# Case study: Long-term care insurance first principles modeling

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This article represents an introduction to a series that Milliman will publish over the coming months addressing the challenges and opportunities faced by long-term care (LTC) insurance companies converting from legacy projection models to a "first principles" modeling approach. Following this brief introductory case study discussion, the articles will address topics such as: development of first principles assumptions, model development and consistency, and other insights we have gained through assisting clients with converting models to a first principles approach.

## THE CHALLENGE

LTC insurance companies are looking to improve and refine their LTC projection and pricing models by changing from legacy models that are often on a "claim cost" basis to a "first principles" basis. First principles models can offer many advantages over claim cost models. Before discussing some of those advantages (and disadvantages) it is important to define what is meant by a "first principles" model. It can mean many different things to different people.

At one end of the spectrum, "first principles" may simply mean taking the components of claim costs, namely incidence and severity, and bringing them directly into the projection model to project future claims, rather than calculating incurred claim costs outside of the projection model and using them as an input into the projection model to project future claims. At the other end of the spectrum, a "first principles" model breaks down all major assumptions into component pieces, including disabled mortality versus healthy life mortality (a distinction not incorporated into most claim cost models), specific care setting assumptions and transfer rates, and claim termination split between recoveries and deaths. This series of articles provides a case study discussion (pulling common elements from three cases), focusing on the middle of the spectrum of complexity—incorporating active and disabled mortality assumptions and using morbidity assumption components based on healthy lives and first situs of care.

The advantages of a first principles model include internal assumption consistency, refined assumption detail, and better benchmarking capability. The advantages come at a cost of several challenges, including developing more detailed assumptions with a lack of fully credible experience and the learning curve of working with a more detailed projection model.

Moving from a claim cost projection model to a first principles model requires two major steps.

1. Develop assumptions needed for the first principles model. This often includes the development of disabled mortality assumptions and healthy life mortality assumptions. It may also include the development of healthy life assumptions for morbidity and lapse if they are not already part of the current claim cost model.

2. Input assumptions into the first principles projection model and test the results. (This assumes that the heavy lifting of working through all of the calculations and nuances of developing a platform for a first principles model has already been done—such as we completed with MG-ALFA®.)

There are many challenges and considerations in developing a first principles model. In this case study, we focus largely on common threads applicable to several companies we have worked with (and some we are still working through the development with). One change particularly in moving to a first principles model is the use of active and disabled mortality. Expressing morbidity assumptions on a first principles basis can also present challenges for companies. For example, the use of healthy or total lives for the claim cost model can mean very different things when moving to a first principles model; or using first situs of care, with all future transfers included in the first situs assumption, will have different considerations than building in transfers within the first principles model. Details of various first principles model considerations will be discussed in future articles and case studies. We are happy to discuss how these important items and nuances are applicable for any individual company.

## THE SOLUTION

We worked closely with several client companies to develop a set of healthy and disabled mortality assumptions as well as healthy life morbidity assumptions that would replicate the current assumptions in the claim cost projection model. Different approaches were used to develop the mortality assumptions. One approach was to perform a disabled life mortality study to develop the assumption and then back it into a healthy life assumption by subtracting disabled life mortality from the original total life mortality assumption. This approach sometimes resulted in zero or negative healthy life mortality and therefore adjustments were necessary to develop a reasonable approach to healthy life mortality. Another approach was to develop healthy life and

disabled life mortality assumptions from performing mortality experience studies. This approach resulted in assumptions that did not always tie back to the total life assumption. As one intermediate goal of moving to a first principles model was to develop a set of assumptions that tied to the claim cost model, a set of adjustment factors to both healthy and disabled mortality was developed in order to tie back to total mortality.

Of course, if we adjust mortality we need to make sure there are not any unintended consequences that flow through to the morbidity assumptions–adjusting disabled mortality can influence implied recoveries in the continuance table. This is one of the benefits/challenges of developing first principles assumptions: making sure the assumptions are internally consistent. Developing a set of assumptions for a first principles model that is created to tie to a claim cost model will almost certainly result in anomalies. In working with companies, we were able to develop an understanding of the anomalies and what was driving them. In addition, it helped to point out an important advantage of moving to a first principles model–that you will likely uncover internal inconsistencies in the claim cost assumptions that you did not even know existed.

In addition to the mortality considerations and consistency with claim cost projection models described above, additional considerations were identified and addressed with the various companies we worked with, including:

- The different impact on healthy lives, disabled lives, and total lives of any mortality improvement assumption.
- The different impact on total lives relative to healthy lives of morbidity improvement in the case where morbidity is changing from a total lives basis to a healthy lives basis.
- The challenges of splitting claim costs into incidence and continuance.
- The challenge of splitting continuance tables into disabled life mortality and recoveries.
- The challenge of including explicit care setting transfers into the first principles model.
- The maintenance of "legacy models." What should be done with legacy active life reserve calculations on a claim cost basis or legacy models for rate increase filings?

Our solution to these various issues included working with each company, taking into consideration many issues unique to its specific situation. In each case, we were able to develop modeling approaches and assumptions to satisfy necessary requirements of the first principles model.

In each case, we were also able to use the assumptions developed and then leveraged in Milliman's MG-ALFA first principles module to test the impact on pricing and projection models. This was a critical step in examining the impact of the first principles projection. Various nuances are important to consider in examining the output of a first principles model relative to a claim cost model and will be further discussed in a forthcoming article.

## THE RESULTS

For each company, we were able to develop a set of assumptions that is internally consistent and that accounted for anomalies implied by the current claim cost assumptions. Where inconsistencies implied by the current claim cost model were significant, the final first principle assumptions were necessarily a departure from the claim cost model. However, the differences were documented and understood.

In each case where assumptions were developed to tie claim cost models to first principles models, we were able to develop and test all of the income statement projection items to within close tolerances.

The final result in all cases is that the client now has a first principles model that can be used for pricing and projection purposes. It also allows clients to leverage some of the benefits of a first principles model, including:

- Detailed refinement of assumptions such that the mortality assumptions for total lives do not significantly over- or understate the combined active and disabled life assumptions.
- A model that contains assumptions that are internally consistent.
- A projection model that calculates paid claims and claim reserves on a more granular basis.
- A projection model that includes incidence of new claims and counts of existing claims.
- Refined benchmarking to be used in examining actual experience.

We will provide additional benefits and considerations regarding various details in first principles modeling in follow-up first principles modeling case studies. The level of sophistication, yet transparency, that is associated with first principles models will help LTC actuaries and the industry in the future.

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