Antitrust Notice

- **The Casualty Actuarial Society is committed to adhering strictly to the letter and spirit of the antitrust laws. Seminars conducted under the auspices of the CAS are designed solely to provide a forum for the expression of various points of view on topics described in the programs or agendas for such meetings.**

- **Under no circumstances shall CAS seminars be used as a means for competing companies or firms to reach any understanding – expressed or implied – that restricts competition or in any way impairs the ability of members to exercise independent business judgment regarding matters affecting competition.**

- **It is the responsibility of all seminar participants to be aware of antitrust regulations, to prevent any written or verbal discussions that appear to violate these laws, and to adhere in every respect to the CAS antitrust compliance policy.**

Meet Your Panelists

- Tad Womack, FCAS, MAAA (he/his)
- Senior Principal with Oliver Wyman

- Joaquin Camara, ACAS, ASA, MAAA
- Consultant with Oliver Wyman

- Natasha Dimitrienko, FCAS, MAAA (she/her)
- Principal with Oliver Wyman

Closure Rate Methodology

- Especially useful in an **environment of changing claim closure rates**

- Produces **additional ultimate loss projections** analogous to the traditional methods we use everyday (e.g., chain ladder, Bornhuetter-Ferguson, frequency x severity)

- Differs from traditional time-based methodology in that historical triangles are organized based on **consistent cumulative closure rates as opposed to consistent maturities**

- Requires **transaction-level payment and case reserve** data files

Step 1: Review Cumulative Closure Rates (CCR)

AY	12	24	36	48	60	72	84	96	108	120	132	144	156	168
2002	50.95%	78.32%	88.25%	91.08%	94.27%	96.88%	97.98%	99.08%	98.90%	99.27%	99.45%	99.82%	99.82%	99.82%
2003	34.95%	77.40%	85.85%	91.57%	95.62%	97.41%	98.87%	99.19%	99.19%	99.19%	99.20%	99.36%	99.36%	99.36%
2004	42.11%	76.74%	86.61%	93.39%	96.00%	98.26%	97.44%	97.95%	98.47%	98.47%	98.30%	98.47%	98.81%	98.64%
2005	37.30%	77.65%	86.73%	92.16%	95.56%	96.14%	97.15%	98.50%	98.66%	99.00%	99.00%	99.17%	99.17%	99.50%
2006	35.75%	78.63%	87.43%	93.71%	95.38%	97.10%	98.81%	99.15%	99.49%	99.83%	99.66%	99.83%	100.00%	100.00%
2007	32.50%	70.41%	88.61%	92.69%	94.60%	96.91%	97.38%	98.61%	99.38%	99.23%	99.38%	99.38%	99.54%	99.69%
2008	40.61%	78.29%	85.50%	89.64%	94.24%	96.39%	97.55%	98.20%	98.69%	98.85%	99.02%	99.35%	99.35%	99.35%
2009	43.84%	80.18%	87.83%	93.74%	96.53%	97.75%	98.96%	99.31%	99.13%	99.31%	99.48%	99.48%	99.48%	
2010	43.41%	78.23%	89.07%	92.72%	95.60%	97.27%	98.33%	99.24%	99.24%	99.39%	99.39%	99.39%		
2011	45.51%	78.91%	85.89%	90.63%	94.27%	96.53%	98.04%	98.34%	98.94%	98.79%	99.09%			
2012	47.35%	74.64%	85.40%	90.57%	95.61%	96.38%	97.80%	98.71%	98.97%	99.35%				
2013	45.03%	74.58%	85.33%	92.05%	95.68%	97.74%	98.82%	99.21%	99.41%					
2014	46.69%	76.79%	89.02%	94.42%	97.87%	98.78%	99.49%	99.49%						
2015	45.91%	83.63%	90.13%	94.62%	97.42%	98.65%	98.99%							
2016	52.93%	86.10%	92.85%	96.38%	98.19%	98.72%								
2017	58.19%	88.42%	93.23%	96.67%	98.06%									
2018	61.42%	87.97%	93.02%	96.43%										
2019	66.52%	91.75%	95.88%											
2020	66.41%	88.81%												
2021	68.17%													

Conclusion: Green shaded values indicate **accelerated** claim closure environment

Step 2: Re-Order Closure Rate Triangle

AY	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
2005	37.295%	77.645%	86.735%	92.164%	95.563%	96.141%	97.152%	98.497%	98.664%	99.000%	99.000%	99.167%	99.167%	99.500%	99.833%	100.000%	100.000%			
2006	35.753%	78.634%	87.435%	93.706%	95.385%	97.099%	98.807%	99.150%	99.490%	99.830%	99.660%	99.830%	100.000%	100.000%	100.000%	100.000%				
2002	50.954%	78.322%	88.249%	91.076%	94.266%	96.875%	97.978%	99.081%	98.897%	99.266%	99.452%	99.817%	99.817%	99.817%	99.817%	99.817%	99.817%	99.817%	99.817%	99.817%
2007	32.504%	70.411%	88.608%	92.691%	94.599%	96.914%	97.377%	98.611%	99.383%	99.230%	99.384%	99.384%	99.538%	99.692%	99.692%					
2014	46.688%	76.789%	89.024%	94.416%	97.868%	98.783%	99.493%	99.493%												
2009	43.841%	80.175%	87.826%	93.739%	96.528%	97.747%	98.960%	99.307%	99.133%	99.307%	99.480%	99.480%	99.480%							
2013	45.030%	74.581%	85.335%	92.051%	95.682%	97.743%	98.822%	99.215%	99.411%											
2010	43.408%	78.234%	89.074%	92.716%	95.599%	97.269%	98.331%	99.241%	99.241%	99.393%	99.393%	99.393%								
2003	34.951%	77.401%	85.849%	91.572%	95.624%	97.411%	98.867%	99.192%	99.192%	99.194%	99.196%	99.357%	99.357%	99.357%	99.357%	99.357%	99.357%	99.357%	99.357%	
2012	47.347%	74.644%	85.401%	90.568%	95.607%	96.382%	97.804%	98.708%	98.966%	99.354%										
2008	40.608%	78.291%	85.502%	89.638%	94.243%	96.388%	97.545%	98.200%	98.691%	98.854%	99.018%	99.345%	99.345%	99.345%						
2004	42.105%	76.744%	86.609%	93.391%	96.000%	98.261%	97.440%	97.952%	98.467%	98.467%	98.296%	98.467%	98.807%	98.637%	98.637%	98.978%	99.148%	99.148%		
2011	45.513%	78.907%	85.888%	90.634%	94.268%	96.531%	98.036%	98.338%	98.943%	98.792%	99.094%									
2015	45.905%	83.632%	90.135%	94.619%	97.422%	98.655%	98.991%													
2016	52.935%	86.096%	92.850%	96.375%	98.190%	98.722%														
2017	58.194%	88.415%	93.234%	96.667%	98.056%															
2018	61.423%	87.972%	93.019%	96.425%																
2019	66.518%	91.751%	95.882%																	
2020	66.414%	88.809%																		
2021	68.168%																			

- Organize accident years from **highest CCR at top to lowest CCR at bottom** (i.e., accident years do not need to flow in chronological order)
- Doing so means that **each year above a given year has experienced the CCR for the given year**

Step 3: Values at Target Closure Rates (TCR)

AY	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%	99.411%	99.480%	99.493%	99.692%	99.817%	100.000%	100.000%
2005	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%	99.411%	99.480%	99.493%	99.692%	99.817%	100.000%	100.000%
2006	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%	99.411%	99.480%	99.493%	99.692%	99.817%	100.000%	
2002	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%	99.411%	99.480%	99.493%	99.692%	99.817%		
2007	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%	99.411%	99.480%	99.493%	99.692%			
2014	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%	99.411%	99.480%	99.493%				
2009	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%	99.411%	99.480%					
2013	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%	99.411%						
2010	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%							
2003	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%								
2012	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%									
2008	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%										
2004	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%											
2011	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%												
2015	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%													
2016	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%														
2017	68.168%	88.809%	95.882%	96.425%	98.056%															
2018	68.168%	88.809%	95.882%	96.425%																
2019	68.168%	88.809%	95.882%																	
2020	68.168%	88.809%																		
2021	68.168%																			

- Use the transactional files to **secure paid, incurred, closed, and reported values** at the target closure rates (TCR)

- Think of each accident year as a **continuum of activity** from a 0% CCR to its current CCR – the goal is to "stop the clock" when a **closure transaction** yields **CCR = TCR** and record the above values

Step 4: Input Assumptions

- Evaluation date

- Accident or policy period date grouping

- Retentions to cap the transactions

- Which groups to split analyses by (e.g., states, business units, lost time vs medical only)

Step 5: Create Candidate Transaction Totals

- Purpose: create a running total of AY reported counts, closed counts, limited paid, and limited incurred as of each closure transaction

Claim.ID	AY	Trans.Status	Transaction.Date	Paid_trans	Inc_trans	Total AY Limited Paid	Total AY Limited Inc	TotalReptAY	TotalClsdAY	CumuClosure
1	2021	Closed	3/12/2021	428	-	44,224	476,192	67	1	1.49%
2	2021	Closed	4/26/2021	-	(500)	44,580	476,548	68	2	2.94%
3	2021	Closed	5/7/2021	-	(310)	53,524	584,065	77	3	3.90%
4	2021	Closed	5/14/2021	1,120	-	53,719	583,665	77	4	5.19%
4	2021	Closed	5/14/2021	-	(2,381)	57,351	616,278	77	5	6.49%
5	2021	Closed	5/16/2021	-	(400)	60,574	616,278	77	5	6.49%
6	2021	Closed	5/16/2021	243	243	60,656	618,900	77	5	6.49%
7	2021	Closed	5/21/2021	-	(811)	62,971	627,472	78	6	7.69%
8	2021	Closed	5/31/2021	31	-	63,735	641,090	78	6	7.69%
9	2021	Closed	5/31/2021	9	-	68,996	723,714	84	7	8.33%
6	2021	Closed	5/31/2021	8	8	69,770	770,295	90	8	8.89%
10	2021	Closed	5/31/2021	63	-	70,030	805,875	90	8	8.89%

- We will then "stop" each AY at the "same" cumulative closure rate to create our desired triangles

Candidate Closure Transaction Considerations

- Because the number of reported counts vary by accident year, there is likely **no combination** of closed claims and reported claims that **exactly matches** the TCR

  ✓ **Candidate closure transactions** are those which produce a CCR within 1/n of the TCR, where n is the number of reported claims at that transaction

- Further, we want the most "representative" closure transaction. We do not simply choose the closure transaction that produces the closure rate mathematically-nearest the TCR. For example, consider a TCR of 50% where 400 claims are closed out of 800 reports:

  ○ We don't want a year to return paid and incurred loss values when 1 claim closes out of 2 reports. That would be too soon to be representative. So, **we cannot always choose the first closure transaction within 1/n of the TCR**.

  ○ We also don't want to choose a transaction that happens too late, particularly at the first TCR where the denominator (reported counts) continues to increase. If we always choose the last closure transaction that comes within 1/n of 50%, some years could be biased upward relative to others. That is, some paid and incurred loss values could be overstated, leading to an understatement of the first link ratio. So, **we cannot always choose the last closure transaction within 1/n of the TCR.**

Method 1: Preliminary Closure Transaction Selection

The **preliminary** closure transaction selection process is as follows:

- Determine if the AY reaches the TCR before or after X months maturity, where X is the months of maturity of the target AY (i.e., the current time-based maturity)

  - If the AY reaches the TCR before X months maturity, choose the latest closure transaction before X months maturity that comes within 1/n of the TCR (defined as **last**)

  - If the AY reaches the TCR after X months maturity, choose the first closure transaction after X months maturity that comes within 1/n of the TCR (defined as **first**)

✓ This methodology ensures that the selected closure transaction is the **closest directionally-logical transaction** within 1/n of the TCR

AY	12	Method
2002	65.30%	first
2003	70.67%	last
2004	68.14%	last
2005	69.37%	last
2006	66.89%	first
2007	65.51%	first
2008	65.79%	first
2009	65.05%	first
2010	63.96%	first
2011	60.79%	first
2012	61.99%	first
2013	60.28%	first
2014	61.65%	first
2015	61.44%	first
2016	63.45%	first
2017	66.25%	first
2018	64.60%	first
2019	65.92%	first
2020	65.98%	first
2021	67.60%	TCR

Last
The highlighted AYs reach a 67.60% closure rate before 12 months maturity. So, the last closure transaction within 1/n of 67.60% before 12 months maturity is selected

First
The other AYs reach a 67.60% closure rate after 12 months maturity. So, the first transaction within 1/n of 67.60% after 12 months maturity is selected

Why is it Deemed Preliminary?

- The **closure transaction is deemed "preliminary"** because the nature of the first/last definitions, coupled with the small number of incremental closures in the right-side of the triangle, can lead to **undesired reversals** (i.e., closure transaction dates in a given row should not decline from left to right)

Methodology

AY	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%
2005	first	first	first	first	first	first	first	first	last	last	first
2006	first	first	first	first	first	first	first	last	last	last	last
2002	first	first	first	first	first	first	first	last	last	last	first
2007	first	first	first	first	first	first	first	last	last	last	first

Closure Transaction Date

AY	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%
2005	10/17/05	3/23/07	3/17/09	3/31/10	7/31/11	9/6/12	6/20/13	12/31/14	7/31/16	11/30/17	6/22/15
2006	5/23/06	3/23/08	3/31/10	5/31/10	4/26/11	10/31/11	4/24/12	6/4/13	6/4/13	9/30/13	9/30/13
2002	6/22/01	1/27/03	4/29/05	7/8/05	11/15/06	8/15/07	9/7/07	9/30/10	9/30/10	11/30/10	9/30/10
2007	12/31/07	1/5/09	5/11/11	5/31/11	7/31/13	12/31/13	7/14/14	9/30/14	9/30/14	2/29/16	2/29/16

Non-Decreasing?

AY	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%
2005		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
2006		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
2002		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
2007		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

Method 2: Most Recent Closure Transaction

- As seen on the prior slide, if reversals occur, they tend to occur "to the right"

  ✓ When **reversals begin to occur**, they can be **overcome** by <u>Method 2 – choosing the **most recent closure transaction**</u> that comes within 1/n of the target closure rate

Non-Decreasing?

AY	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%	99.411%	99.480%	99.493%	99.692%	99.817%	100.00%	100.00%
2005		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE
2006		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	
2002		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE		
2007		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE			
2014		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE				
2009		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE					
2013		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE						
2010		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE							
2003		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE								
2012		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE									
2008		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE										
2004		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE											
2011		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE												
2015		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE													
2016		TRUE	TRUE	TRUE	TRUE	TRUE														
2017		TRUE	TRUE	TRUE	TRUE															
2018		TRUE	TRUE	TRUE																
2019		TRUE	TRUE																	
2020		TRUE																		
2021																				

Use Method 2 here (most recent within 1/n)

Use Method 1 here (last/first)

Final Closure Transaction Selection Results

- Selecting Method 1 and Method 2 per the prior slide yields the following final CCR results:

AY	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%	99.411%	99.480%	99.493%	99.692%	99.817%	100.00%	100.00%
2005	68.136%	88.756%	95.734%	96.309%	97.993%	98.664%	98.833%	99.000%	99.167%	99.500%	99.500%	99.500%	99.500%	99.500%	99.500%	99.500%	99.833%	99.833%	100.00%	100.00%
2006	68.070%	88.656%	95.726%	96.410%	97.952%	98.637%	98.978%	99.150%	99.150%	99.490%	99.490%	99.490%	99.490%	99.490%	99.490%	99.660%	99.830%	99.830%	100.00%	
2002	67.991%	88.710%	95.772%	96.324%	97.978%	98.713%	98.897%	99.269%	99.269%	99.452%	99.452%	99.452%	99.452%	99.452%	99.634%	99.634%	99.817%	99.817%		
2007	68.038%	88.766%	95.833%	96.296%	97.994%	98.611%	98.920%	99.228%	99.228%	99.384%	99.384%	99.384%	99.538%	99.538%	99.538%	99.538%	99.692%			
2014	68.107%	88.720%	95.838%	96.345%	97.970%	98.783%	99.087%	99.189%	99.189%	99.391%	99.391%	99.391%	99.493%	99.493%	99.493%	99.594%				
2009	67.992%	88.696%	95.833%	96.354%	97.917%	98.614%	98.960%	99.133%	99.307%	99.480%	99.480%	99.480%	99.480%	99.480%	99.480%					
2013	68.115%	88.802%	95.878%	96.369%	98.037%	98.626%	98.921%	99.117%	99.215%	99.411%	99.411%	99.411%	99.411%	99.411%						
2010	68.092%	88.771%	95.751%	96.358%	98.027%	98.634%	98.938%	99.241%	99.241%	99.393%	99.393%	99.393%	99.393%							
2003	68.251%	88.655%	95.786%	96.272%	97.896%	98.706%	99.029%	99.195%	99.195%	99.357%	99.357%	99.357%								
2012	68.140%	88.760%	95.866%	96.382%	97.933%	98.708%	98.966%	99.096%	99.225%	99.354%	99.354%									
2008	68.166%	88.651%	95.724%	96.382%	98.036%	98.691%	98.854%	99.018%	99.182%	99.345%										
2004	68.008%	88.696%	95.826%	96.348%	97.913%	98.637%	98.978%	98.978%	99.148%											
2011	68.140%	88.671%	95.777%	96.380%	98.036%	98.640%	98.943%	99.094%												
2015	68.141%	88.789%	95.852%	96.413%	97.982%	98.767%	98.991%													
2016	68.138%	88.794%	95.842%	96.375%	98.083%	98.722%														
2017	68.152%	88.786%	95.833%	96.481%	98.056%															
2018	68.112%	88.782%	95.815%	96.425%																
2019	68.126%	88.889%	95.882%																	
2020	68.156%	88.809%																		
2021	68.168%																			

Outputs

- Triangles – paid, incurred, closed, reported

- Diagnostics – paid severity, incurred severity, average case reserves

- No need to perform alternative ultimate claim count projections – traditional methods still apply

- Paid and Incurred Link Ratios – ignore instances where there are no incremental closures

Incremental Closures

AY	68.168%	88.809%	95.882%	96.425%	98.056%	98.722%	98.991%	99.094%	99.148%	99.345%	99.354%	99.357%	99.393%	99.411%	99.480%	99.493%	99.692%	99.817%	100.00%	100.00%
2005	402	119	50	3	12	5	2	1	1	2	-	-	-	-	-	-	2	-	1	-
2006	388	120	52	4	10	5	2	2	-	2	-	-	-	-	-	1	1	-	1	-
2002	291	136	39	3	9	4	1	1	-	1	-	-	-	-	1	-	1	-	1	-
2007	430	131	60	3	11	4	2	2	-	2	-	-	1	-	-	-	-	-	1	-
2014	662	211	71	5	16	9	3	1	-	2	-	-	1	-	-	1				
2009	359	151	42	3	9	5	2	1	1	1	-	-	-	-	-					
2013	690	214	73	5	17	6	3	2	1	2	-	-	-	-						
2010	446	139	46	4	11	4	2	2	-	1	-	-	-							
2003	359	188	44	3	11	5	2	4	-	2	-	-								
2012	524	163	55	4	12	6	2	1	1	1	-									
2008	394	145	43	4	13	4	1	1	1	1										
2004	321	189	41	3	11	4	2	-	1											
2011	447	140	48	4	10	4	2	1												
2015	601	191	63	5	14	7	2													
2016	633	199	67	5	17	6														
2017	719	239	77	7	17															
2018	754	259	86	7																
2019	778	270	93																	
2020	732	252																		
2021	651																			

Link Ratios Selection

- Paid and Incurred Link Ratios – ignore instances where there are no incremental closures

Incurred Loss Link Ratios

AY	.68168-.88809	.88809-.95882	.95882-.96425	.96425-.98056	.98056-.98722	.98722-.98991	.98991-.99094	.99094-.99148	.99148-.99345	.99345-.99354	.99354-.99357	.99357-.99393	.99393-.99411	.99411-.99480	.99480-.99493	.99493-.99692	.99692-.99817	.99817-1.00000
2005	1.224	1.242	1.018	1.034	1.019	1.017	1.010	1.009	1.012								1.003	1.004
2006	1.587	1.316	1.015	1.044	1.008	1.001	1.016		1.006							1.003	1.007	1.001
2002	1.621	1.356	1.009	1.017	1.012	1.008	1.007		1.008					1.009			1.001	
2007	1.295	1.330	1.006	1.051	1.007	1.005	1.010		1.010				1.008				1.004	
2014	1.511	1.133	1.009	1.029	1.018	1.025	1.001		1.006				1.006		1.006			
2009	1.577	1.181	1.004	1.025	1.028	1.017	1.023	1.008	1.003									
2013	1.689	1.193	1.004	1.051	1.011	1.003	1.015	1.003	1.014									
2010	1.621	1.263	1.047	1.049	1.019	1.014	1.003		1.004									
2003	1.538	1.133	1.043	1.051	1.023	1.002	1.010		1.009									
2012	1.593	1.120	1.017	1.049	1.011	1.010	1.004	1.004	1.008									
2008	1.449	1.227	1.008	1.046	1.035	1.003	1.020	1.006	1.003									
2004	1.703	1.104	1.012	1.041	1.038	1.011		1.003										
2011	1.799	1.130	1.013	1.046	1.032	1.003	1.005											
2015	1.478	1.208	1.020	1.017	1.046	1.008												
2016	1.523	1.217	1.005	1.044	1.032													
2017	1.674	1.368	1.020	1.038														
2018	1.732	1.333	1.020															
2019	1.689	1.215																
2020	1.993																	

Insufficient – Alternative approach required

Sufficient observations to select link ratios

Tail Factors

- Alternative Approach – use ratio of [Traditional Incurred Chain Ladder Method Ultimate] / [Paid or Incurred at TCR] to calculate cumulative LDFs directly (i.e., no link ratios)

Ratio of Traditional Incurred Chain Ladder Result to Incurred Loss at TCR

AY	.68168-.88809	.88809-.95882	.95882-.96425	.96425-.98056	.98056-.98722	.98722-.98991	.98991-.99094	.99094-.99148	.99148-.99345	.99345- 1.000	.99354- 1.000	.99357- 1.000	.99393- 1.000	.99411- 1.000	.99480- 1.000	.99493- 1.000	.99692- 1.000	.99817- 1.000
2005										1.012	1.012	1.012	1.012	1.012	1.012	1.012	1.009	1.009
2006										1.017	1.017	1.017	1.017	1.017	1.017	1.014	1.007	1.007
2002										1.012	1.012	1.012	1.012	1.012	1.003	1.003	1.002	
2007										1.020	1.020	1.020	1.012	1.012	1.012	1.012		
2014										1.025	1.025	1.025	1.019	1.019	1.019			
2009										1.012	1.012	1.012	1.012	1.012				
2013										1.022	1.022	1.022	1.022					
2010										1.014	1.014	1.014						
2003										1.003	1.003							
2012										1.019								
2008																		
2004																		
2011																		
2015																		
2016																		
2017																		
2018																		
2019																		
2020																		

This column establishes the "tail factor" to which the link ratios selected "to the left" of the line are applied

Selected Loss Development Factors

- Combine LDFs "to the right" of the line with Link Ratios "to the left" of the line

Selected Incurred Loss Development Factors at TCR

AY	.68168-.88809	.88809-.95882	.95882-.96425	.96425-.98056	.98056-.98722	.98722-.98991	.98991-.99094	.99094-.99148	.99148-.99345	.99345-1.000	.99354-1.000	.99357-1.000	.99393-1.000	.99411-1.000	.99480-1.000	.99493-1.000	.99692-1.000	.99817-1.000
2005	1.224	1.242	1.018	1.034	1.019	1.017	1.010	1.009	1.012	1.012	1.012	1.012	1.012	1.012	1.012	1.012	1.009	1.009
2006	1.587	1.316	1.015	1.044	1.008	1.001	1.016		1.006	1.017	1.017	1.017	1.017	1.017	1.017	1.014	1.007	1.007
2002	1.621	1.356	1.009	1.017	1.012	1.008	1.007		1.008	1.012	1.012	1.012	1.012	1.012	1.003	1.003	1.002	
2007	1.295	1.330	1.006	1.051	1.007	1.005	1.010		1.010	1.020	1.020	1.020	1.012	1.012	1.012	1.012		
2014	1.511	1.133	1.009	1.029	1.018	1.025	1.001		1.006	1.025	1.025	1.025	1.019	1.019	1.019			
2009	1.577	1.181	1.004	1.025	1.028	1.017	1.023	1.008	1.003	1.012	1.012	1.012	1.012	1.012				
2013	1.689	1.193	1.004	1.051	1.011	1.003	1.015	1.003	1.014	1.022	1.022	1.022	1.022					
2010	1.621	1.263	1.047	1.049	1.019	1.014	1.003		1.004	1.014	1.014	1.014						
2003	1.538	1.133	1.043	1.051	1.023	1.002	1.010		1.009	1.003	1.003							
2012	1.593	1.120	1.017	1.049	1.011	1.010	1.004	1.004	1.008	1.019								
2008	1.449	1.227	1.008	1.046	1.035	1.003	1.020	1.006	1.003									
2004	1.703	1.104	1.012	1.041	1.038	1.011			1.003									
2011	1.799	1.130	1.013	1.046	1.032	1.003	1.005											
2015	1.478	1.208	1.020	1.017	1.046	1.008												
2016	1.523	1.217	1.005	1.044	1.032													
2017	1.674	1.368	1.020	1.038														
2018	1.732	1.333	1.020															
2019	1.689	1.215																
2020	1.993																	
Link Ratios	1.698	1.268	1.017	1.041	1.035	1.009	1.010	1.005	1.008									
LDFs	2.485	1.463	1.154	1.134	1.089	1.052	1.043	1.032	1.027	1.019	1.018	1.017	1.015	1.014	1.013	1.012	1.008	1.008

Incurred Loss Development Method

- Note how the LDFs applied are more logical (i.e., inversely proportional to the closure rate as opposed to time/maturity)

AY's in Target Closure Rate order				
AY	Target Closure Rate	Incurred Loss & ALAE at TCR	Selected Incurred LDF	Estimated Ultimate Loss & ALAE
2005	100.000%	79,191,775	1.000	79,191,775
2006	100.000%	82,608,778	1.000	82,608,778
2002	99.817%	69,204,890	1.008	69,758,529
2007	99.692%	67,882,889	1.008	68,425,952
2014	99.493%	70,000,880	1.012	70,840,891
2009	99.480%	75,362,050	1.013	76,311,612
2013	99.411%	68,390,220	1.014	69,347,683
2010	99.393%	70,108,691	1.015	71,170,337
2003	99.357%	68,925,730	1.017	70,080,236
2012	99.354%	77,190,934	1.018	78,580,371
2008	99.345%	80,021,410	1.019	81,541,817
2004	99.148%	75,254,069	1.027	77,262,651
2011	99.094%	69,974,210	1.032	72,236,095
2015	98.991%	70,255,289	1.043	73,274,335
2016	98.722%	70,682,014	1.052	74,387,926
2017	98.056%	69,928,367	1.089	76,170,164
2018	96.425%	68,508,268	1.134	77,676,770
2019	95.882%	68,943,038	1.154	79,532,738
2020	88.809%	51,363,771	1.463	75,143,887
2021	68.168%	30,904,554	2.485	76,784,768

AY's in Chronological order				
AY	Target Closure Rate	Incurred Loss & ALAE at TCR	Selected Incurred LDF	Estimated Ultimate Loss & ALAE
2002	99.817%	69,204,890	1.008	69,758,529
2003	99.357%	68,925,730	1.017	70,080,236
2004	99.148%	75,254,069	1.027	77,262,651
2005	100.000%	79,191,775	1.000	79,191,775
2006	100.000%	82,608,778	1.000	82,608,778
2007	99.692%	67,882,889	1.008	68,425,952
2008	99.345%	80,021,410	1.019	81,541,817
2009	99.480%	75,362,050	1.013	76,311,612
2010	99.393%	70,108,691	1.015	71,170,337
2011	99.094%	69,974,210	1.032	72,236,095
2012	99.354%	77,190,934	1.018	78,580,371
2013	99.411%	68,390,220	1.014	69,347,683
2014	99.493%	70,000,880	1.012	70,840,891
2015	98.991%	70,255,289	1.043	73,274,335
2016	98.722%	70,682,014	1.052	74,387,926
2017	98.056%	69,928,367	1.089	76,170,164
2018	96.425%	68,508,268	1.134	77,676,770
2019	95.882%	68,943,038	1.154	79,532,738
2020	88.809%	51,363,771	1.463	75,143,887
2021	68.168%	30,904,554	2.485	76,784,768

Question & Answer

Casualty Actuarial Society

4350 North Fairfax Drive, Suite 250

Arlington, Virginia 22203

www.casact.org