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Getting Started with Advanced Analytics: The How and Why

By Gregory Pence

Actuaries are experts at estimating the financial risks and opportunities of future contingent events. They are trained to use complex data to gain insight into well-defined business challenges.

However, they are very often seen as tacticians, rather than strategists who do deep analysis on a narrow set of issues. In many insurance companies, an increasing number of strategic projects are going to professionals with data and analytic backgrounds, not actuaries. The issue is not related to competence but to firming up skills and broadcasting them in the right way, with solid analytics to back them up.

General knowledge of an enterprise's strategic challenges is needed to identify the data and analytics necessary. I see two steps to remedy this.

1. Be comfortable accessing, integrating and building complex data sets from big and broad sources of information to study the value of multidimensional drivers of change
2. Shape the strategic dialogue by making and sharing the economic value of a full range of strategic options

In this article, I will address the first step.

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Letter from the Editor

By Kurt Wrobel



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This *Health Watch* is focused on a topic that has received a considerable amount of attention in the business community and the media—the opportunity to use advanced analytics and behavioral economics to improve outcomes and predict future results. While this opportunity is often referred to in broad terms as “Big Data,” this edition will drill down on the topic and help define the actual application of the concept with several specific case studies. These case studies highlight a wide variety of different modeling techniques that could be deployed in addressing important business questions and improving the provision of care.

Greg Pence begins the discussion by highlighting the opportunities available to deploy advanced analytics and the skills necessary to do this modeling. He also showcases a case study where he used a mixed decision tree and duration model to develop a care coordination and patient registry program to more effectively manage patients. In addition to highlighting an interesting statistical technique, the analysis also shows that our technical work can go well beyond financial questions and could have a significant impact on health outcomes.

Sheamus Parkes continues with Pence’s themes by discussing the statistical techniques he has used to predict which facilities within an accountable care organization (ACO) would produce the most cost effective outcomes. He also discusses the importance of having a broad statistical knowledge base and programming skills.

Using advanced analytics, John Albert tackles a topic that has been widely debated among large group underwriters and actuaries—the development of credibility factors. Instead of using a static formula or simplified heuristics, he provides us with a more explanative definition and then uses stochastic modeling to more accurately estimate these factors.

In her interview with Alan Mills, Mary Beth Moran focuses on a modeling technique that Mill’s has long advocated for extension into the actuarial field. The agent-based modeling approach uses individual based parameters to guide the decisions and behavior of different agents in a complex system. The collected actions of these individual actors then determine the outcome of the wider system.

In direct contrast to the agent-based approach, Thomas Getzen discusses a macro model for estimating the long term trajectory of future health care costs. He suggests that by focusing on the bigger picture variables in the system, one can more accurately estimate the future.

After addressing more complex modeling, this edition moves to a discussion of behavioral economics by John Stark. Unlike most economic models, behavioral economics predicts how individuals will behave by explicitly assuming that they will be suboptimal in their decision making in certain circumstances. One particular prediction that seems interesting in light of our Affordable Care Act (ACA) experience is the concept of loss aversion. As Stark notes, individuals experience much more anxiety when losing something, versus joy in gaining something, even given equal value. This could explain, in part, the anxiety that many people have been experiencing with the cancellation of their insurance policies.

Philip Castevens continues with the behavioral economics discussion by using its tenants to explain the differences in health care costs among parents, married people, and employees.

In their respective articles, Kristi Bohn and Juan Herrera focus on the actuarial value calculator and the minimum value calculator. As many of us know from our rate development work, the ACA has many details that could have an important impact on our rates and the

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Chairperson's Corner

By Donna Kalin

As the new Chair of the Health Section Council, I would like to extend a warm welcome to the newly elected Health Section Council members:

Theresa Bauer Aetna
Julia Lambert Wakely
Michelle Roark Blue Cross Blue Shield
North Carolina
Troy Holm Humana

We look forward to their contributions to the Health Section Council for the next three years.

I would like to give special thanks to our outgoing council members. **J. Patrick Kinney** served as the council's chairperson this past year. His leadership was inspirational. **Dewayne Ullsperger** was our liaison to the American Academy of Actuaries and coordinated our sessions at the SOA Annual Meetings for the last two years. **Karl Volkmar** coordinated the SOA Health Meetings for the last two years. **Tom Handley** helped coordinate our Boot Camps and Medical School for Actuaries events. We welcome their continued participation as a "friend" of the Health Section Council.

2014 Schedule of Events

We are planning an exciting year of events for the upcoming year. Major meetings to put on your calendars are:

- Payment Reform Seminar: Feb. 24–25, Chicago
- Canada Health Day: TBD (one day) in May, Toronto
- Health Meeting: June 23–25, San Francisco
- Annual Meeting: Oct. 26–29, Orlando
- Boot Camps: TBD in November, likely Phoenix or Las Vegas

For our Canadian members, **Canada Health Day** will debut this year. We will be working with the Canadian Institute of Actuaries in planning this informative day.

Medical School for Actuaries will immediately follow the Health Meeting in San Francisco, so look for that as well if you would like to extend your trip. While not your typical actuarial event, Medical School for Actuaries changes each time and is a great way to learn about the clinical matters underlying health care claims.

The boot camps were a great success this year; they offer access to great speakers and provide a less formal venue for staying on a specific topic for 1.5 to 2 days. We plan to offer even more boot camps next November, so stay tuned. Watch for more information on specific topics, dates and locations. We plan on expanding to nearly twice as many webcasts this year as well.

Member Survey

Thank you to all who participated in our recent member survey. It has been two years since we last conducted a survey and the responses are very helpful for planning future services to meet the needs of section members.

Some brief highlights of the survey follow:

- Our methods of providing research and educational information are perceived to be generally effective, although there is room for improvement.
- The top five topics members would like to see an increased educational focus on include:
 - The Affordable Care Act's (ACA) impact on commercial pricing and reserving
 - Risk adjustment/risk assessment
 - Trend analysis
 - Accountable care organizations
 - Predictive modeling
- The top five topics members would like to see an increased research focus on include:
 - ACA outcomes
 - The ACA's impact on commercial pricing and reserving
 - Risk adjustment/risk assessment
 - Predictive modeling
 - Trend analysis



ISSUE 73 JANUARY 2014

Health Watch

Published by the Health Section Council of the Society of Actuaries.

This newsletter is free to section members. Current issues are available on the SOA website (www.soa.org).

To join the section, SOA members and non-members can locate a membership form on the Health Section Web page at <http://www.soa.org/health/>

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underlying benefit packages offered in the market. These articles focus on the methodologies used in these calculators and propose potential future improvements to these models.

The edition concludes with a detailed discussion of the Risk Management and Own Risk and Solvency Assessment (RMORSA) Model Act that

was recently approved by the NAIC and is being adopted by legislatures across the country. As highlighted by Eli Russo, Lee Resnick, and Jacky Kwan, the guidelines include establishing an appropriate governing process, developing a methodology to quantify risk, and ensuring adequate capital reserves are in place to support the risk accepted by the organization. ■

Chairperson's Corner | FROM PAGE 3



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Not surprisingly, these are the same top topics that rose to the top in the survey conducted two years ago. We will continue to provide our members with information regarding these topics in the upcoming year.

There were many comments requesting more dental focused items. As a result, the Health Section Council approved the formation of a **Dental Special Interest Group**. We hope to get this group started by January 2014. This group will be open to all interested members. The group will be a forum for more frequent communication and professional discussion. Information regarding this group should be available soon; look to our e-newsletter and join the listserve.

We were pleased to receive a number of offers from Health Section actuaries to **volunteer** their services in our future work. We are a council of only 12

elected members and about 15 active “friends” to help coordinate activities, so we can use additional help. The more **volunteers** there are to work with us, the more we can accomplish to serve our membership.

If you are interested in volunteering, please fill out the volunteer interest form found on the SOA Health Section website (<http://www.soa.org/professional-interests/health/hlth-detail.aspx>) or contact me at donna.kalin@milliman.com, or contact any member of the Health Section Council. ■

Be comfortable

It will take some time to become comfortable accessing, integrating and building complex data sets from big and broad sources of information. But getting comfortable is about taking the time to understand new vendors and tools that allow you to access the newer and bigger world of Big Data and the Big Table.

In health care, the new world is about integration of a broad range of information, including claims, enrollment, electronic health records, clinical charts, diagnostic laboratory, prescription drugs, care coordination, clinical trials, socio economic status, satisfaction surveys, provider-service patterns, benefit designs, provider payment and social media.

Most of the big data challenges are analogous to using the structured relational data sets typically available in many organizations. Like the puritans that sought a better life in the new world, you will need to make a leap. However, the leap you must make is away from corporate IT and toward vendors familiar with these new approaches. While security is a concern, many of these vendors know how to satisfy Health Insurance Portability and Accountability Act (HIPAA) and business security needs. In fact, some are able to meet federal defense contractor requirements.

Start your use of advanced analytical tools by casting a broad net to find and mine the right data sources. This is because the tools you work with often follow the available data. There are many tools that can make the actuary effective and efficient in finding and using data, which in turn make the challenge of communication easier.

Favorite Mixed Model

One of my favorite approaches to making analytical work fun and useful is combining a decision tree model to mine data and a durational model for establishing and valuing the contingencies historically and to test various scenarios.

In health care, for example, this approach makes it easy to create a multidimensional model of cost and utilization trends and to study assumptions about the potential impacts of targeted clinical interventions.

I like decision tree models because they are very good at:

- Developing the best categorization with a hierarchy structure for the questions you are asking
- Discovering data problems
- Creating a model structure related to the factors underlying change

The decision tree model is so named because it is based on a branching structure typically used to assess decision-making strategies using probabilities. It could also be named the “branching” model.

I have used them to categorize health care risks with hierarchies based on their significance. These structures are unlimited but you start with something you are comfortable with. For example, I have defined the most significant patient risk cohorts, the most credible factors driving change, the sources of the most variation in patterns of care and the highest quality providers. Patient cohorts could be defined first at a high level like catastrophic claims, and then refined down to diagnostic profile or risk score. The factors of change could be those catastrophic cohorts that have changed by the largest cost. The sources of variation could be variation around physician value per service. The decision tree model allows you to test many categorization possibilities for one question but then to come back and do it differently for another question.

During the categorization, you are also testing for quality problems. When looking at catastrophic claims by major diagnostic profiles, you will likely find some profiles with little data. This then will lead you to testing for credibility and setting assumptions that account for the lack of information



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Ultimately, the combination of the decision tree and durational models is a very powerful tool for an actuarial review and is used widely by those who understand them.

in these categories. The challenge then is to find the best categorizations that will stand on their own except for outliers, which you will have to adjust for and additionally address in your durational model.

With categorization done, you will then look at how the categories have changed over time. If you do not like the results, go back and revisit the categorizations. The process is iterative, ending when your model seems to hold together with the data and assumptions you have developed—or when you are fed up enough to move on.

The next stage is to develop durational models, which are the most familiar to most actuaries. They are excellent for valuing contingent patterns for your categorization structure, and as the basis for assumptions about future change such as clinical care initiatives. They are also called survival models because they were first developed for mortality. However, think of them as patterns of events over time reflecting contingent patterns with related values, patterns of care, outcomes, etc. In retirement work, this is essentially what is used to project cash flows and calculate actuarial present values. The same concepts are working here.

Durational models can be prepared for every category in your decision tree or a single aggregate model can be developed that is adjusted based on your assumptions as to the sensitivities of each categorization you want to value.

Ultimately, the combination of the decision tree and durational models is a very powerful tool for an actuarial review and is used widely by those who understand them. For example, in actuarial attestations of clinical innovation grants by HHS, this combination of models is very useful to value the impact in a narrow risk cohort to an aggregate across a diverse population.

Anorexia Nervosa

An interesting case in behavioral medicine, which seemed to show a bizarre spike in cost and an unusual number of deaths, was found around

the cost and quality of care for members with an anorexia nervosa diagnosis.

We solved the problem with the mixed decision tree and a durational model. The decision tree model helped us to focus on the diagnosis and the durational model helped us to understand how much of the experience was unusual and could be reduced.

The initial finding was that the providers did not track these patients, who bounced around the system when they were in crisis and only got care when hospitalized. Death could occur after multiple admissions and months of in-patient care because, in some cases, the patients presented to the hospital when their organs were failing. The solution was to establish a care coordination structure and a patient registry to track any and all cohorts with this diagnosis, and to contract a narrow network of specialists with a clear history of success with these patients.

Add Monte Carlo Simulation

In situations where it was hard to make the assumptions necessary using raw data directly, I have sometimes added a Monte Carlo simulation of underlying contingent probability estimates of various outcomes. Some of the problems I have or know of being addressed in this manner include:

- Expectations of enrollment risks on the health insurance exchanges in 2014
- Impact of developing narrow or broad networks on cost and quality
- Capitated health care risks and opportunities using Medicaid provider networks
- Impact of HHS risk-adjustment structures under healthcare reform
- Impact of pricing too high or too low on exchanges
- Incentives designed to change patient health care behavior



Getting Started is Easy and Counts for CE

First of all, I suggest you plan to do some homework. When I investigate new models or get deeper into ones I have developed, I set aside continuing education time. I record as much as half my required CE to doing this.

When getting started, I looked for free models to download, usually from academic work. In addition, programming tools like R have a lot of modules you can pull from for just about any model you can imagine. An emerging tool worth considering is PowerPivot; a lot of analytical expertise is being developed with this tool, and a lot of models are becoming available to use with it.

Other excellent tools I have used are available from organizations like SAS or SPSS, who have built environments for easy flow of data and assumptions between models. These tools allow rapid cycling from beginning to end for scenario testing. Despite their expense, these environments are built and vetted by some very smart PhDs. As a profession, before they understand what we do, we need to take advantage or they will do our work for us too. ■

Advanced Business Analytics: Applied Statistics, Programming and Actuaries

By Sheamus Parkes



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I'm enjoying the Society of Actuaries (SOA) recent emphasis on advanced business analytics. The SOA's classic education and examination programs produce professionals with robust subject matter expertise; however, once actuaries are credentialed, the education opportunities available to them are still focused on the same topics as the exams. It can be hard to learn what you don't realize you need to learn as there are a lot of unknown unknowns in a recent fellow's knowledge space. Almost any pertinent topic has a rich discussion going on in both academia and business if you are just willing and able to find and join it.

Many of those knowledge gaps exist in advanced business analytics. The SOA's Advanced Business Analytics initiative closely overlaps with the larger data science movement. Actuaries come into the data science realm with a healthy amount of domain knowledge, but they are weak on statistics and programming skills. By focusing on these extra skills, actuaries have a large opportunity to break out of their regulation-enabled roles and compete in the broader business world on pure analytic strengths.

The three sections below shine light on some of those opportunities. The first is an interesting case study that shows how closely related classic actuarial knowledge can be to applied statistics. The last two sections illuminate what there is to learn about applied statistics and programming in general.

Case study: ACOs

Accountable care organizations (ACOs) have a fresh incentive to find savings in the health care system. Some clients have found the required willpower to take on provider profiling, which is a political and statistical minefield. Success takes a mix of tact and sophistication. This case study will focus mostly on the statistical point of view.

The outcome studied is often a rate (utilization/cost per service/episode/member), but the sample size of exposure by provider is often akin to a Pareto distribution. Actuaries are trained to understand that the majority of providers will not have credible observed rates, but their toolset for addressing this issue is often inadequate. They throw out

low-sample providers or use rough partial credibility blending. A more useful approach involves mixed modeling (also known as hierarchical modeling) (Gelman and Hill 2007). Properly applied mixed modeling is statistically identical to least-squares credibility, and can be easily extended.

This case study investigated the cost of one of three planned procedures at various facilities. Much energy was invested in using a medical episode grouper and pruning/combining the results into some semblance of homogeneity. Business rules had to be defined to exclude episodes that could possibly have been emergency procedures or those done in an outpatient setting. Expert clinicians were consulted and presented with summaries and statistical visualizations; as part of this, the analysts grew their own subject matter expertise. After that manual exercise, a series of robust statistical procedures were developed to prevent any particular observations from having unlimited influence in this or any future refresh of the analysis. Robust statistics are very useful tools to learn and apply to messy real world data (Maronna, Martin and Yohai 2006).

The primary modeling exercise then began and involved important subjective decisions such as:

- Choice of conditional gamma distribution
- Inclusion of eligibility status covariates to provide implicit case mix adjustment
- Inclusion of region covariates to provide room for region-appropriate full credibility targets

The effects of interest were the estimated costs of the three chosen procedures by facility. The modeling space was expanded such that a given facility's relative performance on different procedures could be correlated; e.g., it could be that if a hip replacement costs more at a certain facility than at the average facility, knee replacement will likely cost more there as well.

Uncertainty around these estimates was calculated, but limited to the estimated uncertainty given the model was actually true. We carefully communicate these uncertainty estimates as being most useful for comparing relative credibility between facilities. The observational nature of the data is also limit-

FIGURE 1

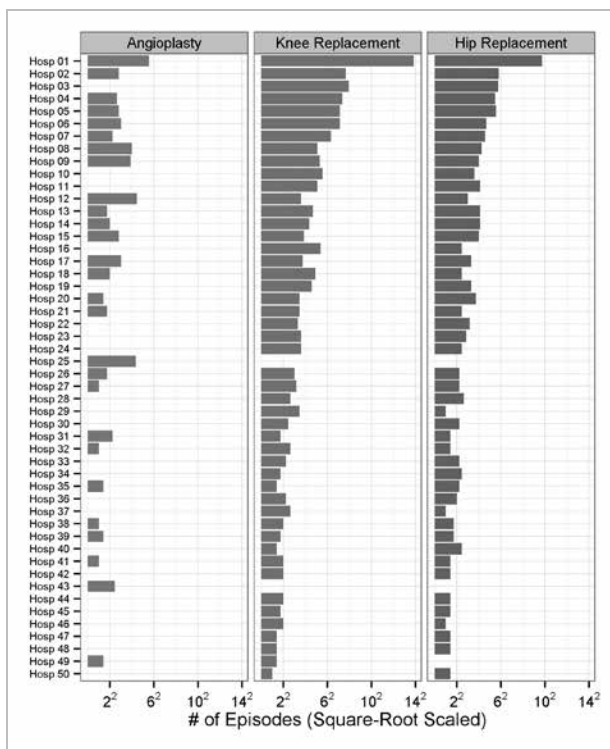
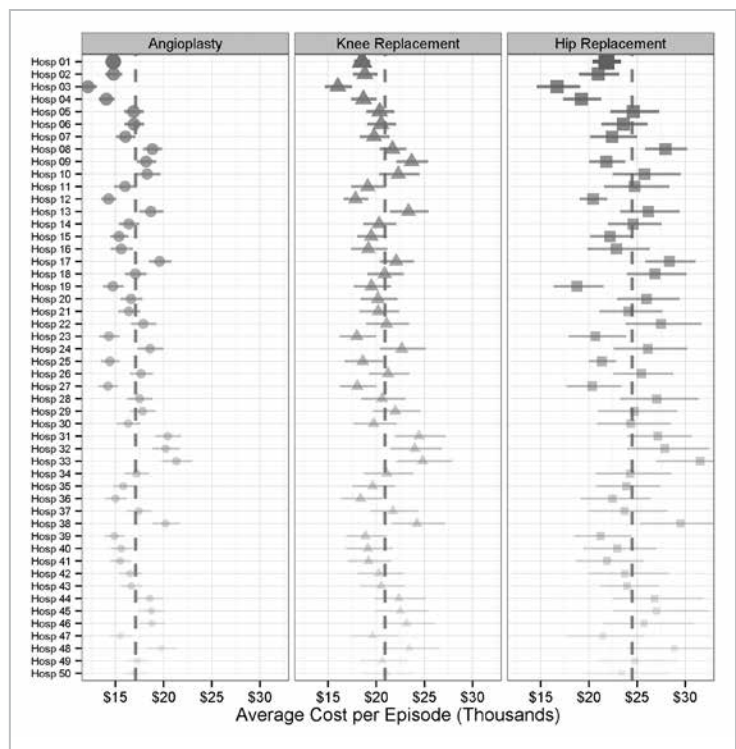


FIGURE 2



ing when planning action steps from the results; it is a leap of faith that a facility would continue to have similar costs per episode if more episodes were performed there. All of the results must be consumed with common sense and a healthy dose of skepticism.

A series of visualizations give insight into the case study. These particular visualizations were designed for the audience of this article; the complexity would be scaled back for a less analytic audience. **Figure 1** shows the frequency of episodes by facility and episode trigger (angioplasty, hip replacement or knee replacement). Actuaries would intuitively understand that the majority of the facilities would have weakly credible costs per episode. Seeing the gaps of zero episodes, especially for angioplasty, would suggest some facilities just don't provide certain services and any estimates of their costs for doing so should be disregarded.

Figure 2 shows the estimated average costs per episode for each facility and episode trigger. The facilities are still sorted as in **Figure 1** (descending number of episodes). The points represent the best estimates of the model and the horizontal bars are one standard error wide; the vertical dashed lines represent the overall average cost. Size and transparency of the shapes were used to emphasize the more credible results. The generally tighter bars on the angioplasty results suggest facilities are more consistent in their costs for angioplasty. However,

that tightness can somewhat be an artifact of the multiplicative nature of the model and the lower overall cost of angioplasty.

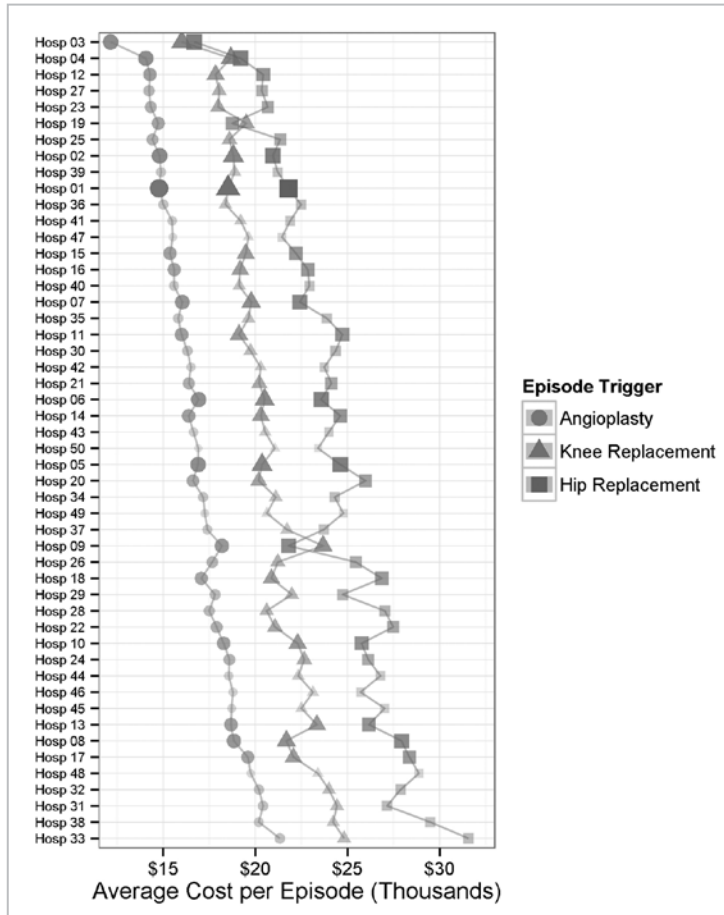
The effect of penalization/actuarial credibility/shrinkage can be seen in that the facilities with low support are usually constrained to be close to the average. The shrinkage would be more obvious if the unadjusted cost estimates were presented for comparison. It is possible to observe some of the correlation between angioplasty, knee replacement and hip replacement in **Figure 2**, but **Figure 3** makes it more obvious.

Figure 3 on page 10 presents the same information, but the facilities are now sorted by their average estimated costs across the three episode triggers. This visual goes closest to the heart of the business need: Which facilities would best minimize costs? This ordering is much more useful than a raw observed cost ordering; the estimated cheapest facilities are all of credible size, and yet not all credible facilities are cheap. The correlation assumption appears front and center; the episode trigger lines are almost painfully parallel. That strong correlation assumption enabled borrowing strength between episode triggers to reach stronger conclusions about facilities with moderate support.

More simplistic approaches could still have been useful. It would be reasonable to just limit reporting

CONTINUED ON PAGE 10

FIGURE 3



to facilities with a minimum number of episodes per trigger and sort by their observed averages. The generalized linear mixed model approach can provide some competitive advantage by keeping those facilities with moderate to weak support in consideration. A facility that showed consistently excellent performance across a small sample of different procedures could be compelling evidence when the modeled correlation pools strength between the procedures. It also alleviates the need of choosing the full credibility threshold of a simpler method.

The next two sections highlight the subject areas that would support an analysis such as one shown in this case study.

Applied statistics

“Statistics: a subject which most statisticians find difficult but in which nearly all physicians are expert,” wrote Stephen Senn (2008). This could also apply to many young actuaries who believe the exams did a thorough job covering applied statistics. They are taught the basics of frequentist statistics, but seldom with a true understanding. They won’t realize how many pitfalls are looming

when trying to bend a statistics paradigm designed for random control trials to a common business problem domain. They will brush aside issues of observational data. They will present significant p-values when they have enough data for any effect measured in any form to provide a p-value less than 0.001. They might present some uncertainty in their parameter estimates, but they are unlikely to think of the uncertainty in their modeling or data choices.

Bayesian statistics provide a bit more palatable rationale in the business world, but they are not a silver bullet. There are no silver bullets. Machine learning is a great lens to view predictive modeling through, but actuaries are often focused on inferences and quantifying uncertainty as well as accuracy (Hastie, Tibshirani and Friedman 2009). In addition to learning about the modern fusion of statistics and computers, actuaries should be reading the classic works of enlightened practitioners such as George Box (Box, Hunter and Hunter 2005) and John Tukey (1977). It takes broad knowledge and experience to produce, communicate and defend useful results.

Programming

Business analytics can’t be considered advanced until they are reproducible and reusable. Point-and-click interfaces are wholly inadequate. Spreadsheets are a land mine of horrible practices; even well thought out and strictly enforced formatting guidelines might enable an almost sane separation of data and analysis. A similarly colossal effort will keep analysis flowing along a single path, at least for a while.

Real analysts write code. Programming provides a clean separation of data and analysis. It takes only an achievable level of effort to ensure smooth flow of logic through a code base. Abstracting repetitive tasks into reusable routines is a cinch, and any useful language likely already has an appropriate routine if you just look for it.

Writing good code can be difficult, however; skill differences among any sample of programmers commonly vary by many orders of magnitude (McConnell 2009). It is possible for an individual to improve, but it takes effort and practice. In addi-

tion to knowledge of specific languages, an analyst needs to have strong programming fundamentals. Intelligent programming is all about managing complexity; duplication is evil and modularity is bliss (Hunt and Thomas 1999).

There are many useful programming languages available, and different business problems will fit into different languages more easily. Learning additional languages will let your mind expand to see problems from different angles. Time and will-power should be the only limitations on learning; many of the best languages are available as open source (free to use even in a commercial setting). My personal favorite is R (“a language and environment for statistical computing and graphics”) (R Core Team 2013). R is a domain-specific language for applied statistics and those are the problems I am most often solving. Python is a general purpose language with many packages to extend its applicability to statistics (or any other problem space). Commercial software such as SAS and SPSS are excellent choices, especially if they are already in use in an organization (Littell, et al. 2006). Every analyst should be comfortable in some variants of SQL; countless commercial and open source options are available.

Additional References

This article was written for a technical audience, but the communicated skepticism can be retained even when presenting to a more business-oriented audience. As George Box said, “All models are wrong, but some are useful” (Box and Draper 1987). To learn about the particular methods used in the case study (and advanced business analytics in general), I recommend the books *Data Analysis Using Regression and Multilevel/Hierarchical Models* (Gelman and Hill 2007) and *Regression Modeling Strategies: With Applications to Linear Models, Logistic Regression, and Survival Analysis* (Harrell 2001). This specific analysis and visualization was completed in the R programming language (R Core Team 2013) utilizing the lme4 (Bates, et al. 2013) and ggplot2 (Wickham 2009) packages respectively. For information about learning R, I recommend *The Art of R Programming: A Tour of Statistical Software Design* (Matloff 2011) and *R for Dummies* (Meys and de Vries 2012). ■

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Developing Group Health Credibility Factors through Stochastic Modeling

By John N. Albert



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In the current group health marketplace, credibility factors are generally the result of years of marketing pressure to increase the factors in order to quote more competitive rates for groups with lower-than-expected claims experience. We have seen the minimum size of groups considered “fully credible” diminish over the decades. Using higher credibility factors than can be actuarially justified may not be an optimum strategy to maximize either market share or profitability.

A group’s annual claims are highly random for all but the largest cases. By utilizing high credibility factors and quoting low rates on groups with low current claims, insurers take a great risk if the claims revert to their normal levels. Conversely, they price themselves out of the market for groups with high current claims.

Insurers do not make money by writing low claims groups; they make money by quoting appropriate rates for all groups. They can do this by using actuarially determined credibility factors.

In my 42 years of experience in group actuarial practice, I have long been interested in the concept of credibility. I have attended many credibility sessions and read many papers but have not really been satisfied with any of the approaches.

I propose we drop the attempts to develop a purely mathematical formula for group health insurance credibility and instead see what can be obtained through the use of stochastic models creating simulated claim data.

We can create member-based claim distribution tables if we have sufficient claim data. If not, we can use leased data from a consulting firm.

With a member claim distribution table based on actual group health claims experience, we can develop a stochastic model to generate annual claims for each member of any size group we want. For a particular hypothetical group of any size, we can then simulate any number of policy years’

claims experience. This is, of course, not possible with actual claims.

What is Group Health Credibility?

We talk about actuarial science, but science implies precise definitions of terms. What is our definition for group health credibility? How do we define it mathematically?

I propose we define group health credibility as the probability that the actual annual claims of a particular group will fall within ± 5 percent of the expected value. Using this definition, we can measure the credibility of a group’s experience directly from the simulated annual aggregate claims developed by our model for that group. If we run n policy years of claims for the group, then the credibility is equal to the total number of years in which the annual claims were ± 5 percent of the expected amount divided by n .

To properly develop credibility factors, we need to take into account the following three parameters that impact the credibility of group health claims experience:

- Pooling levels
- Member claim correlation
- Member turnover

Pooling Levels

Many current credibility factor tables make no provision for the pooling mechanism group carriers employ to stabilize claims experience for new business quotes and existing policy renewals. Intuitively, we know that lower pooling levels produce more stable claims experience from year to year and therefore higher credibility. By excluding claims above the pooling level and adding an appropriate pooling charge (the expected amount of the claims exceeding the pooling level) to each members’ claims, we can incorporate the effects of pooling into the simulated claims provided by the model. We can then directly measure their effects on credibility.

Chart 1 shows the effects of different pooling levels on credibility based on the output of the stochastic model for groups of 50 to 1,050 members.

The output of the model confirms that the lower the pooling level, the greater the credibility of the group's claim experience. The experience of a group with 1,050 members has a credibility of 30 percent with no pooling, which increases to 58 percent by pooling at a level of \$60,000.

Member Claim Correlation

Many mathematical approaches to credibility theory utilize the simplifying assumption that a member's claims from year to year are independent. Without that, the math becomes too complex. To develop more accurate credibility factors, we need to account for the fact that a particular member's claims are not independent from one year to another. People who are healthy tend to remain healthy, while people with chronic health issues will continue to have them.

By comparing each member's claims from one year to the next using actual claim data, we can develop a cumulative probability claim distribution by claim ranges. Within the credibility model, we can use this distribution to develop a current-year claim amount for each existing member based on their prior year's claim amount.

Chart 2 shows a small segment of the complete cumulative probability distribution for a given range of claim values. It can be seen that if a member has \$0 claims in the prior year, the probability of their having \$0 claims in the current year is roughly 54 percent. If the member had \$799.25 in claims in the prior year, their probability of having \$0 claims in the current year is only about 6 percent. The \$799.25 and other claim amounts shown are actually the lower boundaries of a range of claims. This distribution was based on the actual experience of a major carrier's large group and Administrative Services Only (ASO) claim data for members that were in force over a two-year period.

CHART 1

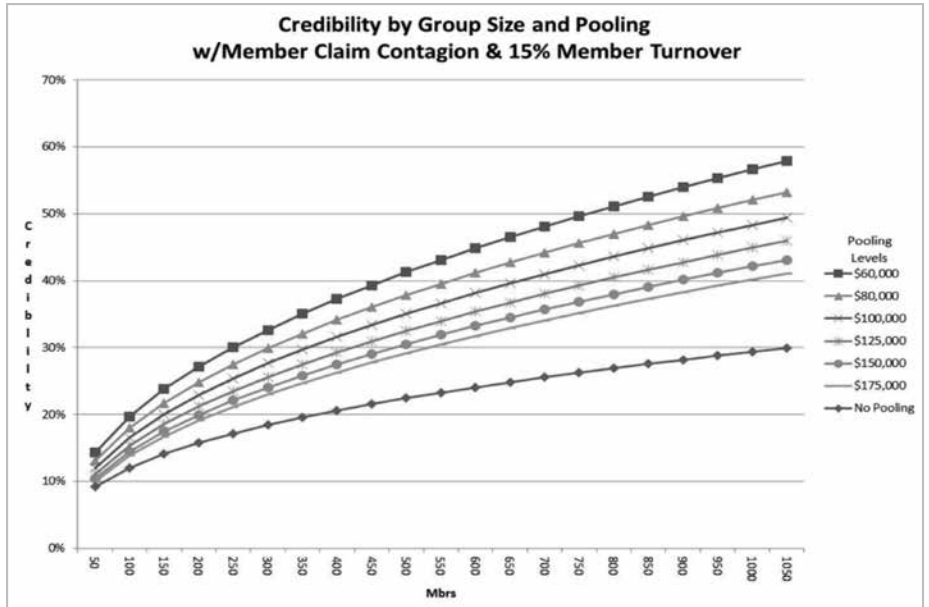
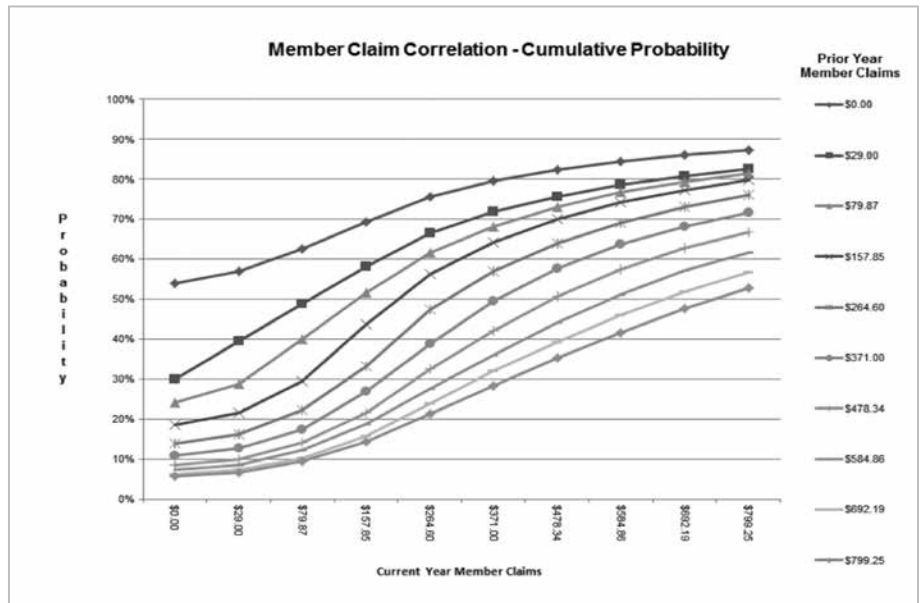


CHART 2



Member Turnover

This parameter somewhat offsets the member claim contagion since if a member is no longer with the group, it doesn't matter what their claims were last year. Conversely, if they are new to the group, their claims are not included in the prior year's claim experience.

I am defining member turnover here as one minus the ratio of the total member months of a group for a 12-month period to the count of the unique members in force during that period multiplied by 12. This definition takes into account the member months of exposure lost by those leaving the group during the policy year as well as those who enter the group after the effective date.

The weighted mean member turnover of a typical block of large group and ASO business is roughly 15 percent.

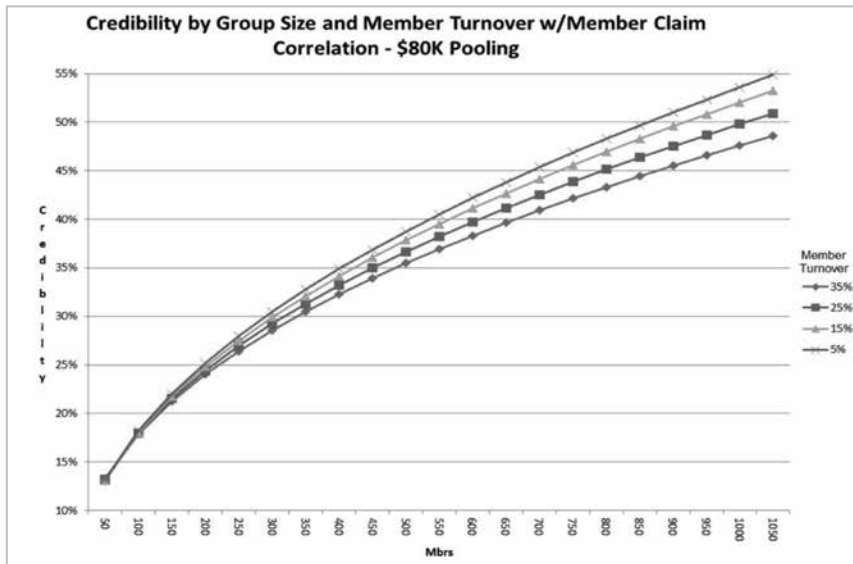
Chart 3 shows the effect of member turnover on credibility. The effect is more noticeable in the larger groups because they are more credible to begin with.

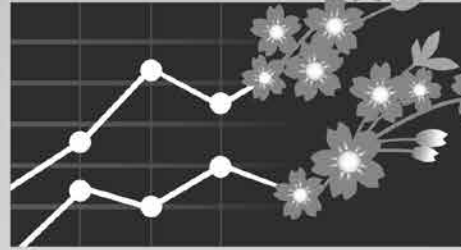
Summary

I have demonstrated that developing credibility factors for group health insurance can be accomplished empirically through the use of stochastic models with appropriate parameters and fairly readily obtainable data, without the need for unrealistic assumptions.

Stochastic modeling is a powerful tool that can be used to solve many problems a pricing actuary may come across. I hope this article will stimulate interest in this topic as well as my new approach to credibility theory. ■

CHART 3





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A Conversation with Alan Mills, ND, FSA

By Mary Beth Moran

Mary Beth Moran, FSA, FIA, MAAA, is a health actuary with over 20 years of experience including a recent role as VP and Head of European Actuarial for a Fortune 500 company. She may be reached at maryb7830@hotmail.com.

Introduction: Following the Agent-Based Modeling and Simulation Workshop at Argonne National Laboratory in August 2013, I phoned Alan Mills to have a conversation about complexity science and his pioneering work for the actuarial profession in this area. Below are selected excerpts from that dialogue.

Mary: First tell us about yourself. You are an actuary and a physician. Which came first? How does one set of skills and experiences enrich the other?

Alan: Yes, I am a family-practice naturopathic physician¹ and a health actuary. Even though I have always been passionate about health and healing, actuarial work came first, perhaps because at university I was even more passionate about the beauty of mathematics. Later, as I became distressed about our health system and the poor health of people around me, I decided to try to make a difference in a more personal way, as a physician. I had lived in other countries—Germany, France and Japan—with health systems that seemed to work better than ours, and with populations that seemed healthier, so I knew we could do better.

Being a physician has enriched my actuarial work. Having first-hand experience with patients, clinicians, hospitals and other aspects of our health system helps keep my actuarial work grounded in reality. I understand how the system's players—what I call its "agents"—behave.

But more importantly: As a naturopathic physician, I see a person's body and mind and environment as one complex holistic system. To keep patients healthy, I help them address all aspects of this holistic system. Such a holistic perspective has profoundly influenced how I approach health system problems as an actuary. A health system is generally also a complex holistic system. Its major problems usually cannot be solved by addressing isolated components; rather, the system must be addressed as a whole.

Mary: I remember reading in your paper "Complexity Science: An Introduction (and Invitation) for Actuaries" about how you became interested in complexity science. Could you describe this process? What was the seed of interest that started it, and was there an epiphany that spurred you to go into it more deeply?

Alan: It was a lovely fall day in 2003, in a Barnes & Nobel bookshop in Boulder, Colo., when the seed was planted. As I often did, I browsed the nonfiction section of the store, and saw a big—very big—relatively new colorful book by Stephen Wolfram titled *A New Kind of Science*. I picked it up, started reading, and was so entranced that I sank down in the aisle and continued reading for an hour or more. In the book, Wolfram shows how the intricate behavior of complex systems—everything from weather patterns to the way shells form—can arise from very simple rules. Our intuition is that complex behavior must arise from something equally complex, but Wolfram shows that such intuition—as with so many of our intuitions—is wrong.

Complex behavior from simple rules. This is a cornerstone of the new field of complexity science. Although Wolfram didn't use the term "complexity science" in his book, he certainly helped me to see the world in a new way that I would now call the complexity science perspective.

Wolfram's book also inspired me to pursue a project that I had long pondered, namely to build a model of the U.S. health care system. It had become clear to me that to solve our health care system problems, we need to see it holistically, and to do that we need a good model of the system. We cannot solve the problems piecemeal.

To build the model, I went to work and study at the University of Michigan. There I came upon an amazing group of people with amazingly fresh perspectives about how the world works. Many of these people were part of an interdepartmental center called the Center for the Study of Complex Systems. It was there that I got to work with giants

of complexity science like Scott Page and Stephen Wolfram.

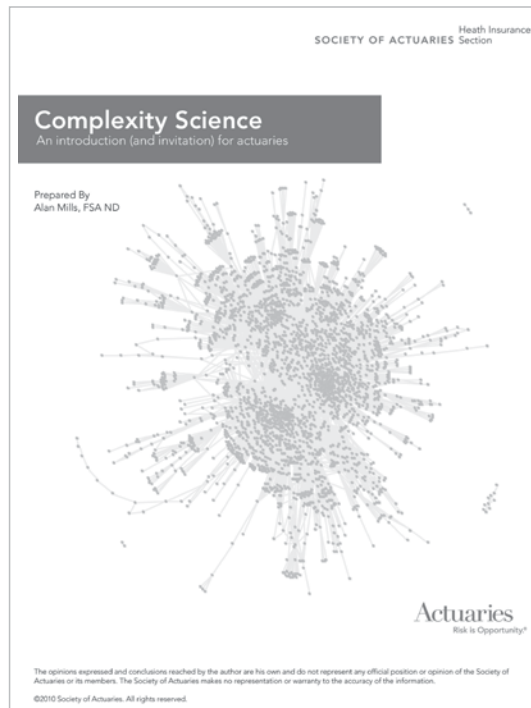
And it was there that I found another book—this time a very small book—that led me to delve more deeply into complexity science. The book is *Growing Artificial Societies: Social Science from the Bottom Up*, by Joshua Epstein and Robert Axtell. In it, Epstein and Axtell do something amazing: Using a new modeling technique called “agent-based modeling,” they grow an entire economic system from the bottom up, from very simple agents and agent behavior rules, and in the process discover powerful new insights about the way that economic systems work. My epiphany was that if this could be done for an entire economic system, then surely I could do it for a health care system, perhaps even the U.S. health care system.

Mary: From there, at the University of Michigan, you were introduced to the scientists at Argonne [National Laboratory]?

Alan: Yes, Scott Page introduced me to Argonne. A student of his had attended an Argonne workshop about agent-based modeling and simulation (ABMS). He gave me a copy of the workshop notebook—another book. That inspired me to visit Argonne, attend its ABMS workshops and get to know its scientists.

Mary: When you were at the University of Michigan ... did you produce [a model of the U.S. health care system]?

Alan: While people at the Center for the Study of Complex Systems were strong supporters of my proposal to build a model of the U.S. health care system (as were members of the university’s governing body), the professors in the school of Health Management and Policy—my home at the university—were not. In fact, they said it could not be done. Which is understandable, because they were entrenched in the perspectives of traditional health economics and traditional modeling. Nevertheless, I hit an impenetrable wall.



Mary: Change is difficult. One of the things I appreciated about your paper is that it is difficult to define even what complexity science is. So on the one hand, it doesn’t surprise me that there can be entrenchment within a particular well-established field, but on the other hand sometimes “hitting the wall” is a sign that change is needed.

Alan: I think it was [the 19th century mathematician Carl Friedrich] Gauss who said “Science marches forward, one death at a time.” The same may be true of complexity science. To step away from well-worn paths takes people with tremendous courage. When I meet them, I am extremely grateful.

Mary: That’s really an honest assessment. Is it true to say that, to the best of your knowledge, before the SOA publication of your U.S. health system models that there was no agent-based model of the system available in the public domain?

Alan: There are a few other excellent agent-based models of health systems, but they are generally not in the public domain. For example, as I mentioned in my recent SOA research report, Joshua Epstein has

For more information on complexity science and agent-based modeling, read Alan Mills’ two reports found on soa.org.

www.soa.org/research/research-projects/health/research-complexity-science.aspx

www.soa.org/Research/Research-Projects/Health/Simulating-Health-Behavior-A-Guide-to-Solving.aspx

developed wonderful models of worldwide pandemic containment strategies. Some of these models involve billions of diverse agents and reflect a wide range of agent behaviors.

But I don't want to give you the impression that I have developed a model of the entire U.S. health care system. I haven't. The SOA models are important components of the entire system, but they are not an entire system. To build an entire system will require an advanced modeling platform to which many people and organizations—such as academic researchers, health insurers, health care providers and governmental bodies—can cooperate to add vital pieces, like putting together a huge puzzle. I am working on a public-domain platform to enable such cooperation.

Mary: All of the work that you did to get the beginning of the platform built is really important. I think that the work you have done on defining a common ground, drafting a compendium of health behavior, developing an ontology—a standard language to define health behavior—and the multidimensional definition of behavior has been amazing. It's helping actuaries and others to have a common starting point.

Alan: Thank you. One of the key ingredients in modeling health systems is to better understand the behavior of the agents—the clinicians, patients, hospitals and so on—within a health system. So, in my latest SOA research paper I concentrated on agent behavior. I defined behavior (which, curiously, had never been done); started a compendium of health behavior so that actuaries and others will have a central repository to find information about health behavior; prepared a template for a health system ontology so that we will be able to discuss health system problems using a consistent vocabulary and consistent definitions of processes and interrelationships; and I developed sample agent-based simulation models to demonstrate how these can be used to help solve health system problems.

Mary: You have a vision for a new type of actuary, a complex systems actuary. Explain what it is.

Alan: Conditions are right for the rise of a second great arc of work for actuaries, particularly for a special type of actuary that I call a complex systems actuary.

The first great arc of actuarial work arose in the 1600s, and continued more than three centuries. In 1660, John Graunt—a London haberdasher in love with mortality—introduced the study of what he called “social numbers,” counts of aggregate social outcomes such as death, for guiding social policy. The arc rose higher as scholars, scientists and business people nurtured the paradigm of social numbers. [In 18th and 19th centuries] the German scholar [Gottfried] Achenwall introduced the concept of “Statistik” (statistics), the French mathematician [Nicholas de] Condorcet applied the probability theory of games to social issues (just before he was guillotined), the astronomers [Adolphe] Quetelet and [Pierre-Simon] Laplace applied statistics and probability to demographic and other aggregate social outcomes, and so on through the establishment of insurance companies and the rise of actuaries to a place of prominence—prominence based on the actuary's expertise in applying the top-down paradigm of aggregate social numbers to address social problems.

The first great actuarial arc is now on its way down. Even as the number of actuaries grows, our effectiveness in the face of increasingly complex social problems declines. We cannot foresee or prevent the frequent unintended consequences of health care strategies or even effectively foretell health care expenditures, much less develop effective strategies to increase health care value. And, as harbinger of our waning prominence, we no longer sit on the boards of health care organizations, or lead health care policy. We've become a legion of highly skilled, highly paid, social mechanics in a world where social systems are more like living beings than machines. We have ridden the arc of aggregate social numbers as far as it will go.

But health actuaries—indeed, all actuaries—can now embark on what promises to be a second great arc, one that even a decade ago was hard to con-



ceive. The second arc's new paradigm, together with its enabling facts, theories and tools, arose only recently, together—not coincidentally—with the rise in computer power. The new paradigm is complexity science and one of its main tools is agent-based modeling.

A complex systems actuary is an actuary who uses this new paradigm and its tools to address problems of complex systems of all types. Not just pension, insurance and health care systems, but also financial systems, city and state systems, and corporate systems—any complex system where people, money and contingency intersect.

Now, there is a window of opportunity: Because the concept of the complex systems actuary is so new, it does not currently have significant competition. But this will surely change, and soon. The interesting question is whether actuaries and the SOA will seize this opportunity.

Mary: When we talk about this new type of actuary, a complex systems actuary, I don't think you are arguing that we should not use our old tools. It's not an either/or situation. Maybe you can talk a little bit about that. What are the similarities and differences between a traditional actuary and this new type of actuary?

Alan: Certainly. Our training regarding risk, statistics, economics, law, accounting and the like are necessary for any actuary, including the complex systems actuary. And it is likely that there will

always be situations where our traditional modeling tools are appropriate. But when we address big problems within complex systems—which are most of today's pressing problems—our traditional Excel spreadsheet and micro-simulation models are often inadequate. To address such problems, we need more appropriate modeling tools and a broader modeling perspective, which agent-based modeling and complexity science provide.

One difference between the complex systems actuary and the traditional actuary is that, even though the complex systems actuary will have a field of specialty, he or she will venture beyond this into other related fields. For example, a complex systems actuary with a health specialty might also work on complex system problems related to an economy as a whole. Rather than nestle down into ever more limiting subspecialties—as actuaries have traditionally done—the complex systems actuary would continually broaden the scope of complex system problems he or she can address.

Another difference—the critical importance of which I have only recently begun to fully realize—is that the complex systems actuary must become an expert in how people and organizations behave, a topic that has been absent from our training. Complex systems are nothing but intricately interwoven relationships among many diverse agents and their behaviors. If we do not understand how individual agents behave, how can we possibly model the trajectory of a complex system as conditions in the world change? The

One difference between the complex systems actuary and the traditional actuary is that, even though the complex systems actuary will have a field of specialty, he or she will venture beyond this into other related fields.

complex systems actuary must master the new fields of behavioral economics and behavioral finance, and might even contribute to SOA research that elucidates agent behaviors.

A complex systems actuary is like a family-practice physician. You never know what kind of problem will walk through the door, but whatever the problem, you will address it from a holistic perspective and with the most appropriate tools.

Mary: That really leads nicely to the next question: how complexity science, or this new type of actuary you have written about, fits into the new mission statement of the Society of Actuaries, which is as follows:

“The SOA, through research and education, advances actuarial knowledge and improves decision making to benefit society. We enhance the ability of actuaries to be trusted financial and business advisors on problems involving uncertain future events. We provide and ensure the integrity and relevance of our credentials.”

As highlighted in the February/March 2013 issue of *The Actuary*, the updated mission of the SOA includes equipping actuaries to adapt and cross over into wider and more diverse areas that traditionally actuaries might not have been practicing in. SOA Past President Tonya B. Manning said, “Our profession cannot be sustained without growing and adapting as businesses and the financial sector change around us. ... Through adaption and expansion, our profession will remain relevant.”

Alan: I wholeheartedly agree. If actuaries remain ensconced in traditional niches, we will become obsolete. We saw this happen with the ERISA [Employee Retirement Income Security Act] law that Congress passed in the 1970s. ERISA marginalized pension actuaries. The same could happen for health actuaries. The ACA [Affordable Care Act] may be the first step in that direction.

As the world changes, actuaries must change. The ever-more intricately interwoven complexity of our world offers untold opportunities for a complex systems actuary to address far more diverse and

interesting problems than actuaries have traditionally addressed, problems that transcend traditional actuarial niches, and that even transcend traditional academic, professional and geographic borders.

Mary: People may be wondering, what do I need to do to learn the tools of this emerging new field? Is an advanced degree necessary? What is the SOA doing to help provide the education/training to fill in the skills gaps?

Alan: Although there are not yet any degrees in complexity science in the [United States], there is a lot one can do to learn more about this new paradigm and its tools. A good place to start might be my SOA research paper “Complexity Science—An Introduction (and Invitation) for Actuaries,” and the list of top 10 complexity science books found at the end of the paper. Also, presentations about complexity science have become a regular feature at SOA meetings. And I hope the SOA will continue to sponsor agent-based modeling and simulation workshops such as the one held recently at Argonne National Laboratory.

Mary: Thank you for your time; I really enjoyed talking with you. So when we have the hall of fame for actuaries, you’ll be in there, Alan. You have my vote! You’ve done some really great work to start establishing that foundational platform that you talked about, for all of us to stand on.

Alan: Mary, the work is nothing without people like you who recognize it and want to carry it further. Could we enter the hall of fame together? ■

END NOTES

¹A naturopathic physician emphasizes prevention, a whole-person perspective, and minimally-invasive—and often more natural and less costly—evidence-based treatment. To achieve this, in addition to the standard medical curriculum, naturopathic physicians study non-standard subjects such as clinical nutrition, botanical medicine, psychology, and counseling. Naturopathic doctors (NDs) are generally family-practice physicians, and are currently licensed in 17 states and the District of Columbia.

Modeling the Cost of Medical Care for the Elderly

By Thomas E. Getzen

Forecasts need to be accurate, timely and comprehensible. The challenge of predicting medical costs 20, 30 or 50 years into the future is formidable, but some organizations (Medicare, employers with retiree health plans) have no choice: They must make decisions today affecting funding for the rest of the century. While the complexity of the task seems overwhelming, the best and most readily understood results often come from rather simple macro models that rely on a few key parameters, rather than micro models that simulate detailed interactions among a myriad of individuals and illnesses. This excerpt from a presentation at the January 2014 Society of Actuaries' Living to 100 Symposium (<http://livingto100.soa.org/>) describes an open-source model for use by actuaries attempting to estimate future health benefit costs, discusses its strengths and limitations, and projects that spending for those age ≥ 65 will take more than \$13 trillion by 2055, about 50 percent of total medical expenditures.

Macro Model for Long-Term Medical Cost Trends

In 2006, the SOA posted a request for proposal (RFP) to develop "Models of Long-Term Medical Trends for Valuation" of retiree health benefits. The result of that effort was a parsimonious macroeconomic Excel model to project cost trends from 2015 to 2099 (SOA 2011). This model, with subsequent updates, was adopted by many actuaries as a standard tool. The model split health care cost trend into three components:

$$\text{TREND} = \text{inflation} + \text{real growth} + \text{medical share}$$

(consumer price index) (gross domestic product/wages) (technology/demand)

To the extent that the medical cost trend is matched by growth in wages, the share of total earnings required to fund future health benefits remains steady. Thus most interest has been focused on the last factor, often termed "excess cost growth" by Medicare and the Congressional Budget Office.

As the original model was being constructed, questions were raised about the higher costs of older retirees. Although costs per person age ≥ 65 were clearly larger, and commonly perceived to be growing much faster, analysis of data for the prior 25 years showed that relative growth in spending was actually slower, especially among the most advanced age groups ($\geq 75, 85$). Rather than attempt to reform a deeply held, albeit incorrect, public opinion, a decision was made that the original model would not project separate cost trends for people over/under age 65.

Extending the Model to Determine the Share of Expenditures for Age ≥ 65

Developing a new paper provided an opportunity to explore the issue of age-related costs in greater depth, with more data, and within a larger perspective that highlights the total amount of expenditures for care of the elderly. The baseline projections in this article continue to use equal trends in per-person medical costs over and under age 65, but do so in a more nuanced context, exploring the reasons for staying with the original baseline, and for how and why divergences might occur that would substantially change results. The original model is extended by including:

- i.* the ratio of costs per person over/under 65, and
- ii.* the fraction of total population age ≥ 65 .

$$(\$Share \geq 65) = (\text{medical share of GDP}) \times (\% \text{ age } \geq 65) \times (\text{cost ratio})$$

Retrospective analysis is provided in Table 1 on page 22. Reliable data on spending by age group are difficult to come by, and availability dictates the choice of years to measure growth in relative costs. The first line presents previous results: The share of GDP quadrupled from 4 percent to 16 percent from 1953–2004, an annualized rate of growth in share (excess costs) of +2.7 percent. Population estimates from the Census Bureau are shown in the second line: The percentage age ≥ 65 rose from 8.5 percent in 1953 to 12.2 percent in 1987 and 12.4 percent in 2004, indicating



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CONTINUED ON PAGE 22

Table 1. Cost of Medical Care for the Elderly					
	1953	1963	1987	2004	Growth '53-'04
National health expenditure share of GDP	.041	.057	.110	.160	2.7%
% Pop ≥65	8.5%	9.4%	12.2%	12.4%	0.7%
\$ per capita ≥65	\$109	\$299	\$5,830	\$14,797	
\$ per capita <65	\$65	\$127	\$1,088	\$3,953	
in nominal 2009 dollars					
cost ratio old:young	1.7	2.4	5.4	3.7	1.6%
% \$ spending ≥65	13%	20%	43%	35%	1.9%
≥65 share of GDP	.006	.011	.047	.055	4.6%
≥65 \$ (billions)	\$2.1	\$6.9	\$222	\$657	11.9%

that the rise in the fraction of the elderly population had been almost negligibly small in the most recent years, and averaged only 0.7 percent per year over the entire 50-year period. Expenditures on the elderly had already begun to rise rapidly before the advent of Medicare in 1965, but then soared to 536 percent of the average cost for younger people in 1987. Since then, however, medical costs for older people continued to rise but less rapidly than average costs for younger people. Moderation in annual cost increases is particularly evident at advanced ages (75+ and 85+, not shown here).

As with health care spending in general, the main factor driving expenditures on care of the elderly is the growth of the overall economy. The 11.9 percent annualized rate of increase from 1953–2004 can be decomposed as growth of GDP, growth in the share of GDP devoted to medical care and growth in the percentage of health spending attributable to

the elderly. Just as the annualized rate of growth in GDP (7.0 percent) can be decomposed into components of real incomes per capita (+2.1 percent), inflation (+3.6 percent) and population (+1.2 percent) as shown in Table 2, the rise in the percentage of health care costs attributable to the elderly can be decomposed into growth in the fraction of population age ≥65 (0.7 percent) and growth in the ratio of cost per elderly person relative to the mean (+1.2 percent).¹

The rate of increase in spending for the elderly was more than twice as rapid during the first half of this period than the second half (14.7 percent vs. 6.6 percent). Population aging decelerated, but the main factor causing the change in trend was a reduction in relative spending on the elderly (cost ratio), which was 1.7 in 1953, rose rapidly to 5.4 by 1987 and then fell to 3.7 in 2004.

Forecast Application: Estimating Future Expenditure Liabilities

As shown in the first line of Table 3, extrapolation using the annual excess cost growth rate (+1 percent) implicit in the most recent Centers for Medicare and Medicaid Services (CMS) Office of the Actuary national health expenditure (NHE) projections yields a rise in projected health spending from 17.9 percent of GDP in 2012 to 26.3 percent by 2050 (Getzen 2013). Census Bureau

Table 2. Annual Rate of Growth in Health Spending Age ≥65, 1953–2004			
	2.1%	Real income per capita	
	3.6	Inflation	
GDP	1.2	Population	(7.0%)
Medical	2.7	Health share ("excess")	(9.9%)
	0.7	% Population age ≥65	
≥65 Medical	1.2	\$ cost ratio old:average	(11.9%)

midline projections indicate that the fraction of the population age ≥ 65 will rise from 14 percent to 21 percent as shown in the second line. If the cost ratio old:young remains at 3.74 as it was when last estimated (in 2004), then the percentage of health expenditures attributable to age ≥ 65 will rise from 37 percent in 2012 to 46 percent in 2025, and reach 50 percent by 2050. Spending on the elderly would grow more than tenfold to \$13 trillion in 2050, more than 13 percent of GDP.

Uncertainties and Limitations of the Macro Model

Assuming that medical costs for people age ≥ 65 relative to those under 65 remains at 3.7:1 is a large and uncertain if. In the previous five decades, the ratio has ranged from 1.7 to 5.4. The baseline projection implies 50 percent of total health expenditures would be for those age ≥ 65 by 2050. This percentage would decline to 40 percent if the ratio were 2.5, and rise to 54 percent if the ratio were 4.5. The top and bottom of the historical range would indicate even larger shifts. Although future cost ratios that depend on the vagaries of a complex health system and the whims of legislators can be expected to move somewhat unpredictably within a sizable range, the essential demographic factors (population growth and fraction of the population age ≥ 65) are much less uncertain and lie within a much smaller range, even out to 2050 and beyond. Current census bureau projections for the proportion age ≥ 65 in 2060 has a low of 21.3 percent and high of 22.6 percent, a range of just ± 0.7 percent.

The rate of increase in national health expenditures in excess of GDP is likely to be the second largest source of uncertainty. The most recent CMS estimate for excess growth in medical costs averaged +1 percent for the next 10 years, which is used as a default baseline here. However, anything from +0.5 percent to +2.5 percent can be quite reasonably defended. A quantification of the range of uncertainty is speculative at this point, but the likelihood of being inside that defensible range is probably on the order of 90 percent (Getzen 2013). Uncertainty regarding the rate of growth in GDP is perhaps even larger, and certainly more important in terms of

	<u>2012</u>	<u>2025</u>	<u>2050</u>
Health (NHE) share of GDP	.179	.205	.263
% Pop age ≥ 65	13.8%	18.8%	20.9%
cost ratio old:young	3.74	3.74	3.74
% \$ spending ≥ 65	37%	46%	50%
≥ 65 share of GDP	.067	.095	.131
≥ 65 \$ (billions)	\$1,062	\$2,832	\$13,202

public welfare, but falls outside the scope of health care forecasting. The CMS projected rate of long-run growth in real income per capita of 1.4 percent is reasonable as an estimate of central tendency, but the average actual rate exceeded 2.0 percent for the last half of the 20th century, and the recent recession has so shaken the confidence of some economists that they predict long-run average growth of just 1 percent or less. Inflation, assumed by CMS to lie mostly between 1 percent and 4 percent, is generally considered to be almost unpredictable over the long run. It is also essentially irrelevant to the extent that prices, costs, wages, taxes and so on all move together and hence do not materially affect “real” resource use or growth in the long run.

This forecast of future health spending for the elderly depends heavily on two distributional parameters, what share of total resources available should be spent on health (health share of GDP) and what fraction of that health spending should be devoted to the elderly (percent of health care spending for those ≥ 65). Both are determined primarily by politics and social choice rather than demographics or biology.

What Effect Will the ACA Have on Health Spending Trends?

From a long-run macro perspective, legislation such as the Home Maintenance Organization (HMO) Act of 1973, Tax Equity and Fiscal Responsibility Act (TEFRA) of 1982, Employee Retirement Income Security Act (ERISA) of 1974 and the Affordable Care Act (ACA) of 2010 are part of the

process by which spending is managed. They are visible traces of internal workings within a complex system that shape costs to conform with underlying economic, demographic and technological trends in ways that people want. Unlike earthquakes, floods or asteroids, they are not random external events that strike, suddenly shifting resources to cover a loss. Every law has effects, but the enactment and effects depend on forces in play at that time and place, much as the influence of Thomas Jefferson, Abraham Lincoln or Adolf Hitler depended upon the forces in play when they were elected. Medicare is a useful example of the process. While certainly raising spending, it did so within the context of an expanding economy, the ascent of academic medicine, public faith in the power of advancing medical technology, and provider supply strengthened by Hill-Burton Act of 1946 and the Health Professions Act of 1963. These underlying forces had begun to push spending up well before Medicare was enacted. Most legislation shapes continuing trends with only gradual movement up or down. Medicare marked a change in trend—but it was a change already taking place. Medical historians similarly use a single event, publication of the Flexner Report of 1910, as the marker for a revolution in the education of doctors and the social and scientific practice of medicine that was already taking place and continued for years afterward.

Will the ACA eventually come to be seen as marking a turning point like Medicare and the Flexner Report? That depends on history. It also depends on how well the ACA is made to conform to current conditions, or if the act is replaced. “Bending the curve” may ultimately be considered to have started in 1983 or 1994 or 2008 rather than 2014, or as not starting until 2025. What is clear is that excess cost growth and relative per capita spending on the elderly has been mostly slowing down over the last 20 years.

Micro or macro? When to use national aggregates and when to use detailed demographic and biological categories

Macro models are useful when a major element of the total system is more predictable than the

individual parts. National health expenditures are well suited to macro modeling because they are allocations of income subject to a budget constraint imposed at the national level, rather than the outcome of individual illnesses or decisions subject mainly to individual budget constraints. Mortality and illness may be individual events, but spending on them is not. The purpose of medical insurance is to aggregate losses and pass the budget constraint on to a larger group (Getzen 2006).

A budget constraint means that errors are not independent, or independently distributed, but are forced in aggregate to sum exactly to 0; no more, no less. A patient seeking treatment is usually no more aware of this constraint on total resources (hospital beds, doctors) than a person buying 18th century chairs, gallons of gasoline or gold krugerrands is aware of total constraints on those items. Individuals experience only how much of their own personal income must be used to obtain an item for themselves, not how much is available in aggregate.

Many projections for the cost of health care begin at the individual level, creating detailed weights by age, sex and morbidity category, multiplying each by a specific disease incidence rate, and then by a cost per illness episode. Finally, costs are summed across categories and types of illnesses and then extrapolated using a general price inflator as in the equation below.

$$\text{Total \$ Cost} = \sum(\text{age, sex, morbidity category}) \times (\text{incidence rates}) \times (\text{cost per case}) \times (\text{future CPI})$$

Such models may encompass hundreds or even thousands of computations, although it has become common to estimate the cost for just one disease (diabetes, stroke, HIV), type of patient (hospice, obese, bp>140) or provider (ambulatory surgery centers, emergency rooms, MRI facilities) in isolation. A primary weakness of category decomposition models is that the current detailed estimates for weights, rates and itemized costs must all be assumed stable, and then be extrapolated into the future using a multiplier for expected average increase per year—a multiplier that is usually more uncertain and has larger effects on the total than most changes in the projected mix of weights, rates and costs. Categorical extrapolations tend to focus

Table 4. Advantages of Macro Health Modeling

- A. Accuracy is better (especially when forecasting rather than backcasting)
- B. Empirically sounder, incorporating the central budget constraint
- C. Focuses attention on the system, not the parts
- D. Clarifies the essential choices (What share of GDP? What percent for the elderly?)
- E. Concentrates on largest sources of uncertainty
- F. Highlights policy-relevant variables rather than technical details or immutable facts
- G. Simplification allows time for thought, analysis of long-run determinants and disturbances

on individuals and components rather than the system, and may thus skip over a core fact about spending: budgets matter, and budgets matter absolutely in long-run aggregate totals. To the extent that a forecast is concerned only with a tiny sliver, spending just on MRIs, Oxycontin or BMWs for example, then the aggregate constraint can sometimes be usefully ignored. Budgets cannot be ignored if the expenditure is for a large share, like the 20 percent that will be spent on health care, or even for the half of that amount which will be spent on the elderly. Of course most issues and policy questions benefit from a combination of micro and macro perspectives, selectively combining the strengths of each.

The macro forecast model used here has three elements: the amount of money spent each year (GDP), the share of that spent on health (share), and the fraction of the health share devoted to the elderly (percent of health care spending on those ≥ 65). This model simplifies and abstracts away from many fascinating details regarding MRIs, microbes, doctors, patients, triple-tiered reimbursement schemes and price transparency. It forces the analyst to concentrate on the system as a whole rather than the individual parts. Such simplification might not be worthwhile if it did not lead to a considerable improvement in accuracy—which it does, routinely yielding far more accurate and comprehensible results than the many intricate large-scale demographic projections of cost by disease category (Getzen 2000, 2006). ■

END NOTES

¹ Decomposition of a compound rate means that the annual percent growth rates must be multiplied, rather than simply added, and the appropriate multiplier for the cost ratio is the ratio relative to the average, which depends upon the fraction of the population age ≥ 65 as well as the over:under cost ratio.

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Behavioral Finance Concepts for Actuaries

By John Stark



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In our work as actuaries, we have always embedded assumptions about the behavior of people and firms, often implicitly. These assumptions range from the effects of cost sharing on consumer-purchasing behavior to how a sales force will market a new product. As the behavioral finance literature becomes better known and understood, we will have to make our behavioral assumptions more explicit—and change some of our beliefs.

A good example is adverse selection. Traditionally, actuaries have assumed people purchase health insurance that best suits their needs by calling on their superior knowledge of their physical and emotional well-being. This has led us to explicitly consider this selection and price richer products much higher than their cost-sharing differences. However, considering the complexity and the difficulty in truly understanding the richness of benefit design and the significant costs of health benefits, does this concept hold up? Should we assume consumers can choose the best product—and that they can afford it? If consumers need a rich product but cannot afford it, then they will choose a lower benefit product. This can result in a risk pool of members whose health is poorer than our standard adverse selection theory suggests. Similarly, if consumers do not comprehend the products available to them, they may choose more randomly than we anticipate, resulting in risk pools different than those assumed in pricing the products.

Wellness and disease management programs provide additional examples. The goal of these programs is to change behavior in order to have a healthier risk pool, thereby improving member health, reducing claims cost and potentially reducing product prices. Actuaries are asked to help design these programs (including participant incentives), to assess potential program effectiveness, and to determine how the programs affect pricing and financial results. A critical part of the actuary's job is to understand how people learn and what motivates them to make changes in their lives, and then to incorporate these behaviors into program design and potential effects. For example, if a program that requires participants to make significant lifestyle changes uses mailings and gift card incentives as the vehicle for change, the actuary may decide the program will fail or will

take much longer than anticipated to achieve the desired results.

To improve the explicit recognition of behavior in our work, actuaries can learn much from the relatively new field of behavioral finance. In the remainder of this article, I will describe seven results from behavioral finance that actuaries may find useful: heuristics, the endowment effect, loss aversion, prospect theory, satisficing, strategic thinking and agent-based modeling.

Heuristics

In his book *Thinking, Fast and Slow*, Daniel Kahneman discusses heuristics and a related concept called substitution: If we cannot answer a hard question quickly, we will identify an easier question and answer that one (i.e., substituting one question for another). He calls the simpler question, the heuristic question. Kahneman defines heuristic as “a simple procedure that helps find adequate, though often imperfect, answers to difficult questions.” If consumers are trying to make a decision about something as hard to understand as health insurance, would this be a fair representation of the way they might choose a policy? Information about consumer heuristics could help actuaries design materials and processes to aid consumers in choosing appropriate policies. Also, such information would help actuaries ensure that pricing assumptions are reflected in marketing strategy.

Endowment effect

Richard Thaler coined the term “endowment effect” to describe the phenomenon that people do not want to give up assets—or relationships—they possess. This phenomenon is a type of inertia, and may apply when people have to decide whether to change insurance coverage or change physicians. If actuaries and network managers could measure this effect, they would have a better understanding of how members would respond to policy changes, and how such behavior might affect risk pools, physician reimbursement and premiums.

Loss aversion

It has also been found that the anxiety associated with losing a given amount of money is generally



greater than the enjoyment derived from winning the same amount. This phenomenon is called “loss aversion.” When considering alternatives with the same expected value, it makes people desire the status quo. This is another measure of inertia. Interestingly, people begin to take risks only when all options are bad. Thus, it is important for actuaries to assess situations in which people must make choices and to understand how they may perceive the alternatives.

Prospect theory

In response to problems they found when trying to explain behavior using classical utility theory, Daniel Kahneman and Amos Tversky developed prospect theory. Their seminal paper, “Prospect Theory: An Analysis of Decision under Risk,” gives many insights into different aspects of risk. Prospect theory describes how people decide between alternatives when the probability of each alternative is known. The theory also describes how decisions are based on relative amounts (i.e., gains or losses) as opposed to final outcomes. These decisions are based on heuristics rather than detailed review of the information.

Given a set of assumptions for a given risk, using prospect theory may give unexpected results. For example, during provider negotiations, how is a change in an offer by an insurer viewed? If the providers make decisions based on the incremental

change of the offer and the insurer assumes they are only interested in the final aggregate result, the negotiations could drag out and cause disruptions for both parties.

Satisficing

In 1956, Herbert Simon coined the term “satisficing.” His intent was to capture the fact that we as humans do not have the cognitive resources to optimize when making decisions. As a result, a person may select the first option that satisfies a need or may choose the option that appears to satisfy most of the decision criteria. As a product design team considers how prospective buyers will make decisions, it is good to keep this concept in mind.

Strategic thinking

Strategic thinking takes actuaries into the realm of game theory. Game theory could be especially helpful for actuaries working in the areas of provider negotiations and the design of provider incentives.

The four main components of a game are the players, payoffs, strategies and information.

As insurers enter into talks with providers over new reimbursement schedules, actuaries can actually map out different strategies and analyze them using game theoretic concepts. Determining how the four

CONTINUED ON PAGE 28

components apply can be useful and enlightening. For example, there are cases where the payoffs are not only monetary but can be reduced medical management. Actuaries are uniquely qualified to blend these qualitative and quantitative components.

Classical game theory suffers from the fact that it depends on concepts which use classical ideas of rational behavior that behavioral finance has called into question. However, Colin Camerer’s *Behavioral Game Theory: Experiments in Strategic Interaction* compares theoretical game theory results to experimental results in areas such as bargaining. Actuaries who want a basic understanding of game theory should read *Game Theory for Applied Economists* by Robert Gibbons.

The table below is a simple two-person game in which players choose their strategies simultaneously. The entries are pairs where the first element is the payoff for Player 1 and the second is the payoff for Player 2. Also, the row and column headings represent the strategies for each player.

Since the payoffs for Player 2 are always higher for strategy N, he/she will always play that strategy. This is a dominant strategy and Player 1 will have to pick the strategy that gives him/her the best result when Player 2 plays N. In games where the moves are sequential, it is important to know how far ahead players think. For example, if players must think five moves ahead to reach the theoretical equilibrium, experiments show they can think only three moves ahead. Thus the real-world solution becomes very different from the theoretically optimal solution.

		Player 2		
		Strategies	L	M
Player 1	A	1, 1	-1, 2	3, 3
	B	-2, 3	2, 1	-1, 4
	C	2, -4	3, 4	-3, 5

Agent-based modeling

Agent-based modeling (ABM) is an excellent tool for actuaries to use to analyze complex situations involving a variety of agents that must interact to attain their goals. ABM has been around for many

years and has an established track record. Agents can be individuals or organizations and the model allows the user to establish behaviors and goals for each agent as well as how the agents interact. For more information on this topic, and how it can be applied in health care, see the recent Society of Actuaries’ (SOA) research project from Alan Mills, “Simulating Health Behavior: A Guide to Solving Complex Health System Problems With Agent-Based Simulation Modeling.”

ABM is a tool that can be used to analyze many of the items discussed above. In Mills’ research project, there are examples of ABM applied to adverse selection and provider network dynamics. These models contain a wealth of detail and include the behaviors of a wide variety of stakeholders including members, insurers, providers and regulators.

As a first step to improve our recognition of behavior, actuaries can document the behavioral assumptions that they use. Next, see if there are ways to track the validity of these assumptions, as we track the validity of other parameters such as trends. Also, becoming familiar with behavioral finance concepts will lead actuaries into more fertile, non-traditional areas.

In conclusion

Actuaries are well-versed in the study of different types of risk and in the design of risk management systems. Human behavior in the face of risk is a crucial factor that we should try to include in our work. Looking back over some of the financial crises of the past several decades, we see there were certain behaviors associated with each one. Being able to detect risky behaviors and to determine how they affect our organizations, our society and our financial systems would be an important next step in the evolution of actuaries. Behavioral finance contains valuable tools we can use to further this goal. ■

Additional resources about these topics can be found on the Behavioral Finance portion of the Health Section webpage.

On The Research Front

NEW REPORT EXPLORES FUTURE COSTS OF THE CANADIAN HEALTH CARE SYSTEM

The Society of Actuaries and Canadian Institute of Actuaries sponsored research on the Canadian health care system. Performed by Stéphane Levert, FSA, FCIA, the study estimated the future costs of the Canadian health care system, assessed the sustainability of the system over a 25-year horizon and analyzed the implications of the changes to the Canada Health Transfer proposed on Dec. 19, 2011, by the federal government.

<http://www.soa.org/Canadian-Health-Care-Sustainability/>

NEW REPORT: ISSUES IN APPLYING CREDIBILITY TO GROUP LTD INSURANCE

The Society of Actuaries Health Section has released a research report examining issues in applying credibility to group long-term disability (LTD) insurance. The report, authored by Paul Correia of Milliman, provides background information on the use of credibility in LTD insurance and its challenges. As part of the research, a survey was conducted of 11 LTD insurers and state regulators to gather information on how credibility is currently being applied. The report also includes discussion of actuarial guidelines governing the use of credibility in LTD. A follow-up project is currently under consideration.

<http://www.soa.org/Research/Research-Projects/Disability/research-2013-iss-app-cred.aspx>



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The Impact of Family Structure on Spare Capacity and Health Care Utilization

by Philip Castevens

Occasionally, my business partner (actuary Carlton Harker) and I research the health care claims history of some of our third party administrator (TPA) databases to see if our family tier ratios need adjusting. As I analyzed the data of one mid-sized TPA recently, I noticed some surprising findings: The employee-plus-spouse ratio seemed extremely high and the employee-plus-children ratio seemed extremely low. I wondered what was going on, especially with the adults in these families.

After analyzing the more obvious factors, there was still a significant unexplained effect, so I turned to behavioral economics. I was intrigued by the idea that people's priorities are affected by the amount of time, social support and free attention (what I call "spare capacity") they have on their hands. And I found that Ross, Mirowsky and Goldstein¹¹ had already documented the relationship between family structure and many of these social factors. In this article, I will use my TPA study and references to other studies to explore the relationships between family structure, spare capacity and health care utilization.

Spare Capacity

The Cambridge Business English Dictionary¹⁶ defines spare capacity as:

The ability of a factory, company or industry to produce more of a product than is now being produced.

It has most commonly been used in relation to crude oil production, especially concerning OPEC. Kahneman used this term in a slightly different way. He defines a capacity model for attention (rather than oil) and then defines spare capacity as the difference between total capacity of an individual and the capacity currently supplied to high priority tasks. "Spare capacity decreases as the effort invested in the primary task increases: attention is withdrawn from perceptual monitoring and concentrated on the main task."²¹ In *Thinking, Fast and Slow*, Kahneman says people's response to mental overload is to protect "the most important activity, so it receives the attention it needs; 'spare capacity' is allocated second by second to other tasks."²⁴

For this article, I will use spare capacity in a similar but broader way, adding social support in addition to attention, so that it becomes a more general measure of one's available energy resources.

Wills distinguishes four functions that are part of social support:¹⁵

1. Esteem or emotional support
2. Informational support, which may include problem-solving and learning new skills
3. Instrumental or tangible support, which may include time and money
4. Companionship

For this article, I will refer to spare capacity as the amount of available attention and social support a person has in their day-to-day life.

First, we'll take a look at the TPA study to explore the effects of the family structure on health care costs, and then we will consider the impact of the family structure on the spare capacity available to the adults in the family.

TPA Study

The TPA study I performed consisted of more than 2 million claims (more than \$347 million) from more than 200 self-funded plans for employers mainly in the southeastern United States. Most of these plans covered fewer than 500 employees each. More than 42,000 employees and 32,000 dependents were included in the study.

Here are some per-employee averages from the study.

Age:	43.5 (59% male)
Age of spouse:	45.8 (28% male)
Age of children:	12.7 (51% male)
Family size:	1.77
With spouses:	28%
With children:	25%

See Appendix III: Health Care Claims by Age from the TPA Study for a detailed look at the annual health care expenses per person.



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CONTINUED ON PAGE 32

Below are the unadjusted family tier claim cost ratios from the study. Note that “EE” means employee.

Family Tier	Number of EEs	Ratio to EE-Only
Employee only	26,925	1.00
Employee/child(ren)	2,485	1.25
Employee/spouse	2,504	3.76
Family	10,441	3.09

The raw data from which the ratios above were obtained consisted of healthy and nonhealthy members of self-funded health care plans. The claims used above were not adjusted for age and gender differences. The value that jumps out is the employee/spouse ratio of 3.76 because most would tend to assume the health care costs of two adults would be only about twice that of one adult. Bohn reported a ratio of 2.751 from a similar population.²

Marriage and parenthood. After adjusting for certain obvious confounding factors, such as age and gender, I observed that married people spent an average of 24 percent more on health care than unmarried people (see Appendix I on page 35 for details). I also found that employees with children spent an average of 10 percent less on themselves than employees without children. I will look at marriage in more detail below. Throughout this article, I include details concerning my analysis of marriage’s effect on health care costs. I use similar methods to analyze the effects of parenthood on health care costs, though the analysis details are omitted from this article.

Employment. I also observed a strong negative employment effect; that is, workers tend to have lower health care costs than their unemployed spouses. However, I discovered that most of this difference is likely due to ill health, as opposed to spare capacity. Employment does seem to increase certain aspects of spare capacity, such as tangible support, but decreases others such as time and attention for body awareness and trips to the doctor. Thus, there may be a small positive or negative net employment effect due to spare capacity but if there is one, it

is less obvious than with marriage and parenting. More data and much work would have to be done to measure how much (if any) difference employment has on health care utilization.

Impact of Marriage and Parenthood on Health Care Utilization

Marriage. In addition to the TPA study, there are consistent and significant results from the U.S. Department of Labor’s Consumer Expenditure (CE) Survey indicating higher health care expenses for married people than for singles, after adjusting for age, gender and size of consumer unit. For example, the 2012 CE Survey¹² indicates higher (13 percent) health care expenses for married people (see Appendix II on page 37 for more details). In fact, almost all of the research I could find supports the hypothesis that married people spend more on health care than nonmarried people. Here is a sampling of the conclusions from such studies.

- Single people in their 20s tend to spend less on health care than do married people of the same age.⁸
- “Married persons were more likely than unmarried persons to report ever having undergone a colorectal endoscopy exam,” according to a 2012 study on people over the age of 50.⁹
- The Commonwealth Fund reported that single men between the ages of 18 and 64 had 33 percent less utilization of the health care system than married men.¹⁰ For further support of this conclusion, see Figure 4 at the end of Appendix I for a table by age and gender.
- Married people are more likely to seek checkups, screening and other early detection services than nonmarried people with the same symptoms, functioning and general level of health.¹¹

In fact, I could not find any study against the claim that married people spend more on health care.

Parenthood. Similar to the marriage effect, there are consistent and significant results from the CE Survey indicating lower health care expenses for



parents than for nonparents, after adjusting for age, gender and the size of the consumer unit. For example, the CE Survey¹² indicates much lower (20 percent) health care expenses for parents than for nonparents. This is an even stronger effect than I found in my study (10 percent). I could not find much research that studied the impact of parenting on health care utilization. What I have found indicates parents spend less on their own health care than nonparents, all other things being equal.

Impact of Marriage and Parenthood on Spare Capacity

There is strong evidence that marriage and parenthood affect the amount of spare capacity. Ross, Mirowsky and Goldsteen address this in their article,¹¹ and although they do not use the term spare capacity, their extensive analysis focuses on how marriage and parenthood affect social support and economic well-being, both important aspects of spare capacity.

Marriage. It makes sense that married people will generally have more time and money to go to the doctor and take care of their health problems, since the responsibilities of working and household chores are shared with another person. Division of labor reduces the “basic tasks” for each partner. Further, married people tend to have more informational and emotional support because their

partner can often spot trouble better than they can themselves.⁷ These factors tend to increase the total capacity of married people.

The hypothesis that marriage increases spare capacity is also supported by research. According to Ross, Mirowsky and Goldsteen,¹¹ marriage increases the health of the partners by increasing social support:

Social support is the commitment, caring, advice, and aid provided in personal relationships. It has several dimensions, including emotional and instrumental support. Marriage typically provides social support of all forms—particularly the emotional element.

and economic well-being:

Married people have higher household incomes than the nonmarried.

Parenthood. Kristi Bohn’s recent study on this topic had a much larger sample and showed how “the adults on the employee-only and employee-plus-spouse contracts were much more expensive than the adults on the contracts with children.” She hypothesized that “parents of multiple children have less time and money to take themselves and their children to the doctor.”²² In other words, it makes sense that parenthood reduces spare capacity, all other things being equal. According to Ross, Mirowsky and Goldsteen,¹¹ parenthood tends to

There seems to be a strong correlation between health care utilization and spare capacity. If spare capacity goes up or down, then health care utilization goes up or down respectively.

decrease social support and physical, psychological and economic well-being:

Children do not generally improve the psychological well-being of parents. ... People with children at home do not have higher levels of well-being than nonparents.

Two explanations stand out: children increase economic hardships on families, and children decrease the amount of emotional support that spouses receive from each other. Economic well-being and social support reduce the detrimental impact of children on the health and well-being of parents, but children deplete those very resources (providing an example of structural amplification).

It is informative to look at the effect the number of children has on the average claims cost of employees. The data below is from my study, and is adjusted for age, gender and health status. The parenting effect is relative to those employees on single contracts.

Family Tier	Parenting Effect
Employee/1 child	-7%
Employee/2 children	-11%
Employee/3 children	-14%
Employee/4+ children	-23%

The more children in the family, the less claims the parent had. This supports the compelling behavioral argument that the more parenting responsibilities the adult has, the less spare capacity and health care utilization they have.

Confounding Factors

There seems to be a strong correlation between health care utilization and spare capacity. If spare capacity goes up or down, then health care utilization goes up or down respectively. However, it is possible there are other selective characteristics of married people and parents that cause the correlation with health care utilization. For example, it may be that married people tend to have a more extensive social network even before they marry

and this extensive social network correlates to increased health care utilization. However, Ross, Mirowsky and Goldstein, in studying the effects of marriage, found that although there may be some selection before marriage, it is the effects of marriage itself, mainly through social support and economic well-being, that accounts for more of the association.¹¹ In this sense, marriage itself seems to bring more spare capacity to couples' lives.

Impact of Spare Capacity on Health Care Utilization

It is difficult to argue against the notion that, all things being equal, having more spare capacity will result in higher health care utilization. If people have less time and money, then they will tend to go to the doctor less. There is a general sense that spare capacity has a direct effect on health care utilization. For example, it is generally accepted that factors such as "income, insurance, time and inclination" influence the frequency of doctor visits.¹¹

It is not so much a question of whether spare capacity influences health care utilization, but rather by how much. If we take into account the possibility of confounding factors, we can say that spare capacity may have an effect of as much as 24 percent on health care spending in the case of marriage. For parenthood, spare capacity may account for as much as 10 percent of the decrease in health care expenditures. Additional work would need to be done to fix more exact numbers with confidence. Also, note that Kahneman says that (mental) spare capacity is allocated second by second.⁴ With health insurance, it is year by year.

Implications to Setting Tier Ratios

There are possible implications of these findings to plan design, marketing, risk adjustment and compliance. In this article, I only consider some implications relevant to family tiering structure alternatives. In the TPA study, I was able to calculate some averages based on common family tiering structure alternatives.

Family Tier	Average Family Size	Tier Ratio
Employee only	1.00	1.00
Employee/child(ren)	2.74	1.47
Employee/spouse	2.00	2.44
Family	3.46	2.76
Employee/1 child	2.00	1.22
Employee/2 children	3.00	1.45
Employee/3 children	4.00	1.67
Employee/4+ children	5.25	1.73

The data from which the tier ratios above were estimated reflects adjustments for age and gender differences, with some minor smoothing performed. As demonstrated above, spare capacity significantly impacts the tier ratios. Experiential data does not always reflect the intuitive building block approach used to create claims cost expectations. However, some of these ratios are surprisingly close to the ratios used in premium rating (the family tier, for example). Overall, there are practical limits that come into play when setting rates. In particular, it is unlikely the employee/spouse premium will ever be set at 244 percent of the employee-only premium; a more practical ratio for the employee/spouse tier is 2.00. Employers tend to partially make up for the additional cost of spouses through their premium subsidization policy, rather than through their calibration of family tiers.

Conclusion

Marriage has been observed to increase health care utilization by 24 percent, while parenthood has been observed to decrease health care utilization by 10 percent. Marriage and parenthood have been reported to increase and decrease spare capacity, respectively. There is a positive correlation between

spare capacity and health care utilization. These relationships may be a common and understandable response to the simple situational demands on the population, including limited time, money, attention and support available for doctor visits and other medical services. Family structures' impact on health care utilization may be an important next step for inclusion in risk adjustment methodologies, since it seems to play an important additional predictor of health care cost.

Appendix I. Marriage and my TPA Study (Details of Analysis)

What effect does marriage have on health care costs? The most straightforward comparison I could make from the results of the TPA study for this question was between employees with the following tier coverages:

employee-plus-spouse vs. employee-only

By comparing these two kinds of employees without covered children, I tried to avoid any biases due to parenting or employment.

From the TPA study, I found that the total average annual claims amount per employee with employee-plus-spouse coverage was \$5,736 (67 percent male, average age 52, 100 percent married), while the average claims for employee-only coverage was \$3,632 (52 percent male, average age 43, 91.5 percent single).

I will first adjust for the gender and age differences and then make an adjustment for the fact that the employee-only people are "only" 91.5 percent single.

GENDER ADJUSTMENT

It has been observed that per capita health care spending for females is about 30 percent higher than for males⁵ and that "per capita differences were most pronounced among the working-age population, largely because of spending for maternity care."⁶ So, to remove this gender bias, I normalized the

employee-plus-spouse amount, which comes from a sample with 67 percent males, to a “gender neutral” (50/50) value, as follows:

$$\frac{(.50)(1) + (.50)(1.3)}{(.67)(1) + (.33)(1.3)} \times (5,736) = \$6,002$$

In a similar manner, I also normalized the \$3,632 (which comes from a sample with 52 percent males) to its gender-neutral equivalent: \$3,664.

AGE ADJUSTMENT

Then I adjusted for the significant difference in age—the employee-only employees have an average age of 43, while the employee-plus-spouse employees have an average age of 52. As Bohn noted in her article, adults with no children covered may be older, because it is likely their children have grown up and are no longer covered under their parents’ plan (although this is changing somewhat with the age-26 student status provision of the Affordable Care Act).

To adjust for age, I used the ratio:

$$\frac{C_{52}}{C_{43}} = \frac{4,832}{3,591} = 1.35$$

where C₄₃ and C₅₂ are the average annual expenses for ages 43 and 52, taken from the TPA study (the same population we are studying). If I now adjust the employee-only value for age, then it becomes \$3,664 x 1.35 = \$4,946.

ADJUSTMENT FOR THE EFFECT OF THE MARRIED WITH EMPLOYEE-ONLY COVERAGE

The database of the TPA study contains the marital status and I used it to calculate 91.5 percent as the percentage of single employee-only. Therefore, if I let CR = Claims Ratio of married/single, then when I solve for CR in the formula below,

$$4,946 = (.915) (6,002/CR) + (.085)(6,002),$$

I see that CR = 1.24. In other words, for the TPA study, married people spent 24 percent more than unmarried people of the same age and gender, on average.

CONFIDENCE INTERVAL (CI) AND STATISTICAL SIGNIFICANCE

First, I needed to adjust the employee-plus-spouse value to its 100 percent unmarried equivalent: \$6,002/1.24 = \$4,840. Then I performed 100,000 Monte Carlo simulation trials using the single and married mean claim amounts, \$4,840 and \$6,002, and their respective sample sizes, N = 27,000 and N = 2,500. I used the lognormal probability distribution for annual claims per person, and a standard deviation of 4.5 times the mean, which was observed in the population.

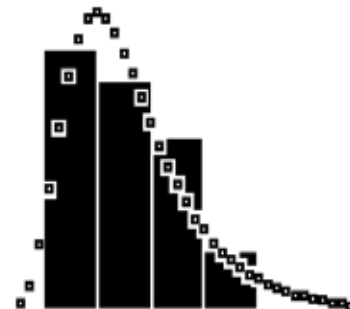


Figure 3. Lognormal distribution. I have found that, among several distributions tested, the lognormal distribution is the best fit for the claims data based on the chi-square and Kolmogorov–Smirnov tests.

I found that in 95 percent of the trials, the claims ratio was between 1.00 and 1.45. Thus there is a high level of confidence in the hypothesis that there is a positive marriage effect.

**Observed Marriage Effect:
24% and 1.00 < CR < 1.45 (95% CI)**

I also tested the “null hypothesis” that this 24 percent difference happened by chance and found this chance is less than 1 percent; that is, the “observed significance level” (P-value) is P < 1 percent. Therefore, it is not only statistically significant, it is “highly significant.”

THE MARRIAGE EFFECT BY AGE AND GENDER

The marriage effect in the TPA study is much stronger for men than for women and for young adults than for older adults, as shown in the following subgroup results.

Ages	Males	Females
21–42	+61%	+18%
43–64	+26%	+9%

Figure 4. The marriage effect by age and gender

Appendix II. Marriage and the Consumer Expenditure Survey (Details of Analysis)

From the 2012 CE Survey,¹² I compared the “Husband and wife only” column with the “Single person and other consumer units” column. Like with my TPA study, by comparing these two kinds of consumer units without children, I tried to avoid any biases due to parenting. Even so, I was unable to eliminate as many possibly confounding factors. “Other consumer units” include dependents and “husband and wife” units include the reference person (the one who owns the house or pays the rent) and the spouses, who appear to be mostly unemployed—since there are 1.2 earners (out of 2) in this consumer unit, this makes me think that 80 percent of these spouses are unemployed.

TOTAL ANNUAL HEALTH CARE EXPENDITURES PER PERSON

The husband-and-wife “Average number in consumer unit” is 2.0, so the average annual health care expenditures per person in the “Husband and wife” class was $\$5,407/2 = \$2,704$ (55 percent male, average age 58, 100 percent married). Note that this \$5,407 also includes the average health care expenses of the spouse. The single-person “Average number in consumer unit” is 1.7. We want the expenses of just the single person, not the other .7 people in the consumer unit. Most of this .7 is made up of children under 18 (.2) and people 65 and

older (.3). Because of the lower costs associated with children and the fact that people 65 and older are covered under Medicare, I am going to assume their costs are less than 100 percent of the adult single person. So the average annual health care expenditures per person in the “Single person” class was between the full \$2,430 and $\$2,430/1.7 = \$1,429$ (44 percent male, average age 51, 100 percent single). For simplicity, I will use the midpoint of this range: \$1,930. I will now adjust for the gender and age differences.

GENDER ADJUSTMENT

As above, to remove the gender bias, I normalized the single-person amounts to “gender neutral” (50/50) values.

$$\frac{(.50)(1) + (.50)(1.3)}{(.44)(1) + (.56)(1.3)} \times (1,930) = \$1,897$$

Note the husband-and-wife value is already gender neutral because it includes the averaged health care expenditures for exactly one adult male and one adult female.

AGE ADJUSTMENT

Then I adjusted for the difference in age—the single-person people have an average age of 51, while the husband-and-wife people have an average age of 58.

To adjust for age, I used the ratio:

$$\frac{C_{58}}{C_{51}} = \frac{5,805}{4,609} = 1.26$$

where C_{58} and C_{51} are the average annual expenses for ages 58 and 51, taken from the TPA study (see Appendix III). If I now adjust the single-person value for age, then it becomes $\$1,897 \times 1.26 = \$2,390$. Note that 58 is the average age of the reference person and we assume the spouses are the same average age.

CLAIMS RATIO

If I let CR = Claims Ratio of married/single, then:

$$CR = \frac{2,704}{2,390} = 1.13$$

In other words, for the 2012 CE Survey, this group of married people spent 13 percent more than unmarried people of the same age and gender, on the average.

Appendix III. Health Care Claims by Age from the TPA Study

Age	AAE	Age	AAE	Age	AAE	Age	AAE
1	\$3,744	17	\$1,809	33	\$2,855	49	\$4,239
2	\$3,516	18	\$1,831	34	\$2,902	50	\$4,405
3	\$3,140	19	\$1,848	35	\$2,964	51	\$4,609
4	\$2,721	20	\$1,865	36	\$3,039	52	\$4,832
5	\$2,341	21	\$1,891	37	\$3,121	53	\$5,049
6	\$2,041	22	\$1,936	38	\$3,201	54	\$5,240
7	\$1,830	23	\$2,001	39	\$3,274	55	\$5,396
8	\$1,701	24	\$2,084	40	\$3,345	56	\$5,528
9	\$1,638	25	\$2,182	41	\$3,420	57	\$5,658
10	\$1,618	26	\$2,291	42	\$3,501	58	\$5,805
11	\$1,626	27	\$2,404	43	\$3,591	59	\$5,962
12	\$1,651	28	\$2,513	44	\$3,691	60	\$6,113
13	\$1,683	29	\$2,615	45	\$3,800	61	\$6,263
14	\$1,718	30	\$2,704	46	\$3,905	62	\$6,428
15	\$1,751	31	\$2,770	47	\$4,006	63	\$6,605
16	\$1,781	32	\$2,816	48	\$4,111	64	\$6,776

Figure 5. The annual average expenses (AAE) per person from the TPA study

Acknowledgements

- Carlton Harker, FSA, MAAA for getting me started on this project.
- Kristi Bohn, FSA, MAAA for her “Rethinking Family Tiers” article and her many suggestions.
- J. Patrick Kinney, FSA, MAAA and Kurt Wrobel, FSA, MAAA for their many suggestions.
- Cindy Castevens for helping me improve the wording throughout the article. ■

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Family Values and the ACA

By Kristi Bohn

The overall objective of the Actuarial Value Calculator was to increase the comparability of health insurance plans, and flexibly standardize the value of plans to individual and small group health insurance purchasers across the country. However, the exchange plan designs that are similar when viewed as single coverage may look materially different when viewed from the perspective of family coverage, despite the metal level—bronze, silver, gold or platinum—the plan falls under. While the ± 2 percent actuarial value corridor may seem small, it implies a relatively wide range of allowable deductibles, particularly for silver and bronze plans, and even more so for family (versus single) contracts since the deductible range within the metal level doubles (or more).

Family Plans with Embedded Structures

If a family design has an “embedded” structure—that is, there is a lower interim deductible (typically half of the family deductible) for one individual within the family to meet, with no requirement for that one person to absorb the entire family deductible—then Department of Health and Human Services (HHS) gave insurers a long rein for creating the family plan design’s multiplier. In other words, actuaries were instructed to ensure that the single plan design fell into the ± 2 percent corridor of the metal level thresholds, but could create family plans that were any multiplier of the single deductible. Many plans have a 2x multiplier (for example, a \$1,000 single deductible is paired up with a \$2,000 family deductible). However, some plans were designed with a 2.5x or 3x family multiplier. The family multiplier is material enough to be included in insurer’s pricing tools. However, HHS did not have the data it needed to value the family multiplier design element since the member records in their data source were not connected to one another.

A solution to this lack of data could have been to simply require all plans to use one standard family multiplier to achieve consistency and ease comparisons for families shopping in the exchange market (2x is a very common design choice). Family multiplier standardization is something that California has achieved at the 2x level since California created

a standard set of benefit parameters at every metal level for all design elements.

The variation in family multipliers may create a competitive scenario that changes when viewing single versus family contracts for a plan, whether in terms of design attractiveness, pricing implications or even risk adjustment outcomes. In terms of risk adjustment outcomes, it is possible there is bias in risk adjustment for those who are single, versus those who are married without children, versus those who are married with children, and also for the number of children in a family.

Family Plans with Nonembedded Structures

Alternative guidance was given for valuing family designs with “nonembedded” structures. Nonembedded deductibles must be met by any and all family members before the coinsurance provisions kick in to reduce enrollees’ costs (note that out-of-pocket maximums are also embedded or nonembedded, the choice of which typically matches up to the treatment of the deductible). Nonembedded structures are very common in plans compatible with health savings accounts (HSAs), plans that are highly sought on the individual market.

Under guidance from HHS, actuaries are not allowed to simply rely on the single metal level valuation when a nonembedded family structure exists. While the family parameters could have been used directly in the calculator, special actuarial adjustments were generally employed because the option to use the family parameters in the calculator would have created odd placements into the metal categories.

Family Values Reflect a Variety of Personal Beliefs

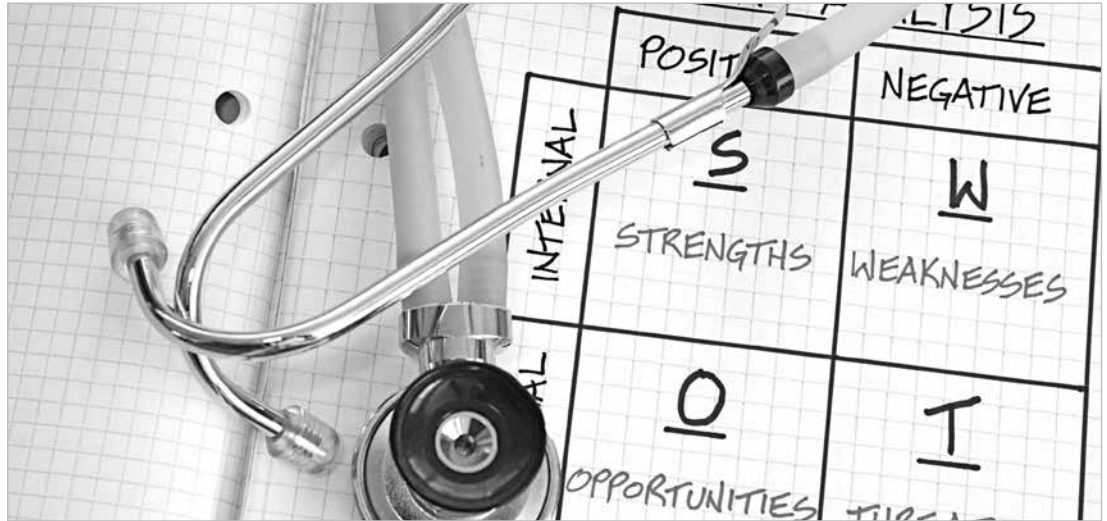
There is a wide range of legitimate data sources, methods and assumptions for valuing a nonembedded deductible and the family multiplier, which has resulted in a wide range of designs falling under the metal levels. Here are some key questions to consider about the various data sources, assumptions and methods that actuaries probably used. The answers



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If you are not familiar with the Actuarial Value Calculator and are interested in learning more, follow the link below to the Plan Management/Regulations section in order to download both the AV calculator and its methodology. <http://www.cms.gov/ccio/Resources/Regulations-and-Guidance/index.html>

CONTINUED ON PAGE 40



will help explain the variation of designs that exist in 2014 at each metal level.

- Did the actuary assume that because embedded structures could use any family multiplier, the only feature needing a special adjustment for nonembedded plans was the value of nonembedded compared to embedded structure? For those taking this stance, the work of valuing the family multiplier is skipped. The use of this method is visible through higher deductibles that approach the allowable HSA limits for 2014 of up to \$12,700.
- In valuing the family multiplier, did the actuary build a family continuance table based upon HHS' actuarial value tools' source data?
 - If so, was the continuance table based on HHS average members, or instead did the actuary bifurcate the HHS member data into a composition of adults and children?
 - Was a distribution of family sizes and compositions used? Or, was a single expected member-to-contract ratio used?
 - Was experiential data or existing pricing tool adjustments used? If so, was calibration performed to ensure the adjustment reflects the data that sourced HHS' actuarial value tool?
- In valuing the nonembedded versus embedded structure, did the actuary build this estimate based upon HHS' actuarial value tools' source data?
 - If so, was the continuance table based on HHS average members, or instead did the actuary bifurcate the HHS member data into a composition of adults and children?
 - Was a distribution of family sizes and compositions used? Or, was a single expected member-to-contract ratio used?
 - Was the insurer's experiential data or existing pricing tool adjustments used? If so, was calibration performed to ensure the adjustment reflects the data that sourced HHS' actuarial value tool?
 - Many actuaries would have combined this adjustment with the family multiplier adjustment and expressed just one aggregate adjustment factor (assuming the actuary thought the family multiplier was necessary in the first place). If not performed in a bundled approach, were the data sources, methods and assumptions used to make the nonembedded adjustment consistent with those used to calculate the family multiplier adjustment?
 - Was Monte Carlo simulation performed to more readily model the difference between embedded versus nonembedded structures? If so, was the random but right-skewed variation in costs at the family level simulated to be consistent with HHS' average member costs? Were distributions of family sizes and compositions included, or just one single average member-to-contract ratio?
 - Alternatively, an insurer could have measured this special adjustment by reviewing previous designs'

outcomes, noting though that this is a very difficult analysis since a myriad of embedded and non-embedded design parameter combinations exist.

- Did the actuary assume that the family plan's actuarial value could be weighted with the single plan's actuarial value, and thus each could separately fall outside of the +/-2 percent corridor but meet the corridor threshold in aggregate? This would more readily allow for more traditional family multipliers (2x, for example). Or, did the actuary assume that the single plan's actuarial value must meet the metal level corridor on its own and the family parameters must be calibrated to the same metal level range? This would be visible by plans with very atypical family multipliers.
- What was the weighting between single contracts versus family contracts?
- What was this weighting based on: Past experience in the specific product? Past experience of the entire risk pool? Predicted compositions? Some hypothetical estimate of HHS' data source?

In my view, in terms of ranking the types of special adjustments the Actuarial Value Calculator could not handle, the family multiplier is nearly universally needed and is quite visible to the public, and thus should rank very high on HHS' list of future tool upgrades. It is also quite material in and of itself, as well as in terms of the differences in special adjustments that result from different actuarial approaches aimed at the exact same designs. Going forward, if the data source continues to fail to support this tool upgrade, I believe it is worthwhile for HHS to consider either creating some design standardization requirements that will improve the comparability of all plans for families on the individual and small group markets (such as implementing 2x standard for all plans). HHS could also provide more guidance so that the data sources, methods and assumptions used by actuaries in valuing both the family multiplier special adjustment as well as the embedded versus nonembedded design special adjustment are more consistently applied.

I purchased a family plan on the individual exchange that I would not have attested as meeting the 58 percent actuarial value under any of the alternative

measurement methods described above. The plan has a nonembedded family deductible/out-of-pocket maximum at the IRS maximum of \$12,700, which seems too high to fit into the bronze level category. Perhaps the actuary did not hear about HHS' guidance on nonembedded structures. Heck, even a single plan at \$6,350 gives me pause on the individual and small group markets (58 percent might show up on the calculator, but the error message suggests that the value of this plan is on the wrong side of the rounding). Perhaps the actuary priced an embedded HSA-compatible plan and the insurer's marketing department did not get the message (I checked—the paperwork backing up the product clearly lists a nonembedded deductible). That did not stop me from purchasing the plan though, since the small network, plus high level and nonembedded nature of the deductible brought the price tag down significantly. People like me who purchase such high levels of deductible have little plans to need the insurance and purchase it for peace of mind. The lower the price for that peace of mind, the better. People as individuals do not really follow actuarial equations of value. ■

Using the Minimum Value Calculator

By Juan Herrera



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One provision of the Affordable Care Act (ACA) was to define minimum essential coverage for employer-sponsored insurance. In determining whether a benefit plan is complying with this provision, benefits must meet a minimum 60 percent actuarial value. The Minimum Value Calculator was created to test this condition by inputting the benefit designs into the model and then calculating an actuarial value. The concept of actuarial value in this context is defined as the portion of services covered by the benefit plan administrator for a standard population.

The Department of Health and Human Services (HHS) commissioned two variations of the same model. The version used in the small group and individual markets is known as the Actuarial Value Calculator. This article addresses using the Minimum Value Calculator version in the large group and administrative services only (ASO) markets and understanding some of the limitations of the calculator. Some of these limitations also impact the Actuarial Value Calculator (AVC). The implications of tool limitations are actually more material for the AVC because the outputs must hit a much smaller range of actuarial values in order to fit into each of the metal level designations. The Minimum Value Calculator is a pass/fail test where very few plans fail or come close to the 60 percent pass mark.

In August 2013, the American Academy of Actuaries published an exposure draft on the Minimum Value and Actuarial Value Determinations under the ACA.¹ This exposure draft, and any finalized practice note that may be adopted in response to the feedback, should be the actuary's primary source for determining what to consider in using the calculators when things don't quite fit. However, it is important to point out that practice notes are meant to aid the profession in understanding best practices, and are not binding as are actuarial standards of practice. It is possible an exposure draft on a standard of practice for the minimum value tool could be coming.

Before the practice note was available, a cloud of mystery surrounded some aspects of this tool. Obviously any beta version of the model was likely to have small issues. There were two versions of the model released. An initial version was released in

the late fall of 2012 with a final version at the end of February 2013. It was hinted by HHS a new version would be released; however, we were told no data would be changed until at least 2015.

As in any model, there are only so many things the tool can handle and there is a balance between simplicity and flexibility. We will discuss the tool's limitations and offer solutions on how to address them. The exposure draft offers a much more detailed explanation of the development of the models.

The tool was designed, as the name implies, to define whether a benefit plan meets the new Minimum Actuarial Value regulation. The calculator is not intended to be used as a pricing tool, as the unique geographical cost structure, likely provider practice patterns, membership demographics and induced demand treatment will not line up to what is needed for any given insurer or employer. As mentioned earlier, there are some input limitations. Obviously, designing a fully robust model requires a large number of inputs and data to support it. And no matter how robust those inputs were designed to be, there are marketing, consultants and employers who have already created, or will create, benefit designs that any model would have been unable to handle without some very specific actuarial judgment.

Below are examples of limitations of the model, along with ideas actuaries have developed to create special adjustments to address these limitations. Along with each limitation, I discuss possible solutions and/or implications of the problem. Alternate solutions may illuminate the differences in AVs that exist when special adjustments are developed by different individuals, and this discussion also touches upon whether benefit design features are material in relation to the purpose of the model.

To use the model, you should differentiate between benefit design features that can be handled by inputting a representative cost sharing number into the model, as compared to features that should be adjusted for after the model calculates an AV. We will also discuss some features that theoretically should impact the AV result much differently than the model suggests. For many of the features below, you can fairly represent the benefit as some weight-



ed average and input that weighted average expectation into the model. There are other items that fall out of the scope of what the model was designed to do and must be adjusted as a top-line or bottom-line adjustment, depending on your perspective.

The model values medical and pharmacy benefits together. Items that are medically related, versus pharmacy related, are separated out in the descriptions below on how to handle them. Some of the issues below are addressed in the practice note as well, as noted.

Changes in MV may be illogical as employer contribution approaches the full amount of the deductible. For example, an MV at 95 percent contribution may exceed the MV at 100 percent contribution.

Because of the utilization assumptions in the continuance table, contributions levels impact the increases or decreases in utilization, thereby increasing or decreasing total costs. In actuarial pricing, more employer contributions given a set benefit design will create a more expensive product. The logic causing the issue above seems to have the correct pricing impact but does not account for the purpose of the model, which is to determine what proportion of the benefit is covered by the employer and what portion is covered as cost sharing by the employee or dependent.

Actuaries familiar with pricing benefits know that very rich benefits cost more than leaner benefits because of increased utilization. This is not due to the fact that more benefits are being covered.

For purposes of meeting the minimum value, this is clearly immaterial since it is at the upper end of the AVs and therefore should be documented but not be a cause for further determination.

Service-specific deductibles separate from the global deductible (for example, an inpatient deductible)

In the past few years, carriers have introduced focused deductibles or deductibles that apply to only specific services. The purpose of these deductibles is to incent patients to seek out lower costing settings for care. For example, a carrier may use a deductible if the service is performed in a hospital, but that deductible is waived if the service is performed at an ambulatory surgical center or a comprehensive medical facility. The Minimum Value tool clearly does not have the required inputs to value this plan feature.

The model does allow you to use global deductibles for specific categories of services, such as emergency room or outpatient services. The academy's practice note and guidance from HHS state that the actuary can use his judgment in adjusting the global deductible in the model to reflect its partial application for different service settings. The actuary should document how this deductible adjustment was developed. Also, if the deductible applied is different by category of service, this may be problematic since the model only allows one deductible to be used for all medical services.

Copays in conjunction with coinsurance (for example, \$250 + 10 percent)

Copays apply after the deductible (see practice note draft page 10)

Visit maximums (if material)

Stepping up copays (emergency room, for example)

The authors of the model could not include all of the unique possible options to provide for all the possible combinations of benefits allowed in the market place and still make it a fairly simple model to use.

In stepping up copays for emergency room visits, actuaries can use their own past experience to determine the frequency of visits and weight each step of the copay. An actuary would then enter the average copay of the steps and enter that average into the tool. However, the continuance tables of the model should be consulted for the calibration because the calculation should be based on a standard population and not based on the carrier's experience. That said, there are instances where the underlying data for the tool does not provide sufficient detail to allow these one-off calculations and calibrations.

Copays on outpatient services

At my organization, this limitation came as a complete surprise. The explanation given for this omission is that the data source behind the model did not have the ability to split utilization for this category. The source data came from a preferred provider organization (PPO) network where claims were paid on a coinsurance basis. Therefore, there was no way to determine the value of a copay on outpatient services. In creating special adjustments, the actuary should estimate a coinsurance equivalent to the copay and use that value in the tool. It is a good idea for your organization to create a table that converts outpatient surgery copays into equivalent coinsurance amounts. Such a table should be built, or at least calibrated, upon the Minimum Value tool's standard population table. The exposure note covers this specific example on page 11 as example 1.

Per script minimums and/or maximums

Preventive drug list

Mail order copay

The section for prescription drugs is simplified over what is available in the market place. To differentiate themselves, carriers over the past few years have done a good job of determining new benefit tiers to use for prescriptions drugs. These varying benefit tiers also are important in steering usage to lower costing drugs and to limit selection exposure in the market place. The tool handles generics, preferred brands, nonpreferred brands and specialty drug benefit tiers. The tool also allows a unique pharmacy deductible to be applied, or not applied, to each of these categories.

The practice note discusses on page 11 how to handle minimum and maximum per script limits. The exposure draft suggests the data provided within the tool includes the average cost per script within each drug tier. However, the tool's data source does not capture the variety of costs that built up to the average cost per script, which is very important to consider when valuing minimum and maximum limits. Actuaries should be able to convert the cap or floor into a coinsurance or copay and therefore input into the model that way, but will likely need to seek their own pharmacy experience and think about calibrating that experience to the tool's pharmacy averages.

For both preventive drug lists, where the copays are low or zero, as well as for mail order copays, where a more generous (lower) multiple of the monthly copay is used for 90-day supply, a weighted copay or an adjusted coinsurance level can be used.

Family tiering: family deductible and out-of-pocket (OOP) max (e.g., single 2x versus 3x)

Embedded vs. aggregate family deductible

The data for the standard model was based on a single deductible and out of pocket applying to one member. The impact of a family limit was not considered. The practice note describes this further under example 3 on page 11. The note states that the data collected was under single claimants only. It goes on to suggest that actuaries interested in determining the impact of these family limits should use the underlying data and create an impact that is added/subtracted to the final AV calculation. This topic is described in more detail by Kristi Bohn in this same issue, but that article relates to the AVC for the small group and individual markets. Some actuaries believe that family design considerations is not a critical topic in relation to the Minimum Value calculations because the family aspects of affordability and benefits were taken off the table for the most part, and that the guidance focuses on the benefits offered to employees within the single contracts they are eligible to enroll in. Clarity from HHS on how family tiering and aggregate family deductibles fit in to Minimum Value regulations would be welcome.

Different results for global coinsurance at 100 percent versus 99.9 percent

Coinsurance that is the same as the global coinsurance may yield different AVs

When there is no deductible, an integrated deductible can yield a different AV than using a separate deductible

Increasing the drug deductible can increase AV

In some cases, actuaries are finding some of the results of the inputs are counterintuitive. The actuary should try to determine the impact of these benefit differences. If the answer is counterintuitive, then it is important to determine whether the issue is material to the task at hand. If it is something the model was not designed to do but can be translated into the inputs the model does accept, then do so.

There are certain limitations in the model. I am assuming the reader is familiar enough with Excel to realize that table look ups and continuance tables jump in a discrete manner from one value to another. In the real world, small changes in inputs should equal small changes in outputs. In reality, models do not interpolate between values in tables and therefore the jumps in values are much greater. The actuary should use sound judgment and not take advantage of these discrepancies. This issue is discussed at more length in the practice note. These discrepancies seem more troubling in cases where actuaries and nonactuaries are not working with the tool long enough to notice these issues. However, very often employer plans are generous enough (maybe more than 95 percent of the time) that these issues do not affect the ultimate pass/fail answer of the test. It is when plans are close to the 60 percent threshold that the tool's technical issues become worrisome.

Tiered plans with cross-applicable deductibles and OOP maximums

While the model does handle a multiple tiered product, the deductibles are assumed to apply to services within a tier. The actuary should use a deductible in each tier that is adjusted down for the impact of cross accumulation across tiers. The OOP maximum

would also be lowered in each tier to reflect the amount being spent in the other tier.

Wellness incentives incorporated into plan design

Wellness benefits may or may not impact the cost of the plan. Incentives that shift utilization and perhaps adjust the portion paid by the benefit administrator for an expected reduction in the total cost of the plan could not be used to adjust the AV.

After all this work, we may have been amused to figure out that a plan will always meet or exceed 60 percent as long as it's nongrandfathered and therefore compliant with the newly applicable IRS limits on deductibles and OOP maximums. It almost begged the question "what is the point?" This is the case for 2014 at least, and may have been coincidental, but it will be interesting to see how the tool's results and the IRS limits evolve through time.

The calculator is accessible to the public; folks from all areas are using it. This is potentially dangerous in light of the calculator's subjectivity on how inputs should be entered. Ask an actuary, an underwriter, an account manager and a broker what a plan's MV is, and you could get four different answers. As an actuary, you should be aware of potential areas where the benefit inputs may not adequately represent the actual benefit design. This will give you the opportunity to defend your answer in light of potentially different interpretations. ■

I would like to thank James Chu, Kristi Bohn and Rebecca Katz for reviewing the article and suggesting items to discuss.

END NOTES

¹ MV/AV Practice Note Work Group of the American Academy of Actuaries, "Minimum Value and Actuarial Value Determinations Under the Affordable Care Act," August 2013, http://www.actuary.org/files/MVAV_exposure_draft_081213.pdf.

Ask an actuary, an underwriter, an account manager and a broker what a plan's MV is, and you could get four different answers.

Understanding ORSA: Risk, Solvency and Beyond

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In August 2012, the National Association of Insurance Commissioners (NAIC) approved the Risk Management and Own Risk and Solvency Assessment (RMORSA) Model Act and state legislatures are in the process of adopting it. Is your company ready to demonstrate to regulators how the overall enterprise risk management framework is maintained? Does your company have a risk appetite aligned with the risk strategy set forth by the board of directors? Will your C-suite be able to demonstrate how your capital level is tied to the business plan? These are some of the Own Risk and Solvency Assessment (ORSA) questions that go beyond the current risk-based capital requirements. Starting in 2015, all insurers meeting the minimum premium threshold must comply with ORSA requirements.

The NAIC RMORSA Model Act will have a lasting impact on the insurance industry. A product of the NAIC's Solvency Modernization Initiative, ORSA is a capital and enterprise risk management (ERM) requirement. Similar to the current risk-based capital (RBC) requirements, ORSA requires an insurer to demonstrate capital adequacy. But unlike RBC, ORSA is designed to be a customized, forward-looking and, in many ways, more holistic solvency system.

What Is ORSA?

All individual insurers writing at least \$500 million in direct written and nonaffiliate assumed premium are subject to ORSA requirements effective Jan. 1, 2015. To prevent their subsidiaries from taking on excessive risk, insurance groups writing at least \$1 billion in direct written and nonaffiliate assumed premium are also subject to ORSA. Under the RMORSA Model Act, insurers are required to conduct an internal assessment and file the results in a confidential ORSA summary report to the lead state regulator once a year.

The ORSA summary report is divided into three sections to address different aspects of an insurer's risk management capabilities: minimum risk management framework, internal assessment of risk exposures, and assessment of group risk capital and prospective solvency.

Section 1 concerns the insurer's ERM framework. The insurer must demonstrate evidence of risk culture and governance, processes of identifying and prioritizing risks, a formal risk appetite statement, risk management procedures and a reporting mechanism that monitors risks. The insurer must show how risks are managed and how they are integrated into the business strategy. Section 1 should also identify the tools that actively assess changes in the insurer's risk profile and mitigation procedures in place.

Section 2 concerns the insurer's qualitative and quantitative assessment of its risk exposure. In this section, the insurer must detail the methodology, key assumptions and outcomes from its risk exposure assessment. The NAIC states that the assessment should be carried out with techniques appropriate to the insurer's "nature, scale and complexity." This means ORSA must be conducted in a manner consistent with how the business is managed and also meet what is informally known as a "use test." To pass the ORSA use test, the insurer must demonstrate that the previously mentioned risk assessment serves as an integral part of management's business planning process. The risk embedded in a business plan needs to be addressed and the actuarial team must engage management to tackle difficult questions. For instance:

- What is the most effective approach to assess the insurer's underwriting (or operational, credit, etc.) risks?
- What constitutes a normal business environment? How are stress scenarios defined?
- How does available capital fluctuate over the defined timeframe?
- Is the correlation relationship between different risk categories appropriate? Should the relationship be static or does it change under stress scenarios?

The risk measurement aspect of ORSA may not be as prescribed as requirements such as RBC or the European Union's Solvency II Directive. The NAIC's intention is to allow insurers the freedom to reflect the unique nature of their risk profiles, not give them an excuse to choose the easiest approach. As opposed to a checkbox exercise, ORSA dictates that an insurer's results must be consistent with its



business plan. Insurers who do not take ORSA seriously will likely fail the use test.

Section 3 concerns the manner in which an insurer's capital resources are tied to the qualitative and quantitative assessment of its risk profile over the long run. The purpose of Section 3 is to "assist the commissioner in assessing the quality of the insurer's risk and capital management." The idea is that insurers who take on more risk should hold more capital.

In this section, the insurer must carry out two forms of assessment: a group assessment of risk capital and then an assessment of prospective solvency. Risk capital concerns the level of financial resources required to underwrite risks, whereas solvency is the insurer's ability to meet its obligation in a manner consistent with its risk appetite. The NAIC provided a list of considerations insurers should address in determining their capital adequacy at the group level.

- The relevant and material risk types to be included in the measurement of risk capital
- The definition of solvency in terms of risk capital and liquidity (e.g., threshold defined at x percent of annual premium)
- The accounting or valuation basis for the measurement of risk capital (e.g., generally accepted accounting principles [GAAP], statutory)

- The business segments to be included
- The time horizon to model and measure risks
- The methodology to quantify risk exposure (e.g., deterministic stress testing, stochastic modeling)
- The metrics to be used in measuring the level of aggregate risk capital

As for the assessment of an insurer's prospective solvency, the NAIC mandates insurers have "a robust capital forecasting capability that supports its management of risk." The assessment of solvency should be carried out in conjunction with an insurer's business planning process. Unlike the current RBC framework, ORSA is measured on a going-concern basis. Long-term business plans developed by management must be accompanied by an adequate level of capital that supports all inherent risk types.

Potential Improvements

The main objectives behind the NAIC's Solvency Modernization Initiatives (SMI) is to improve the existing solvency requirements in the United States by examining elements of other regulatory frameworks around the world. The ORSA framework, the product of NAIC's SMI, has three improvements over the current RBC requirements.

CONTINUED ON PAGE 48

With ORSA's holistic view of risk and solvency, health plans can use new ERM tools to truly balance risk and reward.

First, ORSA accounts for all risks material and relevant to an insurance company. The current health RBC formula accounts for only five risks: affiliate asset risk, nonaffiliate asset risk, underwriting risk, credit risk and business risk. The intention was to capture the key risk categories that would ensure the well-being and solvency of the industry as a whole. Where the RBC formula differs is that it was calibrated to the *average* insurer's probability of ruin and cannot account for every permutation of risks for all insurers. For instance, operational risk—a risk category gaining attention in the ERM community—is an area the RBC formula currently does not account for. As a factor-based approach, the static RBC formula cannot account for all risks tied to an insurer's business plan. Unlike RBC, ORSA is tailored to each insurer's risk profile and, therefore, by design, addresses all risks an insurer is exposed to. ORSA allows for a customized approach to assess an insurer's unique capital needs.

Second, ORSA results must be proved reliable and embedded in the insurer's business plan. This is a feature of ORSA that goes beyond capital adequacy. The RBC is a rule-based approach to quantify an insurer's risk profile. In reality, however, there may be a substantial disconnect with what an insurer files for its statutory reporting and what it considers in its business strategy. The use test embedded in ORSA eliminates the ambiguity between the two bases.

Third, ORSA requires a prospective view of an insurer's capital needs. The RBC formula is not carried out on a going-concern basis and is therefore disconnected from the forward-looking nature of business planning. RBC filings do not account for management's view of emerging risks—such as the expiry of the 2Rs or the impact of newly insured young individuals—that often defines an insurer's strategy. Strictly speaking, this aspect of ORSA is not necessarily an improvement over RBC. The two frameworks serve different purposes; RBC is a point-in-time statutory measurement, whereas ORSA examines the insurer's risk profile as an ongoing entity. RBC takes a snapshot of an insurer's capital level and balance sheet at the valuation date. ORSA ensures an insurer's capital adequacy

and prudent risk management practice going forward. To continue to underwrite risks, an insurer must demonstrate it is financially stable under both regulatory regimes.

Challenges for Health Plans

Relative to other insurers, health plans are likely to experience additional challenges in the implementation of various ORSA provisions. Due to the nature of their long-tail liability, life insurance carriers typically have much stronger capital and risk modeling capabilities than the average health plan. Additionally, health actuaries cannot simply replicate the ERM functions at life insurance companies for many reasons: People shop for new health coverage much more often than a new life policy, health plans have to deal with the uncertainty of working with providers and networks, claims cost can change significantly from one period to another, and life insurance payouts typically do not have friction costs arising from litigation and complex adjudication processes.

What this means is that there is no off-the-shelf ORSA solution for health plans. Some health plans operate on the national level, whereas others thrive in a single region. Meeting all ORSA requirements will be challenging for health plans, but the upside is that we are starting from scratch and can draw from lessons other practitioners have learned.

An ORSA Game Plan

With 12 months until the requirements are in effect, insurers must start to prepare. ORSA is a game changer and requires a new mindset. Full implementation will likely require a plan to address all key areas.

• Capital management

- Determine the optimal approach for economic capital calculation and projection
- Find the proper balance between feasibility and accuracy

• ERM framework

- Integrate existing and new risk management processes into one consistent corporate policy
- Strengthen ERM governance framework
- Establish a meaningful link between the group's and the subsidiaries' risk tolerance

• **Strategy**

-Align key aspects of business planning and risk modeling to increase the relevance of ORSA in decision-making processes; buy-in at the C-suite level is important

• **Resources**

-Update skillsets of finance, actuarial and risk management practitioners
-Develop adequate risk processes, controls and quantification tools

• **Risk culture**

-Create broad ownership of the ORSA process to prevent a “silo-based” approach across entities and risk categories, with full staff engagement on all levels
-Improve communication between key stakeholders
-Manage business in accordance with the defined risk appetite and risk tolerance levels

• **Technology**

-Develop robust systems and data environment to analyze risk metrics in a timely manner

A lot of times we get asked what an actuary does. We all have our little scripted answers. But long story short, we manage risk. And risk is what ORSA is all about. ■

END NOTES

¹National Association of Insurance Commissioners (NAIC). “NAIC Own Risk and Solvency Assessment (ORSA) Guidance Manual.” March 2012. http://www.naic.org/documents/committees_e_orsa_wg_related_docs_guidance_manual_2013.pdf.

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ORSA will likely allow the industry to gain a better understanding of the underlying risks. As the effects of the Patient Protection and Affordable Care Act (ACA) are realized in the years to come, ORSA will likely empower insurers to examine their own risk profiles and objectively study the benefits of specific strategies, business segments and product offerings. Be it the health plan’s financial viability in the exchange market, the long-term claims impact from high-risk individuals or the profitability pressure due to new minimum loss ratio rules, the ACA certainly poses many layers of strategic and operational challenges. With ORSA’s holistic view of risk and solvency, health plans can use new ERM tools to truly balance risk and reward. ORSA alone may not be enough for the insurance industry to weather the next economic downturn unscathed, but as we have seen since the 2008 credit crisis, companies with more advanced risk management frameworks tend to be better positioned to withstand unfavorable conditions.

Applications of Statistical Techniques e-Course to Launch Early 2014

The Applications of Statistical Techniques Module, which was launched in November 2013 for candidates pursuing fellowship on the General Insurance track, will be available in early 2014 as a Professional Development e-Course. Members who complete the e-course will use the free statistical computing package R to build, validate, and interpret models. Special emphasis is placed on using the generalized linear model for classification ratemaking and reserving, including estimating reserve variability. Other topics covered in the e-course include clustering, Bayesian, and bootstrap methods.

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