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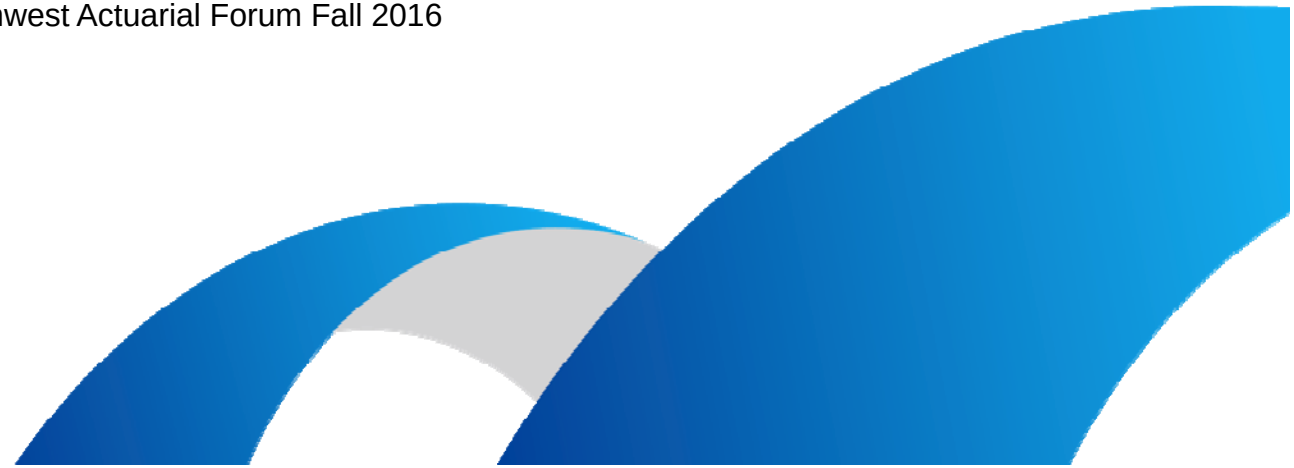
# Economic Scenario Generators and Negative Interest Rates

Presented at the Southwest Actuarial Forum Fall 2016

Mario DiCaro



# References

**Economic Scenario Generators – A Practical Guide;** by the SOA and Conning, July 2016
https://www.soa.org/Files/Research/Projects/research-2016-economic-scenario-generators.pdf

**A Quant's View of Negative Interest Rates**; Global Association of Risk Professionals (GARP)
http://www.garp.org/#!/risk-intelligence/detail/a1Z40000002vWhd
http://www.garp.org/#!/risk-intelligence/detail/a1Z400000033TqUEAU/quants-view-negative-interest-rates-part-II

**Everything You Need to Know About Negative Interest Rates**; Wall Street Journal, June 2016
http://www.wsj.com/articles/everything-you-need-to-know-about-negative-rates-1465906559

**WARNING: Physics Envy May be Hazardous to Your Wealth***; Andrew Lo and Mark Mueller, March 2010
http://mitsloan.mit.edu/media/Lo_PhysicsEnvy.pdf

# Balance Sheets 101

| Balance Sheet of Progressive (PGR) 2005 | | |
|---|---|---|
| **Assets** | | |
| Investments | 14.3 | [1] |
| Policyholder Money We Don't Have Yet | 3.5 | [2] |
| Other Assets | 1.2 | [3] |
| Total Assets | 18.9 | [4]=[1]+[2]+[3] |
| **Liabilities & Equity** | | |
| Policyholder Money We Have | 10 | [5] |
| Debt | 1.3 | [6] |
| Other Liabilities | 1.5 | [7] |
| Total Liabilities | 12.8 | [8]=[5]+[6]+[7] |
| Shareholders' Equity | 6.1 | [9]=[4]-[8] |
| Total Liabilities + Equity | 18.9 | [10]=[8]+[9] |

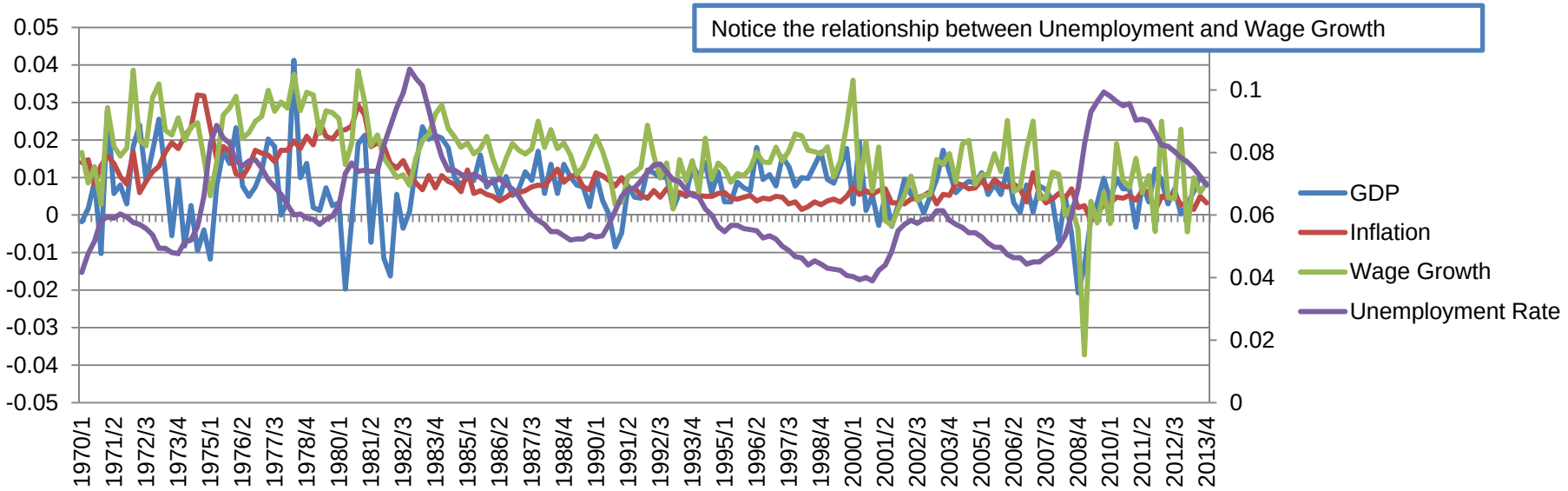
## Economic variables influencing valuations

- Inflation
- Corporate bond yields
- Treasury yields
- Unemployment
- Stock indexes like S&P 500

Balance sheet items represent future cash flows.
If **inflation rises** more than considered in your reserving analysis then liabilities could turn out to be much more than thought.
If **bond yields increase** then the value of your Investments will drop. That's an interesting one though because it doesn't really affect cash flows – just market value!
**Unemployment** affects liabilities
Large market disruptions may affect the ability to collect Other Assets and PMWDHY.
Drops in stock indexes could impact lines of business associated with market

http://www.fool.com/personal-finance/insurance/2007/01/26/understanding-an-insurers-balance-sheet.aspx

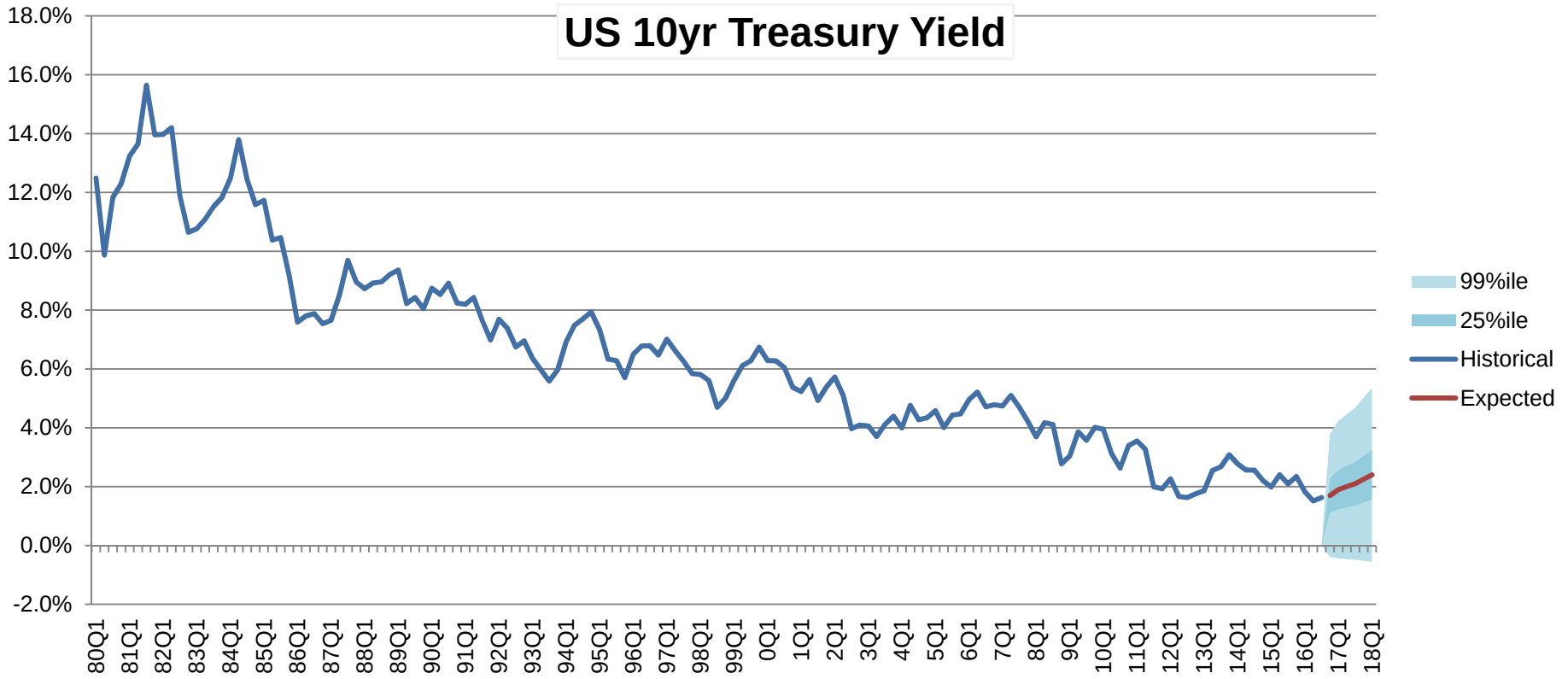
# Economic Variables




**ESGs need to capture correlations *and* range of possible outcomes**

- Will future correlations match those of the past?
- Will future movements fall within same bounds as history?
- How much will future behaviors match historical behaviors?

# What is an Economic Scenario Generator?

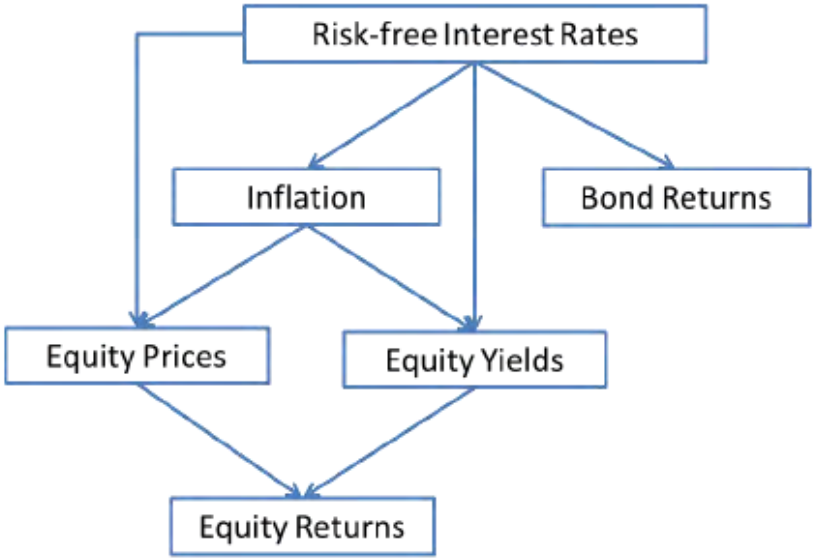


# Capturing correlations of economic variables

- Correlation across
  - Time
  - Variables
- Structural relationships
- Correlated sampling

| US Bonds | Int'l Emg Equ'ty | US Sml Growth | US Sml Value | Int'l Dev Equ'ty | Int'l Bonds | US Lrg Value | US Lrg Growth |
|---|---|---|---|---|---|---|---|
| 1 | -0.049 | 0.012 | 0.023 | -0.083 | 0.491 | -0.124 | -0.075 |
| -0.049 | 1 | 0.729 | 0.637 | 0.736 | -0.064 | 0.614 | 0.694 |
| 0.012 | 0.729 | 1 | 0.746 | 0.741 | -0.082 | 0.482 | 0.811 |
| 0.023 | 0.637 | 0.746 | 1 | 0.659 | -0.065 | 0.697 | 0.526 |
| -0.083 | 0.736 | 0.741 | 0.659 | 1 | 0.100 | 0.714 | 0.800 |
| 0.491 | -0.064 | -0.082 | -0.065 | 0.100 | 1 | -0.042 | -0.063 |
| -0.124 | 0.614 | 0.482 | 0.697 | 0.714 | -0.042 | 1 | 0.655 |
| -0.075 | 0.694 | 0.811 | 0.526 | 0.800 | -0.063 | 0.655 | 1 |

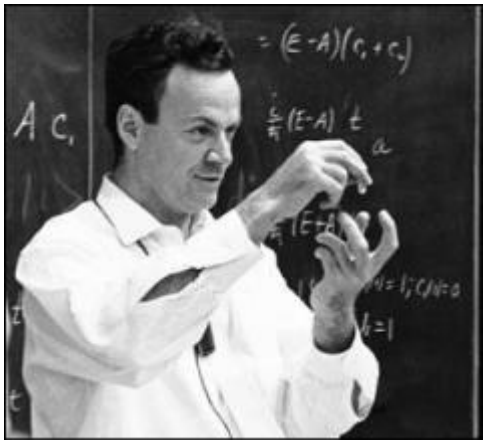
CASCADE STRUCTURE OF A HYPOTHETICAL ECONOMIC SCENARIO GENERATOR



# Be realistic about what you can model

Imagine how much harder physics would be if electrons had feelings!

– Richard Feynman, speaking at a Caltech graduation ceremony



Financial economics may be a long way from physics, but this state of affairs is cause for neither castigation nor celebration—it is merely a reflection of the dynamic, non-stationary, and ultimately human aspect of economic interactions.

– Lo & Mueller

The dominant core principles of interest rate modeling of the past decades have been that (1) interest rates don't go negative; (2) there must be consistency with current bond prices; and (3) there must be parametric consistency with historical data. Clearly the first principle is gone (forever?), and there is no intuitive and convincing lower bound to replace zero. Moreover, all historical data now strikes us as irrelevant to the current paradigm in which central banks dictate the yield curve. There is no history to guide an appropriate contemporary model approach.

-Joe Pimbley, GARP

# Lessons from Lo & Mueller

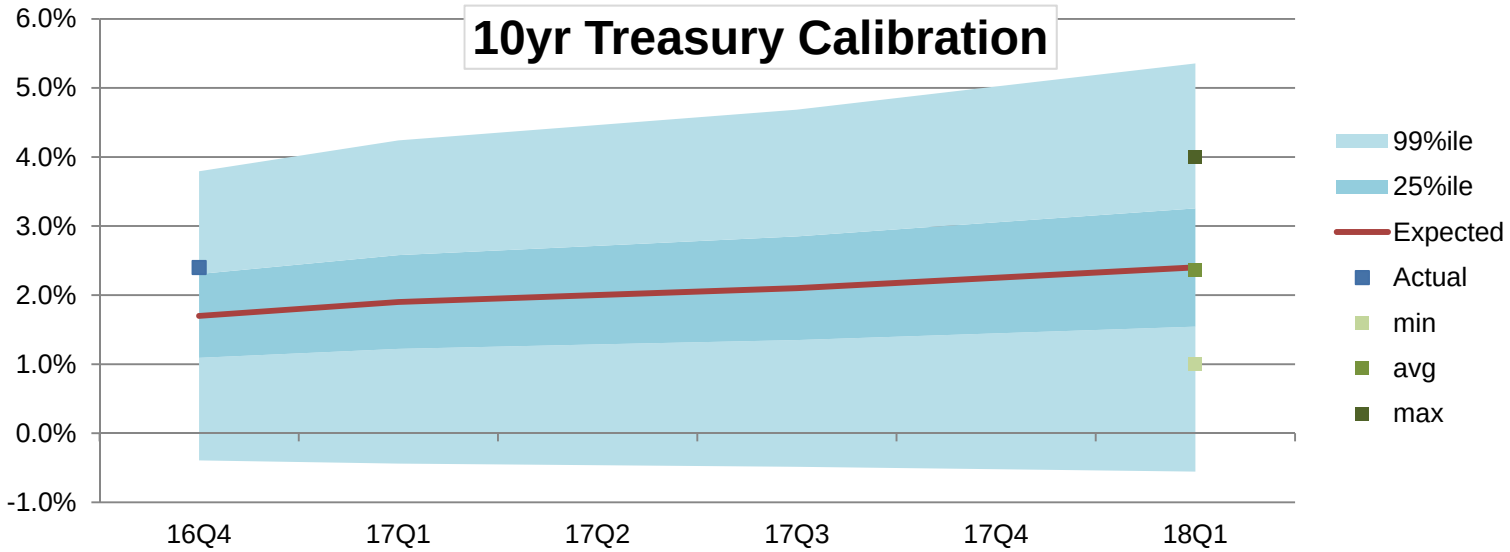
## Taxonomy of Uncertainty

| | |
|---|---|
| 1. Complete certainty | **Newtonian physics**<br>Cause and effect are structurally linked, if you know the rules then there are no surprises. |
| 2. Risk without uncertainty | **A roulette wheel**<br>The games are well defined and the odds are computable. Plenty of surprises buy you know the bounds within which they occur. |
| 3. Fully reducible uncertainty | **A covered roulette wheel**<br>The odds are set but you must figure them out by experience. More data and better methods lead closer to level 2 uncertainty. |
| 4. Partially reducible uncertainty | **A covered roulette wheel with odds that change occasionally**<br>Business acumen is needed to notice when the odds or rules change and understand their impact. Then data and methods start bringing you back towards level 2. |
| 5. Irreducible uncertainty | Total ignorance which cannot be remedied with current capabilities. No quantifiable way to measure the outcomes of the game. More data and better methods do not reduce uncertainty. This type of problem only transitions to level 4 when there are advances in capabilities or the problem is redefined. |

# Economic Scenario Generators vs Natural Catastrophe Models

| | ESG | Cat Model |
|---|---|---|
| Environmental model | Captures various global economies and correlations between variables.<br>Based on historical data, current state of economy, and assumptions about future directions. | Models assume long-term averages or make adjustments for assumptions about current global climate.<br>Events follow natural laws. |
| Scenario models | Simulated variables based on deterministic links with stochastic elements and correlated sampling.<br>New scenarios produced with each run possibly. | Catalogues of hypothetical events which remain static in each run. Only updated with new version of model every couple years. |
| Loss models | Difficult to know how market values of different securities will change under different market conditions. Simple securities like Treasury Bonds are easy – but many securities are complex: options, ABS, MBS, CDO… difficult to know with precision how market values will move. | Engineering models used to measure damage to property given a simulated event. Actuarial models used for business interruption and financial costs of property damage. |

# Calibrate the ESG




- I find good graphic overlays to help with calibration
- Compare actual to projection
- Get some external views
  - Bloomberg, investment manager, finance department
  - Variables like spreads, stock indexes, inflation, bond yields

Calibration steps:

- Choose your targets
- Run the model to see where current projections are
- Change the model inputs or outputs
  - Changing inputs requires understanding of parameters.
  - Changing outputs requires changing probabilities on generated scenarios.

# How do you decide on an ESG?

Same way you pick a car

- Price
  - How much do you have for this expense?
  - Have you researched *at all* what benefit you need from it in order to justify the cost?
- Ease of use
  - Sometimes this is independent of cost – the more expensive one may be more difficult to use.
- Will anyone else be using it?
- How will you maintain it?
- Who do you need to impress?
- Can it do what you need it to?
- Is it easy to modify? Too easy to modify?
- Do you like dealing with the people at the dealership?
  - Do you trust them?
  - Are they responsive?

# History of negative interest rates

Photo of Sidney Homer by George E. Joseph

Sidney Homer wrote the book “A History of Interest Rates” in 1963.

The book covers all recorded history of interest rates – which goes back to 3000 B.C.! It almost seems like people started writing in order to keep track of what they owed each other.

I highly recommend reading at least the introduction, pages 1-13.

So, what is the history of negative interest rates?

None – never before our modern times have they existed. Why? Central banks have unprecedented control over currency.

- Banks were largely private institutions
- Lending to kings to carry out wars as often as farmers to plant crops
- Lending was also run by the religious institutions
- Silver and Grain were used as currency
- What does that have to do with modeling interest rates today?

**Table 1**
**Summary of Mesopotamian Interest Rates: 3000–400 B.C.**

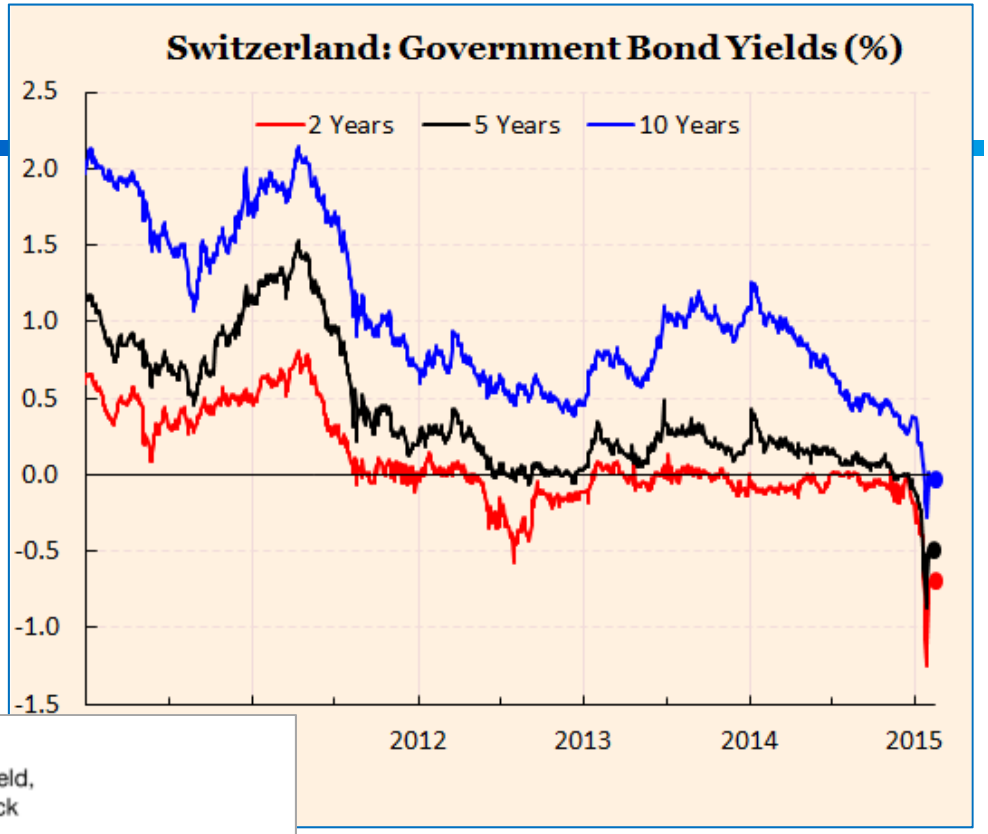
| Dates B.C. | Normal Rates, % | | Legal Maxima, % | |
|---|---|---|---|---|
| | On grain | On silver | On grain | On silver |
| Sumer | | | | |
| 3000–1900 | $33\frac{1}{3}$ | 20–25 | | |
| Babylonia | | | | |
| 1900–732 | 20–$33\frac{1}{3}$ | 10–25 | $33\frac{1}{3}$ | 20 |
| 732–625 | 20–$33\frac{1}{3}$ | 10–20 | $33\frac{1}{3}$ | 20 |
| 625–539 | ?–20 | 10–20 | 20 | 20 |
| Fifth–fourth centuries | | 40 (?) | | |
| Assyria | | | | |
| Ninth–seventh centuries | 30–50 | 20–40 | | |
| Persia | | | | |
| Sixth century | 40 | 40 | | |

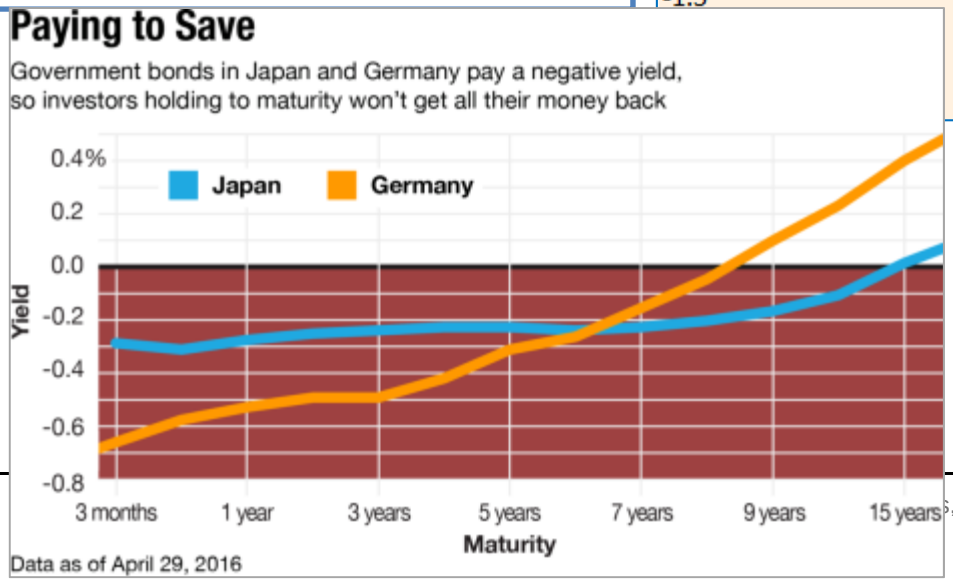
**Real Estate Loans**

| | | | |
|---|---|---|---|
| Fifth century B.C. | City property, at least | 8% | (59) |
| | Country property | 8–12 | (59) |
| Fourth century B.C. | City property, at least | 8 | (59) |
| | Country property | 8–12 | (59) |
| | Town mortgages | 8 | (64) |
| 400 B.C. | Mortgage loans at | 16–18 | (62) |
| 369 B.C. | A man borrowed on multiple dwelling at | 16 | (74) |
| 346 B.C. | Horoi pledge, mill and slaves at | 12 | (72) |
| 305 B.C. | 5000 drachmas, on horoi at | 10 | (73) |
| Third century B.C. | | | |
| 300 B.C. | Horoi pledge on extensive land at | 10 | (75) |
| | Horoi pledge on home, roof, and land at | 10 | (72) |
| 210–195 B.C. | Land in Thera pledged at | 7 | (76) |
| Second century B.C. | Gift to Aegiale to be loaned on land at | 10 | (76) |
| 160 B.C. | Gift to Delphi to be loaned on land worth at least twice the loan, 5-yr. term | $6\frac{2}{3}$ | (76) |

# ESG projections didn't deal well with low and negative interest rates

- In 2012 ESG's did not deal well with low and negative rates
- They either
  - Ignored 0 as a lower bound altogether
  - Floored rates at 0
- Why?
  - Historical data used to build, design, calibrate and test ESGs had no negative interest rates



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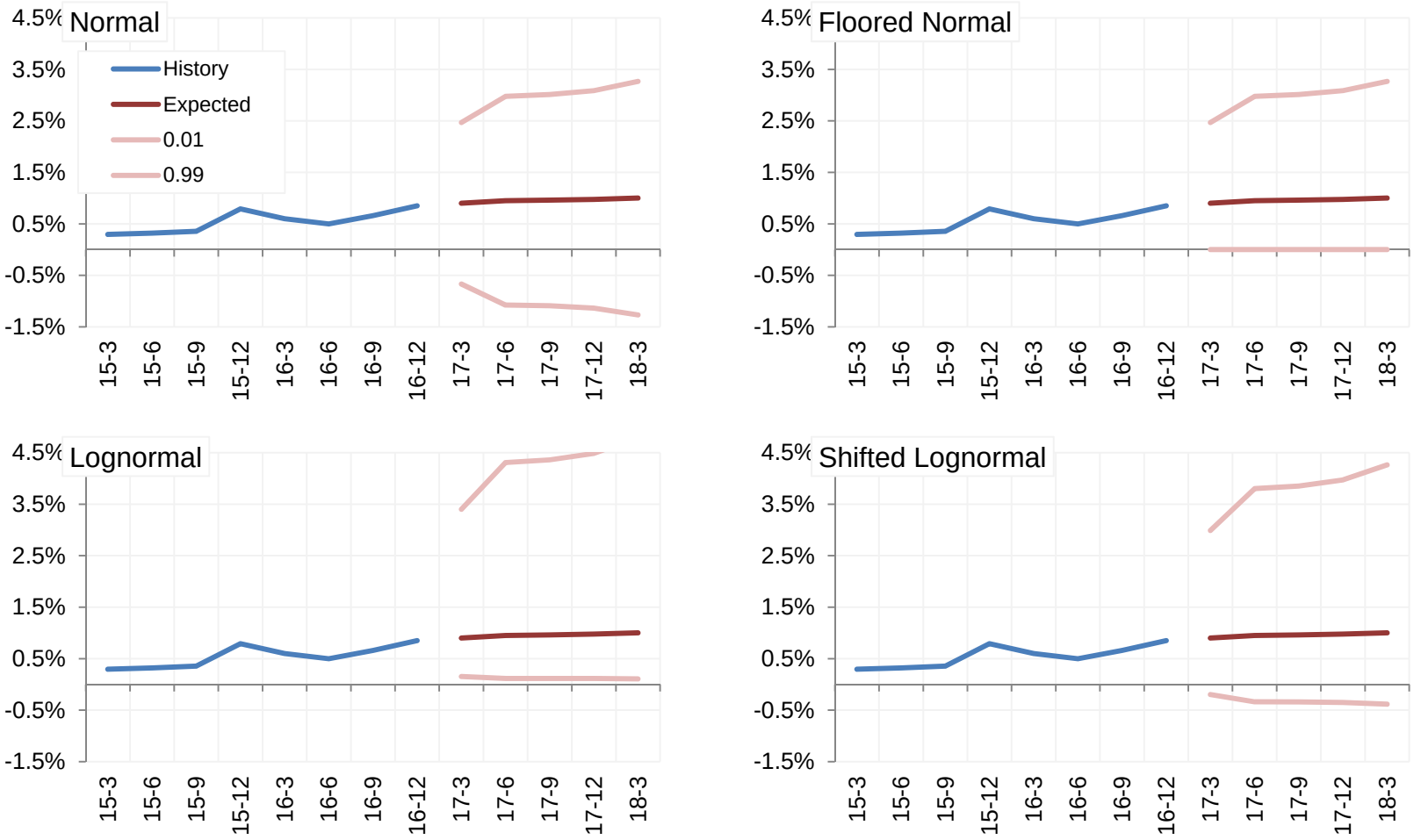
# ESG adjustments for negative rate possibilities

**1yr Treasury Yields**



# The Who and What of the Joint Risk Management Section (JRMS)

JOINT RISK MANAGEMENT SECTION

# What is an SOA section?

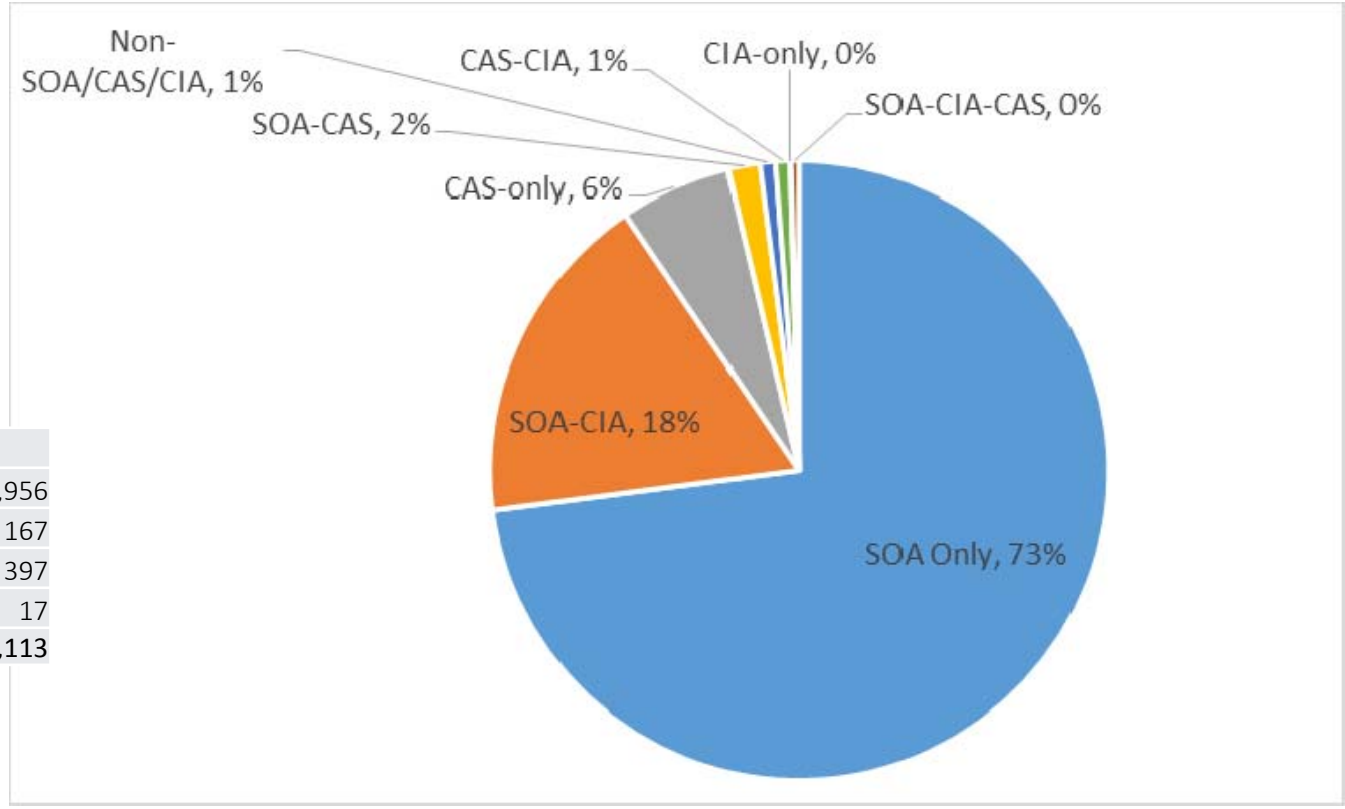
- The Society of Actuaries sponsors professional interest groups, known as sections. Each section focuses on common issues related to an area of practice or special interest. Members of the SOA and fellow industry professionals can join one or more sections. The SOA has 20 sections dedicated to bringing their members important and relevant information about their area of interest through a variety of channels.
- Each special interest section provides members:
- Premier access to the section newsletter
- Professional development opportunities
- Networking opportunities online and at SOA events
- Volunteer opportunities within a section council or section sponsored activity
- Discounts to section sponsored events

# JRMS Mission, Vision and Priority

- Mission/Vision
  - The Society of Actuaries (SOA), Casualty Actuarial Society (CAS) and Canadian Institute of Actuaries (CIA) jointly sponsor the Risk Management Section. The purpose of the Risk Management Section is to further the education and research in the area of risk management and establish leading risk management techniques. These efforts should help to increase the profile of the actuarial profession as being leaders in this field and should be rigorous and based on sound principles such that the resulting techniques are broadly transportable across disciplines and industries.
- Objectives:
  - Increase level of communication and interaction with Section members.
  - Expand ERM educational opportunities for Section members and sponsoring organizations.
  - Continue to foster risk management research.
  - Support promoting the Actuarial profession as risk managers.

# JRMS made of three partnering associations

| With double counting | |
|---|---|
| SOA | 1,956 |
| CAS | 167 |
| CIA | 397 |
| Other | 17 |
| Total (w/o double counting) | 2,113 |



# JRMS council, 10-2016/09-2017

| Name | Role | Association | Term Expires |
|---|---|---|---|
| Thomas Weist | **CHAIR** | CAS | 2018 |
| Frank Reynolds | **Vice Chair** | SOA, CIA | 2017 |
| Hugo Leclerc | **Secretary** | SOA, CIA | 2017 |
| C. Ian Genno | Treasurer, Webcast Coordinator | SOA, CIA | 2018 |
| Mario DiCaro | Council Member | CAS | 2019 |
| Robert He | Council Member, Newsletter Editor | SOA | 2017 |
| Rahim Hirji | Council Member | SOA, CIA | 2019 |
| Yangyan Hu | Council Member, Webcast Coordinator | SOA | 2018 |
| Cheryl (Baoyan) Liu | Newsletter Editor, Webcast Coordinator | SOA | 2017 |
| Leonard Mangini | Council Member | SOA | 2019 |
| Mark Mennemeyer | Council Member, L&A Symposium Rep. | SOA | 2018 |
| Fei Xie | Council Member | SOA | 2019 |

# JRMS Achievements

- Meeting sessions
- Webcasts
- Newsletters
- Networking events
- Research
- E-book library & Call for essays in 2016 on Cyber

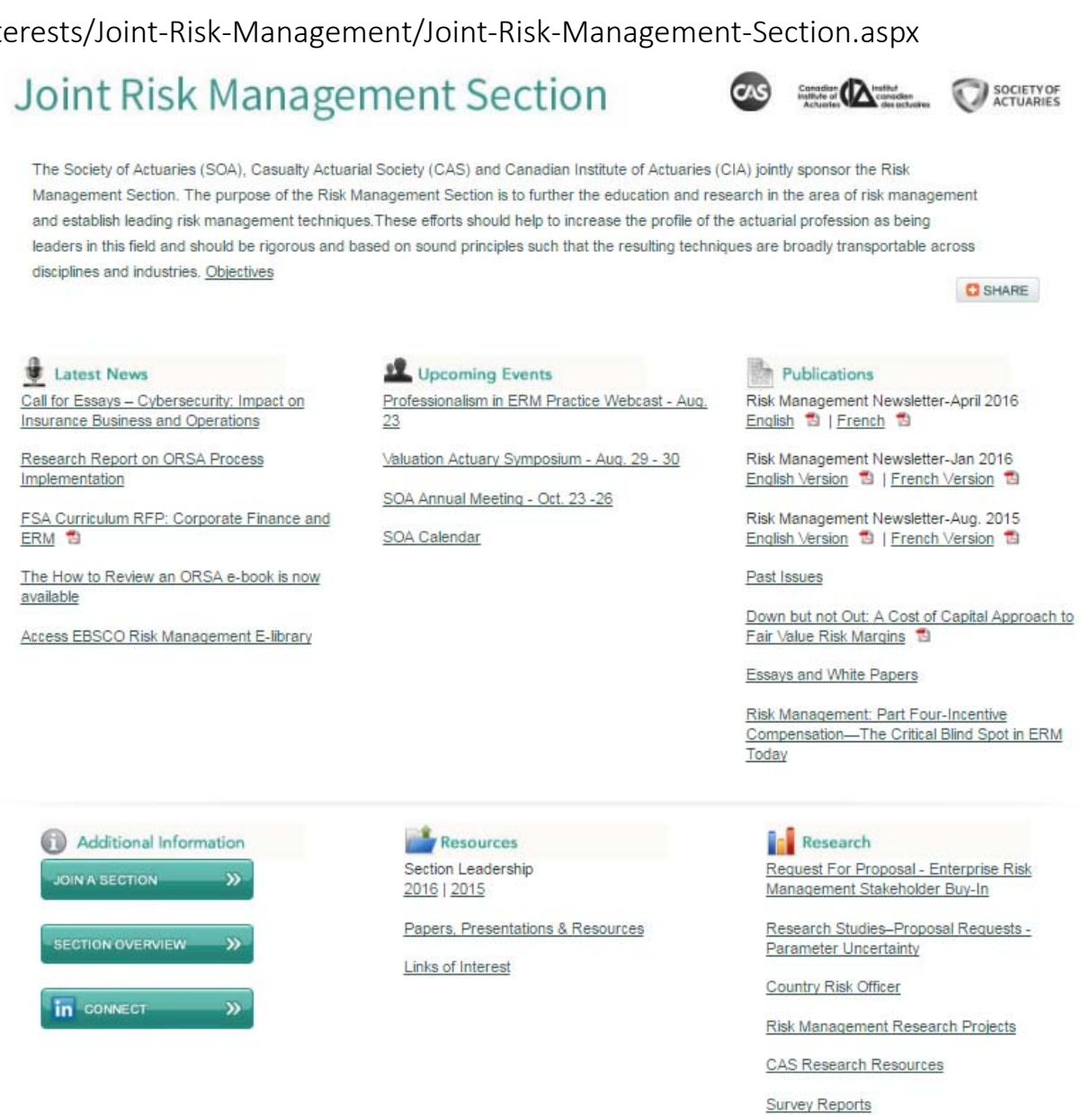
# JRMS Newsletter

- #35 April issue
  - What is a CAT model
  - GLWB Rider for FIA's
  - Corporate pension risk management
  - Model vetting
  - Risk Implication of Unemployment and Underemployment
  - Global risk report
  - Annual emerging risk survey
- #36 August
  - ERM in the US Life and Annuity Industry: 2015 Survey-Summary Report
  - Risk Aggregation and Diversification
  - IAA Risk Book
  - A Discussion of Canadian and U.S. Capital Adequacy Requirements
  - ORSA Experience: A consultant's view
  - Recent Publications in Risk management

# E-book library

- E-book library through EBSCO
  - Borrow, read and return books
  - E-book only to read on computers, tablets or any devices
  - https://www.soa.org/professional-interests/joint-risk-management/new-jrm-benefit-access-e-library.aspx

https://www.soa.org/Professional-Interests/Joint-Risk-Management/Joint-Risk-Management-Section.aspx



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## Latest News

Call for Essays – Cybersecurity: Impact on Insurance Business and Operations

Research Report on ORSA Process Implementation

FSA Curriculum RFP: Corporate Finance and ERM

The How to Review an ORSA e-book is now available

Access EBSCO Risk Management E-library

## Upcoming Events

Professionalism in ERM Practice Webcast - Aug. 23

Valuation Actuary Symposium - Aug. 29 - 30

SOA Annual Meeting - Oct. 23 -26

SOA Calendar

## Publications

Risk Management Newsletter-April 2016
English | French

Risk Management Newsletter-Jan 2016
English Version | French Version

Risk Management Newsletter-Aug. 2015
English Version | French Version

Past Issues

Down but not Out: A Cost of Capital Approach to Fair Value Risk Margins

Essays and White Papers

Risk Management: Part Four-Incentive Compensation—The Critical Blind Spot in ERM Today

## Additional Information

JOIN A SECTION

SECTION OVERVIEW

CONNECT

## Resources

Section Leadership
2016 | 2015

Papers, Presentations & Resources

Links of Interest

## Research

Request For Proposal - Enterprise Risk Management Stakeholder Buy-In

Research Studies–Proposal Requests - Parameter Uncertainty

Country Risk Officer

Risk Management Research Projects

CAS Research Resources

Survey Reports

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# QUESTIONS?