Exploring the Fundamental Insurance Equation

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Purpose of an Indication

An indication calculates the percent change in premium needed to cover ***expected future*** losses and expenses while making targeted underwriting profit for policies written and renewed during the following 12 month time period

The purpose of the indication is ***not*** to recoup losses paid out in the past

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Fundamental Insurance Equation

- CAS Statement of Principle: "A rate provides for **all costs** associated with the transfer of risk."
- **Premium** = **Losses** + **LAE** + **UW Expenses** + **UW Profit**
- Key is to find appropriate balance
  - Ratemaking is prospective
  - Balance should be attained at the **aggregate** and individual levels
  - CAS Statement of Principles Regarding Ratemaking

Two Methods to Determine Rate Level Adequacy

- Pure Premium Method

$$\text{Indicated Avg Rate} = \frac{\text{Pure Prem (including LAE)} + \text{Fixed UW Expense Per Exposure}}{1.0 - \text{Variable Expense \%} - \text{Target UW Profit \%}}$$

$$\text{Indicated Change} = \frac{\text{Indicated Avg Rate}}{\text{Projected Avg Premium @ Current Rate Level}}$$

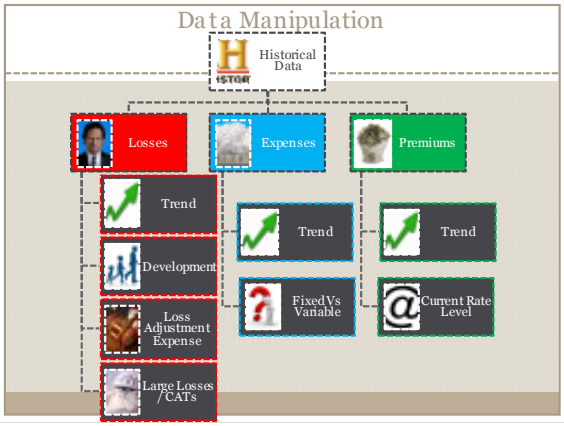
- Loss Ratio Method

$$\text{Indicated Change} = \frac{\text{Loss \& LAE Ratio} + \text{Fixed Expense Ratio}}{1.0 - \text{Variable Expense \%} - \text{Target UW Profit \%}}$$

Pure Premium Vs. Loss Ratio

When to use Pure Premium Method	When to use Loss Ratio Method
Historical premium data is unreliable/volatile	Historical exposure data is unreliable/changing
New company	Exposures are not well defined

Data Manipulation



Exposures

- Must Be **P**roportional
  - Losses should be highly correlated with exposures
- Must Be **P**ractical
  - Easy, Objective, and Inexpensive
- Must Consider Historical **P**recedence
  - Regulators and Transition Costs

Data Aggregation for Losses

- **Calendar Year**
  - Transactional
  - Fixed at year end
- **Accident Year**
  - Tied back to when accident occurs
  - Will develop over time
- **Policy Year**
  - Tied back to when policy was written
  - Will develop over time
- **Report Year**
  - Tied back to when accident was reported
  - Will develop over time

- **Single Example**
  - 12-month policy
  - Policy written 11/1/17
  - Accident occurs 10/1/18
  - Accident reported 1/15/19
  - Payment of 10k on 2/1/19
  - Payment of 5k on 5/1/20

Data Aggregation for Losses

- Given the information on the last slide, how much loss is attributed to:
  - Calendar Year 2017? 2018? 2019? 2020?
  - Accident Year 2017? 2018? 2019? 2020?
  - Policy Year 2017? 2018? 2019? 2020?
  - Report Year 2017? 2018? 2019? 2020?

Data Aggregation for Losses

- Given the information on the last slide, how much loss is attributed to:
  - Calendar Year
    - 2017, 2018: $0
    - 2019: $10,000
    - 2020: $5,000
  - Accident Year
    - 2017, 2019, 2020: $0
    - 2018: $15,000
  - Policy Year
    - 2017: $15,000
    - 2018, 2019, 2020: $0
  - Report Year
    - 2017, 2018, 2020: $0
    - 2019: $15,000

Detailed Calculations

Development of statewide indicated rate level change

"In order to cover our future losses and expenses and make our desired profit, we need to increase our current premium by 16.2%"

1	Indicated provision for loss and loss adjustment expense	$117.48
2	Indicated provision for fixed expense	$15.46
3	Variable expense and profit ratio	28.7%
4	Indicated average premium [(1) + (2)] ÷ [1 - (3)]	$186.45
5	Projected average earned premium at current rates	$160.51
6	Indicated rate level change [(4) ÷ (5)] - 1	16.2%

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Step 1

Development of Indicated Provision for Loss and Loss-Adjustment Expense

Detailed Calculations

Development of statewide indicated rate level change

"How much do we expect to pay for future losses?"

1	Indicated provision for loss and loss adjustment expense	$117.48
2	Indicated provision for fixed expense	$15.46
3	Variable expense and profit ratio	28.7%
4	Indicated average premium [(1) + (2)] ÷ [1 - (3)]	$186.45
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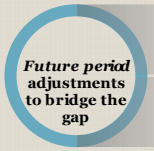
Adjustments to Losses

The first step in estimating the future losses is to start with the historical accident year losses. Single year or multiple, depending on credibility of historical data

However, because we are pricing for a ***future period***, there are adjustments that are needed in order to bridge the gap



Loss Development

Trend

Adjustments to Losses

Loss development

- Technique of using historical patterns to estimate the ultimate loss amount based on losses incurred or paid to date
- WHY?? Accident Year losses develop for two reasons
  1. ***New losses*** emerge after year end
  2. ***Incurred loss*** (paid + reserve) ***on known claims increase*** because either
     a. Reserves are increased

     or

     b. Paid loss exceeds the case reserve

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Loss Development Methods

- Each method makes assumptions about the nature of loss development.
- Each method makes assumptions about future loss development based on past loss development.
- The appropriateness of those assumptions influences the accuracy of the method. Therefore, the best method depends on the situation at hand.
- Common Methods include:
  - Chain Ladder Method – Next Slide
  - Expected Loss Ratio (ELR) Method – A Priori Loss Ratio
  - Bornhuetter-Ferguson (BF) – Blending of Actual and Expected
  - Berquist-Sherman (B-S) – Adjusts for Reserving/Payment Patterns
  - Regression – Linear or Exponential (Curve Fitting)

Detailed Calculations

Step 1

Development of Indicated Provision for Loss and Loss-Adjustment Expense Comprehensive Coverage

Physical damage coverages tend to settle quickly with little development

Paid Loss

FAY	15 Months	27 Months	39 Months	51 Months	63 Months	75 Months	87 Months
12/31/2009	2,997,407	3,087,330	3,149,076	3,180,567	3,180,567	3,180,567	3,180,567
12/31/2010	4,727,364	4,869,185	4,966,568	5,016,234	5,016,234	5,016,234	5,016,234
12/31/2011	4,064,114	4,186,038	4,269,758	4,312,456	4,312,456	4,312,456	4,312,456
12/31/2012	4,421,474	4,554,119	4,645,201	4,691,653	4,691,653	4,691,653	
12/31/2013	5,954,188	6,132,814	6,255,470	6,318,025	6,318,025		
12/31/2014	4,734,276	4,828,961	4,973,830	5,023,568			
12/31/2015	2,847,187	2,961,074	2,990,685				
12/31/2016	2,445,244	2,518,601					
12/31/2017	3,612,634						

Estimate of "ultimate" losses for AY ending 12/31/2017 is $3,612,634 x 1.03 x 1.02 x 1.01 x 1.00 x 1.00 x 1.00 = $3,833,388

	15-27	27-39	39-51	51-63	63-75	75-87(ultimate)
2nd prior	1.02	1.02	1.01	1.00	1.00	1.00
1st prior	1.04	1.03	1.01	1.00	1.00	1.00
Current year	1.03	1.01	1.01	1.00	1.00	1.00
3 year average	*1.03*	*1.02*	*1.01*	*1.00*	*1.00*	*1.00*

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Discussion: Spring 2015, Question 22

- An actuary is using the development technique based on accident year data to calculate ultimate claim estimates at 12 months maturity. For each issue provided below, briefly discuss how it may impact the analysis and propose an appropriate response to mitigate the issue.
  - The actuary observes a long development pattern
  - Tort reforms anticipated to decrease severity on all open and future claims were recently enacted
  - In recent years, policies have been written with higher deductibles than in prior years
  - The insurer has implemented a new claims system that allows faster processing of claims

Discussion: Spring 2015, Question 22

- The actuary observes a long development pattern
  - Early maturities are highly leveraged. Use BF Method.
  - Claims at early maturities will be volatile, which can cause incorrect estimates. Expected claim method can be used instead.
- Tort reforms anticipated to decrease severity on all open and future claims were recently enacted
  - Overstates estimation based on historical claims. Use report year data as it will address the issue.
  - It would cause lower true cumulative development factor (CDF) than historical. To mitigate the issue use a frequency-severity technique and modify the severity.

Discussion: Spring 2015, Question 22

- In recent years, policies have been written with higher deductibles than in prior years
  - Probably will be more development in later periods since it will take longer for losses to reach deductible, as well as large losses more likely settled later. Restate all claims at new deductible levels to mitigate effect.
  - Mix of business will change after the higher deductibles. On average, insurer will pay less and so development technique based on historical data will overestimate. Policy Year data should be used to neutralize or isolate the change.
- The insurer has implemented a new claims system that allows faster processing of claims
  - Overstates estimation, CDF developed based on historical data will be higher than actual. Use B-S to account for change.

Trend

Trend

Trend

Trend

- Why?
  - To estimate **future** values in order to account for expected differences between the historical period and the period for which rates are being set
- How?
  - Identify trend amount
  - Identify trend period

Adjustments to Losses - Trend

Historical experience period

"Trends"

"Projections"

2015

2016

2017

Projection date

Projection date is average earned date for all policies written during the policy period

We can choose to assume a 1-year pricing period, yielding a projection date 9 months past the effective date for a 6 month policy, and 12 months past the effective date for an annual policy

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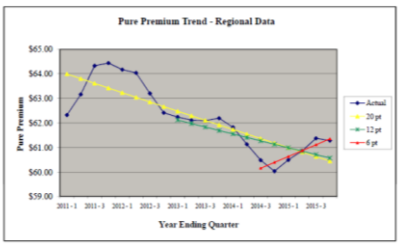
Trend Amount

Trend

Trend

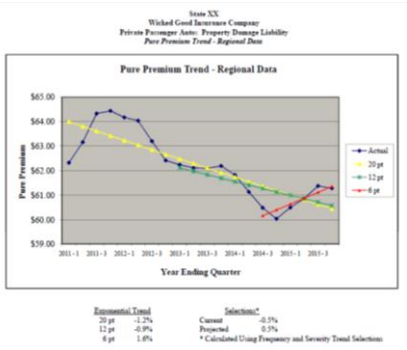
Trend

State XX
Wicked Good Insurance Company
Private Passenger Auto: Property Damage Liability
Pure Premium Trend - Regional Data



Exponential Trend	
20 pt	-1.2%
12 pt	-0.9%
6 pt	1.6%

Trend Amount



Credibility

- Where can credibility be used?
  - Overall indication
  - An individual loss estimate
  - Loss trends
  - Large Loss / CAT provisions
- How?
  - Choose a method
  - Choose a complement of credibility

Credibility Methods

- **Classical Credibility** (a.k.a Limited Fluctuation) – goal is to limit the effects that random fluctuations in the data can have on an estimate
- **Buhlmann Credibility** (a.k.a. Least Squares Credibility) – goal is to make estimation errors as small as possible (minimize the squared error)
- Credibility weighted estimate is calculated as
  Z * (Observed Estimate) + (1-Z) * (Complement)

Complement of Credibility

- Desired traits
  - 1) Accurate
  - 2) Unbiased
  - 3) Statistically independent from the base statistic
  - 4) Available
  - 5) Easy to compute
  - 6) Logical relationship to base statistic
- Examples include other lines of business, countrywide data, industry data, or other competitor information to name a few.

Complement of Credibility

- You are responsible for pricing an Alaska book of auto business for the year 2019.
- Your company began writing auto business in Alaska in 2016 and since then you have written 1,000 policies.
- What are some appropriate complements of credibility for:
  - Loss Trends
  - Average Loss Provision
  - Overall Indication
- Consider the pro's and con's of each complement of credibility

Complement of Credibility

- Loss Trends
  - Alaska Industry Trend
  - Other Northwest States
  - Countrywide Data
  - Competitors
- Average Loss Provision
  - Other Northwest States
  - Countrywide Data
  - Competitors
- Overall Indication
  - Competitors
  - Countrywide Data

Loss Adjustment Expenses

Loss Adjustment Expense

- Costs incurred by a company during the claim settlement process.
- Two types
  - Allocated Loss Adjustment Expense (ALAE)
    - Costs that can easily be related to individual claims
    - Typically included with loss (loss development triangle)
  - Unallocated Loss Adjustment Expense (ULAE)
    - Costs that are more difficult to assign to particular claims
    - Must determine proper allocation method for ratemaking

Large Losses / Catastrophes

Large Losses /CATs

- Large individual losses and catastrophes can add unwanted volatility
- General approach to ratemaking:
  - 1) Remove either a portion, or all large loss and/or catastrophes
  - 2) Replace with a more stable alternative, typically:
    - A) Average over a longer time period (with judgment)
    - B) In case of some types of catastrophes, a model
- We do this to optimize the credibility and relevancy of the data

Detailed Calculations

Step 1

Development of Indicated Provision for Loss and Loss-Adjustment Expense Comprehensive Coverage

Calendar year	Total incurred losses	Catastrophe losses	Incurred losses ex. catastrophes	Catastrophe losses Percent
1993	$ 2,062,835	$ 283,155	$ 1,779,680	15.9%
1994	1,967,170	50,023	1,917,147	2.6%
1995	2,084,698	14,710	2,069,988	0.7%
1996	3,179,286	932,774	2,246,512	41.5%
1997	2,737,399	169,844	2,567,555	6.6%
1998	3,320,365	82,416	3,237,949	2.5%
.	.	.	.	
.	.	.	.	
.	.	.	.	
2015	13,064,311	6,233,048	6,831,263	91.2%
2016	7,583,256	1,216,266	6,366,990	19.1%
2017	8,468,534	1,157,517	7,311,017	15.8%
25-year aggregate average		**$21,391,353**	**$120,831,928**	**17.7%**

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Detailed Calculations

Step 1

Development of Indicated Provision for Loss and Loss-Adjustment Expense Comprehensive Coverage

1 Fiscal year ending …	Earned exposures	2 Accident Year non catastrophe ultimate loss	3 Average catastrophe factor	4 Accident year ultimate loss (2) * (1+(3))	5 Ultimate Loss and LAE	6 Factor to adjust for loss trend	7 Projected ultimate loss and LAE	8 Projected average loss and LAE (7) / (1)	9 Year weights
12/31/2015	31,619	$ 3,020,592	0.177	$ 3,555,237	$ 4,099,188	1.040	$ 4,263,156	$ 134.83	14%
12/31/2016	37,813	2,594,664	0.177	3,053,920	3,521,170	1.040	3,662,017	96.85	43
12/31/2017	40,847	3,833,388	0.177	4,511,898	5,202,218	1.040	5,410,307	132.45	43
					10 Indicated Provision for Loss & LAE			$117.48	

Accident year weights depend on number of paid claims

Accident year data ties back all losses to the year in which the accident occurred regardless of the year losses were paid

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Expense Types

- 4 Expense Types
  - Commissions and Brokerage
  - Taxes, Licenses, and Fees
  - Other Acquisitions
  - General Expense
- General approach to ratemaking
  - 1) Calculate ratios of expenses to premium using historical data
  - 2) Determine what % of each expense type is fixed and variable
  - 3) Apply total fixed and variable expenses appropriately

Profit Provision

- 2 sources of profit
  - Investment Income (Capital + Policyholder Supplied Funds)
  - Underwriting Profit
- Calculate Underwriting Profit that achieves a target Rate of Return on Equity
- For some long-tailed lines, investment income is large enough to accept an underwriting loss!

Detailed Calculations

Development of statewide indicated rate level change

"How much premium do we need to cover future losses and expenses and still make our desired profit?"

1	Indicated provision for loss and loss adjustment expense	$117.48
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Detailed Calculations

Recall formula for indicated average premium

Total needed average premium formula

$$\frac{\text{Future losses} + \text{Future fixed expenses}}{1 - \text{Variable expense/profit ratio}}$$

Total needed average premium

$$\frac{\$117.48 + \$15.46}{1 - 0.287} = \$186.45$$

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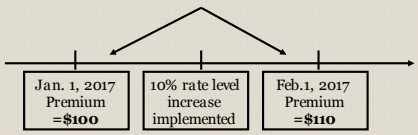
Current Rate Level Adjustment

@ Current Rate Level

- Why bring premiums to current rate level?
  - To measure the adequacy of current premiums projected to the period for which rates will be in effect.



- Without this adjustment, premium trends could be severely distorted.

Current Rate Level Methods

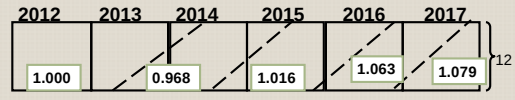
@ Current Rate Level

- Some Methods to choose from
  - Extension of Exposures
    - Re-rate all historical policies using current rating structure
    - The most accurate method
  - Parallelogram Method
    - Assumes policies are written uniformly across time
    - Applies an average factor to historical periods
- Choice of method will depend on data restraints and accuracy thresholds
  - A trade-off between accuracy and time

Parallelogram Method

@ Current Rate Level

Earned Premium - Annual (12 month) Policy



Renewal Process	4/15/13	7/16/14	11/15/15	12/2/16
Renewal Effective	5/16/13	8/16/14	12/16/15	1/2/17

Rate Change History

Renewal Process	Percent Change	Renewal Effective	Rate Level
4/15/13	-3.2	5/16/13	0.968
7/16/14	5.0	8/16/14	1.016
11/15/15	4.6	12/16/15	1.063
12/2/16	1.5	1/2/17	1.079

Detailed Calculations

Step 5

Development of Projected Earned Premium at Present Rates

1 Fiscal year ending ...	2 Earned exposures	3 Earned premium at current rates	4 Factor to adjust to projected premium level	5 Projected earned premium at current rates (3) x (4)	6 Projected earned premium at current rates (5) / (2)	7 Experience year weights
12/31/2017	40,847	6,427,796	1.020	6,556,351	160.51	100%

Projected average earned premium at current rates $ 160.51

"At Current Rates" means that premium has been adjusted for historical rate changes by bringing past premiums to Current Rate Level

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Detailed Calculations

Development of statewide indicated rate level change

"In order to cover our future losses and expenses and make our desired profit, we need to increase our current premium by 16.2%"

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Acting on Rate Indications

- Considerations
  - Regulatory
    - Some states impose certain methodologies and restrictions that need to be considered
    - Profit provisions are also capped in certain states
    - Use of modeled losses to account for hurricanes
  - Operational
    - A small rate increase in a small book of business may not be efficient to pursue
  - Marketing
    - Acting on rate indications has desired and undesired consequences that must be balanced

Acting on Rate Indications

Acting on Rate Indications

	Company 1	Company 2
Average Premium	$400	$500
Item Count	200,000	100,000
Total Premium	$80,000,000	$50,000,000
Average Loss Provision	$240	$300
Total Expected Loss	$48,000,000	$30,000,000
Pure Premium Trend	0.0	5.0
Written Premium Trend	-0.5	-3.5
Net Trend*	0.5	8.8
Variable Expense Ratio	21.3%	18.0%
Current Indication	5.0%	5.0%

***Net Trend** =
(1 + PP Trend)/(1 + WP Trend) -1.

Think of this as the amount an indication will change by if you do nothing this year and re-evaluate the indication in 1 year. Assumes all other inputs stay the same.

- You have capacity to take a rate change on one of these companies this year and for the other company you will re-run the indication next year and take a rate change. Both indications are currently at 5%. Which company would you change rates for this year and which next year, and why?

Relevant ASOPs

- There are numerous Actuarial Standard of Practice which are relevant to the material presented here:
  - ASOP 13: Trending Procedures in P/C Insurance
  - ASOP 25: Credibility Procedures
  - ASOP 29: Expense Provisions in P/C Insurance Ratemaking
  - ASOP 30: Treatment of Profit and Contingency Provisions and the Cost of Capital in P/C Insurance Ratemaking
  - ASOP 39: Treatment of Catastrophe Losses in P/C Insurance Ratemaking

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