Session 11: Insight available to Download

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Efficient Nested Simulation for CTE of Variable Annuities

Joint work with Dr. Mingbin (Ben) Feng and Dr. Mary Hardy

2018 ERM Symposium

Outline

VA Contracts (Simplified)

Example (GMMB)

- $S_t :=$ underlying asset price/fund value at time t
- $G_t :=$ guaranteed maturity value
- $T :=$ maturity of the policy

Example (GMAB)

- $R \in (0, T) :=$ renewal time
- $G_{R^-} :=$ minimum guarantee prior to renewal
- $G_{R^+}, S_{R^+} := \max\{S_{R^-}, G_{R^-}\} :=$ renewed guarantee/fund value

- Both contracts pay $\max\{S_T, G_T\}$ to the policyholder at time T.
- Assume no fee, decrement or expense.

Dynamic Hedging for VAs

Delta hedging program

At each time t, setup a hedge (replicating) portfolio consisting of

- $B_t :=$ amount invested in risk-free bond
- $\Delta_t S_t :=$ amount invested in underlying asset S_t
- $H_t := B_t + \Delta_t S_t =$ value of portfolio set up at time t
- $H_{t+1}^{BF} := B_t e^r + \Delta_t S_{t+1} =$ value of portfolio *brought forward* from time t
- The *hedging error* realized at time t is

$$HE_t = H_t - H_t^{BF}$$

  Essentially, "what you need" minus "what you have" at each t.

- The loss-from-hedging random variable of the VA policy is

$$L = H_0 + \sum_{t=1}^{T} e^{-rt} HE_t$$

  The r.v. whose tail risk measure is estimated via nested simulation.

Nested Simulation of Conditional Tail Expectation (CTE)

1. **Outer Sim**: asset sample paths (scenarios) $S_1^{(i)}, \ldots, S_T^{(i)}$ for $i = 1, \ldots, J$
2. Estimate the r.v. $\widehat{L}^{(i)}$ for each scenario i
   - **Inner Sim**: estimate $\widehat{\Delta}_t^{(i)}$, $t = 0, \cdots, T-1$
3. Rank the estimated r.v. $\widehat{L}_{(1)} \geq \ldots \geq \widehat{L}_{(J)}$
4. Given confidence level α, the CTE_α is

$$CTE_\alpha = \frac{1}{(1-\alpha)J} \sum_{i=1}^{(1-\alpha)J} \widehat{L}_{(i)}$$

Features of CTE estimation

- Full nested simulation can be prohibitively difficult.
- Simulation efforts for non-tail scenarios are essentially "wasted"
  1. needed to rank & identify tail scen.
  2. does not affect accuracy of estimating CTE
- If somehow we can identify the tail efficiently...?

Importance-Allocated Nested Simulation (IANS)

Main Steps (fixed simulation budget)

1. Outer simulation of sample paths (the scenarios)
2. Proxy evaluation in every scenario (avoid inner sim)
3. Identify tail scenarios based on proxies (rank & select)
4. Concentrate total budget to tail scenarios (importance allocation)

Main Questions

1. Good proxy model?
   - Similar to the inner sim model, but much faster
2. Calibrate the proxy model?
   - Inner sim model param $\Rightarrow$ proxy model param
3. More tail scenarios as safety margin?
   - A proxy is a proxy
   - Tradeoff between tail coverage and budget concentration

IANS for GMMB (put option)

Example (GMMB, with additional details)

- S_t modeled by Regime-Switching (RS)
- 20yr maturity, monthly rebalancing

Main Questions Answered

1. Black-Scholes (BS) as the proxy model (closed-form B_t & Δ_t)
2. Match BS implied vol to average RS vol in the same period
3. Safety margin:
   - $1-\alpha = 5\% \Rightarrow \xi = 10\%$
   - $1-\alpha = 20\% \Rightarrow \xi = 25\%$

Numerical Experiment (GMMB and GMAB) – Settings

"True Value" for Comparisons

- Full nested simulation with 10K outer sim & 10K inner sim

Benchmarks for Comparisons

Comparison of simulations with the same total budget:

1. Standard Monte Carlo

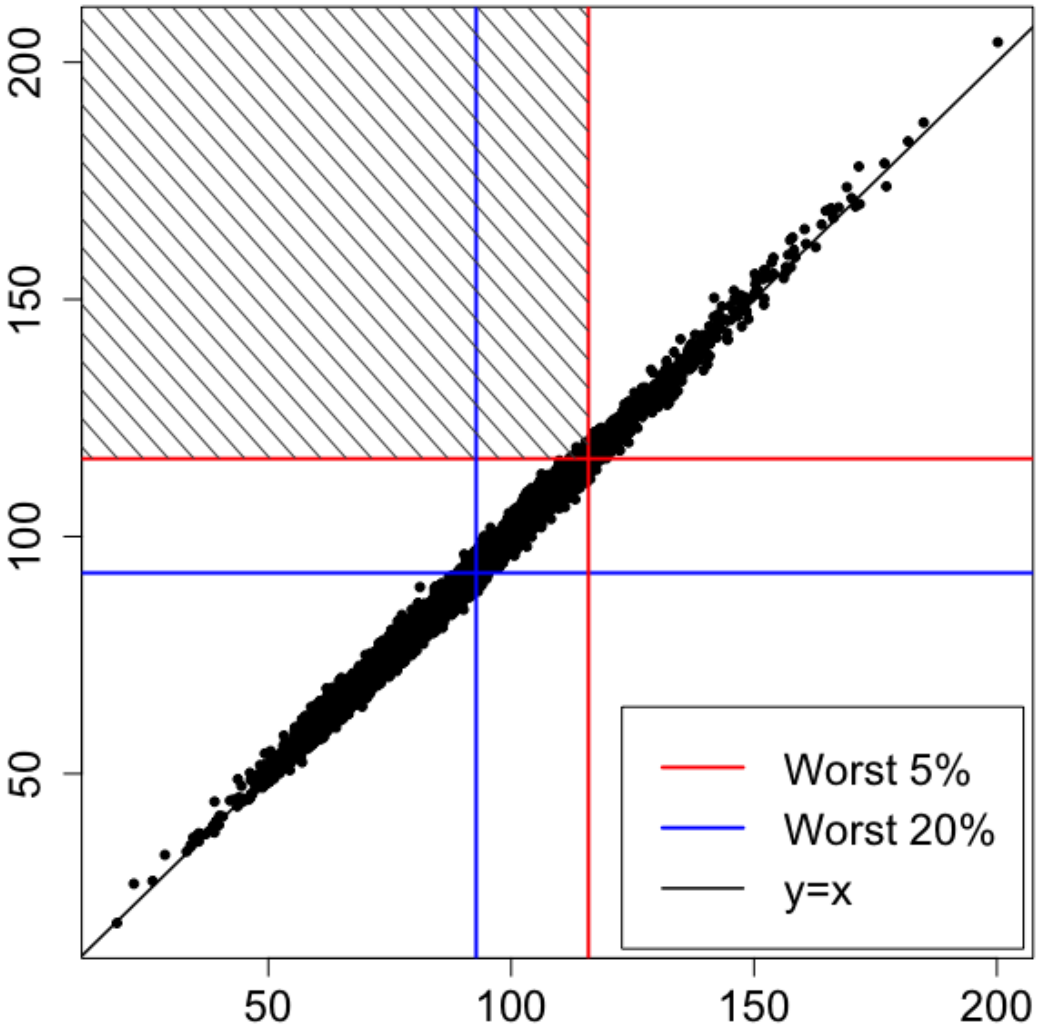
SMC1. 5K outer sim & 200 inner sim
SMC2. 1K outer sim & 1K inner sim
SMC3. 200 outer sim & 5000 inner sim

2. IANS with 5K outer scenarios considered

CTE95. $\xi = 10\%$, 500 outer sim (tail scenarios) & 2K inner sim
CTE80. $\xi = 25\%$, 1250 outer sim (tail scenarios) & 800 inner sim

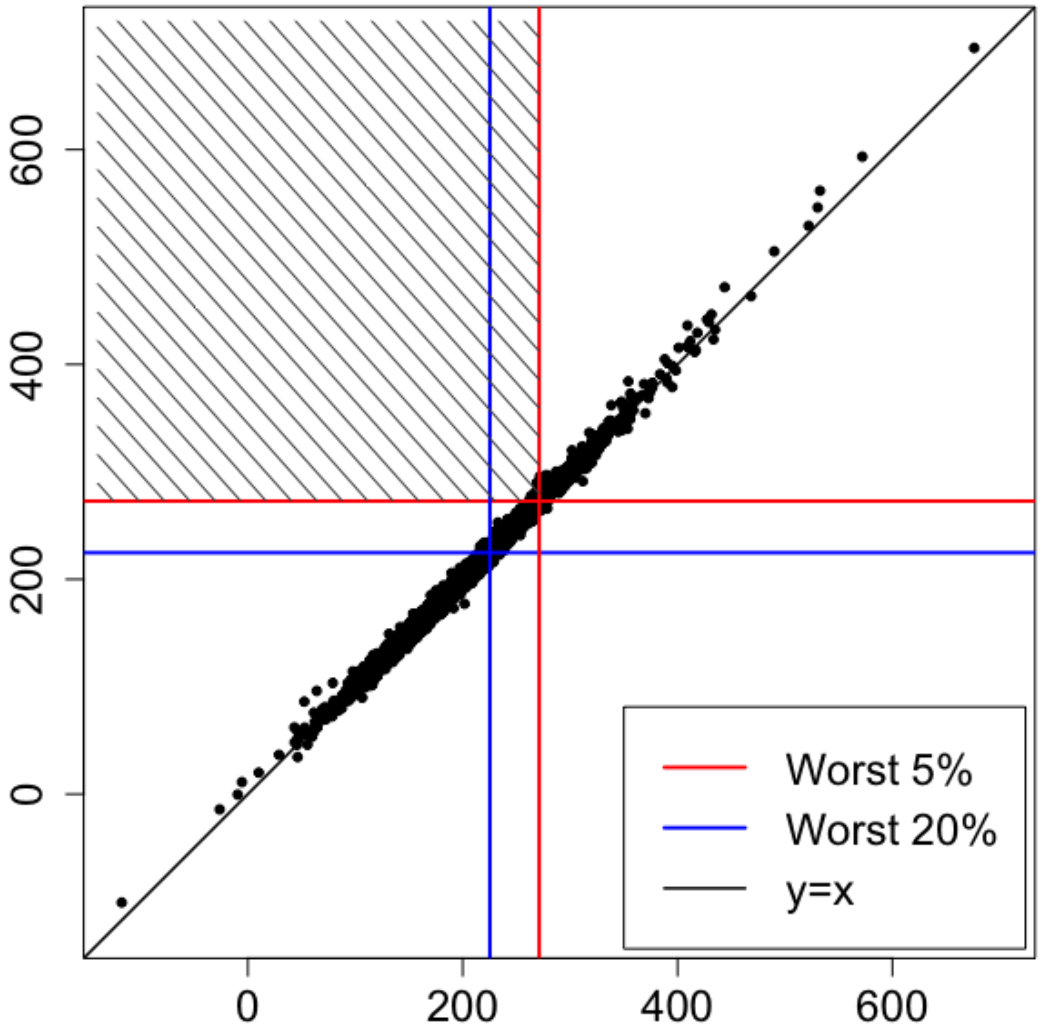
Repeat the experiment 100 times to assess accuracies

Numerical Experiment (GMMB) – Results



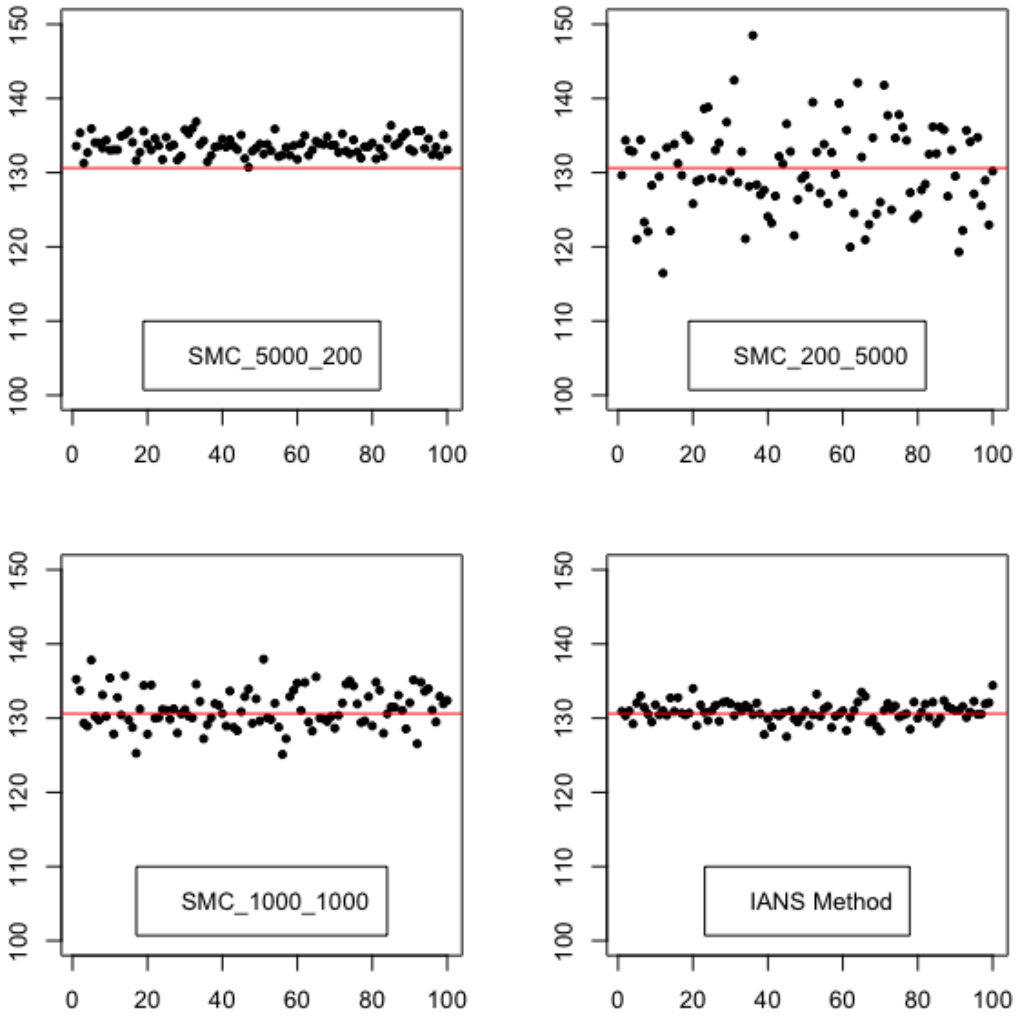
Q-Q plot of GMMB r.v. L (proxy model vs. 10K inner sim.) for 10K scenarios

Numerical Experiment (GMAB) – Results



Q-Q plot of GMAB r.v. L (proxy model vs. 10K inner sim.) for 10K scenarios

Numerical Experiment (GMMB) – Results



Scatter plots of 100 CTE95 estimate of L. The "true value" is displayed in red.

Numerical Experiment (GMMB) – Results

	CTE95		CTE80	
	MSE	Normalized	MSE	Normalized
IANS	1.68	1	0.49	1
SMC1 (5K/200)	10.87	6.5	2.80	5.7
SMC2 (1K/1K)	7.03	4.2	2.15	4.4
SMC3 (200/5K)	33.31	19.8	11.82	24.1

Table: MSEs for different simulation procedures with the same simulation budget.

Findings

- IANS is superior than SMC

Numerical Experiment (GMAB) – Results

Single Renewal	CTE95		CTE80	
	MSE	Normalized	MSE	Normalized
IANS	16.60	1	2.45	1
SMC1 (5K/200)	48.01	2.9	17.10	7.0
SMC2 (1K/1K)	80.65	4.9	14.34	5.9
SMC3 (200/5K)	316.47	19.8	57.11	23.3

Table: MSEs for different simulation procedures with the same simulation budget.

Findings

- IANS is still superior than SMC

Numerical Experiment – More Complex Settings

Dynamic Lapse

- Fund value S and guarantee value G are reduced proportionally by lapse.
- q_{x+t}, the monthly lapse rate as of time t is:

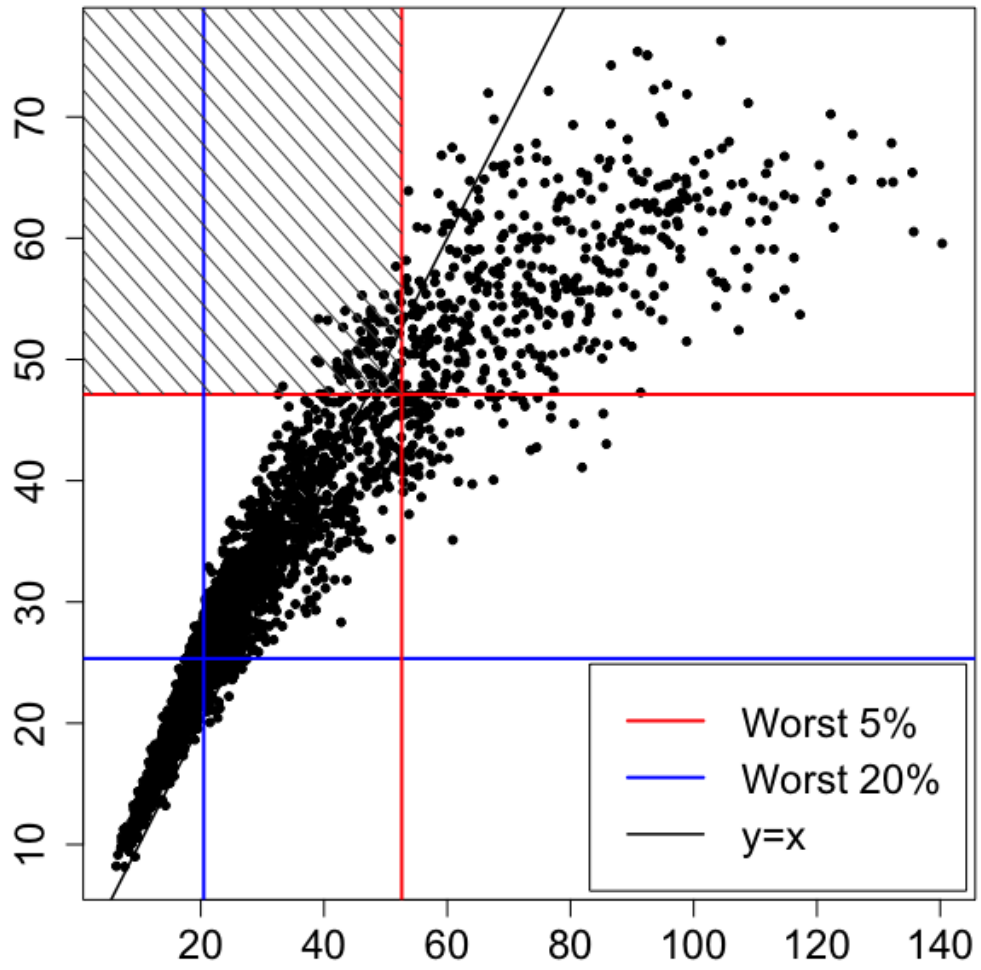
$$q_{x+t} = \min\left(1, \max(0.5, 1 - 1.25 \times (\frac{G_t}{S_t} - 1.1))\right) \times q_{x+t}^{base}$$

where

$$q_{x+t}^{base} = \begin{cases} 0.00417 & \text{if } t < 84, \\ 0.00833 & \text{if } t \geq 84. \end{cases}$$

Numerical Experiment – Dynamic Lapse

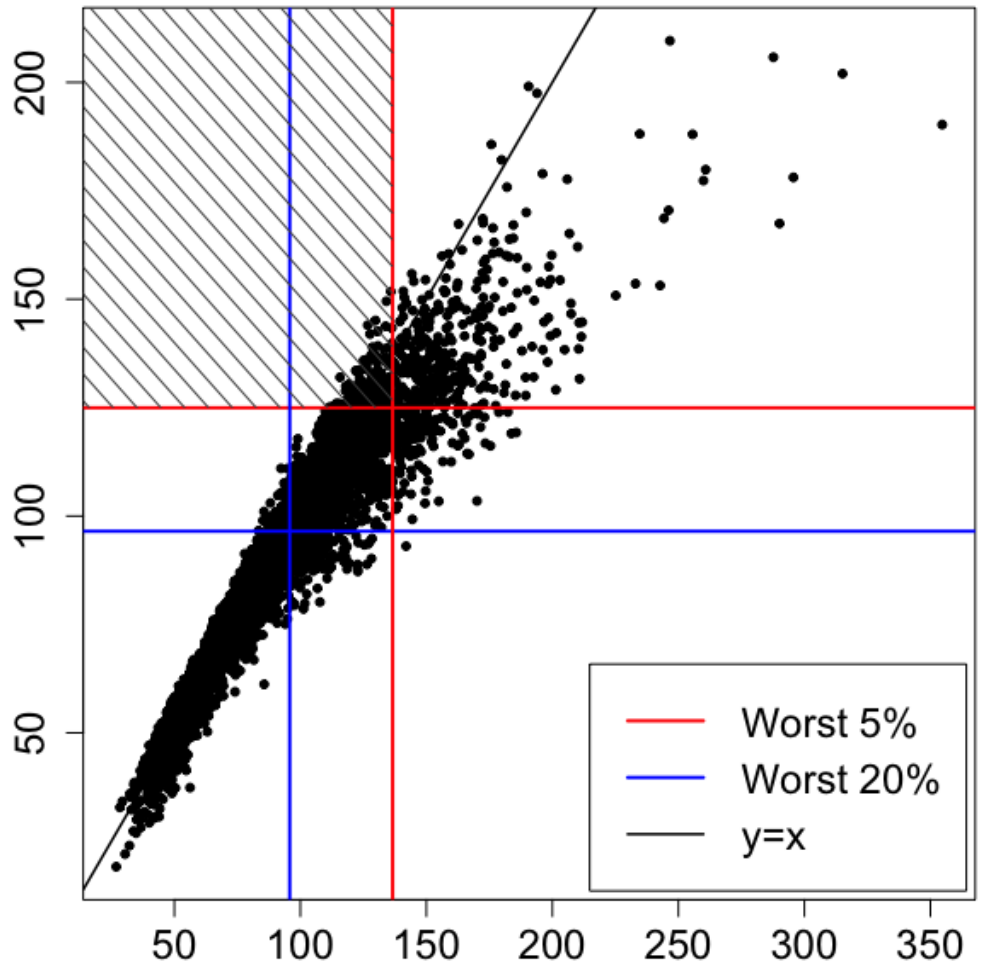
- GMMB with dynamic lapse under Regime-Switching Model



Q-Q plot of GMMB r.v. L (proxy model vs. 10K inner sim.) for 10K scenarios

Numerical Experiment – Dynamic Lapse

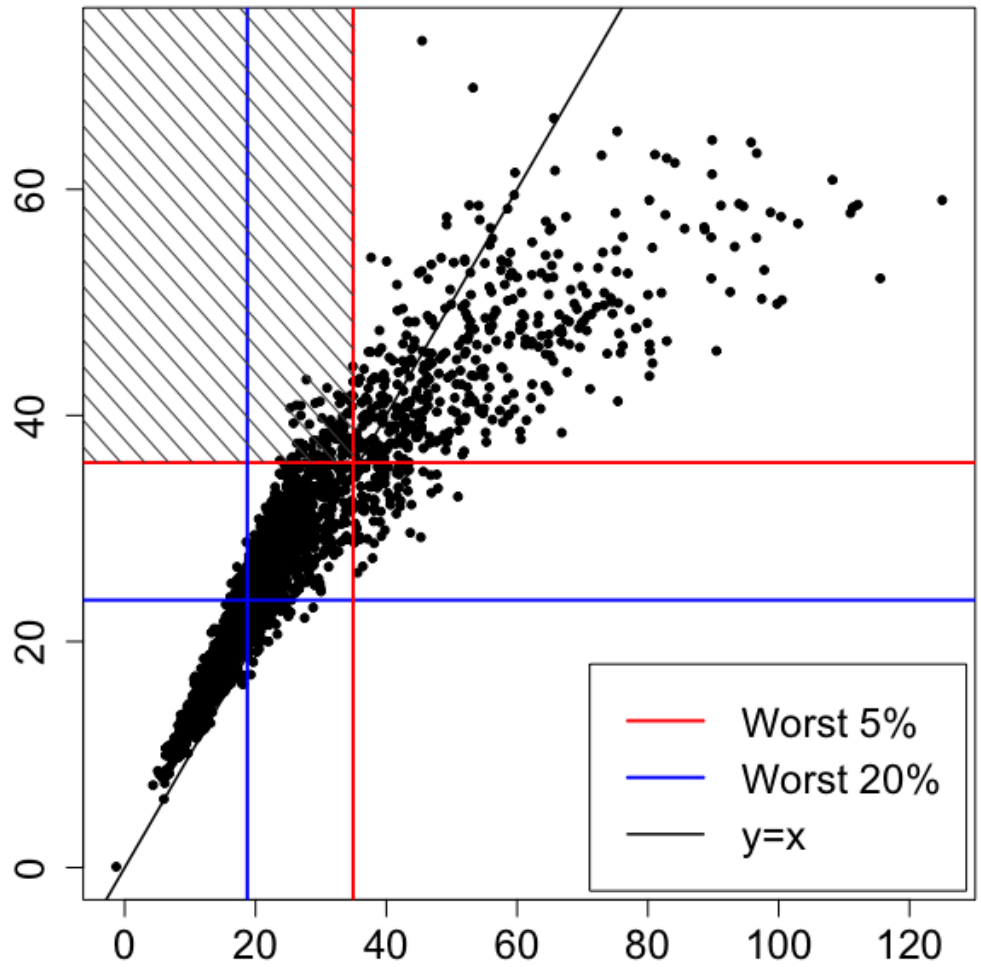
- GMAB with dynamic lapse under Regime-Switching Model



Q-Q plot of GMAB r.v. L (proxy model vs. 10K inner sim.) for 10K scenarios

Numerical Experiment – GARCH Model

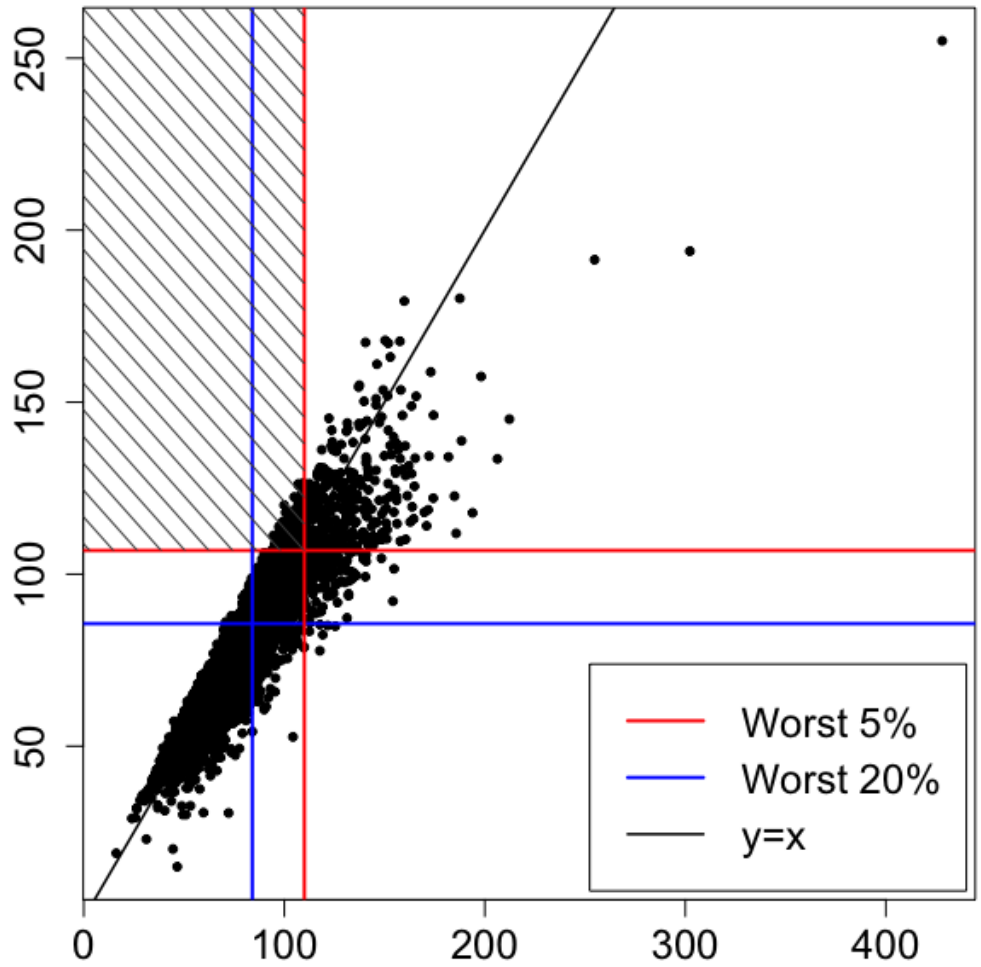
- GMMB with dynamic lapse under GARCH(1,1) Model



Q-Q plot of GMMB r.v.L (proxy model vs. 10K inner sim.) for 10K scenarios

Numerical Experiment – GARCH Model

- GMAB with dynamic lapse under GARCH(1,1) Model



Q-Q plot of GMAB r.v.L (proxy model vs. 10K inner sim.) for 10K scenarios

Concluding Remarks

What's new?

- Efficient nested simulation for tail risk estimation
- Concentrated simulation efforts on tail scenarios identified via proxy
- Numerical demonstrations via improved accuracies in different VAs

What's next?

- Choose ξ based on α and contract complexity
- Proxies for GMIB/GLWB contracts
- Fixed budget vs. Target accuracy
- Non-uniform budget allocation on tail scenarios

Link to This Research Paper

To be posted.

Enterprise Risk Management Symposium

Insight Into The Future

ERM Enterprise Risk Management Symposium

Social Discounting
as applied to Climate Change Risk Management

Sam Gutterman

What I will cover

- The Paper and why you should be interested
- Social risk management
- Social discounting – why is different
- Ethical aspects
- Uncertainty
- Social discount rates
- Real options

The paper and why should you should be interested

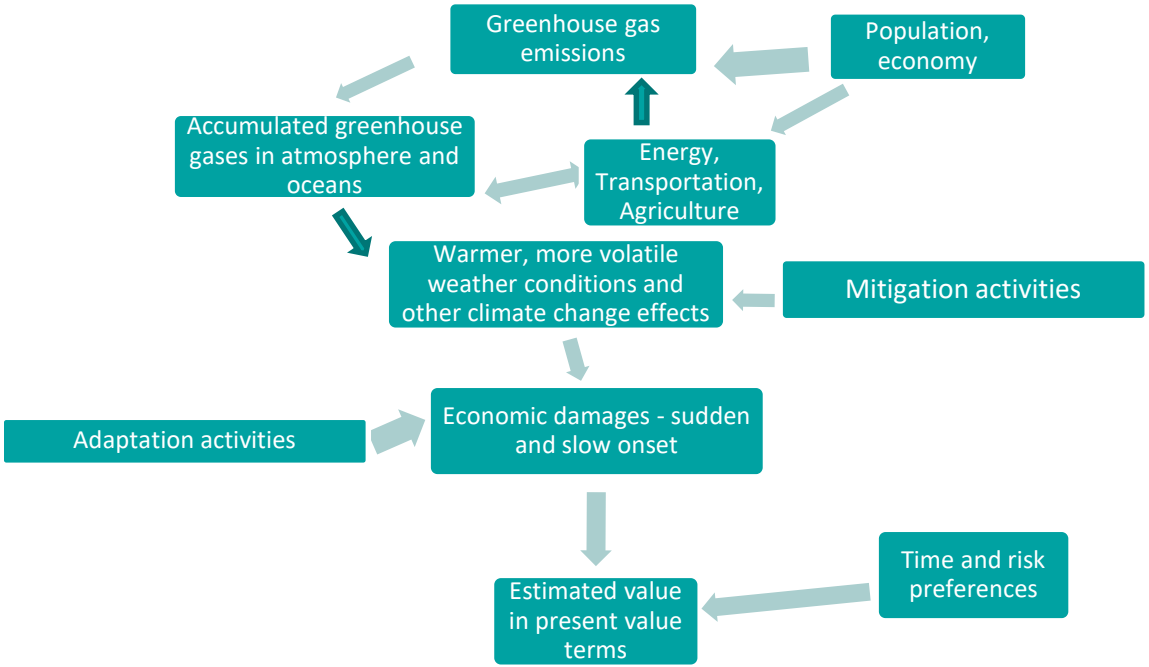
- Sponsored by the Society of Actuaries' Climate and Environmental Sustainability Research Committee
- Still a work-in-progress

- The process and associated issues represent an application of a risk management process applied to a global social issue, parts of which an ERM actuary might apply in other situations
- Actuaries have the tools and experience to play a role in analysis of many social policy discussions
- Climate change and its analysis are important: to society, your firm and you personally
  - Due to its expected adverse effects and ultra-long time horizon

Social risk management (SRM)

- The framework in which social discounting is applied
- Definition: SRM is the application of ERM to a social issue
  - Social cost/benefit analysis is key analytical and quantifiable assessment of a social issue
  - Social discounting is the process of reflecting the value of time of cash flows and other elements in a social cost/benefit analysis
    - At its heart it involves a present value of future expected cash flows

Climate process



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Relation to climate change

- To assess the current value of costs associated with a strategy or project whose aim is to mitigate or adapt to the effects of climate change
- CO_2 emissions remain in the atmosphere for centuries
  - Thus, very long time frames and multiple generations are involved
    - Almost irreversible in the absence of effective sequestration
    - A primary reason why climate change costs are looked at differently from other long-term costs
  - Other greenhouse gas emissions are more intense, but have much shorter half-life, e.g., methane

Why not use market-based discount rates

- Because of imperfections in the market relative to the purpose of this application
  - Market prices don't include costs (and benefits) to society external to the parties directly involved (externalities)
    - Welfare of future generations relative to the current generation
    - Global considerations
    - Non-financial costs
  - Shorter-term focus
  - Irreversible environmental damage
  - Effective hedges unavailable
  - Usually lower than market-based discount rates, reflecting externalities, related co-benefits and a sustainability premium
- Recent survey of 197 climate change economists*
  - Range 0% to 10%, with 92% between 1% and 4%
  - Mean 2.0%, median 2.25%

*Drupp et al.(2015) "Discounting Disentangled"

Ethical aspects

- Uncommon for actuaries to directly consider ethical aspects of a problem
- Relevant to consider
  - Scope of stakeholders
    - The global community, even when analyzed at the local level
    - Future generations (inter-generational effects), in additional to usual intra-generations issues
  - Seriousness of issue
- Capital budgeting: how to fairly weight the benefits resulting from current expenditures with irreversible future costs to be borne by future generations?
- Has led some economists to assert a 0% pure discount rate

The Ramsey formula

- Normal economics-based method of quantifying the discount rates
  - Economist Frank Ramsey (1928) presented a social discount rate approach to an analysis of savings

$$r = \rho + \eta\, g$$

where

r = social discount rate

ρ = pure rate of time preference

η = elasticity of marginal utility (in terms of a utility function)

g = per capita growth rate of consumption

ηg is a growth factor, representing the expected extent that the future will be “better off” than the present

Uncertainty

- Any projection of the effects of climate change involves great uncertainty
  - Future GHG emissions
  - Natural offsets
  - Effects of climate – frequency, amount, and timing
  - Costs of mitigation and adaptation
  - Discount rate
- Environmental decisions should consider uncertainty
- Classical actuarial theory
  - Either an increase to expected cash flows or reduction in discount rate
  - In this context, typically a reduction in discount rate
- Ramsey formula assumes certainty
  - Can be adjusted by addition of a third term: $-0.5\eta^2\sigma^2$

Structure of social discount rates

- Practice to date varies by national government:
  - Level discount rates
    - Simple
    - U.S. approach
      - Between 2003 and 2016 required alternative discount rates, e.g., 3%, 3.5% and 5.0%
      - Prior to 2003 and since 2017 requires 7%
  - Declining (hyperbolic) discount rates
    - More consistent with currently accepted theory and reflection of uncertainty
    - U.K. – start at 3.5% declining to 1.0% after 300 years
    - France – start at 4.0% declining to 2.0% after 30 years

Real options

- Definition
  - The right, but not the obligation, to undertake an initiative, such as deferring, abandoning, expanding, staging, or contracting a capital investment project
- In valuation, there may be many options available to a public policy decision-maker
  - To act now or defer (kicking the can down the road) action
  - May consider expected costs and benefits of flexibility
    - New information, future resource availability or new technologies
- Discussions of climate change prior to 2007
  - Common to assume future costs won't be that bad and future technologies will provide a cost-effective response
- Difficult to quantitatively reflect these options

Application of social discount rates

- Important to recognize who is the user of a social cost-benefit analysis
- Ramsey formula is often applied to consumption, reflecting society's utility function
  - But some have concern regarding the ability to accurately quantify this function
  - Difficult to incorporate non-financial costs, such as human life, oceanside property and heritage asset
- Another approach is to conduct a scenario analysis
- In contrast, actuaries usually apply discount rates to cash flows or risk-adjusted cash flow equivalents

Conclusion

- Often fraught with political constraints
- Allocation of limited resources (“fairness”) between
  - Developed and developing countries
  - Well-off and vulnerable, who are most affected
  - Jobs for current voters and future well-being
  - Generations
- Unsurprisingly, advocates of immediate action justify a lower social discount rate, while those who advocated limited or deferred action justify a higher social discount rate

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IAA Risk Book – chapter 17
Risk and Uncertainty

Sam Gutterman

What I’ll be talking about

- Why should we be concerned
- What are risk & uncertainty
- How to communicate them

Why should we be concerned

- Need to understand the past and present
  - Although we can make observations, they may not always be useful
  - Starting point is data and experience
- But: the future is unpredictable and not the same as the past
  - Nevertheless, need to estimate relevant aspects of the future
  - The forest – do we have the best model and variables
  - The trees – have we understood:
    - What is new
    - Changes in condition
    - Mix of exposures
    - Relationships

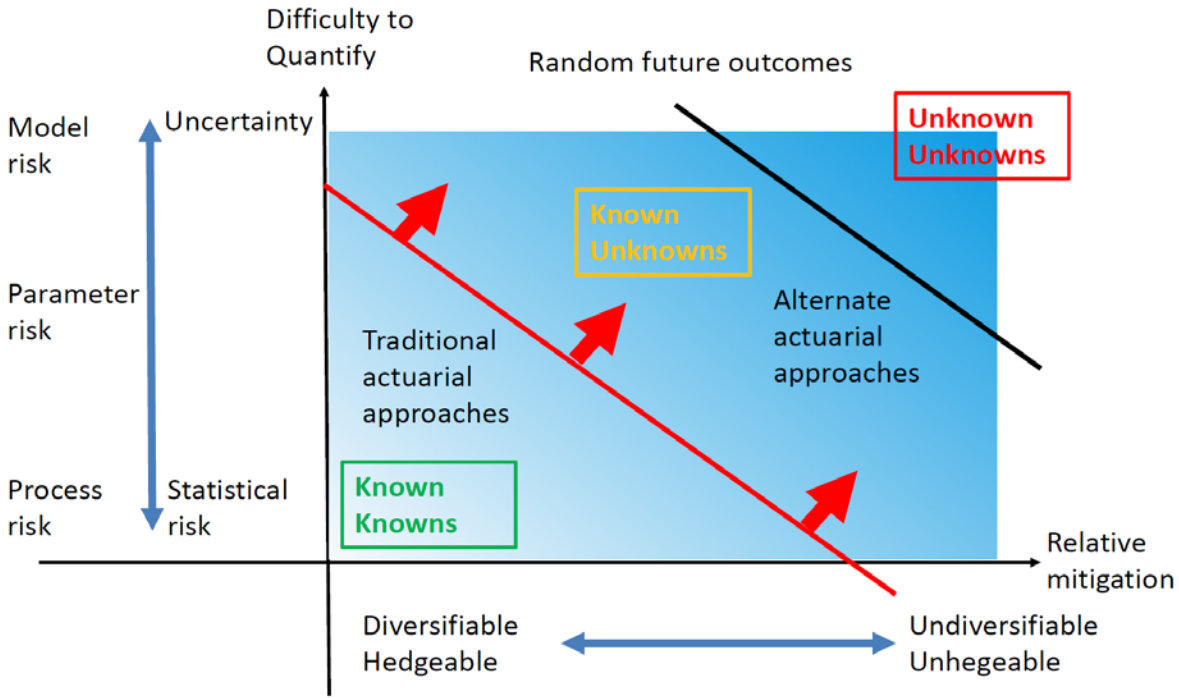
What are risk & uncertainty

- Risk
  - the effect of variation that results from the random nature of the outcomes being studied (i.e., a quantity susceptible of measurement, such as through probabilities)
- Uncertainty
  - involves the degree of confidence in understanding the effect of perils or hazards not easily susceptible to measurement
- Classic distinction from the economics literature:

  The essential fact is that 'risk' means in some cases a quantity susceptible of measurement, while at other times it is something distinctly not of this character; and there are far-reaching and crucial differences in the bearings of the phenomena depending on which of the two is really present and operating. It will appear that a measureable uncertainty, or 'risk' proper is so far different from an unmeasurable one that it is not in effect an uncertainty at all.

  Frank Knight (1921, *Risk, Uncertainty, and Profit*)

Aspects of Risk & Uncertainty



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How should they be communicated

- As actuaries, we often spend too much time emphasizing expected values
  - But they are useful as benchmarks
- The role of the actuary is to identify, quantify and, where possible, help manage the process
- To test outcomes, use
  - Statistics and hypothesis testing
  - Confidence intervals
  - Smoothed vs raw data
  - Study deviations from benchmarks, but not ignoring seeming outliers
  - Professional knowledge/judgment
- Displayed through, for example,
  - Charts
  - Scenario analysis and displays

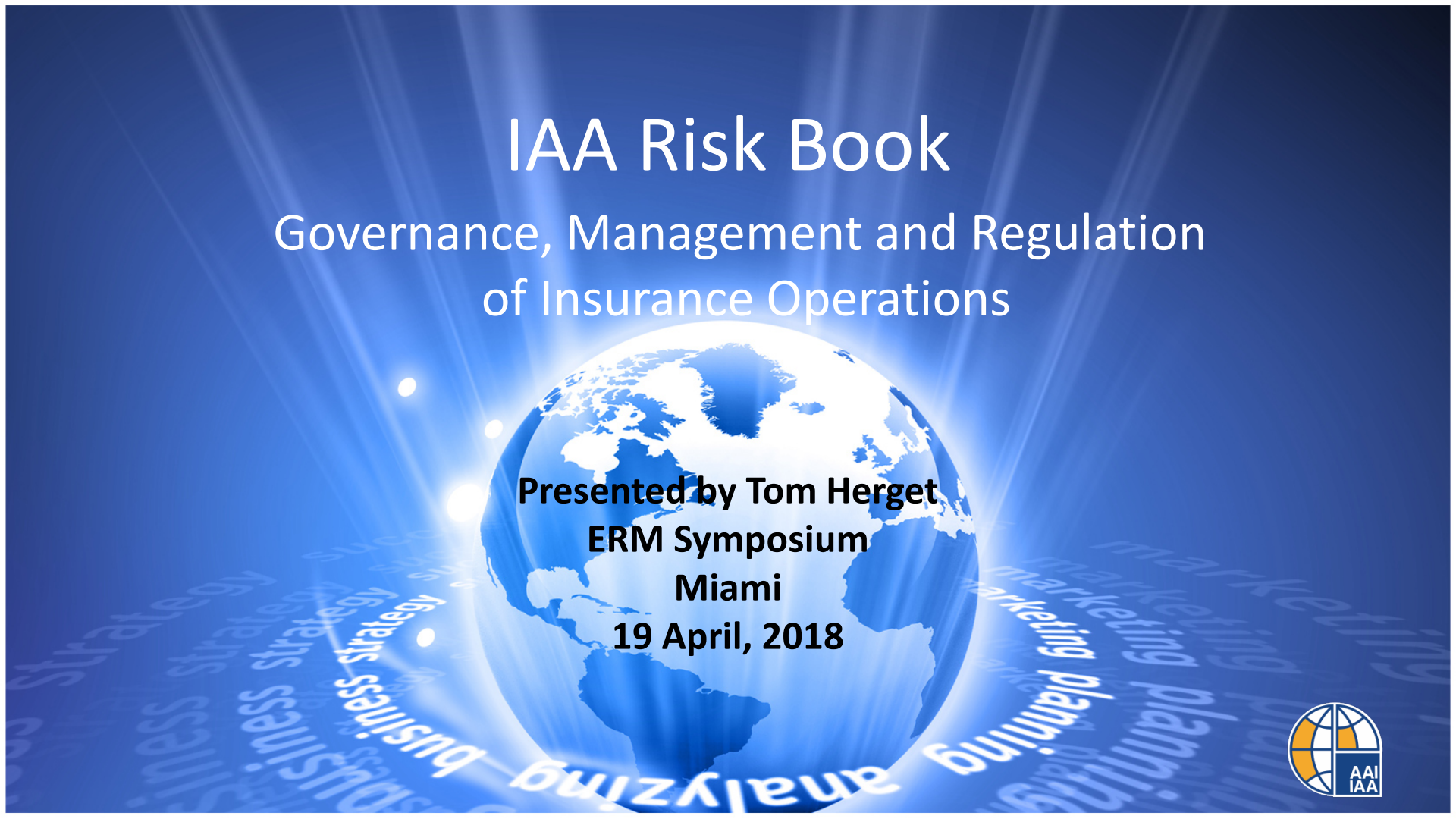
Where to find the chapter

On the IAA website:

http://www.actuaries.org/LIBRARY/Papers/RiskBookChapters/Ch17_Risk_and_Uncertainty_6June2017.pdf

IAA Risk Book

Governance, Management and Regulation of Insurance Operations



Presented by Tom Herget
ERM Symposium
Miami
19 April, 2018

Today's Talk

- The goal of this presentation is two fold:
  - ✓ Provide concise overview of the IAA Risk Book rather than teach the concepts
  - ✓ Encourage audience engagement via further reading, feedback and critiques of this project
- Each chapter is summarized in 2 – 3 slides

About the IAA Risk Book

Background

- IRC published “Blue Book” on Insurer Solvency Assessment in 2004
- “Blue Book” explored the then current best practice elements needed for an international capital standard for insurers
- The Risk Book has been a two+ year project to update our prior work to reflect current perspectives on risk
- The Risk Book explores the many dimensions of risk through the multiple tools available to manage risk in a sustainable manner

About the IAA Risk Book

Contributors

- Risk Book steering committee includes regulators, current practitioners and retirees
- Individual authors – from around the world
- Many more contributing to review
- Objective = write each chapter in 20 pages or less
- Geared more to practice than theory

About the IAA Risk Book

How it works (on the website), how it gets updated and how to access

- Located at IAA website under PUBLICATIONS, pull down to RISK BOOK -or-
- http://www.actuaries.org/index.cfm?lang=EN&DSP=PUBLICATIONS&ACT=RISKBOOK
- Will accept and respond to comments
- Will update chapters as needed

About the IAA Risk Book

Table of contents 1 of 2

About the IAA Risk Book

Table of contents 2 of 2

About the IAA Risk Book

Chapters under construction

- Stress Testing
- Dynamic Hedging

Chapter 1 Introduction

Key messages include:

- Managing and Communicating Uncertainty – Our Professional Opportunity & Responsibility
- ERM Is the Core Franchise Value of Insurance

What is the Important Problem?

- What Pillar 2 (ERM) processes and tools can be used to sustain the Balance Sheet before Pillar 1 indicates the “ship has sunk”.
  - And, are they robust or smoke and mirrors?

Chapter 1 Introduction

What are the Important Solutions?

- To manage and communicate uncertainty, processes are essential
- Can the Actuarial Function step into and/or assist these roles more directly?
  - ORSA
  - Model governance
  - Stress testing
  - ERM
  - Recovery and resolution planning oversight
  - Micro (firm specific) vs macro (sector specific) implications

Chapter 5 Catastrophe Risk

Key messages:

- Catastrophes result in a sudden and mass destruction of property, lives, environment, and/or the economy.
- Catastrophes can be natural or man-made (e.g., terrorism).
- The frequency and severity of catastrophe losses have been increasing over past several decades primarily due to increasing concentrations of population and property in geographical areas prone to disasters.

Chapter 5 Catastrophe Risk

Key messages (continued):

- Catastrophes impact society first, and insurers only to the extent that the damages are insured.
- Due to their infrequent nature, analysis of past losses can't sufficiently measure catastrophe risk, so many insurers use catastrophe models to estimate potential losses.
- Catastrophe models are based on four primary components – event catalogs, intensity formulas, damage functions and a financial module.

Chapter 5 Catastrophe Risk

Key messages (continued):

- Model uncertainty is unavoidable and is impacted by both data issues (related to quality and availability) and political issues (influencing how events will unfold in times of stress). This is in addition to the uncertainty related to random events.
- Model development and usage is evolving, including a trend towards open models (as opposed to closed proprietary models) and their use for scenario analysis.
- Catastrophe models are part of the risk management process both in terms of pricing/underwriting and in terms of solvency/capital management.

Chapter 6 Non-Proportional Reinsurance

Key messages:

- Non-proportional reinsurance (NPR) is a very powerful tool in spreading risk, diversifying risk and managing the “dangerous” tail of loss distributions.
- NPR is used extensively in P&C reinsurance , but is less common for life and health insurance where proportional reinsurance continues to dominate.
- In addition to risk and capital considerations, NPR is used extensively to reduce the potential volatility of a company's quarterly or yearly earnings.

Chapter 6 Non-Proportional Reinsurance

Key messages (continued):

- The risk assessment and the pricing of NPR products are reliant upon having good meaningful data.
- As regulatory capital regimes become more risk-based it is likely that NPR solutions will become more common across all lines of business.
- NPR structures, and reinsurance in general, carry a risk in respect of a failure of the reinsurer which needs to be reflected in the capital requirements.

Chapter 7 Intra-Group Reinsurance

Key messages:

- Rationale for IGR transactions is similar to normal reinsurance transactions, but the relationship between the two related transacting companies gives rise to special considerations. The presence of third party, the Group (parent), requires that good process and governance is in place.
- IGR transactions are useful within a group for managing risk and capital across the entire organization; IGRs are often used as an alternative to increasing the capital within a subsidiary company as they can transfer risk to another subsidiary company where there is surplus capital.

Chapter 7 Intra-Group Reinsurance

Key messages (continued):

- The IGR structure depends upon the intended outcome. Aiming to reduce the overall capital requirement of a ceding legal entity will be different to seeking to reduce P&L volatility.
- These transactions need to be executed as if they are between independent parties; each legal entity takes responsibility that the transaction is beneficial from its own perspective.

Chapter 7 Intra-Group Reinsurance

Key messages (continued):

- Conflicts of interest will arise. Individual participants need to recognize potential conflicts and know to whom are they advising or for whom are they taking a decision.
- Active negotiation needs to take place and be evident. Transaction pricing should be in the range of what is observable within the market that each company operates.
- Where IGR transactions involve the use of Special Purpose Vehicles (SPVs) or other similar vehicles then additional considerations may apply.

Chapter 8 Addressing the Consequences of Insurance Groups

Key messages for management:

- There is a need for a group level ERM function supported by local risk functions.
- Identification of all the material linkages between members of the insurance group and their associated risks, including concentration or accumulation of risk exposures (both direct and indirect) is very important for the risk and capital management of the group as well as its prudential supervision.
- Members of the insurance group and its head need to understand the roles, expectations and requirements of their respective involved supervisors.
- Head of the insurance group has ultimate responsibility within the group for meeting expectations and requirements of group-wide supervisor.

Chapter 8 Addressing the Consequences of Insurance Groups

Key messages for the Supervisor:

- Group-wide supervisor, in cooperation and coordination with involved supervisors, plays a lead role in effective group-wide supervision, including addressing any resolvability issues.
- The cooperation and co-ordination of all involved supervisors in carrying out their roles as local supervisors and as members of the supervisory college is important to the effective supervision of the group.

Chapter 8 Addressing the Consequences of Insurance Groups

Key messages for the actuarial profession:

- Actuaries involved in risk management generally, and control functions specifically have appropriate regard not only to their entity specific responsibilities/risks but also for the wider group context/risks within which their work is conducted.
- Head of insurance group should have adequate access to actuarial expertise; internationally active insurance groups (IAIG's) may be required to establish an actuarial function at the group level.

Chapter 11 Resolution of Insolvencies

Recovery vs Resolution:

- Recovery – actions trying to prevent failure
- Resolution – mitigates the impact of an actual failure

Insurers vs. Banks: Insurer features

- Long time horizon for business decisions & resolution needs
- Illiquidity
- Uncertain liabilities
- Asset values readily available
- Run unlikely
- Lower risk of contagion

Chapter 11 Resolution of Insolvencies

Insurers vs. Banks: Bank features

- Value of assets (loans) uncertain & difficult to quantify
- Liabilities easy to quantify
- Liabilities are extremely liquid – business model assumes depositors will not all ask for their money at the same time
  Susceptible to “run” – could pay first depositors requesting, but not later
- Nothing fundamental needs to be wrong with bank for a run to occur
- Resolutions typically happen over a weekend

Chapter 11 Resolution of Insolvencies

Resolution of Insolvencies – key elements

a. The identification of two to four principal scenarios, including idiosyncratic and sector-wide or market-wide stress situations which create significant capital or liquidity shortfalls
b. Detailed quantitative & qualitative description of the scenarios
c. A description of principal recovery options that are likely to have a material impact on the firm in at least one scenario considered, including an assessment of each option in detail
d. Valuation and impact analysis (capital, liquidity, franchise)
e. Speed and timing of actions
f. Suitability & feasibility in each recovery scenario

Chapter 11 Resolution of Insolvencies

Resolution of Insolvencies – key elements (continued)

g. Operational aspects and responsibilities, including dependencies on outside suppliers

h. Impediments and constraints

i. Internal and external risks and issues

j. Credibility and necessary preparations

k. Maintenance of the recovery plan, including the process by which the recovery plan is refreshed and aligned to the changing shape of the business

Chapter 11 Resolution of Insolvencies

Resolution of Insolvencies – key insurer/regulator options

- Capital raising (equity and/or debt)
- De-risking the investment portfolio
- Enhanced use of reinsurance
- Reduce the volume of new business written/transition into run-off
- Proactive run-off by actively commuting policies
- Disposal of subsidiaries or blocks of business
- Scheme of arrangement – use existing statute or regulation to agree to a compromise that binds all parties

Chapter 12 Capital

Reading the tea leaves of capital:

1. What is its purpose? (Will vary by stakeholder - investor, policyholder, supervisor, rating agency, etc.)
2. What level is desired for each stakeholder?
3. What method(s) are used to calculate required capital?
4. What actions are available to management and/or the supervisor?
5. What actions will follow if capital is “not sufficient”?

Chapter 12 Capital

Various stakeholder interests:

1. Financial strength indicator (Assets less Liabilities)
2. Solvency buffer (Required Capital)
3. Earnings/liquidity buffer (Margin Over Current Estimate)
4. Source of funds for future growth, acquisition or investment
5. Source of future shareholder & policyholder dividends
6. Legal trigger to constrain management or to transfer authority to supervisor

Chapter 12 Capital

Considerations:

1. Solvency measurement should reflect real economic risks.
2. Required capital insolvency is not cash insolvency.
3. Addressing the uncertainty of any capital estimate.
4. Risk based capital charges should lead to better risk management practices.
5. Group vs. Legal Entity Capital
    a. Fungible?
    b. Diversification vs. Too Big to Fail

Chapter 12 Capital

6. Business Model
   - First line of defense for liquid risk banking business model
   - Last line of defense for the uncertainty of liabilities and/or the ability to raise new capital via premiums or asset sales
   - Relation of debt to interconnectedness
7. Pro-cyclicality of market based capital requirements

Chapter 12 Capital

8. Role of Insurer Liabilities
   - Value of liabilities is driven by assets due to risk sharing
     - Can value cost to fully hedge guarantees at today's market costs OR
     - Assets needed to fund "expected" range of payouts over "expected" range of asset returns
   - Value of liabilities which are not liquid
9. Impact of Insurer Franchise Value due to ERM/ORSA process

Chapter 14 Financial Statements

Key messages:

- Purpose – multiple users such as
  - Investors
  - regulators
  - tax authorities
  - management
- Components –
  - Balance sheet (assets, liabilities, capital)
  - Income statement (revenue, expense, earnings)
  - Disclosures
  - Supplemental solvency measures (RBC, SII, CROSS, SST)

Chapter 14 Financial Statements

Key messages (continued):

- Insurer-unique challenges to preparing a financial statement
  - Significance of estimates
  - Long-term nature of business
  - Volatility around a mean estimate
  - Significant use of counterparties
  - Same assumptions needed for multiple applications
  - When does a “blip” become a “trend”?
  - Provisions for margins where required
  - Consistency in valuing assets and liabilities
  - And many more

Chapter 19 Stress Testing

- **Prior IAA paper (Provide link) was focused on "How to do":**
- **Risk Book chapter looks at the effective use and application of stress tests:**
  - **Early uses tended to focus on setting a capital charge (Banking world)**
  - **More valuable use in creating conversations about what could possibly happen and is that risk tolerable, independent of the probability**
  - **Impacts other chapters such as Capital, Resolution & Recovery, ORSA, Actuarial Function, Model Governance, etc.**

Chapter 20 Dynamic Hedging

Given its mathematical and financial complexity, what principles can used to assess when hedging is a risk dampener or is a risk inflator? For example:

1. **Use of Daily traded options and futures vs. long, complex options.**
2. **Rigorous use of tracking error report**

Even for hedging which is intended to be a risk dampener, what are the key vulnerabilities and are they being monitored?

Thank you

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Emerging Risks

Session 11: Insights Available to Download

April 19, 2018 @ 2 pm

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Rumsfeld's Unknown Unknowns

- Known/known – historical data, law of large numbers
- Unknown/unknown – ?
- Known/unknown – south Florida flood risk
- **Unknown/known** – auto (distracted driver, driverless car), mortality (opioids, obesity, cancer cure)

Key Findings of 11th Survey

- #1 Cyber concerns continue
- #2 Geopolitical risks strengthen
- #3 Extended time horizon changes in risk rankings

#1 Cyber Concerns Continue

Year	2014	2015	2016	2017
1	Cybersecurity / interconnected-ness of infrastructure	Cybersecurity / interconnected-ness of infrastructure	Cyber / interconnected-ness of infrastructure	Cyber / interconnected-ness of infrastructure
2	Financial volatility	Financial volatility	Financial volatility	Terrorism
3	Terrorism	Terrorism	Terrorism	Technology
4	Regional instability	Asset price collapse	Technology	Regional instability
5	Asset price collapse	Regional instability	Retrenchment from globalization	Asset price collapse

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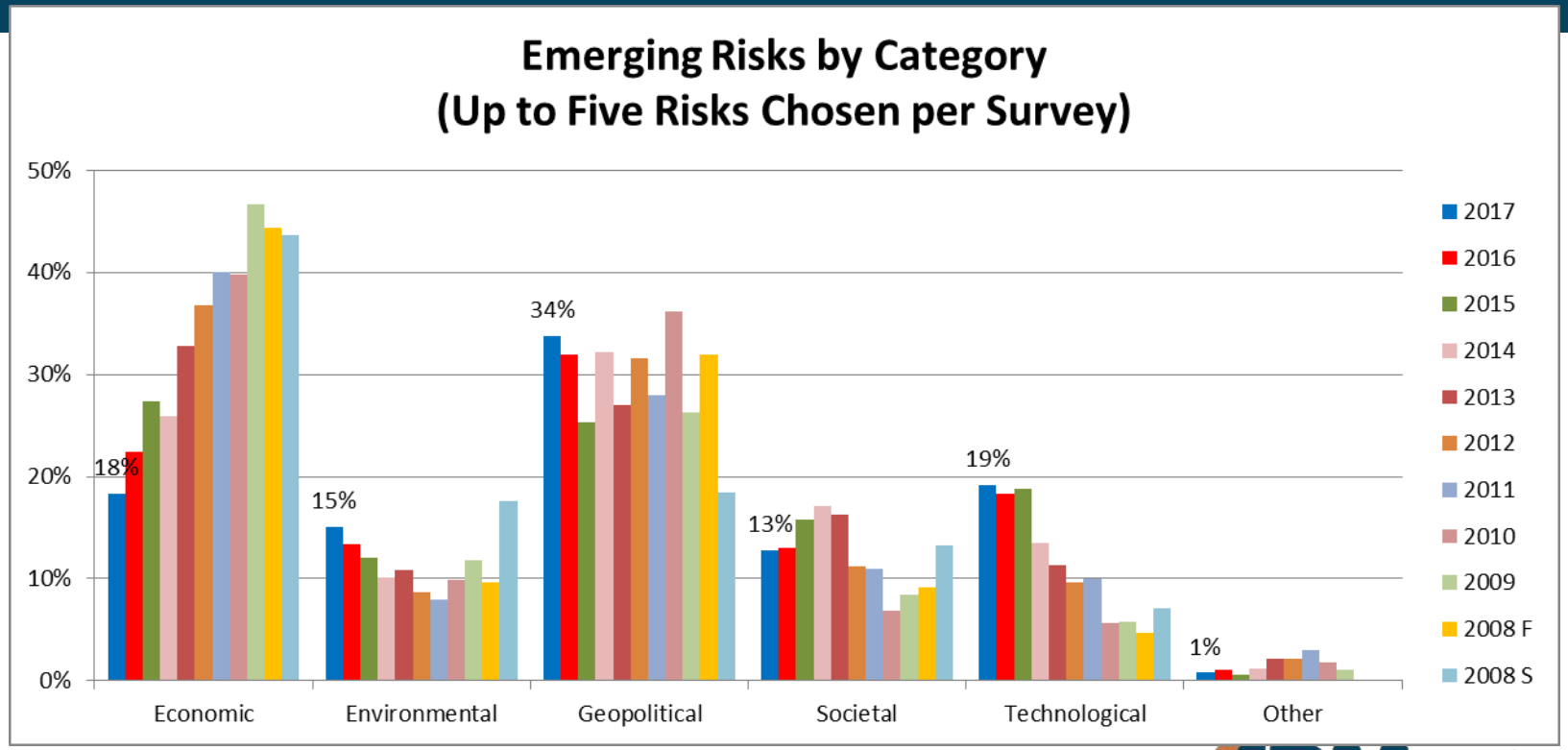
#2 Geopolitical risks strengthen



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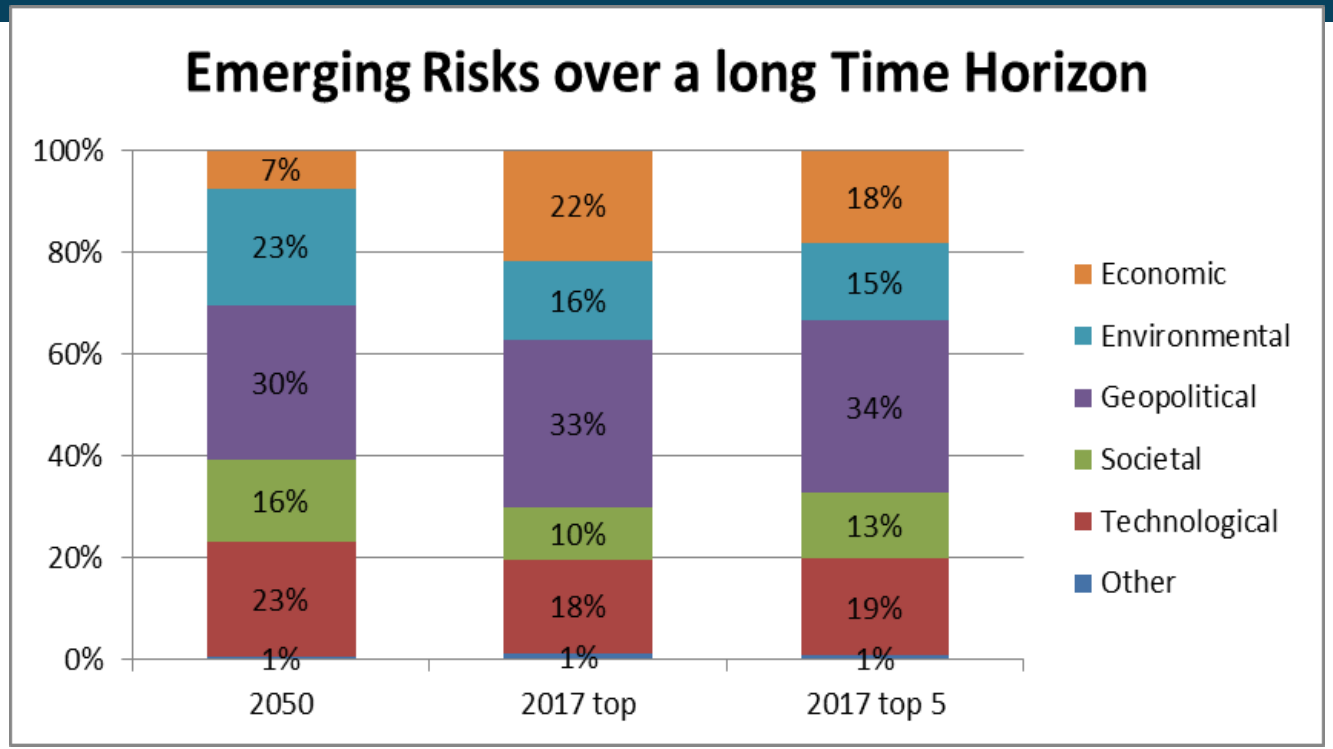
#3 Extended time horizon



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To access surveys/articles

http://www.soa.org/Research/Research-Projects/Risk-Management/research-emerging-risks-survey-reports.aspx

11th Survey of Emerging Risks

- Economic
  - Energy price shock
  - Currency shock
  - Chinese economic hard landing
  - Asset price collapse
  - Financial volatility
- Environmental
  - Climate change
  - Freshwater loss
  - Tropical storms
  - Earthquakes
  - Severe weather

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Emerging Risk Categories

- Geopolitical
  - Terrorism
  - Weapons of mass destruction
  - Interstate/civil wars
  - Failed and failing states
  - Transnational crime
  - Globalization shift
  - Regional instability
- Societal
  - Pandemics
  - Chronic diseases
  - Demographic shift
  - Liability regimes/regulations
- Technological
  - Cyber
  - Technology

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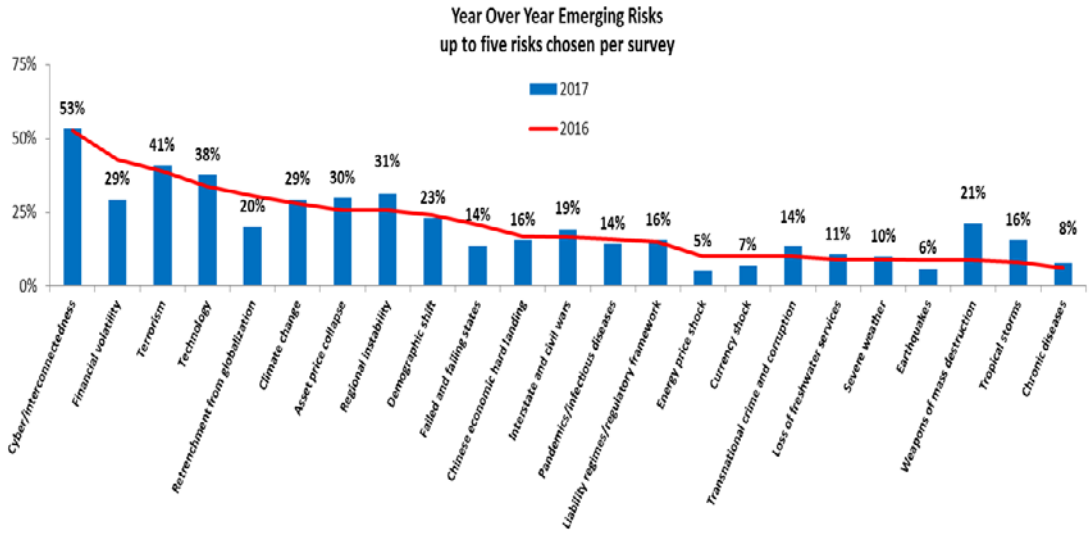
Changes from prior year



Thank you!
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  - SOA President's Award
  - Past Chair, Investment Section
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  - ASB ERM Committee (ASOPs 46/47, capital assessment)
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