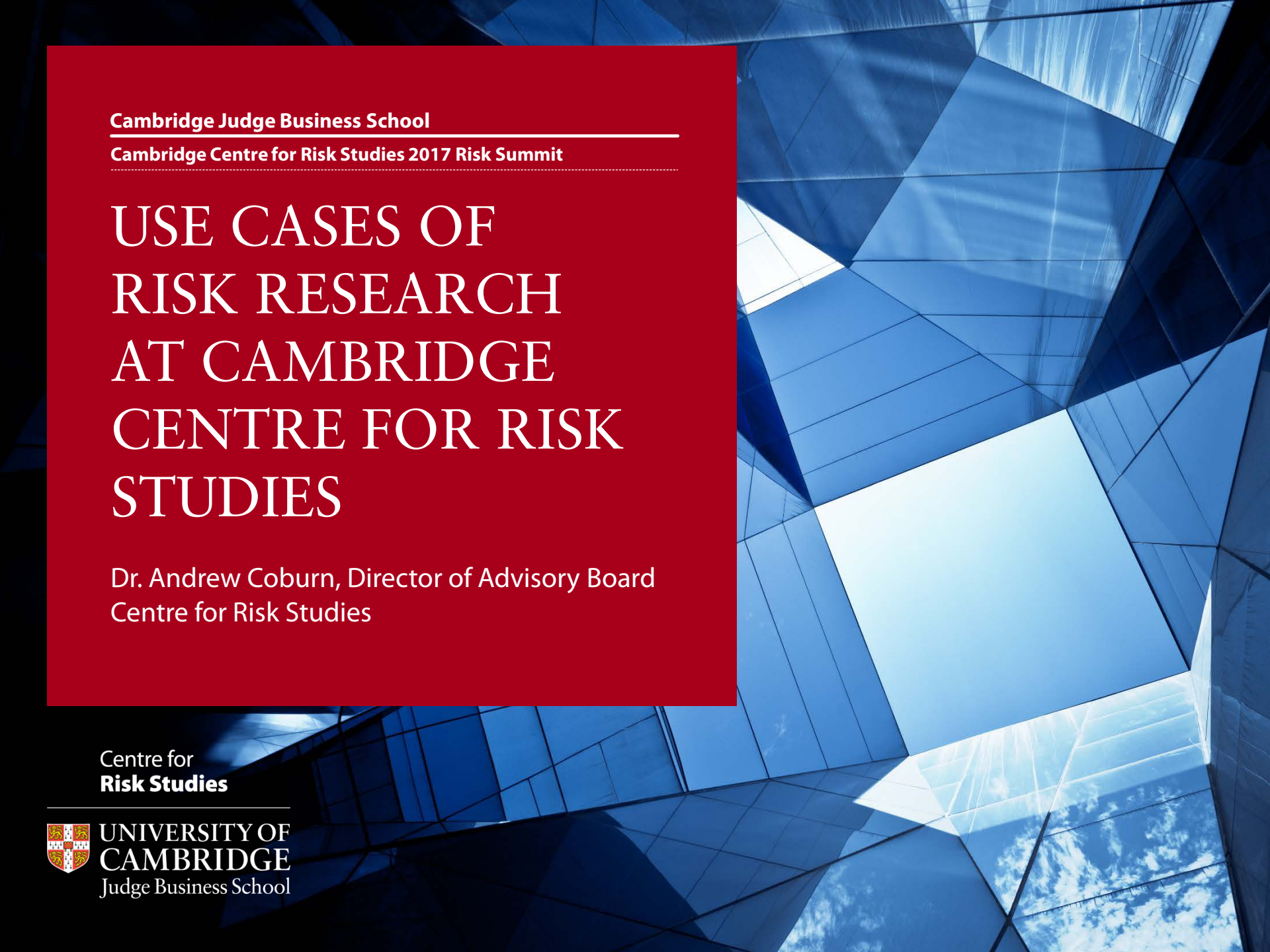


Cambridge Judge Business School

Cambridge Centre for Risk Studies 2017 Risk Summit

USE CASES OF RISK RESEARCH AT CAMBRIDGE CENTRE FOR RISK STUDIES

Dr. Andrew Coburn, Director of Advisory Board
Centre for Risk Studies

Centre for **Risk Studies**

UNIVERSITY OF CAMBRIDGE
Judge Business School

Phew, Wot a Scorcher!

- 33˚C (91˚F) in London
- We had a one ‘degree day’ event – a day in excess of 32˚C, the human productivity threshold
- At around 20 degree-days, a heatwave has a noticeable effect on the economic output of a city
- For London, a 20 degree-day heatwave would cause the 2017 economic output to reduce by **$2.5 Bn**

Catastronomics of Heatwaves

Workforce supply shock
- Absenteeism increases

Demand shock
- Consumer demand reduces

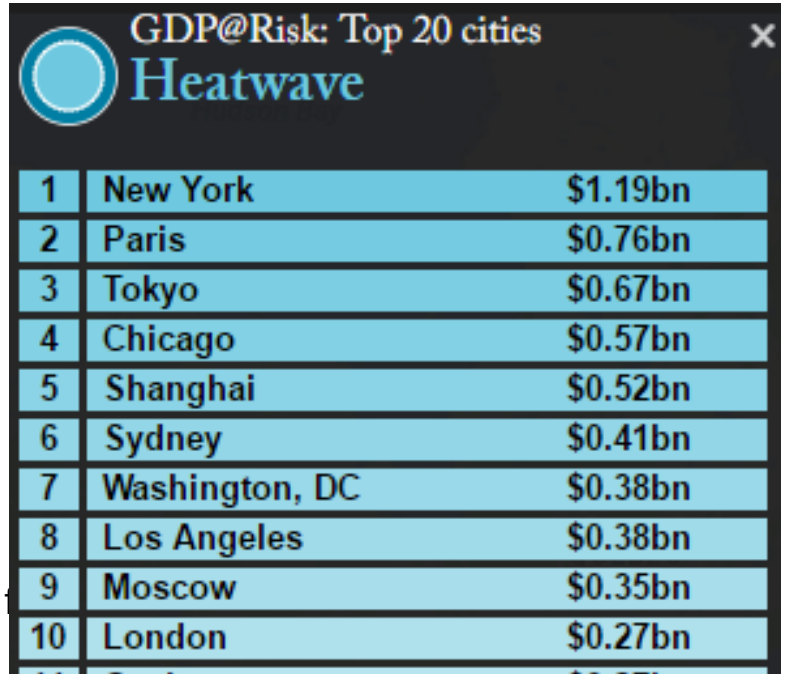
Agriculture impacts
- Livestock mortality increases
- Crop yield reduction

Transport traffic reduction

Infrastructure stress
- Increased demand for cooling
- Breakdowns in distribution
- Generation may be taken offline (nuclear cooling

Heat stress on healthcare systems

Triggers other threats
- Power outages
- Drought
- Wildfires
- Violent crime
- Geopolitical conflicts



1	New York	$1.19bn
2	Paris	$0.76bn
3	Tokyo	$0.67bn
4	Chicago	$0.57bn
5	Shanghai	$0.52bn
6	Sydney	$0.41bn
7	Washington, DC	$0.38bn
8	Los Angeles	$0.38bn
9	Moscow	$0.35bn
10	London	$0.27bn

Past heatwave events
- UK 1976, 1906 (120 DD)
- Australia 1923 (1,000+ DD), 2015,
- Eastern US 1896 (500 DD, 1,500 dead)
- Europe 2003
- US 2012
- California 2006

UNIVERSITY OF CAMBRIDGE Judge Business School | Centre for Risk Studies

Potential Threats to the Economy

Finance, Economics and Trade

Market Crash | Sovereign Crisis | Commodity Prices

Geopolitics and Security

Interstate Conflict | Terrorism | Separatism Conflict | Social Unrest

Natural Catastrophe and Climate

Earthquake | Tropical Windstorm | Temperate Windstorm | Tsunami | Flood | Volcanic Eruption | Drought | Freeze | Heatwave

Technology and Space

Nuclear Accident | Power Outage | Cyber Attack | Solar Storm

Health and Humanity

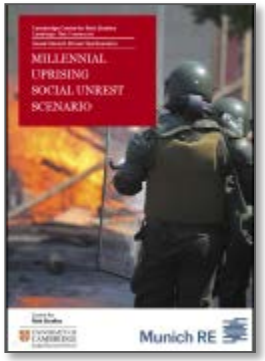
Human Pandemic | Plant Epidemic

Studies for a Range of Audiences

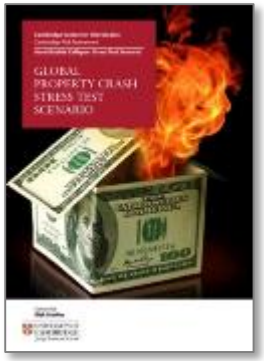
Geopolitical Conflict
Emerging Risk Scenario

Pandemic
Emerging Risk Scenario

Cyber Catastrophe
Emerging Risk Scenario



Social Unrest
Emerging Risk Scenario



Global Property Crash
Financial Risk Scenario

Eurozone Meltdown
Financial Risk Scenario

- Private sector companies and corporations
- Financial services, investors, insurers, and bankers
- Public sector authorities, governments, regulators

Making Scenarios More Useful: CCRS Evolution

2013

Class	Line of Business	
Property		
	Personal Lines/Homeowner	4
	Personal Contents	4
	Commercial Combined	5
	Construction & Engineering	3
	Commercial Facultative	5
	Binding Authorities	3
Casualty		
	Workers Compensation	5
	Directors & Officers	4
	Financial Lines	4
	General Liability	4
	Healthcare Liability	5
	Professional Lines	4
	Professional Liability	3
Auto		
	Personal Lines	4
	Commercial & Fleet	5

Class	Line of Business	
Marine & Specie		
	Cargo	5
	Marine Hull	5
	Marine Liability	3
	Specie	4
Aerospace		
	Airline	5
	Airport	4
	Aviation Products	3
	General Aviation	2
	Space	4
Energy		
	Downstream	1
	Energy Liability	4
	Onshore Energy & Power	5
	Upstream	3
Specialty		
	Accident & Health	5
	Aquaculture insurance	1
	Contingency - film & event	1
	Equine insurance	1
	Excess & Surplus	0
	Life Insurance	4
	Livestock	3

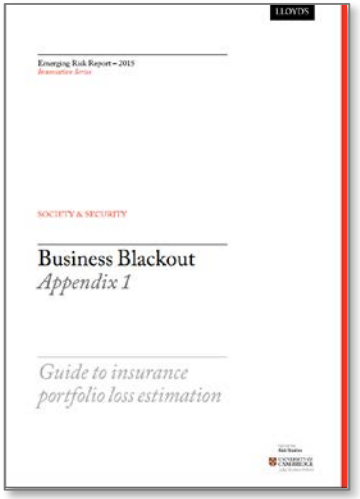
Impact on Insurance Claims

Decrease ... Increase

-5 -4 -3 -2 -1 0 1 2 3 4 5

Industry loss estimate and Line of Business scorecard

2015



Published calculations for portfolio-specific loss estimation

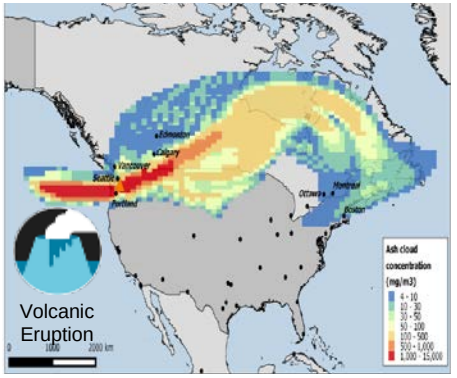
2016

Leakomania
Accumulation Scenario

	Premier	Large	Medium	Small
Information Technology - Software	4.2%	10.3%	3.4%	0.3%
Information Technology - Hardware	3.8%	10.1%	4.7%	0.5%
Information Technology - Services	4.0%	2.4%	0.8%	0.1%
Retail	1.1%	0.6%	0.1%	0.0%
Financial Services - Banking	4.8%	7.2%	1.1%	0.1%
Financial Services - Insurance	2.4%	7.0%	3.0%	0.2%
Financial Services - Investment Management	3.2%	6.3%	1.2%	0.3%
Healthcare	12.7%	3.8%	1.2%	0.1%
Business & Professional Services	4.3%	0.4%	0.2%	0.0%
Energy	0.3%	2.3%	0.3%	0.0%
Telecommunications	3.3%	7.0%	2.2%	0.1%
Utilities	0.2%	1.4%	0.5%	0.0%
Tourism & Hospitality	1.6%	0.4%	0.1%	0.0%
Manufacturing	0.3%	0.4%	0.2%	0.0%
Pharmaceuticals	1.0%	7.0%	2.8%	0.2%
Defense / Military Contractor	2.0%	0.1%	0.2%	0.0%
Entertainment & Media	1.2%	0.9%	0.2%	0.0%
Transportation / Aviation / Aerospace	0.3%	0.3%	0.1%	0.0%
Public Authority / NGOs / Non-Profit	1.0%	1.1%	0.2%	0.0%
Real Estate / Property / Construction	0.8%	0.2%	0.0%	0.0%
Education	0.9%	20.3%	8.0%	0.4%
Mining & Primary Industries	2.1%	1.3%	0.3%	0.1%
Food & Agriculture	0.5%	0.3%	0.2%	0.0%
Other	2.0%	1.1%	0.2%	0.0%

Scenario loss calculations as SQL queries

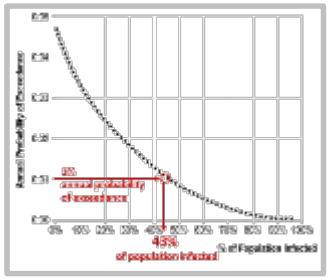
2017



Loss Models on Cambridge Risk Framework

UNIVERSITY OF CAMBRIDGE Judge Business School | Centre for Risk Studies

CCRS Scenario Development Methodology



Context

A justification and context e.g. for a 1% annual probability of occurrence worldwide

Timeline & Footprint

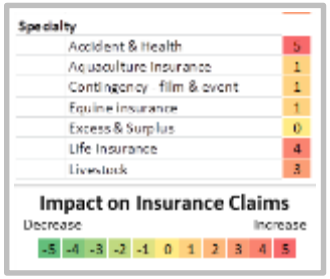
Sequencing of events in time and space in hypothetical scenario

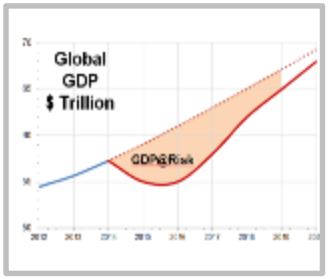
Narrative & Variants

Detailed description of events
Multiple Variants of events
S1; S2; X1

Loss Assessment

Metrics of underwriting loss across standardized lines of insurance business



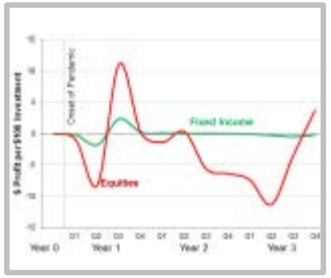


Macroeconomic Consequences

GDP@Risk: Quantification of effects on many variables in the global economy

Investment Portfolio Impact

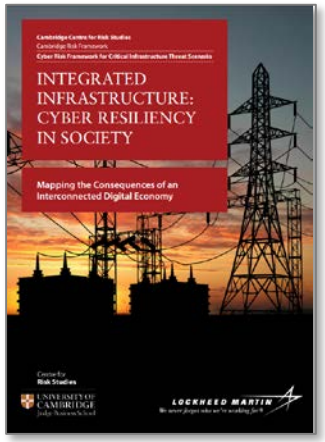
Returns and performance over time of a range of investment assets



UNIVERSITY OF CAMBRIDGE
Judge Business School
Centre for Risk Studies

The Role of CCRS Research in Managing Cyber Risk

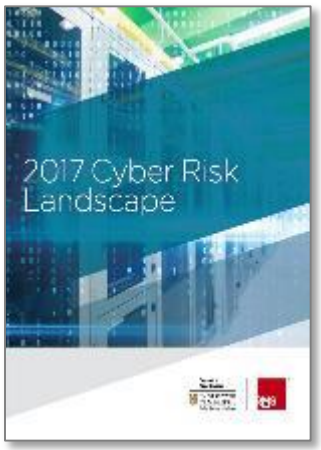
- 2010-11 Cyber considered exotic risk
  - Listed in CCRS Taxonomy of Threats
- 2012: Cyber is an Emerging Risk
  - Catlin requests a study of potential for systemic loss from a cyber event
  - Sybil Logic Bomb Scenario, pub 2013
- 2014: Cyber insurance regulator concerns
  - Lloyd's CCRS scenario highlights loss potential in ambiguous insurance coverages
  - Business Blackout Scenario of cyber attack on US power grid, published 2015
- 2015: Affirmative cyber insurance $2M
  - CCRS develops cyber exposure data standard
  - CCRS develops suite of scenarios for RMS CAMS
  - Lockheed Martin asks CCRS for UK cyber scenario
- 2016: Regulator-mandated cyber reporting
  - CCRS scenarios form 5 of 8 Lloyd's scenarios
- 2017: Cyber-Physical accumulation
  - CCRS develops destructive cyber scenarios




FINANCIAL TIMES

Cyber risks too big to cover, says Lloyd's insurer

Governments should step in to provide aid, says Catlin boss



UNIVERSITY OF CAMBRIDGE Judge Business School | Centre for Risk Studies

Developing a Data Standard for Multi-Line Exposure

- Insurance industry has well defined data schemas for NatCat exposure and modelling
- Other lines of insurance are more diverse and insurers find it problematic to consolidate their multi-line exposure
- Emerging and systemic risk scenarios impact more lines and need a more extensive data standard
- We are currently working on developing an exposure data standard for multi-line insurance loss estimation

High Priority, Phase 1

- Casualty/Liability
- Marine
- Aviation
- Energy

Medium Priority, Phase 2

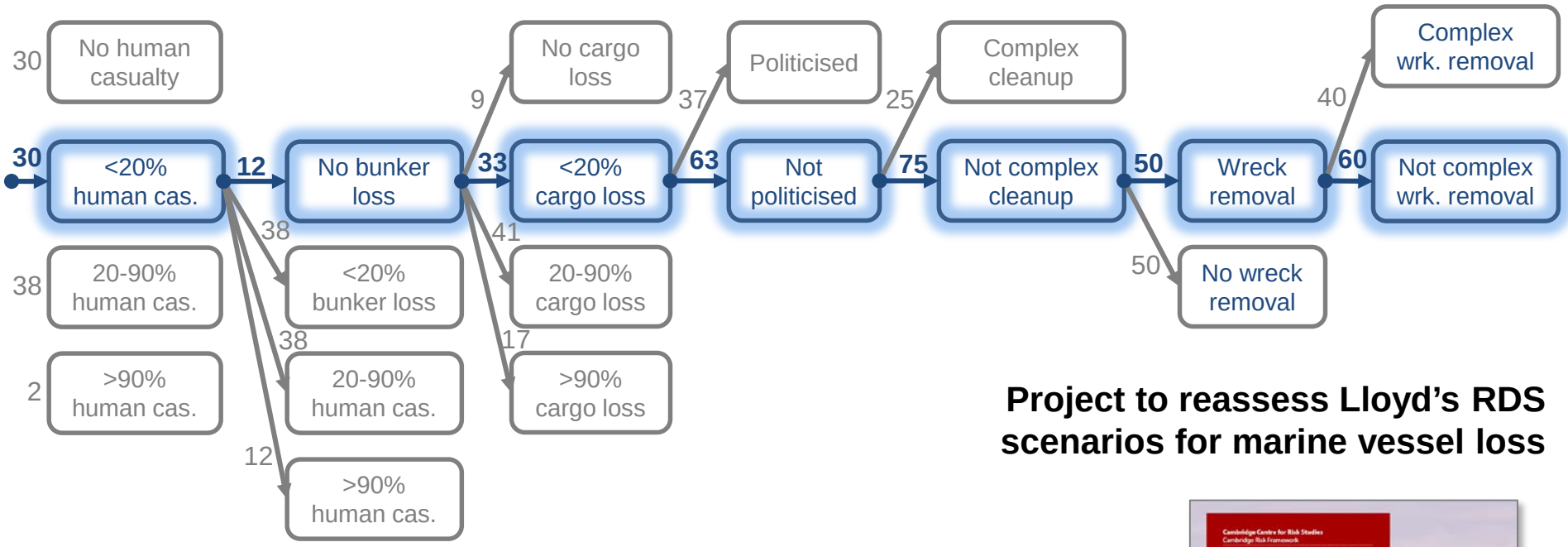
- Specialty
- War and Political Risk
- Trade Credit and Surety
- Personal Lines

Lower Priority, Phase 3

- Auto
- Health Insurance
- Pension and Annuities
- Life and Health

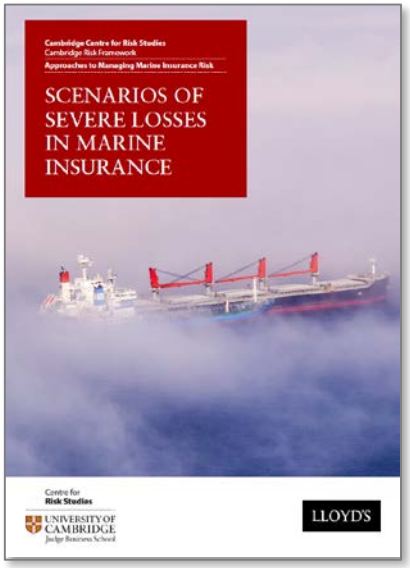
UNIVERSITY OF CAMBRIDGE Judge Business School | Centre for Risk Studies

Improving Scenarios with Event Trees



Project to reassess Lloyd's RDS scenarios for marine vessel loss

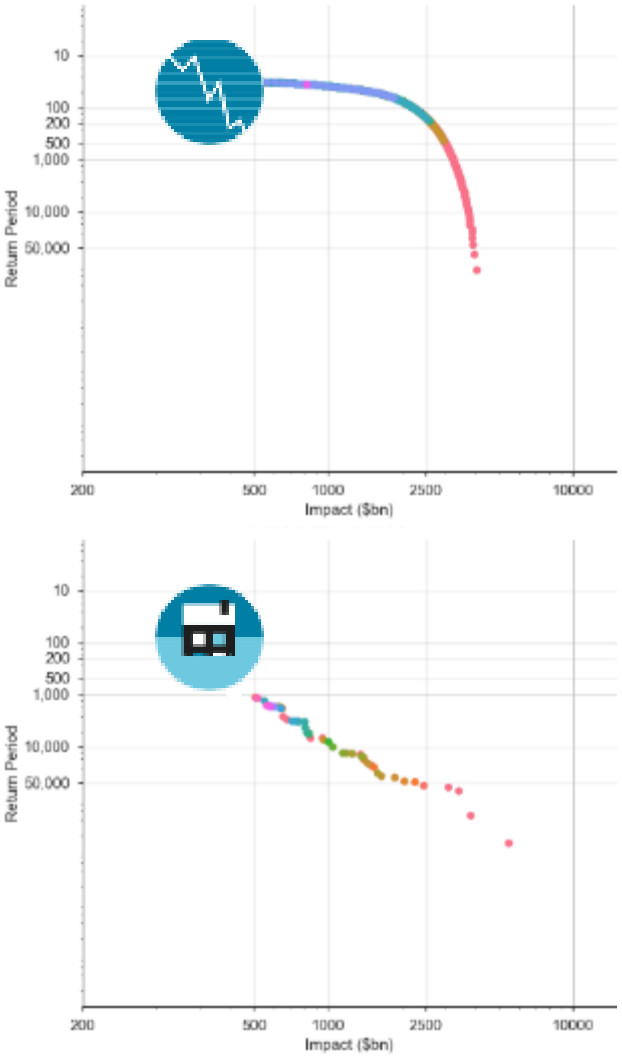
- A Bayesian variant event tree enables a much clearer assessment of potential permutations of outcomes
- It generates thousands of scenario variants, which improves assessments of uncertainty and extremes
- An insurance PML, stress test, or accumulation scenario needs to explore uncertain extremes



UNIVERSITY OF CAMBRIDGE Judge Business School | Centre for Risk Studies

Being Exhaustive in Scenario Generation

- Can we identify **ALL** scenarios that can cause $1+ Tr of economic disruption to global economy?
- Going systematically through the whole taxonomy of threats, and all 300 cities to find potential events
- Generating events where one threat cascades to trigger another threat type
- Mapping all the networks and contagion processes that might escalate scenarios
- Assigning return periods to the classes of scenarios



CRS Helping to Develop Scenario Best Practices

- Best Practices Publication
  - Best Practice for Developing Scenarios
  - Best Practice for Using Scenarios in Insurance Business Practice
- Conference on **Developing and Using Scenarios**
- Exploration of scenario use in business planning; stress testing; PML assessment; accumulation etc.

Use Cases of Cambridge Research

- Financial Services Industry
  - Identification of new business opportunities
  - Insurance product alignment with threats
  - Demonstration of the value of the use of insurance capital as a key component of disaster resilience
- Corporate Risk Profiling
  - A comprehensive and independent external risk register
  - Probabilistic approaches to risk evaluation
  - Enterprise balance sheet viability assessment
- National and Regional Government
  - Use of a comprehensive event set of shocks to the global economic system
  - Quantifiable metrics, benchmarks, and comparatives
  - Value of the factors that constitute ‘resilience’

In Conclusion

- The Cambridge Centre for Risk Studies has a ongoing programme of innovative research
- It focusses on catastrophic shocks to complex economic systems
- These have applications for several business sectors and user communities
- We are committed to working with our industry supporters to provide business value from this research
- We focus on engagement and publication to maximise the impact of this research to reduce risk for society

Centre for
Risk Studies

UNIVERSITY OF
CAMBRIDGE
Judge Business School