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A Modern Approach to Traditional Reserving

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For over 20 years health actuaries have had the computing power and software to apply advanced statistical methods to set reserves and eliminate more traditional reserving approaches. In practice most reserving actuaries, auditors and insurance examiners employ the traditional lag triangle and forecasting methods, which have changed very little in the last 40 years. Today's reserving actuaries often struggle with tight timelines, increased reporting needs, and more actuarial liabilities (3Rs, medical loss ratio (MLR) rebates, provider risk contracts, and more). In this article, I will outline four modern conveniences that could help keep traditional reserving methods relevant for years to come. To start, I will define what I mean by a traditional reserving approach.

Traditional Reserving Approach: The common actuarial practice of using a claims lag triangle to estimate claims completion, assess recent trends, and impute seasonal patterns. The goal for each month is to estimate the ultimate incurred claims level and then net out any paid claims to calculate the reserve. For most months the ultimate incurred per member per month (PMPM) is estimated using the completion factors. For the recent and very incomplete months, the actuary forecasts ultimate claims PMPM using completed months, a trend estimate, and any observed seasonal pattern. In addition, it is common to have multiple reserve cells—one for each business line and with multiple claims categories (inpatient, outpatient and other non-facility medical, Rx, and mental health).

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While the traditional approach has many variations and is unique to each actuary, for this article I am assuming a model with 36 months of data, where the most recent two months use the PMPM forecast and older months use completion factors. The numbering system I will use assumes the most recent and most incomplete month is Month 1. For example, at year-end 2014, December 2014 is Month 1, November 2014 is Month 2, and January 2012 would be Month 36.

In order to effectively address today's health reserving challenges, this article will explore the following tools: automation, data storage, use of risk scores, and statistics. These four tools can help beat timelines, increase reporting and improve accuracy.

Automation and the Eight-Day Close

Most of us have moved to the eight-day financial close, meaning the reserve is likely due to the accountants by the fifth business day. In response, many actuaries have applied some degree of automation. This article is not going to go into depth about how and why to automate except to state that aside from possibly the actuarial judgment, most of the process can be automated.

A more interesting discussion is how actuaries should behave in an automated environment. I find there are three important questions each actuary should address when using an automated process:

1. How much can you rely on an automated process (in other words, do you need to check every cell)?
2. Is robo-reserving (relying 100 percent on automated calculations) an actuarial sound practice?
3. Do the answers to questions 1 and 2 change depending on if it is quarterly statutory reports, year-end orange blank, or managerial reporting?

These questions are open for interpretation, and are based on each individual's comfort level, resource availability, and quality of automation. However, I have found the following guidelines are effective in addressing the questions. First, a good rule of thumb in automation is to spend the time you saved checking the results (this is also a good way to minimize staff fears of automating their job away). Second, robo-reserving may lead to some embarrassing professional moments; at a minimum I recommend a simple reasonableness check to all automated work. For the third question, not all projects carry the same financial risks or professional liability, so the reality is there will likely be some trade-offs.

Automation is a must in today's world. In addition to speed, automation generates the accuracy, consistency and detail data required to advance traditional reserving to the next level.

Space Is Cheap and Data Is Valuable

With an automated process an actuary will have organized data elements that can be retained and used. As research for this article I counted the number of components in my standard reserving workbook—over 17,000 data points. Compounding the 17,000 times the number of business lines and claims categories, I had 2.5 million reserving data points per month. This creates a need to structure an entire database out of just information in the reserving workbooks.

I am not suggesting storing all the data, but the following are some examples of projects and data elements that could be stored for reserving:

- Tracking restatements (requires reserve and paid claims)
- Estimating your durational accuracy (requires incurred estimates by month)
- Comparing lag factors (requires storing all reserve factors, not just actuaries' picks)
- Simulating reserve volatility and fitting statistical distributions (see examples in later section).

Having a well-structured database of reserving data will speed up standard recast analysis and open the door to many new and useful reporting applications. Organized data storage is the starting point to the modern approach and enables important advances like the integration of risk scores or applications of statistics.

Member Level Reserve Allocation

A reserving actuary's biggest resource drain may be the detailed reporting requirements requested by senior management. Building an extra reserve model for each reporting cell creates work and lowers credibility of that model. Most actuaries have prospective risk scores readily available. These are a great tool to allocate the reserve to the individual member level. With a member level allocation of reserve, reporting can be efficiently and easily performed at any level. Some examples where this method has assisted me include:

1. Reporting to detailed lines of business—for example, at the employer account level
2. Developing provider-level allocations for provider bonus accruals
3. Affordable Care Act (ACA) 3Rs—reinsurance and allocating claims to exchange vs. non-exchange products.

A benefit of the member-level allocation that should not be lost is the ability to calculate all the accruals and directly tie them to the incurred but not reported (IBNR) for the auditors.

The goal is to allocate the reserve for months with zero, one or two months of run-out to each member (older months can use the lag factors or a uniform PMPM). The method can be straightforward to complex—I will introduce the simplest form, and then outline some ideas for developing more complex allocations.

The simple method assumes all members have a full month of eligibility and a valid risk score. Using the **simple assumptions in this formula ensures an algebraic equivalence** between the total monthly reserve in any reserve cell and the sum of the member-level reserve allocation across that reserve cell.

$$Reserve^{month=k}_{month_i} = Reserve^{month=k} \times \frac{RiskScore_{member_i}}{\sum_{j=1}^{M} RiskScore_{member_j}}$$

Where

$Reserve^{month=k}_{member_i}$ = The member reserve allocation for month k for member i

$Reserve^{month=k}$ = Total dollar portion of the IBNR reserve due to month k

RiskScore = Prospective risk score (I will leave it to the actuary on appropriate risk score selection). The calculation assumes there are M members and member i is one of those members.

Conceptually the simple method is a great way to understand the risk score allocation, but many may find it is too simple to effectively work in practice. Members have different plan designs; some providers have lower costs; and not all members have an available risk score—hence the need for more complex methods. I will not outline the formulas here except to say that while they add complication they are fairly straightforward to address. Some items to consider include:

1. Addressing partial risk scores—It is key that actuaries understand the risk scores they are using. Modern risk score models adjust for members with fewer than 12 months of experience; however, some older versions do not. In addition, new members may not have a risk score so you may need to build an algorithm to default to a demographic factor.
2. Experience cells—Allocating the reserve to a provider or employer group may require adding an experience adjustment factor. A possible approach might be taking the most recent 12 months of experience and adjusting for credibility (a good start is the credibility formula used in large group underwriting).
3. Plan design—Adding a benefit factor is fairly easy in the reserve allocation, but even this can get complex if you try to adjust for specific benefit seasonality. Don't let perfection be the enemy of the good.

The list of refinements is never-ending, but the **most important item to remember using complex methods is that you may lose the algebraic equivalence the simple method relied upon**; complex methods require a conservation of reserve factor. A formula to conserve the total reserve is below:

$$Conservation\_Factor^{month=k} = \frac{Reserve^{month=k}}{\sum_{j=1}^{M} Reserve^{month=k}_{member_i}}$$

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With the work automated and the financial reporting benefits of the member-level reserve obtained, we can shift focus to understanding and improving the accuracy of the reserve. The next section discusses how, with a good database and application of probability and statistics, you can start that process.

Apply Probability and Statistics

With the time saved from automation and the data maintained in the reserving process, you can start to incorporate more complex statistical processes (many of which can be performed in Excel). While the applications are limitless, I will outline a few that I have found work well in practice—simulating reserve volatility, monitoring provider payment patterns, and applications of more advanced statistics.

Monte Carlo Simulation of Reserve Volatility: From the data storage we have a host of information at our fingertips. One great example of how to leverage that data is to use a Monte Carlo simulation to address and justify "good & sufficient" margin. The following is an example of a Monte Carlo simulation using historic reserving data that can be performed in Excel.

Formula: To start, reserve volatility needs to be defined. Here, I define it as the distribution of the difference between the reserve incurred estimate and the ultimate incurred estimate. A simplified version of the formula:

$$\text{Reserve Volatility} = \textit{Members} \times \sum_{n=1}^{36} \epsilon_n$$

Where

$$\epsilon_n = \textit{Reserve Inc PMPM}_n - \textit{Ultimate Inc PMPM}_n$$

In this simulation $\textit{Reserve Inc PMPM}_n$ is fixed, but $\textit{Ultimate Inc PMPM}_n$ is an unknown random variable making ϵ_n a random variable as well. *Members* is a simplifying assumption that all months have the same membership. In this case, n represents the month of the claims estimate (as stated earlier, $n=1$ is the most recent month, $n=2$ is the second month, etc.).

The next step is to develop a probability distribution around each ϵ_n; for this example we can use the database we have built in the prior section to identify historic values. See Table A for an example:

In the table below, there are 10 observations from 10 reserve estimates, comparing the initial incurred PMPM estimate versus the ultimate incurred PMPM estimate. Example, Observation 1 was from the January 2014 financial close (performed early February 2014), and the estimate of the error for January 2014 is $3 PMPM, which is the difference between the ultimate incurred PMPM at May 2015 and the initial incurred PMPM. In practice, the actuary would want to simulate over more observations.

Table A: Example of Month 1 Error Distribution

	Reserving	Month 1 Estimate		Ultimate Estimate		
Obs #	Close Month	Initial Time	Incurred PMPM	Ult Time	Incurred PMPM	ϵ_n
Obs 1	Jan-2014	Jan-2014	$353	May-2015	$356	$3
Obs 2	Feb-2014	Feb-2014	$354	May-2015	$364	$10
Obs 3	Mar-2014	Mar-2014	$355	May-2015	$353	-$2
Obs 4	Apr-2014	Apr-2014	$356	May-2015	$358	$2
Obs 5	May-2014	May-2014	$357	May-2015	$353	-$4
Obs 6	Jun-2014	Jun-2014	$358	May-2015	$357	-$1
Obs 7	Jul-2014	Jul-2014	$359	May-2015	$364	$5
Obs 8	Aug-2014	Aug-2014	$360	May-2015	$358	-$2
Obs 9	Sep-2014	Sep-2014	$361	May-2015	$357	-$4
Obs 10	Oct-2014	Oct-2014	$362	May-2015	$356	-$6

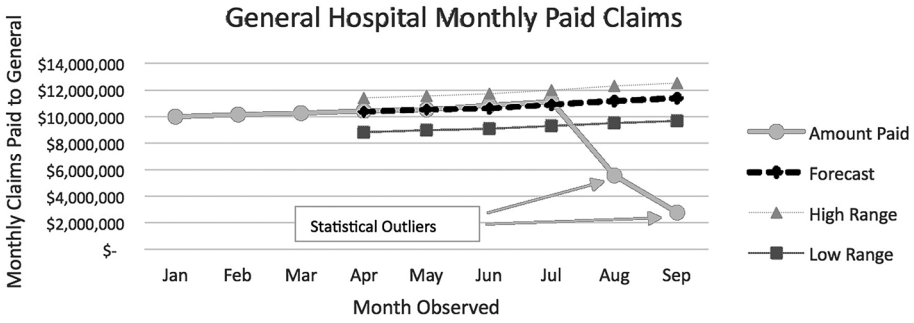
With the formula and distribution in hand the simulation steps are easy:

1. Generate a random number and use it to select an observation and its prediction error. In Table A, assume the random number is 7 then the ϵ_1 = $5 (for Excel users try = int(Rand( )*10)+1 to generate a random integer).
2. Replicate the experiment for each run-out month.
3. Sum across all months and multiply by membership; this is the first simulation.
4. Repeat Steps 1 to 3 about 100 times.
5. Evaluate the distribution of reserve errors. The simplest way is to sort high to low, then with 100 observations you can easily view percentile ranges.
6. The last step is to use the historical reserve recast numbers to validate that the simulated distribution is reasonable.

This simulation is a nice way to quantify the reserve volatility; however, in my experience, reserve restatements often are caused by non-random claims processing issues. The next application describes using statistics to monitor claims processing issues.

Statistical Monitoring: Often the random reserve volatility is manageable, but reserve volatility from operational risk, such as claims processing or provider reporting errors, may not be. Statistics can be a great tool to monitor many small items to identify processing issues—one such example is a statistical monitoring report of each hospital's monthly paid claims. In the right hand column above is a graphical example of a hospital's paid claims reported to the insurer over nine months.

Using the historic period, the actuary can develop a statistical distribution and range around the standard monthly volatility. From the example it is easy to see that General Hospital had low outlier August and September claims reported. If these errors were not caught early, the traditional reserving actuary would likely set the reserve too low. While this example is graphical, it is possible to build algorithms to identify and triage statistical outliers across all providers.



Stochastic Reserving Techniques: The entire premise of this article is that actuaries do not need stochastic reserving techniques to set the reserve. That said, there are some benefits to using black box statistical software for fitting stochastic functions to claims and then using them to estimate the reserve. Here are a few:

- Compare man vs. machine—Compare accuracy of statistical reserves versus the actuaries' reserve picks.
- Develop regression formulas to estimate utilization counts from the reserve PMPM pick.
- Another solution for dealing with very small lines of business.

Statistics and statistical processes do have a big role to play in the traditional reserving process. However, it is unlikely they will replace the actuary anytime soon.

Conclusion

Is there a better reserving approach? I am not sure, and traditional actuaries may constantly need to look over their shoulders. In order for the traditional reserving approach to meet today's demands, the actuary will need to take advantage of automation and data storage capacity. Then to meet sophisticated and detailed analysis, actuaries will also need to embrace statistics and risk scores to supplement the reserving process. With or without these adjustments, the traditional reserving approach is likely to be around for years to come. However, these modernizations may improve accuracy, add functionality, and protect your weekend.