Seminar on Reinsurance

June 5–6, 2023
Westin Philadelphia
Philadelphia, PA

I1: Intermediate Topics on Experience and Exposure Rating

CARe Seminar, June 5-6, 2023 – Philadelphia, PA

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John Maher, FCAS, Senior Vice President
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Intermediate Track Pre-Requisites

These presentations are considered intermediate level and assume you already have a basic understanding of the following concepts:

- General purpose of exposure rating vs experience rating
- Losses occurring vs risks attaching
- Treaty vs facultative
- Excess of loss reinsurance
- Primary vs excess policies
- Claims development and trending/on-leveling: purpose and methodologies
- ALAE, rate change, ILFs, credibility

I1: Intermediate Topics on Experience and Exposure Rating

This session will build upon basic CARe track and prior boot camp materials and will presuppose familiarity with the basics of experience and exposure rating methodologies. This session will include the usage of more advanced techniques to identify and address common excess rating challenges. These challenges have been exacerbated by the significant but waning pandemic disruptions and resulting supply constrained inflation impacts over the last 3 years.   These additional techniques and distortions include:

- **Rating methods: Shifting policy limits, credibility and blending of loss development factors, and combining experience & exposure ratings**
- **Measuring benchmark distortions: LDFs, severities, frequencies, closure ratios, recent adverse development and resulting loss ratios**

Accurately assessing these impacts holistically, and avoiding overconfidence, will lead to more refined pricing/reserving benchmarking and individual account analysis.

Moderator:
Yinglu Fan, FCAS, AVP Treaty Underwriter, QBE Re 5 mins *(1 intro slide + potential polls updates 2022)*

Panelists:
John Maher, FCAS, Senior Vice President, QBE Re 25-30 mins *(27 slides)*
Ralph Dweck, FCAS, Actuarial Director, Verisk/ISO 25-30 mins *(26 slides)*

Q&A 10 mins

Measuring Confidence – Covid/Inflation Trends- 6/2022

2022 CARe Seminar (CS10) - Measuring Actuarial Confidence

1. General Liability Average Annual Frequency Change from 2015 to 2019 (pre Covid)

Lower 90%
Confidence Interval

Upper 90%
Confidence Interval

2. General Liability Frequency Change from 2019 to 2020 (1st Covid year)

Lower 90%
Confidence Interval

Upper 90%
Confidence Interval

3. General Liability Frequency Change from 2020 to 2021 (2nd Covid year)

Lower 90%
Confidence Interval

Upper 90%
Confidence Interval

11. What is your name (Optional)

We **asked 12 Qs (10 US, 2 UK)** via Survey Monkey that was presented at the 2022 CARe Conference in a pair of linked sessions. The poll was left up during the course of the Monday June 13 CS10 2pm presentation. To answer the questions: **If you feel 90% of the time the answer will be between -15% to -5% then enter -15 and -5 in the 2 boxes.** Should **carefully** read the question being asked, such as LOB, frequency or severity, and time period.

You can answer either **anonymously, or provide your name** at the end. You don't need to answer all the Q's leaving certain ones blank or just providing a wider range on those. "Answers" will be presented during CS10s Covid/Inflation section.

Measuring Confidence answers, comparing aggregated confidence interval ranges to the "Answers", was provided in the 2022 **Tuesday linked session CS23 "Overinflated Wheels".** That session will also go deeper into the Covid/Inflation impacts in the Commercial and Personal Auto poll Q results.

ISO CARe 6/2022 Survey of Covid/Inflation Trends

Metrics for Pre Covid, 1st Covid and 2nd Covid year	90% CI (Responses)		"Actual"	Responses in Range
	Lower	Upper		
1. Total GL Frequency Change – 2015-2019	-10%	7%	-4.0%	33.0%
2. Total GL Frequency Change – 2019-2020	**-20%**	**5%**	**-29.5%**	**0.0%**
3. Total GL Frequency Change – 2020-2021	-10%	15%	-2.0%	33.0%
4. Total GL Severity Change – 2015-2019	**0%**	**15%**	**5.2%**	**82.0%**
5. Total GL Severity Change – 2019-2020	0%	20%	10.7%	27.0%
6. Total GL Severity Change – 2020-2021	**0%**	**20%**	**9.1%**	**91.0%**
7. Total CAu Frequency Change – 2019-2020	**-40%**	**20%**	**-26.3%**	**17.0%**
8. Total CAu Severity Change – 2020-2021	2%	20%	10.7%	45.0%
9. Total PAu Frequency Change – 2019-2020	-50%	2%	-22.5%	33.0%
10. Total PAu Severity Change – 2020-2021	2%	30%	7.5%	55.0%
11. UK Personal Motor Frequency Change – 2019-2020	-50%	10%		
12. UK Personal Motor Severity Change – 2020-2021	0%	20%		

NB: Above frequency indications are Nominal, before rate change impacts

Shifting Limits in Excess of Loss Ratings

Shifting Limits in Excess of Loss Rating

- **Changing Policy Limits Distribution**

- Suppose we are pricing a 500,000 excess of 500,000 layer, but the ceding company has recently begun writing higher limit policies that result in more exposure to the layer.

- Can we still use the historical experience rating?

- If so, what adjustments can be made?

Shifting Limits in Excess of Loss Rating

- **There are many possible approaches to overlay an adjustment to the experience rating.**
- **One approach: Adjust historical experience period burn cost based on the relative exposure rating of each historical period (i.e. limits drift factor)**

- Advantage:
  - This is one of the most accurate of possible methods.

- Disadvantage(s):
  - Requires full policy limit profile for each historical period
  - Potential difficulty in explaining adjustment factors

Example on the next slide…

Shifting Limits in Excess of Loss Rating

Adjust historical experience period burn cost based on the relative exposure rating of each historical period (i.e. limits drift factor)

| | Policy Limit Distribution | | | Exposure Rate | |
| | | | | 250,000 excess of 250,000 | 500,000 excess of 500,000 |
AY	500,000	750,000	1,000,000		
2011	75.00%	20.00%	5.00%	14.88%	2.22%
2012	75.00%	20.00%	5.00%	14.88%	2.22%
2013	75.00%	20.00%	5.00%	14.88%	2.22%
2014	75.00%	20.00%	5.00%	14.88%	2.22%
2015	75.00%	20.00%	5.00%	14.88%	2.22%
2016	70.00%	20.00%	10.00%	14.82%	2.87%
2017	65.00%	20.00%	15.00%	14.76%	3.52%
2018	60.00%	20.00%	20.00%	14.70%	4.17%
2019	60.00%	20.00%	20.00%	14.70%	4.17%
2020	60.00%	20.00%	20.00%	14.70%	4.17%
2021	60.00%	20.00%	20.00%	14.70%	4.17%

- The exposure rates from this table are used to adjust the experience rated loss costs. The change in exposure rate combines the impact of the changing layered loss and the change in premium that results from the shift in the limits profile.

Mata & Verheyen "An Improved Method for Experience Rating Reinsurance Treaties using Exposure Rating Techniques" (2005)
http://www.casact.org/pubs/forum/05spforum/05spf171.pdf

Shifting Limits in Excess of Loss Rating

Adjust historical experience period burn cost based on the relative exposure rating of each historical period (i.e. limits drift factor)

AY	Limit	Prem Wgt	Expected Loss to 500K xs 500K Layer	Weighted Expected Loss	Limits Drift Factor
2011	500,000	75.0%	0.00%		
	750,000	20.0%	7.83%		
	1,000,000	5.0%	13.01%	2.22%	1.88
2021	500,000	60.0%	0.00%		
	750,000	20.0%	7.83%		
	1,000,000	20.0%	13.01%	4.17%	1.00

- Limits drift factor for 2011 = Expected Loss for 2020 / Expected Loss for 2011
  - 4.17% / 2.22% = 1.88
- The experience rated loss cost indication for 2011 would then be adjusted by a factor of 1.88 to account for the fact that the ceding company is now writing more high limit policies than they have in the past.
- This adjustment factor would be calculated for each year in the experience period.
- **IMPORTANT – this methodology can be used for an increasing shift in limits or decreasing shift in limits**

AY	Ultimate Loss Ratio	Exposure Indication $500k Xs $500k	Limits Drift Factor	Adjusted Ultimate Loss Ratio
2011	2.8%	2.22%	1.88	5.2%
2012	2.0%	2.22%	1.88	3.8%
2013	1.4%	2.22%	1.88	2.6%
2014	3.3%	2.22%	1.88	6.2%
2015	4.0%	2.22%	1.88	7.5%
2016	2.8%	2.87%	1.45	4.0%
2017	3.4%	3.52%	1.18	4.0%
2018	3.0%	4.17%	1.00	3.0%
2019	2.7%	4.17%	1.00	2.7%
2020	3.1%	4.17%	1.00	3.1%
2021	4.1%	4.17%	1.00	4.1%
Straight Avg ==>	3.0%			4.2%

Credibility in Loss Development

The Issue

- The client data we get is usually not 100% credible, due to volume and insufficient time frame.

- We have some prior knowledge of what the development pattern should look like, either from external data or wider samples of similar business.

- How do we blend our prior knowledge with the new observation in a systematic way?

Brief Introduction to Bayesian Credibility

- "Probability is orderly opinion, and inference from data is nothing other than the revision of such opinion in the light of relevant new information." Edwards, Lindman and Savage

- Bayesian Theory

$$f(\theta \mid x) = \frac{f(x \mid \theta) \cdot f(\theta)}{f(x)} = \frac{f(x \mid \theta) \cdot f(\theta)}{\int_\theta f(x \mid \theta) \cdot f(\theta) d\theta}$$

Bayesian Made Simple

Two coins are in a box: one with both sides heads and one fair coin.

- Select one coin at random and flip it, the odds of a heads are:
  - $Prob(heads) = \frac{1}{2} \times 1 + \frac{1}{2} \times 0.5 = 0.75$

    (one-half chance selecting the sure heads coin and one-half chance selecting the fair coin)

- The first result was heads. Now use the same coin and flip it a second time. The odds of a second heads are:

  We need to first calculate the odds that each of the coins was initially selected, given the result of heads. These are called Conditional Probabilities.

  1. $Prob(heads\ only\ coin) = \frac{0.5 \times 1}{0.75} = \frac{2}{3}$
  2. $Prob(fair\ coin) = \frac{0.5 \times 0.5}{0.75} = \frac{1}{3}$

  Finally, we use theses conditional probabilities as weights and multiply them by the odds of a heads on those respective coins:

  $$\frac{2}{3} \times 1 + \frac{1}{3} \times 0.5 = 0.83$$

Application to Loss Development

- Organize the prior beliefs into an explicit distribution
- By staying in the context of conjugate (posterior distribution follows the same parametric form as the prior distribution) models, the blending of prior knowledge with new data can be done with very simple calculations.
- Z•A + (1-Z)•B
- Can be derived from Bayes Theorem either by assuming that the number of claims follow a Bernoulli process, with a Beta prior distribution on the unknown parameter p, or a Poisson process, with a Gamma prior distribution on the unknown parameter m.

Allen L. Mayerson "A BAYESIAN VIEW OF CREDIBILITY (casact.org)"

Generalized Dirichlet Distribution

- First introduced in the context of biological science.

- Parameter set with alphas and betas

- Alphas proportional to incremental loss and betas proportional to cumulative loss.

- Different weights for each cumulative development age, making it a natural for the development triangle format.

- $ATA_{12-24} = \dfrac{\propto_{k+}\beta_k}{B_k}$

- $ATA_d = \dfrac{\emptyset \cdot (\propto_{k-d}+\beta_{k-d})+\sum_{t=1}^{k} C_{t,d+1}}{\emptyset \cdot \beta_{k-d}+\sum_{t=1}^{k} C_{t,d}}$

- Bayesian theory assumes that an analyst working with a loss development triangle does not start as a "blank slate" with no idea of what a development pattern looks like. Instead, it assumes that the analyst comes with some "prior" expectation and is willing to change that prior belief on what is observed in the new data. (Clark 2016)

- Our prior knowledge, in this case of the industry or market development patterns, is used as though it had been previously observed data.

- There are two main sources of uncertainty in prior information (Parodi and Bonche 2010)
  - Market heterogeneity – the spread of different risks around some industry average
  - Estimation uncertainty – the industry average, though large, may still be of limited size

- As a result, we may choose to give the prior distribution more or less variance (and ultimately credibility) depending on how we view these sources of uncertainty.

Prior Information

	12	24	36	48	60	72	84	96
Prior Pattern LDF's==>	21.950	7.787	3.946	2.512	1.842	1.558	1.415	1.315
% Reported ==>	4.6%	12.8%	25.3%	39.8%	54.3%	64.2%	70.7%	76.0%
ATA ==>	2.819	1.973	1.571	1.364	1.182	1.101	1.076	1.315
Alpha	2.6	2.0	1.5	1.1	0.6	0.4	0.3	1.0
Beta	1.4190	2.0	2.5	2.9	3.4	3.6	3.7	3.0
Alpha + Beta (α+β)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Variance/Mean Ratio (θ)	1,000							
Col. 1	1,419	2,027	2,546	2,933	3,383	3,633	3,717	3,042
Col. 2	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000

- User judgmentally selects α+β and θ, the variance to mean ratio.
- α is $θ \times (1-1/\text{ATA})$
- β is $(α+β) − α$
- Col. 1 is $(θ×β)$
- Col. 2 is $(θ× (α+β))$

Client Data (new observation)

	12	24	36	48	60	72	84	96
1990	73	262	469	528	536	591	604	606
1991	148	346	391	502	522	514	567	
1992	99	198	219	394	408	430		
1993	118	255	352	412	581			
1994	275	415	645	803				
1995	261	446	637					
1996	130	471						
1997	148							
Col. 1	1,104	1,922	2,076	1,836	1,466	1,105	604	
Col. 2	2,393	2,713	2,639	2,047	1,535	1,171	606	
Avg ATA	2.168	1.412	1.271	1.115	1.047	1.060	1.003	

Combine the two for Credibility Weighting

Prior Knowledge

Col. 1	1,419	2,027	2,546	2,933	3,383	3,633	3,717	3,042
Col. 2	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
ATA	**2.819**	**1.973**	**1.571**	**1.364**	**1.182**	**1.101**	**1.076**	**1.315**

New Observation

Col. 1	1,104	1,922	2,076	1,836	1,466	1,105	604
Col. 2	2,393	2,713	2,639	2,047	1,535	1,171	606
ATA	**2.168**	**1.412**	**1.271**	**1.115**	**1.047**	**1.060**	**1.003**

Credibility Weighted

Col. 1	2,523	3,949	4,622	4,769	4,849	4,738	4,321	3,042
Col. 2	6,393	6,713	6,639	6,047	5,535	5,171	4,606	4,000
New ATA	**2.534**	**1.700**	**1.436**	**1.268**	**1.141**	**1.091**	**1.066**	**1.315**

Prior Information (more weight to prior)

	12	24	36	48	60	72	84	96
Prior Pattern LDFs ==>	21.950	7.787	3.946	2.512	1.842	1.558	1.415	1.315
% Reported ==>	4.6%	12.8%	25.3%	39.8%	54.3%	64.2%	70.7%	76.0%
ATA ==>	2.819	1.973	1.571	1.364	1.182	1.101	1.076	1.315
Alpha	3.9	3.0	2.2	1.6	0.9	0.6	0.4	1.4
Beta	2.1286	3.0	3.8	4.4	5.1	5.4	5.6	4.6
Alpha + Beta (α+β)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Variance/Mean Ratio (Θ)	5,000							
Col. 1	10,643	15,202	19,098	21,998	25,375	27,246	27,880	22,814
Col. 2	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000

Credibility Weghted

	12	24	36	48	60	72	84	96
Col. 1	11,747	17,124	21,174	23,834	26,841	28,351	28,484	22,814
Col. 2	32,393	32,713	32,639	32,047	31,535	31,171	30,606	30,000
Avg ATA	2.758	1.910	1.541	1.345	1.175	1.099	1.075	1.315

- The higher selection for the parameters ((α+β), Θ) result in more weight being given to the prior knowledge.

Using a Library of Benchmark Patterns

Benchmark Loss Development Factors (LDF to Ultimate)

	12	24	36	48	60	72	84	96
Fast	14.014	4.93	2.607	1.759	1.406	1.263	1.191	1.155
Medium	21.95	7.787	3.946	2.512	1.842	1.558	1.415	1.315
Slow	49.24	15.86	7.407	4.163	2.706	2.057	1.75	1.567

- In this case, we have not just one, but three benchmark patterns. These may be based on reporting lag, settlement strategies, case reserving practices, etc.
- If we have no knowledge of our client's practices, we can start with giving each benchmark pattern equal weights.
- We perform the credibility weighting of our client's data with each of these three benchmarks. Then use their likelihood functions to update the weights.

Example (Fast Pattern)

Fast Pattern	12	24	36	48	60	72	84	96
LDF	14.014	4.930	2.607	1.759	1.406	1.263	1.191	1.155
Pattern	7.14%	20.28%	38.36%	56.85%	71.12%	79.18%	83.96%	86.58%
ATA	2.843	1.891	1.482	1.251	1.113	1.060	1.031	1.155
Alpha	6.5	4.7	3.3	2.0	1.0	0.6	0.3	1.3
Beta	3.5	5.3	6.7	8.0	9.0	9.4	9.7	8.7
Alpha+Beta	**10.0**	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Variance/Mean Ratio		**1,000**						
Col. 1	3,518	5,288	6,747	7,993	8,983	9,430	9,698	8,658
Col. 2	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Blended ATA	2.681	1.763	1.432	1.226	1.104	1.060	1.030	1.155
LDF	11.554	4.309	2.444	1.706	1.392	1.261	1.189	1.155
Loglikelihood	-0.9363	-1.0052	-0.8252	-0.5260	-0.2687	-0.2535	-0.0290	0.0000

-3.8441

Posterior Weights

Bayesian Updating of Probabilities

	Log-Likelihood A	Difference in LL B = B-max(A)	Relative Likelihood C=exp(B)	Original Weights D	Revised Weights E=C*D/Avg(C)
Fast	-3.84	0	1.00	33.33%	43.98%
Medium	-4.06	-0.21	0.81	33.33%	35.61%
Slow	-4.61	-0.77	0.464	33.33%	20.41%

Credibility In Loss Development

1. Sample Company Data

400K xs 100K Reported Loss Triangle

	12	24	36	48	60	72	84	96	ITD
2014	14,700	462,500	1,082,700	1,675,200	2,156,100	2,458,500	3,347,000	4,296,200	4,296,200
2015	196,900	1,033,300	1,758,900	2,517,000	3,455,800	3,891,300	4,423,300		4,423,300
2016	275,800	946,400	1,738,400	1,956,200	2,077,100	2,383,000			2,383,000
2017	215,700	527,800	1,192,300	2,126,000	2,009,200				2,009,200
2018	332,100	1,447,500	2,562,800	3,170,400					3,170,400
2019	284,800	1,141,400	1,758,600						1,758,600
2020	132,800	262,100							262,100
2021	20,100								20,100

500K xs 500K Reported Loss Triangle

	12	24	36	48	60	72	84	96	ITD
2014	0	322,700	537,600	431,700	450,900	468,000	468,000	468,000	468,000
2015	0	27,200	27,200	0	185,700	371,400	371,400		371,400
2016	183,300	422,700	419,500	603,500	604,200	361,700			361,700
2017	0	0	315,300	605,100	531,900				531,900
2018	0	60,600	463,600	678,500					678,500
2019	0	65,500	482,900						482,900
2020	0	0							0
2021	0								0

Age-to-Age (ATA) Factors

	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96
2014	31.463	2.341	1.547	1.287	1.140	1.361	1.284
2015	5.248	1.702	1.431	1.373	1.126	1.137	
2016	3.431	1.837	1.125	1.062	1.147		
2017	2.447	2.259	1.783	0.945			
2018	4.359	1.771	1.237				
2019	4.008	1.541					
2020	1.974						
Avg	4.007	1.816	1.373	1.172	1.136	1.224	1.284

Age-to-Age (ATA) Factors

	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96
2014	#DIV/0!	1.666	0.803	1.044	1.038	1.000	1.000
2015	#DIV/0!	1.000	0.000	#DIV/0!	2.000	1.000	
2016	2.306	0.992	1.439	1.001	0.599		
2017	#DIV/0!	#DIV/0!	1.919	0.879			
2018	#DIV/0!	7.650	1.464				
2019	#DIV/0!	7.373					
2020	#DIV/0!						
Avg	4.903	2.499	1.315	1.081	0.968	1.000	1.000

- First step would be to check for stability in the profiles and policy limit drift.

- Triangle observations:
  - The lower attaching 400K xs 100K layer has a far more credible triangle than the 500K xs 500K layer.
  - The empirical tail factor generated by the 400K xs 100K layer also significantly longer than the empirical tail factor in the 500K xs 500K triangle.

Credibility In Loss Development
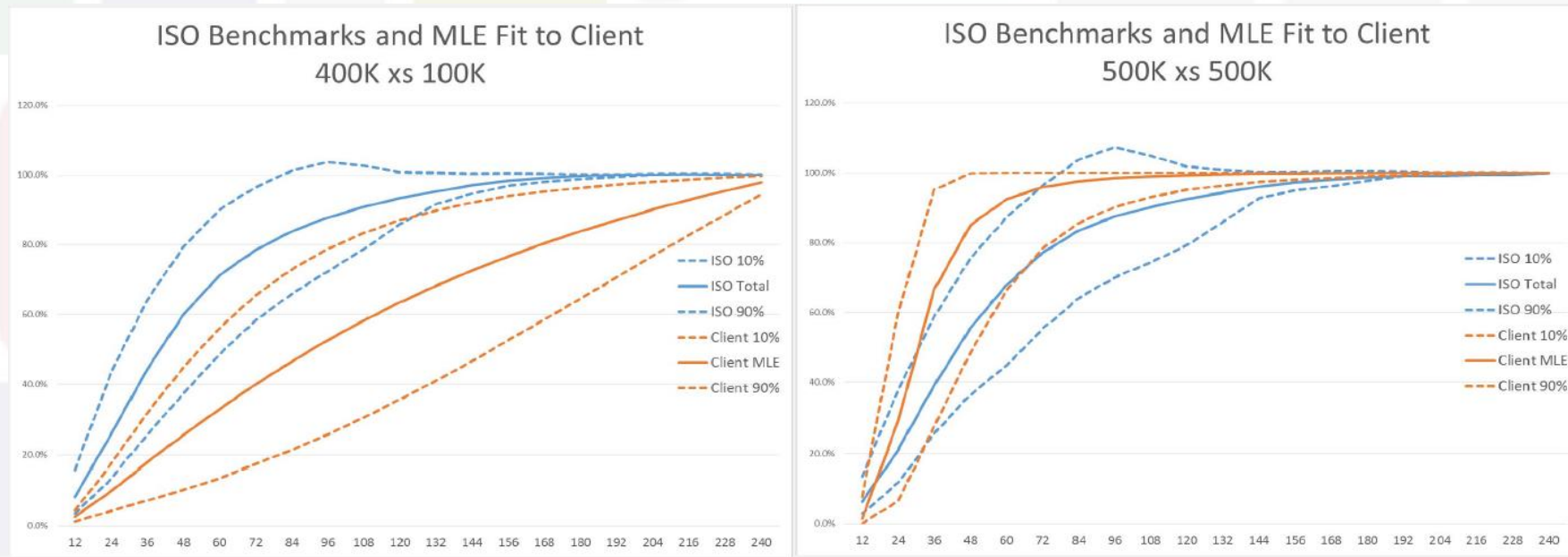
400K xs 100K graph

- The blue lines represent an approximate 90% confidence interval around the industry pattern.
- Similarly, we can fit the client data to a curve to see a similarly calculated 90% confidence interval in orange above.
- The client data has a _slower_ development pattern than the industry data.

500K xs 500K graph

- The client data has a _faster_ development pattern than the industry data.

Application

The credibility weighted patterns are simply the dollar weighted average (utilizing the column 1 and column 2 figures) of the client / benchmark sections.

400K xs 100K Reported Loss Triangle

	12	24	36	48	60	72	84	96		ITD
2014	14,700	462,500	1,082,700	1,675,200	2,156,100	2,458,500	3,347,000	4,296,200		4,296,200
2015	196,900	1,033,300	1,758,900	2,517,000	3,455,800	3,891,300	4,423,300			4,423,300
2016	275,800	946,400	1,738,400	1,956,200	2,077,100	2,383,000				2,383,000
2017	215,700	527,800	1,192,300	2,126,000	2,009,200					2,009,200
2018	332,100	1,447,500	2,562,800	3,170,400						3,170,400
2019	284,800	1,141,400	1,758,600							1,758,600
2020	132,800	262,100								262,100
2021	20,100									20,100

	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - Ult
Client Pattern								
Column 1	1,452,800	5,558,900	8,335,100	8,274,400	7,689,000	6,349,800	3,347,000	
Column 2	5,821,000	10,093,700	11,444,800	9,698,200	8,732,800	7,770,300	4,296,200	
All Year Wtd ATA	4.007	1.816	1.373	1.172	1.136	1.224	1.284	
Benchmark (Medium)								
Column 1	3,166,052	5,845,636	7,385,911	8,416,317	9,080,542	9,364,207	9,547,360	8,779,631
Column 2	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
ATA	3.159	1.711	1.354	1.188	1.101	1.068	1.047	1.139
Credibility-Weighted								
Column 1	4,618,852	11,404,536	15,721,011	16,690,717	16,769,542	15,714,007	12,894,360	8,779,631
Column 2	15,821,000	20,093,700	21,444,800	19,698,200	18,732,800	17,770,300	14,296,200	10,000,000
ATA	3.425	1.762	1.364	1.180	1.117	1.131	1.109	1.139
LDF to Ult	15.499	4.525	2.568	1.883	1.595	1.428	1.263	1.139

Application

The same procedure is performed with the Slow and Fast benchmark patterns (Slow shown below).

400K xs 100K Reported Loss Triangle

	12	24	36	48	60	72	84	96		ITD
2014	14,700	462,500	1,082,700	1,675,200	2,156,100	2,458,500	3,347,000	4,296,200		4,296,200
2015	196,900	1,033,300	1,758,900	2,517,000	3,455,800	3,891,300	4,423,300			4,423,300
2016	275,800	946,400	1,738,400	1,956,200	2,077,100	2,383,000				2,383,000
2017	215,700	527,800	1,192,300	2,126,000	2,009,200					2,009,200
2018	332,100	1,447,500	2,562,800	3,170,400						3,170,400
2019	284,800	1,141,400	1,758,600							1,758,600
2020	132,800	262,100								262,100
2021	20,100									20,100

	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - Ult
Client Pattern								
Column 1	1,452,800	5,558,900	8,335,100	8,274,400	7,689,000	6,349,800	3,347,000	
Column 2	5,821,000	10,093,700	11,444,800	9,698,200	8,732,800	7,770,300	4,296,200	
All Year Wtd ATA	4.007	1.816	1.373	1.172	1.136	1.224	1.284	
Benchmark (Slow)								
Column 1	2,695,053	5,274,099	6,893,431	7,865,311	8,562,197	8,968,553	9,214,586	7,610,350
Column 2	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
ATA	3.711	1.896	1.451	1.271	1.168	1.115	1.085	1.314
Credibility-Weighted								
Column 1	4,147,853	10,832,999	15,228,531	16,139,711	16,251,197	15,318,353	12,561,586	7,610,350
Column 2	15,821,000	20,093,700	21,444,800	19,698,200	18,732,800	17,770,300	14,296,200	10,000,000
ATA	3.814	1.855	1.408	1.220	1.153	1.160	1.138	1.314
LDF to Ult	24.316	6.375	3.437	2.441	2.000	1.735	1.495	1.314

Application

Our prior weights (33.33%) are adjusted to posterior weights to reflect the fact that the client data is most representative of the slow curve.

Bayesian Updating of Probabilities

	LogLikelihood	Difference in LogLikehood	Relative Likelihood	Original Weights	Revised Weights
	A	B = A - Max(A)	C = exp(B)	D	E = C * D / Avg (C)
Fast	-22.7256	-6.1971	0.002	33.33%	0.18%
Medium	-18.5356	-2.0071	0.134	33.33%	11.82%
Slow	-16.5285	0	1.000	33.33%	87.99%
		Avg:	0.379		

The final pattern is a credibility-weighted average of the individual benchmark patterns weighted with the client data.

Benchmark Loss Development Factors (LDF to Ultimate) - 400K xs 100K

	12	24	36	48	60	72	84	96	108	120	A Posteriori Weights
Fast	11.274	3.507	2.101	1.591	1.366	1.240	1.113	1.028	1.019	1.013	0.18%
Medium	15.499	4.525	2.568	1.883	1.595	1.428	1.263	1.139	1.101	1.073	11.82%
Slow	24.316	6.375	3.437	2.441	2.000	1.735	1.495	1.314	1.226	1.149	87.99%
Average	22.741	6.073	3.301	2.356	1.940	1.691	1.463	1.290	1.209	1.139	
Original Average	11.720	3.774	2.265	1.691	1.423	1.285	1.201	1.149	1.109	1.076	

Application

- Same process is followed for the 500K xs 500K layer. However, now we can use what we learned on the 400K xs 100K layer and begin with our apriori weights equal to the posterior weights from the previous slide.
- Since the 500K xs 500K triangle has limited credibility, we would utilize a larger scale parameter which will result in a final pattern that is close to the "slow" benchmark.

Benchmark Loss Development Factors (LDF to Ultimate) - 500K xs 500K

	12	24	36	48	60	72	84	96	108	120	A Posteriori Weights
Fast	9.909	3.242	1.866	1.399	1.203	1.084	1.038	1.025	1.020	1.015	0.16%
Medium	16.705	4.811	2.474	1.760	1.462	1.286	1.195	1.143	1.109	1.081	12.81%
Slow	33.051	7.635	3.480	2.416	1.965	1.638	1.454	1.343	1.267	1.201	87.03%
Average	29.272	7.087	3.303	2.303	1.880	1.581	1.414	1.313	1.244	1.184	

Experience Rating (400K xs 100K)

- Utilizes the credibility weighted LDFs.
- Also makes use of any limits drift adjustment.

Experience Rating $400K xs $100K layer

AY	On-Level Premium	Exposure Trend	Trended OLP	LDF	Premium / LDF	400K xs 100K Reported	Severity Trend	Frequency Trend	Policy Limit Drift*	400K xs 100K Trended	Rate
2014	18,432,700	1.083	19,959,973	1.290	15,472,235	4,296,200	1.267	1.000	0.995	5,415,086	35.0%
2015	17,258,900	1.072	18,503,877	1.463	12,649,328	4,423,300	1.230	1.000	0.995	5,412,901	42.8%
2016	17,916,600	1.062	19,018,832	1.691	11,248,161	2,383,000	1.194	1.000	0.996	2,834,045	25.2%
2017	18,544,100	1.051	19,490,035	1.940	10,045,621	2,009,200	1.159	1.000	0.997	2,322,226	23.1%
2018	18,470,700	1.041	19,220,684	2.356	8,157,962	3,170,400	1.126	1.000	0.998	3,561,177	43.7%
2019	19,199,500	1.030	19,781,264	3.301	5,991,728	1,758,600	1.093	1.000	0.998	1,917,826	32.0%
2020	19,157,800	1.020	19,542,872	6.073	3,217,946	262,100	1.061	1.000	0.999	277,784	8.6%
2021	19,374,100	1.010	19,567,841	22.741	860,450	20,100	1.030	1.000	1.000	20,703	2.4%
Total	148,354,400		155,085,378		67,643,430	18,322,900				21,761,747	32.2%
Prospective	20,000,000									6,434,253	32.2%

* Calculation as discussed in Part 1 of the presentation

Experience Rating (500K xs 500K)

- For the higher 500K xs 500K layer, the experience is volatile and not fully credible. In this case, the experience indication is credibility weighted with an exposure rated relativity selection.

Experience Rating $500K xs $500K layer

AY	On-Level Premium	Exposure Trend	Trended OLP	LDF	Premium / LDF	500K xs 500K Reported	Severity Trend	Frequency Trend	Policy Limit Drift	400K xs 100K Trended	Rate
2014	18,432,700	1.083	19,959,973	1.313	15,202,738	468,000	1.267	1.000	1.037	614,784	4.0%
2015	17,258,900	1.072	18,503,877	1.414	13,087,677	371,400	1.230	1.000	1.033	471,849	3.6%
2016	17,916,600	1.062	19,018,832	1.581	12,027,621	361,700	1.194	1.000	1.025	442,686	3.7%
2017	18,544,100	1.051	19,490,035	1.880	10,365,785	531,900	1.159	1.000	1.020	628,950	6.1%
2018	18,470,700	1.041	19,220,684	2.303	8,344,685	678,500	1.126	1.000	1.016	775,876	9.3%
2019	19,199,500	1.030	19,781,264	3.303	5,988,227	482,900	1.093	1.000	1.012	534,010	8.9%
2020	19,157,800	1.020	19,542,872	7.087	2,757,660	0	1.061	1.000	1.004	0	0.0%
2021	19,374,100	1.010	19,567,841	29.272	668,474	0	1.030	1.000	1.000	0	0.0%
Total	148,354,400		155,085,378		68,442,867	2,894,400				3,468,155	5.1%
Prospective	20,000,000									1,013,445	5.1%

400K xs 100K Rate	32.2%
Exposure Rating Relativity	0.461
Expected 500K xs 500K Rate	14.8%
Credibility	75%
Selected 500K xs 500K Rate	7.5%

Selected 500K xs 500K Expected Loss 1,501,632

Measuring Benchmark Distortions:
Three Year Pandemic and Heightened Inflation View

Measuring Benchmark Distortions:
Three Year Pandemic and Heightened Inflation View
Agenda

A. Benchmarking analysis framework
- Benchmarking components
- External forces disruptions – pandemic 2020, inflation impacts 2021-22
- Assessing confidence and avoiding overconfidence

B. Tools to assess the disruption
- Frequencies with on-level premium
- Average reportings and settlements
- Loss development factors – pre/during pandemic
- Closure ratios
- Adverse development - exante

C. Impact Analysis – Experience through 12/31/2022
- Holistic view: frequencies, severities, loss ratios – focus on GL
- Impact on Commercial Lines
- Where to now?

A. Benchmarking Framework

- **Trends**
  - Severities, frequencies, exposures
  - Ground-up and Excess
- **Loss Development Factors**
  - Reporting and payment patterns
  - Closure ratios
- **Rate Changes**
- **Loss Costs**
  - Ground-up and ILFs
- **State / Hazard / Class Differentiations**
- **External forces – disruptions**
- **Resulting expected loss ratios**

**Goal: Confident entry / exit decisions,
          anticipating competitive market cycle changes**

Benchmark Assessment Matrix
Estimating Confidences – Pre-Pandemic - Illustrative

As part of an annual or quarterly Best Practices framework, after gathering all relevant internal and external information, it is useful to assess all actuarial benchmarking components. And how confident you are in each.

Some for example like LDFs and rate changes may feel quite confident, if no major disruptions. While others like ILFs may feel less confident in times of high and unknown social inflation and litigation financing impacts.

	1	2	3	4	5	6	7	8
	Trends					Loss Dev't Factors		State/ Hazard/ Subline
	Ground Up			Excess				
	Severity	Frequency	Exposure	Severity	Frequency	Ground Up	Excess	
Casualty	●	◎	●	◎	◉	●	●	◎
Property	●	◎	◎	◎	◉	●	●	◎
Specialty	●	◎	○	◎	◉	◎	◎	◉

	9	10	11	12	13	14	15	16
	Rate Changes		Loss Costs		External Forces	Loss Ratios		Where In the Cycle?
	Primary	Reinsurance	Ground-up	ILFs		Primary	Reinsurance	
Casualty	●	●	●	◎	○	●	●	●
Property	●	●	●	◎	○	●	●	◎
Specialty	◎	◎	◎	◉	○	◎	◉	◉

Confidence:	Good	●	Medium	◎	Some	◉	Minimal	○

Pandemic and Inflation Impact: Questions

- What are the **base-line** expectations?
- How much have they been **distorted**?
- What does the **recovery shape** look like?
- What are the **expectations** for 2023/24?
- How **confident** are we in this assessment?

B. Tools to assess the disruption

- **Review loss and premium triangles**
  - Calendar / accident quarter
- **Loss development factor distortions**
  - Distorted diagonals
- **Frequency ratios**
- **Average severities**
- **Closure ratios**
  - Cumulative, available to be closed, incremental
- **Adverse development - exante**

Total General Liability – Raw Data Triangles

Illustrative

Reviewing overall GL triangles, focusing on pre and post Covid onset, can see even with relatively stable and increasing premium base, that claim counts are way down, but severities at a heightened level. Both significantly higher than longer term trends.

Losses evaluated through 12/31/2022

General Liability

Subline	(All)	PremOps | Products | Other			

Values	Loss Year	Loss Month	3	6	9	12
1 # Incurred Claims (I+A)	2017	3	28,485	33,899	32,642	31,748
	2017	6	30,922	37,756	35,810	35,167
	2017	9	31,913	37,039	35,787	35,359
	2017	12	26,097	32,249	31,166	30,682
	2018	3	30,454	35,428	33,804	33,138
	2022	6	19,197	24,982	24,014	
	2022	9	19,709	24,828		
	2022	12	15,099			
2 # Closed Claims (I+A)	2017	3	4,610	11,981	15,811	18,229
	2017	6	6,455	15,060	19,442	21,913
	2017	9	6,675	15,099	19,306	21,924
	2017	12	4,505	11,617	15,311	17,495
	2018	3	4,641	11,949	15,497	18,167
	2022	6	3,715	9,200	12,035	
	2022	9	3,866	9,168		
	2022	12	2,534			
8 Average Paid Indemnity	2017	3	2,972	4,612	5,488	6,883
	2017	6	2,722	3,977	5,330	6,586
	2017	9	3,293	4,341	5,359	6,641
	2017	12	3,346	4,186	5,545	6,874
	2018	3	3,007	4,152	5,562	7,212
	2022	6	4,140	6,056	8,319	
	2022	9	4,645	6,644		
	2022	12	4,779			
10 Average Outstanding	2017	3	10,016	21,251	34,797	50,666
	2017	6	8,922	19,210	33,984	47,734
	2017	9	9,566	20,093	34,176	48,783
	2017	12	9,183	20,360	35,080	51,136
	2018	3	9,985	22,505	36,576	55,197
	2022	6	12,415	27,835	47,808	
	2022	9	12,890	28,371		
	2022	12	13,806			
11 Earned Premium	2017	3	2,781,004,204	2,809,170,105	2,829,429,649	2,855,953,604
	2017	6	2,792,717,475	2,825,305,669	2,852,204,084	2,872,578,896
	2017	9	2,808,584,694	2,841,544,310	2,864,732,241	2,895,677,024
	2017	12	2,821,749,786	2,847,545,647	2,878,428,747	2,912,486,170
	2018	3	2,842,191,888	2,861,973,117	2,892,276,639	2,910,103,157
	2022	6	3,225,943,873	3,287,253,704	3,344,781,990	
	2022	9	3,280,734,544	3,333,411,677		
	2022	12	3,337,263,322			

Total General Liability – Overall LDFs

Can see lengthening impact on total LDFs, including affecting most recent evaluation of all accident years. And affecting both total reporting and payment patterns.

But the story goes much deeper than impact on LDFs.

GL Reported Indemnity LDFs

	12	24	36	48	60
AY 2005	1.628	1.297	1.118	1.039	1.011
AY 2006	1.607	1.282	1.122	1.044	1.018
AY 2007	1.617	1.273	1.114	1.036	1.034
AY 2008	1.610	1.238	1.114	1.073	1.024
AY 2009	1.552	1.235	1.123	1.049	1.036
AY 2010	1.527	1.255	1.133	1.058	1.025
AY 2011	1.579	1.277	1.131	1.053	1.023
AY 2012	1.588	1.279	1.134	1.063	1.033
AY 2013	1.657	1.283	1.149	1.072	1.036
AY 2014	1.611	1.305	1.159	1.069	1.041
AY 2015	1.634	1.341	1.183	1.077	1.024
AY 2016	1.719	1.347	1.188	1.070	1.045
AY 2017	1.741	1.366	1.163	1.077	1.057
AY 2018	1.720	1.337	1.150	1.112	
AY 2019	1.742	1.300	1.200		
AY 2020	1.781	1.355			
AY 2021	1.816				

GL Paid Indemnity LDFs

	12	24	36	48	60
AY 2005	2.710	1.807	1.508	1.253	1.125
AY 2006	2.856	1.783	1.495	1.252	1.130
AY 2007	2.835	1.790	1.466	1.254	1.131
AY 2008	2.711	1.741	1.490	1.259	1.133
AY 2009	2.680	1.724	1.441	1.253	1.126
AY 2010	2.763	1.726	1.463	1.254	1.116
AY 2011	2.834	1.748	1.430	1.242	1.130
AY 2012	2.739	1.692	1.432	1.244	1.144
AY 2013	2.770	1.725	1.475	1.281	1.130
AY 2014	2.724	1.776	1.520	1.277	1.143
AY 2015	2.849	1.847	1.520	1.291	1.107
AY 2016	2.964	1.817	1.515	1.216	1.131
AY 2017	2.985	1.828	1.413	1.247	1.183
AY 2018	3.026	1.718	1.434	1.318	
AY 2019	2.910	1.721	1.496		
AY 2020	2.856	1.810			
AY 2021	3.145				

Total General Liability – Frequency Ratios - OLEP

Losses evaluated through 12/31/2022
General Liability
Additional Calculated Analytics - Closure and Frequency

Subline PremOps | Products | Other
F. Incurred Counts / OLI = (1) / (11 * OL Factor / 1000000)

		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
2017	3	8.46	9.96	9.53	9.18	9.10	9.12	9.15	9.18	9.35	9.46	9.48	9.46	9.49	9.47	9.45	9.47
2017	6	9.09	10.97	10.30	10.05	9.96	9.97	9.92	10.00	10.18	10.26	10.23	10.25	10.26	10.28	10.29	10.28
2017	9	9.26	10.62	10.18	9.95	9.82	9.81	9.84	9.95	10.14	10.19	10.22	10.19	10.26	10.25	10.25	10.24
2017	12	7.51	9.19	8.79	8.55	8.43	8.43	8.44	8.53	8.68	8.74	8.71	8.74	8.78	8.79	8.79	8.78
2018	3	8.69	10.03	9.47	9.23	9.23	9.14	9.16	9.18	9.37	9.37	9.42	9.44	9.48	9.49	9.48	9.46
2018	6	8.29	10.32	9.80	9.66	9.51	9.56	9.55	9.62	9.70	9.82	9.82	9.83	9.87	9.87	9.87	9.86
2018	9	8.41	10.33	10.15	9.89	9.80	9.74	9.80	9.81	10.02	10.06	10.05	10.08	10.10	10.10	10.09	10.09
2018	12	6.77	8.87	8.56	8.40	8.31	8.31	8.27	8.37	8.49	8.54	8.55	8.56	8.59	8.59	8.57	8.58
2019	3	7.79	9.43	9.12	8.92	8.85	8.75	8.83	8.89	9.05	9.13	9.12	9.12	9.17	9.14	9.14	9.12
2019	6	6.98	9.17	9.11	8.95	8.81	8.84	8.83	8.89	9.07	9.10	9.12	9.13	9.16	9.18	9.16	
2019	9	7.53	9.70	9.33	9.12	9.15	9.11	9.12	9.22	9.33	9.39	9.41	9.39	9.41	9.42		
2019	12	6.60	8.26	7.86	7.82	7.74	7.73	7.76	7.78	7.93	7.99	7.99	8.01	8.03			
2020	3	5.93	6.67	6.53	6.44	6.43	6.48	6.46	6.51	6.64	6.67	6.68	6.69				
2020	6	4.27	5.71	5.55	5.57	5.57	5.57	5.59	5.64	5.70	5.75	5.75					
2020	9	5.83	7.06	7.06	7.05	6.96	6.93	6.97	7.01	7.11	7.14						
2020	12	4.61	6.10	6.01	5.93	5.85	5.83	5.85	5.92	5.99							
2021	3	5.35	6.73	6.53	6.37	6.29	6.25	6.30	6.33								
2021	6	5.59	7.20	6.91	6.80	6.70	6.69	6.69									
2021	9	5.87	7.17	6.97	6.87	6.80	6.73										
2021	12	4.76	6.12	6.00	5.86	5.70											
2022	3	5.51	7.04	6.80	6.53												
2022	6	5.73	7.32	6.91													
2022	9	5.89	7.31														
2022	12	4.52															

Even after on-leveling the premium used as an exposure base, the total ground-up frequencies remain significantly down, with no indicated reversal yet or reversion to normalcy through 12/31/2022. Would want to compare against any overall downward frequency trend including impacts of increasing deductibles and size of claim, before making any full assessments.

Average severity trends are up significantly beyond normal long-term averages. For example, for Total GL, long term pre-pandemic severity trends were about 5.7% and about 7.7% since the start of the pandemic. Total CAu severity trends also increased by about 2% from before and after the start of the pandemic.
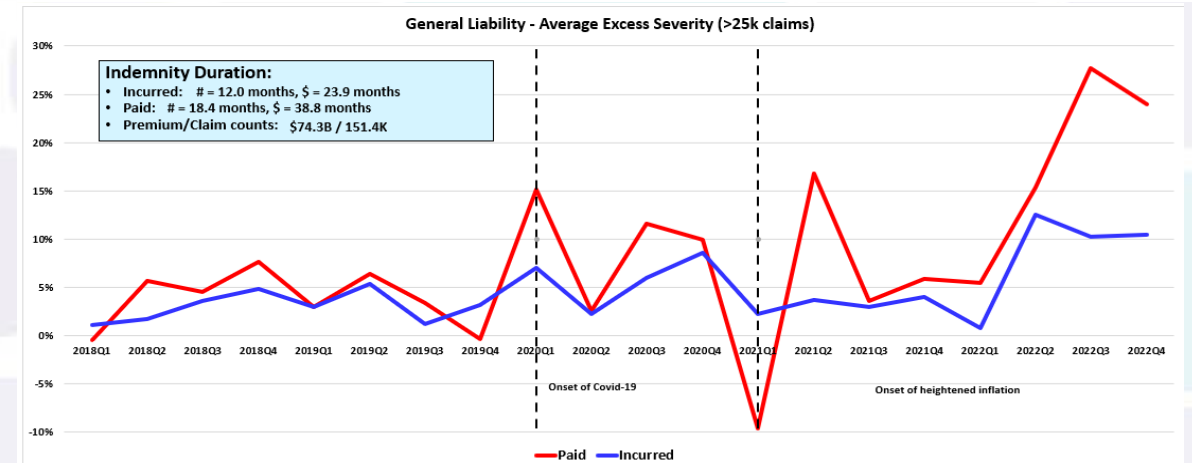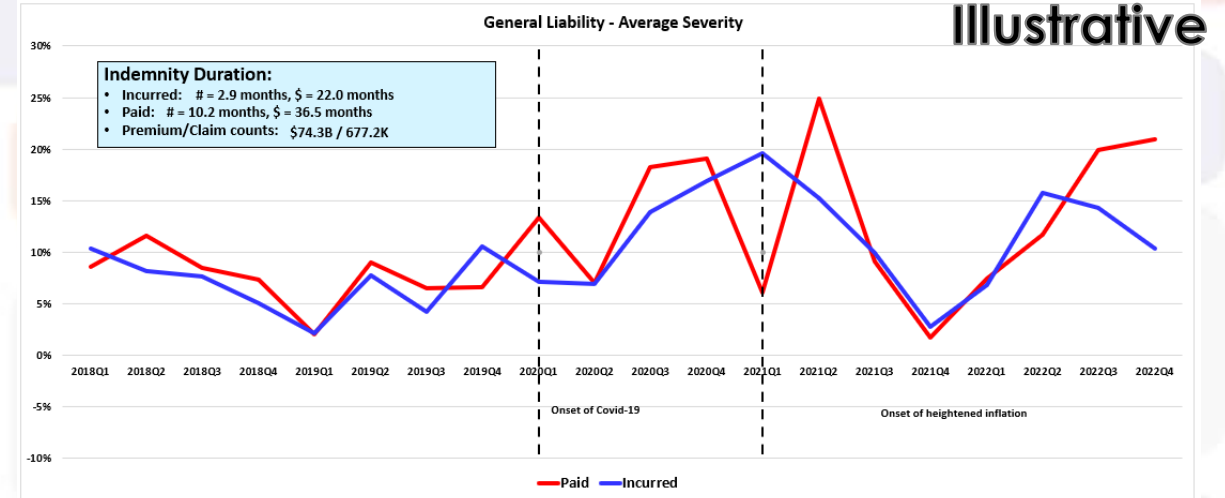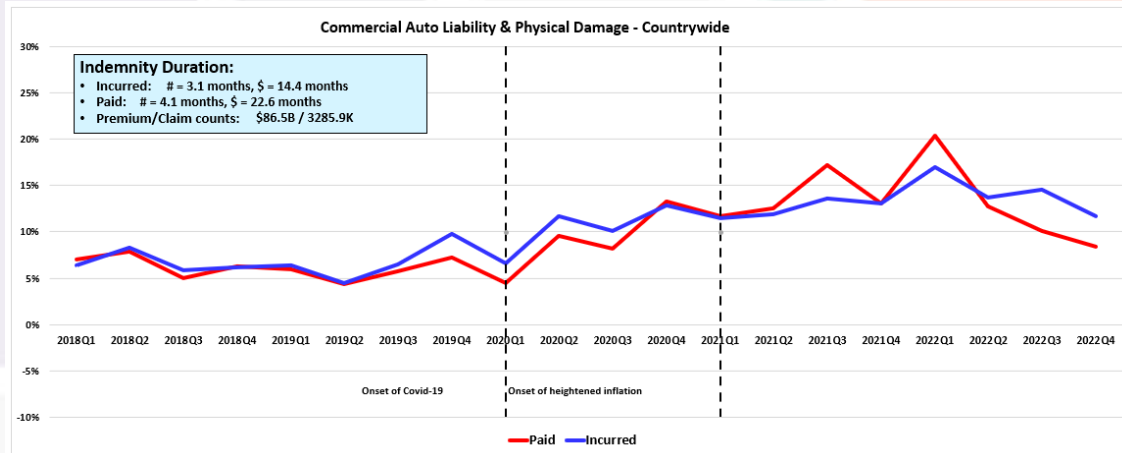
Total General Liability – Closure Ratios #1

Illustrative

Losses evaluated through 12/31/2022

General Liability
Additional Calculated Analytics - Closure and Frequency

A. Cumulative Closed = 1. Closed Claims / 2. Incurred Claims

		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
2017	3	16.2%	35.3%	48.4%	57.4%	63.2%	67.1%	70.1%	73.0%	74.9%	76.5%	78.5%	80.7%	82.7%	84.4%	86.3%	87.5%
2017	6	20.9%	39.9%	54.3%	62.3%	67.6%	71.2%	74.7%	76.9%	78.3%	79.6%	81.7%	83.2%	84.8%	86.0%	87.1%	88.3%
2017	9	20.9%	40.8%	53.9%	62.0%	67.5%	71.4%	74.1%	76.2%	77.5%	79.3%	80.8%	82.7%	83.7%	85.2%	86.6%	87.8%
2017	12	17.3%	36.0%	49.1%	57.0%	63.6%	67.6%	71.0%	73.1%	75.0%	76.7%	79.1%	80.7%	82.2%	83.5%	85.0%	86.5%
2018	3	15.2%	33.7%	45.8%	54.8%	60.2%	64.9%	68.1%	71.1%	72.8%	75.1%	76.8%	78.7%	80.3%	81.9%	83.7%	85.4%
2018	6	19.3%	37.6%	52.7%	60.7%	66.9%	70.6%	73.9%	76.0%	78.1%	79.2%	80.8%	82.2%	83.5%	85.1%	86.5%	87.9%
2018	9	18.5%	39.7%	52.6%	60.8%	66.2%	70.3%	72.9%	75.7%	76.7%	78.2%	79.9%	81.2%	82.9%	84.6%	86.1%	87.6%
2018	12	19.9%	38.2%	51.3%	59.2%	65.1%	69.0%	72.6%	74.2%	75.8%	77.4%	79.0%	80.6%	82.1%	83.7%	85.5%	87.1%
2019	3	16.1%	35.2%	47.6%	56.5%	62.2%	67.0%	69.6%	71.9%	73.4%	74.7%	76.8%	78.9%	80.5%	82.6%	84.5%	86.3%
2019	6	20.3%	39.7%	53.7%	61.4%	67.6%	70.8%	73.6%	75.6%	76.6%	78.4%	80.0%	81.6%	83.2%	84.7%	86.5%	
2019	9	20.5%	40.5%	53.6%	62.0%	66.7%	70.6%	73.2%	75.0%	77.0%	78.4%	80.0%	82.0%	83.7%	85.4%		
2019	12	18.1%	35.7%	49.0%	56.0%	62.0%	66.1%	68.9%	71.9%	73.4%	74.9%	77.2%	78.9%	80.8%			
2020	3	18.2%	36.8%	48.3%	56.3%	61.9%	65.6%	69.2%	71.6%	73.1%	75.2%	77.3%	79.4%				
2020	6	24.1%	42.9%	55.8%	62.6%	67.7%	70.8%	73.3%	75.1%	76.9%	78.3%	80.1%					
2020	9	23.1%	42.5%	54.0%	60.9%	66.0%	69.7%	72.3%	74.5%	76.1%	77.9%						
2020	12	21.3%	36.8%	48.2%	55.0%	60.7%	64.5%	67.5%	69.7%	71.7%							
2021	3	16.9%	33.9%	44.9%	52.5%	58.0%	62.1%	65.0%	67.6%								
2021	6	20.7%	38.4%	51.0%	58.7%	64.3%	68.0%	71.3%									
2021	9	20.1%	38.4%	50.6%	58.0%	63.4%	67.8%										
2021	12	18.2%	35.5%	47.1%	55.1%	61.0%											
2022	3	15.2%	31.5%	42.7%	51.2%												
2022	6	19.4%	36.8%	50.1%													
2022	9	19.6%	36.9%														
2022	12	16.8%															

> **Reviewing a standard closure analysis of cumulative closed to incurred claims, indicates that there still remains slower than average settlements. Catchup to more normal levels has not yet occurred.**

Total General Liability – Closure Ratios #2

Losses evaluated through 12/31/2022

General Liability
Additional Calculated Analytics - Closure and Frequency

B. Closed/Available to be closed = (2 incremental) / (1 - 2@3 mo prior)

Year	Qtr	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
2017	3	16.2%	25.2%	18.5%	15.2%	13.1%	10.7%	10.1%	10.3%	11.4%	9.5%	9.1%	9.8%	11.2%	9.3%	10.9%	9.9%
2017	6	20.9%	27.5%	21.1%	15.7%	14.3%	11.3%	11.1%	10.9%	11.2%	8.4%	9.9%	9.1%	10.0%	8.9%	8.9%	8.9%
2017	9	20.9%	27.7%	20.3%	16.3%	14.2%	12.1%	10.6%	10.7%	10.9%	9.7%	8.5%	8.9%	8.5%	9.4%	9.0%	8.4%
2017	12	17.3%	25.6%	18.9%	14.2%	14.4%	11.7%	11.0%	9.7%	11.3%	8.7%	9.3%	8.8%	9.5%	8.0%	8.7%	9.7%
2018	3	15.2%	23.7%	16.2%	15.1%	12.7%	11.1%	9.6%	9.9%	10.3%	8.4%	8.3%	8.8%	9.1%	8.6%	9.5%	9.9%
2018	6	19.3%	26.3%	22.1%	16.3%	14.7%	11.5%	11.4%	9.9%	11.1%	9.0%	7.6%	7.7%	9.1%	9.3%	9.8%	10.1%
2018	9	18.5%	29.1%	20.9%	15.7%	13.8%	12.1%	10.3%	10.2%	10.1%	7.8%	7.3%	8.1%	9.5%	9.8%	9.4%	10.7%
2018	12	19.9%	27.2%	19.8%	15.4%	14.3%	11.8%	10.5%	9.0%	9.6%	8.3%	7.6%	8.1%	9.4%	9.0%	10.2%	11.0%
2019	3	16.1%	25.3%	18.0%	15.9%	13.1%	11.3%	9.7%	9.1%	9.4%	7.5%	8.0%	9.3%	9.3%	10.0%	10.6%	10.8%
2019	6	20.3%	28.8%	23.3%	15.8%	14.3%	11.0%	9.7%	9.1%	10.2%	8.6%	8.2%	8.3%	10.4%	9.9%	10.5%	
2019	9	20.5%	29.3%	20.3%	16.2%	13.2%	11.1%	9.5%	9.1%	11.0%	8.4%	8.2%	9.2%	10.8%	10.5%		
2019	12	18.1%	24.9%	18.6%	13.6%	12.5%	10.7%	9.2%	9.9%	9.6%	7.7%	9.0%	8.4%	9.9%			
2020	3	18.2%	24.7%	17.1%	14.2%	12.5%	10.5%	9.8%	9.5%	9.3%	8.9%	8.7%	9.9%				
2020	6	24.1%	30.5%	21.0%	15.7%	13.9%	10.1%	9.0%	8.8%	10.2%	8.7%	8.2%					
2020	9	23.1%	29.1%	19.9%	15.1%	12.2%	10.6%	9.8%	9.2%	10.4%	8.6%						
2020	12	21.3%	24.8%	17.5%	12.5%	11.9%	9.9%	8.9%	9.3%	9.1%							
2021	3	16.9%	23.8%	15.6%	12.5%	11.3%	9.6%	9.2%	8.3%								
2021	6	20.7%	26.8%	19.0%	15.1%	13.1%	11.5%	10.7%									
2021	9	20.1%	26.5%	19.1%	14.8%	13.4%	11.8%										
2021	12	18.2%	25.0%	17.8%	14.4%	11.9%											
2022	3	15.2%	22.4%	15.6%	13.1%												
2022	6	19.4%	25.8%	19.1%													
2022	9	19.6%	25.3%														
2022	12	16.8%															

An alternative closure analysis of reviewing closed claims divided by available to be closed from prior quarter shows a similar pattern, but with a bit more catching up done in the earliest accident quarters to longer term averages.

Total General Liability – Closure Ratios #3

Illustrative

This closure ratio, which requires triangulation estimates to ultimate and using that as a base, can see a bit more clearly the impact of the onset of Covid in 2020Q1 affecting most of the calendar quarters due to shutdown of claims activities and courts. Inventories are again starting to be cleared up.

Total Commercial Auto and Personal Auto - Closure Ratios #1 and #3

Commercial Auto - Paid Indemnity

Illustrative

For CAu and PAu, can see rather clearly the cumulative slowdown over 3 to 6 quarters to longer-term averages, and the attempts being made to catch up. There does appear to be some residual slowdown occurring in the first quarter evaluation even in the most recent 6 or so quarters. Claims departments "Robbing Peter to close Paul"?

Source: CAu SOLM-Qtr at 12/31/2022 & PAu SOLM-Qtr at 9/30/2022

Calculating Ex-Ante – latest 7 qtr VWA

Illustrative

Incurred Indemnity	Loss Year	Loss Month	3	6	9	12
	2017	3	235,792,295	435,267,017	521,038,784	596,499,959
	2017	6	220,567,681	421,774,494	522,466,412	578,562,538
	2017	9	247,413,547	432,547,564	525,280,507	598,618,493
	2017	12	202,102,163	394,431,467	495,103,550	575,816,400
	2018	3	254,598,809	479,281,533	578,644,170	686,129,604
	2018	6	236,398,209	447,886,135	545,466,794	623,139,877
	2018	9	241,228,024	466,888,959	566,106,470	647,132,941
	2018	12	211,381,021	395,107,536	499,767,868	579,627,824
	2019	3	254,295,029	490,005,975	572,558,890	672,000,243
	2019	6	212,435,853	425,468,806	530,356,934	626,477,507
	2019	9	246,821,695	466,989,212	555,743,544	642,756,109
	2019	12	213,529,884	423,042,583	521,590,607	628,725,380
	2020	3	203,439,711	341,141,147	420,107,935	493,008,826
	2020	6	133,434,024	290,745,716	355,247,251	407,972,246
	2020	9	181,807,838	363,399,355	441,440,873	517,800,023
	2020	12	178,666,134	335,669,747	425,198,978	493,922,335
	2021	3	193,561,607	388,166,931	480,402,079	555,244,076
	2021	6	191,898,603	400,342,009	482,989,806	544,669,125
	2021	9	206,492,869	385,276,442	485,471,711	556,570,518
	2021	12	169,258,582	330,464,474	429,309,459	511,494,001
	2022	3	203,902,588	415,756,352	522,753,075	616,906,874
	2022	6	195,624,844	424,670,546	539,688,932	
	2022	9	210,001,292	442,774,601		
	2022	12	176,493,239			

	Loss Year	Loss Month	6/3	9/6		15/12
	2017	3	1.846	1.197	1.145	1.100
	2017	6	1.912	1.239	1.107	1.134
	2017	9	1.748	1.214	1.140	1.127
	2017	12	1.952	1.255	1.163	1.140
	2018	3	1.882	1.207	1.186	1.082
	2018	6	1.895	1.218	1.142	1.120
	2018	9	1.935	1.213	1.143	1.117
	2018	12	1.869	1.265	1.160	1.119
	2019	3	1.927	1.168	1.174	1.111
	2019	6	2.003	1.247	1.181	1.120
	2019	9	1.892	1.190	1.157	1.109
	2019	12	1.981	1.233	1.205	1.120
	2020	3	1.677	1.231	1.174	1.091
	2020	6	2.179	1.222	1.148	1.117
	2020	9	1.999	1.215	1.173	1.146
	2020	12	1.879	1.267	1.162	1.127
	2021	3	2.005	1.238	1.156	1.096
	2021	6	2.086	1.206	1.128	1.134
	2021	9	1.866	1.260	1.146	1.136
	2021	12	1.952	1.299	1.191	1.147
	2022	3	2.039	1.257	1.180	
	2022	6	2.171	1.271		
	2022	9	2.108			

			3 - 6	6 - 9	9 - 12	12 - 15
0	ATA	2017-2020Q1	1.886	1.220	1.160	1.114
0	ATA	2020Q2-2022Q3	2.026	1.248	1.161	1.129
1	ATA	Last 7 Quarters	2.034	1.256	1.162	1.129
	ATU		7.350	3.614	2.878	2.477
33,903,398,296	Ultimate		1,297,172,858	1,600,273,299	1,553,324,794	1,528,153,920
Duration: # of Months			1.5	4.5	7.5	10.5
22.0	% Reptd - Incr		13.6%	14.1%	7.1%	5.6%

PremOps | Products | Other
GL-Comp Op | GL-Contr | GL-CRR | GL-Lcl Prd | GL-Liquor | GL-Mfg | GL-OLT | GL-Pollution | GL-Prod
Faster | Slower   Midwest | North | South | West
All Causes of Los >=25k | 1 - <10k | 10k - <25k
Note: Using last 7 factors for Incurred LDF

1 Ex Ante

Estimated Ultimate	AQ	Actual n-1	Actual n	7-Yr ATA	Expected n	Actual - Expected
1,366,239,853	2017Q1	1,366,239,853	1,374,025,145	1.000	1,366,239,853	7,785,292
1,388,662,460	2017Q2	1,362,319,667	1,372,605,005	1.019	1,388,662,460	(16,057,455)
1,468,971,115	2017Q3	1,423,425,078	1,446,649,411	1.012	1,441,104,875	5,544,536
1,374,983,871	2017Q4	1,314,139,366	1,336,568,526	1.014	1,332,351,946	4,216,580
1,567,722,663	2018Q1	1,475,371,535	1,506,259,772	1.016	1,498,349,260	7,910,512
1,467,964,413	2018Q2	1,358,889,263	1,373,705,802	1.017	1,381,489,827	(7,784,025)
1,593,790,071	2018Q3	1,446,921,722	1,482,933,298	1.020	1,475,365,612	7,567,686
1,409,568,865	2018Q4	1,250,731,535	1,296,830,173	1.023	1,279,676,569	17,153,604
1,523,992,891	2019Q1	1,317,056,538	1,373,397,331	1.027	1,352,261,685	21,135,646
1,476,576,103	2019Q2	1,241,128,731	1,277,358,907	1.028	1,276,078,269	1,280,638
1,510,507,169	2019Q3	1,231,012,448	1,289,549,867	1.031	1,269,649,321	19,900,546
1,450,142,367	2019Q4	1,132,963,677	1,187,918,096	1.043	1,181,817,168	6,100,928
1,182,078,290	2020Q1	882,840,109	933,916,856	1.046	923,531,231	10,385,625
962,334,501	2020Q2	681,139,248	714,666,730	1.055	718,723,543	(4,056,813)
1,255,055,494	2020Q3	832,505,330	894,989,761	1.067	888,326,828	6,662,933
1,214,509,533	2020Q4	746,914,854	811,847,514	1.079	805,610,321	6,237,193
1,290,356,051	2021Q1	737,692,683	820,337,661	1.076	793,559,931	26,777,730
1,293,556,111	2021Q2	680,558,405	742,068,891	1.087	739,522,148	2,546,743
1,326,608,235	2021Q3	632,459,458	720,042,408	1.104	697,947,601	22,094,807
1,202,806,326	2021Q4	511,494,001	586,502,614	1.121	573,436,993	13,065,621
1,422,637,997	2022Q1	522,753,075	616,906,874	1.157	604,977,531	11,929,343
1,441,848,717	2022Q2	424,670,546	539,688,932	1.248	529,812,118	9,876,814
1,426,838,943	2022Q3	210,001,292	442,774,601	2.001	420,249,688	22,524,913
31,617,752,036						

This exhibit shows how "ex-ante" or reserve runoff calculations are produced. This calculation, which rolls back each of the LDF sets to estimate what would have known at the time, to give one of the best actual vs expected early warnings of lengthening LDFs. In the highlighted cell, the 2.108 LDF experienced for 2022Q3, is higher then the prior 7 qtr LDFs average of 2.001, producing adverse development of 22.5M for that cell.

CAS

General Liability – ExAnte Reserve Runoff
All GL – Reserve Run-off Test @12/31/2022 - Ground-up

Illustrative

Comparing to initial selected excess loss ultimates at 3 months using a mechanical 7-year average, produces adverse development across all quarters since 2020Q2.

General Liability – ExAnte Reserve Runoff
All GL – Reserve Run-off Test @12/31/2022 – BI xs 25k

Illustrative

Similar to total GL GU, BI claims excess of 25k have for developed adversely for almost all quarters since 2020Q2.

C. Main Impacts

- **Severities up** beyond normal increases
- **Frequencies down** significantly below pre-pandemic, also below normal base-line decreases
- **Adverse development**
- **Delayed closures** and catch-up settlements
  - 1st evaluation claims: maybe "Robbing Peter to Close Paul"
- **Increasing loss ratios**

- **Concern for future:**
  - if average severities remain high, frequencies revert closer to pre-pandemic, closure catch-up continues to occur, and adverse development continues
  - loss ratios could significantly increase soon as the pandemic abates

Recent Trends Impacted by Covid / Inflation – Total GL
2017 through 2022 Year-End – On-level

Illustrative

On an On-Level basis, GL showed a 28% frequency reduction in 2020 due to Covid, with a slight increase in frequency in 2021 and similar level in 2022. This slight frequency increase coupled with the 11% severity increases in recent years has led to increasing on-level loss ratios to about pre-pandemic levels in 2022. If severities continue to stay high and frequencies return closer to pre-pandemic levels, loss ratios may continue to rise.

ISO SOLM QTR

SOLM Qtr GL 2022 Q4
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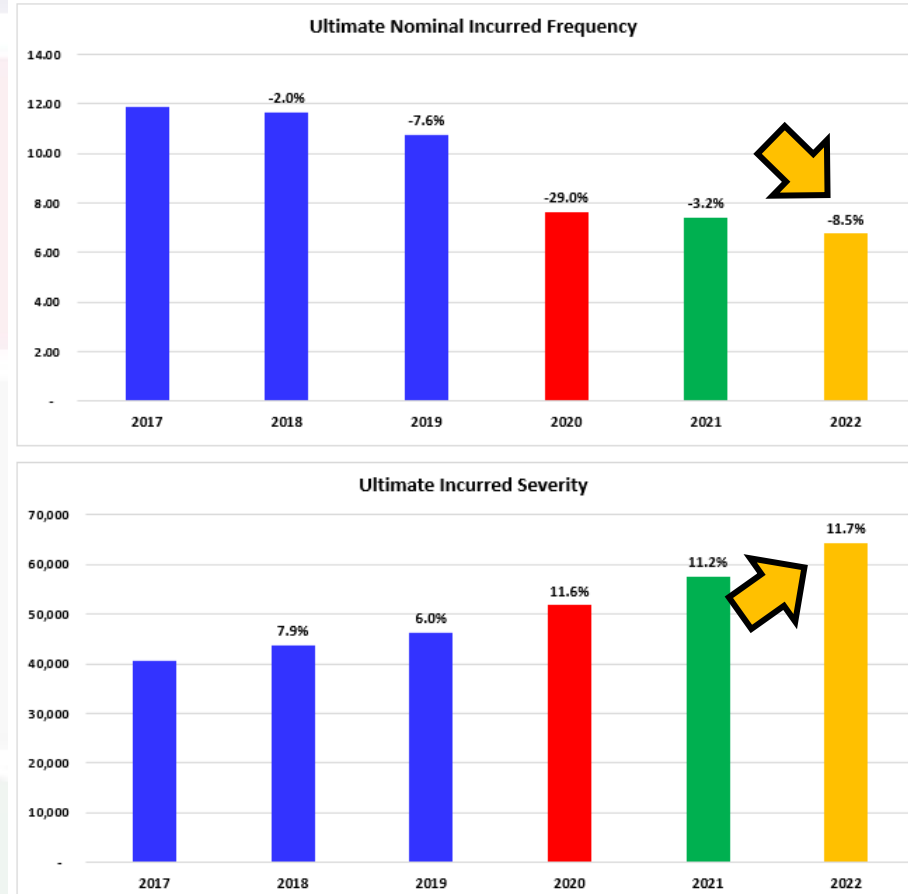
Subline	PremOps | Products | Other
Class Group	GL-Comp Op | GL-Contr | GL-CRR | GL-Lcl Prd | GL-Liquor | GL-Mfg | GL-OLT | GL-Pollution | GL-Prod
Region	Midwest | North | South | West
Cause of Loss	All Causes of Loss
Claim Size	>=25k | 1 - <10k | 10k - <25k
Company Speed	Faster | Slower
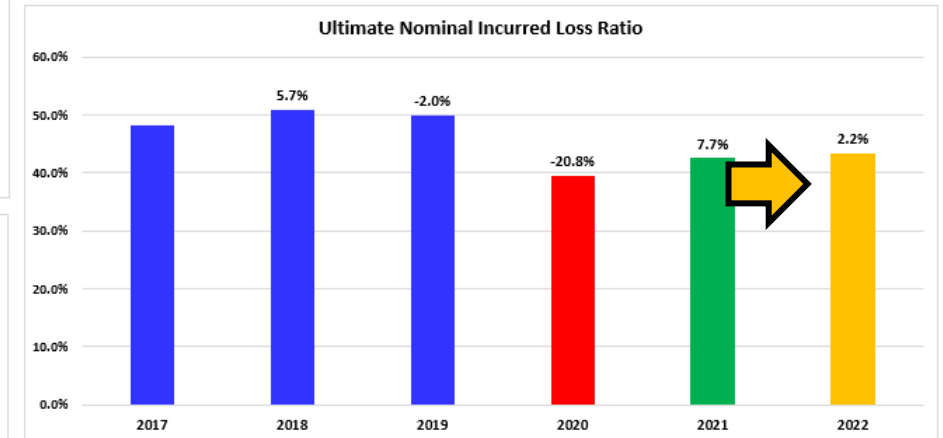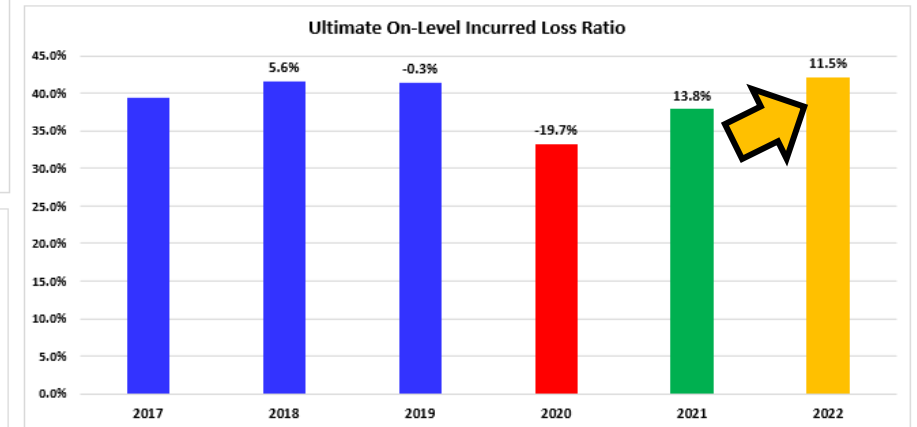
CvIF

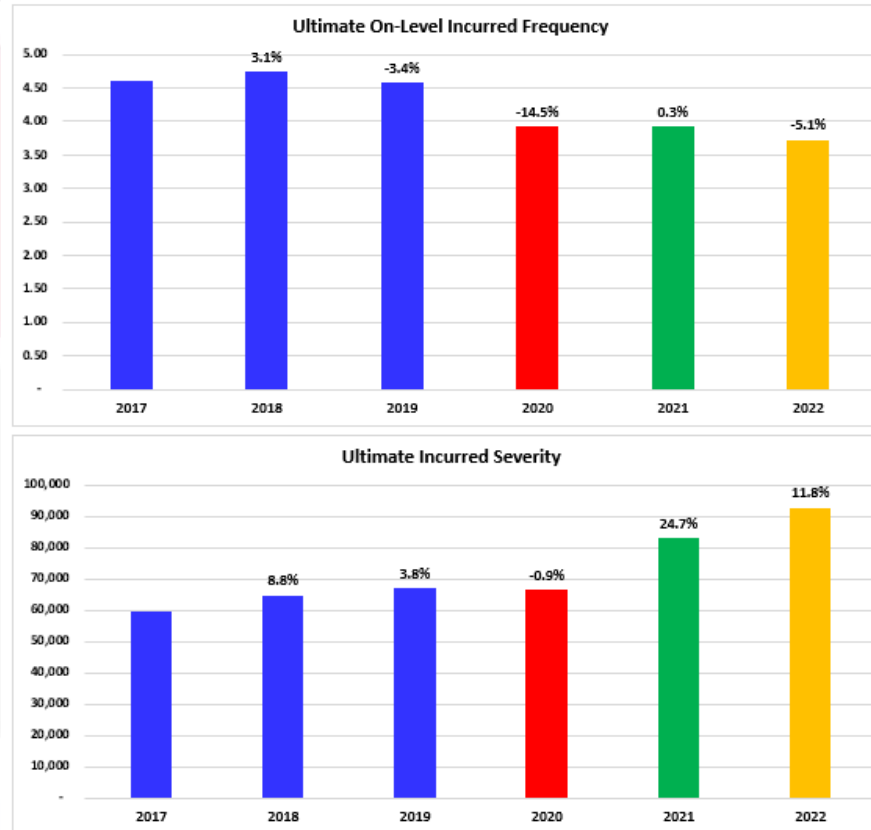|	Frequency	Severity	Loss Ratio
2020	0.685	1.188	0.816
2021	0.701	1.322	0.928
2022	0.699	1.477	1.035

# of Claims (6 years) 677,196

NB: mechanical selection for LDFs of last 7 qtr VWA used in projections from GL SOLM-Qtr at 12/31/2022. No tail beyond 2017 supplied. Indemnity Only uses ISO MarketWatch 6/30/2022 rate changes

55

Recent Trends Impacted by Covid / Inflation – Total CAu
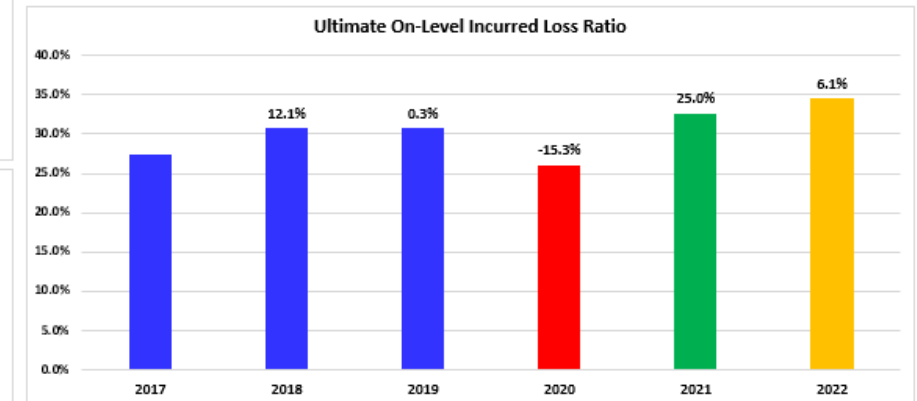## 2017 through 2022 Year-End – On-Level

Illustrative

As observed previously, in 2020 there was a significant frequency reduction driving a significant loss ratio reduction. For severity, we see YTY changes significantly higher than in the past with increases above 10% in 2020 - 2022. This large increase in severity, paired with a partial rebound in frequency led to an increase in loss ratio in 2021 and 2022 to higher than pre-pandemic levels.
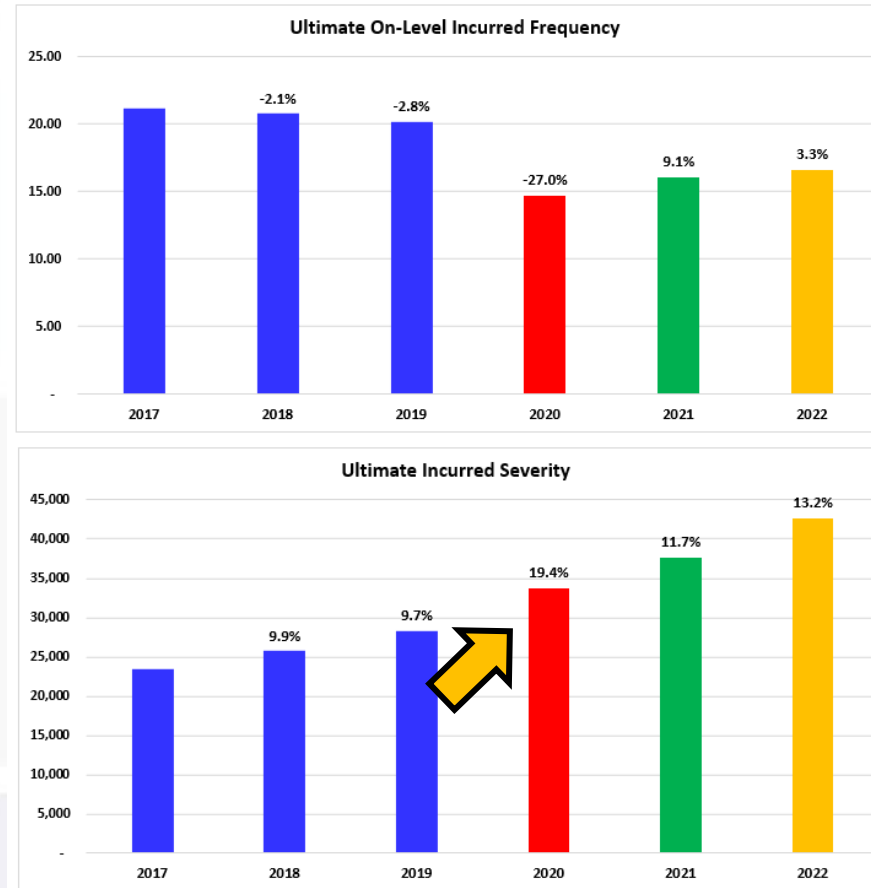
ISO SOLM QTR

Class Group	Liability
Region	Midwest | North | South | West
Cause of Loss	All Causes of Loss
Claim Size	1 - <10k | 10k - <25k | >=25k

Ultimate On-Level Incurred Frequency

Ultimate Incurred Severity

Ultimate On-Level Incurred Loss Ratio
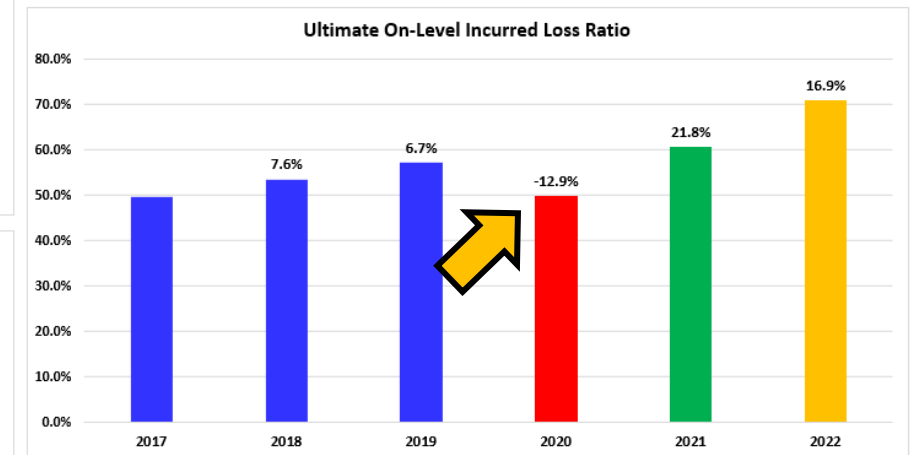
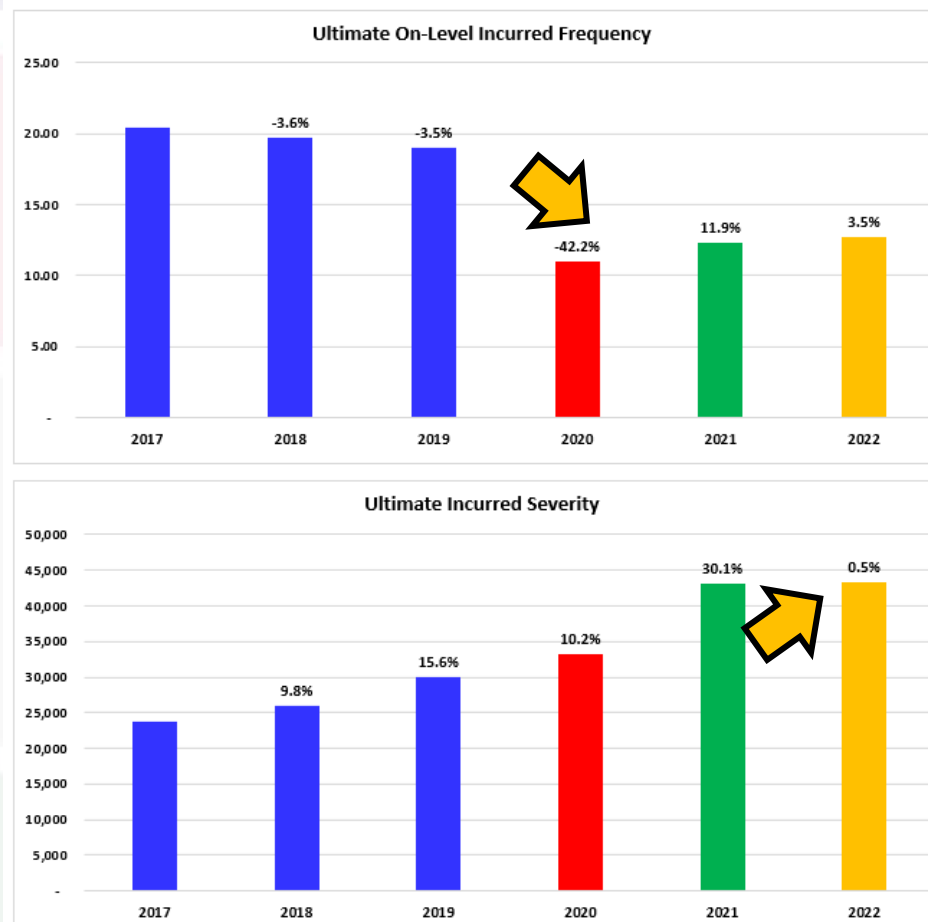| CvIF	Frequency	Severity	Loss Ratio
2020	0.711	1.307	0.931
2021	0.776	1.459	1.134
2022	0.801	1.651	1.325

# of Claims (6 years) **1,574,141**

NB: mechanical selection for LDFs of last 7 qtr VWA used in projections from CAu SOLM-Qtr at 12/31/2022. No tail beyond 2017 supplied. Indemnity Only
uses ISO MarketWatch 6/30/2022 rate changes

Recent Trends Impacted by Covid / Inflation – Total CP
## 2017 through 2022 Year-End – On-Level

Illustrative

CP showed a 14.5% on-level frequency reduction in 2020 due to Covid, with similar depressed level in 2021 and further reduction in 2022. Average severities increased in 2021 and 2022 by about 25% and 12% respectively, much higher than in prior years. This led to on-level loss ratios getting to higher than pre-pandemic levels in 2022.

Ultimate On-Level Incurred Frequency

Year	Value
2017	
2018	3.1%
2019	-3.4%
2020	-14.5%
2021	0.3%
2022	-5.1%

Ultimate Incurred Severity

Year	Value
2017	
2018	8.8%
2019	3.8%
2020	-0.9%
2021	24.7%
2022	11.8%

ISO SOLM QTR

SOLM Qtr CP 2022 Q4
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Market	CP-Comml	CP-Mfg	CP-Resid
Class Group	All Classes
Region	Midwest	North	South	West
Cause of Loss	All No CAT
Claim Size	>=100k	1 - <25k	25k - <100k

Ultimate On-Level Incurred Loss Ratio

Year	Value
2017	
2018	12.1%
2019	0.3%
2020	-15.3%
2021	25.0%
2022	6.1%

CvIF

	Frequency	Severity	Loss Ratio
2020	0.844	1.044	0.880
2021	0.846	1.301	1.101
2022	0.803	1.455	1.168

# of Claims (6 years) 273,209

NB: mechanical selection for LDFs of last 7 qtr VWA used in projections from CP SOLM-Qtr at 12/31/2022. No tail beyond 2017 supplied. Indemnity Only uses ISO MarketWatch 6/30/2022 rate changes

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Recent Trends Impacted by Covid / Inflation – GL Restaurants & Bars 2017 through 2022 Year-End – On-level

Illustrative

GL Restaurants and Bars was one of the most impacted class groups for GL over the past 3 years. On-Level frequency fell more than 40% in 2020 due to the pandemic, but then saw a 12% recovery in 2021 with slight increase again in 2022. Severity saw a significant increase in 2021 of 30% with similar level in 2022. These frequency and severity impacts led to a sharp drop in on-level loss ratio in 2020 with increases back to pre-pandemic levels in 2021 and 2022.

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Subline	PremOps	Products
Class Group	Restaurants and Bars
Region	Midwest	North	South	West
Cause of Loss	All Causes of Loss
Claim Size	>=25k	1 - <10k	10k - <25k
Company Speed	Faster	Slower
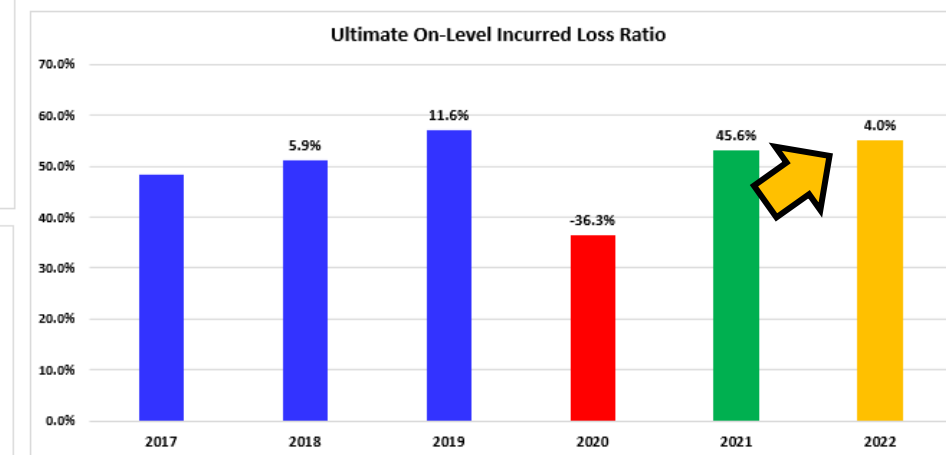
CvIF

	Frequency	Severity	Loss Ratio
2020	0.557	1.247	0.697
2021	0.623	1.622	1.014
2022	0.645	1.631	1.055

# of Claims (6 years) 44,558

Residual Trends (ART) – GL Restaurants & Bars (incl Covid Adjustment)

Illustrative


Nominal ultimate loss ratios were adjusted by various development, trend, and on-leveling adjustments. The goal of this analysis is to end up with a straight line of loss ratios (black line on graph) that only exhibit random variations around a mean (process variance).

Any remaining trend would be due to not including enough adjustments (coverage changes, risk management improvements, one-time plateau events in either direction (Great Recession), etc. These are similar adjustments that are relevant to Rate Change Method 5.

This is especially important in 2020/2021 and beyond as if it is believed that the Covid Pause, with its impact on economic and loss activity, will eventually revert back to normal, then there would need to be an explicit adjustment for both the numerator and denominator.

This same analysis can be done on other metrics such as frequencies, excess layers, partial loss trends, etc.
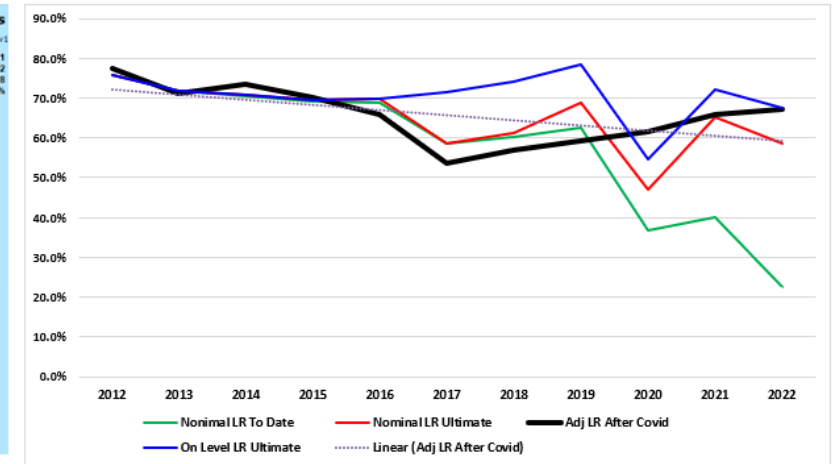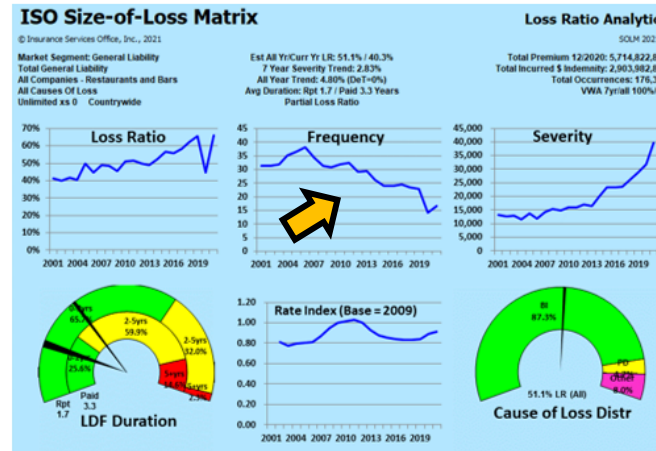
In this example, there is a generally negative positive trend in the adjusted loss ratios of about 2.65%, with some moderate downward trend from 2015-2017 and then some moderate upward trend since 2017. Therefore, we can conclude that there must be some loss or premium influences that have not been considered.

Source: SOLM-Qtr at 12/31/2022 (SOLM-annual for 2016 & prior)

Your post pandemic assessment of parameter confidence should reflect any unknowns that may occur as to frequency drop reversals, closures back to normal, inflations impacts, adverse development, size of claim impacts, etc. The confidence levels of some attributes may still remain high, like well monitored rate changes. But others in particular longer tail line frequencies, excess severities, ILFs, and LRs may suffer due to the additional unknowns.

Some of the benchmarks may in essence become "couchmarks".

	1	2	3	4	5	6	7	8
	Trends					Loss Dev't Factors		State/ Hazard/ Subline
	Ground Up			Excess				
	Severity	Frequency	Exposure	Severity	Frequency	Ground Up	Excess	
Casualty	◉	◎	●	◎	◎	◉	◉	◉
Property	◉	◉	◉	◉	◎	●	●	◉
Specialty	◉	◎	○	◉	◎	◉	◉	◎

	9	10	11	12	13	14	15	16
	Rate Changes		Loss Costs		External Forces	Loss Ratios		Where In the Cycle?
	Primary	Reinsurance	Ground-up	ILFs		Primary	Reinsurance	
Casualty	●	●	◉	◎	○	◎	◎	◎
Property	●	●	◉	◉	○	◉	◉	◉
Specialty	◉	◉	◎	◎	○	◎	◎	◎

Confidence: Good ●   Medium ◉   Some ◎   Minimal ○

Mechanical Indication of Trends @12/2022– Post Pandemic

Illustrative

Metrics for Pre Covid, First 2 Covid years and Heightened Inflation year	90% CI (Responses)		"Actual"
	Lower	Upper	
1. Total GL Annual Severity Change – 2015-2019			4.2%
2. Total GL Annual Severity Change – 2019-2021			11.4%
3. Total GL Severity Change – 2021-2022			11.7%
4. Total GL Annual Frequency Change – 2015-2019			-4.1%
5. Total GL Annual Frequency Change – 2019-2021			-12.9%
6. Total GL Frequency Change – 2021-2022			-0.2%
7. Total CAu Annual Severity Change – 2019-2022			12.3%
8. Total CAu Annual Frequency Change – 2019-2022			-5.8%
9. Total CP Annual Severity Change – 2019-2022			11.9%
10. Total CP Annual Frequency Change – 2019-2022			-6.5%

- Actual annual trend indications using SOLM-Qtr mechanical LDFs last 7 quarters Frequency indications use on-level premium @12/31/2022 as base

Questions and Feedback