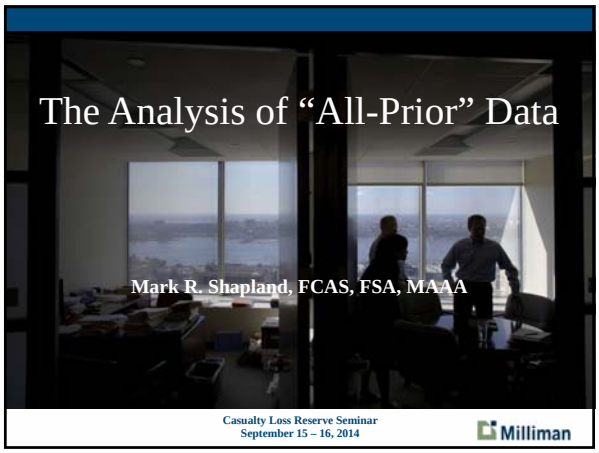
The Analysis of "All-Prior" Data



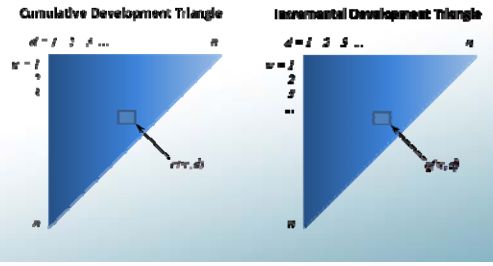
Overview

- Notation
- Graphical Representation of the Data
- All-Prior Methodology
- Example
- Conclusions

2 Milliman

Notation

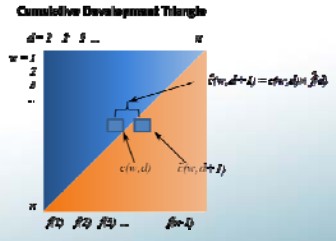
- Followed notation in WP on Reserve Variability Report



3 Milliman

Notation

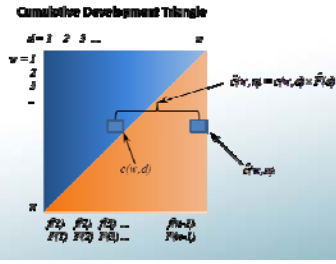
- Followed notation in WP on Reserve Variability Report



4 Milliman

Notation

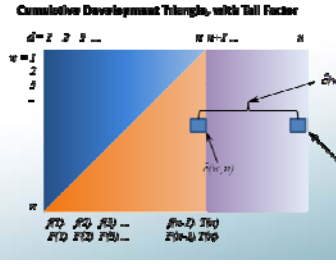
- Followed notation in WP on Reserve Variability Report



5 Milliman

Notation

- Followed notation in WP on Reserve Variability Report, with additions

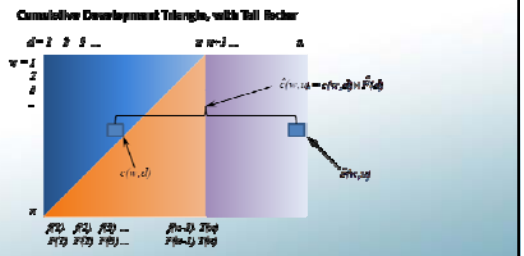


6 Milliman

The Analysis of "All-Prior" Data

Notation

- Followed notation in WP on Reserve Variability Report, with additions

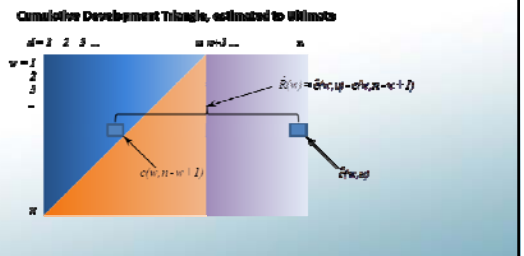


7

Milliman

Notation

- Followed notation in WP on Reserve Variability Report, with additions

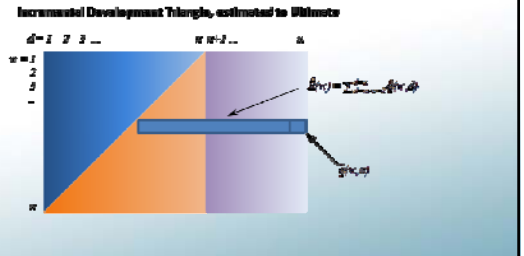


8

Milliman

Notation

- Followed notation in WP on Reserve Variability Report, with additions



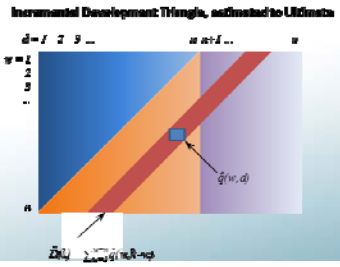
9

Milliman

The Analysis of "All-Prior" Data

Notation

- Followed notation in WP on Reserve Variability Report, with additions

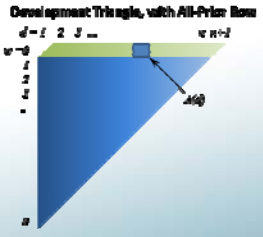


10

Milliman

Notation

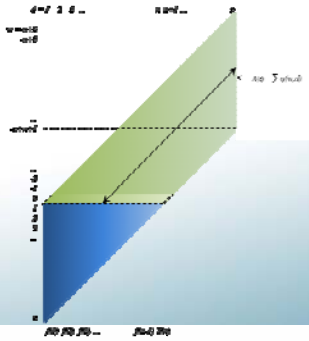
- Followed notation in WP on Reserve Variability Report, with additions



11

Milliman

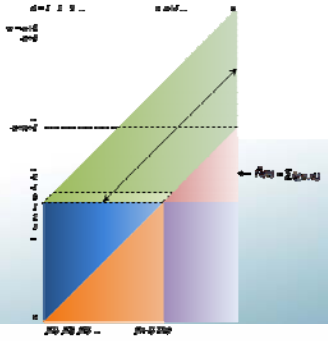
Graphical Representation of the Data



12

Milliman

Graphical Representation of the Data



13

Milliman

All-Prior Methodology

1. Calculate the age-to-age factors excluding the all-prior row,
2. Extrapolate the age-to-age factors and select a tail factor,
3. Estimate the cumulative data for each prior accident period which is part of the all-prior row,
4. Estimate the incremental data for each prior accident period (from Step 3) and sum the diagonals to estimate the values in the all-prior row,
5. Use comparisons of the estimated all-prior row data to the actual all-prior row data to evaluate and calibrate the selected factors,
6. Re-select, re-estimate and re-calibrate (repeat Steps 2 through 5) as needed, and
7. Sum all future diagonals for each prior accident period to estimate the all-prior row reserves.

14

Milliman

Example

Data set 1 – Paid

	12	24	36	48	60	72	84	96	108	120	132
A-P		-	124,151	196,502	234,850	256,775	269,143	276,080	279,086	281,182	282,390
2004	74,998	189,335	252,351	284,850	301,895	311,600	317,040	319,748	321,762	322,784	
2005	92,015	216,237	283,370	316,672	335,600	346,804	352,535	356,275	357,748		
2006	90,909	191,270	262,856	289,054	310,018	319,763	325,725	328,463			
2007	100,503	215,220	271,927	315,048	333,808	343,553	348,988				
2008	94,647	225,979	295,390	330,250	349,553	359,694					
2009	99,464	204,539	271,740	308,343	329,792						
2010	83,463	200,265	274,434	309,186							
2011	76,140	184,681	255,177								
2012	112,865	243,840									
2013	100,689										

15

Milliman

The Analysis of "All-Prior" Data

Example

1. Calculate the age-to-age factors excluding the all-prior row

	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	Tail
2004	2.525	1.333	1.129	1.060	1.032	1.017	1.009	1.006	1.003	
2005	2.350	1.310	1.118	1.060	1.033	1.017	1.011	1.004		
2006	2.104	1.374	1.100	1.073	1.031	1.019	1.008			
2007	2.141	1.263	1.159	1.060	1.029	1.016				
2008	2.388	1.307	1.118	1.058	1.029					
2009	2.056	1.329	1.135	1.070						
2010	2.399	1.370	1.127							
2011	2.426	1.382								
2012	2.160									
VWA	2.268	1.332	1.126	1.063	1.031	1.017	1.009	1.005	1.003	
5-Yr VWA	2.270	1.328	1.128	1.064	1.031	1.017	1.009	1.005	1.003	
3-Yr VWA	2.308	1.359	1.126	1.062	1.030	1.017	1.009	1.005	1.003	
TF Fitted	1.395	1.213	1.115	1.062	1.034	1.018	1.010	1.005	1.003	1.003
User	2.250									
Selected	2.250	1.332	1.126	1.063	1.034	1.018	1.010	1.005	1.003	1.0015
Ultimate	3.856	1.714	1.287	1.143	1.075	1.040	1.021	1.012	1.006	1.0033
% Paid	25.9%	58.4%	77.7%	87.5%	93.0%	96.2%	97.9%	98.9%	99.4%	99.7%
% Unpaid	74.1%	41.6%	22.3%	12.5%	7.0%	3.8%	2.1%	1.1%	0.6%	0.3%

16

Milliman

Example

2. Extrapolate the age-to-age factors and select a tail factor

	All Prior			
Tail Years:	12	Actual	282,390	Decay 0.540
Tail Factor:	1.0033	Estimated	303,022	Intercept 0.732
		Error %	7.3%	

Period	Factor	Dev	Log	Excl	Period	Log	Fitted	Selected	ATA	ATU
1	2.26832	1.26832	0.238	Y			1.395339		1.395339	2.155306
2	1.33162	0.33162	(1.104)	Y			1.213371		1.213371	1.544647
3	1.12622	0.12622	(2.070)		3	(2.070)	1.115159		1.115159	1.273022
4	1.06314	0.06314	(2.762)		4	(2.762)	1.062153		1.062153	1.141560
5	1.03099	0.03099	(3.474)		5	(3.474)	1.033545		1.033545	1.074760
6	1.01707	0.01707	(4.070)		6	(4.070)	1.018105		1.018105	1.039878
7	1.00923	0.00923	(4.685)		7	(4.685)	1.009771		1.009771	1.021386
8	1.00516	0.00516	(5.267)		8	(5.267)	1.005274		1.005274	1.011502
9	1.00318	0.00318	(5.752)		9	(5.752)	1.002846		1.002846	1.006195
10							1.001536		1.001536	1.003339
11							1.000829		1.000829	1.001800
12							1.000447		1.000447	1.000970
13							1.000242		1.000242	1.000523
14							1.000130		1.000130	1.000281
15							1.000070		1.000070	1.000151
16							1.000038		1.000038	1.000080
17							1.000020		1.000020	1.000042
18							1.000011		1.000011	1.000022
19							1.000006		1.000006	1.000011
20							1.000003		1.000003	1.000005
21							1.000002		1.000002	1.000002

17

Milliman

Example

3. Estimate the cumulative data for each prior accident period which is part of the all-prior row

	Premium	Loss Ratio	24	36	48	60	72	84	96	108	120	132
1984	402,171	70.0%	164,287	218,768	246,380	261,937	270,724	275,625	278,319	279,786	280,583	281,014
1985	406,193	70.0%	165,930	220,956	248,844	264,557	273,431	278,382	281,102	282,584	283,389	283,824
1986	410,255	70.0%	167,589	223,165	251,332	267,202	276,165	281,165	283,913	285,410	286,222	286,662
1987	414,357	70.0%	169,265	225,397	253,846	269,874	278,927	283,977	286,752	288,264	289,085	289,529
1988	418,501	70.0%	170,958	227,651	256,384	272,573	281,716	286,817	289,619	291,147	291,975	292,424
1989	422,686	70.0%	172,667	229,927	258,948	275,299	284,534	289,685	292,516	294,058	294,895	295,348
1990	426,913	70.0%	174,394	232,226	261,537	278,052	287,379	292,582	295,441	296,999	297,844	298,302
1991	431,182	70.0%	176,138	234,549	264,153	280,832	290,253	295,508	298,395	299,969	300,823	301,285
1992	435,494	70.0%	177,899	236,894	266,794	283,640	293,155	298,463	301,379	302,968	303,831	304,298
1993	439,848	69.1%	177,368	236,187	265,998	282,794	292,280	297,572	300,479	302,064	302,924	303,389
1994	472,929	64.9%	179,117	238,515	268,620	285,581	295,161	300,505	303,441	305,041	305,910	306,380
1995	412,911	75.1%	180,964	240,975	271,390	288,526	298,205	303,604	306,570	308,187	309,064	309,539
1996	460,127	68.0%	182,592	243,143	273,831	291,122	300,888	306,335	309,328	310,960	311,845	312,324
1997	471,803	67.0%	184,472	245,646	276,651	294,120	303,986	309,490	312,514	314,162	315,056	315,540
1998	443,804	71.9%	186,215	247,968	279,265	296,899	306,858	312,414	315,467	317,130	318,033	318,522
1999	448,454	71.9%	188,166	250,565	282,191	300,009	310,073	315,687	318,772	320,453	321,365	321,859
2000	439,491	74.1%	190,048	253,071	285,013	303,010	313,174	318,844	321,960	323,658	324,579	325,078
2001	499,204	65.9%	191,981	255,646	287,912	306,092	316,360	322,088	325,235	326,950	327,881	328,384
2002	447,766	74.2%	193,888	258,184	290,772	309,132	319,502	325,286	328,465	330,197	331,137	331,646
2003	468,659	71.6%	195,823	260,762	293,675	312,218	322,691	328,534	331,744	333,493	334,443	334,956

	Growth	Loss Ratio
Prior to 1993	1.0%	70.0%

18

Milliman

The Analysis of "All-Prior" Data

Example

4. Estimate the incremental data for each prior accident period (from Step 3) and sum the diagonals to estimate the values in the all-prior row

	12	24	36	48	60	72	84	96	108	120	132	144
1994												254
1995											475	257
1996										885	479	259
1997									1,648	894	484	262
1998								3,053	1,664	903	489	264
1999							5,614	3,085	1,681	912	494	267
2000						10,164	5,670	3,116	1,698	921	499	270
2001					18,180	10,268	5,728	3,147	1,715	931	504	272
2002				32,587	18,360	10,370	5,785	3,179	1,732	940	509	275
2003			64,939	32,913	18,543	10,473	5,842	3,210	1,750	949	514	278
Totals:	**(144+)**	**(36-132)**	**36**	**48**	**60**	**72**	**84**	**96**	**108**	**120**	**132**	**144**
Estimated	1,309	303,022	138,094	73,886	41,383	23,068	12,720	6,947	3,774	2,044	1,106	598
Actual		282,390	124,151	72,351	38,348	21,925	12,368	6,937	3,006	2,096	1,208	
Differences		20,632	13,943	1,535	3,035	1,143	352	10	768	(52)	(102)	
Cumulative Percent Difference			7.3%	4.2%	6.0%	4.5%	3.8%	4.7%	9.7%	-4.6%	-8.4%	
Weights			0.25	0.50	1.00	2.00	3.00	4.00	5.00	6.00	7.00	
Weighted Average			0.4%									

Milliman

Example

5. Use comparisons of the estimated all-prior row data to the actual all-prior row data to evaluate and calibrate the selected factors

		All-Prior Projection					Change in IBNR	
Tail Years	(#) Ultimate	Total Difference	Cumulative Percent	Weighted Percent	IBNR	Total IBNR	All-Prior	Total
1	11	16,039	5.7%	-28.1%	(1,323)	176,381		
2	12	18,173	6.4%	-14.9%	(1,045)	179,629	278	3,248
3	13	19,311	6.8%	-7.8%	(746)	181,532	299	1,903
4	14	19,920	7.1%	-4.0%	(506)	182,639	241	1,107
5	15	20,245	7.2%	-2.0%	(334)	183,279	172	640
6	16	20,419	7.2%	-0.9%	(218)	183,647	116	368
7	17	20,512	7.3%	-0.4%	(143)	183,857	75	211
8	18	20,562	7.3%	0.0%	(97)	183,978	47	120
9	19	20,588	7.3%	0.1%	(68)	184,046	29	68
10	20	20,602	7.3%	0.2%	(51)	184,085	17	39
11	21	20,619	7.3%	0.3%	(31)	184,116	20	31
12	22	20,632	7.3%	0.4%	(14)	184,139	17	23
13	23	20,642	7.3%	0.4%	(2)	184,155	13	16
14	24	20,648	7.3%	0.5%	7	184,166	9	11

Milliman

Example

7. Sum all future diagonals for each prior accident period to estimate the all-prior row reserves

Estimate of Total Unpaid Claims Using Paid Data
***All-Prior Estimate in Separate Exhibit**

	(1) Paid to Date	(2) Paid CDF	(3) (1) x (2) Ultimate	(4) (3) - (1) Estimated Unpaid	(5) (7) - (1) Case Reserve	(6) (4) - (5) Estimated IBNR
A-P*	282,390	*1.0046*	*283,699*	*1,309*	1,323	(14)
2004	322,784	1.0033	323,862	1,078	1,132	(54)
2005	357,748	1.0062	359,964	2,216	2,030	186
2006	328,463	1.0115	332,241	3,778	3,473	305
2007	348,988	1.0214	356,451	7,463	6,054	1,409
2008	359,694	1.0399	374,038	14,344	11,865	2,479
2009	329,792	1.0748	354,447	24,655	19,049	5,607
2010	309,186	1.1426	353,283	44,097	34,772	9,326
2011	255,177	1.2868	328,373	73,196	61,512	11,684
2012	243,840	1.7136	417,840	174,000	118,332	55,669
2013	100,689	3.8556	388,215	287,525	189,983	97,542
				633,661	449,522	184,139

Milliman

Example

Same data, but incurred projection

Estimate of Total Unpaid Claims Using Incurred Data
***All-Prior Estimate in Separate Exhibit**

	(7) Incurred to Date	(8) Incurred CDF	(9) (7) x (8) Ultimate	(10) (11) + (12) Estimated Unpaid	(11) (7) - (1) Case Reserve	(12) (9) - (7) Estimated IBNR
A-P*	283,713	*1.0001*	*283,735*	1,344	1,323	*21*
2004	323,915	1.0001	323,948	1,164	1,132	33
2005	359,778	1.0002	359,866	2,118	2,030	88
2006	331,936	1.0006	332,131	3,668	3,473	195
2007	355,042	1.0014	355,543	6,555	6,054	501
2008	371,559	1.0039	373,025	13,331	11,865	1,466
2009	348,841	1.0093	352,096	22,304	19,049	3,255
2010	343,957	1.0226	351,733	42,548	34,772	7,776
2011	316,689	1.0525	333,326	78,149	61,512	16,637
2012	362,172	1.1214	406,131	162,291	118,332	43,959
2013	290,672	1.2840	373,216	272,527	189,983	82,544
				605,997	449,522	156,475

22 Milliman

Example

Data set 2 – Paid

Estimate of Total Unpaid Claims Using Paid Data
***All-Prior Estimate in Separate Exhibit**

	(1) Paid to Date	(2) Paid CDF	(3) (1) x (2) Ultimate	(4) (3) - (1) Estimated Unpaid	(5) (7) - (1) Case Reserve	(6) (4) - (5) Estimated IBNR
A-P*	546,393	*1.0122*	*553,046*	*6,653*	6,075	578
2004	386,452	1.0114	390,872	4,420	3,476	944
2005	434,642	1.0185	442,661	8,020	5,946	2,074
2006	407,012	1.0306	419,475	12,463	7,684	4,779
2007	457,165	1.0518	480,866	23,701	16,130	7,571
2008	398,617	1.0892	434,190	35,574	23,671	11,903
2009	431,152	1.1550	497,975	66,823	33,566	33,257
2010	400,155	1.2794	511,940	111,786	63,349	48,437
2011	304,450	1.5237	463,877	159,427	94,442	64,985
2012	231,388	2.2836	528,388	297,000	159,371	137,629
2013	105,488	5.0838	536,281	430,793	206,653	224,140
				1,156,658	620,362	536,296

23 Milliman

Example

Data set 2 – Incurred

Estimate of Total Unpaid Claims Using Incurred Data
***All-Prior Estimate in Separate Exhibit**

	(7) Incurred to Date	(8) Incurred CDF	(9) (7) x (8) Ultimate	(10) (11) + (12) Estimated Unpaid	(11) (7) - (1) Case Reserve	(12) (9) - (7) Estimated IBNR
A-P*	552,468	*1.0019*	*553,494*	7,101	6,075	*1,026*
2004	389,928	1.0025	390,883	4,432	3,476	955
2005	440,588	1.0045	442,586	7,944	5,946	1,998
2006	414,696	1.0084	418,178	11,166	7,684	3,482
2007	473,295	1.0164	481,067	23,902	16,130	7,772
2008	422,287	1.0298	434,869	36,252	23,671	12,581
2009	464,718	1.0551	490,328	59,176	33,566	25,610
2010	463,503	1.1028	511,172	111,017	63,349	47,669
2011	398,892	1.1871	473,531	169,080	94,442	74,639
2012	390,758	1.3800	539,250	307,862	159,371	148,491
2013	312,141	1.7137	534,926	429,438	206,653	222,785
				1,167,370	620,362	547,007

24 Milliman

Conclusions

- Starting point to analyzing the all-prior data is understanding the data (i.e., how was it created and what is included)
- Once the data is understood, the methods introduced in this paper can be used to analyze the all-prior row
- Regardless of whether the unpaid claims in the all-prior row are significant or not, the value of the methodology in helping to calibrate the tail factor should not be underestimated
- The process of calibrating (and validating) the tail factor may reveal that the tail factor is different than otherwise expected, which will have an impact on estimates for all accident periods

25

Milliman

Contact Information:

Mark R. Shapland, FCAS, FSA, MAAA
mark.shapland@milliman.com

Milliman, LLC
Unit 809, Level 8
Liberty House
Dubai International Financial Centre
P.O. Box 506784
Dubai
United Arab Emirates

Tel. +971 4 386 6990
Fax +971 4 386 6950

Milliman