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RPM WORKSHOP 1: BASIC RATEMAKING

Ratemaking Relativities

March 19, 2012
Philadelphia, PA

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EagleEye Analytics

INTRODUCTION TO RATEMAKING RELATIVITIES

Agenda

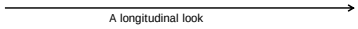
- Purposes & considerations of risk classification systems
- Implementation issues to consider
- Determining rate relativities

3

INTRODUCTION TO RATEMAKING RELATIVITIES

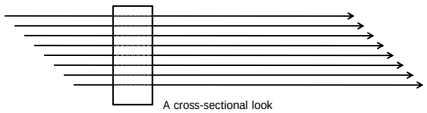
How might you determine a fair price for a given risk?

1. Wisdom and judgment
2. Examine that risk's experience over time



A longitudinal look

3. Examine the experience of similar risks



A cross-sectional look

4

INTRODUCTION TO RATEMAKING RELATIVITIES

"The grouping of risks with similar risk characteristics for the purpose of setting prices is a fundamental precept of any workable private, voluntary insurance system.

This process, called risk classification, is necessary to maintain a financially sound and equitable system.

It enables the development of equitable insurance prices, which in turn assures the availability of needed coverage to the public.

This is achieved through the grouping of risks to determine averages and the application of these averages to individuals." (page 1)

Note: all quotes in this presentation are from the American Academy of Actuaries' Risk Classification Statement of Principles. Only page numbers will be noted.

5

PURPOSE OF RISK CLASSIFICATION

Three purposes of risk classification:

1. Protect an insurer's financial soundness
2. Enhance fairness
3. Provide an insurer with economic incentive to write large portions of the market

6

PURPOSE OF RISK CLASSIFICATION

Adverse selection occurs when economic forces are not in equilibrium: when buyers move in, out, and throughout the market.

For example…

- Group A expected costs = $100
- Group B expected costs = $200
- Your company charges $150 for both
- Competitor charges $100 for A and $200 for B
- Assume you still make money at a 60% loss ratio

7

PURPOSE OF RISK CLASSIFICATION

At time 0, you price to the total…

YOU	Current Exp	Price	Expected Prem	Expected Loss	Expected LR
Group A	10,000	$150	$1,500,000	$900,000	60.0%
Group B	10,000	$150	$1,500,000	$900,000	60.0%
Total	20,000	$150	$3,000,000	$1,800,000	60.0%

Your competitor changes their price to match the cost…

Competitor	Current Exp	Price	Expected Prem	Expected Loss	Expected LR
Group A	10,000	$100	$1,000,000	$600,000	60.0%
Group B	10,000	$200	$2,000,000	$1,200,000	60.0%
Total	20,000	$150	$3,000,000	$1,800,000	60.0%

What happens during the next year at these prices?

8

PURPOSE OF RISK CLASSIFICATION

Assume ¼ of customers shop at renewal. During year 1…

YOU	Actual Exp	Ave Prem	Actual Prem	Actual Loss	Actual LR
Group A	7,500	$150	$1,125,000	$450,000	40.0%
Group B	12,500	$150	$1,875,000	$1,500,000	80.0%
Total	20,000	$150	$3,000,000	$1,950,000	**65.0%**

Group A shoppers all choose your competitor.
Group B shoppers all choose you.

Competitor	Actual Exp	Ave Prem	Actual Prem	Actual Loss	Actual LR
Group A	12,500	$100	$1,250,000	$750,000	60.0%
Group B	7,500	$200	$1,500,000	$900,000	60.0%
Total	20,000	$150	$2,750,000	$1,650,000	60.0%

You don't know about Group A or B. You just see a rate need.

9

PURPOSE OF RISK CLASSIFICATION

At time 1, you think you need an 8.3% increase…

YOU	Current Exp	New Price	Expected Prem	Expected Loss	Expected LR
Group A	7,500	$163	$1,218,750	$731,250	60.0%
Group B	12,500	$163	$2,031,250	$1,218,750	60.0%
Total	20,000	$163	$3,250,000	$1,950,000	**60.0%**

With your new rates, you *expect* to be back at a 60% loss ratio. But what happens during the year?

Competitor	Current Exp	New Price	Expected Prem	Expected Loss	Expected LR
Group A	12,500	$100	$1,250,000	$750,000	60.0%
Group B	7,500	$200	$1,500,000	$900,000	60.0%
Total	20,000	$138	$2,750,000	$1,650,000	60.0%

Note: Your competitor didn't have to change its prices.

10

PURPOSE OF RISK CLASSIFICATION

But during year 2, the mix shifts more…

YOU	Actual Exp	Ave Prem	Actual Prem	Actual Loss	Actual LR
Group A	5,625	$163	$914,063	$337,500	36.9%
Group B	14,375	$163	$2,335,938	$1,725,000	73.8%
Total	20,000	$163	$3,250,000	$2,062,500	**63.5%**

Even with your rate increase, you continue to lose money…

Competitor	Actual Exp	Ave Prem	Actual Prem	Actual Loss	Actual LR
Group A	14,375	$100	$1,437,500	$862,500	60.0%
Group B	5,625	$200	$1,125,000	$675,000	60.0%
Total	20,000	$128	$2,562,500	$1,537,500	60.0%

…and your competitor continues to make money.

11

PURPOSE OF RISK CLASSIFICATION

Several notes on the example…

- Your primary defense against adverse selection is risk classification.
  - *Purpose 1: Protect an insurer's financial soundness*
- Because they were properly priced, your competitor was happy to write the whole market.
  - *Purpose 3: Provide an insurer with economic incentive to write large portions of the market*
- Because no subsidization was occurring and each insured's price matched its average risk, your competitor's prices were more fair.
  - *Purpose 2: Enhance fairness*

12

RISK CLASSIFICATION CONSIDERATIONS

How a risk classification system is designed will affect its ability to achieve the three purposes. We'll consider…

- Underwriting
- Marketing
- Program design
- Statistical considerations
- Operational considerations
- Hazard reduction
- Public acceptability
- Causality
- Controllability

13

RISK CLASSIFICATION CONSIDERATIONS

Consider the following potential predictors…

- Having Blue Eyes
- Driving a Red Car
- Living in a Flood Plane
- Current Limits
- Electronic Stability Control
- Credit
- Miles Driven

14

IMPLEMENTING RATE RELATIVITIES

Fixed Expenses and "Expense Flattening"

Relativities are found using losses. Consequently, the adjustment is applicable only to the loss portion of the premium.

Companies tend to handle fixed expenses in one of two ways…

1. Use a separate fixed expense fee
   Premium = (Base Rate)(Rate Rels) + (Expense Fee)*
   In this case, there is no need to adjust the calculated rate relativities!

2. Incorporate fixed expenses implicitly within the base rate
   Premium = (Base Rate)(Rate Rels)*
   In this case, you must "flatten" the calculated rate relativities!

15

IMPLEMENTING RATE RELATIVITIES

Fixed Expenses and "Expense Flattening"

Since the premium, P, is…

$$P = \frac{LC + FED}{1 - VEL}$$

where LC = loss cost, FED = fixed expense dollars, VEL = variable expense load.

…we can express the new adjusted premium, P', as…

$$P' = \frac{LC(R) + FED}{1 - VEL} = \frac{(LC + FED)R_F}{1 - VEL} = P(R_F)$$

where R = calculated relativity, R_F = expense flattened relativity

Solving for R_F we get…

$$R_F = \frac{(1 - VEL - FEL)R + FEL}{1 - VEL}$$

where FEL = fixed expense load (the fixed expense expressed as a percent of premium)

16

IMPLEMENTING RATE RELATIVITIES

Fixed Expenses and "Expense Flattening"

Consider a situation where… LC = \$120 VEL = 0.22 FED = \$32

The unadjusted premium would be…

$$P = \frac{\$120 + \$32}{1 - 0.22} = \frac{\$152}{0.78} = \$194.87$$

If the relativity is 1.50, then the correct new premium would be…

$$P = \frac{\$120(1.5) + \$32}{1 - 0.22} = \frac{\$180 + 32}{0.78} = \frac{\$212}{0.78} = \$271.79$$

By implication, R_F would be…

$$R_F = \frac{P'}{P} = \frac{\$271.79}{\$194.87} = 1.395$$

Find R_F using the formula for expense flattening.

17

IMPLEMENTING RATE RELATIVITIES

Fixed Expenses and "Expense Flattening"

Consider a situation where… LC = \$120 VEL = 0.22 FED = \$32

The unadjusted premium would be… R=1.50

$$P = \frac{\$120 + \$32}{1 - 0.22} = \frac{\$152}{0.78} = \$194.87$$

The formula for expense flattening is…

$$R_F = \frac{(1 - VEL - FEL)R + FEL}{1 - VEL}$$

So, we need FEL…

$$FEL = \frac{FED}{P} = \frac{\$32}{\$194.87} = 0.164$$

And finally…

$$R_F = \frac{(1 - 0.22 - 0.164)(1.5) + 0.164}{1 - 0.22} = 1.395$$

18

IMPLEMENTING RATE RELATIVITIES

Rate Impact and Off-Balance

Remember that the overall rate need is determined completely separately from any rate relativity changes.

You find that the rate relativities for Fire Hydrant Distance (FHD) need to be modified.

Currently, houses within 3 miles of a fire hydrant are the base. Houses greater than 3 miles from a hydrant are surcharged 20%.

You believe the surcharge should be changed to 40%. Will this not increase the premium taken in? Will this not impact the overall rate level?

19

IMPLEMENTING RATE RELATIVITIES

Rate Impact and Off-Balance

All relativity changes have the potential to impact the overall rate level.

The **rate impact** is the change in the overall rate level that any relativity change would cause in and of itself.

The **off-balance** is the adjustment to the base rates needed to off-set the rate impact so that the total change is revenue neutral.

The off-balance is the inverse of the rate impact.

20

IMPLEMENTING RATE RELATIVITIES

Rate Impact and Off-Balance

There are at least three ways to calculate the rate impact.

1. Exposure-weighted average rate impact
   Simplest and least accurate. Used when premium and a rerating approach are not available.
2. Premium-weighted average rate impact
   Most accurate approach when a rerating approach is not available. Fails when multiple changes are made.
3. Rerated rate impact
   Works even when multiple changes are made. Can calculate total rate impacts.

21

IMPLEMENTING RATE RELATIVITIES

Rate Impact and Off-Balance

Consider again, the current surcharge for being far from a fire hydrant is 20%. You are changing it to 40%.

The exposure-weighted method…

FHD	Exposures	Current Rel	New Rel
0-3	12,000	1.00	1.00
3+	8,000	1.20	1.40
Total	20,000	1.08	1.16
		Rate Impact	7.4%
		=1.16/1.08 - 1	
		Off-balance	-6.9%
		=1/(1+.074) - 1	

Other relativities may impact the average premium of each class. This method ignores that.

22

IMPLEMENTING RATE RELATIVITIES

Rate Impact and Off-Balance

Consider again, the current surcharge for being far from a fire hydrant is 20%. You are changing it to 40%.

The premium-weighted method…

FHD	Exposures	Current Prem	Current Rel	Base Prem	New Rel	New Prem
0-3	12,000	14,142,000	1.00	14,142,000	1.00	14,142,000
3+	8,000	8,061,000	1.20	6,717,500	1.40	9,404,500
Total	20,000	22,203,000		20,859,500		23,546,500
					Rate Impact	6.1%
					=23,546,500/22,203,000 – 1	
					Off-balance	-5.7%
					=1/(1+.061) - 1	

This method assumes that every other relativity, the relativities that generated those premiums, are correct. If you are simultaneously changing other relativities, this is a dubious assumption.

23

IMPLEMENTING RATE RELATIVITIES

Rate Impact and Off-Balance

Consider again, the current surcharge for being far from a fire hydrant is 20%. You are changing it to 40%.

The rerating method…

This method works entirely differently. Assume, as before, that the collected premium under the old rate relativities is $22,203,000.

Record by record, recalculate the historical premium as if the new relativities were used. This requires extensive preparation and computing power.

If the rerated premium is $24,667,000 using the new relativities, then the premium increased 11.1%, and that is the rate impact.

24

DETERMINING RATE RELATIVITIES

Rates are considered to have two pieces:

Overall Rate Level & Rate Relativity

Why?

Having the overall rate separate lets you…

a) Use all the experience to find overall indications.
b) Use overall trends and development.
c) Gives the most credible answer by using all the data.

Determining correct rate rels requires dealing with all the complexity of different rates…

a) Slicing and dicing data.
b) Dealing with the multivariate nature of the problem.
c) Can ignore trends and loss dev – everything's relative!

What assumption do you make by saying trends and loss dev can be ignored?

25

DETERMINING RATE RELATIVITIES

Two approaches for determining rate relativities:

Keep what you have in place and look only to alterations or additions

- Examine existing loss ratios
- Compare actual and expected loss ratio
- Requires current-leveled premium, but allows for modifications to existing factors

Throw out what you have and start from scratch

- Model loss costs, or alternatively frequency and severity
- Develop expected cost per unit of exposure
- Assumes a from-the-ground-up approach

26

DETERMINING RATE RELATIVITIES

Pure Premium Method - Univariate

Class	Exposure	Losses	Pure Premium	Proposed Relativity
1	6,195	$759,281	$123	1.00
2	7,508	$1,472,719	$196	1.60

27

DETERMINING RATE RELATIVITIES

Pure Premium Method – Univariate
Solve for the rate relativities

Age	*Exposure*	*Loss*	*Loss Cost*	*Relativity*
Younger	150	6,000		
Older	1000	12,500		1.00
Total	1,150	18,500		

Points	*Exposure*	*Loss*	*Loss Cost*	*Relativity*
Clean	550	6,500		1.00
Pointed	600	12,000		
Total	1,150	18,500		

28

DETERMINING RATE RELATIVITIES

Pure Premium Method – Univariate
Solve for the rate relativities

Age	*Exposure*	*Loss*	*Loss Cost*	*Relativity*
Younger	150	6,000	40.0	3.20
Older	1000	12,500	12.5	1.00
Total	1,150	18,500		

Points	*Exposure*	*Loss*	*Loss Cost*	*Relativity*
Clean	550	6,500	11.8	1.00
Pointed	600	12,000	20.0	1.69
Total	1,150	18,500		

Where's the problem?

How much should we charge younger, pointed drivers?

3.20 * 1.69 = 5.42

Or, 5.42 times as much as we charge older, clean drivers.

29

DETERMINING RATE RELATIVITIES

Pure Premium Method – Multivariate
Solve for the rate relativities again

Age	Points	*Exposure*	*Loss*	*Loss Cost*	*Relativity*
Younger	*Clean*	50	1,500		
Younger	*Pointed*	100	4,500		
Older	*Clean*	500	5,000		
Older	*Pointed*	500	7,500		
Total		1,150	18,500		

30

DETERMINING RATE RELATIVITIES

Pure Premium Method – Multivariate
Solve for the rate relativities again

Age	Points	Exposure	Loss	Loss Cost	Relativity
Younger	Clean	50	1,500	30.0	3.00
Younger	Pointed	100	4,500	45.0	4.50
Older	Clean	500	5,000	10.0	1.00
Older	Pointed	500	7,500	15.0	1.50
Total		1,150	18,500		

Our previous estimate was 5.42

Now we charge younger, pointed drivers 4.5 times as much as the base driver.

What we have here is a correlation of the exposure distributions of Age and Points.

31

DETERMINING RATE RELATIVITIES

Point of Confusion: Correlation versus Interaction

Correlations between two variables' exposure distributions cause the results to be linked. This is NOT an interaction. It is an important effect and using multivariate techniques solves this problem. Often referred to as "double counting" the effect of a predictor.

Interactions are correlations between two variables' indicated factors. When you don't know what factor to use until both variables are specified, you have an interaction.

It is perfectly possible for two variables to be correlated but have no interaction. It is also possible for two variables to have an interaction but not be correlated!

32

DETERMINING RATE RELATIVITIES

Correlation of exposure distributions – no Interaction of fields

Exposure	Clean	Pointed	Total
Younger	50	100	150
Older	500	500	1000
Total	550	600	1,150

Loss	Clean	Pointed	Total
Younger	1,500	4,500	6,000
Older	5,000	7,500	12,500
Total	6,500	12,000	18,500

Loss Cost	Clean	Pointed
Younger	30.0	45.0
Older	10.0	15.0

33

DETERMINING RATE RELATIVITIES

Interaction of fields –
no Correlation of exposure distributions

Exposure	*Clean*	*Pointed*	*Total*
Younger	50	100	150
Older	450	900	1,350
Total	500	1,000	1,500

Loss	*Clean*	*Pointed*	*Total*
Younger	1,500	6,000	7,500
Older	6,750	40,500	47,250
Total	8,250	46,500	54,750

Loss Cost	*Clean*	*Pointed*
Younger	30.0	60.0
Older	15.0	45.0

34

DETERMINING RATE RELATIVITIES

Insurance is inherently a stochastic (random) process.

Any set of data you examine will contain random results in addition to true relationships.

$$\textit{Dependent Variable} = \textit{Signal} + \textit{Noise}$$

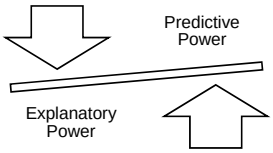
$$\textit{Dependent Variable} = \textit{Systematic Component} + \textit{Random Component}$$

The presence of noise along with our signal is the basic reason credibility was conceived. Due to the presence of noise, we don't fully believe our point estimate.

35

DETERMINING RATE RELATIVITIES

Modeling of any variety is a balance act…



Ultimately, we want to find signal and not noise. Signal represents true relationships which will persist over time. Noise is a random event which will likely not repeat.

36

DETERMINING RATE RELATIVITIES

Multivariate Loss Cost Approaches

Multi-way loss cost tables
- Smaller & smaller segments
- No estimate of noise. Incorporate credibility weighting.

Minimum Bias
- Can handle many predictors, but still be done in Excel.
- No estimate of noise.

GLM
- Generalization of classical linear models. [y = mx + b]
- Gives estimate of noise: significance testing; confidence intervals

GIA
- Generalization of minimum bias models. (Fu, Wu, 2007)
- More flexible model assumptions than GLM.

37

DETERMINING RATE RELATIVITIES

Loss Ratio Method - Univariate

Class	Premium @CRL	Losses	Loss Ratio	Loss Ratio Adjustment		
1	$1,168,125	$759,281	0.65	1.00		
2	$2,831,500	$1,472,719	0.52	0.80		

Which class is the higher risk?

38

DETERMINING RATE RELATIVITIES

Loss Ratio Method - Univariate

Class	Premium @CRL	Losses	Loss Ratio	Loss Ratio Adjustment	Current Relativity	Proposed Relativity
1	$1,168,125	$759,281	0.65	1.00	1.00	1.00
2	$2,831,500	$1,472,719	0.52	0.80	2.00	1.60

Which class is the higher risk?

39

DETERMINING RATE RELATIVITIES

Advantages of using Loss Ratio

Even one-way loss ratios are inherently multivariate because the premium "takes into account" the rest of the class plan.

For example, if you look at the relative loss ratios between youthful and adult drivers, the premium within that loss ratio will reflect the current factors for points.

Because youthfuls have a higher percentage of points, their average premium will be higher due to the higher pointed factors. This will lower the loss ratio. In this way we don't "double count" the effect of points and age.

40

DETERMINING RATE RELATIVITIES

Why aren't one-way loss ratios sufficient?

One-way studies using loss ratios assume that the rest of the class plan is good. This is a big assumption when there are multiple changes which need to be made.

Suppose you want to examine the adequacy of both your age and points curves. When you look at loss ratios by age, you are assuming your current points factors are good. Vice versa for when you look at loss ratios by points.

Univariate studies of any type will also not uncover interactions.

41

DETERMINING RATE RELATIVITIES

Multivariate Loss Ratio Approaches

Machine Learning / Data Mining

- Search the residual space after the existing model has predicted risk.
- Is there signal that the underlying rates have missed?
- Uses techniques like trees and clustering.
- Can use sampling, bootstrapping, bagging, etc. to understand model stability and enhance model results.
- Prone to over-fitting models. Must make use of unseen validation data to evaluate and select models.

42

DETERMINING RATE RELATIVITIES

Summary of Approaches for Determining Relativities

Univariate Loss Ratios	Univariate Loss Costs
• Allows for correlation of exposures, but assumes the rest of the class plan rels are correct • Ignores interactions	• Ignores correlation of exposures • Ignores interactions
Multivariate Loss Ratios	**Multivariate Loss Costs**
• Explore residual space using an automated routine (trees, machine learning, data mining) • Allows for correlation of exposures • Good at finding interactions • Must validate results	• Build a model from the ground up (GLM, GIA, Minimum Bias) • Allows for correlation of exposures • Allows for interactions • Difficult to explore entire solution space

43

DETERMINING RATE RELATIVITIES

Summary of Implementation Issues

Expense Flattening
• Are fixed expenses handled as a separate fee or not? • Flatten rate relativities if they were determined by looking at losses but will be applied to the loss and fixed expense portion of the premium
Rate Impact and Off-Balance
• Determine the rate impact of any rate relativity changes. • Off-balance the base rates so that the overall rate change is unaffected.

44

DETERMINING RATE RELATIVITIES

Summary of Risk Classification Purpose & Considerations

Purposes of a Risk Classification System
• Protect an insurer's financial soundness • Enhance fairness • Provide an insurer with economic incentive to write large portions of the market
Considerations when using a Risk Classification System
• Underwriting & Marketing • Program design • Statistical & Operational considerations • Hazard reduction, Public acceptability, Causality, and Controllability

45

RPM WORKSHOP 1: BASIC RATEMAKING

QUESTIONS?

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