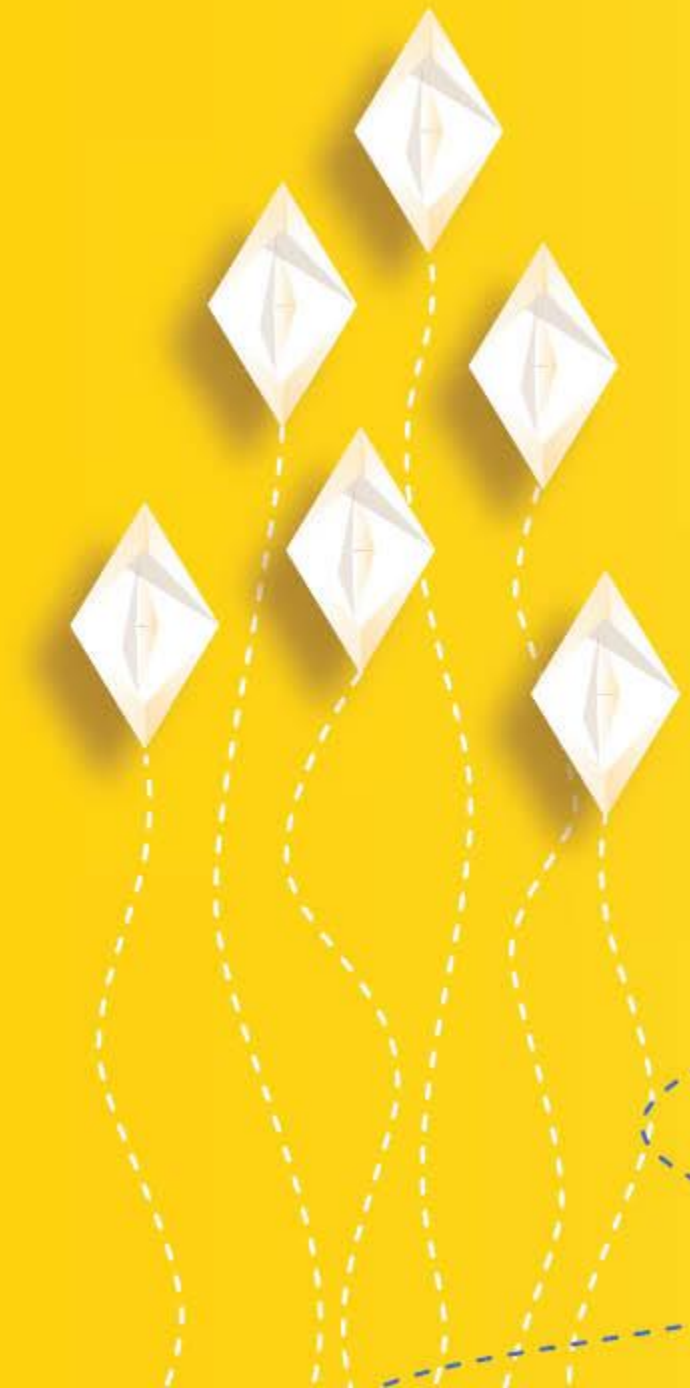
NAVIGATE.
PREDICT. LEAD.



SPRING MEETING

May 7–10, 2023
The Westin Boston Seaport District
Boston, MA

Antitrust Notice

- **The Casualty Actuarial Society is committed to adhering strictly to the letter and spirit of the antitrust laws. Seminars conducted under the auspices of the CAS are designed solely to provide a forum for the expression of various points of view on topics described in the programs or agendas for such meetings.**
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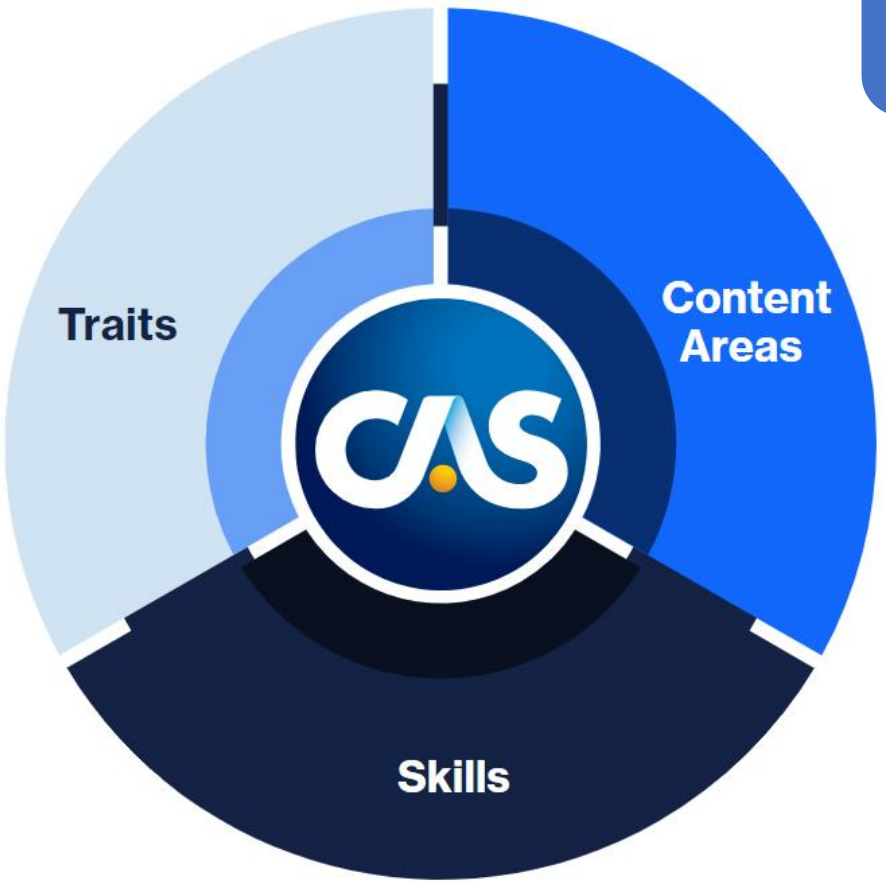
- **It is the responsibility of all seminar participants to be aware of antitrust regulations, to prevent any written or verbal discussions that appear to violate these laws, and to adhere in every respect to the CAS antitrust compliance policy.**

CAS Capability Model

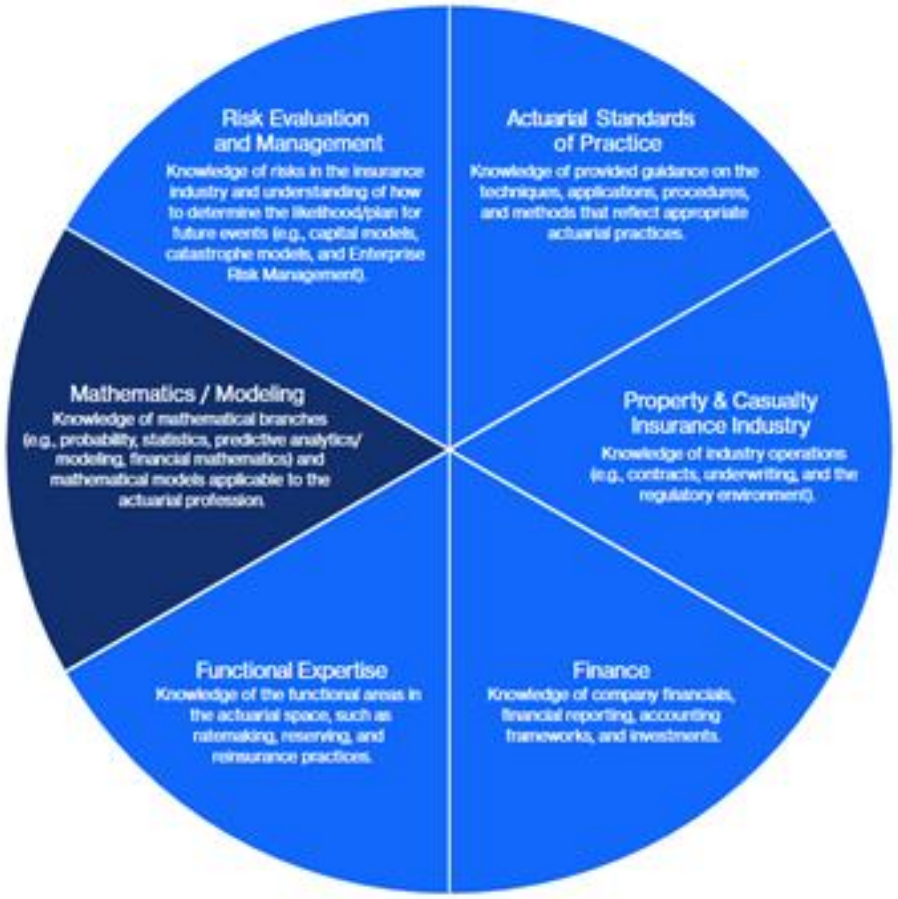
Visual framework that articulates and provides guidance on the traits, skills and knowledge important for most property/casualty actuaries



Use the model to self-assess your levels of professional attributes in 18 different areas

Then identify areas of opportunity to learn and grow and plan your professional development journey

CAS Capability Model



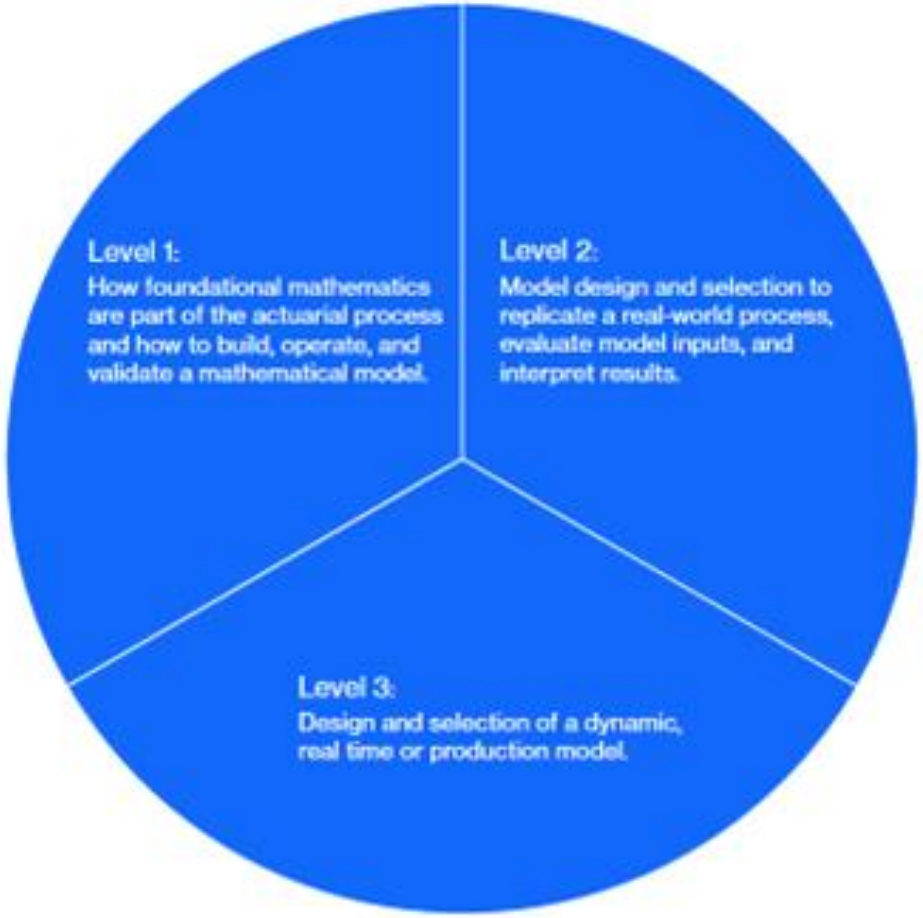
Content Area

Mathematics/Modeling

Knowledge of mathematical branches modeling

- **Predictive modeling**

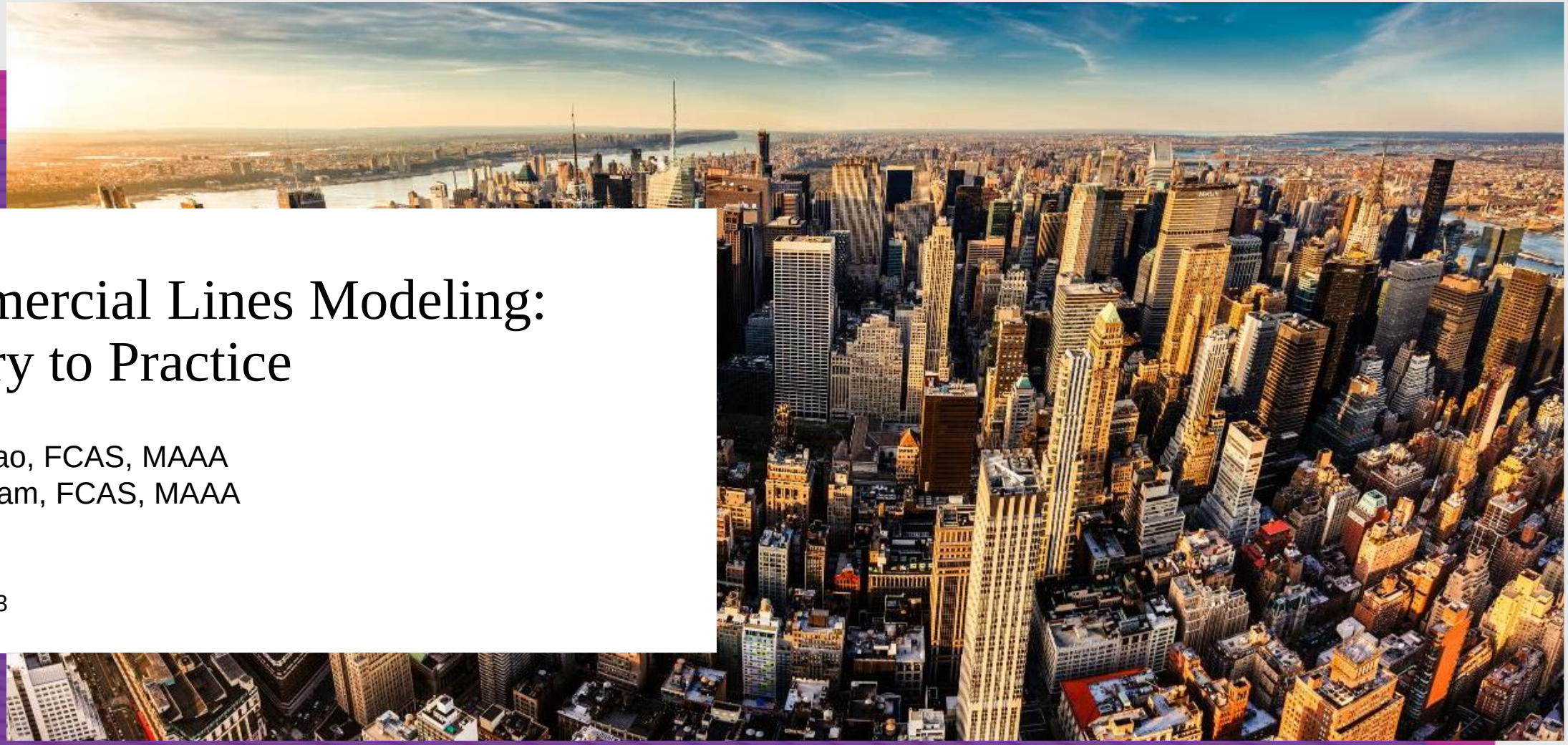
CAS Capability Model



Level 2

Model design and selection to replicate real-world process

- We will be discussing how to ensure your model builds are appropriate in common commercial lines cases



Commercial Lines Modeling: Theory to Practice

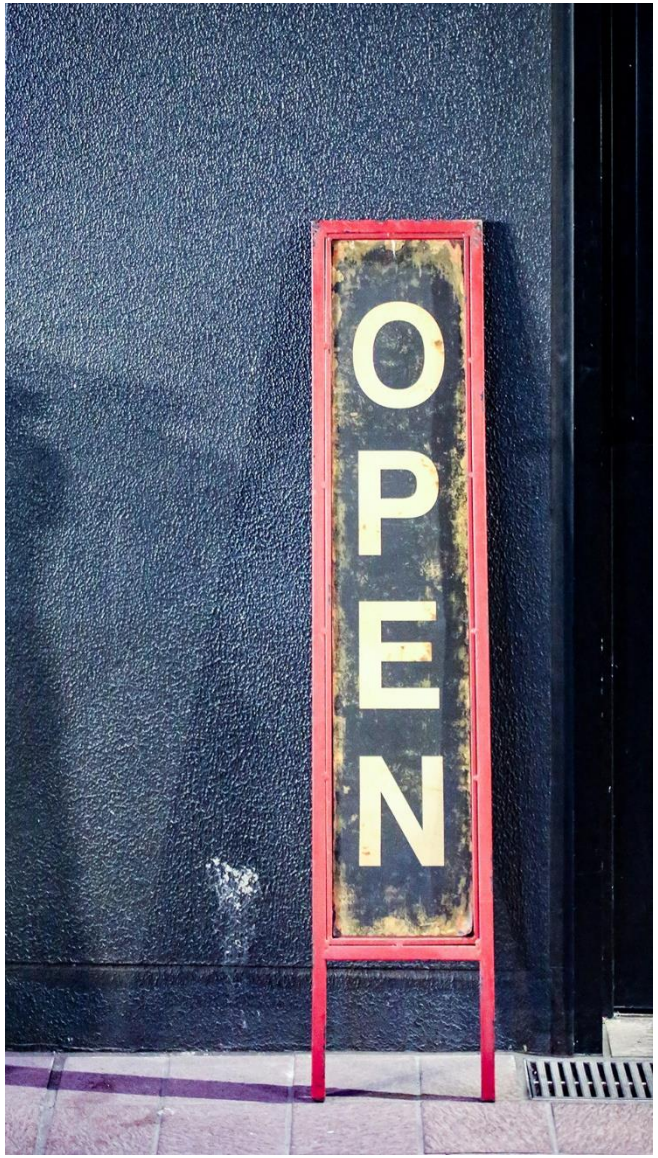
Helen Zhao, FCAS, MAAA
Justin Milam, FCAS, MAAA

May 10, 2023

Commercial Lines Modeling: Theory to Practice

Agenda

- Background of theoretical models
- The real world
- Varying exposure bases
- Inclusion of credit scores/tiering models
- Adjusting for debits and credits (IRPM)
- Building a GLM on top of bureau rating
- Loss development for claims made vs occurrence basis
- Handling endorsements
- How to handle third party data



Background of theoretical models

Background of theoretical models

Generalized Linear Models for Insurance Rating, Second Edition

- Components of the GLM
  - Systematic component: That portion of the variation in the outcomes that is related to the values of the predictors.
  - Random component: The portion of the outcome driven by causes other than the predictors in our model (including “pure randomness”)
- In a GLM, y—the target variable—is modeled as a random variable that follows a probability distribution. That distribution is assumed to be a member of the exponential family of distributions.
- GLMs model the relationship between μ_i (the model prediction) and the predictors as follows:

$$g(\mu_i) = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_p x_{ip}.$$

Background of theoretical models

Generalized Linear Models for Insurance Rating, Second Edition

Table 1. The Exponential Family Variance Functions

Distribution	Variance Function $[V(\mu)]$	Variance $[\phi V(\mu)]$
normal	1	ϕ
Poisson	μ	$\phi\mu$
gamma	μ^2	$\phi\mu^2$
inverse Gaussian	μ^3	$\phi\mu^3$
negative binomial[2]	$\mu(1+\kappa\mu)$	$\phi\mu(1+\kappa\mu)$
binomial	$\mu(1-\mu)$	$\phi\mu(1-\mu)$
Tweedie	μ^p	$\phi\mu^p$

Background of theoretical models

Generalized Linear Models' Key Assumptions

- The response variable "Y" does not need to be normally distributed, but the distribution is from an exponential family (e.g., binomial, Poisson, multinomial, normal)
- The original response variable need not have a linear relationship with the independent variables, but the transformed response variable (through the link function) is linearly dependent on the independent variables
- Assumes that the data is 100% credible
- Data should be independent and random (i.e., each random variable has the same probability distribution)
- Homoscedasticity (i.e constant variance) does not need to be satisfied. Response variable Error variance can increase, or decrease, with the independent variables.

The real world

The real world

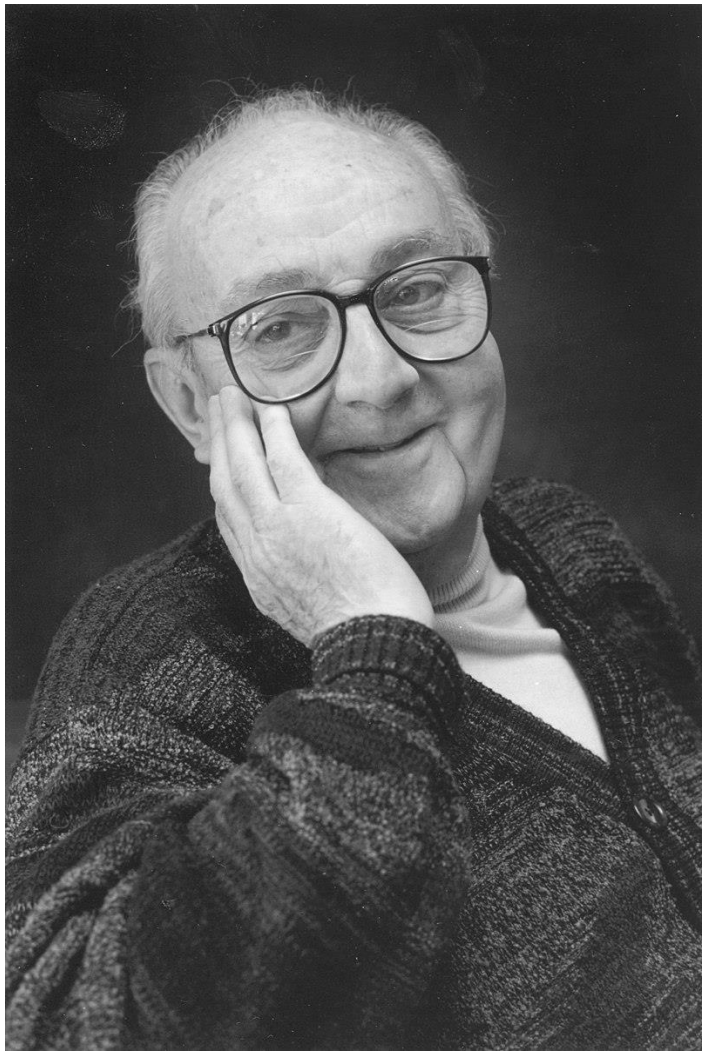
It’s important to recognize how close your model is to reality

All models are wrong but some are useful

-George E.P. Box, 1978

All models are wrong, but some models are useful. So the question you need to ask is not “Is the model true?” (it never is) but “Is the model good enough for this particular application?”

-Box et al, 2009



The real world

While all models are wrong, some are less useful than others

While personal lines risks such as private passenger auto are mostly homogeneous…

…many commercial lines risks are not

The real world

Commercial Lines Overview

- Commercial line products are designed to be offered to a wide variety of industries /classification groups
- In order to offer a product that is flexible enough to accommodate the insureds' ever-changing needs, carriers often offered the product as a package with hundreds of optional coverages

Energy

Financial Services

Hospitality

Manufacturing

Real Estate

Retail

The real world

Commercial Lines Ratemaking Considerations

- Rating considerations when pricing for commercial lines

Multiple Industry Segments

- Exposure Base = Proxy for the true exposure of risk for each industry segment
- Core coverage rating should be generalized enough for all industry segments

Market Size Consideration

- Rating variables and rates need to be suited for the target risk (SME vs MM vs Large Account)
- Rating structure may require additional flexibility depending on the target market

Rating Flexibility

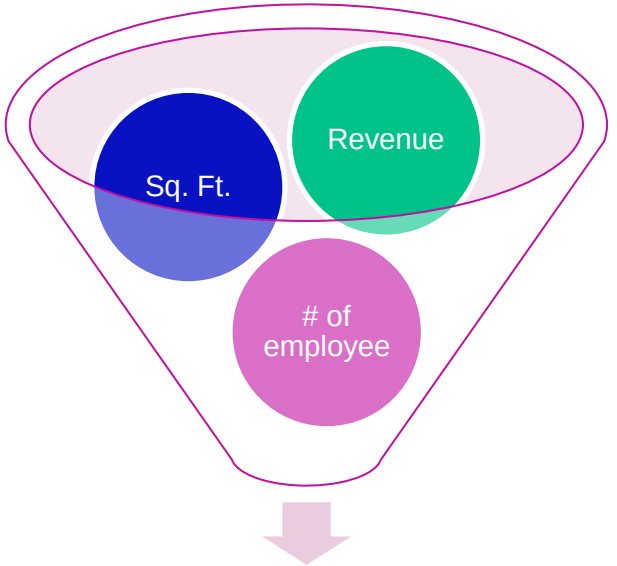
- Final premium should properly represent the project loss cost of the associate industry/ classification group
- Rating characteristics used in Sch Rating vs Manual Premium Calculation (avoid double counting)

Varying exposure bases

Varying exposure bases

Exposure base examples

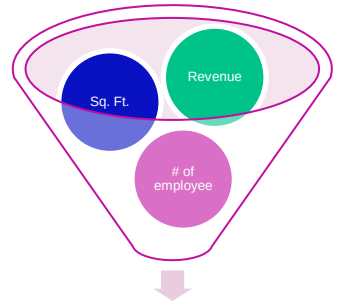
- Exposure base can vary by both the line of business (LOB) and class code / industry segment / occupancy type
- Examples of exposure base in property:
  - Total Insured Value (TIV) - most common
  - Gross Receipts
  - Number of objects
- Examples of exposure base in casualty:
  - Square footage
  - Number of employees
  - Revenue
  - Number of beds



General Liability Rating

Varying exposure bases

Predictive models with varying exposure bases



- Core coverage rating needs to accommodate for all eligible industry segments
  - There will be multiple exposure bases in casualty lines of business such as GL

01

Understand data and system requirements and limitations

02

Consider grouping industry segments with similar risk exposures

03

Evaluate correlations between exposure bases and other rating variables

04

Balance between overfitting to experience data vs. lack of modeled variables

Inclusion of credit scores/tiering models

Inclusion of credit scores/tiering models

Not all commercial risks will have credit scores like those available for PPA

When dealing with commercial risks, the legal structure of the business being insured could make the use of credit scores challenging

- A sole proprietor is likely to have a personal credit score
- Whose score do you use for a partnership?
- With an LLC, whose credit score (if any) to use is not always clear
- An S Corp will be even more difficult to determine the credit score to use, or even if it would be relevant
- An insurance company that writes small commercial business risks is likely to encounter all these legal entities for risks that are otherwise very similar

There are also business credit scores available, but they will likely be structured differently than a personal credit score

- Different range of scores
- Different characteristics used to quantify the scores

Inclusion of credit scores/tiering models

Considerations before building your model

01

Understand the value of including credit in pricing

02

Understand the regulatory environment(s)

03

Understand “business” interactions

04

Understand your UWG and target market(s)

Inclusion of credit scores/tiering models

Considerations before implementing

How will this look to the client?

How will this look to the agent?

Can this be manipulated?

Adjusting for debits and credits (IRPM)

Adjusting for debits and credits (IRPM)

IRPM can have different goals depending on the company and line of business

- IRPM: Individual Risk Premium Modifications
  - Used to make premium adjustments that are not included as part of the rating algorithm
  - Debits (increases)
  - Credits (decreases)
- Underwriters may use IRPM for different business purposes
  - Adjusting premium for unique risks that don’t fit perfectly in one class
    - Ex: How do you classify a butcher shop that also has three tables where they serve lunch?
  - Modifying premium for safety programs, employee training, prior losses, etc.

Adjusting for debits and credits (IRPM)

Considerations before building your model

01

What is included in determining debits and credits?

02

What is the purpose of including this in the model?

03

Are there business constraints to consider before modeling?

04

Organization of debits and credits into categories

Adjusting for debits and credits (IRPM)

Considerations before implementing

- Buy in from other business users
- Understand correlations and interactions
- Confirm there are no process changes

Building a GLM on top of bureau rating

Building a GLM on top of bureau rating

Why bureau rating?

- Due to data challenges, insurers often rely on bureau ratings (e.g., ISO, AAIS, NCCI) to provide guidance on how to set rates for various industry groups

Potential pros for using bureau rating

- Bureau rating is developed based on industry data = more credible rating analysis
- Allow rating of policies in industries / classification groups one may have limited to no data on
- Rating algorithms have been approved by the regulators = speed to market

Potential cons for using bureau rating

- Rating is developed based on industry data = not suitable for your portfolio mix
- Bureau rating is loss cost based = loss cost calibration is required
- Sophisticated rating variables (e.g., tier) are not included in the rating algorithm
- Subscription may be required

Building a GLM on top of bureau rating

Considerations when incorporating bureau rating

1. Understand data and system requirements and limitations

- Availability of data on risk characteristics not considered in the bureau rating
- Availability of credible data required for proprietary rating analysis

2. Understand the target portfolio mix and how that is different from industry benchmark

- Exposure distribution differences by industry segments or classification groups

3. Understand the target level rating sophistication desired

- Bureau rating + tier only
- Including rating deviations for all variables included in bureau rating + proprietary variables

4. Understand the cost benefit trade off between the various modeling techniques

- Residual Calculation: Actual losses vs Expected losses

Loss development for claims made vs occurrence basis

Loss development for claims made vs occurrence basis

Common modeling practice and its potential pitfall

- One of the common practices when performing a predictive modeling analysis is to include policy year in the model to control for the effect of loss cost levels across the different years
- When will this assumption/method not be appropriate?
  - High inflationary environment (including social inflation) causing different claims behaviors
  - Policies with different exposure bases have different development patterns
  - Policies with the same exposure base but from different industries may have different development patterns
  - Claims made policies and occurrence-based policies will have different development length

Loss development for claims made vs occurrence basis

Consideration for loss development patterns

01

What is the distribution of claims made vs occurrence basis policies?

02

What is the maturity of claims made policies in the data?

03

Are there enough data to develop separate models?

04

Are development pattern differences across different classification groups accounted for?

Handling endorsements

Handling endorsements

Understand how endorsements impact the line of business you are modeling

Endorsements typically expand, restrict, or change coverage

Endorsements are at times used by underwriters like IRPM debits

Recognizing when and how endorsements are used is key to ensuring they are modeled appropriately

Handling endorsements

Considerations before building your model

01

What is the endorsement used for?

02

How widespread is its use on your book?

03

What is the purpose of including it in the model?

04

How correlated is the endorsement with classes/other policy characteristics?

How to handle third party data

How to handle third party data

How to handle third party data

Considerations before choosing third party data sources

01

What are you trying to accomplish?

02

How will external data help you accomplish your goals?

03

How much time will it take to add third party data source(s) to your dataset?

04

Safety of your customer's personally identifiable information (PII)

05

Is there a realistic possibility of deployment?

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