Escaping Hindsight: Case Reserve Development Using the Reserve Runoff Ratio

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Abstract: The common calculation used in developing case reserves are based on "hindsight" from a separate development test, thus they are based on data that already reflects judgment. A method is presented for estimating development factors for case reserves that strictly uses data within the standard loss development triangles, primarily the paid loss to case reserve disposed or "runoff" ratios. This method is thus, a truly independent view of the case development factors.

Keywords: case reserve development, hindsight

1. INTRODUCTION

Developing case reserves of older years instead of using chain-ladder or other common methods to estimate the ultimate losses for those years has received at least one laudatory review. A 2009 paper by Jing, Lebens and Lowe suggests that case reserve development is often the best method of the alternatives for some maturities. It does have a weakness, though. Developing case reserves often uses "hindsight" methods that begin with the same chain-ladder, etc. methods and then compute the case reserve development factors that would have been needed in the years above the diagonal if the estimated ultimate is an accurate estimate. The case reserve factor for the current diagonal is estimated from the results. Aside from the development beyond the last diagonal being driven by a potentially misjudged ultimate loss[1], ultimate losses developed using this hindsight case reserve development process may be prone to match the beginning chain-ladder ultimate loss. So using the hindsight case development method could result in either repeating a misjudgment or (maybe also) a misleading confidence in the results.

1.1 The Benefits

That being said, developing case reserves on mature years has high potential to estimate the loss on mature years. They potentially reflect whether a large number of claims remain open, or whether few claims, or only small claims, are open at present. So, it is advisable to have a case reserve development process that is not based on an initial ultimate loss estimate.

[1] In the context of this paper, the word "loss" is used to represent whatever data is being developed, whether that is "loss", "loss and defense and cost containment", or some similar type of data.

2. THE METHOD

This paper presents an alternative method that strictly uses information inside the triangles, and does not involve any external judgment. Rather it is a slight extension of the "runoff ratio" presented in Sherman 2006. That in turn stems from the "paid loss to reserve disposed of ratio" used in Sherman 1984, Boor 2006, and the Report of the CAS Tail Factor Working Party (Herman, et al 2013).

That process is fairly simple. It will be illustrated by an example that follows the process from start to finish. First, each incremental paid loss by development cell is computed by subtracting the adjacent-to-the-left paid loss from the paid loss in each corresponding cell. Secondly, the reserve disposed of uses a negative process. The value in each cell of the case reserve triangle is instead subtracted from the value to the left. So, the incremental paid loss value is the actual costs in the cell. Dividing by the case reserve produces a measure of the actual cost (in that cell) of disposing of a dollar of case reserve. That is the core calculation behind this set of correction factors for case reserves.

However, one factor from that analysis will not make a proper correction factor for the case reserves. The changes between the key processes of the claims department must be considered. As said in Boor 2006 and repeated in the 2014 Report of the Tail Factor Working Party

> "It is important to consider the primary activity within each development stage.
>
> When using multiple periods to estimate a tail factor, it is relatively important that the periods reflect the same general type of claims department activity as that which takes place in the tail. For example, in the early 12 to 24 month stage of workers compensation, the primary development activity is the initial reporting of claims and the settlement and closure of small claims. The primary factors influencing development are how quickly the claims are reported and entered into the system, and the average reserves (assuming the claims department initially just sets a 'formula reserve', or a fixed reserve amount for each claim of a given type such as medical or lost time) used when claims are first reported.
>
> In the 24 to 36-48 month period, claims department activity is focused on ascertaining the true value of long-term claims and settling claims. After 48-60 months most of the activity centers on long-term claims. So, the 12-24 link ratio has relatively little relevance for the tail, as the driver behind the link ratio is reporting and the size of initial formula reserves rather than the handling of long-term cases. Similarly, if the last credible link ratio in the triangle is

the 24 to 36 or 36 to 48 link ratio, that triangle may be a poor predictor of the required tail factor."

Of course, the exact maturities at which the stages change may not match a particular reserving situation, but the progression through the stages likely will be an issue[2].

So, in summary, the key concerns dictate using the paid loss/reserve disposed of and being able to target the activity in a stage are key. As one might surmise, the first step is to develop a triangle of paid/disposed ratios.

Thankfully, such a triangle can be computed from the standard paid and reported loss reserving triangles. For example, given the following sample paid and reported loss data triangles,

Table 1: Cumulative Paid Loss

Accident Year	12	24	36	48	60	72	84	96	108	120
1999	2,065	4,759	8,883	11,832	13,005	13,290	13,502	13,508	13,510	13,510
2000	1,915	6,662	13,952	17,899	19,406	19,796	20,066	20,068	20,140	
2001	3,976	12,534	21,164	26,134	29,416	32,098	32,942	33,074		
2002	3,906	11,115	18,526	30,371	41,207	44,158	48,138			
2003	7,619	21,043	41,439	58,151	72,731	79,336				
2004	10,376	19,406	39,902	58,127	69,684					
2005	9,662	23,869	32,016	38,311						
2006	9,225	18,106	24,546							
2007	3,062	8,751								
2008	2,278									

[2] It would seem, though, that for claims-made products the first stage might either not occur or have a short duration.

Table 2: Cumulative Reported Loss

Accident Year	12	24	36	48	60	72	84	96	108	120
1999	5,605	8,126	10,710	12,586	13,378	13,495	13,508	13,516	13,516	13,516
2000	7,074	11,431	16,681	19,466	20,178	20,223	20,132	20,082	20,140	
2001	9,913	18,493	25,986	29,141	31,815	32,906	33,154	33,300		
2002	9,979	17,277	23,366	38,199	45,036	47,100	48,804			
2003	22,625	34,198	58,881	70,094	79,626	82,086				
2004	23,770	37,119	54,780	68,054	73,579					
2005	20,019	32,326	40,188	39,814						
2006	20,176	28,624	29,439							
2007	9,080	13,335								
2008	6,011									

one may readily compute the incremental paid loss by subtracting values in adjacent columns in the cumulative paid loss data (Table 1).

Table 3: Incremental Paid =Costs of Disposing of Case

(Table 1 Value – Value in Previous Table 1 column)

Accident Year	12	24	36	48	60	72	84	96	108	120
1999	2,065	2,694	4,124	2,950	1,172	285	212	6	2	0
2000	1,915	4,747	7,290	3,948	1,507	390	270	2	72	
2001	3,976	8,558	8,630	4,970	3,282	2,682	844	132		
2002	3,906	7,209	7,411	11,845	10,836	2,951	3,980			
2003	7,619	13,424	20,396	16,712	14,580	6,605				
2004	10,376	9,030	20,496	18,225	11,557					
2005	9,662	14,207	8,148	6,295						
2006	9,225	8,881	6,440							
2007	3,062	5,690								
2008	2,278									

Next, the case reserves disposed of in each cell must be computed. The first step, of course, is to compute the case reserves.

Table 4: Case Reserves

(Table 2 – Table 1)

Accident Year	12	24	36	48	60	72	84	96	108	120
1999	3,540	3,367	1,827	754	374	205	6	8	6	6
2000	5,159	4,769	2,730	1,566	771	427	66	14	0	
2001	5,937	5,959	4,822	3,007	2,399	808	212	226		
2002	6,073	6,162	4,840	7,827	3,829	2,942	666			
2003	15,006	13,156	17,442	11,943	6,896	2,750				
2004	13,394	17,713	14,878	9,927	3,895					
2005	10,357	8,458	8,172	1,503						
2006	10,950	10,518	4,893							
2007	6,019	4,584								
2008	3,733									

Then, the reserve disposed of is computed using the additive inverse of the process used to compute the incremental paid loss. In other words, instead of subtracting the value in the previous column from the value in the current3 column, one would subtract the value in the current column from the value in the previous column. That is logical since case reserves tend to decrease after some point in the triangle whereas paid loss would increase. Thus, one would compute the case disposed of using the outline bin Table 5.

Table 5: Case Reserves Disposed of

(Value in Previous Table 4 column – Table 4 Value)

Accident Year	12	24	36	48	60	72	84	96	108	120
1999	-3,540	173	1,540	1,074	380	169	199	-2	2	0
2000	-5,159	390	2,039	1,163	795	345	361	52	14	
2001	-5,937	-22	1,137	1,815	608	1,591	596	-14		
2002	-6,073	-89	1,322	-2,987	3,998	887	2,276			
2003	-15,006	1,851	-4,286	5,498	5,047	4,145				
2004	-13,394	-4,319	2,836	4,951	6,032					
2005	-10,357	1,899	286	6,668						
2006	-10,950	433	5,625							
2007	-6,019	1,435								
2008	-3,733									

[3] The is perhaps an unusual phrase to some readers. The "value in the current column" would be the value in the cell with the same maturity and accident (or report for some coverages) year as the cell being computed.

Once the reserves are computed, it is easy to compute the ratio of paid loss to case reserves disposed of (the "runoff ratio").

Table 6: "Runoff Ratio"---Paid Loss to Case Reserve Disposed of
(Table 3 Value/Table 5 Value)

Accident Year	12	24	36	48	60	72	84	96	108	120	Tail
1999	-0.5833	15.5812	2.6777	2.7471	3.0870	1.6918	1.0646	-3.0000	1.0000	1.0000	
2000	-0.3712	12.1603	3.5747	3.3942	1.8955	1.1301	0.7487	0.0385	5.1429		
2001	-0.6697	-385.8499	7.5895	2.7382	5.4000	1.6855	1.4168	-9.4286			
2002	-0.6432	-80.5960	5.6059	-3.9656	2.7101	3.3284	1.7484				
2003	-0.5077	7.2531	-4.7588	3.0394	2.8886	1.5934					
2004	-0.7746	-2.0908	7.2282	3.6810	1.9159						
2005	-0.9329	7.4801	28.4870	0.9440							
2006	-0.8425	20.5332	1.1449								
2007	-0.5086	3.9647									
2008	-0.6100										
	12	24	36	48	60	72	84	96	108	120	Tail
Averages:											
Column $$ Weighted	-0.6746	42.5288	7.8996	3.5718	2.5464	1.8094	1.5461	3.8889	4.6250	N/A	
3 Col. Centered $$ Weighted				4.1898	2.8637	2.2295	1.7313	1.5845	4.1154		
5 Col. Centered $$ Weighted					3.7254	2.7655	2.2331	1.7356			
All-Time Unweighted	-0.6444	-44.6182	6.4436	1.7969	2.9828	1.8858	1.2446	-4.1300	3.0714	1.0000	
Selected Values	0.0000	0.0000	7.0000	3.0000	3.0000	2.2500	2.5000	3.0000	4.0000	4.0000	4.0000

Notes: Early factors set at zero as they clearly do not involve upward development in existing claims-they appear to often show increases in case reserves instead of decreases. The 12 and 24 paid/disposed ratios were set at zero since case reserves are clearly being built, not disposed of, in those periods.

Selections generally relied heavily on the 3 column average, then the 5 column, although some credence was given to consistency with the single column dollar weighted, especially at earlier maturities

Where no 5 column or 3 column averages existed, the nearest ones were considered.

Also, note, efforts were made to round for consistency and to show consistent patterns of increase and decrease.

This gives the core information of the process --- how much it costs to eliminate a dollar of case reserve. These may be called runoff ratios, since they represent the true value of closing or "running off" each dollar of case reserve. Note that comments on how the runoff ratios were selected are included. However, as one may see, each of the selected runoff ratios only covers the activity during a twelve month period of development. Since a case reserve will pay out over multiple development periods, it is necessary to use a weighted average of the appropriate set of runoff ratios. There is more than one way to compute the weights. One could analyze the average decrease in case reserves (the case at the end of the period divided by the case at the beginning of the period) through each twelve month stage of development, and use that decrease pattern to determine the weights for the various value factors. That process is shown in Appendix A. When one is performing a reserve review, it is likely that reported loss and paid loss development patterns, and corresponding patterns of the percentages of loss reported and paid, have already been estimated. Using those, one may back into the case reserves at each stage as a percentage of ultimate loss at the various twelve month stages. That allows for a calculation of the expected decay in case reserves.

The table below begins with paid and reported loss development factors arising from mechanical selection of all-time weighted average link ratios and Sherman-Boor tail analysis (using the runoff ratio expected for the tail in Table 6). Then, case reserves development factors are computed by weighting the runoff ratios using the case decay rates. Of course, since the disposition will take in subsequent periods, one must use the data in subsequent columns, not the column in question. Note that all that is required to both compute the runoff ratios and the weights are the paid and reported loss triangles. This example does use paid and reported development patterns as a start for computing the decay rates. But one could just as readily compute decay rates by dividing adjacent values in Table 4 (see Appendix A). Therefore, this reserve runoff approach to case development is not heavily affected by the other development tests.

Table 7: Calculation of Case Reserve Development Factors

	12	24	36	48	60	72	84	96	108	120	Tail
Selected Runoff Ratios **(A)**	0.0000	0.0000	7.0000	3.0000	3.0000	2.2500	2.5000	3.0000	4.0000	4.0000	4.0000
% Incrd to-Date per ILDFs	63.21%	72.70%	82.14%	91.08%	97.62%	99.01%	99.92%	99.86%	100.00%	99.40%	100.00%
% Paid to-Date per PLDFs	12.05%	31.74%	55.69%	75.95%	90.06%	95.39%	98.87%	99.02%	99.21%	99.21%	100.00%
Case @Date **(B)**	51.16%	40.96%	26.45%	15.13%	7.55%	3.62%	1.04%	0.83%	0.79%	0.20%	0.00%
Decay in Period **(C)** **=(B next)/(B)**	80.07%	64.57%	57.22%	49.92%	47.87%	28.90%	79.85%	95.11%	25.00%	0.00%	100.00%
Cumulative Case Development Factors (D) **(next A)*(1.0-(C))+(D next)*(C)**	3.4701	4.3341	2.8713	2.7750	2.5493	2.8752	3.7985	4.0000	4.0000	4.0000	

At this stage, one has factors that could plausibly be used to develop case reserves at 36 months maturity and could more plausibly be used to develop case reserves of 48 or more months of maturity. On that basis, this process could be used to convert case reserves into estimated loss liabilities, at least for some years. However, in practice most actuaries first develop ultimate loss, and then develop the loss reserve/liability indication from the ultimate losses.

Therefore, it is necessary to show how the ultimate loss may be estimated using case development. It should be clear that to estimate the ultimate loss of a given accident or report year, one need only develop the case reserves, then add in the paid loss to date. Table 8 shows the calculations.

Table 8: Final Case Reserve Development and Ultimate Loss

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(Table 1))	(Table 4)	(Table 7)	(3)*(4)	(2)+(5)	
Begin of Accident Year	Paid to Date @ 12/31/08	Case Reserves @ 12/31/08	Case Reserve LDF	Estimate of Ultimate Reserve	Estimate of Total Ultimate	Are Claims Developed Enough to Be Usable?
1999	13,510	6	4.0000	24	13,534	Yes
2000	20,140	0	4.0000	0	20,140	Yes
2001	33,074	226	4.0000	904	33,978	Yes
2002	48,138	666	3.7985	2,530	50,668	Yes
2003	79,336	2,750	2.8752	7,908	87,244	Yes
2004	69,684	3,895	2.5493	9,929	79,612	Yes
2005	38,311	1,503	2.7750	4,172	42,483	Yes
2006	24,546	4,893	2.8713	14,049	38,595	Yes
2007	8,751	4,584	n/a	n/a	n/a	No
2008	2,278	3,733	n/a	n/a	n/a	No
	337,768	22,257		39,516	366,255	

3. CONCLUSIONS

A process of case reserve development without relying on ultimate loss estimates from other methods is presented above. Hopefully, this method will achieve wide adoption and improve the quality of ultimate loss estimates, especially for the years near the tail.

Appendix A– Computing the Case Reserve Decay (and Consequent Case Reserve Development Factors) from the Case Reserve Triangle

If one desires to more completely isolate the case reserve development results from the paid and incurred loss development tests, one need only compute the decay in the case reserves from the triangle of case reserves. Then, one may weight the runoff ratio in a column with the decay in the case reserve over that period, and assign the remaining weight to the (composite) case reserve development factor for the next maturity. The process proceeds as follows:

Table A: Case Decay

Next Maturity Case(Table 4 Value)/Current Case(Table 4 Value)

Begin of Accident Year	12	24	36	48	60	72	84	96	108	
1999	0.9512	0.5426	0.4124	0.4961	0.5488	0.0292	1.3333	0.7500	1.0000	
2000	0.9243	0.5724	0.5739	0.4924	0.5531	0.1547	0.2121	0.0000		
2001	1.0037	0.8092	0.6235	0.7978	0.3367	0.2625	1.0660			
2002	1.0147	0.7855	1.6171	0.4892	0.7684	0.2264				
2003	0.8767	1.3258	0.6848	0.5774	0.3988					
2004	1.3224	0.8399	0.6672	0.3923						
2005	0.8166	0.9662	0.1840							
2006	0.9605	0.4652								
2007	0.7616									
	12	24	36	48	60	72	84	96	108	Tail
Averages										
All-Time $Weighted	0.9771	0.8502	0.6677	0.5186	0.4998	0.1332	0.8732	0.2727	1.0000	
3 Year $Weighted	0.8621	0.7616	0.5773	0.4923	0.4953	0.2260	0.8732	0.2727	1.0000	
5 year $Weighted	0.9767	0.8968	0.6821	0.5191	0.4998	0.2168	0.8732	0.2727	1.0000	
All-Time Unweighted	0.9591	0.7884	0.6804	0.5409	0.5212	0.1682	0.8705	0.3750	1.0000	
Selected **(A)**	0.8621	0.8502	0.6677	0.5186	0.4998	0.2000	0.2000	0.2000	0.2000	1.0000
Incremental Runoff Ratio **(B)**	0.0000	0.0000	7.0000	3.0000	3.0000	2.2500	2.5000	3.0000	4.0000	4.0000
Case Reserve Development Factor **(C)** **= (B)*[1-(A)]+(A)(B next)**			4.2131	2.8258	2.6641	2.3280	2.6400	3.2000	4.0000	4.0000

Note that because slightly different decay rates are used here, the case reserve development factors differ slightly from those in Table 7.

4. REFERENCES

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Joseph Boor is an actuary at the Office of Insurance Regulation in Florida. He has a Baccalaureate degree in Mathematics from Southern Illinois University at Carbondale, and Master's and Doctoral degrees in Financial Mathematics from Florida State University. He is a Fellow of the CAS and is a Chartered Risk Analyst. Over a long and varied career he has had roles as diverse as regulator, Chief Actuary, consultant, and regional actuary. He also contributed significantly to the CAS literature on topics such credibility procedures, tail factors, interpolation, and the commercial market cycle.