Long-term care first principles modeling: Advantages and enhancements in modeling

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This article continues Milliman's series on long-term care (LTC) first principles modeling. The first article in the series, released in March 2016, introduced the topic and set the stage for the series of case study discussions that would follow. The second and third articles in the series, released in June 2016 and November 2016, examined the development of mortality and lapse assumptions, respectively, for use in an LTC first principles model. This article builds on these discussions with a look into how a first principles model, using these assumptions, can enhance and simplify the modeling of LTC projections. Once the groundwork of developing the key assumptions is completed, first principles models provide an improved platform for modeling by automating many processes and making refinements both easier to implement and more varied.

Automation: How first principles models bring more calculations "in-house"

Legacy models for LTC business often use total life persistency assumptions, in which status (healthy versus disabled) is not necessarily tracked and the same mortality and lapse assumption applies to all lives, regardless of status. However, most models use incurred claims that are based on healthy lives, which requires separating the population between healthy and disabled lives. In many cases, this is expressed as a ratio of healthy lives to total lives, which can then be applied as an adjustment to the incurred claims.

For example, consider an LTC projection with 100 lives, and an assumed healthy lives claim cost of $100 per life. Before applying the $100 claim cost, we need to determine how many of the 100 lives are healthy. Using an outside calculation, we may estimate that 80% of the total population is healthy, and therefore can calculate the healthy lives incurred claims as 100 * 80% * $100 = $8,000. This outside calculation is oftentimes complex, as it should account for every assumption and variation that impacts the persistency and morbidity of lives in the model. This includes incidence rates, utilization and continuance, lapse and mortality, benefit and elimination periods, and other coverage options.

By contrast, many first principles models automatically track policyholder status. In some first principles models, policyholders are classified as either "healthy" or "disabled." Others allow for more sophisticated tracking of status, such as healthy, disabled, or healthy following claim recovery, and may even track transitions between care situs. Models that track policyholder status have the number of healthy lives readily available, and avoid the need for time-consuming and lengthy efforts of estimating this outside the model. First principles models are also highly adaptive to assumption changes, automatically calculating the separation between healthy and disabled lives in response to adjustments to the underlying assumptions.

In a claim cost model, the manual effort of estimating the ratio of healthy lives to total lives requires updating and maintenance to keep in step with the latest assumptions. Every time an experience analysis prompts an assumption change, this calculation needs to be revisited. Also, if this ratio is calculated on an aggregated basis, instead of policy-by-policy, then it will also need to be recalibrated routinely as the mix of business shifts over time.

Beyond tracking the status of policyholders, many first principles models follow lives as they progress through claims or as they recover back into the healthy population, keeping tabs on their used and remaining benefits. This detailed tracking of lives allows for first principles models to precisely determine when benefits will be exhausted, and also to more accurately reflect the payment patterns of claims as claimants move along their respective continuance curves. In many claim cost models, benefit exhaustion and the runout of incurred claims into paid claims are calculated outside of the model, and then entered as additional inputs.

With a first principles model, this work can be done inside the model while also improving the accuracy of the calculations. Particularly, for the runout of incurred claims into paid claims, claim cost models often use aggregated runout patterns that do not fully reflect all the varied continuance curves and utilization assumptions for a covered population, often not even accounting for the different claimant ages. First principles models pay claims exactly as the continuance curve and utilization assumptions suggest, allowing for detailed patterns for all segments of the population.

Adjustments are simpler and more accurate

First principles models make it simple to adjust claim costs at the component level or to change persistency assumptions on a healthy life basis. Because incidence, disabled deaths, and recovery rates are loaded as inputs to a first principles model, these assumptions can be adjusted directly.

For example, applying a 5% load to disabled deaths is a simple exercise in a first principles model, but presents a significant challenge in a claim cost model. Further, a first principles model automatically accounts for the second-order impacts of such an adjustment. Adjusting the disabled deaths rate will flow through to not only the claims but also to the projected lives and the mix of the population between healthy lives and disabled lives. On the other hand, consider a claim cost model that uses total life mortality and healthy life incurred claims. To reflect the impact of a 5% increase to disabled mortality, a number of assumption changes need to be made:

- New incurred claim costs need to be generated with the adjustment.
- The runout of incurred claims into paid claims should be updated to reflect the new continuance curve.
- An increase to the disabled deaths will result in the population shifting more toward healthy lives, as claimants terminate at a faster rate. This shift in the population needs to be accounted for before applying the new healthy life incurred claim costs.
- Both the shift in the population and the faster termination rates should prompt the creation of new benefit exhaustion rates.
- Consideration needs to be given to the total mortality rates. If left unadjusted, this implies the 5% load to the disabled death rates does not occur in isolation, but rather is offset by a commensurate decrease to the healthy life mortality rates.

Using a first principles model, this work is eliminated, and the adjustment becomes a simple matter of applying a 5% increase to the disabled mortality tables.

Even for changes as straightforward as an incidence adjustment, there are second-order impacts that need to be manually handled in claim cost models (for instance, the split of the population between healthy and disabled lives). First principles models make sensitivity testing simpler and more precise, by allowing direct changes to the base components of claim costs and automatically accounting for the interaction of assumptions.

New options and modeling approaches are available

A first principles model allows for modeling choices that may not have been previously available. Because the benefits used by policyholders are tracked, some first principles models can store this information for policies that recover. One use of this is for modeling "no restoration of benefits," in which case future claims of recovered policies are deducted by already used benefits. Further, a first principles model that tracks separate sites of care could easily toggle between integrated or nonintegrated benefit periods. Another simple option to model is inflationary policies, and whether inflation protection applies to their original pool of money or their remaining pool of money.

Policy riders also benefit from improved modeling capabilities by utilizing the mechanics already built into a first principles model. Just as policies are split into disabled lives and healthy lives and separately modeled, they could also be segmented by nonforfeiture status at an assumed rate, with their reduced benefits easily accounted for by the model. Waiver of premium can be directly calculated based on the number of open claims, and when appropriate, return of premium benefits can be offset by benefits used to date.

In prior articles, we briefly explained how the same numerical assumptions can have different interpretations if expressed on a total or healthy life basis. A first principles model makes it simple to apply lapses, mortality improvement, and morbidity improvement all on a healthy life basis. This is an option that would not have been easily handled in a claim cost model, and it removes the concerns related to applying these assumptions on a total life basis. For example, an ultimate total life lapse rate does not imply a constant ultimate healthy life lapse rate because the mix of healthy and disabled lives is always in flux. With a first principles model, the lapses can be applied directly to healthy lives and an ultimate lapse rate becomes a more meaningful and straightforward assumption. For mortality improvement, the option to use it as a total life improvement is still present (by applying it to both disabled and healthy mortality), but the approach of using it solely as a healthy life assumption is an alternative that is only accessible in a first principles model.

Efficiency at what cost?

While a first principles model opens up more modeling opportunities and simplifies adjustments, it does present some challenges. The complexity of the calculations demands more computer resources, which translates into longer run-times. In our own work, we have observed run-time increases of twentyfold or more for some of the more complex first principles models. However, as computer power and the pervasiveness of distributive processing increase, this issue will subside. This complexity also makes audits of the models a more daunting task. For each item that was previously an input in a claim cost model but is now calculated internally for a first principles model, auditing the model becomes that much more involved. As the details of the calculations grow more complex, a continued review of higher-level results is very important. At what rate are policies and claims terminating? Can you replicate the model's splitting of the population (healthy versus disabled) using an outside calculation? At what rate are policies exhausting?

While these issues should not be dismissed out of hand, they also are relatively minor compared with the benefits. The increased run-time and auditing work is more than made up for by the time saved—both by internal calculations that replace outside work, and by the ease with which adjustments can be made.

Increased understanding of the business

In addition to improved modeling, important statistics can be easily tracked using the information available in a first principles model—the number of new and open claims, the rate at which claims are terminating (often with splits for death, recovery, and exhaustion), and the split of the population between disabled and healthy lives. These statistics offer increased transparency on what is driving adverse deviation in experience, e.g., higher than assumed claim incidence or claims persisting longer than expected. The ability to directly compare these figures against emerging experience is a useful tool that is not readily available with a claim cost model. Used together with sensitivity testing, the additional information accessible in a first principles model allows for better insight into the business and the impacts of different assumption changes on its projected development.

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