Risk Management

JOINT RISK MANAGEMENT SECTION

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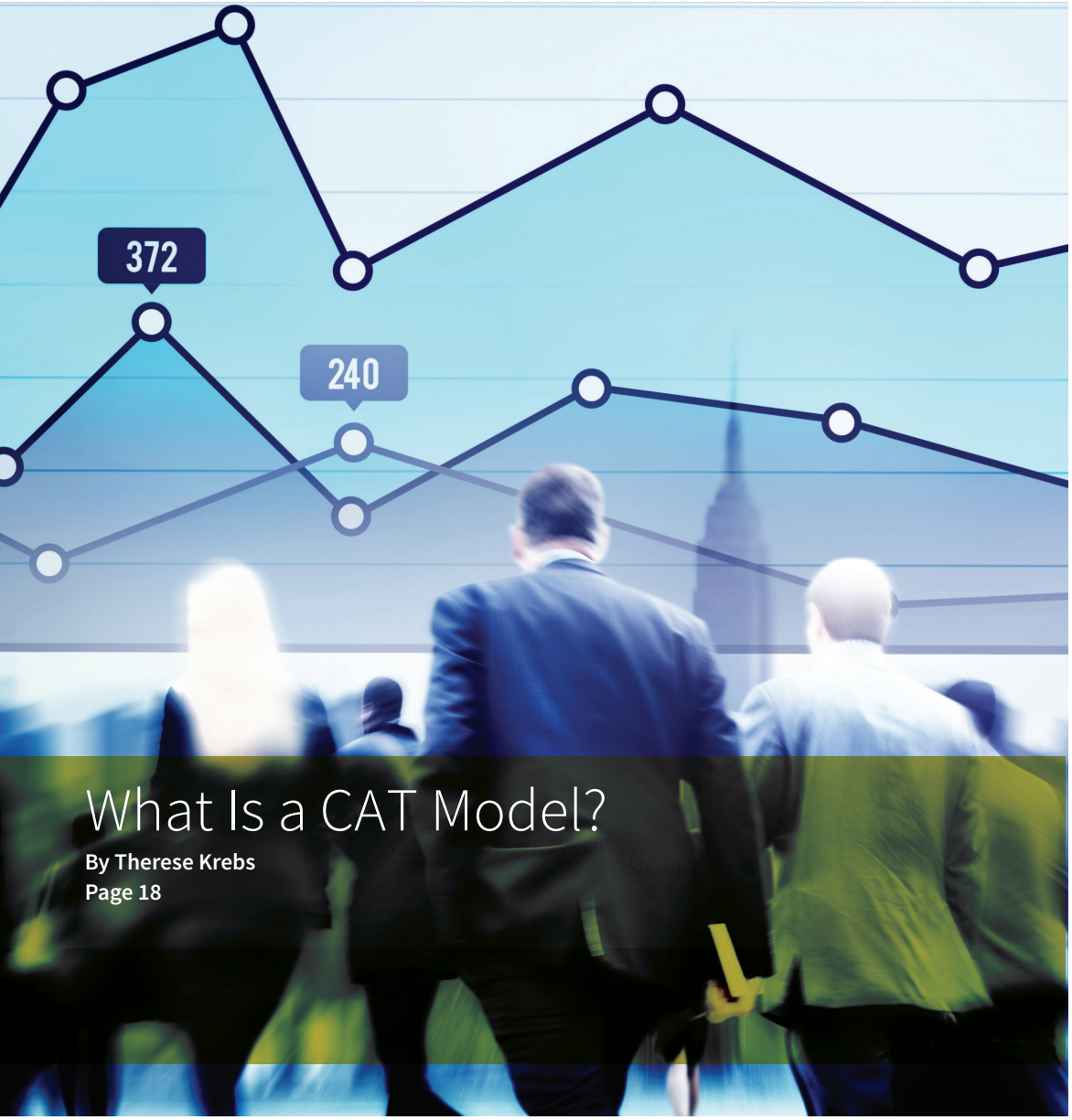

What Is a CAT Model?

By Therese Krebs
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Risk Management

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Published by the Joint Risk Management Section Council of Canadian Institute of Actuaries, Casualty Actuarial Society and 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 Joint Risk Management Section Web page at http://www.soa.org/jrm

Chairperson's Corner

By Mark Yu

Hopefully by the time you are reading this issue, the winter is completely behind us and the spring has arrived wherever you are. Being a risk professional, I pay attention to the "volatility" around me. In addition to the volatile equity markets, I noticed the unusually volatile weather pattern. The temperature swings between two consecutive days in Connecticut (where I reside) can vary by more than 30 degrees! Being an avid skier and season pass holder, I see this volatile weather has negative implication to the intrinsic value of my ski season pass. Weather aside, in this "Chairperson's Corner," I would like to emphasize the exciting JRMS educational activities that are taking place in 2016 and how you, as a member, can benefit from these offerings.

- **Research**. For the last three years, approximately $400K has been committed to JRMS research budget. At the end of 2015, two research projects were completed and reports have been recently published on soa.org/jrm. Summaries of both research projects, "Risk Implications of the Unemployed and Underemployed" and "The Emerging Risk Survey Report," appear in this issue and I encourage you to visit our website where you can find downloadable copies of all past research papers and essay calls. There are more research projects being funded with topics including Country Risk Officer, ERM Stakeholder Buy-in, Parameter Uncertainty and Climate Change. Of course, we are always open to new ideas and please send your topic ideas to Louise Francis, who chairs this committee.
- **Virtual Town Hall Meeting**. On March 31, 2016, we hosted our second town hall meeting to collectively share experience and knowledge on ORSA. This is complimentary event was a great opportunity to exchange ORSA implementation challenges and best practices with other participants.

- **Webcast**. JRMS is sponsoring the following webcasts in the next few months: Professionalism, Interest Rate and Economic Scenario Generator, and Climate Change Impact. We have invited great panelists for these educational topics and ask you to utilize these efficient channels for your continuing education needs. We have an additional six webcasts planned for the latter half of 2016 so stay tuned!

The world is getting more complex and volatile (weather temperature being one example) and it is an exciting time to be a risk professional confronting and addressing these evolving issues/trends in our environment. The JRMS offers a great avenue of educational contents to the risk profession. We are well represented by members from SOA, CIA, and CAS within the JRMS council. The section strives to embrace topics from different disciplines and we believe that diversity sparks growth and innovation. We would like you to consider getting more involved with our JRMS section: running for council, writing an article, joining a sub-work group, organizing a webcast, or sharing any ideas or thoughts. We are only an email away. We look forward to hearing from you! ■

Mark Yu, FSA, MAAA, is enterprise risk and capital management professional at General Re-New England Asset Management in Farmington, Conn. He can be reached at *mark.yu@grneam.com.*

Editor's Note

By Robert He

In this new issue of *Risk Management*, the editorial team is pleased to offer readers thought-provoking articles on a wide range of topics. This demonstrates the far-reaching impact risk management professionals have on our economy and society as a whole.

We have two articles discussing the risks that are on top of risk professionals' watch list. "Eighth Annual Emerging Risk Survey" by Max Rudolph and "The Global Risks Report 2016" present how risk managers around world are prioritizing their efforts. Both articles extend the definition of "risk" beyond economic/capital markets risks. This will give us a broader view of the "risks" we are facing. If you are a "pure" capital markets person, you might find these two articles interesting.

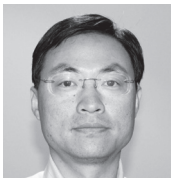
In "Understanding the Riskiness of a GLWB Rider for FIAs," Pawel Konieczny and Jae Jung from Numerix present an article on Fixed Indexed Annuities. As sales of FIA continue grow, this article is very timely and provides some practical thoughts on how to deal a few critical modeling issues.

Kailan Shang has a research paper published on SOA website entitled "Risk Implication of Unemployment and Underemployment." The article in this newsletter summarizes some key points of the research with a conclusion "Labor market-related plausible stress scenarios are also useful to test a company's ability to take risk."

"What is a CAT Model?" and "What is Model Vetting?" are two articles on models. In "What is a CAT Model?" Theresa Krebs explains in detail the various aspects of a CAT model. In "What is Model Vetting?" Stephanie Beaulne illustrates the model vetting process.

In "Corporate Pension Risk Management and Corporate Finance," Liaw Huang and Minaz Lalani present ideas trying to bridge the gap between theory and practice in pension risk management. This is excerpted and based on the Society of Actuaries' research report published in August 2015.

As usual, we would like to give a special thank you to David Schraub and Kathryn Baker for helping us pull together this April newsletter. ■



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Eighth Annual Emerging Risk Survey

By Max J. Rudolph

Risk management practices continue to evolve as new techniques become available and new regulations are enacted. Some feel a new asset bubble may have formed, with leading indicators such as margin debt matching pre-crisis highs. Non-economic emerging risks dominated the news in 2014 as Geopolitical risks were driven by Russia's involvement in the former Soviet states of Crimea and Ukraine, and an Ebola outbreak in West Africa reminded us how destructive infectious diseases can be to economic growth. Cyberrisk continues to evolve in new and scary ways, with companies and governments fighting a losing battle to stay ahead of hackers. This year's Survey of Emerging Risks, the eighth, captures this shift. Geopolitical and technological emerging risks have increased, taking share from economic risks.

Rapidly changing regulations and cyberrisk are replacing economic risks as risk managers prioritize their efforts. Trends across surveys reveal awareness by risk managers of emerging risks prior to their mainstream acceptance, showing some predictive qualities as risks increase or decrease in ranking.

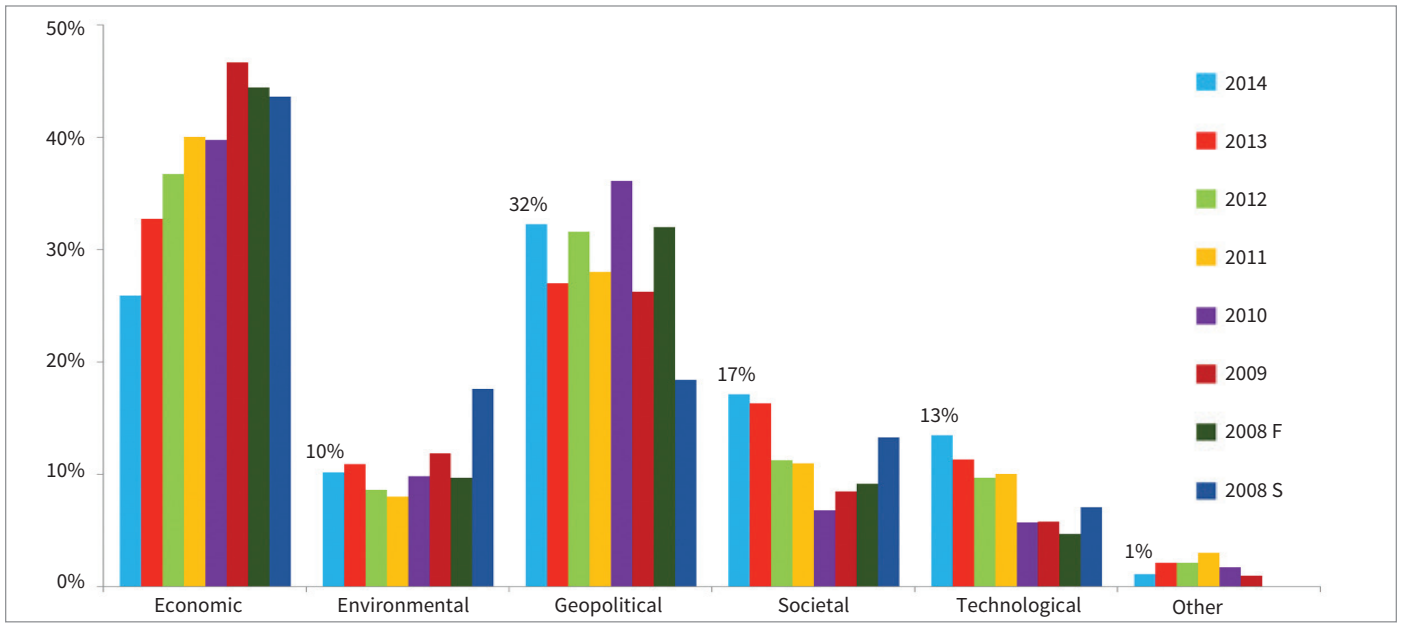
In late 2014 geopolitical and technological headlines anchored results, with *cybersecurity/interconnectedness of infrastructure edging out financial volatility* as the top emerging risk. Risk managers were also worried about topics like ISIS, Russia/Ukraine, asset bubbles and regulatory burdens.

What will become of coastal regions with growing populations as changing climate results in rising sea levels and higher frequency of extreme weather events? The aging demographics of the developed world have major implications for maintenance of infrastructure. How will we react to these types of questions?

TOP FIVE EMERGING RISKS

Each time this survey is completed (spring 2008, fall 2008, then annually) there are nuanced shifts in sentiment, sometimes due to recent events and sometimes due to the evolving experience of the respondents. The economic category of risks ceded ground to both geopolitical and technological risks (when up to five emerging risks were selected), falling to a low of 26 percent. The societal (up slightly to a new high) and environmental (down slightly) categories both recorded double-digit results. Finishing first overall (32 percent), five of the seven geopolitical risks increased. Top choices (all in the top 10) in the category were *international terrorism* (41 percent up from 27 percent), *regional instability* (37 percent up from 29 percent) and *failed and failing states* (28 percent down from 29 percent). Risks with new highs across the survey history were *interstate and civil wars* (19 percent) and *cybersecurity/interconnectedness of infrastructure* (58 percent, overall leader with increasing results for the sixth consecutive year). New lows were recorded by risks *currency trend* (7 percent), *Chinese economic hard landing* (27 percent), *financial volatility* (44 percent), *retrenchment from globalization* (8 percent), and *demographic shift* (23 percent).

Figure 1
Emerging Risks by Category (up to five risks chosen per survey)



Cybersecurity has completed its move to the top of the list of emerging risks, trending up from 21 percent in 2009 to this year's survey where 58 percent listed it among their top five emerging risks. Even five years ago the risk was receiving attention, and every year it has reached a new high point.

The evolution of the top four risks chosen provides evidence that trends can be relied on in this survey. The general continuity between survey iterations is very reassuring. The emergence of risks like *cybersecurity/interconnectedness of infrastructure* (3, 3, 2 and 1 in the past four years) shows how concerns are evolving away from the economic category. In the most recent survey, in the economic category only *financial volatility* made the top four after having two risks in the top five in each of the previous three surveys.

Year	2011	2012	2013	2014
1	Financial volatility	Financial volatility	Financial volatility	Cybersecurity / interconnectedness of infrastructure
2	Failed and failing states	Regional instability	Cybersecurity / interconnectedness of infrastructure	Financial volatility
3	Cybersecurity / interconnectedness of infrastructure	Cybersecurity / interconnectedness of infrastructure	Blow up in asset prices	International terrorism
4	Chinese economic hard landing	Failed and failing states	Demographic shift	Regional instability

These results have evolved over time by risk, with some increasing consistently (*international terrorism—risk no. 11*, *cybersecurity/interconnectedness of infrastructure—risk no. 22*) and others consistently dropping (*energy price shock—risk no. 1*, *currency trend—risk no. 2*).

LOOKING AHEAD

2015 was the world's warmest year on record. We continue to get regular reports of extreme climate—strong storms in Australia, drought in California, Arctic and Antarctic ice melts, hurricane like storms occurring more frequently than ever. The financial world balances between a future where central banks lead rates up and one where deflation and recession become common. Regional tensions are growing, due in part to oil prices at recent lows. Cyberrisk is regularly in the news, with health insurers joining the growing club of those breached. What will come next? What emerging risks will we deal with next year, five years from now, or 20 years from now? How will they interact with other risks and events? How can you prepare? The answers will lead to opportunities for some. Will it be you? ■

Max Rudolph is the founder of Rudolph Financial Consulting, LLC where he consults on risk and investment topics including common sense ORSA implementation. He can be reached at *max.rudolph@rudolph-financial.com.*

Understanding the Riskiness of a GLWB Rider for FIAs

By Pawel Konieczny and Jae Jung

ABSTRACT

GLWB guarantees have different risks when attached to an FIA vis-a-vis a VA. In this article we will assess the risks associated with this rider and analyze how different modeling choices can affect these risks. In particular, the impacts of improving the estimate of future caps will be explored.

INTRODUCTION

Insurance guarantees are exotic in nature because they have to take into consideration not only actuarial parameters (e.g., mortality) but have to address financial market guarantees and be tailored to more detail.

Given that exotic derivatives can be, in general, very sensitive to all kinds of modeling assumptions we immediately see that their appropriate modeling is a key for a company dealing with more and more narrow profit margins and lower returns on investments.

Cliquets/Monthly Sum Cap is a sequence of forward starting options—such a simple feature surprisingly results in quite a lot of pricing difficulties. When one puts a guarantee on such an index (FIA GLWB) one sees that it may inherit such sensitivities. One can encounter even a bit more exotic modification which would be GLWB on a Monthly Sum Cap on a Vol Controlled index.

SETUP

In the next few sections we will lay out assumptions underlying our analysis as well as, for the sake of completeness, recall some standard definitions.

We will be focusing on exploring how assumptions about the cap value for a Point to Point construct affects the price and Greeks of a policy with a GLWB rider.

Renewal cap setting for Point to Point.

In order to investigate different approaches to modeling the cap setting we need to make a few assumptions which are the most relevant for the analysis. Those will include Index Modeling, General Account/Budget assumption and Hedging assumptions.

Index Modeling

While it may be the simplest case, we are going to focus on a Point to Point indexing to illustrate the concept of cap renewal.

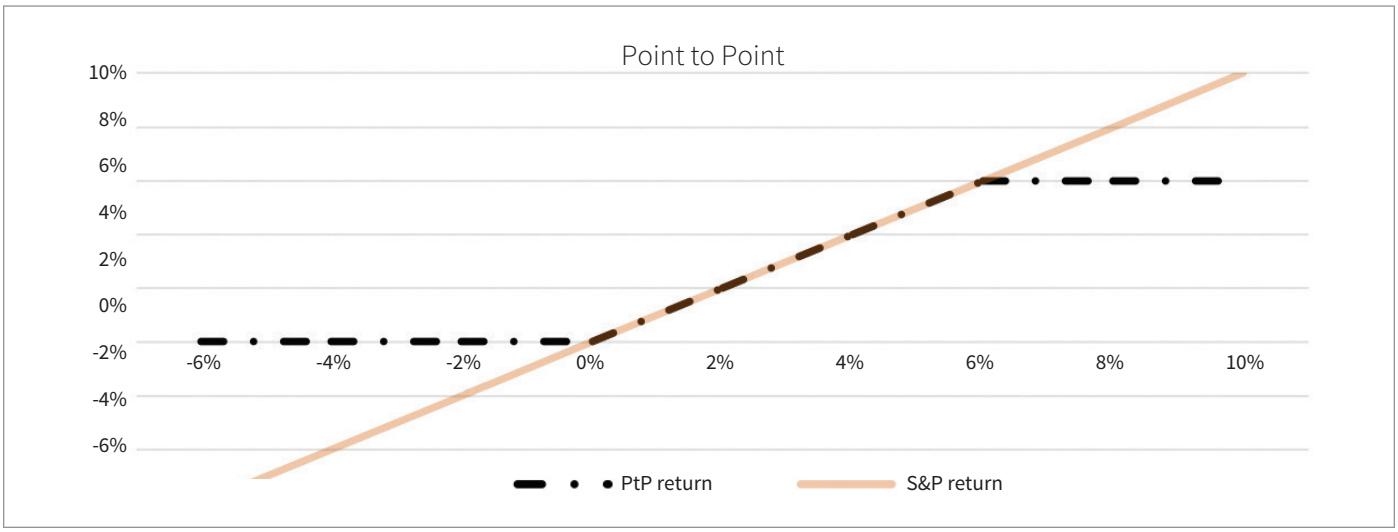
The Point to Point structure

The cap is a limit on what an FIA policy can return. FIAs have caps and floors. The caps help control costs and make it cheaper to have a floor. For the policyholder, the floor is the index guarantee they are buying and in order to keep the costs lower they give up some upside potential (set by the cap).

Insurers have the right to reset these caps on every renewal year. In simulations, however, often times that cap setting does not change. It is reasonable though to model the dynamic nature of that feature in the simulation.

Figure 1

Point to Point with a floor at 0 percent and cap of 6 percent and participation rate of 100%



The cap determined based on the available budget coming from returns on the General Account as well as market environment (cost of options in case of a static hedge).

We will discuss the General Account setup next, but for the completeness of the discussion we recall some relevant structures met in VAs and FIAs for a side by side comparison.

The following are formulas for index growth for Variable Annuities and for Fixed Index Annuities (two of the three most commonly used: Monthly Sum Caps and Point to Point (PTP)):

- VA Fund Performance

$$Fund\ return\ = \frac{S_T}{S_0} - 1$$

- FIA Crediting Mechanics

$$PTP\ = \min\left(cap, p \cdot max\left(0, \frac{S_T}{S_0} - 1\right)\right)$$

$$Monthly\ Sum\ Caps\ = \max\left(0, \sum \min\left(cap, \frac{S_i}{S_{i-1}} - 1\right)\right)$$

where p in the PTP formula is the participation rate.

Looking through the prism of put/call payoff formulas, we immediately see that PTP as well as *Monthly Sum Caps* exhibit that option-like structure.

For VA, capital is invested directly into funds and no optionality is involved. On the other hand, index credits are awarded for the FIAs depending on performance. Market risk is transferred from policyholder to insurer.

Option Budget

The General Account modeling is a common problem for many areas of insurance, including VAs and FIAs. The General Account is mainly composed of a diversified fixed income portfolio invested in Treasuries, corporates and mortgages. It enjoys yield from rates, credit spreads and structure premia.

A Fixed Annuity credits policyholders with the income of this portfolio, less a spread; an Indexed Annuity swaps this credit for an equity option.

In this study we accept a 10y swap rate as a proxy for the crediting rate. It is a reasonable assumption and, most of all, fairly straightforward to simulate.

The 10y swap rate will evolve through time and on each path independently. So will option indices which are used to find the right cap, given the budget.

Hedging Assumptions

In general, insurance companies should consider static or dynamic hedging. In this article, we focus on the static hedge.

Static Hedging is going to be a perfect hedge for the underlying index. However, due to mismatch of lapse assumptions and experience, an overhedge may appear.

Dynamic Hedging on the other hand will require hedge strategy replicated in the coding and requires pricing of assets throughout the projection.

One may also perform hedging of the base policy and GLWB together.

RENEWAL CAP SETTING. ANALYSIS.

The main theme of our article is focused on this problem. We consider two approaches:

- A static cap of 4 percent
- A dynamic cap, which is determined as follows:
  - Option budget estimated as 10y swap rate
  - Obtain European call prices using American Monte Carlo framework
  - Solve for cap/call spread using the option budget and option prices
  - Cap is reset annually

RESULTS OF THE STUDY

Details of the policy contract being modeled:

Base Policy

- Point to Point
- Age 60
- Account Value of $100 at start of projection

GLWB Rider

- Rollup Rate of 5 percent
- Rider Fee of 0.85 percent
- Withdrawals begin at 72 at 6 percent of Benefit Base

The results of the simulation look as follows:

	Static Cap	Resetting Cap
PV (Fees – Claims)	$(0.26)	$2.23
Fair GLWB Fee	0.88%	0.61%
Delta ($)	$0.043	$0.040
Rho ($)	$0.335	$0.605

We immediately see that for this particular setup (in this particular market environment), Resetting Cap case shows higher PV and in consequence a lower fee could be offered to the client. We also observe higher sensitivity to interest rates for Resetting Cap. This is to be expected because the budget for the cap (and hence the cap level) now depends on the level of interest rates (10y swap rate).

We emphasize the dependence of the results on the market environment as it is a crucial component which may swing Static Cap vs Resetting Cap results. It depends on the relationship between levels of interest rates and the cap assumption in the static case.

Another illustration worth looking at is the average claims and fees level:

Figure 2
Dynamic Cap Setting

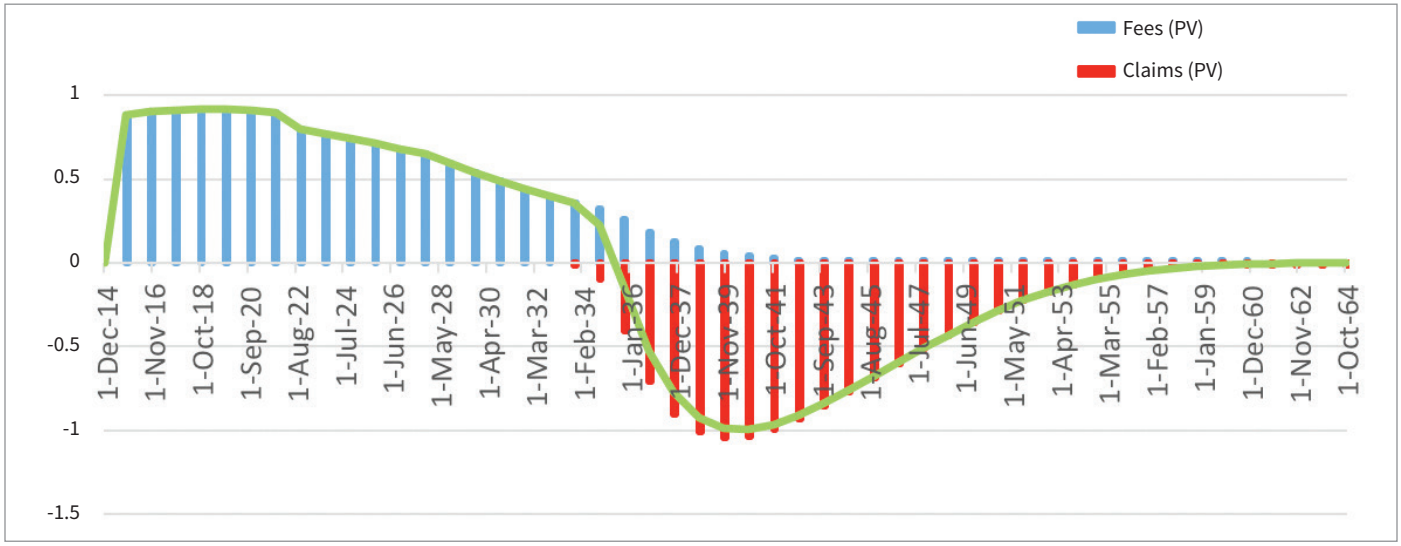
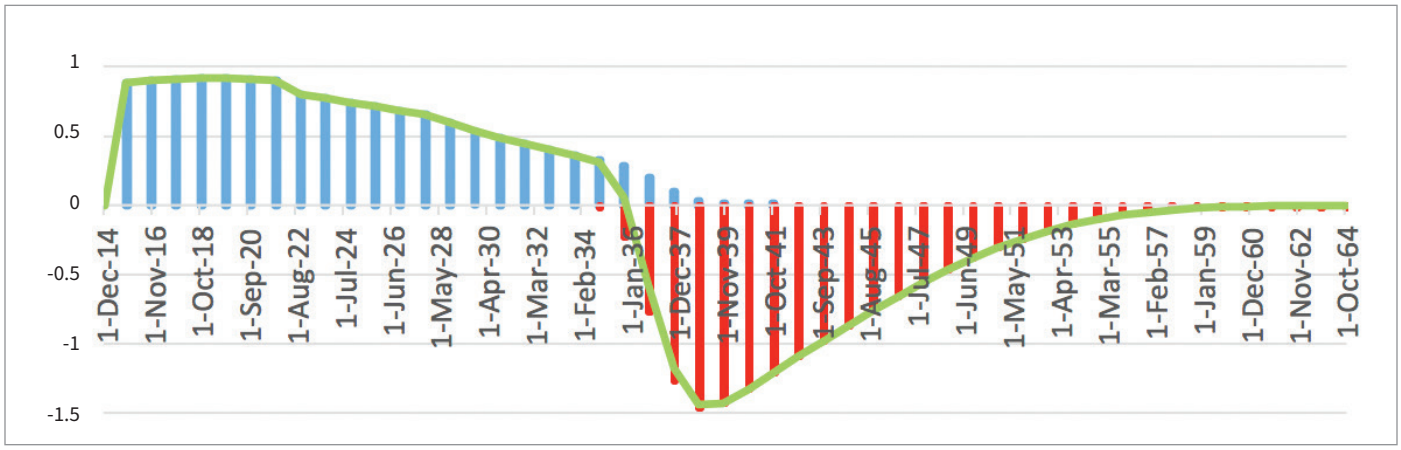


Figure 3
Static Cap



We see that claims (on average) begin sooner with Dynamic Cap Setting. That is to be expected because there will be paths where the cap remains below static 4 percent resulting in lower AV and claims occurring sooner. At the same time, the magnitude of those is smaller due to the term structure allowing one to have a higher than 4 percent cap.

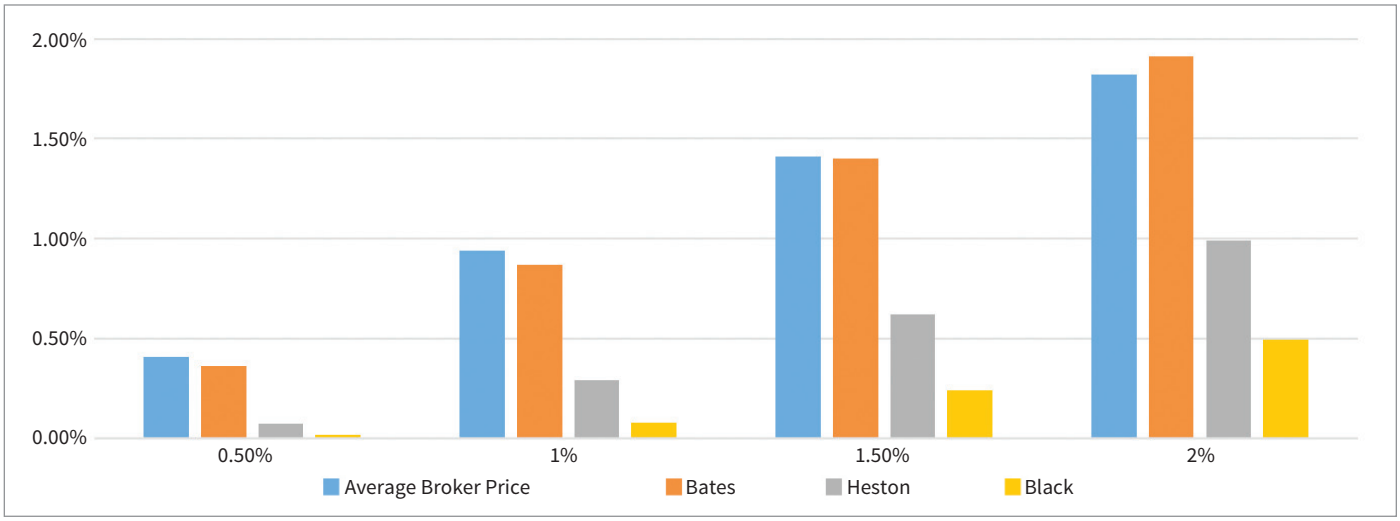
Forward starting optionality may be sensitive to modeling assumptions. We would like to present another example of how drastic of a difference market model choice can make.

MONTHLY SUM CAP: ILLUSTRATION OF IMPACT OF THE MARKET MODEL CHOICE

Monthly Sum Caps (Cliquets) are a popular FIA index choice. Their modeling can be quite challenging and we will illustrate its impact on the prices.

In the case of a base contract being statically hedged by purchasing OTC options, one needs to model the price of those in the future. The following graph illustrates how much of an impact different choices of market models can have on the price:

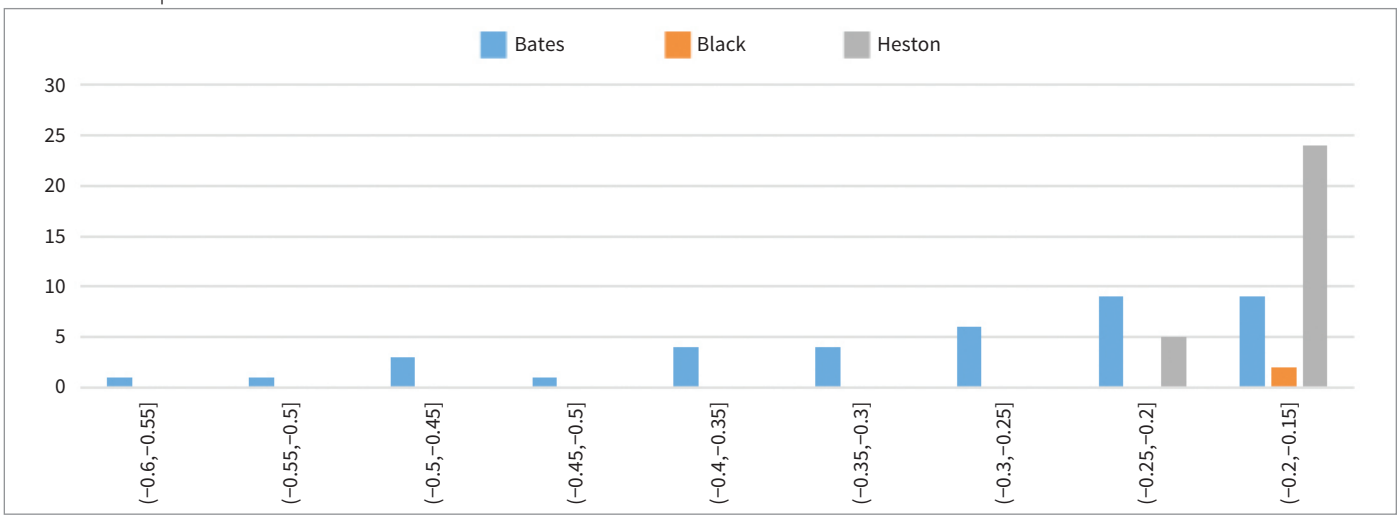
Figure 4
Monthly Sum Cap prices compared with counterparty quotes as of 2/24/15



We see that the choice of using the Bates equity model to price those deals gives one the closest price to the market quotes, but what is more important is that other choices (Heston and Black) result in drastically lower values.

The reason behind such drastic differences lies behind the distribution of returns for those different models (calibrated to the same market data). To further illustrate this observation, the graph below shows a left tail distribution of returns for Bates, Heston and Black models calibrated to the same market data.

Figure 5
Left tail of simple return distribution

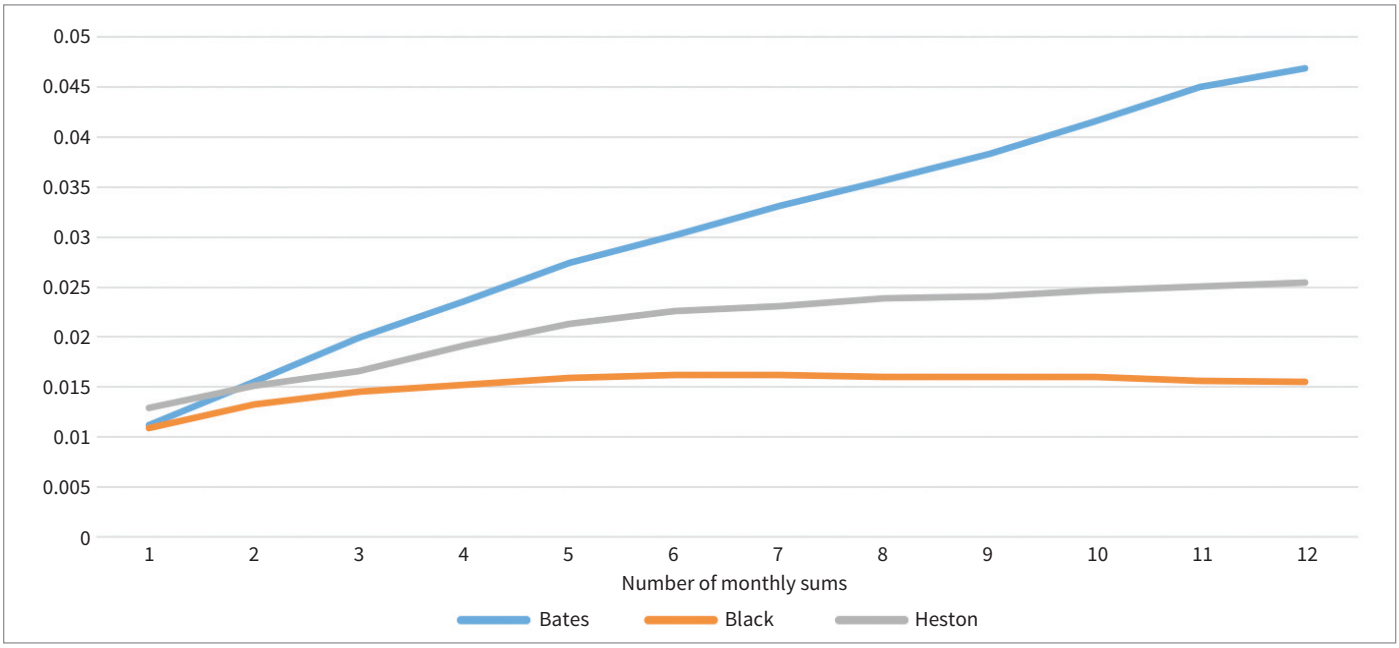


For the sake of readability we omit the full distribution range.

We see, as expected, that Bates and Heston models are heavier in tails than Black. Bates model is much heavier in negative returns than Heston. All of that is relevant to the monthly sum cap. Drawing from a qualitatively same distribution and capping the returns (monthly sum cap) will make those differences even more prominent.

In order to back up that observation with real numbers, we provide the following graph of price of a sum cap under different models and depending on how many sum-periods are considered.

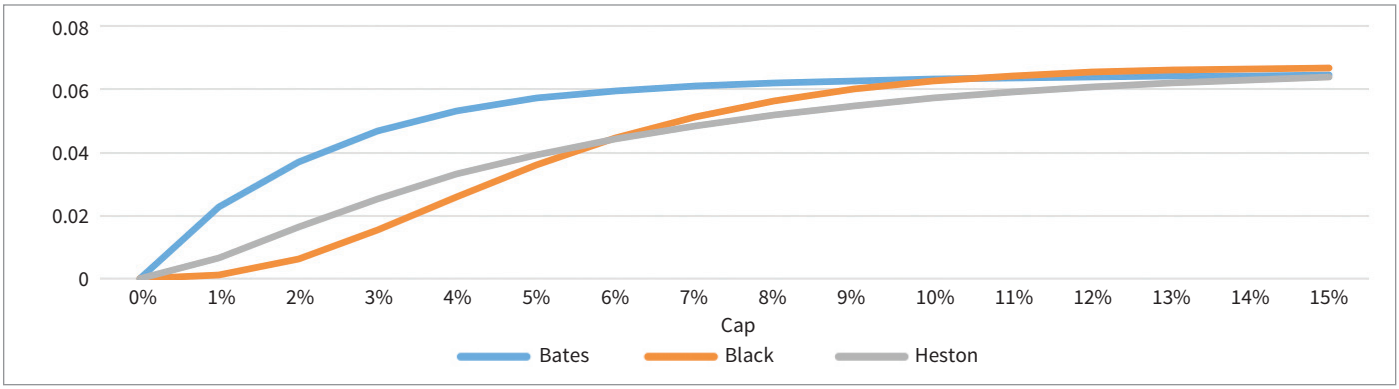
Figure 6
Price of Monthly Sum Cap – 3% cap



Moreover, it is expected that the value of the cap will have significant influence on the results. To see that more easily, one should think of similarities between applying the cap and the shape of the Cumulative Distribution Function of a given distribution. When the cap is (artificially) high, it will have limited effect on the value of the monthly sum cap and one ends up with just valuing the floor. Hence one expects all models to value it similarly. On the other hand, setting the cap equal to zero (see the formula for the monthly sum cap) results in 0 value of the monthly sum cap, regardless of the model.

The shape of the curve (x axis being the cap value, y axis being the value of the sum cap) will depend on the distribution of returns. For the completeness of this part of the study, we present a graph depicting these results:

Figure 7
Value of the Monthly Sum Cap



SUMMARY

In this article, we focus on some problems insurance companies may be facing when modeling Fixed Index Annuities. We illustrate that those challenges are quite impactful and should be taken into consideration in the modeling process. Forward starting optionality, as well as modeling choices (effectively the choice of distribution of returns)—which is seen in both the resetting cap feature as well as pricing of a MSC—should be treated with care and will have significant impact. ■

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Risk Implication of Unemployment and Underemployment

By Kailan Shang

This article summarizes some key points of the research paper entitled Risk Implication of Unemployment and Underemployment. The paper can be found at *http://www.soa.org/Research/Research-Projects/Risk-Management/2015-risk-implications-unemployment-underemployment.aspx.*

The labor market is a critical part of the economic system. Labor is one of the key factors of production, and the employment income earned by labor resources is an important source of income. It affects many aspects of the economy, including consumption, savings, real interest rates, and fiscal policies. Unemployment, as one of the key issues that macroeconomic policies address, is a reflection of the mismatch between supply and demand in the labor market. It has a direct impact on consumption, savings, production, and investment. The unemployment rate is used by policy makers to measure economic activities and social stability. The term "underemployed," which is not included in the standard unemployment rate, refers to involuntary part-time workers or overqualified workers. Like unemployment, underemployment reflects the labor market oversupply, and because of its impact the insurance industry, as part of the economic system, is exposed to the uncertainty of labor market.

For insurance companies, unemployment and underemployment are important not only because of their impact on the economic assumptions, but also their direct impact on the insurance business. **A deep understanding of unemployment and underemployment can help actuaries in economic forecasts, insurance assumptions and risk management.**

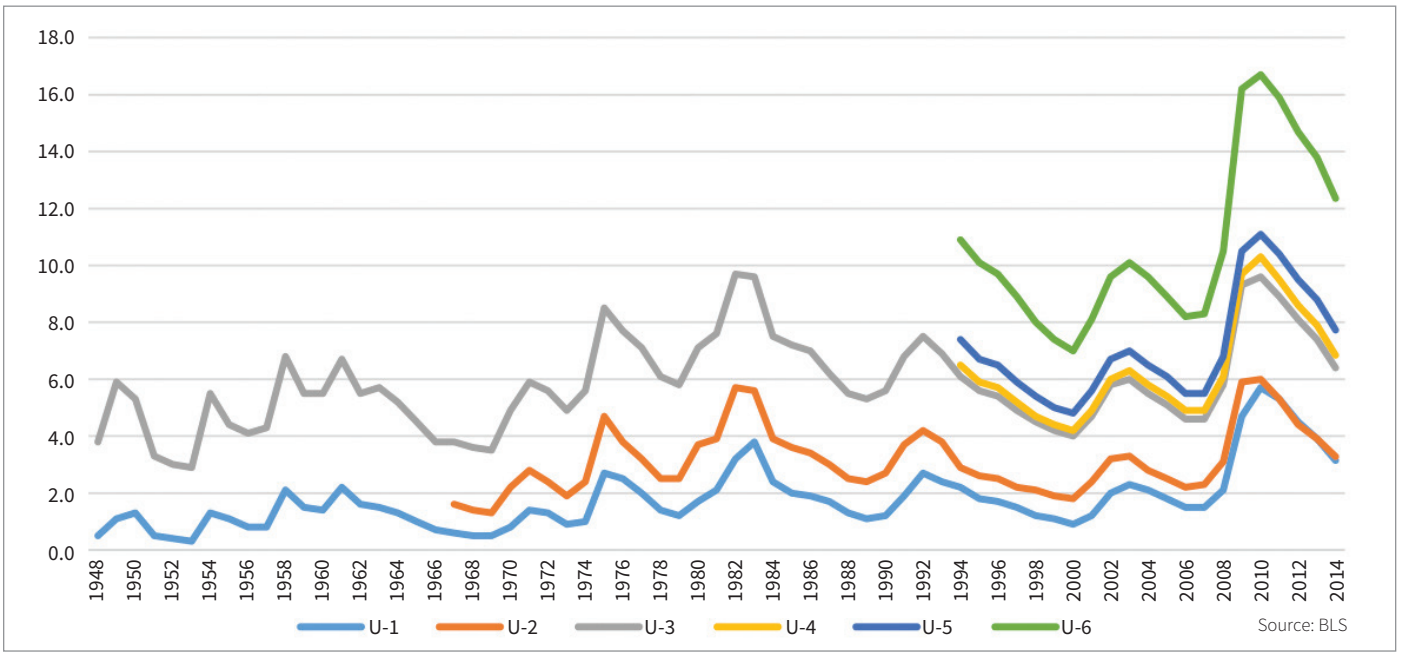
UNEMPLOYMENT RATE AND UNDER-EMPLOYMENT RATE

The Bureau of Labor Statistics (BLS) publishes six different measures of labor underutilization on a monthly basis:

1	U-1 Rate:	Persons unemployed 15 weeks or longer / Labor force
2	U-2 Rate:	Persons who lost jobs+ Persons who completed temporary jobs / Labor force
3	U-3 Rate:	Unemployed / Labor force), the official unemployment rate
4	U-4 Rate:	Unemployed+Discouraged workers[1] / Labor force+Discouraged workers
5	U-5 Rate:	Unemployed+Marginally attached workers[2] / Labor force+Marginally attached workers
6	U-6 Rate:	Unemployed+Marginally attached workers+Involuntary part time workers / Labor force+Marginally attached workers

Figure 1 shows the historical value of the six measures from 1948 to September 2014 when available. The difference between the U-6 rate and U-5 rate can be considered as a measure of time-related underemployment.

Figure 1
Alternative Measures of U.S. Labor Underutilization (Percent)



The six measures turn out to be highly correlated based on the experience data. Therefore, even though the official unemployment rate (U-3 rate) does not encompass everything we want, it can serve as an indicator of changes in other components.

CURRENT MODELING PRACTICE

A survey of unemployment and underemployment modeling practices in the actuarial community was conducted. The use of unemployment and underemployment information in assumption setting is limited, according to the survey result shown below.

Figure 2
Survey Result for Unemployment

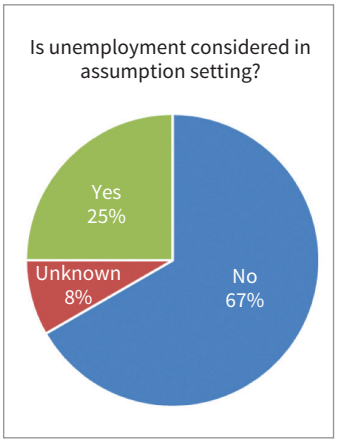
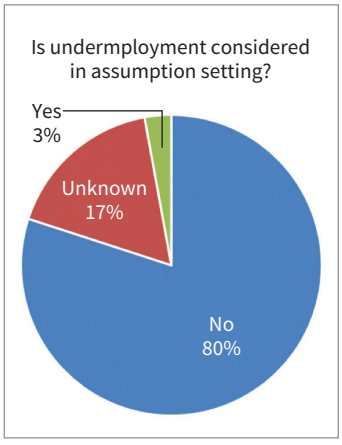


Figure 3
Survey Result for Undermployment



A possible explanation is the high correlation between the labor market and the overall economy. When considering other economic variables, the impact of unemployment and underemployment is incorporated implicitly to a certain extent. The lack of popularity of using information on unemployment and underemployment in actuarial modeling presents an opportunity for further improvement.

ECONOMIC ASSUMPTIONS

Determination of economic assumptions needs to consider the future condition of the labor market. The focus is not the cause-and-effect relationship because it is hard to say whether the labor market causes the changes in other economic variables or vice versa. For example, with a higher interest rate, people have more incentives to save rather than consume, which will cause a slowdown of investment and job openings. A higher unemployment rate is expected in this situation. On the other hand, a high unemployment rate may lead to central bank monetary policies that lower the interest rates.

During a recession, an increase in unemployment normally happens with widening credit spreads, decreasing interest rates and inflation rate, and increased stock market volatility. The unemployment rate and underemployment rate can be used as indicators for future changes in other economic variables. During an economic expansion, the relationship is unclear.

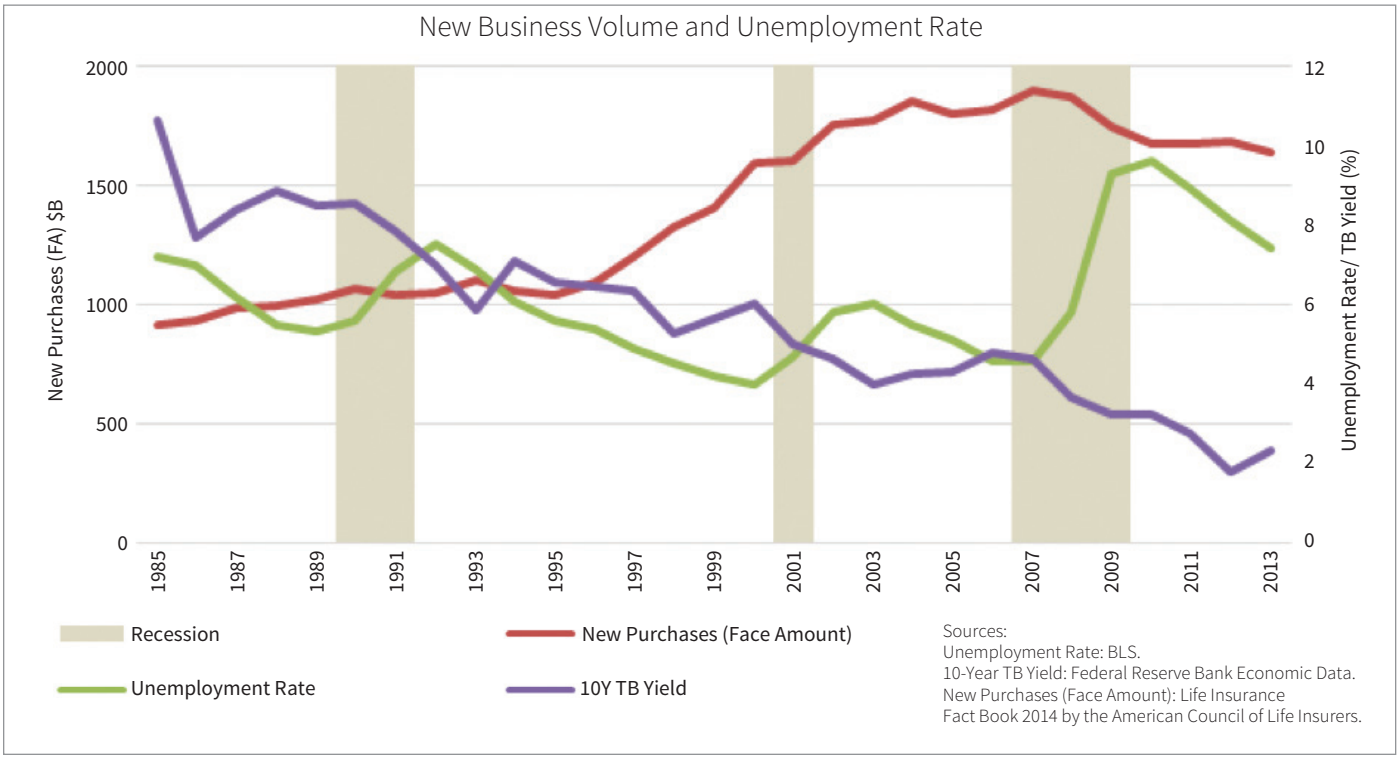
INSURANCE EXPERIENCE

Besides the general economic assumptions, unemployment and underemployment can also affect the experience of products that pay unemployment benefits. They reflect the potential loss of household income. Reduced income may cause policy lapses, reduced future premium payments, reduced new business volume, and so on.

Figure 4 shows U.S. individual life insurance new business volume in terms of face amount from 1985 to 2013. The gray areas are three periods of recession (1991, 2001, and 2007–2009). Unemployment rates and 10-year Treasury bond yields are also illustrated. During the recessions, new business growth slowed with increasing unemployment rate and decreasing Treasury bond (TB) yield. However, **the unemployment rate is better than the bond yield for predicting low business growth** for the following reasons:

1. An increase in the unemployment rate normally triggered a Fed rate reduction, not the other way around.
2. In the data period, an increase in the unemployment rate always triggered a slowdown of business growth. However, a decrease in the TB yield did not always coexist with a slowdown.
3. Around the time of the three recessions, the decreases in TB yield are about the same magnitude. However, during the first two recessions, the individual life insurance business growth rate was near zero. In the latest recession, new business volume decreased significantly. On the other hand, the increase of the unemployment rate was much higher in the latest recession than the previous two. This indicates that the size of change in the unemployment rate can help predict the size of change in business growth.
4. With the TB yield at a low level, if another recession happens in the near future, the room for yield reduction is limited. Therefore, the TB yield is less useful for predicting new business growth at the current level.

Figure 4
U.S. Individual Life Insurance New Business Volume (Face Amount)



The average annual new business volume growth rate measured by face amount is 2.1 percent during the period from 1985 to 2013. Table 1 lists business growth rates, changes in unemployment rate, and TB yield during the three recession periods. It is clear that changes in the unemployment rate have more prediction power than changes in bond yield.

Table 1
U.S. Individual Life Insurance
New Business Growth during Recession

Time Period	New Business Growth Rate (Face Amount)	Change in Unemployment Rate	Change in 10-year TB Yield
1991	−2.6%	1.2%	−0.7%
2001	0.4%	0.7%	−1.0%
2008-2010*	−11.5%	5.0%	−1.4%

*The rate and changes are not annualized for the entire 3-year period.

For prediction, the explained variable Y is the annualized deviation of new business growth rate from the average growth rate of 2.1 percent. The explanatory variable X is the annual change in the unemployment rate. Three data points for (X,Y) are (0.7, -1.7), (1.2, -4.8) and (1.7, -6.0) representing three time periods, 2001, 1997 and 2008-2010, respectively. Given this simple model, the new business growth rate can be projected based on a projected unemployment rate using linear interpolation. For example, if a 1 percent increase of unemployment rate is expected, the growth rate is expected to be -1.4 percent. During the process of business planning, consistency between the unemployment rate and new business growth rate can be achieved based on the fitted relationship.

STRESS SCENARIOS

Labor market instability can be a major cause of an economic crisis. Maintaining a low and sustainable unemployment rate is a major goal of economic policies. Stress scenarios highly related to the labor market can be constructed. The following example shows a stress scenario that starts with a surprising jump in the unemployment rate.

The 2008 financial crisis caused a surge of unemployment rate from a precrisis level of 5 percent to the highest rate of 9.6 percent in 2010. With a basket of economic incentive plans including quantitative easing and interest rate reductions, the unemployment rate dropped to 5.3 percent in July 2015.

However, the labor force participation rate dropped from 66 percent in 2006 to 62.6 percent in July 2015. This can be explained partly by an aging population and partly by discouraged workers who give up on finding a job. Compared to a drop from 67 percent in 1997 to 66 percent in 2006, the recent sharp drop in the labor force participation rate is mainly caused by discouraged workers. The actual labor market conditions have not improved that much as implied by the decrease of the unemployment rate. For simplicity, out of the 3.4 percent drop (66 percent to 62.6 percent), 1 percent is attributed to aging population and 2.4 percent is attributed to discouraged workers.

The average duration of an economic cycle after World War II in United States is less than seven years. It has already been six years since the trough of the latest economic cycle in June 2009[3] and so the risk of having another recession in the near future is not low.

The Fed rate has dropped to a near-zero level for more than six years. A negative rate could be an option, but clearly the possibility and impact of a further reduction of interest rates are small.

Bear commodity markets, especially the oil market, caused job losses and a higher risk of a low inflation rate. At the same time, discouraged workers may come back to the job market. These factors together can cause an unexpected jump in the unemployment rate. Assuming that half of the 2.4 percent of discouraged workers return to the market, the unemployment rate can increase from 5.3 percent in July 2015 to 7.1 percent, which could lead to a series of challenges for insurance companies:

1. *Lower new business volume:* Using the simple linear interpolation model discussed above, a new business growth rate of –4.1 percent is expected given a 1.8 percent increase in the unemployment rate.

Labor market-related plausible stress scenarios are also useful to test a company's ability to take risk.

2. *Higher lapse rate:* More lapses are expected although the impact can be quite different by product lines. The U.S. individual life insurance lapse rate increased from 6.4 percent in 2007 to 7.6 percent in 2008 (American Council of Life Insurers 2014) and gradually decreased to a precrisis level. For simplicity, the same level of lapse rate percentage increase can be assumed for the stress scenario. The lapse rate is expected to increase by 19 percent.

3. *Low interest rate:* A low interest rate environment is expected to persist for a prolonged period.

4. The combination of low interest rates and a higher unemployment rate could make the recovery much more difficult: The next recession is expected to have a much longer duration. For simplicity, a recession period of five years can be assumed, which is twice the length of the 2008 financial crisis.

This possible stress scenario could be used for various purposes, including risk identification, risk appetite setting, capital management, and business planning.

CONCLUSION

The state of the labor market is important for insurance companies. As an indispensable component of the economic system, it affects other economic variables and therefore the economic environment. It also determines employment income, which affects consumption, policyholder behaviors, and new insurance sales. It is beneficial to analyze the impact of unemployment and underemployment. Labor market-related plausible stress scenarios are also useful to test a company's ability to take risk. ■

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ENDNOTES

1 Discouraged workers are defined by the BLS as "persons who are not in the labor force, want and are available for work, and had looked for a job sometime in the prior 12 months. They are not counted as unemployed because they had not searched for work in the prior 4 weeks, for the specific reason that they believed no jobs were available for them."

2 Marginally attached is defined by the BLS as "a group that includes discouraged workers. The criteria for the marginally attached are the same as for discouraged workers, with the exception that any reason could have been cited for the lack of job search in the prior 4 weeks."

3 *http://www.nber.org/cycles.html.*

4 (62.6% × 5.3% + 2.4%/2) / (62.6% + 2.4%/2).

What Is a CAT Model?

By Theresa Krebs

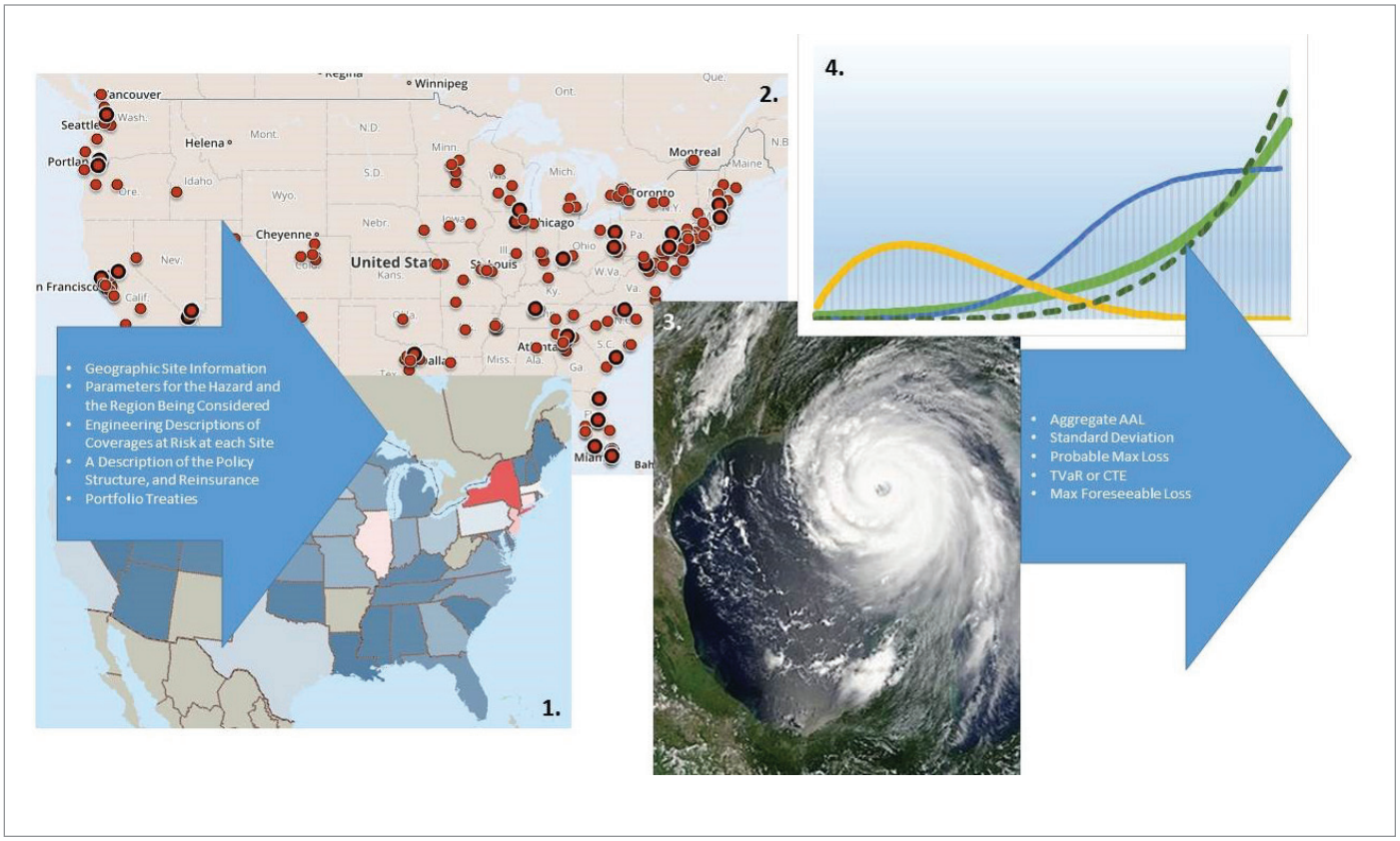
> Below, a vast database of economic exposure... in the middle, 10,000 hurricanes... and above, structural engineering curves of vulnerability to hazard.

I. Introduction: The Three-Decker Sandwich
II. Exposure
III. Hazard
IV. Vulnerability
V. The Financial Module
VI. Conclusion

INTRODUCTION

An influential mentor at Risk Management Solutions once described a CAT model as a 'three-decker sandwich.' In the lowest layer, lies a vast database of economic exposures, including property values by locations and by coverage, along with attributes such as sector and occupancy. The middle decker is a powerful stochastic model of the natural hazard, which represents tens of thousands of individual geographic event footprints, each assigned a frequency of occurrence and each defined in terms of severity of the hazard at each location. The top decker is vulnerability, which begins with the physical fragility of a certain building construction to earthquakes, flood, and hurricanes, but also has to include secondary societal concerns such as business interruption and the cost inflation of repairs when there is a shortage of contract labor following a major catastrophe. In the end, once we've constructed our three-decker sandwich, comes the financial module, which overlays policy terms and conditions onto the 'ground-up' financial output.

So what is a CAT model? It may be best to describe it in terms of its inputs and outputs.



In the flow chart at left, one begins with the underlying economic exposure in image #1, to develop assumptions about geographic distributions of building characteristics. In image #2, we have geocoded the risks associated with the U.S. portion of a large multinational account, and we know the building characteristics and the economic values at each latitude and longitude, as well as any location-specific terms and conditions. In image #3, we evoke the hazard model with an image of Hurricane Katrina. And in image #4, we combine elements of the vulnerability model with examples of model output, both of which are further explained below.

The Probable Maximum Loss (PMLs) is a point along the Exceedance Probability Curve (EP Curve) in which individual scenario losses are ranked and plotted in terms of their cumulative frequency. The EP curve can be plotted both as a loss in an individual event and the aggregate loss over some time period, such as a year. In the aggregate loss there is the question as to what assumption to make about event clustering—whether to treat it statistically as a in a negative binomial assumption or whether to apply a model of spatiotemporal clustering.

PMLs correspond to 'average return periods.' If I talk about the 100-year PML, I do not mean that a given severity event will happen every 100 years. Rather, what I mean that this severity of loss has a 1 percent chance of happening this year, and next year it will again have another 1 percent chance of occurrence.

The Tail Value at Risk is a conditional integration over the EP curve past a certain return period. So the 100-year TCEAEP is the tail of the aggregate EP curve past the 100-year return period.

When CAT models are used to price accounts, the marginal TCEAEP can tell you what the account will do to the portfolio's tail, and this can be considered a risk load.

Now, let's return to our three-decker sandwich.

EXPOSURE

Each model vendor develops a proprietary database of the total and insured building stock, based on a combination of engineering expertise, economics expertise, and data that is purchased from the market. In some underdeveloped markets, without proper data collection capabilities, this exposure data may also be developed based on assumptions about GDP and insurance penetration that come into play. This database helps to calibrate the model to industry loss experience in the final stages of model development. Detailed information about building inventory and construction styles can also be used to supplement data when an underwriter doesn't have information about a risk. Given an occupancy such as a hospital, for example, within a specific territory, a certain percentage will be reinforced concrete, reinforced masonry, steel, or even wood frame. A weighted average of vulnerability curves for each construction type can be applied to the coverage losses.

This concept of conditional probabilities and weighted averages can apply to a number of elements that are not available, such as year built, number of stories, and even "secondary modifiers" such as the type of cladding on a building. This enables an insurer to obtain an overview assessment of an entire portfolio's losses in the face of uncertainty. When writing many risks, this can take advantage of averaging across the portfolio. However, a company that wants to carefully select the better risks will need to collect better data at the point of underwriting.

HAZARD

The first step in modeling a risk begins with accurate geocoding. Given a complete street address, one can find a precise latitude and longitude. The location is assigned a grid cell, and that grid cell has an ID in the stochastic database. This allows for the retrieval of hazard intensity and frequency information for this specific, individual location.

Beyond capturing the properties of individual simulated events, there are questions around how the occurrence of one event affects the potential for another event in the same contract period. Where events are considered completely independent of one another, the Poisson distribution can be applied, in which each event has a unique frequency and is statistically independent of every other event. Where the occurrence of one event increases the potential for there being other events in that season, then the negative binomial distribution might be more appropriate. For earthquakes, the model of time-dependency can be applied where there is enough information about mean recurrence intervals and the time that has elapsed since the last rupture of a particular fault. Also stress transfer models may be appropriate for when the occurrence of one earthquake alters the probability of other earthquakes in the surrounding region. The choice of the model for event occurrence varies by model vendor.

In addition to ambient geophysical conditions such as wind speed, flood depth, and ground shaking, there is another type of hazard that is commonly referred as site hazard. In the case of earthquake, site hazard includes parameters such as the soil type, liquefaction potential and landslide potential at that location. In the case of windstorm, site hazard includes the effects of upwind surface roughness potential. Elevation will also be very critical for modeling the impact of storm surge.

The actual procedures for generating all event footprints, ensuring they span the full range of possible occurrence and identifying the probability of each simulation are generally considered proprietary by the model vendors. One attribute that most models share, however, is called secondary uncertainty,

reflecting the uncertainty in loss estimation, whether related to missing knowledge about what is covered, or imperfect data around the vulnerability, or simply the inherent variability in the way a building has been constructed or the properties of the hazard at that location. Given one earthquake, and two adjacent contemporary buildings of identical construction and style, one may collapse while the other remains standing. In truth, this may come down to resolution and detail and our ability to capture differences in liquefaction potential across a distance measured in feet, but in practice this must be regarded as randomness in the model. As such, it is considered a form of uncertainty, a "distribution around the distribution," and it is used to load the results of the model, increasing the standard deviation and fattening the tail. A key differential across modeling companies comes from whether this secondary uncertainty has the potential to be correlated across the various simulated events in the model. Where the uncertainty is epistemic—i.e., related to our underlying knowledge—it can be expected to correlate across all the events. However some model vendors do not fully capture this correlation.

Each stochastic model is a hybrid of statistical and deterministic methods. At the heart of the model, there is almost always some form of parameterization. Even if we had enough historical data to initialize the model 10,000 times, that data would contain noise, and the noise in the initial conditions would cause the model to veer off. Academic scientists get around this using a method called "normal mode initialization." Modelers employ a range of techniques to explore bias in the output of climate models for example, testing the outputs against actual data—for example on the wind speeds of storms across Europe over the past fifty years. However for tropical cyclones, climate models have not achieved sufficient resolution, and parametric models may be applied, based on the copious information on past track behavior.

Typically, the models are at least somewhat parameterized, and they contain fewer degrees of freedom than the natural data. This does and does not carry implications for risk loading. For example, take the log-distribution of Rmax, the radius to maximum winds of a hurricane from the center. It is normally distributed. Each vendor can decide at what percentile to cut off the distribution. However, this has less implications for the tail than you would think—the further you get out into the normal tail, the lower the event rate and the less it contributes to the whole, so it doesn't necessarily fatten the loss tail nearly as much as you would think. So while companies do load the models for uncertainty in data quality, they generally see no need to compensate for the bounded scatter in the distribution.

Hazard modules vary greatly in their sophistication between vendors. For example, storm surge models can range from fully time-stepping, numerically discrete solutions of the high-viscosity (and therefore highly nonlinear) Navier-Stokes equations, or they may be a simple lookup table that relates the angle of attack of the hurricane, to the continental shoreline, to its minimum pressure and maximum offshore wind speeds. Both actuaries and scientists need to exercise astute caution in interpreting the output of the various CAT models, and understand their strengths and weaknesses.

VULNERABILITY

While every module of a CAT model is uncertain, the vulnerability module can be at once the most uncertain and the most influential. At the heart of the vulnerability model is the "vulnerability curve," a classically S-shaped curve that is bounded by a standard deviation, and which relates hazard on the X-axis to a ground-up "damage ratio" on the Y-axis.

The standard deviation around the vulnerability curve is the essence of secondary uncertainty. Each vendor assigns a proprietary distribution around that standard deviation and integrates over the distribution. The vulnerability team carries the greater burden of uncertainty and expert judgment.

Vulnerability requires a strong understanding of the performance of different building types under a range of loads. Wood frame, for example, performs extremely well in earthquakes, while reinforced concrete, built to code can also be very resistant to earthquake shaking, although not when built without proper reinforcing, or the attentions of an engineer. Steel performs relatively well, while masonry, especially unreinforced masonry, performs terribly.

In a hurricane, wood frame performs terribly. Masonry is prone to water damage, and the stiffness of the walls can cause tension between the walls and the roof. Concrete, including reinforced concrete, performs extremely well. Steel performs well, but glass surfaces and certain forms of cladding do not. The behavior of the roof—its configuration, its attachment to the frame, the materials of which it is made, and whether the frame forgives the flexing of the roof—all can be strong determinants of the performance of a building in a hurricane.

THE FINANCIAL MODULE

Once the ground-up loss is calculated for a single location, location-level policy terms such as site limits and site deductibles can be applied to achieve a gross location-level loss that is only net of the location-level terms. This in turn can be aggregated over the entire location schedule underneath the layer for each stochastic event. Lastly, policy terms and conditions are applied. The gross and net-of-fac losses can be re-allocated to the location level using deconvolution, a task that is made much easier by the assumption of a Poisson distribution.

CONCLUSION

CAT models are complex, and it often can be difficult to determine what is driving a large modeled loss or a change upon renewal. The levers are many. However, modelers strive to be rational, a-political, neutral arbiters of the true financial loss, indifferent to hard or soft markets. To this end, each model is steadily becoming more state-of-the-art. Over time, each geophysical model becomes less and less parameterized—in fact, some storm surge models are fully dynamic, time-stepping, academic models that are run on Linux clusters to develop the stochastic database. CAT models are getting better every day, and as they improve, uncertainty decreases. ■

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What is Model Vetting?

By Stephanie Beaulne

Model risk management is a growing concern in the insurance industry. This is in reaction to the subprime crisis, which, in part, can be attributed to overreliance on a model. When calculating aggregated risk, the Gaussian copula model assumed there was independence between mortgages when in fact they were highly correlated. Due to the assumed independence, low interest rates and a high level of approval of subprime mortgages occurred. In reaction, the regulators around the world are providing guidance:

- U.S. Federal Reserve Board (FRB) set new requirements for the banking sector in 2011;
- Solvency II provided a framework for insurers in Europe;
- Basel III introduced additional safeguards against model risk and measurement error;
- North American CRO council issued the Model Validation Principles Applied to Risk and Capital Models in the Insurance Industry

They all recommended/proposed, to different extent, a framework for model risk including the creation of an independent review process.

EVOLUTION OF MODEL VETTING

Crises that occurred prior to the subprime crisis, namely the 1998 collapse of the Long-Term Capital Management hedge fund and the stock market crash of 1987, had already created concerns on the use of models for insurance companies.

In the early days, model vetting—when it existed—was not as structured as it is today. In general, the most significant models were to be documented following some documentation guidelines. In addition, there was some level of peer review.

The next phase was the creation of a model inventory. The notion of independence in the review was also introduced. The most significant models were vetted through oversight committees. The responsibilities of these committees were to:

- Ensure the ongoing integrity of the models;
- Ensure the model is in accordance with regulator/internal guidelines/standards/policies;
- Ensure the appropriateness of the change process;
- Ensure appropriate documentation exists.

These committees consisted of experts on each model component and risk management. The reviews were high level as there were no resources to do a more thorough review. For example, ensuring that appropriate documentation exists would consist in confirming that every subject required in the internal model documentation standard was covered.

Nowadays, many insurers established a model risk framework and have a team dedicated to model vetting. This team performs some independent review of the models' results using an alternative model (usually a different platform). The level of granularity of this review may vary from one insurance company to another and from a model to another. Full replication of a model is resource intensive and it may not be possible computer power-wise to process an entire block of business.

WHAT IS A MODEL?

Model risk management policies and guidelines must be clear, comprehensive, and globally applicable to ensure consistency in vetting work. Defining what a model is is not straight forward. For example:

The Board of Governors of the Federal Reserve System provided the following definition of model in its Supervisory Guidance on Model Risk Management issued on April 4, 2011: "the term model refers to a quantitative method, system, or approach that applies statistical, economic, financial, or mathematical theories, techniques, and assumptions to process input data into quantitative estimates. A model consists of three components: an information input component, which delivers assumptions and data to the model; a processing component, which transforms inputs into estimates; and a reporting component, which translates the estimates into useful business information"

The CIA Draft Educational Note issued October 2015 on the Use of Model defines model as "a practical representation of relationships among entities or events using statistical, financial, economic, or mathematical concepts. A model uses methods, assumptions, and data that simplify a more complex system. A model is composed of a model specification, a model implementation, and one or more model runs. Calculation simple enough to be effectively performed manually would not be considered a model."

MODEL INVENTORY

Whatever the chosen definition is, an inventory containing all the models must be built. When maintained, the inventory becomes a powerful tool to assess the risk related to each model and to monitor progress. Helpful information that can be found in the inventory is (but not limited to):

- General model description (purpose, owner, last/next vetting date, any limitation);
- Materiality assessment (annual sales, IFRS reserve);
- Exposure to errors assessment (based on pre-selected criteria);
- Unresolved issues from last vetting.

VETTING PROCESS

The vetting process is a collaborative work between the vetting team and the model owner(s). The first step is to meet with the model owner(s) and discuss what is needed by the vetting team in order to perform their work. A vetting plan must be developed to formalize the different milestones of the project: time constraints, order in which the model should be vetted and to what extent, or performance testing. It can also be used to address some concerns about the model that the model owner has. If required, the model owner can provide an overview of the model.

The next step is to get familiar with the product(s) linked to the model. A review of the marketing documentation as well as the model documentation is required. Particular attention must be given to the product features and model limitations.

Then, it is time for programming. An independent tool must be built to reconcile the results based on the requirement of the vetting plan. Any change to the plan must be communicated to the model owner. When issues are identified, the feedback of the model owner is required.

The final step is to prepare a report describing the review performed, the findings including the comments of the model owner and an opinion on whether or not the model is valid for its documented purpose. The report should be approved by an independent, appropriate member of management (e.g., a VP of Risk) and distributed to all the stakeholders.

FUTURE CHALLENGES

Whenever a model is used there is model risk. Model vetting practices have changed through time. The pace of the changes has increased recently. In order to maintain the insurance companies' models sustainability, efficiency and integrity, the model vetting teams will have to:

- Enforce the model risk culture within the insurance company outside of the risk department. Roles and responsibilities of every stakeholder must be clearly defined.
- The vetting process must be disclosed to the model owners so they can more accurately provide documentation/information.
- Align the vetting work with other model risk reviews such as SOX to avoid duplication and/or gaps.
- Determine a balance between work details and associated risk to optimize the use of resources.
- Develop an appropriate way to demonstrate to management how their work helps reduce the model risk the company is facing. This is especially important as, unlike other risks, model risk cannot be monitored with the use of quantifiable limits. The "amount" of model risk is mostly based on judgement. ■

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Corporate Pension Risk Management and Corporate Finance

By Liaw Huang and Minaz Lalani

Author's Note: The following is excerpted and based on the Society of Actuaries' research report entitled Corporate Pension Risk Management and Corporate Finance: Bridging the Gap between Theory and Practice in Pension Risk Management *by Liaw Huang and Minaz Lalani, published in August 2015.*

"Since the 2007–2008 recession, de-risking has become the most-discussed topic in corporate pension risk management. Despite this trend, the authors believe that the actuary's role in decision-making at a corporate strategic level regarding defined benefit (DB) pension plans has typically been confined to the pension silo; in other words, the actuary's advice regarding decision-making on corporate defined benefit plans is often limited to statutory and accounting requirements and typically without regard to corporate finance considerations at an enterprise level. However, over the past 10 years, major decisions regarding corporate DB pension plans, such as freezing of defined pension plans or transferring pension risks to insurers, have been made in a corporate finance framework at an enterprise level. Similarly, corporate pension funding policies and investment policies are being analyzed within a set of corporate finance metrics. Therefore, there is a need for actuaries to understand current corporate finance practices and be able to provide strategic and holistic solutions for corporate decision-makers."

To this end, the report, *Corporate Pension Risk Management and Corporate Finance: Bridging the Gap between Theory and Practice in Pension Risk Management* was completed by the authors to survey current literature to fill this void for actuaries.

The authors discuss the elements of a "strategic" pension risk management framework from a corporate finance perspective. By "strategic" the authors mean the level of how much pension risk a corporation should take and where on the corporation's capital structure the risks should be taken. An understanding of the following appears to be essential for developing a strategic pension risk management framework:

1. Key corporate metrics used by the corporation for operating their business and how corporate defined-benefit pension plans impact these metrics
2. Approaches to quantifying the trade-off between risk and capital
3. Empirical studies on how pension plans impact shareholder value

Based on current literature, it is clear that different corporations employ different processes for risk management and strategic planning, however they mostly always involve financial metrics and capital allocation procedures. In addition, any corporate action that may have a potential to result in negative market reactions is usually a "no-go" from the "get-go."

The most visible corporate metric impacted by pension plans is corporate leverage - for example, the debt to equity ratio. To calculate corporate leverage properly, it is important to use the augmented or holistic balance sheet, where pension assets and liabilities are integrated with other operating assets and liabilities. When pension liabilities are recognized as long-term debt, the debt to equity ratio usually increases. Realizing the insufficiency of the accounting balance sheet, the rating agencies have made adjustments to the calculation of various corporate metrics to take into account the impact of corporate pension plans.

A less recognized, but equally important, consideration is the impact of pension plans on a corporation's weighted average cost of capital. If the pension plan is not taken into account, the weighted average cost of capital may be overestimated. In their 2006 paper, Jin, Merton, and Bodie[1] looked at several companies and concluded that the overestimation could be as high as 30 percent.

Appropriately adjusting corporate metrics for pension plans is the first step toward strategic pension risk management. Next, a strategic pension risk management framework should consider the trade-off between holding equity capital and mitigating pension risk. The more risk a corporation assumes, the more capital is required. The authors explain,

"This trade-off is made explicit with financial companies that have capital requirements. Here the concept of value at risk is used. For example, a company may hold enough capital to survive a 1-in-200 year event with respect to its pension plans; that is, a company may want to have enough liquid assets or can raise additional funds to cover pension shortfall at the 99.5 percent level, so that the pension shortfall would not bankrupt the company."

"More generally, pension risks give rise to volatility in corporations' financial statements. How do corporations evaluate this volatility and decide how much to spend to mitigate pension risks? This is generally described as risk budgeting."

Besides using value at risk, two other approaches are possible. The first approach is the traditional sensitivity analysis, where

"… pension volatility is translated into its impact on corporate earnings and cash flows. The impact on earnings or cash flows is multiplied by a market multiple to estimate its impact on a corporation's stock price. Alternatively, the net present value of contributions is calculated."

"The other approach is based on the beta of a corporation's stock. Pension risks increase the beta of a corporation. By targeting a fixed beta, one can calculate how much equity capital is needed for a given level of pension risk. This approach is presented by Merton in his analysis of the weighted average cost of capital."

A detailed exposition of these concepts as well as numerical examples can be found in the report.

Finally,

"Empirical evidence helps to validate the perspective of corporate finance on pension plans, and provides helpful guides for selecting the right financial metrics to focus on. For example, corporate managers may not want to focus only on pension underfunding, but also on the size of the pension liability, and the relationship of pension liability to the market capitalization of the corporation, since these relationships tend to impact stock prices and credit spreads."

The authors conclude,

"To move toward a more holistic way of including pension plans in corporate planning and risk management, key financial metrics should be adjusted for pension and pensions should be included in the process of risk budgeting. Such information will in turn inform corporate decision-makers on the appropriate strategy for managing the pension plans. It is likely that different corporations will focus on different financial metrics and develop their own processes of risk management and capital allocation that are appropriate for their respective business. Thus it may not be possible to have a single process that will work for all corporations. Nevertheless, we have identified elements of pension analysis from a corporate finance perspective that can be integrated into such processes." ■

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ENDNOTE

[1] Jin, L., Merton, R., & Bodie, Z. (2006). Do a firm's equity returns reflect the risk of its pension plan? Journal of Financial Economics, (December). Retrieved from *http://www.sciencedirect.com/science/article/pii/S0304405X05002370*

Recent Publications in Risk Management

As an ongoing feature in *Risk Management*, we will provide recent publications we find noteworthy to our readers. Please send suggestions for other publications you find worth reading to *dschraub@soa.org*, or *cheryl.by.liu@fwd.com.*

Casualty Accumulation Risk
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Global Risks Report 2016
WORLD ECONOMIC FORUM
http://www3.weforum.org/docs/GRR/WEF_GRR16.pdf

Forward look, Top regulatory trends for 2016 in insurance
DELOITTE
https://www2.deloitte.com/content/dam/Deloitte/us/Documents/financial-services/us-outlooks-top-regulatory-trends-for-2016-in-insurance-reg.PDF

Actuarial model governance: Empowering people with technology
MILLIMAN
http://us.milliman.com/uploadedFiles/insight/2016/20160205_2168LDP_Actuarial-Model.pdf

Operational risk modelling: common practices and future development
INSTITUTE OF RISK MANAGEMENT
https://www.theirm.org/media/1454276/IRM_Operational-Risks_Booklet_hi-res_web-2-.pdf

The Global Risks Report 2016

By The World Economic Forum

Editor's Note: This article has been excerpted from the Global Risks Report 20161, 11th Edition, published by the World Economic Forum in 2016. It is reprinted here with permission. Copyright World Economic Forum, 2016.

EXECUTIVE SUMMARY

Now in its 11th edition, The Global Risks Report 2016 draws attention to ways that global risks could evolve and interact in the next decade. The year 2016 marks a forceful departure from past findings, as the risks about which the Report has been warning over the past decade are starting to manifest themselves in new, sometimes unexpected ways and harm people, institutions and economies. Warming climate is likely to raise this year's temperature to 1° Celsius above the pre-industrial era, 60 million people, equivalent to the world's 24th largest country and largest number in recent history, are forcibly displaced, and crimes in cyberspace cost the global economy an estimated US$445 billion,[1] higher than many economies' national incomes. In this context, the Report calls for action to build resilience – the "resilience imperative" – and identifies practical examples of how it could be done.

Geopolitical concerns remain prominent in the minds of respondents to the Global Risks Perception Survey for the second year in a row. The *Report* therefore delves into the international security landscape and explores what drives this evolution and, in particular, how it could be affected by the Fourth Industrial Revolution and climate change. The three scenarios for possible futures developed in this context inform new ways of building resilience to security threats through public-private collaboration.

The *Report* also steps back and explores how emerging global risks and major trends (see Box 1), such as climate change, the rise of cyber dependence and income and wealth disparity are impacting already-strained societies by highlighting three clusters of risks as Risks in Focus. As resilience building is helped by the ability to analyse global risks from the perspective of specific stakeholders, the *Report* also analyses the significance of global risks to the business community at a regional and country-level.

DEFINITION OF GLOBAL RISKS AND TRENDS

A global risk is an uncertain event or condition that, if it occurs, can cause significant negative impact for several countries or industries within the next 10 years. A global trend is a long-term pattern that is currently taking place and that could contribute to amplifying global risks and/or altering the relationship between them.

THE GLOBAL RISKS PERCEPTION SURVEY

Almost 750 experts and decision makers in the World Economic Forum's multistakeholder communities responded to this year's Global Risks Perception Survey. Respondents are drawn from business, academia, civil society and the public sector and span different areas of expertise, geographies and age groups.

The survey asked respondents to consider 29 global risks – categorized as societal, technological, economic, environmental or geopolitical – over a 10-year time horizon, and rate each according to their perceived likelihood of it occurring and impact if it does.

After its presence in the top five most impactful risks for the past three years, the **failure of climate change mitigation and adaptation** has risen to the top and is perceived in 2016 as the most impactful risk for the years to come, ahead of **weapons of mass destruction**, ranking 2nd, and **water crises**, ranking 3rd. Large-scale involuntary migration was also rated among the top five for impact, as was **severe energy price shock (increase or decrease)**.

The risk rated most likely was **largescale involuntary migration**, with last year's top scorer – **interstate conflict with regional consequences** – giving way to the environmental risks of **extreme weather events** and the **failure of climate change mitigation and adaptation** and followed by **major natural catastrophes**.

Global risks that remain serious because of their combined impact and likelihood involve some economic risks, including **fiscal crises in key economies** and **high structural unemployment and underemployment**. These are complemented by **cyberattacks** and **profound social instability**. Their assessment reflects the potentially profound impact of the Fourth Industrial Revolution on the economy and society and emphasizes the need for safeguarding future benefits.

Respondents were also asked which risks were related and could give rise to cascading risks. Three emerged strongly: the potential for **climate change to exacerbate water crises**, with impacts including conflicts and more forced migration, calling for improved water governance to adapt to climate change and

accommodate a growing population and economic development; the need to **address the global refugee crisis**, adding emphasis to policies that can build resilience in addition to responding to the immediate crisis; and the risks of failing to fully understand the risks around the Fourth Industrial Revolution and how this transition will impact countries, economies and people at a time of persistently sluggish growth.

RISKS IN FOCUS

Key to building resilience is the stability of societies. The first Risk in Focus therefore looks at the complex dynamics of societies in the age of digitization and discusses the phenomenon of the **(dis)empowered citizen**, which is a result of the interplay of varying dynamics: as technology empowers citizens to find information, connect with others and organize, those citizens feel disenfranchised by distant elites. It explores the risk of social instability if both governments and business embark on either repressive actions or non-action out of uncertainty about how to deal with a more informed, connected and demanding citizenry, which could lead to an escalating downward spiral of broken trust and harsher response on either side. The chapter also, however, explores the benefits governments and business stand to gain by proactively looking for ways to engage with concerned citizens.

Food security risk in the context of climate change is the second Risk in Focus. Building upon the climate-water nexus discussed in Part 1, the chapter looks at how changing climate and weather patterns could jeopardize food security and agricultural production across geographies. The most climate vulnerable countries often heavily depend on agricultural productivity to sustain economic growth and development. But the recent years have also shown the climate vulnerability of G-20 countries such as India, Russia and the United States – the breadbasket of the world – and other large industrial producers of agricultural commodities. The chapter discusses how climate change resilient crops and supply chain networks, as well as financing and insurance schemes, can help mitigate the social, economic and environmental aspects of food security risks related to climate change.

Drawing lessons from the Ebola crisis, the third Risk in Focus discusses **global disease outbreaks**. It warns that population growth, rapid urbanization and increasing transnational flows of commodities, people and animals intensify the risk of infectious transmission across geographies while equally diminishing the ability to respond – all at a time of growing resistance of microorganisms to today's most effective medicines. Preparedness and response measures range from the behavioural, such as fact-based communication and education campaigns, to the need to invest in diagnostic, drug and vaccine R&D and in its enabling environment, especially advancing a regulatory framework. It raises the imperative for public-private sector collaboration across areas such as data availability and analysis, a joint research agenda, regulatory frameworks, long-term financing and ways to promote responsible media engagement as part of effective crisis management communication.

For each Risk in Focus, examples are given of three practical mechanisms that can build resilience against the identified threats.

RISKS TO DOING BUSINESS

Private sector respondents to the World Economic Forum's Executive Opinion Survey were asked to identify their risks of highest concern for doing business in the next 10 years. The responses, from 140 economies, reveal patterns of concern at country and regional levels that can usefully inform initiatives to engage the private sector in building resilience to global risks.

On a global scale, two economic risks – **unemployment and underemployment** and **energy price shocks** – are mentioned as the top risks of highest concern for doing business in half of the 140 economies. These are followed by the failure of national governance, fiscal crises, asset bubbles and cyberattacks.

Economic risks predominate in responses from **Europe**, including fiscal crises, unemployment, asset bubbles and energy prices – the latter also being the top concern in **Canada** – while executives in the **United States** are most concerned about cyber-related risks and attacks. Respondents from Central Asia and Russia worry about fiscal crises and unemployment, along with the risks of unmanageable inflation and interstate conflict. Environmental risks worry business leaders in East Asia and the Pacific, alongside energy prices, asset bubbles, and cyber attacks.

In **South Asia** concerns also include energy prices, together with fiscal crises, unemployment and failure of national governance – which is the top concern in **Latin America and the Caribbean** – followed by energy prices shock and unemployment. Executives in the **Middle East and North Africa** likewise worry about energy prices, together with unemployment, terrorist attacks and interstate conflict. In **Sub-Saharan Africa**, the business community's top concerns include unemployment, energy prices, the failure of national governance and the failure of critical infrastructure. ■

ENDNOTE

[1] The full report can be downloaded at *http://www3.weforum.org/docs/GRR/WEF_GRR16.pdf* and the French version of the Executive Summary is available at *http://www3.weforum.org/docs/Media/GRR16_ExecutiveSummary_FR.pdf.*

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