Session 125: A Green Book – The Actuary's Natural Environment

SOA Antitrust Compliance Guidelines
SOA Presentation Disclaimer

2019 ANNUAL MEETING & EXHIBIT

A Green Book – The Actuary's Natural Environment

Mark E. Alberts, FSA, MAAA

Session 125, Tuesday 10/29/2019, 2:00-3:15PM

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History of SOA Environmental Research – Committees

2011-15 International Working Group on Actuarial Science & Sustainability (IWGASS)

Informal working group coordinated by SOA staff

2016-20 Climate and Environmental Sustainability Research Committee (CESRC)

SOA's first formal, funded research committee on environmental issues

2020+ Catastrophe & Climate Research Program

One of five strategic research programs under the SOA's Strategic Research Program Initiative, scheduled to launch 2nd half of 2020

Actuaries' Climate Index

ACI Overview

- Index of changes in six climate-related variables from a baseline period 1961-1990
  - Temperature highs, temperature lows, heavy precipitation, drought, high wind and sea level change
  - Regional data – US and Canada. Other actuarial organizations considering use of methodology for other regions
- Based on AAA, CAS, CIA, SOA joint research paper published 11/2012

History of SOA Environmental Research – Other Partnership Projects

2017

- Improving Disaster Financing – Six papers sponsored by SOA for November 2016 workshop "Improving Disaster Financing: Evaluating Policy Interventions in Disaster Insurance Markets," presented by Resources for the Future and the Wharton School

2018

- Incorporation of Flood and Other Catastrophe Model Results into Pricing and Underwriting – Davis, Gotham, Frith, Christie, Caravaggio. Jointly sponsored with CAS, CIA

2019

- Actuarial Weather Extremes – monthly report series identifies and examines weather extremes in North America. Provided to Associated Press.

History of SOA Environmental Research – Other SOA Projects

2017

- Climate, Weather, and Environmental Sources for Actuaries – Erhardt
- Climate Sources for Actuaries – Alberts

2018

- Managing Climate and Carbon Risk in Investment Portfolios – Seng Tan, Wirjanto, Fang
- Predictive Modeling of Surface Temperature Extremes over North America, with Actuarial Applications in View - Brazauskas, Kravtsov, Roebber
- How Do They Know and What Could We Do? The Science of 21st Century Climate Projections and Opportunities for Actuaries – Erhardt, Von Burg
- Environmental Sustainability 2017 Call for Essays – Jones, Ostaszewski; Rudolph

History of SOA Environmental Research – Other SOA Projects (cont'd)

2019

- Modeling, Measuring, and Pricing the Flood Risk – Furman, Su, Chen, Santoshkumar, Zhang
- Climate & Environmental Sustainability 2018 Call for Essays – Shen; Rudolph

In Process

- Discount Rates in Climate Change Studies - Gutterman
- International Catastrophe Pooling - Bollman, Schanz & Wang
- Using extreme weather event attribution to determine the impacts of climate change on human health - Bell

SOA Climate Research Links

SOA Climate Research Page - https://www.soa.org/research/topics/research-emerging-topics/#climate

Actuaries Climate Index http://actuariesclimateindex.org/home/

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Now on to our real presenters…

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2019 ANNUAL MEETING & EXHIBIT

A Green Book – the Actuaries Natural Environment

Social Discounting

its application to the Risk Management of Climate Change

Sam Gutterman

Session 125 October 29, 2019

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What I will cover

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

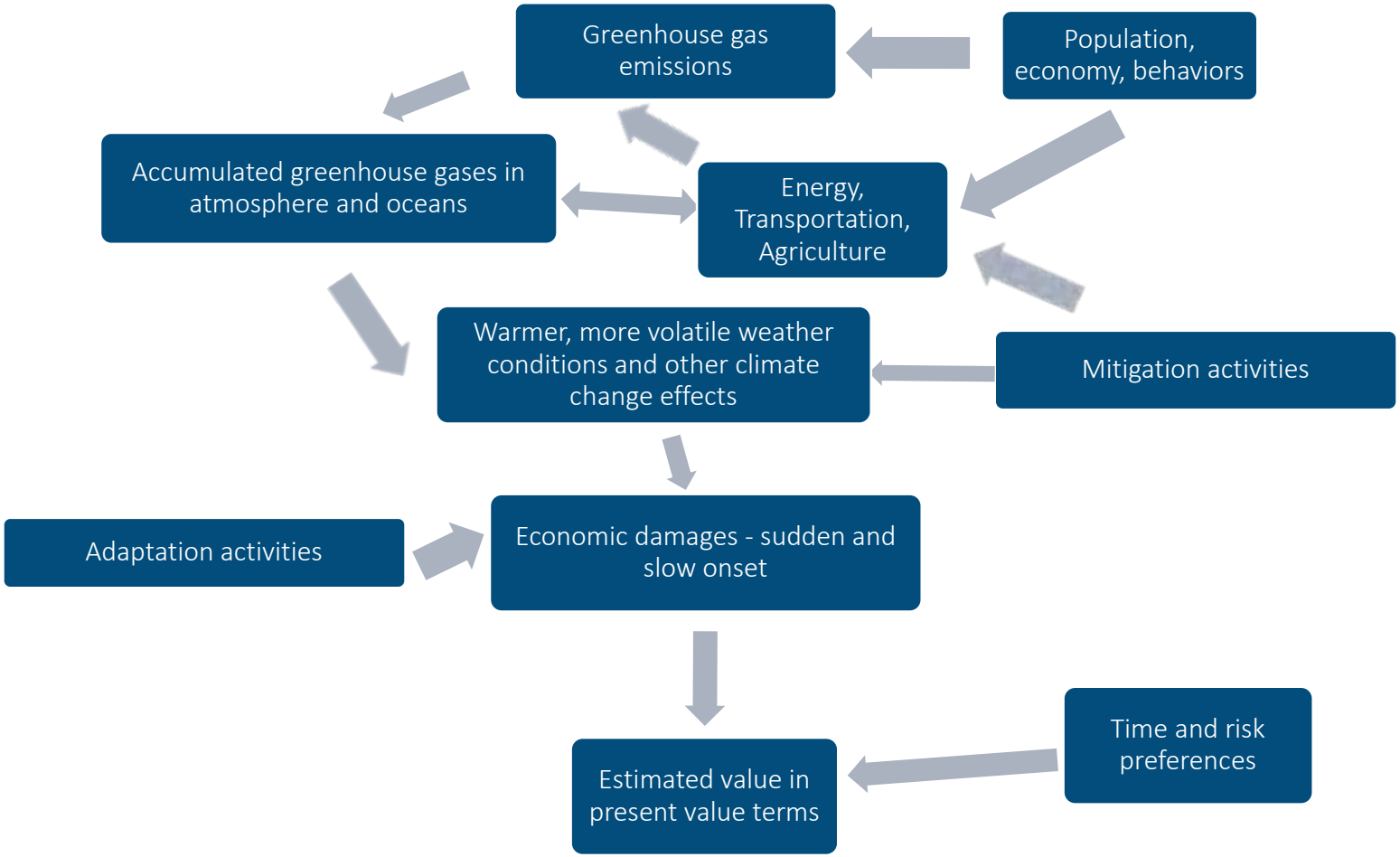
The paper and why should you care

- Sponsored by the Society of Actuaries' Climate and Environmental Sustainability Research Committee
- Still a work-in-progress
- The process used represent an application of a risk management process applied to a global social issue, parts of which may apply in other situations
- Actuaries have the tools and experience to play a role in the analysis of many social policy issues
- Climate change and its risks are important
  - To society, your firm and you personally
  - Due to the severity of its potential adverse effects and its ultra-long time horizon

Social risk management (SRM)

- The framework in which social discounting is applied
- Definition: SRM is the application of Enterprise Risk Management to a social issue
- Social cost/benefit analysis is the key analytical and quantifiable assessment of a social issue
  - Social discounting is the process of reflecting the time value of expected cash flows and other elements in a social cost/benefit analysis
- Basically a present value of future expected cash flows and a qualitative discussion

Climate process



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
  - Very long time frames and multiple generations are involved
  - Other greenhouse gas emissions are more intense, but have much shorter half-life, e.g., methane
- Almost irreversible in the absence of effective sequestration or geoengineering
  - A primary reason why climate change costs are looked at differently from other long-term costs

Why not use market-based discount rates

- Imperfections in the market relative to the purpose of the application
  - Market prices don't include
    - Costs (and benefits) to society external to the parties directly involved (externalities) referred to as social externalities
    - Related benefits (co-benefits, such as pollution reduction and health improvement)
  - Longer-term focus
  - Welfare of future generations at stake relative to the current generation
- Global considerations
- Non-financial costs
  - Irreversible environmental damage
  - Effective hedges unavailable
- Usually lower than market-based discount rates, reflecting externalities, related co-benefits and a sustainability/uncertainty 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"

The Ramsey formula

Economics-based method of quantifying long-term discount rates

- By economist Frank Ramsey (1928) who described a social discount rate approach to analyze 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

Ethical aspects

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

Uncertainty

- Any projection of the effects of climate change involves great uncertainty, especially in the tail of the distribution
  - Future greenhouse gas emissions
  - Natural offsets
  - Effects of climate – frequency, amount, and timing
  - Extent and 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 rates
  - In this context, typically a reduction in discount rate
- Ramsey formula assumes certainty
  - Can be adjusted by addition of a third term: $-0.5\eta^2\sigma^2$
- Often better addressed by scenario rather than stochastic analysis

Structure of social discount rates

- Practice to date varies by national government
  1. Level discount rates
     - Simple
     - U.S. approach
       - Between 2003 and 2016 required alternative discount rates, e.g., 3.0%, 3.5% and 5.0%
         - Reflects consumption and investment views
       - Prior to 2003 and since 2017 requires 7.0%
  2. Declining (hyperbolic) discount rates
     - More consistent with currently accepted theory (Weitzman, Gollier) and reflects uncertainty
     - U.K. – starts at 3.5% declining to 1.0% after 300 years
     - France – starts at 4.0% declining to 2.0% after 30 years

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
  - Some have concern regarding the ability to accurately quantify an population-wide utility function
  - Difficult to incorporate non-financial costs, such as human life, oceanside property and heritage assets
  - Should discount rates differ by application?
- Alternative approach is scenario analysis (e.g., a 2°C one)
- In contrast, actuaries usually apply discount rates to cash flows or risk-adjusted cash flow equivalents

Real Options

- Decision-making under uncertainty
- Definition
  - The right, but not the obligation, to undertake an initiative, such as deferring, abandoning, expanding, staging, or contracting a capital investment project
- Many options may be available to a public policy decision-maker
  - To act now, schedule or defer (kicking the can down the road) action
  - May consider expected costs and benefits of flexibility
    - Examples: new information, future resource availability or new technologies
- Discussions of climate change prior to 2007 (the Stern report)
  - Was common to assume future costs won't be that bad and future technologies will provide a cost-effective response
  - More recently, opinions are either act now or defer as long as possible
- Difficult to quantitatively reflect these options

Conclusions

- Often fraught with political constraints
  - Example – determining social cost of carbon for use in analysis of a carbon tax
- 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 advocate limited or deferred action justify a higher social discount rate
- Given the thousands of economic papers on this, you would expect a consensus – but disagreements remain
- Role / opportunity for actuaries

2019 ANNUAL MEETING & EXHIBIT

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2019 ANNUAL MEETING & EXHIBIT

A Green Book – the Actuaries Natural Environment

International Catastrophe Pooling for Extreme Weather

An Integrated Actuarial, Economic and Underwriting Perspective

Shaun Wang, PhD, FCAS, CERA

Session 125 2:00 – 3:15 p.m. October 29, 2019

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Impacts of Disaster on Small versus Large Nations

- Total damages and losses stemming from Hurricane Katrina in 2005 were estimated to be $160 billion, or about 1% of USA's GDP.
- The 2011 Great East Japan Earthquake and Tsunami total US$ 228 billion, which is about 3.4% of Japan's GDP.
- Small nations can suffer a loss amount to 15% to 60+% of their annual GDP


Search

Bloomberg

Developing

Hurricane Dorian Seen Costing the Bahamas at Least $7 Billion

By Katherine Chiglinsky

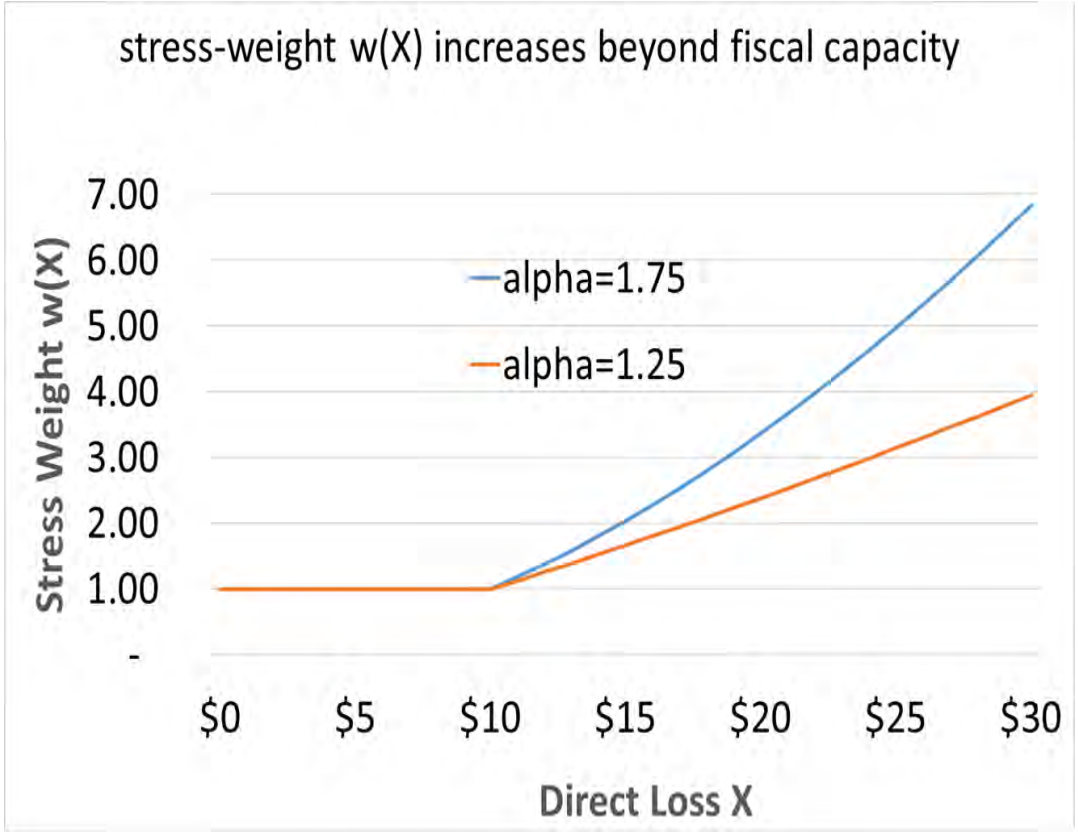
September 5, 2019, 7:53 PM GMT+8

It is 58% of Bahamas 2017 GDP ($12 billion)

Risk-bearing Capacity

- For an entity, we define risk-bearing capacity *C* and financial vulnerability index α >1, such that the fiscal impact by a direct loss *X* is equal a stress-adjusted value: $w(X) \cdot X$
- with

$$w(X) = \begin{cases} \left(\frac{X}{C}\right)^{\alpha}, & \text{when } X > C \\ 1, & \text{when } X \leq C \end{cases}$$



Insurance Cost Multiplier

- An entity's expected stress-weighted value of disaster losses

$$E[w(X)\cdot X] = \int_0^C x dF_X(x) + \int_C^{MPL} x\left(\frac{x}{C}\right)^{\alpha} dF_X(x)$$

- Indifferent to pay a premium $=E[w(X)\cdot X]$, with cost multiplier $\frac{E[w(X)\cdot X]}{E[X]}$ >1

- For small nations, the multiplier is higher!

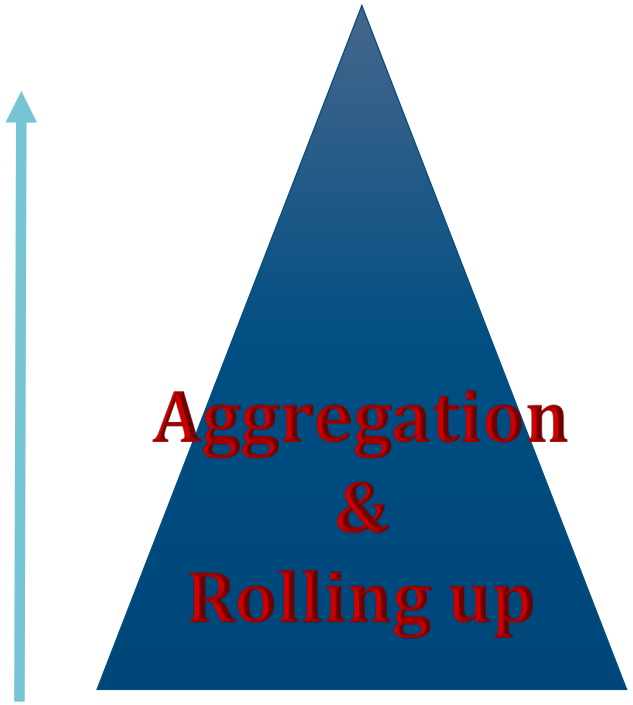
Magnified Effect of Basis Risk for Small Nations

- Parametric triggers are becoming popular for CAT Pool insurance, to avoid the delay in verifying actual damage.
- Consider a scenario outcome, j, the entity suffers a big loss $x_j > C$, if the parametric insurance payout $V(x_j) < x_j$, it creates a big negative stress-adjusted value to the insured:

$$(v(x_j) - x_j) \cdot \left(\frac{x_j}{C}\right)^{\alpha}, \quad \alpha > 1$$

Most Risk Financing are based on Pooling

Level	Financing Tools
4. A Region with several nations	Regional CAT Pools
3. National	**National Pool** seeks Contingent Credit CAT-DDO; CAT bond
2. Local Government	Local Insurance Facility
1. Households, farmers	Insurance Agencies



Promised Benefit of Risk Pooling

- Nation *i* faces disaster loss X_i,
- CAT Pool: $S = X_1 + X_2 + \cdots + X_n$

➢ Expected loss: $E(S) = E(X_1) + E(X_2) + \cdots + E(X_n)$

➢ Volatility: $\sigma(S) < \sigma(X_1) + \sigma(X_2) + \cdots + \sigma(X_n)$

- Most CAT pool design is based on this equation!
- However, there are limitations in practice

1) Pooling does not reduce the expected loss

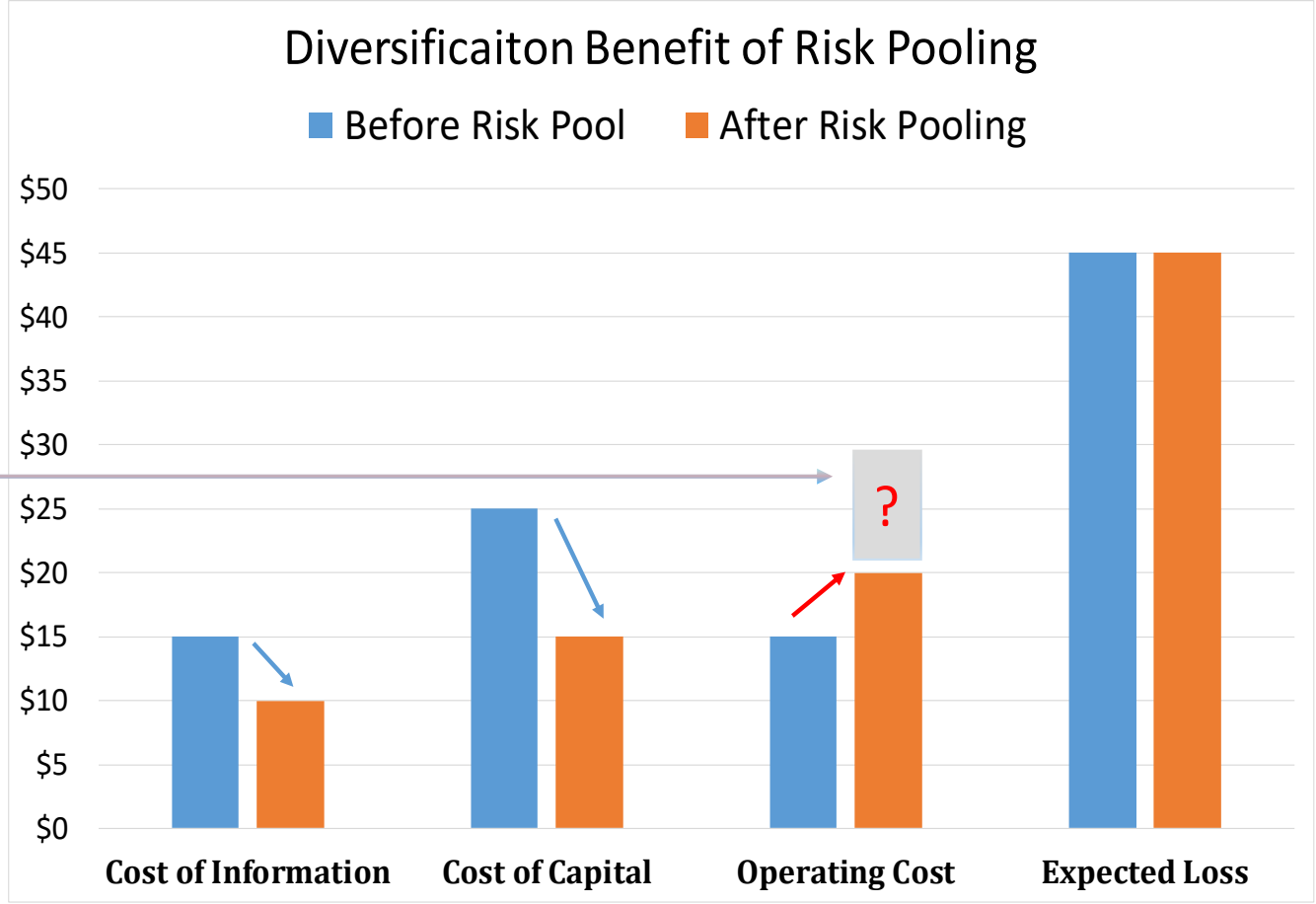
2) Diversification benefits may not be distributed evenly (or perceived fairly)

Theory: CAT Pool reduces cost of capital

Pool covers losses by individual nations:

$$S = X_1 + X_2 + \cdots + X_n$$

? = Extra Cost due to poor design (e.g. disputes due to basis risk of parametric trigger)



Case 1. Florida Hurricane Catastrophe Fund

- The Florida Hurricane Catastrophe Fund (FHCF) was created in November 1993 during a special legislative session after the 1992 Hurricane Andrew.
- The purpose of the FHCF is to protect the state's interest in maintaining insurance capacity in Florida by providing reimbursements to insurers for a portion of their catastrophic hurricane losses.
- As of 2018, FHCF has $14.1 billion year-end fund balance (surplus)
- Estimated benefit to the residence in Florida: hundreds of billions of dollars in premium saving over the past 25 years (1993-2018)
- Key question: why not expand the FHCF to include 2 more states --Alabama and Louisiana? Answer lies in the importance of political unity

Success or Lucky?

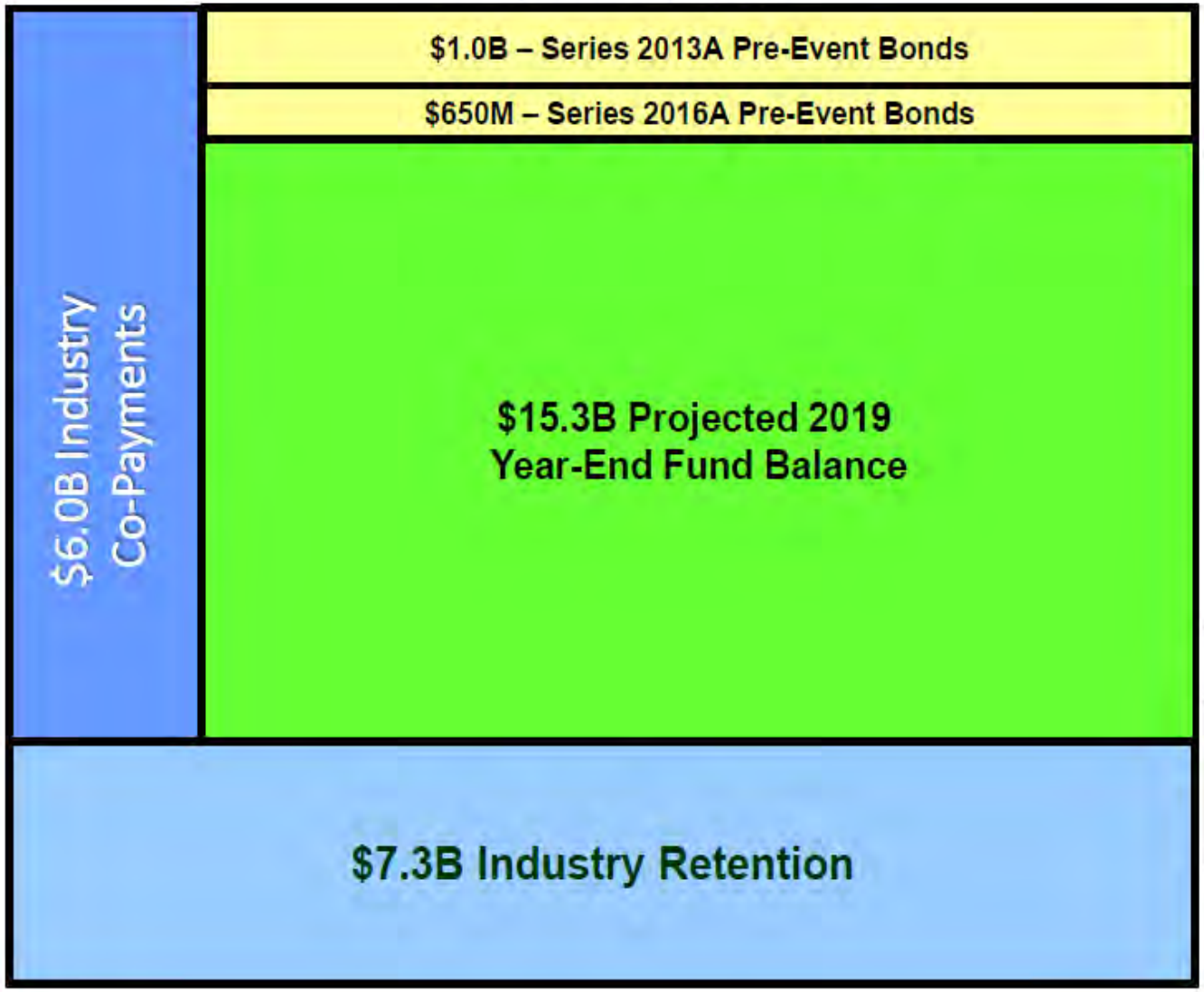
For past 25 years? 1993-2018

$17B FHCF Capacity

(Loss Adjustment Expense is included in the capacity)

as of May 29, 2018

Assumption: *No loss in prior year*



$15.30B	Cash
1.65B	2013A & 2016A Bonds*
$16.95B	Total Resources
-$17.00B	Statutory Limit
$ 0.05B	Potential Bonding Needed

* Excludes $550M debt service payment due July 1, 2019

Post-Event Bonding Capacity May 2018

$8.2B

Case 2 Caribbean Catastrophe Risk Insurance Facility (CCRIF)

- CCRIF SPC is a segregated portfolio company, owned, operated and registered in the Caribbean.
- It limits the financial impact of catastrophic hurricanes, earthquakes and excess rainfall events to member countries by quickly providing short-term liquidity when a parametric insurance policy is triggered.
- It is the world's first regional fund utilizing parametric insurance, giving member governments the unique opportunity to purchase earthquake, hurricane and excess rainfall catastrophe coverage with lowest-possible pricing.

Question Raised about the CCRIF? (ref: Jubilee Debt Campaign, Oct. 2018)

- Total payout $138.8 million for June 2007 - October 2018
  - ✓Tropical Cyclone (14): $94.9 million
  - ✓Earthquake (4): $9.2 million
  - ✓Excess Rainfall (20): $34.7 million
- Quote -- “CCRIF effectively operate as a middle-man between its member nations and profitmaking insurance companies”
- “The total amount spent by CCRIF on reinsurance, minus payments it has received from that reinsurance, is $105 million so far. This $105 million is effectively all profit for global insurance companies.”

Table 4: CCRIF finances 2008–2017[37]

Income	
Donor grants	$75 million
Premium income and membership fees	$218 million
Investment income	$31 million
Total:	**$324 million**
Expenditure	
Claims	$131 million
Administration	$12 million
Technical assistance	$5 million
Net reinsurance cost	$105 million
Total:	**$253 million**
Net assets:	**$100 million**[38]

Bahamas drama due to parametric cover (part 1)

1. Previous “administration had initially forecast just a $100 million deficit for 2016-2017, which (hurricane) Matthew turned into $350 million under its cash-based accounting methods.”
2. The administration ceased paying the annual $900,000 premium after it was advised that the likelihood of ever receiving a payout was “almost zero”.
3. Hurricane Matthew’s passed Bahamas as Category 4 (it would only have received compensation in the event of a Category Five hurricane)
4. The administration decided to drop CCRIF participation and establish its own disaster fund as “the threshold was just too high”.

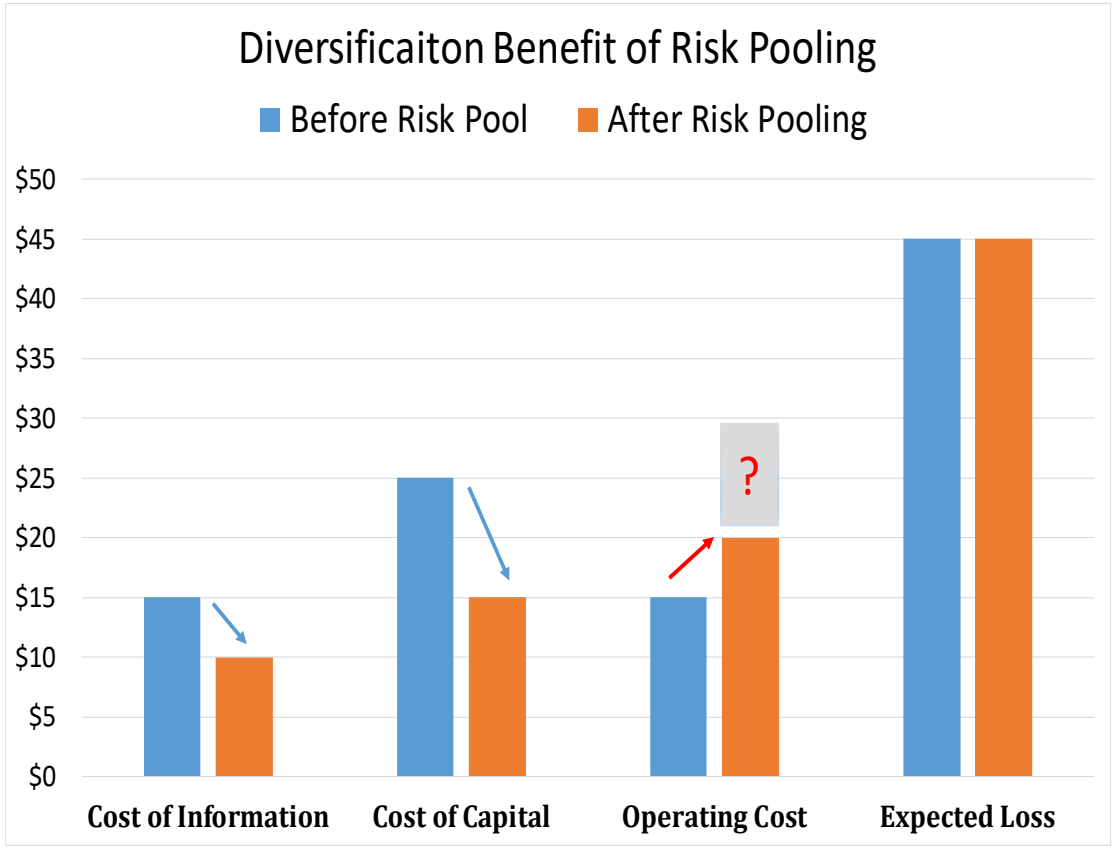
Bahamas drama due to parametric cover (part 2)

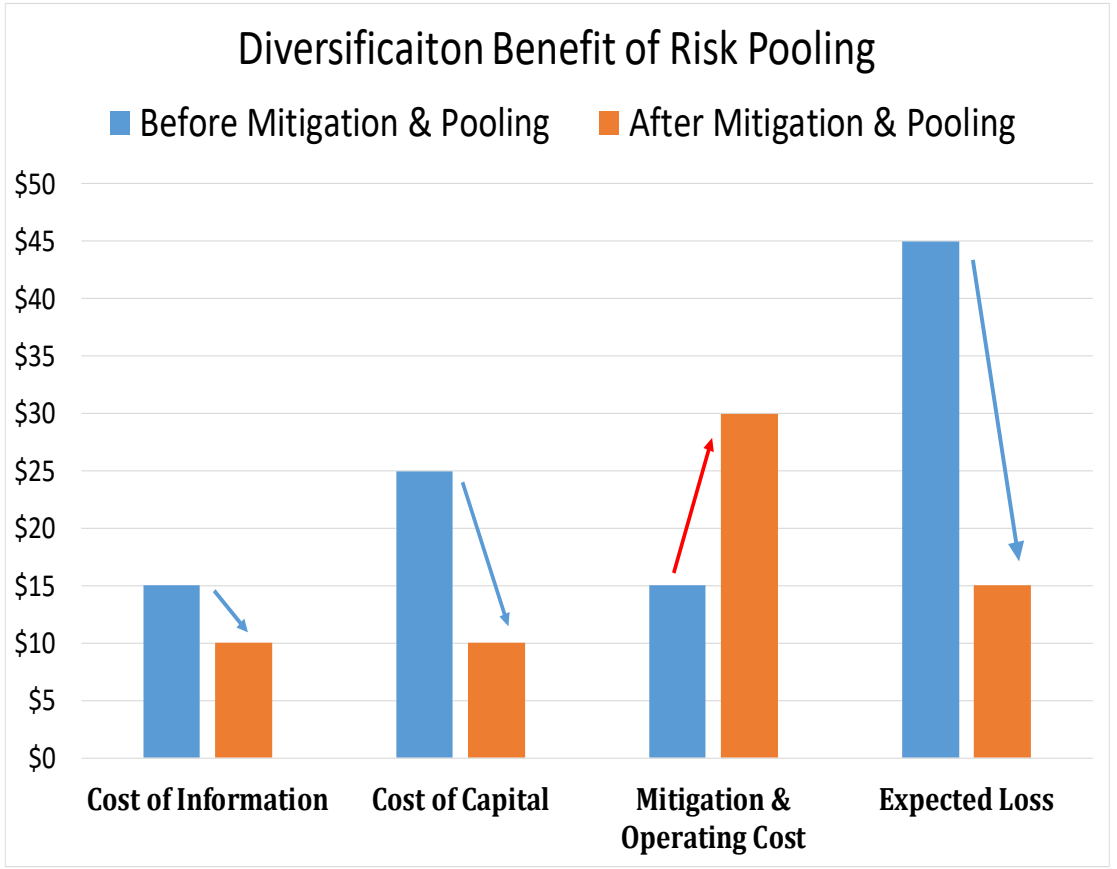
- The CEO of the CCRIF sent a letter to Bahamas -- 'Based on the registered losses, it means that had the Government of the Bahamas renewed its tropical cyclone policy for 2016-2017, using the previous year's policy conditions, the policy would have triggered, resulting in a payout of approximately $31.8 million, equal to the coverage limit'
- New administration of Bahamas wanted to renew the insurance, however, the premium is understood to have increased from $900,000 to between $2.6-$2.8 million
- Hard questions after the 2019 Hurricane Dorian:
  - ✓ What % of the $7 billion loss will be covered by CCRIF?
  - ✓ Did the CCRIF help prevent the 56 deaths and 600 missing?

Need Actuarial Analysis of Economic Benefit of Risk Mitigation/Reduction

1. Building codes,
2. Zoning,
3. Enforce policing
4. Building walls
5. Reservoir

Effect of Mitigation in reducing cost

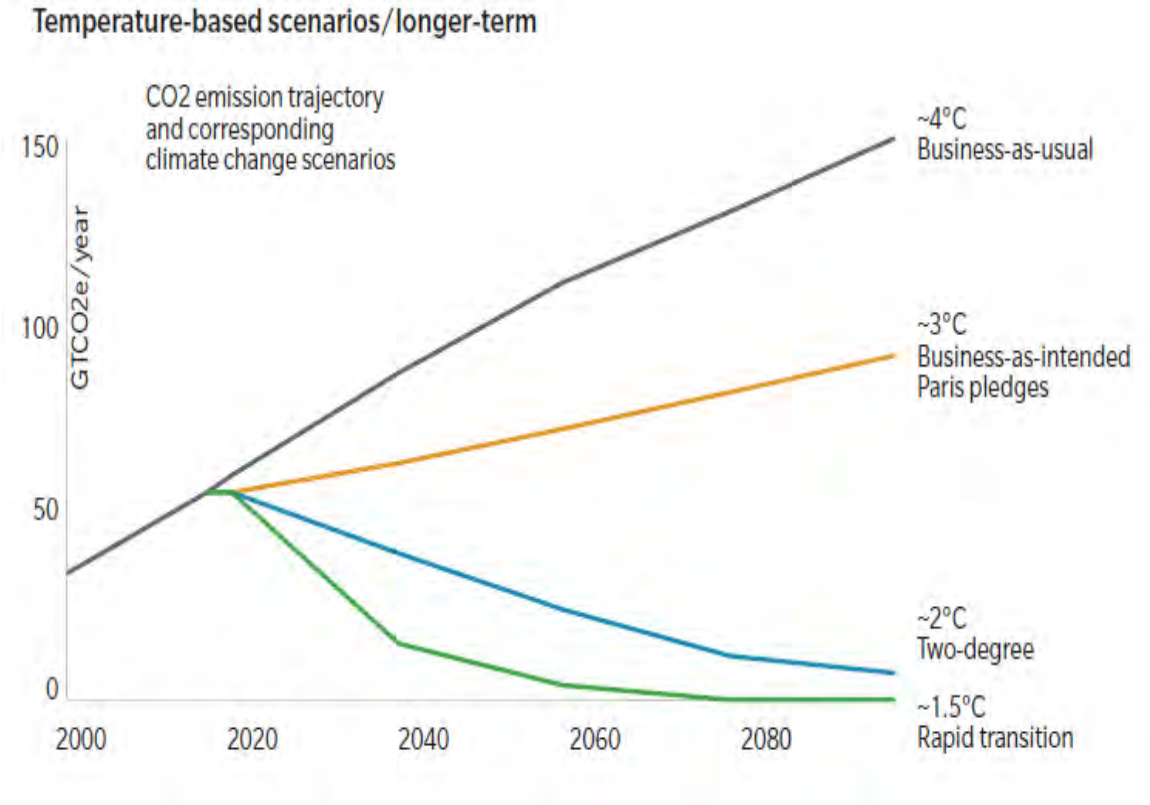




National Day Rally 2019: $100 billion needed to protect Singapore against rising sea levels

3 Scenarios of Sea-Level Rise for Singapore 2020-2010

1) High emission pathway with 1.5 m sea-level rise.
2) Moderate emission pathway with 0.9 m sea-level rise.
3) Low emission pathway with 0.6 m sea-level rise.



Actuaries design sea-level 30-year futures contracts for life insurers?

Conclusions: Opportunity for Actuaries

Actuaries are called to develop a New Generation of Risk Models to facilitate CAT Risk Financing:

1) Tailored to the needs of governments, including protection of livelihoods and resilience of infrastructure and community
2) Optimizing CAT Pool design to avoid political pitfalls due to basis risk and unfair allocation of pooling benefits
3) Designing financing products for hedging the climate change and sea level rises

2019 ANNUAL MEETING & EXHIBIT

Reference:

< International Catastrophe Pooling for Extreme Weather >, Society of Actuaries Research Report, 2019

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