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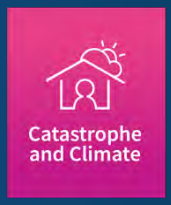

GROWING LIFE AND HEALTH INSURANCE INDUSTRY RISKS FROM CATASTROPHIC EVENTS AND HOW INDUSTRY WILL MODEL THEM

AUGUST | 2024

Growing Life and Health Insurance Industry Risks from Catastrophic Events

How the Insurance Industry Will Model Them

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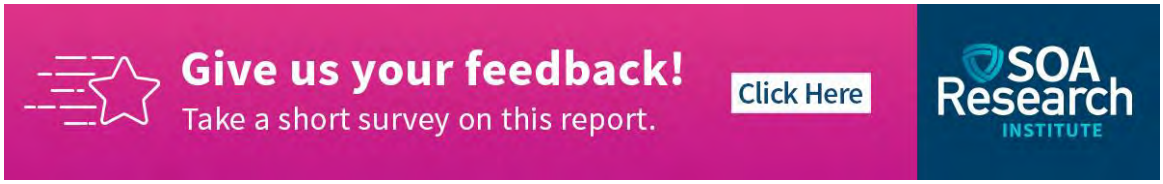

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Executive Summary

On May 1, 2024, the Society of Actuaries Research Institute gathered a panel of experts to discuss the growing risks from catastrophic events in the life and health insurance industry and how to model these risks. The panel members were from actuarial, catastrophe risk modeling, and risk management backgrounds. The outcomes of this panel discussion are summarized below and form the basis of this report.

1. Besides traditional catastrophic events like pandemics, there are nontraditional risks that could be catastrophic for life and health insurers. Among them are the threat of nuclear war, effects of climate change, and negative consequences to humanity of technology use and artificial intelligence. In addition to the initial event, life and health insurers should integrate the downstream outcomes of these events into their risk management modeling. These downstream results could be significant disrupters to business as usual. Using the recent COVID-19 pandemic as an example, the result of social isolation during the pandemic could have a large effect on future morbidity and mortality.

2. The link between catastrophic events and U.S. infrastructure should not be minimized. Some infrastructure has shown itself to be vulnerable to flood risk, extreme temperatures, and other climate related risks.

3. Climate risks are of growing concern for life and health insurers. Changing climate patterns and increasing frequency and severity of climate related events like flooding, wildfires, and heat waves can lead to more future fatalities, injuries, and illnesses than historically observed.

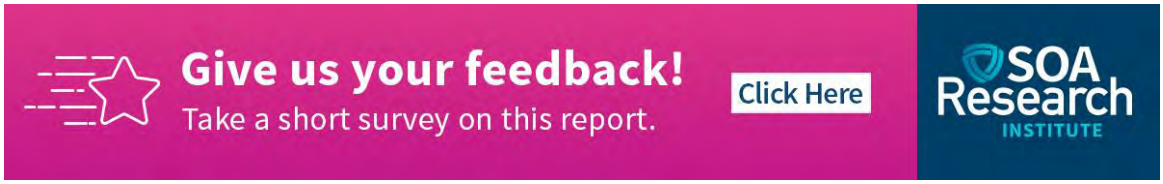
4. It is important for catastrophe (Cat) model builders to understand what Cat model users need, and for Cat model users to have a full appreciation for the capabilities of the models that are constructed.

5. Data limitations, trends, and the way that model outcomes will be utilized by life and health industry professionals are important for modelers and model users to understand, as are the uses of the model such as for short term (acute) or long term (systemic) hazards.

6. Cat models can cover a wide range of events, and model users can have a broad range of risk appetites. A full range of scenario analysis could be done, and it will be good to consider not only what has happened, but what could happen, even if not thought to be likely. The models can show the sensitivity to variables and the range of what can happen. Catastrophe modeling is a good way to highlight the possibilities of what could happen, and even if it may seem unlikely.

7. Cat modeling can be implemented into life and health insurance company books of business, and positive outcomes can occur from catastrophes that have a favorable impact. Modeling can help

companies understand how disruptions can occur which are positive, and companies can be prepared for such opportunities.



Section 1: Growing Life and Health Insurance Industry Risks from Catastrophic Events

Traditionally, catastrophic events have been thought of as low frequency, high severity events. Examples of this are earthquakes and hurricanes. But today's environment is more complex with infrastructure systems interconnected globally. Something that occurs in one part of the world may also have devastating consequences in other areas. Within the insurance industry, the traditional view of catastrophic events is broadening to recognize risks from downstream consequences and the accumulating impact of the initial event.

1.1 INSURANCE INDUSTRY RISKS FROM TRADITIONAL CATASTROPHIC EVENTS

Each year the Society of Actuaries Research Institute surveys risk professionals to gather thoughts on emerging risks and to identify risk trends. In the most recent survey, the seventeenth in the series, administered in the fall of 2023, respondents considered 23 catastrophic events that fell into five broad risk categories.[1] The list shown in Appendix A kicked-off the discussion from which the following nine were identified as potential catastrophic events for life and health insurers. The items are listed in the order they were introduced

1. Infectious disease and pandemics including influenza, SARS, COVID-19, Ebola, antimicrobial resistant superbugs; and vector-borne diseases like Zika and West-Nile viruses.

2. Extreme geophysical events and in particular earthquakes especially in populous areas near a fault such as in California or in Washington with the Cascadia Subduction Zone. Volcanic eruptions are also in the category especially supervolcanoes like the Yellowstone Caldera.

3. Tropical cyclones, extra-tropical cyclones, and severe convective storms such as hurricanes, typhoons, cyclones, or inland thunderstorms, tornadoes, and hail.

4. Perfluoroalkylated substances (PFAs), "forever chemicals," microplastics and the effects on the environment and human health.

5. Effects of climate change such as direct effects of droughts, extreme heat and cold, wind, snow, dust storms and so on that affect property and people. There are also indirect effects such as its impact on ecosystems which makes catastrophic risks much worse and can create famine and water shortages.

6. Terrorism, especially bioterrorism.

7. The likelihood of wars and the use of weapons of mass destruction are increasing given the political environment and instability seen in many parts of the world with leaders of one nation threatening to engage in nuclear warfare with another nation. While it is very unpleasant to think that it may occur, a resilient, informed, and prepared infrastructure can help mitigate the impact of this and other catastrophes. Yet, political disinterest, strife and division can make this difficult to achieve.

[1] Rudolph, Max. 2024. 17th Emerging Risk Survey Key Findings Report. Society of Actuaries Research Institute. https://www.soa.org/48ee3f/globalassets/assets/files/resources/research-report/2024/17th-survey-emerging-risks-key-findings.pdf

One panelist believed that for 2024, the likelihood of nuclear conflict was higher than some of the other catastrophes on the list. Insurers may also be recognizing the risk of nuclear conflict as at least one life insurer has used catastrophe modeling to help them manage this risk.

8. Chronic disease such as cardiovascular disease and cancer is a major driver of morbidity and mortality which can be influenced by new and future medical treatments and technology. This can be both good and bad. For example, while the treatments and technology may result in individuals living longer, it may also lead to additional chronic disease burden, such as increased health care and other costs, impacting not only individuals, families, and insurers but the broader society.

9. Current and future use of technology and artificial intelligence and the potential consequences to humanity.

In addition to death, injury and implications to physical health, another result of catastrophic events impacting life and health insurers is mental health. As the likelihood of a catastrophic event increases, historically there has been a propensity for violence and suicides. We also saw the rise of mental illness during the recent COVID-19 pandemic from isolation and other mitigation measures used to deter the spread of illness. It is important that both physical and mental health, along with financial impacts, are considered when modeling catastrophic events.

The next section presents other indirect and downstream consequences of catastrophic events.

1.2 INSURANCE INDUSTRY RISKS FROM NONTRADITIONAL CATASTROPHIC EVENTS

Not only can life and health insurers examine catastrophes from a traditional viewpoint, but they should consider how the catastrophe may change their "business as usual" environments to something more volatile or permanent. This could be a result of a downstream effect from a catastrophic event, but it does not have to be. Examples are economic shocks that drive interest rates down to zero or below zero or even loss of faith in the financial system which might cause a run on the bank or mass withdrawals.

In section 1.1, social isolation was mentioned as a secondary effect of the recent COVID-19 pandemic. Both short- and longer-term consequences of social isolation should be monitored. For example, uncertainty remains about the long-term implication of social isolation on mortality. Will we see increased mortality for men and women as they age versus what it would have been if there was not the COVID-19 pandemic?

Social media has the potential to also impact the status quo. The argument is that social media is a big part of social strife and polarization that is occurring through the world. If this is true, it could lead to economic and other disruptions.

Related to social strife is political division. In recent years, this has been growing in the United States. Political division and instability are of concern as it might lead to loss of faith in democracy and influence global trade and central bank independence.

Section 2: Climate Related Events of Most Concern for Life and Health Insurers

We have already touched on catastrophe risk in a more traditional sense with catastrophe events being low frequency. But one of the reasons that climate risk is of growing concern for insurers is the frequency of events like wildfires, floods, and heat waves is increasing,[2] and the impacts associated with these events are increasingly considered insurance catastrophes. Therefore, the associated number of fatalities and injuries could be higher in the future.

When looking at them on an individual basis, there might not be the same level of fatalities or injuries when comparing to a very strong earthquake. However, with these types of events occurring more frequently and looking at them on an aggregate basis, the fatalities and injuries really add up.

In this section, we will delve into the climate related events identified by the panelists that should be a primary risk management focus for life and health insurers. The events presented are in the order as discussed by the panelists.

2.1 INCREASING TEMPERATURE

Increasing temperatures and climate events have many facets. One is increasing water temperature. As oceans are absorbing more heat, there is an increase in sea surface temperatures and rising sea levels. Along with this can be changes in climate patterns and the potential for a higher frequency of stronger storms than in the past. There is coastal flooding and storm surge and ultimately, property damage, fatalities, injuries, displaced residents, migration to noncoastal locations and the list goes on and on.

Besides increasing water temperature, increasing air temperature is another area to monitor. Drought can be an outcome of heat and can lead to water challenges, decrease in crop and livestock production, an increase in vector borne disease, exacerbation of chronic disease due to sun exposure, forest fires, and business and economic stress.

Extreme heat can be very deadly. Per the World Meteorological Organization, "extreme heat causes the greatest mortality of all extreme weather."[3] The 2022 summer heat waves in Europe resulted in over 60,000 heat related deaths[4] which exceeds the number of fatalities associated with some large earthquakes such as the 2023 Turkey/Syria quake. Although the U.S. has not experienced the same level of heat-related fatality as experienced by the European Union, the U.S. is not immune to heat waves and their consequences. Per Associated Press analysis based on data from the CDC, there were 2,300 heat related deaths in 2023 with many deaths occurring in the Southwest from the July 2023 heat wave.[5] Heat related deaths have also been on the rise in the U.S. increasing the past 3 years.[6]

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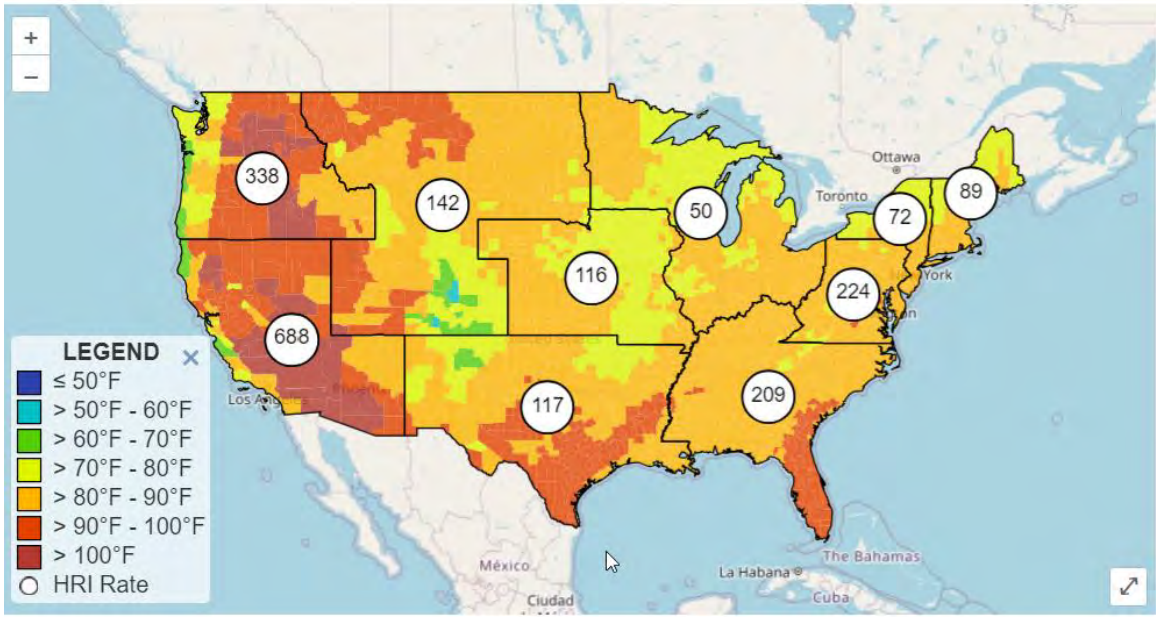
[2] The SOA Research Institute has published studies on the impact of climate change on U.S. inland flood risk report and the wildfire risk report. These reports highlight how the risks are changing and provides estimates for the future.
[3] World Meteorological Society. 2023. 2023 State of Climate Services. *https://library.wmo.int/idurl/4/68500*.
[4] Ballester, Joan et.al. 2023. Heat-related mortality in Europe during the summer of 2022. *Nature Medicine.* 29**.** 1857–1866. https://doi.org/10.1038/s41591-023-02419-z.
[5] Borenstein, Seth et. al. 2024. AP Analysis finds 2023 set record for U.S. heat deaths. AP News May 31, 2024 https://apnews.com/article/record-heat-deadly-climate-change-humidity-south-11de21a526e1cbe7e306c47c2f12438d
[6] Health and Human Services Extreme Heat webpage. https://www.hhs.gov/climate-change-health-equity-environmental-justice/climate-change-health-equity/climate-health-outlook/extreme-heat/index.html#:~:text=Extreme%20summer%20heat%20is%20already,2022%2C%20and%202%2C302%20in%202023.

Heat related illness is also a concern when thinking about extreme heat and heat waves. The CDC's Heat and Health Tracker monitors the health burden of extreme heat which can help individuals and communities prepare and manage these types of events. One example is Figure 1 which shows the correlation between temperature and the rate of emergency department visits associated with heat related illness.

Figure 1

MAP SHOWING THE RATE OF EMERGENCY DEPARTMENT (ED) VISITS ASSOCIATED WITH HEAT-RELATED ILLNESS (HRI) PER 100,000 ED VISITS BY REGION FOR JULY 21, 2024



Source: CDC's Daily Heat-Related Illness map from the Heat and Health Tracker
https://ephtracking.cdc.gov/Applications/heatTracker/

A compounding factor when it comes to excessive heat in the U.S. is the vulnerability of the electrical infrastructure. Heat waves put stress on the electrical grid which can lead to power outages and potentially increased number of deaths and increased frequency and severity of illness.

2.2 COMPOUND CLIMATE RELATED EVENTS

Another reason for life and health insurers to track climate and severe weather events is that the events are often combined. There might be extreme heat, drought, fire, and strong wind all at the same time increasing the potential for significant effects. U.S. infrastructure has been shown to be vulnerable to flood risk.[7] Flood control and drainage infrastructure may have been built decades ago and may not withstand the frequency and severity of today's nor future storms. A dam failing from strong winds and intense flooding especially in a populated area may cause significant loss of life and property. This may be a scenario that life and health insurers may want to include in their risk management modeling.

[7] Hubbard, Kaia. 2021. Flooding Threatens 25% of U.S. Infrastructure Study Says, *U.S. World and News Report*, October 11, 2021
https://www.usnews.com/news/national-news/articles/2021-10-11/flooding-threatens-25-of-us-infrastructure-study-says.

2.3 UNEXPECTED CLIMATE RELATED EVENTS

When thinking about natural perils, there are those peril types in which there is communication in advance of the occurrence. In these instances, planning can take place and protective measures can be employed minimizing the result of the natural peril on morbidity and mortality. An example are hurricanes. Science has advanced enough that hurricanes are monitored and tracked. Coastal municipalities have developed evacuation plans to minimize injuries and death.

There also may be natural perils in which there is notice but the infrastructure may be lacking. An example is extreme heat or cold. Challenging aspects with climate is that we are seeing some spatial changes in where events are occurring. For example, in January 2024 there was an arctic air outbreak that impacted Texas. One might think that in highly developed countries such as the U.S. that we are ready for these types of events. But southern states such as Texas are not prepared for extended periods of cold, just as northern cities such as Seattle are not prepared for extended periods of heat.

Natural perils in which there is no notice or a short planning window are of most concern. Earthquakes are the classic example. But we have also seen communication lacking or coming too late recently with wildfires including the 2023 Lahaina wildfire in Hawaii producing over 100 deaths.

This ability to predict or monitor a catastrophic event or lack of infrastructure to respond to a catastrophic event is another consideration in developing model assumptions or scenarios. More modeling insights shared by the panelists are presented in Section 3.

Section 3: Modeling

The panel moved to begin discussion of modeling in general. Several aspects of modeling were discussed including communication, opportunities, best practices, and model implementation.

3.1 COMMUNICATION BETWEEN MODELERS AND INSURERS

As an example, for a health practitioner, the important thing may be the extent to which health models show how quickly health products need to respond in the model. A panelist noted that health products have a short (1 year) horizon, and they would therefore be looking to highlight whether any climate risk impact would occur versus whether a particular type of climate risk would occur.

Model users would therefore need to know how to benefit from catastrophe models whether health or life insurance was modeled. The abilities of catastrophe models to model physical effects has come a long way. For example, Cat models can model hazards right from weather data. They are becoming increasingly robust and good at modeling out scenarios. To take full advantage of Cat model abilities, it will be good to continue to seek better data, as well as define and model out relevant scenarios. Potential challenges include the interaction between asset and liability cash flows in some lines and general investment overlap with geographically based cat models.

As modeling advances, it will be good for industry model users to understand the services that models can provide and where improvements are needed. This can be accomplished by having good dialogue between Cat modelers and model users.

Some examples of helpful things for model builders to know from the perspective of life and health model users are that more granular data would be helpful. Currently, when model data is too granular, model points could be excluded due to potential confidentiality concerns. To the extent that more and better data can be obtained, within the parameters of confidentiality concerns, this will be advantageous for moving Cat modeling forward as far as value to life and health model users.

3.2 USING MODELS AND OPPORTUNITIES

The use of models varies within a life and health insurer context. Risk managers, pricing actuaries, and asset managers are some of those whose work can be influenced by the catastrophe model for a block of business. These and other users can benefit from good communication as noted above. Some things like weather attribution techniques, and the ways that investment and asset management decisions can be made in the context of Cat modeling information are good to understand.

Some helpful model considerations include thinking about the impacts on data, and what ways to stratify data. For example, confidentiality issues as noted above can lead to exclusion of data points from the data set. For the data that you have, when breaking it into granular pieces, some stratification decisions may be made based on such things as population vs. insured groupings.

When using Cat models, the user would also want to consider trends. For example, Cat modeling is often concerned with low frequency, high severity events. If the frequency or severity of a modeled hazard was increasing, that would be important to note and model.

Another area to consider when using models is whether the modeled hazard is of an acute nature (a calamity) or whether it is more systemic and longer term (such as a pandemic). Both can be catastrophes impacting insurers, but the way that models recognize and incorporate life and health assumption input and loss output would be different.

3.3 MODELING CONSIDERATIONS

Catastrophe models can cover a wide range of events and depending on the type of event, various bucketing approaches can be used to model the events. For example, some models need to use very granular data since short distances may make a big difference in amount of damage; such as for wildfires. Heatwaves and pandemics, on the other hand, are broader in scope and may not need to have very granular data. The exception may be in cases where social determinants of health are relevant, such as with heatwaves, where vulnerable populations may be subject to heat risk more than others in the same area, and so finer geographic detail can be helpful.

When looking at scenarios, deterministic scenarios can be good to use as they are amenable to taking what has historically occurred and then adjusting them in measured steps to see what the impacts are. You could model something that has happened in one location then apply that scenario to a different location.

Management at a life and health insurance company may have a risk appetite they want to manage to, and catastrophe models can incorporate that. Insurers should have a list of questions for a catastrophe modeler to convey what is important. Some companies may want to look at cat risks broadly and some have specific assessment goals as well as regional goals depending on what their regional regulatory environment is.

Model vendors have their own datasets of population data. Insurers could use these and then look at their specific business block and make some assessments. Looking at modeled events can give insight into the evolution of events. For example, looking at how the pandemic spread, and the different groups that were affected, can give insight into how a particular life and health insurer may want to assess their block of business.

3.4 CONSTRUCTING BETTER MODELS

To construct better models, more scenario analysis should be done. More scenarios should be explored, even if they are not considered plausible. For example, the COVID-19 pandemic wasn't considered plausible, and wasn't modeled. Catastrophes can occur from what you are not expecting, not just what you are expecting. A 2017 Lloyd's report outlined a pandemic version of the MERS coronavirus.

In addition to more scenario analysis being done, better scenario analysis should be done. Of the pandemic scenarios that existed, they were very simplified and not very realistic. In this context, better means considering additional variables such as age (1918 flu impacted more younger ages and COVID-19 impacted more older ages). Looking at impacts by age versus looking at mortality in aggregate would be good to do. Additionally, it would be good to construct more scenarios and give serious consideration that scenarios can happen.

To help with acceptance that things we have not considered could occur, ways to get the message across include looking at the full spectrum of what can occur. For climate related risks, it's good to not be too biased by what has been occurring recently when modeling. One approach is to take scenarios that we are familiar with and adjust key assumptions about what might happen, including both positive and negative events.

There is a good middle ground of number of scenarios. More than a few, but not thousands. Maybe dozens would be good to consider. Then when modeling, you can see the sensitivity of where you might be off on some variables and can show the range of what can happen. To ease run-time constraints the modeler could cycle through scenarios, performing some each year, to manage priorities.

3.5 USING MODELS AND SCENARIOS

Some of the ways in which scenarios can be considered in modeling are to nudge insurer management around biases they may have regarding outcomes, or likelihood of occurrence. Having robust scenario sets can help management see the range of possibilities. Scenarios can also help identify relative strengths and weaknesses of the insurer. For example, COVID impacts were deeper than previous models would have looked at. The pandemic had impacts on the broader financial markets and inflation than would have been anticipated.

Models can highlight potential opportunities based on company strengths such as identifying low cost mitigation strategies, diversification opportunities, and highlighting competitive advantages which can be had from modeling.

One Cat modeling aspect that has been a challenge, is modeling catastrophes that involve tipping points, such as melting polar regions. In the Cat modeling space, tipping point events that are not considered imminent, even though very concerning, may not make it to the priority list of items to be concerned about when constructing a model. This could be short-sighted as feedback loops accelerate trends.

A few thoughts on tipping points or areas of concern include:

- Life insurers are concerned about the asset side of the business.
- Not enough attention is being paid to “scary” scenarios.
- It is important to consider the actionability of scenarios and frequency, such as what insight is gained from extreme scenarios, or for very extreme scenarios they may be downplayed due to their low likelihood.

A key takeaway has been that catastrophe modeling is a good way to highlight the possibilities of what could happen, and even though they seem unlikely, understanding what the range of outcomes could be and how the company could react to them is valuable information from Cat modeling. In using Cat models, we can consider what can be learned, gain insights into higher severity impacts beyond what has been observed, and what modeling limitations are.

3.6 IMPLEMENTATION AND POSITIVE OPPORTUNITIES FROM CATASTROPHES

Catastrophe modeling can be implemented into company books of business in aspects such as pricing, business management, and internal hedging (life insurance/annuity balance). There can also be positive outcomes from catastrophes that can have a favorable impact and can be noted as part of the catastrophe modeling efforts.

Some important implementation considerations are to assess key drivers and what is actionable, to focus on scenarios that lead to greatest losses and look at what is causing that, and to understand why these events are occurring and if they can be hedged or managed.

Specific examples of implementing Cat models can be found in (Own Risk and Solvency Assessment) ORSA exercises. ORSA can look at and explore Cat modeling and how catastrophes would be addressed by the company. Cat models may support other efforts related to asset management, financing instruments, and risk mitigation strategies. Cat models are helpful for considering tipping points, which can be more likely than one would think, and could occur sooner than would be thought. It would be good to set models to look at these situations. Cat models can also look at loss of stability of assumptions, and what outcomes look like when long duration pricing assumptions don’t hold, such as when long duration products need to be managed under different assumptions than what was priced.

Finally, some positive opportunities have evolved from catastrophes and catastrophe models can help understand these. An example is the MRNA vaccine development from the COVID-19 pandemic. Companies can look via Cat modeling to see how disruptions can occur which are positive, and make sure they are prepared when positive opportunities occur.

Section 4: Conclusions

1. As modeling advances, it will be good for industry model users to understand the services that model builders can provide. This can be accomplished by having good dialogue between Cat modelers and model users.

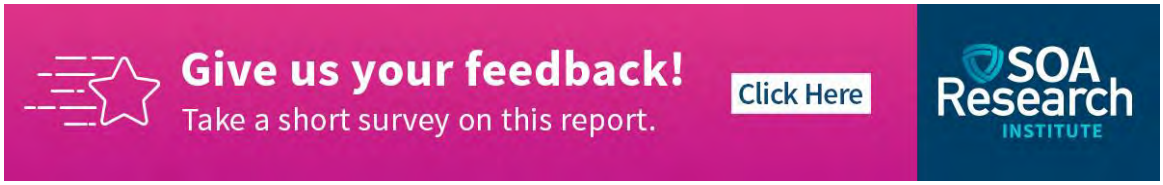
2. Use of models varies within a life and health insurer context and work can be influenced by a catastrophe model for a block of business.

3. Management at a life and health insurance company may have a risk appetite they want to manage to, and catastrophe models can incorporate that.

4. To construct better models, more scenario analysis should be done, including exploring scenarios even not considered plausible. Giving serious consideration that scenarios **can** happen is good to do. To help with acceptance that things that we haven't considered could occur, some ways to get the message across include looking at the full spectrum of what can occur.

5. Catastrophe modeling can be implemented into company books of business in aspects such as pricing, business management, and internal hedging (life insurance/annuity balance).

6. Some positive opportunities have evolved from catastrophes and catastrophe models can help users understand these and prepare for opportunities.



Section 5: Acknowledgments

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Panelists:

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Appendix A: Glossary of 23 Risks across Five Categories, from the Fall 2023 Emerging Risk Survey[8]

ECONOMIC RISKS

- Energy price shock—Price instability and extremes of energy prices.
- Currency shock—Material disruptions to currency equilibrium, including central bank devaluations (currency wars), de-dollarization, and digital currencies.
- Emergent nation destabilization—Fast growing country's economic growth slows, potentially as a result of protectionism, demographics, internal politics, and/or economic difficulties.
- Asset price shock—Price instability and extremes of assets such as housing and equities.
- Financial volatility—Price instability and extremes of sectors, including commodities, equities, or interest rates.

ENVIRONMENTAL RISKS

- Climate change—Change in climate patterns generates both extreme events and changes in trend, impacting infrastructure, agricultural yields, soil degradation, ocean currents, ecosystem biodiversity (e.g., insects, shellfish), and human lives. Drivers of physical and transition risks include, but are not limited to, space weather, pollution, and release of greenhouse gases.
- Loss of freshwater services—Water shortages impact agriculture, businesses, and human lives. Drivers include, but are not limited to, climate change and human influence (e.g., pollution, aquifer depletion).
- Natural catastrophe: tropical storms—Hurricanes, typhoons, and cyclones lead to disruption, catastrophic economic losses, and/or high human loss of life.
- Natural catastrophe: earthquakes—Strong seismic/volcanic activity leads to disruption, catastrophic economic losses, and/or high human loss of life.
- Natural catastrophe: severe weather—Meteorological phenomena lead to disruption, catastrophic economic losses, and/or high human loss of life. Includes inland flooding, tornados, thunderstorms, heatwaves, drought, wildfires, high winds, snowstorms, and dust storms.

GEOPOLITICAL RISKS

- Terrorism—Attacks lead to disruption, catastrophic economic losses, and/or high human loss of life.
- Weapons of mass destruction—Nuclear, biological, radiological, or chemical technologies lead to disruption, catastrophic economic losses, and/or high human loss of life.
- Wars (including civil wars)—Wars erupt between or within countries, leading to disruption, catastrophic economic losses, and/or high human loss of life.
- Failed and failing states—The trend of a widening gap between order and disorder or widening social rifts.

[8] Rudolph, Max. 2024. 17th Emerging Risk Survey Key Findings Report, Society of Actuaries Research Institute. https://www.soa.org/48ee3f/globalassets/assets/files/resources/research-report/2024/17th-survey-emerging-risks-key-findings.pdf

- Transnational crime and corruption—Corruption is endemic. Non-government entities successfully penetrate the global economy.
- Globalization shift—Preference changes to imports and immigration. Changes include populism, democracy, socialism, communism, religiosity, and political uncertainty. Changes in use of technological platforms allow misinformation and disinformation to spread. Countries retrench and become more nationalistic and protectionist or open up their economies to outsiders. Inequality, privacy, and food insecurity challenge the concepts of fairness and egalitarianism.
- Regional instability—Unstable regions cause widespread political and other crises.

SOCIETAL RISKS

- Pandemics/infectious diseases—A pandemic emerges with high mortality/incidence of diseases such as HIV/AIDS, Ebola, coronavirus, or influenza. Antimicrobial resistance becomes common.
- Chronic diseases/medical delivery—Diseases such as obesity, diabetes, cardiovascular, and substance abuse become widespread, or treatments appear. Material changes to medical delivery or financing.
- Demographic shift—Evolving populations size and mix (e.g., age, size, race, fertility rate, mortality rate, migration, skills, workplace environment) drive changes in economic growth and levels of government intervention.
- Liability regimes/regulatory framework—Costs increase faster than GDP, with increases in the spread and size of litigiousness (e.g., social inflation, climate litigation, systemic liabilities due to chemicals, microplastics or hazardous waste) and speed of regulatory revisions. Material changes in tax policy.

TECHNOLOGICAL RISKS

- Cyber/networks—A major disruption in the availability, reliability and resilience of critical information infrastructure caused by cyber risks, terrorist attacks, or technical failure. Results are felt in supply chains, major infrastructure: power distribution, water supply, transportation, telecommunication, emergency services, and/or finance.
- Disruptive technology—Unintended consequences of technology lead to abrupt change (e.g., artificial intelligence, drones, self-driving cars, additive manufacturing, internet of things, nanoparticles). Models become more complex but less descriptive over long time horizons.

About The Society of Actuaries Research Institute

Serving as the research arm of the Society of Actuaries (SOA), the SOA Research Institute provides objective, data-driven research bringing together tried and true practices and future-focused approaches to address societal challenges and your business needs. The Institute provides trusted knowledge, extensive experience and new technologies to help effectively identify, predict and manage risks.

Representing the thousands of actuaries who help conduct critical research, the SOA Research Institute provides clarity and solutions on risks and societal challenges. The Institute connects actuaries, academics, employers, the insurance industry, regulators, research partners, foundations and research institutions, sponsors and non-governmental organizations, building an effective network which provides support, knowledge and expertise regarding the management of risk to benefit the industry and the public.

Managed by experienced actuaries and research experts from a broad range of industries, the SOA Research Institute creates, funds, develops and distributes research to elevate actuaries as leaders in measuring and managing risk. These efforts include studies, essay collections, webcasts, research papers, survey reports, and original research on topics impacting society.

Harnessing its peer-reviewed research, leading-edge technologies, new data tools and innovative practices, the Institute seeks to understand the underlying causes of risk and the possible outcomes. The Institute develops objective research spanning a variety of topics with its strategic research programs: aging and retirement; actuarial innovation and technology; mortality and longevity; diversity, equity and inclusion; health care cost trends; and catastrophe and climate risk. The Institute has a large volume of topical research available, including an expanding collection of international and market-specific research, experience studies, models and timely research.

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