Applying a Robust Actuarial Reserve Analysis to Long-Tailed General Insurance Coverage

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Abstract

Actuaries are regularly presented with the challenge of how to construct and perform a robust reserve analysis that provides reasonable IBNR estimates given a certain set of facts and circumstances. The intent of this paper is to put forth a general framework that actuaries can adopt to meet this challenge, with particular emphasis on long-tailed general insurance coverage.

Introduction

In the sections below, we begin our discussion with a basic reserve estimation process. The remainder of the paper outlines additional steps and considerations that we believe actuaries should implement to further enhance their analyses, summarized as follows:

- Data gathering, resolution of data issues, on-going discussions with company personnel, and compilation of industry-wide data

- Basis of analysis and pre-analysis diagnostics

- Assumptions and potential drawbacks of the chain ladder approach

- Multiple methods, line of business considerations, and method adjustments for changes in internal operations and external environment

- Variability in the reserve estimates

- Back-end diagnostics

Before proceeding, it is important to highlight a few caveats and clarifications, so that the reader may put our discussion in the proper context.

- The purpose of our discussion is to provide a general framework for implementing a robust reserving process. However, we have not produced an exhaustive list of steps or covered all interrelated topics. We recognize there are other roles and responsibilities of the actuary that interrelate to our discussion, such as actuarial communications and documentation, but we intentionally decided to limit the scope of our paper to the paragraphs below.

- We provide a few examples to illustrate our main points; however, attempting to provide full details of various reserving methods and processes is beyond the scope of this paper. We refer the reader to the multitude of actuarial reserving literature instead.

- We believe that some readers of this paper have already adopted an approach similar to the one we outline, while other readers have not considered or are unable to adopt such an approach. Our paper is geared more toward the latter group, who can gain additional insight and reduce the risk of estimating IBNR reserves.

- We purposely focus on a particular type of insurance coverage, long-tailed general insurance coverage, throughout this paper so as not to dilute our main points. Furthermore, we believe this coverage represents a significant portion of the size and complexity of the Indian general (non-life) insurance marketplace.

- Although some of our points may be relevant for life and health insurance practitioners, our discussion below and all references hereafter are geared toward general insurance practitioners.

- The examples and exhibits shown below were prepared with dummy data for illustration purposes only. We focus on losses only; reserving for loss adjustment expenses is beyond the scope of this paper.

The Basic Reserve Estimation Process

The basic reserving process typically involves the following steps which are performed to arrive at ultimate loss estimates and corresponding reserves:

- Extraction and compilation of paid and incurred loss data, extracted from the Company's system. This data may be available in the form of claim or policy level information or an aggregated summary at base year level.

- Reconciliation with accounting/finance summaries. The data is then summarized and reconciled with information from the accounting/finance department or with the prior reported figures to ascertain its validity. The movement in paid and reported losses from the prior year, including offsetting reserve reductions and claim payments, is calculated to identify potential changes in large loss claims, changes in case reserving practices, or changes in claim settlement procedures.

- Dividing data into homogeneous and credible groups. Data is divided into different lines of business to retain homogeneity within the group as different lines have different claims reporting and development patterns.

- Applying chain ladder techniques. The basic chain ladder method assumes that the future pattern of loss development derived from past experience will remain stable. The method for carrying out a basic chain ladder calculation is:

  - Tabulate claims on a cumulative basis by development year / accident (occurrence) year

  - Calculate the development ratios as the amount at a particular development age divided by the amount at the previous development age

  - Calculate averages of the ratios at each development period and make a selection

  - Apply these selected ratios to complete the table

  - The cumulative amount at the end of the table is an indication of ultimate loss for each accident year. Subtracting cumulative paid losses to date from the ultimate loss indication produces an estimate of outstanding reserve liabilities. Subtracting cumulative case incurred losses from the ultimate loss indication produces an estimate of "Incurred But Not Reported" (IBNR) reserves.

- Producing summaries for management and the regulator. Summaries are produced to meet management and regulatory requirements. For example, a Report of the Appointed Actuary is submitted annually to IRDA explaining the reserving methodology followed to arrive at ultimate loss and corresponding IBNR and outstanding reserves estimates.

A More Robust Reserve Estimation Process

Data and Information Gathering

The first step in improving the reserve estimation process is for the actuary to have access to, gather, and use a much larger pool of data. At times, the necessary data is available on the Company's systems, but is not being compiled or used. In other situations, systems must be tweaked or updated in order to pull the proper data. In any case, the actuary must collaborate with the systems manager to communicate his or her data needs in conjunction with the constraints of the system.

As mentioned in the previous section, the data retrieved from the claims system should reconcile with the information prepared by the accounting/finance department. We believe the actuary should play an active role in this reconciliation to help identify and investigate any discrepancies.

We recommend the actuary pursue the following types of numerical data:

- Cumulative case incurred loss "triangles", both gross and net of ceded reinsurance. For example, cumulative incurred losses for each accident year evaluated at the end of each calendar year, 31/12/XXXX.

- Cumulative paid loss triangle, both gross and net of ceded reinsurance.

- Cumulative reported claim count triangle (including or excluding closed without payment claim counts)

- Cumulative closed with loss payment claim count triangle

- Cumulative closed without loss payment claim count triangle

- Open with amount claim count triangle

- Large claim listing with case incurred values that exceed a particular threshold

- Calendar period written and earned premium, policies in force, historical rate changes, other relevant exposure measures.

One of the most important aspects of this process is the Company's ability to segment the data further, provided the segmented data retains enough volume and credibility. For example, there may be differences in claim experience or loss development by state or region that the actuary should consider in his or her analysis. Another example is grouping data by accident quarter instead of accident year to examine whether there are seasonal effects in the loss experience and development patterns. (Note: the segmentation of data plays an important role for the pricing actuary and others in the organization; the reserving actuary should recognize and take advantage of these synergies.)

It is also critically important that the actuary maintain **on-going** communication with others in the organization. At a minimum, discussions should take place with claims, underwriting, pricing, and business/product development. For example, the following is a partial list of items the actuary may want to ask the claims department:

- Describe any changes to the overall claim reserving philosophy.

- Describe any recent changes to claim reserving authority levels.

- Describe any efforts to settle claims more quickly.

- What new processes have been introduced to defend, dispute, or deny unsubstantiated claims?

- Have there been any changes to the claims handling systems? If so, describe the expected impact on claim reporting, case reserving, and claim settlement.

- Is the claims department experiencing high levels of staff turnover?

- What trends or shifts in claim experience is the claims department observing? A shift in the mix of injury type, size of loss, or other attribute?

For underwriting, the actuary should have a good understanding of previous and new risk selection strategies. For pricing, the actuary should have a good understanding of

past and proposed rate increases/decreases and any limits as imposed by the regulators. For business/product development, the actuary should have a good understanding of the Company's growth and retraction activities stemming from product development as well as from mergers, acquisitions, and divestitures.

Having discussions with others in the organization should be viewed as an iterative component in each of the steps listed below. It is not enough to have one conversation prior to performing the analysis. Often, the actuary must follow-up with the various department leaders to clarify a question or issue that arose during the analysis and to engage in a feedback loop upon completion of his or her analysis.

The numeric data elements listed above are intended not only for individual Company actuaries and Appointed Actuaries, but also for regulators. We believe it would be extremely beneficial for the insurance regulators to compile the aforementioned data elements for each Company and aggregate across all Companies for each line of business. This would allow the regulators to have a broader view of the industry-wide reserve adequacy/inadequacy by line of business. Having the aggregated data publicly available would also allow individual Company actuaries and Appointed Actuaries to benchmark their Company's development patterns with those of the broader industry. Depending on data availability and data consistency of the participating companies, it would be desirable to construct at least 10-year by 10-year aggregate data triangles for longer-tailed lines of business such as personal third party motor liability. In other words, the aggregate triangles would show each of the last 10 accident years evaluated at each of the last 10 evaluation dates. Shorter-tailed lines such as Personal Auto Own Damage would presumably require smaller triangles.

Yearly basis for triangles and pre-analysis diagnostic tests

One of the first decisions in organizing an analysis is how to group claims and losses for use in development triangles. For most general insurance lines of business, actuaries typically organize data into accident years, based on when the claim occurred. Report year (when the claim is reported, most commonly used in claims-made coverage), underwriting year (claims associated with policies written in a certain year), and other bases can also be considered. For the remainder of this paper, we will use accident year in our illustrations.

Next, before actually performing an analysis, it is recommended that the actuary calculate and review several triangle diagnostics based on the Company's data to date. Examples of such diagnostics are listed below:

- Paid to incurred loss ratios

- Paid loss severities (paid loss divided by closed with payment counts) and resulting percentage changes between accident years at each age of development

- Incurred loss severities (incurred loss divided by the difference of reported counts and closed without payment counts) and resulting percentage changes between accident years at each age of development

- Closed with payment counts to reported counts ratios

- Closed without payment counts to reported counts ratios

- Open counts to reported counts ratios

- Open counts, case reserves, and average case reserves (case reserves divided by open counts)

- Incremental paid losses and incremental paid loss severities

It is important for the actuary to know how to read and interpret these diagnostics. Typically, the actuary would want to identify any significant changes in the diagnostics for a particular age of development or diagonal. It is extremely important to understand that the diagnostics are not meant to provide the actuary with answers! Rather, they should signal the actuary to ask more questions. For example, suppose the actuary reviews the paid to incurred loss ratios and observes a large ratio for the current accident year relative to prior accident years at the same age. One might prematurely conclude that the claims department is settling claims more quickly. Other plausible reasons might be that average case reserves are less adequate in the current year, a large claim was settled, or the mix of claims in the current year is different than in previous years. This example further highlights our point in the previous step that the actuary should have on-going conversations with others in the organization. In other words, what the actuary sees in the diagnostics should be consistent with what the actuary hears from others in the organization. If this is not the case, the actuary needs to dig deeper into the issue to resolve the discrepancy.

Another important use of diagnostics is to help the actuary identify when methods need to be adjusted and which methods should be ruled out for certain accident years. For example, if the claims department has indicated that they are settling claims more

quickly and the actuary can corroborate this by observing reductions in the open to reported counts diagnostic and increases in the incremental paid loss diagnostic, then the standard paid loss development method may produce estimates that are too high. The actuary would likely not want to rely on this method when selecting ultimate losses.

Aspects of the chain ladder approach for long-tailed lines of business

The chain ladder technique is used extensively to arrive at ultimate loss estimates. However, the actuary should be mindful of several underlying aspects to this approach. First and foremost, the chain ladder method is particularly appropriate when loss development patterns have been historically stable and can be predicted with reasonable accuracy. Chain ladder methods are often appropriate for lines of business that are characterized by high-frequency/low-severity claims. Chain ladder methods also tend to perform better for short-tailed lines since any particular accident year reaches final settlement in a relatively short period of time.

Let's continue this discussion using a paid loss chain ladder method for a personal auto liability line of business written by XYZ Insurance Company.

Paid Loss Development Method For Auto Liability (Rupees in thousands)											
Accident	Months of Development										Ultimate
Year	12	24	36	48	60	72	84	96	108	120	Loss & ALAE
2001	21,831	109,154	141,900	146,157	156,066	156,691	168,599	168,599	168,625	171,099	179,212
2002	53,183	173,375	227,122	247,562	277,022	324,116	356,012	367,155	368,346		389,854
2003	29,383	176,973	283,157	306,942	402,094	404,128	427,629	434,675			466,682
2004	73,583	238,190	301,786	320,799	349,204	408,000	435,323				476,306
2005	31,562	141,713	202,649	210,872	210,872	210,872					247,521
2006	19,803	181,592	226,294	277,724	337,788						421,562
2007	42,866	200,816	223,627	240,427							332,852
2008	44,450	165,818	197,322								305,181
2009	50,388	117,905									215,289
2010	21,017										135,034

Accident	Age-to-Age Development Factors										
Year	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	120-132	132-ULT
2001	5.000	1.300	1.030	1.068	1.004	1.076	1.000	1.000	1.015		
2002	3.260	1.310	1.090	1.119	1.170	1.098	1.031	1.003			
2003	6.023	1.600	1.084	1.310	1.005	1.058	1.016				
2004	3.237	1.267	1.063	1.089	1.168	1.067					
2005	4.490	1.430	1.041	1.000	1.000						
2006	9.170	1.246	1.227	1.216							
2007	4.685	1.114	1.075								
2008	3.730	1.190									
2009	2.340										
All Year Avg	4.659	1.307	1.087	1.134	1.069	1.075	1.016	1.002	1.015		
All Year Wtd Avg	4.102	1.300	1.090	1.148	1.078	1.073	1.019	1.002	1.015		
Last 3 Year Avg	3.585	1.183	1.114	1.102	1.058	1.075	1.016				
Last 3 Wtd Avg	3.519	1.181	1.117	1.109	1.063	1.073	1.019				
Selected											
Age-to-Age	3.519	1.181	1.117	1.109	1.063	1.073	1.019	**1.014**	**1.010**	**1.008**	Tail
Age-to-Ult	6.425	1.826	1.547	1.384	1.248	1.174	1.094	1.074	1.058	1.047	**1.039**

Upon review of this method, there are five points that warrant further discussion.

1. Notice the volatility in development factors at most ages of development. The actuary should be asking himself or herself how comfortable they are with the Company's historical paid loss development and whether this method produces reliable results.

2. As the development age increases, the actuary has fewer points from which to calculate averages. As a result, the actuary must decide at which development age to incorporate a tail estimation process.

3. Notice that losses continue to develop upward, even for the oldest accident year. This means that the actuary needs to incorporate a tail factor that estimates development beyond 113 months. There are a variety of techniques to estimate a tail such as using an implied industry-wide tail factor (if available), using an inverse power or Weibull curve-fitting technique, or estimating the decay in the selected development pattern and extending that decay assumption into future development periods. It usually is not appropriate to assume a tail of 1.000 or the previous selected development factor, as we occasionally encounter when reviewing other actuaries' work.

4. The results illustrate a strategy of selecting one type of average, in this case the 3-year weighted average. We believe it is appropriate for the actuary to begin a chain ladder method with a particular selection strategy. However, the actuary should also recognize when to deviate from that strategy. In our example above, deviating from the 3-year weighted average would be appropriate for the 5-17 and 29-41 loss development factor selections, and likely the 17-29 loss development factor selection as well.

5. Notice how low the ultimate loss indication is for the current accident year compared to previous accident years. This is likely an unreasonable result especially if premium, policies in force, and claim counts have remained relatively stable for all years including the current year and the underlying mix of business has not changed significantly.

This fifth point highlights the leverage effect typically seen in paid loss development methods. Since the cumulative loss development factor is so large for the current accident year, the inclusion or absence of a seemingly small amount of paid losses can have a very large effect on the ultimate loss indication. One way of dealing with this is to incorporate incurred loss development into the analysis. By doing this, the actuary makes full use of the claims department estimates of case reserves and reduces the development factors necessary to produce an ultimate loss indication. The main disadvantage of this method is when the reserving practices of the claims department have not remained consistent over time.

Expanding the list of available methods

For long-tailed lines of business, we recommend the actuary incorporate other methods from which to estimate ultimate losses. The following are brief descriptions of additional methods the actuary may want to consider for inclusion in the analysis. Once again, for the interested reader, we refer you to the actuarial literature for a more comprehensive discussion of these methods:

- Incurred Bornhuetter-Ferguson (B-F) Method

  This method is essentially a combination of two reserving techniques: the loss development method and the expected loss method. The B-F method blends the loss development and the expected loss methods by splitting expected losses into two distinct pieces: expected reported losses and expected unreported losses. As an accident year matures, the expected reported losses are replaced with actual reported losses plus expected unreported losses to produce ultimate losses. Thus, as the accident year matures, the initial expected reported loss estimate becomes less important while the actual reported loss experience increases in importance. To calculate this method, one must estimate initial expected losses and a loss reporting pattern. The initial expected losses can be calculated using an on-level loss ratio technique, an on-level ultimate severity times ultimate claim count technique, a loss cost technique, etc. The reporting pattern is taken from the incurred loss development approach or the adjusted incurred Berquist-Sherman development pattern.

- Paid Bornhuetter-Ferguson (B-F) Method

  The mechanics of this approach mirror the incurred B-F technique, except that ultimate losses are a combination of actual paid losses plus expected unpaid losses. The payment pattern is taken from the paid loss development approach or the adjusted paid Berquist-Sherman development pattern.

- Incurred Berquist-Sherman (B-S) Method

  This method is utilized when average case reserves increase or decrease significantly over time. The incurred B-S technique adjusts historical average outstanding severities to current levels and de-trends these severities back to the appropriate years. Multiplying the severities by historical open claim counts and adding the paid losses will create an adjusted incurred loss triangle. The traditional incurred loss development technique can then be applied to the adjusted triangle.

11

- Paid Berquist-Sherman (B-S) Method

  The paid B-S method adjusts for changes in claim settlement patterns. First, disposal rates are calculated by dividing closed claims by ultimate claim counts at 12, 24, 36, etc. months of development. Next, an exponential curve is fitted to the relationship between historical paid losses and historical disposal rates at given evaluation points. The estimated relationship, which is unique for each evaluation point, is applied to current calendar year's disposal patterns to restate paid losses for each point in time. The traditional paid loss development technique can then be applied to the adjusted triangle.

- Incremental Paid Severity Method

  This approach combines expected incremental paid severities with expected paid claim counts to project ultimate experience for each accident period. Severities are selected from historical severities at the same maturity. Paid claim counts are allocated to future calendar years based on historical claim closure patterns. Key assumptions are explicitly shown in the selected incremental severities and the future incremental number of claims that are expected to close.

- Frequency Times Severity Method

  This method estimates ultimate loss by multiplying ultimate severity projections by ultimate claim counts. Ultimate severity estimates are projected by applying a development method to paid and incurred severities, which is similar to the incurred and paid loss development methods described above. Claim counts are also projected using development methods. From these methods, ultimate severities and ultimate claim counts are selected. The ultimate severity estimate is multiplied by the ultimate claim count estimate to arrive at the ultimate loss estimate.

Suppose the actuary learns from the claims department that a new case reserving system has been implemented such that average case reserves on open claims have increased by 20%. The actuary confirms this by reviewing the average case reserve diagnostic. If the actuary does not adjust for the impact of the new case reserving system, the standard incurred loss chain ladder method will likely produce unreasonably high results, particularly for the most recent accident years. This is an example of when the actuary would want to consider and include an incurred Berquist-Sherman adjustment methodology into the analysis.

Now suppose the actuary learns from the claims department that several senior claims adjusters have resigned from the Company, such that claims backlog has increased and payments have slowed down while the Company hires and trains new people. The actuary confirms this by reviewing the open to reported count diagnostic and incremental paid loss diagnostic. If the actuary does not adjust for the impact of the turnover in claims staff, the standard paid loss chain ladder method will likely produce unreasonably low results, particularly for the most recent accident years. This is an example of when the actuary would want to consider and include a paid Berquist-Sherman adjustment methodology into the analysis.

There are many additional scenarios and influences that could impact the reliability and usefulness of the chain ladder methods if left unadjusted – for example, the presence or absence of large claim activity, shifts in the underlying exposure mix, changes in policy terms or features, etc.

As should be perfectly clear by now, we do not advocate the use of one method for estimating reserves when other methods are available and implementable. Furthermore, we strongly caution the actuary from relying solely on standard chain ladder techniques when there have been significant Company operational changes or significant changes in the insurance regulatory, legislative, or judicial landscapes.

Quantifying variability in the estimates

Our discussion so far has concentrated on incorporating multiple methods from which the actuary can select ultimate losses and then calculate the corresponding reserves and IBNR. The actuary should also devote sufficient time to examining and quantifying the variability around his or her central estimates. Company management and regulatory authorities typically derive greater insight into the reserve risks of the Company when the actuary's central estimates are accompanied by a variability analysis. Some of the more common approaches to quantifying variability are listed below:

- Selecting a range of estimates from available methodologies. The actuary should not simply select the maximum and minimum results of the methods to form a range. As discussed in previous sections, the actuary may be aware of methods that produce unreasonable results for certain accident years, so these results should be excluded from consideration. The actuary can validate the reasonableness of his or her range by performing back-end diagnostics, which are discussed in more detail in the next section.

- Generating a range based on variations in the parameters used in the various methods to project the reserves. For example, parameters such as loss development factors, loss ratios, and loss trend can be varied to generate a range of projections.

- Quantifying variability using stochastic models. In recent years, many actuaries have been using stochastic methods and simulation testing that consider an underlying loss/severity/frequency distribution or statistical process to estimate multiple reserve scenarios. One example may assume a distribution (e.g., normal or lognormal) around each loss development factor and simulate many trials. Another example might be a bootstrapping technique on the residuals of the incremental losses. In any case, a stochastic process should be able to provide statistical properties of the reserve estimate, such as confidence levels, that describe the associated variability around the estimate.

Reserve review and back-end diagnostics

When the actuary makes a selection of ultimate losses from the various methods and calculates the corresponding reserves and IBNR, the analysis does not end there. The actuary should also employ other iterative steps and back-end diagnostics to prompt further refinement and to eventually validate that his or her selections are reasonable. The following is a list of common back-end diagnostics that the actuary may want to consider:

- Ultimate frequency diagnostic—ultimate claim counts divided by exposure or premium (both actual and on-level) for each accident year

- Ultimate severity diagnostic—ultimate losses (both actual and on-level) divided by ultimate claim counts for each accident year

- Ultimate loss ratio diagnostic—ultimate losses (both actual and on-level) divided by exposure or premium (both actual and on-level) for each accident year

- Average outstanding reserve severity—total outstanding reserves divided by the sum of open and IBNR claim counts for each accident year

- Case incurred floor—reviewing the ultimate loss selections for each accident year against case incurred losses and reselecting to avoid negative IBNR (unless historical incurred loss development patterns suggest otherwise).

- Comparison of ultimate loss estimates with estimates from prior studies

- Incurred loss and paid loss expected-versus-actual diagnostics

Additionally, if the actuary decides to produce a range of estimates, some common back-end diagnostics may include the width of the range as compared to the previous study in absolute terms and relative to the central reserve estimate as well as the width of the range for individual accident years (i.e., the range is normally wider for more recent accident periods and narrower for older accident periods).

For example, suppose the actuary calculates an ultimate loss severity in the current accident year that is essentially flat from the previous accident year. However, actual case incurred and paid loss severities show a severity increase of 5-7% from the previous year. By incorporating this diagnostic, the actuary should now know to investigate this issue further and decide whether further refinement to the ultimate loss or ultimate claim count (or both) estimates are necessary.

We think the last diagnostic in the list above, the expected-versus-actual diagnostic, can shed additional light on the actuary's ultimate loss estimates (particularly for prior years), so we will describe this diagnostic in more detail using the example below. Simply stated, the expected-versus-actual diagnostic compares the expected loss emergence using the actuary's prior estimates with actual loss emergence since the prior evaluation date. The following numerical example shows how the actuary can construct this calculation:

Actual versus Expected Incurred Loss

Accident Year Ending -3/31/XXXX	(1) Ult. Loss @12/31/09	(2) Case Inc. Loss @12/31/09	(3) Cumulative Inc LDF @12/31/09	(4) Percent Ult. Incurred @12/31/09	(5) Percent Ult. Incurred @ 03/31/10	(6) Expected Inc. btwn. 12/09 & 03/10	(7) Actual Inc. btwn. 12/09 & 03/10	(8) Difference
2001	29,433	28,881	1.056	94.7%	95.1%	47	24	(22)
2002	24,235	22,786	1.075	93.0%	93.3%	68	11	(56)
2003	25,947	23,851	1.093	91.5%	92.0%	122	133	11
2004	28,694	26,875	1.119	89.4%	90.0%	107	46	(61)
2005	31,873	28,166	1.152	86.8%	87.5%	209	110	(99)
2006	31,506	27,832	1.192	83.9%	84.6%	149	194	45
2007	28,845	23,352	1.238	80.8%	81.9%	334	173	(162)
2008	32,802	25,119	1.335	74.9%	77.3%	724	388	(335)
2009	35,822	23,981	1.569	63.7%	67.8%	1,335	1,384	50
2010	34,847	11,167	2.591	38.6%	51.5%	4,962	6,972	2,010
Total	304,005	242,010				8,055	9,436	1,381

Actual versus Expected Paid Loss

Accident Year Ending -3/31/XXXX	(1) Ult. Loss @12/31/09	(2) Case Paid Loss @12/31/09	(3) Cumulative Paid LDF @12/31/09	(4) Percent Ult. Paid @12/31/09	(5) Percent Ult. Paid @ 03/31/10	(6) Expected Paid btwn. 12/09 & 03/10	(7) Actual Paid btwn. 12/09 & 03/10	(8) Difference
2001	29,433	26,322	1.124	89.0%	89.4%	118	127	9
2002	24,235	20,785	1.145	87.3%	87.7%	112	36	(76)
2003	25,947	21,623	1.167	85.7%	86.1%	126	122	(4)
2004	28,694	24,381	1.193	83.8%	84.4%	167	61	(106)
2005	31,873	26,010	1.232	81.2%	81.9%	234	239	6
2006	31,506	23,845	1.284	77.9%	78.9%	363	405	42
2007	28,845	20,717	1.368	73.1%	74.7%	488	360	(128)
2008	32,802	20,913	1.546	64.7%	68.3%	1,204	792	(411)
2009	35,822	17,278	2.137	46.8%	54.0%	2,503	2,103	(399)
2010	34,847	4,714	5.278	18.9%	25.3%	2,348	4,053	1,705
Total	304,005	206,588				7,662	8,300	638

In the first table above, column 1 displays the actuary's ultimate loss estimates from the prior analysis, column 2 displays case incurred loss at the prior evaluation date, column 3 displays the cumulative incurred loss development pattern from the previous analysis, and column 4 displays the expected percentage incurred, derived as the reciprocal of column 3. Column 5 is calculated from column 4, interpolating for an additional 3 months in the age of each accident year. Column 6 is calculated as the portion of IBNR from the prior estimates that is expected to be incurred during the following 3-month increment. More specifically, it is calculated as (Column 1 – Column 2) x (Column 5 – Column 4) / (1.000 – Column 4). For example, the expected incurred loss emergence

for accident year ending 2010 of 4,962 is calculated as (34,847 – 11,167) x (0.515 – 0.386) / (1.000 – 0.386). Column 7 shows the Company's actual incurred losses that have emerged in the past three months by accident year. Column 8 is simply column 7 minus column 6.

Another approach for estimating the expected incurred loss percentages in column 3 is to calculate the implied development pattern; in other words, column 2 divided by column 1. We caution the reader that under this approach, "reversals" in the development pattern sometimes occur. If so, the actuary can either smooth the implied pattern or use the selected incurred loss development pattern derived from the previous analysis (as originally described above).

The second table works much the same way as the first table except that we are performing a paid loss actual versus expected calculation instead of an incurred loss calculation. In other words, paid losses replace incurred losses and paid loss development patterns replace incurred loss development patterns; ultimate losses in column 1 remain the same.

As is shown in the example above, actual incurred loss emergence exceeds expected incurred loss emergence for the most recent accident year and in total. The same is true for the paid loss calculation. This should indicate to the actuary that for accident year ending 2010, ultimate loss estimates in the current analysis should likely be higher than the ultimate loss estimates from the previous analysis. If they are not, the actuary should investigate this issue further and refine the ultimate loss estimates in the current analysis as appropriate. This investigation may also help the actuary determine the magnitude of the adjustment. A similar process should be followed for other accident years that show large differences. Furthermore, if the differences for all the accident years are positive or if they are all negative, the actuary should investigate further and adjust development patterns as appropriate.

In comparing the incurred results with the paid results from the tables above, it is interesting to note that for the 2009 year, actual losses exceeded expected losses on an incurred basis, but the opposite occurred on a paid basis. This could be due to case reserve development on a large claim that has yet to be paid out, or it could be due to a number of other reasons. Once again, this could prompt the actuary to investigate further if a plausible explanation has not already been identified.

Another approach that the actuary can use to review and refine his or her estimates is to perform more frequent reserve analyses throughout the year (for example, on a quarterly basis). Yet another approach is to perform a full ground-up analysis once a

year, with "roll forward" updates performed at each of the interim quarters. These "roll forward" updates might include the expected versus actual calculation as a method instead of a diagnostic, whereby the difference in actual and expected incurred losses would be added to the previous estimates to arrive at new estimates. The "roll forward" updates might also make use of interpolated loss development factors applied to updated case incurred and paid losses. The point here is that the actuary has a number of tools at his or her disposal to regularly monitor and update results.

Summary

In the sections above, we have covered a number of steps that the actuary could take to implement a robust process for estimating reserves: data considerations, information gathering, pre-analysis diagnostics, simple chain ladder methods, inclusion of additional methods, reserve variability, and back-end diagnostics.

Often, companies purchase or develop their own reserving software models to assist in the estimation of reserves. The features and sophistication of some of the models are quite impressive. However, we believe that some actuaries rely too passively on the outputs of the models without having the proper understanding of the underlying data, the workings of the methods, when to use or exclude certain methods, and when to incorporate adjustments based on discussions with other Company personnel. In these (hopefully) isolated cases, we urge the actuary to follow the process we have laid out above.

When implementing a robust actuarial reserving process, we highly recommend that the actuary begin the process well before the year-end evaluation. This should allow the actuary to avoid a severely compressed timeframe in which to complete the various steps of the process. Referring to the previous section of this paper, one approach to handling this would be to perform a full ground-up analysis at the prior quarter end (provided the necessary data is available) and then perform a "roll forward" update using year-end data.

A summary of the most important points of our discussion is listed below:

- The actuary should gather, organize, and make use of a wide variety of data sources and should identify and work to resolve any data gaps and inconsistencies.

- The actuary should have on-going discussions with various Company personnel to better understand internal operational changes and external influences.

- We recommend that historical industry-wide data be gathered and shared for the benefit of regulators, participating Companies, and other interested parties.

- The actuary should review pre-analysis diagnostics and corroborate them with the information gathered from other Company personnel.

- The actuary should recognize the key assumptions and potential drawbacks of the chain ladder approach.

- The actuary may need to modify his or her approach when moving from one line of business to another.

- The actuary should consider and use multiple methods in his or her analysis, recognizing the nature and complexity of the line of business and adjusting for changes in Company operations and the external environment.

- The actuary should consider ways to estimate and communicate variability around the reserve estimates.

- The actuary should vet initial ultimate loss selections using a variety of back-end diagnostics.

We hope this paper serves as a reference for actuaries who are intent on building, strengthening, or validating the robustness of their reserve analyses. Above all, we encourage readers to consider this process as they head into the next cycle of reserve analyses!

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