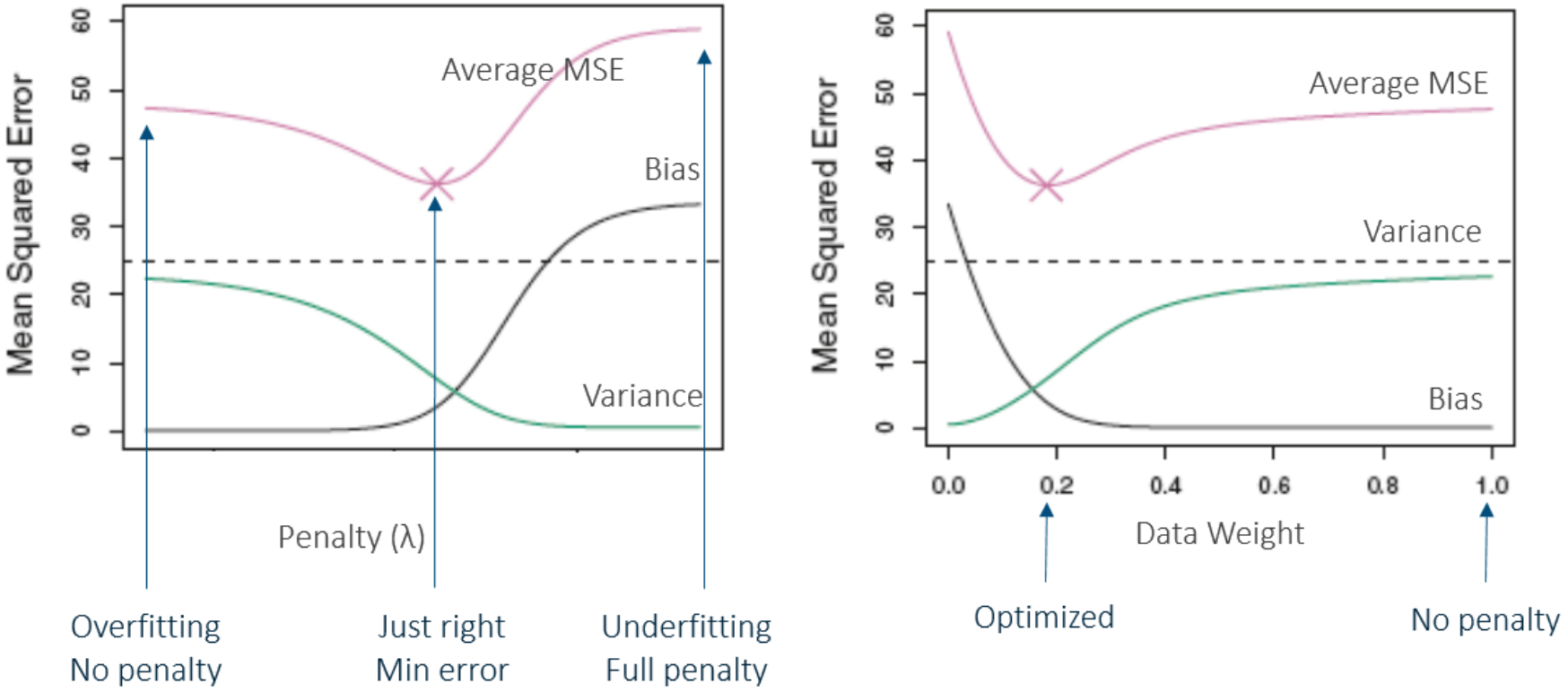
How does a Penalized GLM work?

- Develops coefficients using GLM with expected offset
  - Similar to A:E adjustments
- Penalizes (shrinks) coefficients
  - Determines amount of weight to give data
  - Controls for overfitting

- Chooses penalty to minimize prediction error
  - Automates bias-variance tradeoff
  - Tests prediction error on unseen data

Penalized GLM a.k.a., Generalized linear model with regularization

Automated bias-variance tradeoff



- Chose penalty that minimizes prediction error
- Test range of penalties (data weight)

Test prediction error on unseen data

3-Fold	Test 1	Test 2	Test 3
1 33%	1 Unseen	1 Use	1 Use
2 33%	2 Use	2 Unseen	2 Use
3 33%	3 Use	3 Use	3 Unseen
Calibration data	100%	100%	100%

MSE on unseen data	Average
	Test 1
	Test 2
	Test 3

Automated process!

K-fold cross-validation

- Use subset of data to develop coefficients
- Calculate error of predicted values on unseen data

Why do we like Penalized GLM?

- Automates bias-variance tradeoff
  - Choice of data weight
  - Tests prediction on unseen data
- Efficient to update/modify
  - Reduces human error
- Similarities to traditional
  - Apples-to-apples, except change to data weight

Reminder that challenges still remain

- Navigating complex interactions
  - Gradient Boosting Machine (GBM)
- Limited data
  - Supplement with industry data
- Beyond experience data
  - Hold level or grade off adjustment
- Trend
  - Understand driver
  - Hold level or grade off

How to communicate complex results?

- Present in familiar format
  - Use dummy variables
  - Compare to existing assumptions
  - Same dashboards then introduce new ones

- Waterfall of changes
  - Apples-to-apples, except new data weight method
  - Then add new data, interactions, and/or variables
    - Be mindful of system constraints

How predictive analytics reduce risk?

- Reduce financial fluctuations and deviations
  - More robust assumptions based on statistics
  - Automates bias-variance tradeoff
  - Minimizes prediction error on unseen data
- Uncover relationships to better manage or avoid risk
  - Handles complex interactions
  - Better understand deviations and key risk drivers
- Better use of company data (best source)
- Reduces human error

The Actuarial Timeline

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Principal
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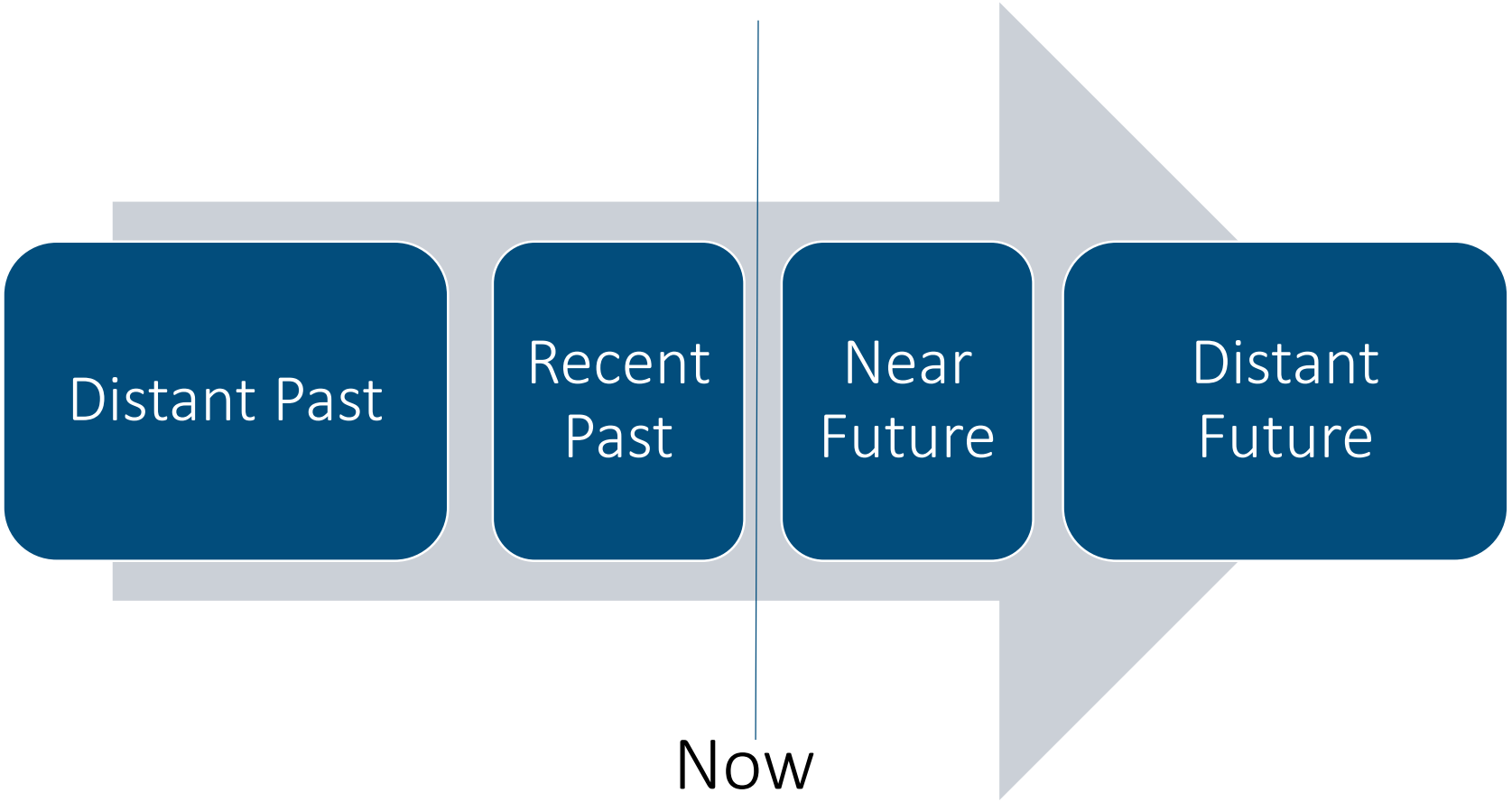
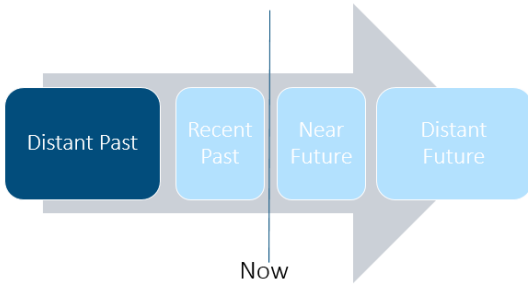
There Are Really Just Two Questions

- What happened?
- What's going to happen?

Actuarial Timeline

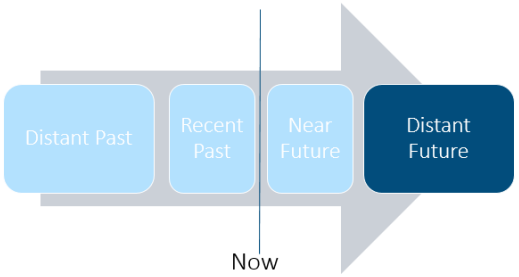


Distant Past



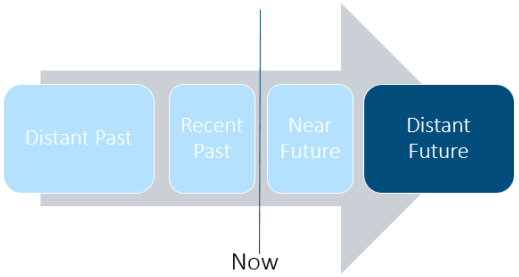
- Provides a lot of information because it covers a longer time horizon
- Use the data as the basis of assumptions
- Derive assumptions using predictive analytics
- Include analysis of confidence level in assumptions
- Include time series analysis: does the past indicate that the variables are changing with time?

Distant Future



- Economic capital models that estimate the long-term solvency and viability of the business
- Use best-estimate assumptions based on historical data
- Include trends for how the future could be different than the past
  - Mortality improvements
  - Morbidity improvements
  - Economic scenarios

Distant Future



- Sensitivity testing
  - How sensitive is the solvency to changes in each key assumption?
  - Exactly how confident are we in the most sensitive assumptions?
  - Remember—we should make statements about how confident we are in the assumptions
- Stress testing
  - What is the financial risk of things going bad?
  - How bad could the various assumptions be?
  - Think a lot about how to model Black Swans

Dealing with risk

- Three approaches:
  - Higher margins (i.e. throw money at the issue with higher premiums and delayed profit distributions)
  - Less risky product design (e.g. Life-LTC combo products have a natural hedge)
  - Variable benefits

Variable Benefits: How LTC Works

- For a relatively low premium, policyholder receives high LTC benefits to pay for LTC care if needed
- This is achieved through premium *leverage*. Leverage created by the following:
  - Insurance company places most of paid premium into fund to save for future claims
  - Fund grows with investment income
  - Premiums from members that lapse or die without receiving full benefits stay in fund to pay benefits of people who become disabled and need care

Big Challenge of LTC

- The big challenge of LTC is making sure the company will have enough money to pay future claims
- Will the existing fund plus future premiums, accumulated with interest, be enough to pay future benefits?
  - What will morbidity patterns look like over next 50 years?
  - How many policies will lapse or die before qualifying for benefits?
  - What will investment returns look like over next 50 years?
- Actuaries need answers to these questions to set the correct premium
- While the actuaries can make reasonable assumptions, the future might vary significantly from the assumptions

Traditional Approach: Fixed Maximum Benefit

- Traditionally, LTC has had a predefined maximum benefit
- To fund the predefined benefit:
  - Set premiums based on best estimates
  - Add a margin. The higher the margin, the less likely a rate increase will be necessary
  - Periodically review emerging experience
  - If emerging experience indicates there might not be enough money to pay the predefined benefits, raise the premium
- Traditional policies are analogous to defined-benefit pension plans and the challenges of funding them

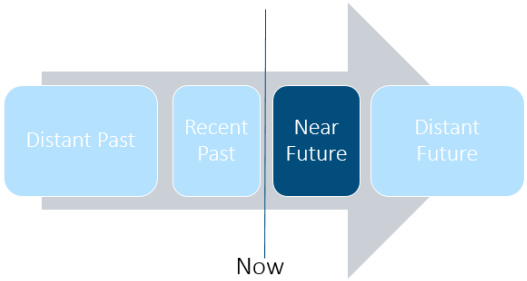
Alternative Approach: Guaranteed Premium

- Rather than having policies with fixed benefits and non-guaranteed premiums, have policies with guaranteed premiums and non-guaranteed maximum lifetime benefits
- Actuaries ensure solvency of plan by adjusting benefit level (rather than premiums)
- Adverse experience results in lower maximum benefit levels rather than higher premiums
- Benefit adjustments are gradually phased in and aren't finalized until the time of claim
- Lower margins are required
- Benefit levels increase in positive scenarios

Advantages of Guaranteed Premium LTC

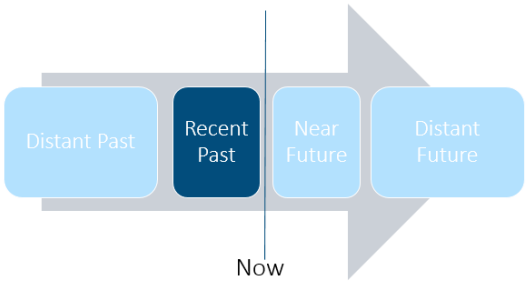
- Insurance leverage still happens—most of premiums go into fund, fund grows with interest, and money in fund from lapsed or deceased members used to fund care of members that file claims.
- **Premiums guaranteed**. No risk of premium increases.
- If future experience is better than predicted, benefit levels will increase—policyholders get the reward of positive experience.
- Lower premiums—since the benefit level is finalized at the time of claim rather than when the premiums are being paid—typically 20 years or more earlier—lower margins are required.

Immediate Future



- Budget forecasts (the plan) over the next several quarters
- All of the key operational and financial metrics that drive results should be included in plan
- The metrics should show a range:
  - Results within range classified as according to plan
  - Results outside of range constitute statistical evidence that there is a problem

Immediate Past



- What caused the most recent financial results?
- What do we need to monitor more closely?
- What management action needs to happen?
- How can this be explained to stakeholders?

Bringing It All Together: Step 1

- A **first-principles model** has the following properties:
  - Mechanics of model replicate way business unfolds
  - This allows the assumptions of model to closely align with the emerging experience

Bringing it together, Step 2

- In a high-quality dashboard, compare the emerging experience to short-term projections over last 5 quarters.
- Extremely insightful way of seeing trends in the recent experience: early warning system.