

University of Cambridge Judge Business School

Cambridge Centre for Risk Studies

2017 RESEARCH AND ACTIVITIES PROSPECTUS

Centre for
Risk Studies



UNIVERSITY OF
CAMBRIDGE
Judge Business School



Research Supporters of the University of Cambridge Centre for Risk Studies:

McKinsey & Company

HSBC 

LOCKHEED MARTIN 



Willis Towers Watson 

Table of Contents

| | |
|--|----|
| Foreword..... | 2 |
| Strategy of the Centre for Risk Studies..... | 4 |
| Current Research Tracks..... | 5 |
| Agenda for Future Research..... | 7 |
| • Research Application Area A: Emerging and Systemic Risks..... | 8 |
| • Research Application Area B: Integrated Risk Assessment..... | 10 |
| • Research Application Area C: Use Cases of Research..... | 12 |
| 2017 Planned Event Calendar for the Cambridge Centre for Risk Studies..... | 14 |
| 2016 Centre for Risk Studies Research Outputs..... | 16 |
| Selected Press Features..... | 17 |
| Engagement Activities 2016..... | 19 |
| Calendar of Events 2016..... | 20 |
| The Cambridge-McKinsey Risk Prize 2015..... | 22 |
| Cambridge Centre for Risk Studies 8th Risk Summit, 22 - 23 June 2017..... | 23 |
| Current Team and Resources at the Centre for Risk Studies..... | 25 |
| Centre Alumni..... | 27 |
| Centre for Risk Studies Advisory Board..... | 31 |
| Advisory Board Members..... | 32 |
| Academic Advisors..... | 37 |
| Funding Opportunities and Support Contribution Structure..... | 39 |

Foreword



2016 has been another very busy and productive year for the Centre for Risk Studies. Our outputs in the public domain include:

- *Managing Cyber Insurance Accumulation Risk*, an exciting new venture into the risk management of cyber insurance, introducing a new data standard and analytical platform, which was written in collaboration with RMS and launched in London on 2 February 2016, at Lloyd's, and again in New York City on 10 February 2016;
- *Integrated Infrastructure: Cyber Resiliency in Society, Mapping the Consequences of an Interconnected Digital Economy*, examined a range of potential economic and business impacts from a cyber attack against the UK power grid, sponsored by Lockheed Martin and launched 12 April 2016 at the National Theatre, London;
- The *Helios Solar Storm Scenario*, sponsored by AIG and launched 3 November 2016, and was the culmination of a year's worth of research into the potential impact of a major space weather incidents on modern critical national infrastructure in the US;
- The *Cambridge Global Risk Outlook for 2017*, launched on 5 December 2016 at Willis Towers Watson, London, is a continuation of our World Cities at Risk project, also known as Lloyd's City Risk Index, and recalibrates our vision for urban risk worldwide over the next decade.

Through 2016, cyber threat has continued to grow as a research area. Beyond our cyber accumulation data schema and associated cyber threat scenarios, which emerged from a collaboration with a host of insurance companies and RMS, we are proud to welcome Pool Re as a research supporter in the emerging research area of cyber terrorism. Our cyber study is part of the broader Systemic and Emerging Threat research pillar that goes into 2017 with a powerful momentum.

Project Pandora – which puts a universe of threat types on a single page – has also been a major research pillar, and we are pleased to welcome Willis Towers Watson as a Pandora research collaborator in 2016. This project is founded on the Cambridge Global Risk Index analytics platform which estimates GDP losses inflicted by 22 categories of disasters on the world's top 300 cities. We launched the first Cambridge Global Risk Index for 2017 in December last year. Looking ahead to 2017, we have a number of methodological advances scheduled for the platform and several business use cases which we will develop with our industry collaborators. These use cases will provide business-ready analytics for areas such as enterprise risk, insurance underwriting and investment portfolio management.

The Centre's outreach and collaborative education activities continue to attract plaudits. In 2016, this includes our second Aspiring Chief Risk Officer programme for HSBC and continuing Cambridge CRO Council Roundtables. Our 7th annual Risk Summit in June 2016 addressed "Risk Culture: Challenging Individual Agency" and showcased research from London School of Economics, Yale University, Columbia University and Cambridge University together with views from a variety of commercial and government organisations. In September 2016, we hosted the Financial Risk and Network Theory Conference. The 2016 Cambridge-McKinsey Risk Prize was expanded to several departments outside of the Cambridge Judge Business School which resulted in a winner from the Department of History.

2016 was also a year in which geopolitical events and their global effects confounded the experts time and again. 2017 promises the roll-out of a "full English Brexit" and profound changes in US domestic and international policy, hence shifting global affairs and unsteady waters ahead. If nothing else, these interesting times point us towards a stimulating and even more active schedule of work and research in the year to come!

Thank you for sharing the journey.

Professor Danny Ralph, Academic Director



Strategy of the Centre for Risk Studies

The mission of the Cambridge Centre for Risk Studies is to be the world's leading academic centre for research into systemic risk in business, the economy, and society.

A Focus on Complex Risk

The Centre for Risk Studies originated from an overlap of specialised research interests into both complex systems and catastrophe risk analysis. Being located in Judge Business School has enabled the Centre to apply these interests to the business community and to structure an appropriate multi-disciplinary team.

The research of the Centre maintains a focus on 'complex risk' – i.e. processes where loss occurs through the disruption of business systems and cascades through interrelated networks in complex and non-intuitive ways. The management and governance of complex risk has attracted interest and support from several sectors of the business community and government policy-makers, including the financial services industry, the energy sector, and major corporations. It poses a wide range of analytical and methodological challenges for the academic community to tackle. These different stakeholders form the community served by the Centre for Risk Studies.

The Centre's strategy for developing thought leadership around complex risk has been:

- **Engagement** – an active programme of events in which academics, business leaders and other stakeholders discuss risk-management issues. Over the past several years the Centre has established a reputation for thought-provoking meetings that tackle leading edge issues, attracting senior executives and influential attendees. Engagement has been the principle method of identifying supporters and ensuring that research is aligned with the issues of most importance to the community served by the Centre.
- **Risk Research** – a number of inter-related tracks of investigation have been developed and are described in the following sections. Research involves the proposal of methodological advances, the structuring of conceptual frameworks, compilation of data, and the development of models to explore issues. Research that is aligned with real-world business problems is valued by the University in terms of its 'impact'.
- **Academic Output** – the quality of a research centre is ultimately judged by its academic output and the current research programme aims to produce high quality peer-reviewed publications that link to the wider impact of our research.

Demonstrating Impact

The Centre is proactive in disseminating its research outputs and demonstrating that such outputs have business value to a community of subscribers. The Centre's programme of dissemination and community-building, detailed in this report, gives the team confidence that the research is relevant and has real impact.

Full Research Programme

The Centre is pursuing a full research programme, expanding the active research team and working in a number of challenging areas. Achievements include methodology breakthroughs, conceptual innovation, and development of new tools and approaches that have attracted positive peer review and external attention.

Academic Output

The Centre contributes to the educational priorities of CJBS and engagement with the students through its MBA elective in Risk Management and the award of the McKinsey Risk Prize. For our more theoretical and fundamental research, we expect the planned academic programme to require sustainable and longer-term funding from a funding body such as the Research Councils.

Current Research Tracks

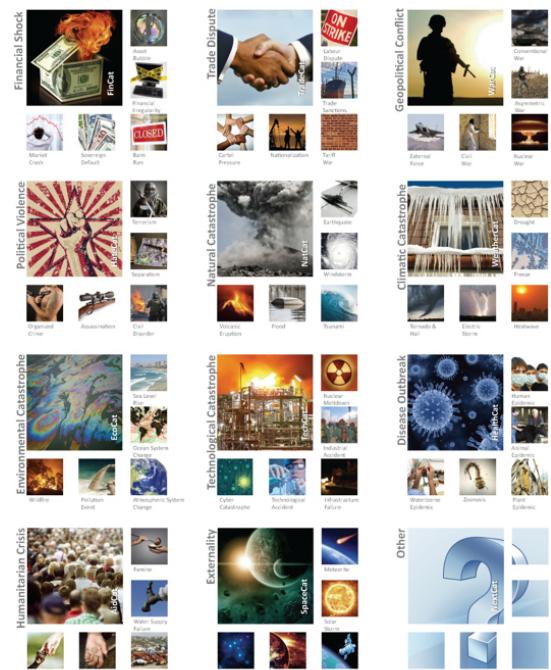
2017 marks the eighth year of the Centre for Risk Studies. The Centre continues to make significant progress understanding and managing systemic risk. This includes scenario development, network analysis techniques, and macroeconomic modelling of shock events. The Cambridge Risk Framework analyses a wide range of emerging and less-well understood threats, with a focus on emerging technology risks, and risks of economic and business disruption. These are integrated into the Cambridge Global Risk Outlook.

Developing the Cambridge Risk Framework

The research programme of the Centre for Risk Studies focusses on business applications of management science to reduce risk. A number of interlinked research themes are being explored. They share a common approach and risk analysis framework to complex risk – the ‘Cambridge Risk Framework’.

Over the past few years, the research has progressed from identifying a ‘Taxonomy of Threats’, to compiling a state-of-knowledge for several of the threat types, and the exploration of the consequences of a stress test scenario for a number of selected threats. A key contribution of the research was the standardisation of scenario selection (e.g. 1% annual probability of exceedance as a ‘1-in-100’ event) for emerging risks.

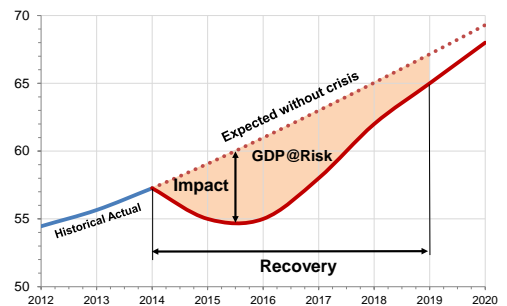
In 2013 an innovative methodology was developed to assess the different facets of scenario impact, ranging from direct loss, to macroeconomic consequences, to investment portfolio effects. This involved developing techniques of network analysis, including gathering and visualizing data on the interconnectivity of the global economy.



The Cambridge Taxonomy of Threats

GDP@Risk: A new metric for comparing different types of shocks

The research continues to explore the similarities and contrasts between shocks from different types of threats, initially using scenarios and their variants analysed in detail. This work has developed a metric – ‘GDP@Risk’ loss of economic output – to measure the severity of shocks from widely different causes. This metric has been well received and has proven to be a useful and versatile benchmark for assessing the magnitude of catastrophes on the macroeconomy. It has enabled historical events to be recalibrated and compared with hypothetical events, and to allow comparison of widely different types of threat events. It provides a financial measure that can be used to assess the value of investment in risk management.



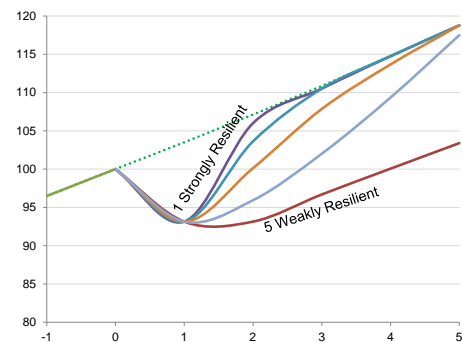
GDP@Risk – measuring economic output loss

Catastronomics: the economics of catastrophe

Assessing the macroeconomic impact of catastrophes is a programme of research to understand how shocks cause output loss, how different types of threat influence specific macroeconomic variables, and how these flow through the economic system, which factors affect the severity of the initial shock and what processes determine how quickly the economy recovers.

GDP@Risk estimation techniques have been successfully applied and could be extended to more classes of catastrophe.

Modelling the economic impact of catastrophes is a key area of focus for the research.

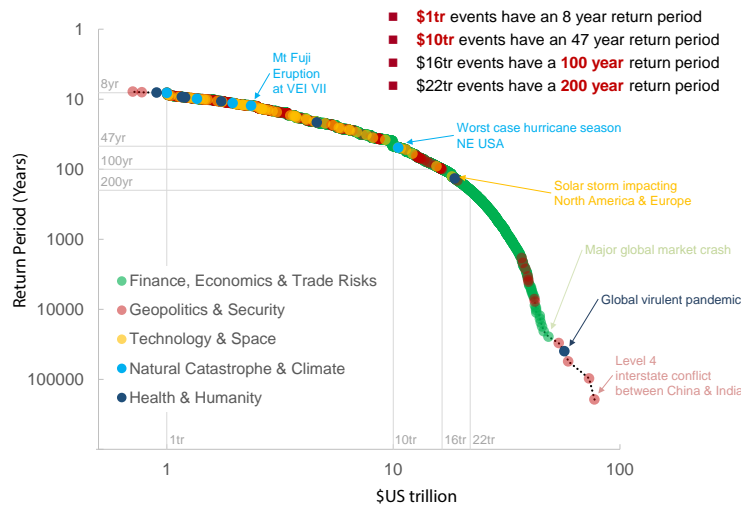


‘Catastronomics’: resilience of an economy determines recovery speed and affects total GDP@Risk

Developing the Global Risk Index

The Cambridge Risk Framework is used to provide a Global Risk Index: a quantitative assessment of the risk of all of the significant systemic shock threats to the global economy.

The Cambridge Global Risk Index uses GDP@Risk assessments to derive economic output loss at city level for the most significant 300 cities of the world, responsible for over half of global GDP. Since its innovation in 2014, the Global Risk Index has served as the backbone of the 2015 Lloyd's City Risk Index and is the basis of 2016's Project Pandora research track.



Global catastrophe exceedance probability curve

Project Pandora

The index makes use of an extensive data set collated on cities, threat maps, and historical precedents for 22 different threats. The resulting model provides a holistic estimate of future catastrophe cost from each of the major threats in our taxonomy for the global economy. We believe this is a major advance in the field of catastrophe studies and provides a platform for 2017 research.

The integration of datasets and multiple threat models constitutes Project Pandora – a specific research track on multi-threat analytics.



Cartography of the internet, IPv4 Census map

Emerging and systemic risks

The Centre for Risk Studies provides research into emerging risks and potential sources of catastrophes that are less well understood.

In 2016, these included solar storms and estimates of their potential disruption to power supplies and the vulnerabilities of the integrated infrastructure systems that underpin society and the economy.

Ongoing research into cyber risk includes tracking the changing landscape of hacker technologies and motivations, and the potential for correlated cyber attacks causing losses to multiple companies. For insurance companies and others to use cyber stress test scenarios in their business requires standardized data structures, and the Centre plays a data secretariat role in developing data schemas for analytics.

Financial crises continue to be one of the leading classes of disruptive threats to business.

Understanding the connectivity of the global financial system and the propagation and consequences of crises continues to be an important area of research at the Centre. The Centre has developed techniques for representing how crises occur and propagate, and is honoured to be part of the editorial board of the *Journal of Network Theory in Finance*.

Resilience in business risk management

How businesses manage a range of risks to their balance sheets, operations, and investment assets is an important focus of the Centre's research. We work with organizations to apply these research areas to find ways of improving the resilience of an organization. Expressing the risk metrics for management monitoring, regulatory reporting, and other decision-support is a key area of exploration with our business support partners.

Agenda for Future Research

The research programme of the Centre for Risk Studies focusses on business applications of management science to reduce systemic risk. A number of interlinked research themes are being explored. They share a common approach and risk analysis structure – the ‘Cambridge Risk Framework’, which enables a range of threats, scenarios, and consequences to be analysed on networks of business and economic relationships. In 2017, we propose to continue development in several research areas.

Research application areas

Research application areas explored through the Cambridge Risk Framework are described in more detail in the next pages of this briefing. For 2017, we envision focussing on three main research tracks:

- A. Emerging and Systemic Risks:** Continuing the research into individual threats, developing scenarios, and improving the understanding of emerging and rapidly changing risks.
- B. Integrated Risk Assessment:** Updating, improving, and extending the framework, datasets, and analytics of the Cambridge Global Risk Outlook, developing standardized risk metrics for multiple threats to the global economy.
- C. Use Cases of Research:** Aligning the research activities and outputs to business decisions and practical applications in improving risk management practices in business and policy-making.

Developing the research framework

In addition to pursuing specific research application area, we intend to continue developing the Cambridge research framework, allocating resources to enabling the platform, improving methodologies, compiling datasets, developing the programming environment for our research models, and exploring other application areas for the research.

Methodology development: “catastronomics”

The economic consequences of major catastrophic shocks of different types are not well understood. The Centre has strong relationships with economists and specialists in macroeconomic analysis. A track of research is to improving methodologies of catastrophics and expanding our understanding of how economic shocks translate into market impacts on asset values in an investment portfolio.

Additional application areas

In addition to our major application areas, we address research topics that are aligned with our objectives of populating the Cambridge Risk Framework in particular threat specializations, or other areas of business decision-making. Recent topics have included how climate change risk will affect investment portfolio strategies; improving risk assessments of geopolitical instability; macroeconomic consequences of extreme natural catastrophe events. We also encourage our research associates to pursue their own research topics for part of their time.

Research platform infrastructure

The Cambridge Risk Framework makes use of a cloud-based research platform for data compilation, model development, and research output. This platform is currently being enhanced to improve its usefulness in the research and presentation of outputs, including enabling research development partners to interact with data and analytics developed at the Centre.

Understanding complex business exposure

We are continuing to populate the Cambridge Risk Framework with datasets about the international economy, business interconnectivity, elements at risk from shocks, and threat information. These datasets represent ‘complex business exposure’ – counterparty relationships, trading flows, supply chains, market dependencies, transportation and communication lines – that are vulnerable to the disruption of business processes. Developing a useful data architecture for this exposure and publishing data schemas for improved adoption of representations of complex business exposure is an important objective for our future research.

Research Application Area A: Emerging and Systemic Risks

Cambridge Centre for Risk Studies continues to research emerging and rapidly-changing risks, and to develop stress test scenarios as a way of understanding and managing these threats. Improving methodologies for developing and using scenarios is a constant theme of management science.

The modern knowledge economy is increasingly reliant on information technology, communication systems, and infrastructure service continuity. Exploring the emerging risk of disruption and catastrophic failure of these critical systems is a key theme of research at the Centre. Understanding cyber risk and the potential for massive failure of interconnected infrastructure systems requires a detailed technical appraisal of complex engineering interactions, a domain-specific assessment of the threat, and a risk analysis framework.

Emerging risks

The Centre continues to monitor emerging risks and changes in the risk landscape. The Centre has a growing network of subject matter specialists on different threat types. Keeping abreast of the latest events, science, and interpreting the implications of changes for risk management is an important part of the research agenda. As new threats arise, these are examined through a standardised process of risk assessment.

Understanding systemic risks

Many businesses, financial institutions, and investors are grappling with improving their understanding of systemic risks, since their importance in the 2008 financial crash. The Centre for Risk Studies' research programme contributes to the understanding of systemic risks, through mapping networks of interconnectivity, trade, and counterparties, and tracing the contagion and propagation mechanisms to amplify shocks through the system.

Cyber risk research

The Cambridge Centre for Risk Studies has been playing a leading role in research into cyber catastrophe risk since its first publications in 2013. The Centre's approach includes developing an understanding of the cyber threat landscape resulting from different technological attack vectors, actors and motivations, and conceptualizing potential scenarios of loss. The framework provides a method of assessing the economic and social impact of future cyber attacks. It also captures risk correlation structures and the potential for systemic cyber catastrophes to impact society, insurance companies, and national governments. This covers various mechanisms of cyber loss to the corporate 'cyber' economy.

Through 2017 and beyond, we intend to develop this framework to explore the key issue of how public and private sectors can collaborate as joint stakeholders in reducing cyber risk to society and the economy. We will examine the roles of individual companies in protecting themselves, the benefits provided by the IT security industry, the value of insurance in providing protection and incentives for risk reduction, law enforcement in deterring cyber criminals, and the function of regulators in enforcing standards for public protection. We believe that the Centre's cyber risk models provide one of the only frameworks that can quantify and inform the public debate around how the many stakeholders can reduce cyber risk to modern society.

Cyber insurance accumulation risk

The Centre has played a significant role in helping develop the growing market for cyber insurance through creating data standards for monitoring cyber insurance exposure and developing accumulation scenarios for systemic cyber insurance losses in both affirmative (IT) and silent (OT) exposure. The Centre will continue to work with insurance partners, industry associations, regulators, and government pools to push forward the frontiers of understanding cyber risk and the best ways to manage this new and emerging class of insurance.

Interdependencies in critical national infrastructure

A major area of societal concern is the potential for failures of critical national infrastructure. The Centre has analysed a number of scenarios of failure of critical national infrastructure, including cyber attacks, solar storms, and interdependencies and cascading failures from one system to another. The interaction and vulnerability of national infrastructure is an important theme for research, involving understanding how power, communications, energy networks, transport and other systems rely on each other and their critical vulnerabilities to disruptive threats. Interdependencies between failure modes of infrastructure, whether digital or physical, is a continuing area of focus of the Centre for Risk Studies.

Research Application Area A: Emerging and Systemic Risks



Leakomania
Accumulation Scenario

| | Premier | Large | Medium | Small |
|--|---------|-------|--------|--------|
| Information Technology - Software | Red | Red | Orange | Yellow |
| Information Technology - Hardware | Red | Red | Orange | Yellow |
| Information Technology - Services | Red | Red | Orange | Yellow |
| Retail | Red | Red | Orange | Yellow |
| Financial Services - Banking | Red | Red | Orange | Yellow |
| Financial Services - Insurance | Red | Red | Orange | Yellow |
| Financial Services - Investment Management | Red | Red | Orange | Yellow |
| Healthcare | Red | Red | Orange | Yellow |
| Business & Professional Services | Red | Red | Orange | Yellow |
| Energy | Red | Red | Orange | Yellow |
| Telecommunications | Red | Red | Orange | Yellow |
| Utilities | Red | Red | Orange | Yellow |
| Tourism & Hospitality | Red | Red | Orange | Yellow |
| Manufacturing | Red | Red | Orange | Yellow |
| Pharmaceuticals | Red | Red | Orange | Yellow |
| Defence/Military Contractor | Red | Red | Orange | Yellow |
| Entertainment & Media | Red | Red | Orange | Yellow |
| Transportation/Aviation/Aerospace | Red | Red | Orange | Yellow |
| Public Authority/NGOs/Non-Profit | Red | Red | Orange | Yellow |
| Real Estate/Property/Construction | Red | Red | Orange | Yellow |
| Education | Red | Red | Orange | Yellow |
| Mining & Primary Industries | Red | Red | Orange | Yellow |
| Food & Agriculture | Red | Red | Orange | Yellow |
| Other | Red | Red | Orange | Yellow |



Mass DDoS
Accumulation Scenario

| | Premier | Large | Medium | Small |
|--|---------|-------|--------|--------|
| Information Technology - Software | Red | Red | Orange | Yellow |
| Information Technology - Hardware | Red | Red | Orange | Yellow |
| Information Technology - Services | Red | Red | Orange | Yellow |
| Retail | Red | Red | Orange | Yellow |
| Financial Services - Banking | Red | Red | Orange | Yellow |
| Financial Services - Insurance | Red | Red | Orange | Yellow |
| Financial Services - Investment Management | Red | Red | Orange | Yellow |
| Healthcare | Red | Red | Orange | Yellow |
| Business & Professional Services | Red | Red | Orange | Yellow |
| Energy | Red | Red | Orange | Yellow |
| Telecommunications | Red | Red | Orange | Yellow |
| Utilities | Red | Red | Orange | Yellow |
| Tourism & Hospitality | Red | Red | Orange | Yellow |
| Manufacturing | Red | Red | Orange | Yellow |
| Pharmaceuticals | Red | Red | Orange | Yellow |
| Defence/Military Contractor | Red | Red | Orange | Yellow |
| Entertainment & Media | Red | Red | Orange | Yellow |
| Transportation/Aviation/Aerospace | Red | Red | Orange | Yellow |
| Public Authority/NGOs/Non-Profit | Red | Red | Orange | Yellow |
| Real Estate/Property/Construction | Red | Red | Orange | Yellow |
| Education | Red | Red | Orange | Yellow |
| Mining & Primary Industries | Red | Red | Orange | Yellow |
| Food & Agriculture | Red | Red | Orange | Yellow |
| Other | Red | Red | Orange | Yellow |



Cloud Compromise
Accumulation Scenario

| | Premier | Large | Medium | Small |
|--|---------|-------|--------|--------|
| Information Technology - Software | Red | Red | Orange | Yellow |
| Information Technology - Hardware | Red | Red | Orange | Yellow |
| Information Technology - Services | Red | Red | Orange | Yellow |
| Retail | Red | Red | Orange | Yellow |
| Financial Services - Banking | Red | Red | Orange | Yellow |
| Financial Services - Insurance | Red | Red | Orange | Yellow |
| Financial Services - Investment Management | Red | Red | Orange | Yellow |
| Healthcare | Red | Red | Orange | Yellow |
| Business & Professional Services | Red | Red | Orange | Yellow |
| Energy | Red | Red | Orange | Yellow |
| Telecommunications | Red | Red | Orange | Yellow |
| Utilities | Red | Red | Orange | Yellow |
| Tourism & Hospitality | Red | Red | Orange | Yellow |
| Manufacturing | Red | Red | Orange | Yellow |
| Pharmaceuticals | Red | Red | Orange | Yellow |
| Defence/Military Contractor | Red | Red | Orange | Yellow |
| Entertainment & Media | Red | Red | Orange | Yellow |
| Transportation/Aviation/Aerospace | Red | Red | Orange | Yellow |
| Public Authority/NGOs/Non-Profit | Red | Red | Orange | Yellow |
| Real Estate/Property/Construction | Red | Red | Orange | Yellow |
| Education | Red | Red | Orange | Yellow |
| Mining & Primary Industries | Red | Red | Orange | Yellow |
| Food & Agriculture | Red | Red | Orange | Yellow |
| Other | Red | Red | Orange | Yellow |



Financial Theft
Accumulation Scenario

| | Premier | Large | Medium | Small |
|--|---------|-------|--------|--------|
| Information Technology - Software | Red | Red | Orange | Yellow |
| Information Technology - Hardware | Red | Red | Orange | Yellow |
| Information Technology - Services | Red | Red | Orange | Yellow |
| Retail | Red | Red | Orange | Yellow |
| Financial Services - Banking | Red | Red | Orange | Yellow |
| Financial Services - Insurance | Red | Red | Orange | Yellow |
| Financial Services - Investment Management | Red | Red | Orange | Yellow |
| Healthcare | Red | Red | Orange | Yellow |
| Business & Professional Services | Red | Red | Orange | Yellow |
| Energy | Red | Red | Orange | Yellow |
| Telecommunications | Red | Red | Orange | Yellow |
| Utilities | Red | Red | Orange | Yellow |
| Tourism & Hospitality | Red | Red | Orange | Yellow |
| Manufacturing | Red | Red | Orange | Yellow |
| Pharmaceuticals | Red | Red | Orange | Yellow |
| Defence/Military Contractor | Red | Red | Orange | Yellow |
| Entertainment & Media | Red | Red | Orange | Yellow |
| Transportation/Aviation/Aerospace | Red | Red | Orange | Yellow |
| Public Authority/NGOs/Non-Profit | Red | Red | Orange | Yellow |
| Real Estate/Property/Construction | Red | Red | Orange | Yellow |
| Education | Red | Red | Orange | Yellow |
| Mining & Primary Industries | Red | Red | Orange | Yellow |
| Food & Agriculture | Red | Red | Orange | Yellow |
| Other | Red | Red | Orange | Yellow |



Extortion Spree
Accumulation Scenario

| | Premier | Large | Medium | Small |
|--|---------|-------|--------|--------|
| Information Technology - Software | Red | Red | Orange | Yellow |
| Information Technology - Hardware | Red | Red | Orange | Yellow |
| Information Technology - Services | Red | Red | Orange | Yellow |
| Retail | Red | Red | Orange | Yellow |
| Financial Services - Banking | Red | Red | Orange | Yellow |
| Financial Services - Insurance | Red | Red | Orange | Yellow |
| Financial Services - Investment Management | Red | Red | Orange | Yellow |
| Healthcare | Red | Red | Orange | Yellow |
| Business & Professional Services | Red | Red | Orange | Yellow |
| Energy | Red | Red | Orange | Yellow |
| Telecommunications | Red | Red | Orange | Yellow |
| Utilities | Red | Red | Orange | Yellow |
| Tourism & Hospitality | Red | Red | Orange | Yellow |
| Manufacturing | Red | Red | Orange | Yellow |
| Pharmaceuticals | Red | Red | Orange | Yellow |
| Defence/Military Contractor | Red | Red | Orange | Yellow |
| Entertainment & Media | Red | Red | Orange | Yellow |
| Transportation/Aviation/Aerospace | Red | Red | Orange | Yellow |
| Public Authority/NGOs/Non-Profit | Red | Red | Orange | Yellow |
| Real Estate/Property/Construction | Red | Red | Orange | Yellow |
| Education | Red | Red | Orange | Yellow |
| Mining & Primary Industries | Red | Red | Orange | Yellow |
| Food & Agriculture | Red | Red | Orange | Yellow |
| Other | Red | Red | Orange | Yellow |

Cyber catastrophe scenario footprints produced for Managing Cyber Insurance Accumulation Risk

Research Application Area B: Integrated Risk Assessment

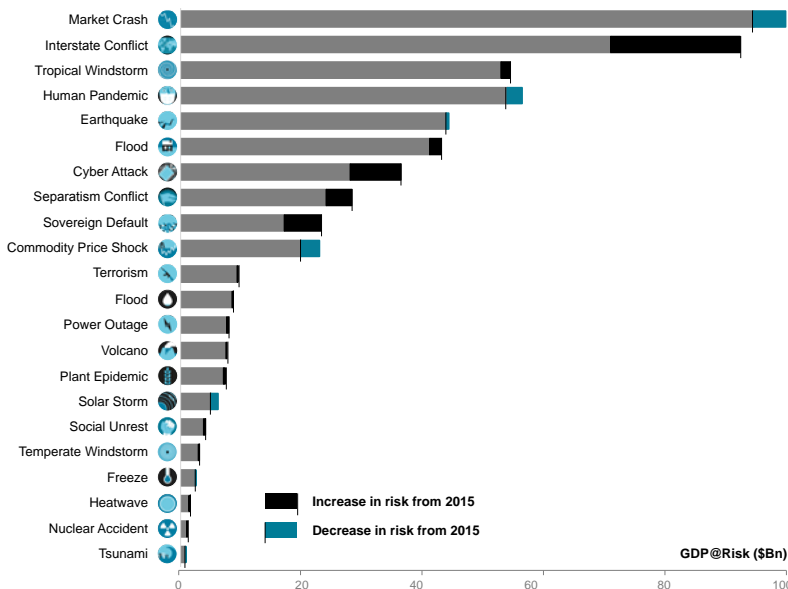
A key objective for our research is to develop a comprehensive risk analysis of major shocks to the global economy. This has been a vision and objective of the Cambridge Centre for Risk Studies since its inception. We have now developed a Global Risk Index to track and update the risk framework of threats and scenarios. We will be updating and improving the analysis of threats, and integrating the risk assessment into decision-support applications. The analysis framework will be geared to making the outputs more useful to business decision makers.

Project Pandora: A Global Risk Outlook

The Centre has compiled a compendium of threat maps, analytics and data layers, as a toolkit for assessing international risk of business disruption. Project Pandora references the classical story of Pandora’s Box of All Ills, and is a culmination of the research programme that the Centre for Risk Studies has been pursuing since its inception. This analysis suite consists of a probabilistic event set of over 12,000 catastrophe scenarios representing 22 threats, with potential to cause disruption to economic activity in 300 of the world’s most important cities, responsible for half of the world’s GDP. The consequences of these events are quantified in terms of their ‘GDP@Risk’ – a constant metric that can be used to compare and standardize different types of threat.



Threat Taxonomy used in Project Pandora’s Global Risk - a standardised approach to all threats



2017 Global Risk Index by Threat Type

Updating for 2018

The update of the Global Risk Outlook for 2018 will utilise the inputs of subject matter specialists in each of the individual threats, to assess changes and trends in the characteristics, severities and geographies of the threats. These are provided both as a ten year outlook (2018 to 2027, as a baseline view) and as a three year outlook (2018 to 2020, as a short term variation from baseline).

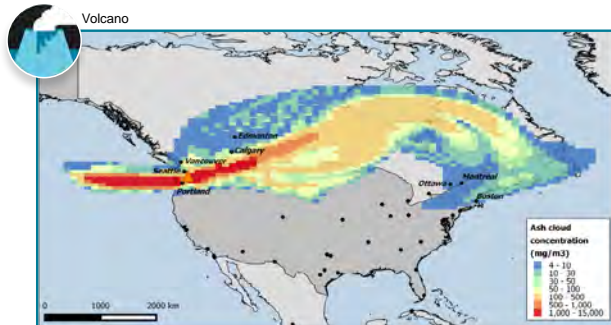
Adding contagion and cascades

The analytical framework is being extended to incorporate contagion of shocks through the global economy, to improve the representation of impacts of localized events elsewhere in the world. The analysis will also explore the potential for one shock event to trigger other shock events in a cascade of consequences.

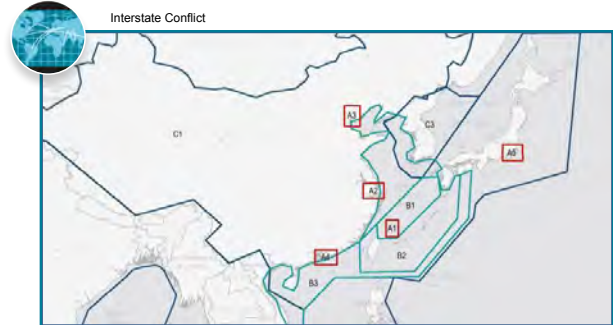
Trillion Dollar Scenarios

Tail events are being explored by identifying all threat events with the potential to cause a loss to the global economy of a trillion dollars or more. The universe of trillion dollar events will continue to be developed to characterise the frequency and characteristics of the distribution of extreme potential shock events.

Research Application Area B: Integrated Risk Assessment



Trillion Dollar Scenario: VEI VII Eruption of Mount Rainier, Seattle, United States



Trillion Dollar Scenario: Military conflict between China and Japan focused on islands in the South China Sea

Additional consequence models

The consequences of the scenarios will be extended from estimating GDP@Risk by adding other types of impacts to the modelling of the events. For insurance use cases this will extend to insurance underwriting loss assessments, derived in terms of index values for different lines of exposure. For international businesses, the consequence modelling will be extended to revenue loss and other operational impact metrics resulting from the scenarios, as needed to support the use case applications.

| | Market Crash | Sovereign Crash | Price Shock | Interstate War | Terrorism | Separatism Conflict | Social Unrest | Earthquake | Volcano | Tropical Windstorm | Temperate Windstorm | Flood | Tsunami | Drought | Freeze | Heatwave | Power Outage | Cyber Attack | Solar Storm | Nuclear Accident | Human Epidemic | Plant Epidemic |
|---------------------|--------------|-----------------|-------------|----------------|-----------|---------------------|---------------|------------|---------|--------------------|---------------------|-------|---------|---------|--------|----------|--------------|--------------|-------------|------------------|----------------|----------------|
| Market Crash | 4 | 3 | 3 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Sovereign Crash | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Price Shock | 2 | 2 | 4 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Interstate War | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 2 | 2 |
| Terrorism | 2 | 2 | 2 | 4 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 2 |
| Separatism Conflict | 2 | 3 | 3 | 3 | 4 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| Social Unrest | 2 | 2 | 2 | 2 | 3 | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| Earthquake | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 2 | 1 |
| Volcano | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 1 |
| Tropical Windstorm | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 1 | 1 | 1 | 0 |
| Temperate Windstorm | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 0 | 0 |
| Flood | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 2 | 0 |
| Tsunami | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 0 |
| Drought | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| Freeze | 1 | 1 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 1 | 1 | 1 |
| Heatwave | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| Power Outage | 1 | 2 | 2 | 1 | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 0 | 0 | 2 | 1 | 1 |
| Cyber Attack | 1 | 2 | 1 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 0 | 2 | 0 | 0 |
| Solar Storm | 2 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 0 | 2 | 0 | 0 | 0 |
| Nuclear Accident | 2 | 2 | 1 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Human Epidemic | 3 | 3 | 3 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 0 |
| Plant Epidemic | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |

Consequential Threat

- 0 No causal linkage
No significant ability to exacerbate
- 1 No causal linkage,
but would exacerbate consequences if they occur
- 2 Weak potential
to trigger threat occurrence
- 3 Strong potential
to trigger threat occurrence
- 4 Ability to trigger
Other threats within same type class

Threat Correlation Matrix, how one shock might cascade into another

Primary Trigger

Real-time event interpretation

As part of our catastrophe scenario research, we are compiling historical case study precedents and calibrating models of likely consequences of unfolding events. We propose to explore the application of these techniques for businesses to respond to potentially threatening current events, by providing interpretation and analysis of the implication of events for various business activities.

Business use cases and project partners

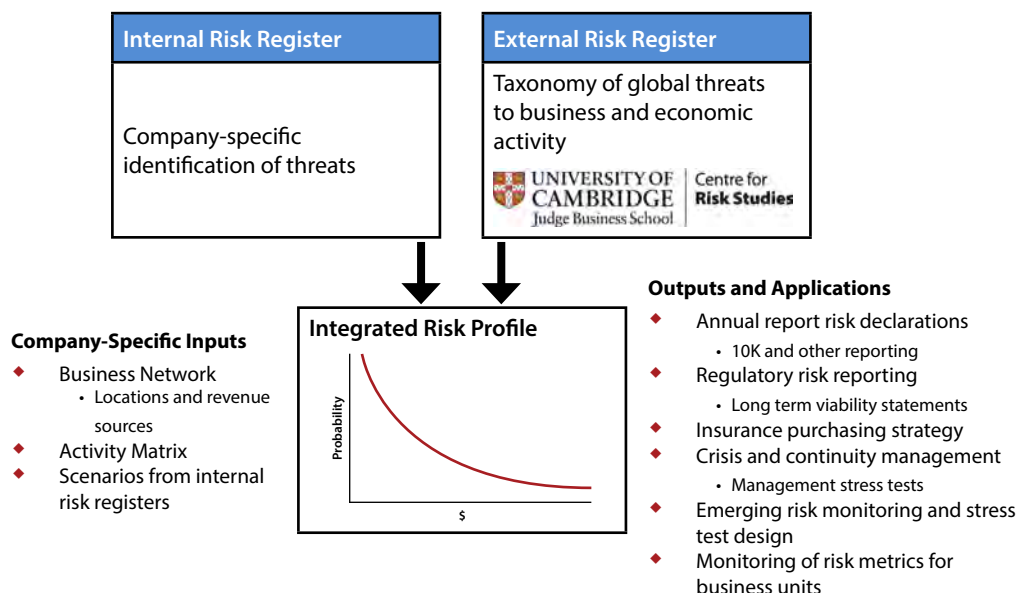
The Centre for Risk Studies works with selected organizations as part of a multi-year partnership to develop and exploit Project Pandora. The Centre works with a steering committee of research partners representing different aspects of potential business users. This development consortium will shape the applications of the research to meet the needs of their specific use cases. The nature of the partnerships will facilitate the practical usage and benefits of the research outputs towards business applications.

Research Application Area C: Use Cases of Research

We focus on the use of research outputs in improving business decision-making. Our engagement with support partners from different sectors of business is focussed on ensuring that research has impact. The usefulness of research outputs in business depend on how they are designed and the decision frameworks into which they flow. This track of research explores the use cases envisioned by our industry partners and how our research can be of more value to them.

Scenarios for business management

Understanding new threats through the development of scenarios is a technique that is used extensively at the Centre for Risk Studies, building on many years of precedents in management science. The Centre continues to refine methodologies for developing scenarios and improving their usefulness in decision support. Scenarios are used in many different aspects of business, from preparedness planning, to financial stress testing, insurance accumulation control and deterministic loss estimation, regulatory requirements, and strategy planning. Our research continues to try to define best practice in the design and use of scenarios, particularly the assessment of severity and likelihood, sensitivity to major variables, and uncertainty distributions in scenario variants.



Using Cambridge research outputs in managing business risk

Data schemas

Scenarios are more useful if they can be applied to the specific activities of a particular company. Analysing the impact of a scenario on a company requires a set of information about the company and its activities. Use cases will help define a standard set of information – a data schema – that can be used to map a scenario to business activity and derive impact assessments. We propose to develop a data schema for international companies to map their global operations and market activities to assess their impacts from global risk scenarios.

In insurance, there are many lines of business that have clash potential, where losses could be experienced across multiple exposure categories by emerging and systemic threats. Developing a multi-line exposure data schema is a priority for the insurance use cases of research at Cambridge Centre for Risk Studies.

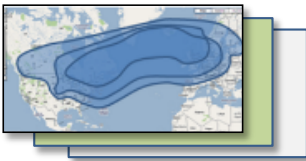
Some of the more extreme scenarios result in market shocks, and have investment portfolio impacts. We propose to develop and publish a standardized data schema to describe representative asset classes in institutional investment portfolios, to enable investment managers to assess their likely impacts from scenarios.

Research Application Area C: Use Cases of Research

Threat Maps



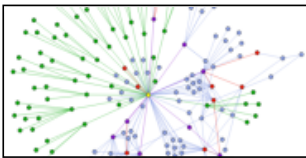
Scenarios



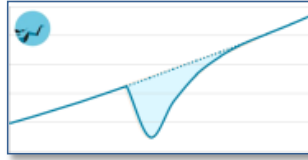
Exposure Data



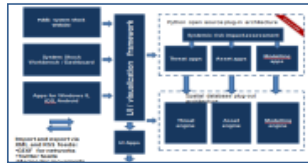
Network Models



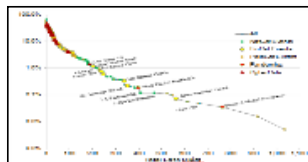
Risk Models & Output Data



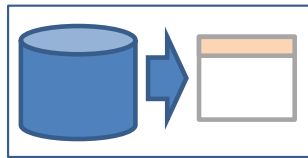
Software Platform (Cambridge Risk Framework)



Use Cases Business Applications



Private Portals APIs & Modelling Interfaces



A toolkit for risk science: quantifying resilience

Insurance use cases

Insurance companies use the research outputs from Cambridge Centre for Risk Studies to explore new potential threats and opportunities for new markets and products, for example in the development of the cyber insurance market. In new markets and for potential systemic threats, accumulation management is important. We will be exploring ways of improving the Centre's research outputs for insurance companies to make better use of scenarios in portfolio-specific loss estimation, clash from complex and systemic risks, and balance sheet risk.

Enterprise risk management

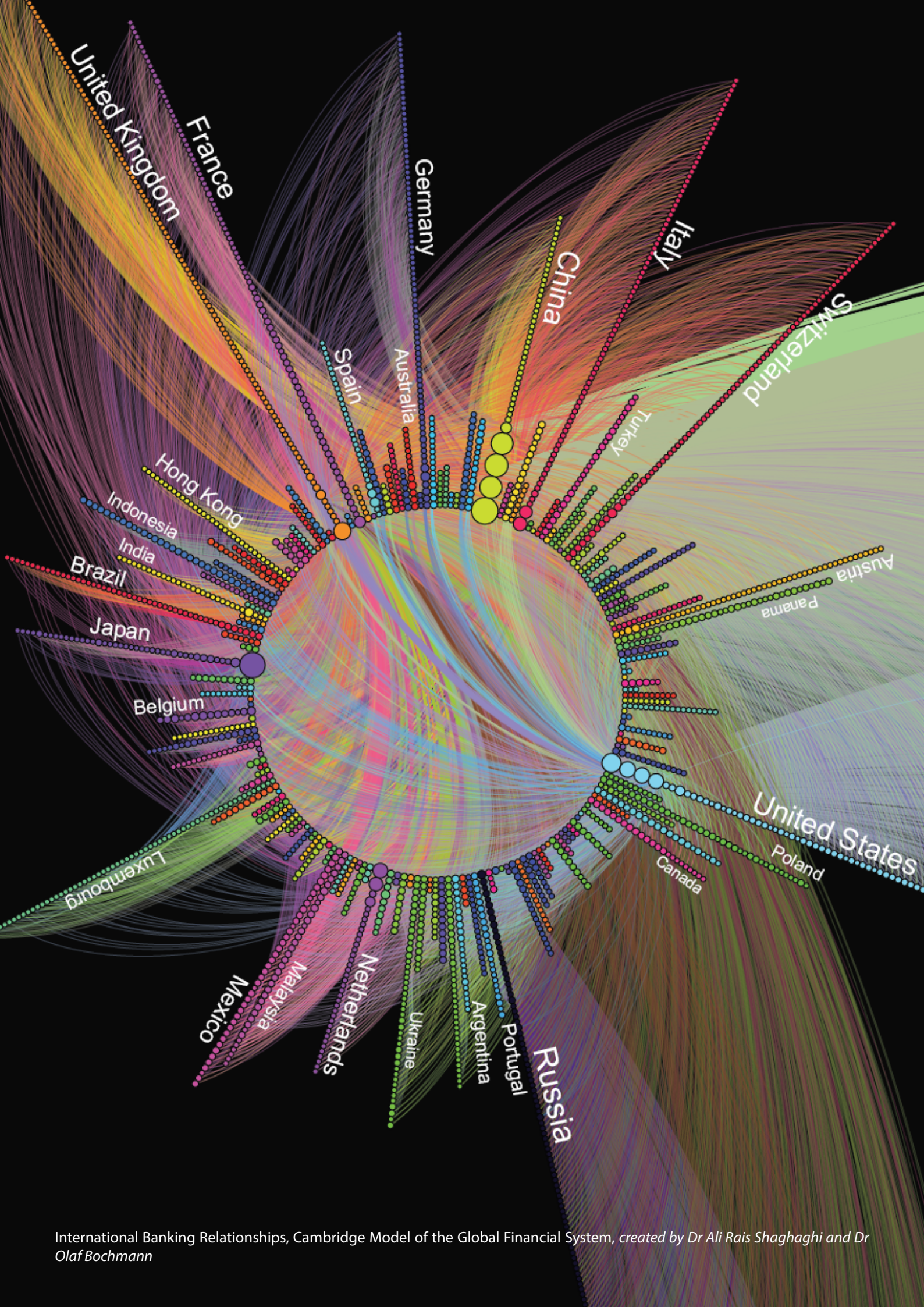
Companies augment their internal risk registers with external threat assessment checklists, such as our Cambridge Taxonomy of Threats. Our research outputs are used for annual report risk declarations such as 10K reporting, regulatory and shareholder reporting, long term viability statements, insurance purchasing strategies, crisis and continuity management, and monitoring of risk metrics across internal business units. We will be engaging with support partners to improve research outputs for use in these business applications.

Applications of our research

Our research agenda is broad. We recognise the need to work closely with our support partners to ensure that the research outputs are aligned with the best use in business decision-making.

2017 Planned Event Calendar for the Cambridge Centre for Risk Studies

| | |
|-------------------|---|
| 24 January | <p>Centre for Risk Studies Advisory Board</p> <p>The Cambridge Centre for Risk Studies will hold the meeting of its Advisory Board, with attendees representing the supporting organisations of the Centre, academic advisors, and invited guests. The executive team of the Centre for Risk Studies will present a progress report on the past year's activities, the current positioning and strategy of the Centre, and the various strands of research.</p> |
| 25 January | <p>Cambridge CRO Council "Leading Ideas in Risk" Roundtable, London</p> <p>The CROs view of the technology space of the future and its implication to the management of risk. This roundtable will be comprised of senior risk executives from a variety of sectors to allow for a broad-based discussion.</p> |
| 6-7 February | <p>Risk and Benefits of Artificial Intelligence and Robotics, with United Nations</p> |
| Deadline: 6 March | <p>The 2017 Cambridge-McKinsey Risk Prize</p> <p>The Centre for Risk Studies, in conjunction with McKinsey & Company, is pleased to announce the annual risk prize. An award will be made for the best submission on risk management by a current student at the University of Cambridge Judge Business School.</p> |
| 2 May | <p>RMS Cyber Project Launch, featuring Cambridge Centre for Risk Studies guest presentations, London</p> |
| 16 May | <p>RMS Cyber Project Launch, New York</p> |
| 11 April | <p>Lloyd's Scenarios of Severe Losses in Marine Insurance</p> |
| 22-23 June | <p>Cambridge Centre for Risk Studies 8th Risk Summit, Cambridge Judge Business School</p> <p>Cambridge Centre for Risk Studies will bring together leaders and decision makers from businesses, governments, intergovernmental organisations, academia and NGOs to explore salient topics in risk management. The summit will be held at the University of Cambridge Judge Business School, followed by a conference dinner at one of the University colleges.</p> <p>This year's summit theme will be 'Managing Risk in a Smarter World', and will explore the meaning of risk culture and its contribution and governance to culture in organisations.</p> |
| September | <p>Scenario Workshop: Best Practice in the Development and Use of Scenarios</p> |
| December | <p>Cambridge Global Risk Outlook 2018</p> |

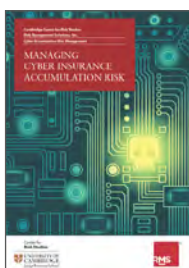


2016 Centre for Risk Studies Research Outputs

Publications

A broad spectrum of risk analysis

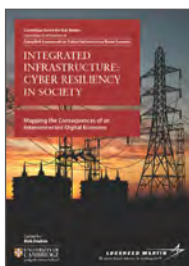
In 2016, the Centre for Risk Studies produced four detailed and highly influential reports which drew attention to emerging vulnerabilities in the industrial economy. The four studies reinforced the Centre's key research themes for the year, namely: multi-risk threat and the threat of cyber and technology-based risks, and contributed to the emerging understanding of these threats in the broader business community. A launch event was held in London for each report with an additional New York event for the Cyber Insurance Data Schema on 10 February. Each report accrued a significant amount of media coverage (see opposite page).



Managing Cyber Insurance Accumulation Risk

Risk Management Solutions, Inc.; 2016; **Managing Cyber Insurance Accumulation Risk**; report prepared in collaboration with and based on original research by the Centre for Risk Studies, University of Cambridge.

A framework for setting risk appetite and evaluating PML scenarios in cyber insurance risk. The report describes five cyber loss processes and scenarios for managing accumulation risk.



Integrated Infrastructure: Cyber Resiliency in Society, Mapping the Consequences of an Interconnected Digital Economy

Kelly, S.; Leverett, E.; Oughton, E. J.; Copic, J.; Thacker, S.; Pant, R.; Pryor, L.; Kassara, G.; Evan, T.; Ruffle, S. J.; Tuveson, M.; Coburn, A. W.; Ralph, D. & Hall, J. W.; 2016; **Integrated Infrastructure: Cyber Resiliency in Society, Mapping the Consequences of an Interconnected Digital Economy**; Cambridge Risk Framework series; Centre for Risk Studies, University of Cambridge.

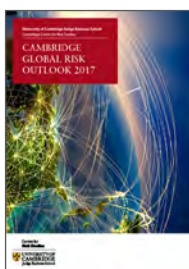
With the increasingly interconnected nature of our critical national infrastructure, the impact of a cyber attack on a power distribution network could be wide-ranging and costly. In collaboration with Lockheed Martin, we examine the economic impact of an attack against the UK power distribution system in the Southeast.



Helios Solar Storm Scenario

Oughton, E.; Copic, J.; Skelton, A.; Kesaitė, V.; Yeo, Z. Y.; Ruffle, S. J.; Tuveson, M.; Coburn, A. W.; Ralph, D. 2016. **Helios Solar Storm Scenario**; Cambridge Risk Framework series; Centre for Risk Studies, University of Cambridge.

An exploration of the economic and business impacts of a significant space weather event, creating a geomagnetic disturbance that generates GICs capable of damaging and destroying EHV transformers in the Northern hemisphere.



Cambridge Global Risk Outlook for 2017

Cambridge Centre for Risk Studies, 2016; **Global Risk Outlook for 2017**, Cambridge Centre for Risk Studies, University of Cambridge.

The Cambridge Global Risk Outlook for 2017 launches the Centre's new index, the Cambridge Global Risk Index, which analyses the exposure to shocks of the global economy against a calculated baseline and provides an overview of risk for the world's economy for the next 10 years.

Selected Press Features

The News Tribute, "Cyberattack an energy threat waiting to happen," 1 March 2016

Cambridge Network: "Is Risk Culture Enough?," 2 March 2016

Insurance Journal: "Re/Insurers Must Respond to Evolving Terrorist Risk with Relevant Products," 25 March 2016

Business Insurance: "Modeling firms take first look at cyber risks," 29 May, 2016

The Economist: "Hack work: Insurers grapple with cyber-attacks that spill over into physical damage," 3 December 2016

Bloomberg Radio: "Cambridge's Ralph: Geopolitical and Sovereign Threats Increase," 3 January 2017

Cyber Exposure Data Schema Coverage

Lexology, "A Common Standard for Evaluating Cyber Risk - Insurers Walk the Walk," 23 February 2016

Claims Journal, "RMS Releases Cyber Modeling System Created With Industry Support," 11 February 2016

FinTech Innovation, "Collaboration to develop core data requirements for cyber insurance," 9 February 2016

Insurance Journal, "RMS Releases Cyber Accumulation Management System to Manage Exposure," 3 February 2016

Insurance Insider, "RMS launches cyber accumulation management tools," 2 February 2016

Intelligent Insurer, "Dealing with an evolving threat," 2 February 2016

DarkReading, "Insurers Getting Smarter About Assessing Cyber Insurance Policy Risks," 26 January 2016

Insurance Business, "Lloyd's appeals to brokers for help on cyber," 22 January 2016

'Helios Solar Storm Scenario' Coverage

Power, "Severe Solar Storm Could Shut Down U.S. Grid for Months, Study Says," 19 July 2016

Canadian Underwriter: "Lights Out", 30 November 2016

Global Reinsurance: "Stress testing solar storms", 16 December 2016

'Integrated Infrastructure: Cyber Resiliency in Society' Coverage

Canadian Underwriter: "Significant UK cyberattack could cost billions of pounds in economic losses, study finds", 12 April 2016

Computer Weekly, "Collaboration vital to reduce economic impact of CNI cyber attack," 12 April 2016

ZD Net: "This is how much a huge cyberattack on the power grid could really cost", 12 April 2016

Cambridge Network: "Collaboration is key to minimising economic impact from a cyberattack," 13 April 2016

SC Media UK: "£442 billion potential loss in UK power sector cyber-attack," 13 April 2016

International Business Times: "UK power grid reportedly at risk from rogue nation states and 'opportunistic' hackers", 19 April 2016

The Actuary: "Shock tactics - exploring the risk of cyber attacks on electricity networks," 1 September 2016

Security News Desk: "Securing critical infrastructure from virtual and physical threats", 24 November 2016

Cambridge Global Risk Index 2017 Coverage

Bloomberg Radio Podcast: "Cambridge's Danny Ralph: Geopolitical and Sovereign Threats Increase", 3 January 2017

Asia Insurance Review: "Risks could cost global economy US\$1.17 trillion in 2017", 14 December 2016

Reconomics: "GDP@Risk: A New Metric Worth Noting", 10 December 2016

Bureau van Dijk: "Global economy 'facing higher risk of major shocks'", 9 December 2016

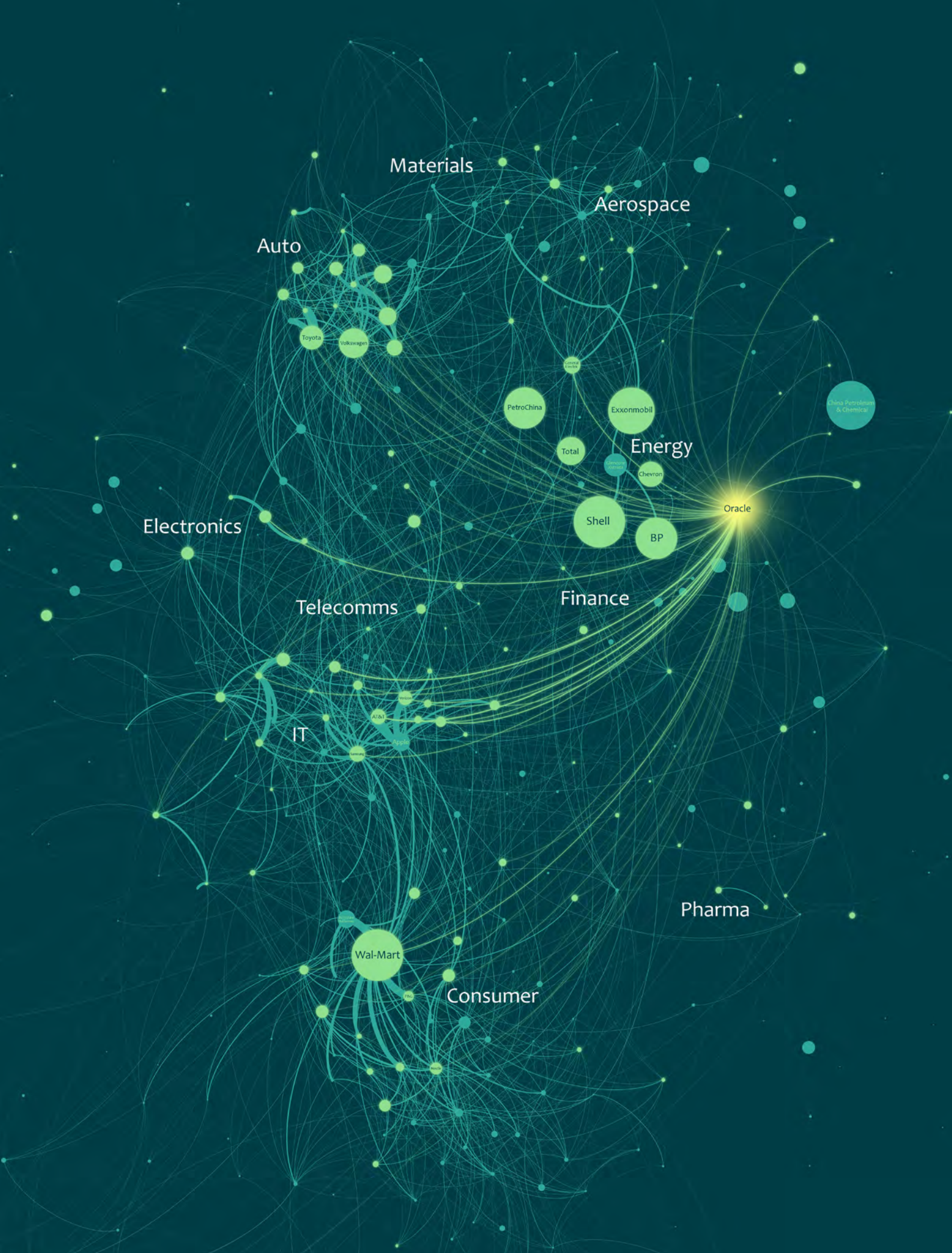
Strategic Risk: "New index lists the top risks to the global economy", 8 December 2016

Insurance Journal: "Rising Risks Could Cost Global Cities \$1.17 Trillion of GDP in 2017", 6 December 2016

Wall Street Journal: "Morning Risk Report: War More Prevalent in 2017 Risk Radar", 6 December 2016

Insurance Day: "Inter-state conflict and cyber risk 'rising significantly'", 5 December 2016

Insurance Day: "Longer-term contracts would help industry boost economic resilience", 5 December 2016



"Systemic Cyber Threats"; the world's largest commercial companies and their trading relationships, showing the systemic linkages through major software providers, using Oracle as an example; *created by Dr Andrew Skelton*

Engagement Activities 2016

In 2016, the Centre continued the expansion of its research dissemination activities for its stakeholder community and with the wider research community. Third party requests for participation in external conferences reached record levels this past year as the Centre's prominence for risk research and thought leadership gained.

The Centre's dissemination strategy involves packaging the research outputs into self-published reports and creating a multi-channel process for publicizing and distributing them. The self-published aspect of this strategy has allowed the Centre to tailor these reports to specific audiences and areas of expertise in 2016. The Centre hosted four formal launch events to present the release of the following research reports:

- Cyber Insurance Data Scheme v1.1 - London and New York, Feb 2016. In partnership with RMS.
- Integrated Infrastructure: Cyber Resiliency in Society - London, April 2016. In partnership with Lockheed Martin.
- Understanding the Helios Solar Storm Scenarios - London, Nov 2016. In partnership with AIG.
- Cambridge Global Risk Index 2017 - London, Dec 2016. In partnership with AIG, Lloyd's, Munch Re, Willis Towers Watson, XL Catlin.

Members of the Centre for Risk Studies continue to receive more invitations than they can accommodate to speak at various risk seminars and business strategy conferences around the world. The following list is a sampling of some thought leadership venues with speaking participation from the Centre's staff:

- Alan Turing Institute Scoping Workshop on Data Science for Whole Energy Systems - Edinburgh, Jan 2016. [Professor Daniel Ralph]
- Skytop's Shareholder Actions in Cyber Security - New York, Mar 2016. [Dr Michelle Tuveson]
- "Risk Science for Resilience" presentation, Towards Coherent Resilience Policy - Integrating Science, Law, and Finance - London, Mar 2016. [Professor Daniel Ralph, Dr Andrew Coburn, Simon Ruffle]
- World Council on City Data Conference - Toronto, Apr 2016. [Dr Michelle Tuveson]
- Professional Liability Underwriter's Society Annual Conference - Chicago, Nov 2016. [Dr Michelle Tuveson]

Due to time constraints, the Centre had to decline invitations to speak at the S&P 500 Insurance Conference, FT Future of Insurance, OECD Policy Meeting on the Use of Scenarios, German Bundesbank Workshop on Cyber Security, PRMIA Conference, International Energy Agency Workshop, Aon Annual Conference, and other external engagement opportunities.

Centre members continue to serve on boards and as senior advisors for external publications and academic series. This includes the World Economic Forum Global Risk Report, the IEEE's Publication on the Ethical Considerations in the Design of Autonomous Systems, and Executive Education Curriculum Design.

The Viewpoints blog also provides an easily accessible platform for commentary and insight on these pertinent topics at the rate of roughly one column per month.

Cambridge Chief Risk Officer Council Discussions

The Centre continues to convene its "*Leading Ideas in Risk*" roundtable discussions with CROs representing many of the companies within the financial and insurance services sectors. 2016 topics covered the senior managers' regime along with as the management of risks in a post-Brexit world.

7th Annual Risk Summit - "Risk Culture: Challenging Individual Agency"

One of our broadest engagement activities continues to be our Risk Summit conference, attended by 150 senior executives and decision-makers. This year the Summit featured more content from our own research, in a pre-conference Special Topics Seminar. Video interviews were conducted with experts and speakers who participated in the conference and were made public online.

Ongoing Special Topic Seminars

Specific topic seminars included *Financial Risk and Network Theory* in September and the *Cambridge Global Risk Index* in December. All seminars were fully subscribed and well received. The Centre continued its efforts, begun last year, to film and record seminar presentations and make them available online in order to contribute to a climate of accessible academic research and discussion.

Calendar of Events 2016

| | |
|-------------------|---|
| 13 January | <p>Centre for Risk Studies Advisory Board Research strategy review by the members of the Centre for Risk Studies Advisory Board.</p> |
| 14 January | <p>Cambridge CRO Council “Leading Ideas in Risk” Roundtable, London <i>Anticipated regimes for senior managers and the measures and implications associated with incentive, administrative, and civil structures</i></p> |
| 2 February | <p>Managing Cyber Insurance Accumulation Risk Introducing a new data standard and risk analysis platform for managing cyber insurance with collaborators RMS, Inc. with support from eight leading insurance and reinsurance companies, provides firms with cyber PML scenarios for cyber insurance accumulation management</p> |
| 10 February | <p>New York Launch of Managing Cyber Insurance Accumulation Risk</p> |
| Deadline: 1 March | <p>The 2016 Cambridge-McKinsey Risk Prize The Centre for Risk Studies, in conjunction with McKinsey & Company, is pleased to announce the 2016 annual risk prize. An award will be made for the best submission on risk management by a current student at the University of Cambridge Judge Business School.</p> |
| 12 April | <p>Launch of Integrated Infrastructure: Cyber Resiliency in Society Published study by the Cambridge Centre for Risk Studies and Lockheed Martin estimate the economic impact of a sustained cyber attack on UK critical infrastructure</p> |
| 20-21 June | <p>Cambridge Centre for Risk Studies 7th Risk Summit, Cambridge Judge Business School Cambridge Centre for Risk Studies will brought together leaders and decision makers from businesses, governments, intergovernmental organisations, academia and NGOs to explore salient topics in risk management. The summit will be held at the University of Cambridge Judge Business School, followed by a conference dinner at one of the University colleges. This year’s summit theme was ‘Risk Culture: Challenging Individual Agency’, and explored the meaning of risk culture and its contribution and governance to culture in organisations.</p> |
| 13-14 September | <p>2016 Financial Risk and Network Theory Conference Organised in collaboration with the new <i>Journal of Network Theory in Finance</i> (JNTF), continued the successful conferences in 2014 and 2015 in generating new collaborations in this emerging multidisciplinary field.</p> |
| October | <p>Cambridge CRO Council Roundtable Discussion, London - Leading Ideas in Risk: Managing Risk in a Post-Brexit World</p> |
| 3 November | <p>Understanding the Helios Solar Storm Scenarios - London Risk Briefing Following the recent release of the Helios Solar Storm Scenario Research Report to the stress testing community, the research teams at CRS and AIG presented the science behind the analysis and discussion.</p> |
| 5 December | <p>Cambridge Global Risk Index 2017: Risk Science for Resilience In collaboration with sponsors AIG, Lloyd’s, Munich Re, Willis Towers Watson and XL Catlin. The conference featured key research at the Centre in modelling catastrophe risk to business activities as well as provide perspectives from business leaders on their new and emerging risk challenges.</p> |



7th Risk Summit - Challenging Individual Agency



Continuing Risk Centre social media presence



UK Cyber Blackout Scenario launch with Lockheed Martin, April 2016



Financial Risk & Network Theory Conference, September 2016



Cambridge Global Risk Index for 2017, December 2016



Official launch events for Helios Solar Storm Scenario with AIG, November 2016



Cambridge-XL Catlin Annual Workshop, November 2016



Cyber Insurance Data Schema Launch, London, February 2016

The Cambridge-McKinsey Risk Prize 2015

The Cambridge Centre for Risk Studies, in conjunction with McKinsey & Company, is pleased to award the “Cambridge - McKinsey Risk Prize”. This award recognises the best submission on risk management by a current student at the University of Cambridge Judge Business School.

Judges include members of McKinsey’s Global Risk Practice, the Editor-in-Chief of the McKinsey Working Papers, and members of the Cambridge Centre for Risk Studies at the Cambridge Judge Business School.



First Place Finalist

Rasheed Saleuddin, PhD candidate in History with the Cambridge Endowment for Research in Finance
Should credit risks be marked to market in crisis? Re-examining subprime securities 'irrationality' 2008-2010

Winning author Rasheed Saleuddin is also a scholar with Cambridge Endowment for Research in Finance, and is a portfolio manager with West Face Capital, managing a dedicated structured securities fund. Honourable mentions went to two degree candidates at Cambridge Judge Business School: MBA student Simone Goldstein and Master of Finance (MFin) student Vladislav Mikhailov.

The winning paper re-examines and challenges the contentions of some market observers and policymakers at the time of the financial crisis of 2008-2010 that the “mark to market” of residential mortgage-backed securities positions based on the observed prices of ABX indices may have exacerbated the crisis by forcing investors to sell such assets to shore up capital – because such indices overshot their fundamental value on the downside.

But the paper found that the prices of the ABX indices were reasonably determined based on market fundamentals at the time, so there was no reason not to mark to market. The research concluded that the problems related to over-leveraging, not mark to market. “Blaming ABX for deepening the crisis may be akin to blaming the meteorologist for the weather,” the winning paper says. “The TV weather forecast is not always correct, and sometimes is horribly wrong. But it is not generally irrational, and we ignore forecasts at our peril... It is only in hindsight that signs of irrationality might be said to have entered ABX pricing.”

This was the first time that the Cambridge-McKinsey Prize has been open to University of Cambridge faculties beyond Cambridge Judge Business School. The Academic Director of the Centre for Risk Studies, Professor Daniel Ralph, said the results of doing so had been so successful that the catchment would be further broadened next year. “Insight into risk can come from many disciplines,” he said.

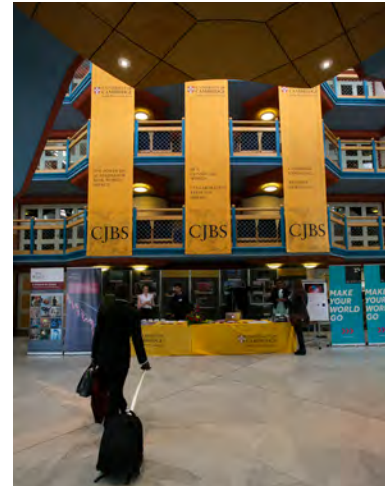
Cambridge Centre for Risk Studies 8th Risk Summit, 22 - 23 June 2017

Managing Risk in a Smarter World

University of Cambridge Judge Business School



In June 2017 the Cambridge Centre for Risk Studies will bring together leaders and decision makers from businesses, governments, academia and NGOs to explore salient topics in risk management. The summit will be held at the University of Cambridge Judge Business School and a conference dinner following at Clare College, Cambridge.



This year's summit theme is *'Managing Risk in a Smarter World'*, and will explore the overall risks and opportunities for risk managers as the financial and insurance sectors adopt greater automation and technology. Topics such as artificial intelligence, fintech, insurtech, virtual currencies and disintermediation platforms, and sociological implications will be discussed within the context of managing risks.

Registration will open in the Spring of 2017.



Last Year's Risk Summit

20 - 21 June 2016 - "Risk Culture: Challenging Individual Agency"

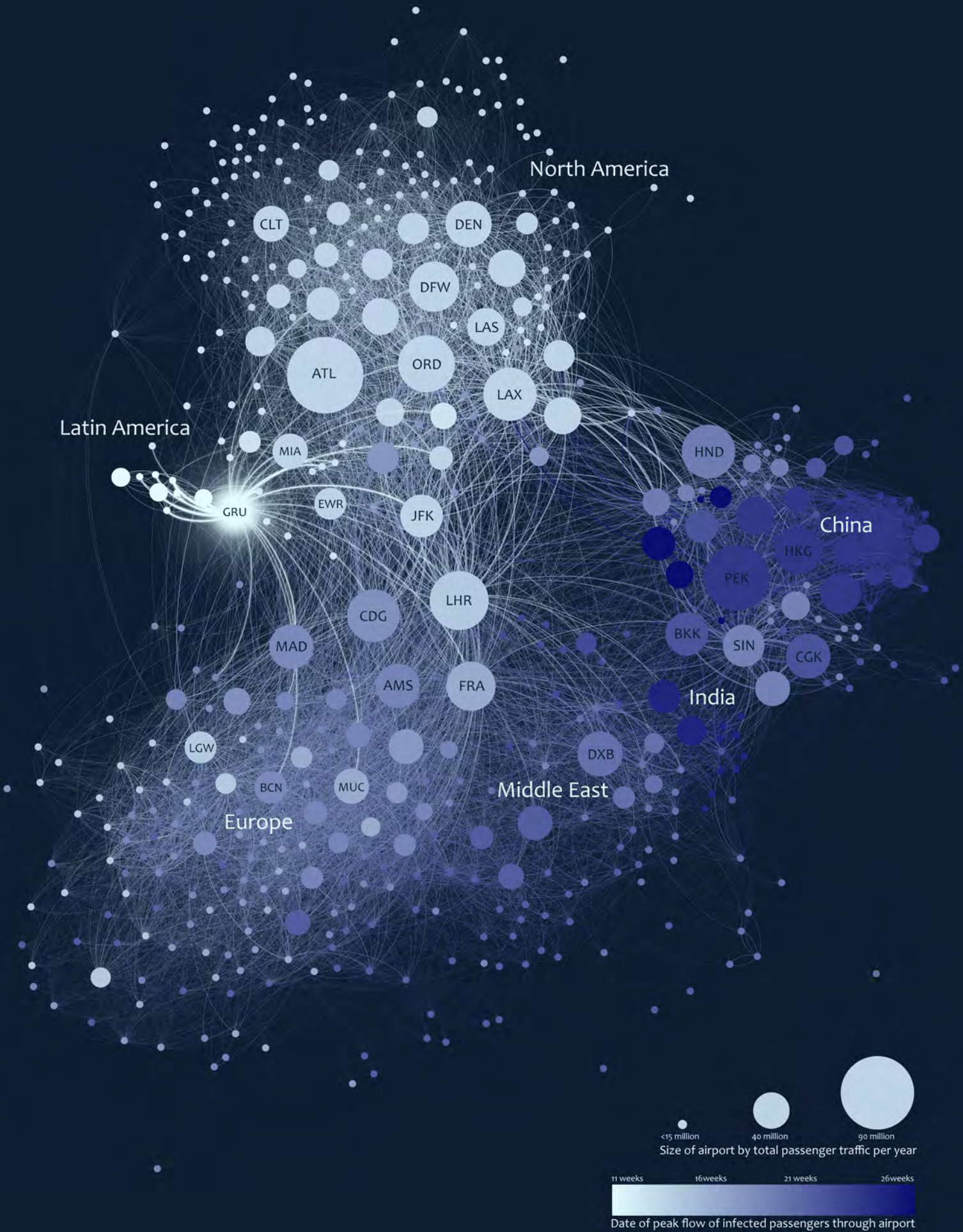


Last year's summit theme was *'Risk Culture: Challenging Individual Agency'*, and explored the meaning of risk culture and its contribution to governance and responsibility in organisations. In the wake of several public incidents of corporate misconduct, there has been a growing focus on risk culture management as a complementary approach to improving individual agency and accountability within both private companies and public bodies. It has now been proposed that the maintenance of good corporate behaviour and responsible attitudes in firms will ensure that its individual employees engage in higher ethical standards and appropriate levels of risk taking in the future.

Over two days, the Risk Summit aimed to shed light on the new debate over the need for risk culture management: what it is, how effective it can be and on what scale, and whether there is a need for its regulation.



Proceedings, speaker biographies, video interviews and photos of the event: <http://www.risk.jbs.cam.ac.uk/news/events/risksummits/risksummit2015.html>



“Conduit for Pandemic Spread”, Sao Paulo Virus Pandemic stress test spread through the global air traffic network; *created by Dr Andrew Skelton*

Current Team and Resources at the Centre for Risk Studies



Executive Team

Professor Daniel Ralph, Academic Director
Dr Michelle Tuveson, Executive Director
Dr Andrew Coburn, Director of Advisory Board
Simon Ruffle, Director of Research & Innovation

Research Team

Jennifer Copic, Research Assistant

Jennifer's research is on financial and organisational networks. She holds a BS in Chemical Engineering from the University of Louisville and a MS in Industrial and Operations Engineering from the University of Michigan.

Tamara Evan, Research Assistant and Editorial Associate

Tamara is the Editorial Associate for the Centre for Risk Studies and oversees the completion and final production of the Centre's research publications. She also assists in social sciences research as a Research Assistant, holding an MA from UCL in Historical Studies.

Dr Jay Chan Do Jung, Risk Researcher

Jay is interested in examining various aspects of risk elements in the network of financial services institutions and developing tools that can monitor and analyse behaviour of financial networks.

Dr Scott Kelly, Senior Risk Researcher

Dr Scott Kelly is a Research Principal at the Institute for Sustainable Futures (ISF) at the University of Technology Sydney (UTS). His research interests include sustainability economics, risk analysis and the economics of climate change. He is a research affiliate at the Cambridge Centre for Risk Studies and an associate of the Centre for Climate Change Mitigation Research. Prior to his role at ISF he was Senior Research Associate at the University of Cambridge and a Junior Research Fellow of Darwin College.

Éireann Leverett, Senior Risk Researcher

Éireann is managing cyber risk research projects at the Centre. He conducts research that focuses upon technological disasters and the economic impacts of computer security failures or accidents.

Arjun Mahalingam, Research Assistant

Arjun is a Research Assistant working on data research at the Centre for Risk Studies. His main focus is currently on Project Pandora; a project that aims to model all-ills under a unified framework. Arjun is a mechanical engineer by undergraduate education and has two postgraduate degrees. He has a MSc in Sustainable Energy Technology from TU Delft, specialising in modelling of complex adaptive systems, and also a MSc in Finance and Economics from the London School of Economics (LSE), specialising in monetary economics.

Dr Shahzeb Malik, Risk Associate

Dr Malik is currently working as a research associate in the cyber research track at the Centre for Risk Studies. Dr Malik holds a PhD in Information Systems from Manchester Business School, University of Manchester, and his research project was mainly based on identifying the technical and social issues with the use of customer relationship management (CRM) in the banking industry.

Dr Duncan Needham, Risk Researcher

Duncan works on financial history for the Centre. Duncan is also Director of the Centre for Financial History at the University of Cambridge and a Research Fellow at Darwin College, Cambridge.

Dr Edward Oughton, Senior Risk Researcher

Edward has expertise in modelling the economic effects associated with interdependent infrastructure networks and has completed a PhD at the University of Cambridge on developing long-term national infrastructure strategies for the UK. He leads the Risk Centre's research into the management of critical infrastructure failure.

Dr Ali Rais Shaghghi, Research Assistant

Ali focuses on analysing systemic risk and contagion in financial systems using computational network models. At the Centre, he is researching a model of contagion effects in the international banking network. Ali holds a PhD in Computational Finance from the Centre for Computational Finance and Economics Agents at the University of Essex. His research mainly focuses on analysing systemic risk and contagion in financial systems using computational network models.

Dr Andrew Skelton, Risk Associate

Andrew is helping to develop a dataset of the world's largest enterprises that drive the global economy and their relationships with each other. He has previously held a research post in the Centre for Climate Change Mitigation Research (4CMR) where he completed his PhD research on the influence that regions, industries, and enterprises have over greenhouse gas emissions stemming from their global supply chains.

Kayla Strong, Research Assistant

Kayla is a Research Assistant at the Centre for Risk Studies and supports research in multi-line insurance exposure and cyber risk. She holds a BES in Geography and Environmental Management from the University of Waterloo, and a MA in Risk from Durham University.

Jessica Tsang, Research Assistant

Jessica is a Research Assistant at the Centre for Risk Studies where she works on the risk modelling of multiple threat types to the global and city-level economy. Jessica joined the Centre following an MPhil in Planning, Growth and Regeneration from the University of Cambridge, focusing on housing policy and urban economics.

Advisors and Fellows

Lee Coppack, Senior Advisor, Insurance & Risk Media

Andrew Freeman, Risk Fellow

Matthew Grant, Senior Advisor, Insurance Markets

Administration

Soňa Krajciová, Centre Administrator

Ruth Newman, Web Editor

Cambridge Judge Business School, Finance, Legal and Administration Offices

Centre Alumni

Many members of our research team continue on to successful careers in academia and business.

Some of our recent alumni and their respective post-Centre positions include:

- **Dr Gary Bowman, CCRS Research Associate 2010 – 2013**
Assistant Professor of Global Strategy, Faculty of Business, Bond University, Australia
- **Dr Fabio Caccioli, CCRS Research Associate 2012-2014**
Lecturer, Financial Computing and Analytics, Faculty of Engineering Science, University College London
- **Dr Roxane Foulser-Piggott, CCRS Research Associate 2013 – 2014**
Model Application Specialist, Suncorp Group; Brisbane, Australia
- **Ganchi Zhang, CCRS Risk Researcher 2014-16**
Associate in Market Risk Capital Analysis at Goldman Sachs
- **Benjamin Leslie, CCRS Risk Researcher 2013-14**
R&D Engineer, Oxford Technical Solutions
- **Dr Grace Campbell, CCRS Risk Researcher 2015**
Geologist at Arup Group
- **Dr Kristen MacAskill, Risk Researcher, 2016**
Construction Engineering Masters Associate Course Director at the Department of Engineering, University of Cambridge
- **Dr Eugene Neduv, Risk Researcher, 2015-16**
VP Business Solutions, Financial Network Analytics, Ltd.
- **Jaclyn Zhiyi Yeo, Research Assistant, 2014-16**
Senior Risk Analyst at Marsh & McLennan Companies
- **Viktorija Kesaite, Research Assistant, 2015-16**
PhD Candidate in Economics at the University of Exeter
- **George Cooper, CCRS Risk Intern 2015**
Risk Analyst, Model Development & Evaluation, SCOR Global P&C
- **Siobhan Sweeney, Risk Fellow, 2014-16**
Founder and CEO of Cambridge Legal Risk Analytics

Executive Committee of the Cambridge Centre for Risk Studies

Professor Danny Ralph



Academic Director, Cambridge Centre for Risk Studies

Professor Danny Ralph is a Founder and Director of the Centre for Risk Studies, Professor of Operations Research at Cambridge Judge Business School, and a Fellow of Churchill College.

Danny received his PhD in 1990 from the University of Wisconsin Madison. He was a faculty member of the Mathematics & Statistics Department at the University of Melbourne before coming to Cambridge University for a joint appointment in the Engineering Department and Cambridge Judge Business School.

Danny's research interests include: risk in business decision making; risk aversion in electricity markets; methods and models for optimisation problems and equilibrium systems. Specific projects undertaken in collaboration with the banking and insurance industry (Catlin, HSBC, ICBC, Lloyd's, Munich Re, Risk Management Solutions, Swiss Re) cover emerging risk scenarios, financial stress testing and a global ranking of cities by risk exposure. Engagements with other sectors include electricity consultancies (Artelys, LCP), oil and gas (Shell Exploration, Statoil) and retail (BT Retail, Gap) on decision making under high uncertainty. Public service contributions to the UK Cabinet Office, UK Industry and Parliamentary Trust, UK Office of the Government Chief Scientific Advisor, and United Nations World Humanitarian Summit.

Professor Ralph is a member of the Australian Mathematical Society, INFORMS, the Mathematical Optimization Society and SIAM. He was Editor-in-Chief of Mathematical Programming (Series B) from 2007-2013 and has served on the editorial boards of Mathematics of Operations Research and the SIAM Journal on Optimization, as well as the SIAM-MPS book series on optimisation.

Dr Michelle Tuveson



Executive Director, Cambridge Centre for Risk Studies

Dr Michelle Tuveson is a Founder and Executive Director at the Cambridge Centre for Risk Studies hosted at the University of Cambridge Judge Business School. Her responsibilities include the overall executive leadership at the Centre. This includes developing partnership relationships with corporations, governments, and other academic centres. Dr Tuveson leads the Cambridge CRO Council and she chairs the organising committee for the Cambridge Risk Centre's Annual Risk Summits. She is one of the lead organisers of the Aspen Crisis and Risk Forum. She is an advisor to the World Economic Forum's 2015 & 2016 Global Risk Report and a contributor to the Financial Times Special Report on Risk Management. She is also an advisor to a number of corporations and boards as well as a frequent conference speaker.

Dr Tuveson has worked in corporations within the technology sector with her most recent position in the Emerging Markets Group at Lockheed Martin. Prior to that, she held positions with management strategy firm Booz Allen & Hamilton, and U.S. R&D organisation MITRE Corporation. Dr Tuveson's academic research focusses on the application of simulation models to study risk governance structures associated with the role of the Chief Risk Officer. She was awarded by the Career Communications Group, Inc. as a Technology Star for Women in Science, Technology, Engineering and Maths (STEM). She earned her B.S. in Engineering from the Massachusetts Institute of Technology, M.S. in Applied Math from Johns Hopkins University, and PhD in Engineering from Christ College, University of Cambridge.

Executive Committee of the Cambridge Centre for Risk Studies

Dr Andrew Coburn



Director of the Advisory Board, Cambridge Centre for Risk Studies

Dr Andrew Coburn is the Director of the Advisory Board at the Cambridge Centre for Risk Studies. Andrew is Senior Vice President at Risk Management Solutions (RMS), the leading provider of catastrophe risk models to the insurance industry. Andrew is the principal coordinator of the research programme on the risk of catastrophic collapse of complex systems at the Centre and leads the financial catastrophe research.

Andrew is one of the leading contributors to the creation of the class of catastrophe models that over the past 20 years has come to be an accepted part both of business management in financial services and of public policy making for societal risk. He has extensive experience in developing risk models and using them for business decision support. Andrew has also provided research inputs into government policy, such as membership of the UK government Blackett Review Panel on strategic shock convened by Sir John Beddington, and U.S. House of Congress legislation on terrorism risk management policy. Andrew is an Editorial Board Member of *Journal of Network Theory in Finance* (publishers Risk.net). He is a Bye-Fellow at Christ's College, Cambridge.

Simon Ruffle

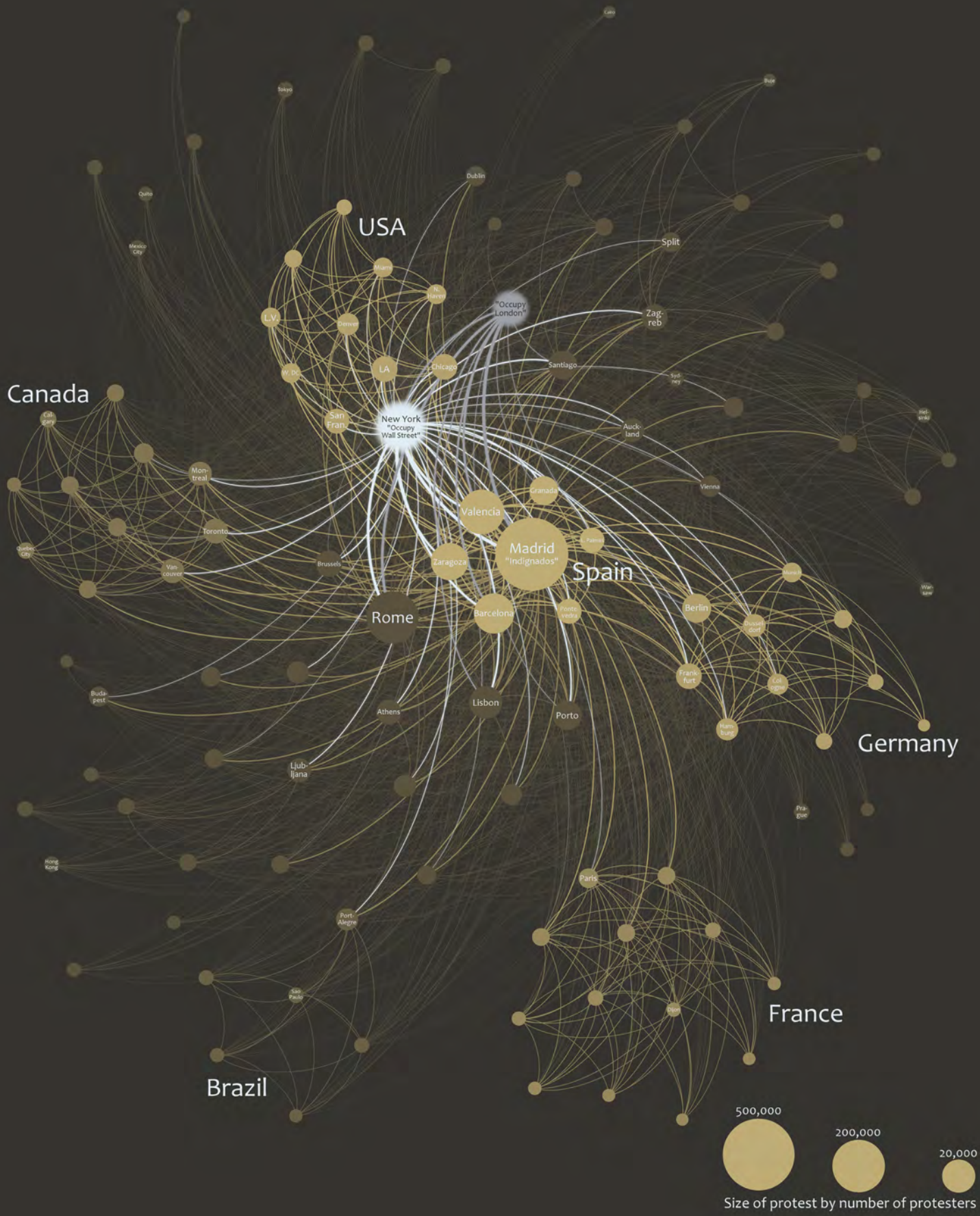


Director of Research & Innovation, Cambridge Centre for Risk Studies

Simon Ruffle is researching a common framework for analysing complex global systemic risk. He coordinates research in the Centre through a unified modelling software platform, a common database architecture and information interchange standards. He is developing methods for storing and applying the Centre's Stress Test Scenarios and other Risk Assessment Tools to macro-economic analysis and investment portfolio impact. He is researching how network theory can be applied to understanding the impact of catastrophes in a globalized world, including supply chains, insurance and banking.

He is involved in specific threat topics, and currently is leading the Centre's cyber threat research track. He is a member of the Centre's Executive Team and manages several external sponsor relationships

Originally studying architecture at Cambridge, Simon has spent most of his career in industry, developing software for natural hazards risk. He has worked on risk pricing for primary insurers, catastrophe modelling for reinsurers, and has been involved in placing catastrophe bonds in the capital markets. He has many years of experience in software development, relational databases and geospatial analysis and has worked in a variety of organisations from start-ups to multinationals.



"Systemic Social Unrest", Geographical spread of the "Occupy" movement's hashtags between September-October 2011 coordinating simultaneous protests in 950 cities across the world; *created by Dr Andrew Skelton*

Centre for Risk Studies Advisory Board



The Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School continues to be widely recognised as one of the UK's leading academic centres providing impactful research and thought leadership in risk management.

The Cambridge Centre for Risk Studies is very grateful to have the participation and support from the members of the Centre's Advisory Board. We view the Advisory Board as being critical to guiding the management strategy and research agenda objectives of the Centre. Advisors are invited from the Centre's partnership organisations, external academics, and subject matter specialists. The Centre's recent research and associated reports have gained visibility and positive media attention through the advocacy of our advisory board members and their respective organisations.

Cambridge Centre for Risk Studies Advisory Board Members

Russell Bean, Head of Financial Institutions Underwriting, Talbot Underwriting

Steve Coates, Chief Underwriting Officer, Pool Re

Dr Siddhartha Dalal, Chief Data Scientist and Sr. VP of Advanced Research and Technology, Science, AIG

Rowan Douglas CBE, CEO Capital, Science and Policy Practice, Willis Towers Watson and Willis Research Network

Anna-Marie Greenaway, Director of University Relations, BP

Dr Sven Heiligtag, Principal, McKinsey & Company

Dr Mike Maran, Chief Science Officer, XL Catlin

Dr Trevor Maynard, Head of Exposure Management and Reinsurance, Lloyd's

Dr Mohsen Rahnama, Head of Model Development, Risk Management Solutions, Ltd.

Dr Rainer Sachs, Head of Group Accumulation and Emerging Risks, Munich Re

Alan Smith, Global Head of Risk Strategy and Chief of Staff, HSBC Holdings PLC

Matthew Swibel, Director, Corporate Sustainability, Lockheed Martin

Academic Advisors

Dr Stylianos (Stelios) Kavadias, Director of Research and Margaret Thatcher Professor of Enterprise Studies in Innovation & Growth, Cambridge Judge Business School

Professor Frank Kelly, Professor of the Mathematics of Systems, Statistical Laboratory, University of Cambridge

Professor John Rees, Risk Research Coordinator, UK Research Councils (RCUK)

Advisory Board Member Biographies

Russell Bean



Head of Financial Institutions Underwriting, Talbot Underwriting

Russell started his career at the Sun Alliance and between 1994 and 2002 he underwrote Professional and Financial Lines before becoming the worldwide FI product leader. He is currently the Head of Financial Institutions at the Talbot Syndicate where he oversees all aspects of the division. He is ACII qualified and sits on a number of market committees, including chairing the LMA FI panel.

Steve Coates



Chief Underwriting Officer, Pool Re

Steve is Chief Underwriting Officer and a member of the Executive management team at Pool Re. Steve has responsibility for all aspects of underwriting and claims, including expo-sure management and modelling. Prior to this, Steve spent 12 years at Allianz UK, latterly as Head of UK Property and Casualty. He also spent a year with Allianz Australia in 2005/6. Before that he worked for Independent Insurance for 10 years, ending up as UK property underwriting manager. Steve started his career with Eagle Star where he worked in a variety of commercial underwriting roles. Steve is an associate of the Chartered Insurance Institute and is also an expert witness in insurance matters.

Dr Siddhartha Dalal



Chief Data Scientist and Sr. VP of Advanced Research and Technology, Science, AIG Property Casual

Sid Dalal joined the Science Team in September of 2013. He comes to AIG from RAND Corporation where he served as CTO, and where he pioneered several new systems for conducting research. Sid also served as VP of Research at Xerox overseeing their worldwide imaging and software services research, and Bell Laboratories and Bellcore/SAIC/Telcordia Technologies, where he served as Chief Scientist and Executive Director. Sid received an MBA and a Ph.D. from the University of Rochester and has published more than 100 peer reviewed publications, patents and monographs covering the areas of risk analysis, medical informatics Bayesian statistics and economics, image processing and sensor networks. He was also responsible for the creation of technology and spinning off of Praedicat, Inc., an insurance analytics company in casualty space, from RAND Corporation. Sid is also a member of US Army Science Board, an advisory board of 20 scientists appointed by Secretary of Defense to advise US Army on technology. Sid has received several awards including from IEEE, ASA and ASQ.

Advisory Board Member Biographies

Rowan Douglas CBE



CEO Capital, Science and Policy Practice, Willis Towers Watson and Willis Research Network

Rowan Douglas is CEO Capital, Science & Policy Practice at Willis Towers Watson, a leading global advisory, broking and solutions company. Previously, he served on the Board of the Group's reinsurance division, Willis Re, as CEO Global Analytics.

In 2011, Rowan was appointed to the UK Prime Minister's Council for Science & Technology; he is also a member of the Royal Society's Working Group on Resilience to Climate Risk and Extreme Weather and chairs the Willis Research Network of fifty universities world-wide.

He has held various appointments within the UN and other international organisations and was awarded a CBE in the 2016 New Year's honours for services to the economy through risk, insurance and sustainable growth. Rowan sits on the Executive Committee of the International Insurance Society (IIS), New York from which he received the Kenneth R Black Award in 2014.

Anna-Marie Greenaway



Director of University Relations, BP

Anna-Marie Greenaway was appointed BP Director of University Relationships in 2015, which is a global role encompassing technical and policy research to support BP's strategic objectives, recruitment, executive education and international research partnerships. Prior to this she was BP's VP Science and Technology at the University of Cambridge and still retains accountability for this strategic partnership. She is a member of the Board of the BP Institute and sits on the Advisory Board of the Scott Polar Institute and the Clean Energy Centre at Tsinghua University, Beijing. Previously, Anna-Marie spent four years in BP's Group Strategy team where she led the 2030 Energy Pathways research programme covering the US, EU, China, India and Brazil. This involved bringing together local, international and multi-disciplinary teams from across BP and incorporating external perspectives from wider industry sectors, government bodies and leading academics.

Earlier roles at BP have spanned special assignments to support Group Technology and Safety & Operations, Head of Downstream Change Leadership Capability and leading the Technical & Commercial Partnership between BMW & Castrol across Western Europe. Prior to BP, Anna-Marie spent 10 years in retail operations, advertising and corporate communications with Exxon after joining their graduate programme in 1989 as a capital investment analyst. She holds a BRc from the Dept of Earth Science RHBNC University of London and a Masters degree in Sustainability Leadership from the Department of Engineering, University of Cambridge.

Dr Sven Heiligtag



Principal, McKinsey & Company

Sven is a Partner in McKinsey & Company's Hamburg office. Sven is a leader in McKinsey's Risk Management Practice as well as in the Electric Power & Natural Gas Practice. He is responsible for all Corporate Risk topics and is leading our energy trading and risk management survey in Europe.

He has deep experience in advising clients in the energy and natural resources industries on challenges in risk management, corporate finance, strategy and organization.

Sven has a master's degree and a PhD in Chemistry from the University of Hamburg.

Advisory Board Member Biographies

Dr Mike Maran



Chief Science Officer, XL Catlin

Michael Maran graduated from St. Catharine's College, Cambridge in 1983 with a bachelor's degree in Natural Sciences (having studied the biological and geological sciences) and subsequently a master's degree and PhD in Astrophysics from Queen Mary College, University of London. He is an ACII qualified Chartered Insurer with over 30 years of experience in the insurance industry, and a Fellow of the Royal Astronomical Society.

Mike joined the Catlin Group in 2002 and spent 10 years as Underwriter for the Space account. In 2012, he was appointed as the Catlin Group's Chief Science Officer, a position which he now holds in the newly formed XL Catlin Insurance.

Formerly the chairman of the Catlin's Emerging Risks Committee, Mike is now an active member of the XL Catlin Emerging Risks Task Force.

As Chief Science Officer, Mike works with XL Catlin underwriters, risk modellers, actuaries and other employees to improve risk assessment capabilities by reviewing the scientific aspects of risks. He also helps to identify new underwriting opportunities for XL Catlin created by scientific progress, and serves as an advisor for various XL Catlin activities that are related to science, such as the current XL Catlin Seaview Survey.

Dr Trevor Maynard



Head of Exposure Management and Reinsurance, Lloyd's

Trevor Maynard was appointed Head of Exposure Management and Reinsurance at Lloyd's in 2011. Prior to this, he was Manager of Emerging Risks and an Actuary at Lloyd's. He was educated at the University of Warwick and received a doctorate in Statistics from the London School of Economics in 2016.

Dr Mohsen Rahnama



Head of Model Development, Risk Management Solutions, Inc.

Mohsen leads model development for RMS, which includes a global team of scientists and engineers responsible for the creation of RMS' catastrophe models, financial model, and exposure and data analytics.

Since joining RMS in 1999, Mohsen has led the development of many of RMS' major models. He is currently overseeing the development of RMS' high-definition, simulation-based flood, earthquake, and typhoon models for RMS(one), Cyber Model, exposure and data analytics and financial modelling. He has more than 25 years of experience in earthquake engineering, seismic structural analysis and de-sign, building performance evaluation, catastrophe modelling, and risk assessment. He holds a master's degree and doctorate in earthquake and structural engineering from Stanford University.

Advisory Board Member Biographies

Dr Rainer Sachs



Head of Group Accumulation and Emerging Risks, Munich Re

Dr Rainer Sachs heads the Group Accumulation and Emerging Risks team at Munich Re's Integrated Risk Management division, developing risk identification and quantification tools for Munich Re's global business operations. Before joining Munich Re, Rainer Sachs was working in the Credit Risk Management division at Unicredit. During his more than 10-year career in risk management, he has held various positions in financial and insurance risk management, both in Germany and Australia. Rainer Sachs's current research interests focus on modelling complex risks in insurance and the human factor in decisions under uncertainty. He holds a PhD from the University of Munich/Max-Planck-Institute for extraterrestrial Physics and a Master in cosmology from the Technical University of Munich/University of Pune (India).

Alan Smith



Global Head of Risk Strategy and Chief of Staff, HSBC Holdings PLC

Alan Smith is Global Head of Risk Strategy and Senior Executive Officer of Group Risk within the Global Risk function of HSBC Holdings, one of the world's largest financial services organisations. He is a member of HSBC's Global Risk Management Board, which oversees the 25,000 member Global Risk Function and of the Group Asset and Liability Management Committee. He co-chairs its Stress Testing, Model Risk and Pensions Risk Oversight Committees.

Alan has worked with HSBC for 21 years in a variety of senior finance, risk and capital management roles in the Group Head Office, in its Global Banking and Markets Business, in London and in Saudi Arabia. Prior to HSBC, Alan worked with KPMG London from 1987 to 1994. Alan is a Fellow of the Institute of Chartered Accountants of England and Wales and has an MBA in Finance from Cass Business School, City University in London which he attended as a UK Commonwealth Scholarship winner after completing his undergraduate degree at the University of the West Indies in Jamaica.

Outside of work, Alan has a keen interest in cricket, theatre and travel, amongst others. He sits on the Audit Committee of the Commonwealth Secretariat, on the Finance Committee of an international faith based organisation working with university students, and on the Advisory Board of the Centre for Risk Studies at Cambridge University's Judge Business School. He is a Fellow of the Royal Society of Arts, Manufactures and Commerce.

Matthew Swibel



Director, Corporate Sustainability, Lockheed Martin

Matt directs sustainability strategy, reporting and stakeholder engagement at Lockheed Martin Corporation, which under his tenure was added to the Dow Jones Sustainability Index and became the top-ranked Aerospace & Defense prime contractor named to CR Magazine's 100 Best Corporate Citizens list. He led Lockheed Martin's inaugural report in 2012, and its first core issues assessment, formal stakeholder summits and GRI-based report in 2013. He reports to the corporate vice president - Ethics & Sustainability, and sits on the Corporate Sustainability Council, which oversees ethics & business conduct, diversity & inclusion, and sustainability policy & performance.

From 2008 to 2012, Matt was Director of Enterprise Communications, where he led a team supporting the CFO, Executive Office of the Chairman and other corporate officers. In this role, he developed and planned multiple aspects of integrated communications including employee and supplier engagement, advertising and outreach to investors and financial/environmental media.

Advisory Board Member Biographies

Matt spent almost a decade as a journalist, most recently as Associate Editor of Forbes, where he co-edited the World Billionaires issue and was recognised by the Overseas Press Club for his business reporting from abroad. Prior to Forbes, he was a staff reporter at Washington Business Journal, where his coverage of marketing and web-based political fundraising each earned Maryland-DC-Delaware and Virginia Press Association awards. He taught as an adjunct professional lecturer at American University's School of Communication from 2005 to 2008. Matt graduated *cum laude* from American University (DC) with degrees in Communications and Sociology and earned an MBA from the University of Maryland. He is an independent director of Cornerstone Capital.

Academic Advisors

Stylianos (Stelios) Kavadias



Margaret Thatcher Professor of Enterprise Studies in Innovation & Growth. Director of the Entrepreneurship Centre and Director of Research, University of Cambridge Judge Business School

Professor Stylianos (Stelios) Kavadias is both Director of Research and Director of the Entrepreneurship Centre at Cambridge Judge Business School. He serves as an Associate Editor for Management Science's Entrepreneurship and Innovation department, and as the Department Editor for the R&D, New Product Development and Project Management department of Production and Operations Management. At Georgia Tech's Huang Executive Education Center he regularly contributed to open enrolment and custom executive programmes on innovation and project management, and was the Academic Director of their GE Energy PLMP programme. He has authored several case studies through close collaboration with major firms across multiple industries.

Professor Frank Kelly



Professor of the Mathematics of Systems, Statistical Laboratory, University of Cambridge

Frank Kelly was elected a Research Fellow of Christ's College in 1976, and served as Director of Studies in Mathematics and as a Tutor. In 2006 he was elected the 37th Master of the College, a role from which he stepped down in August 2016.

His main research interests are in random processes, networks and optimization. He works on the mathematics of very large-scale systems, such as telecommunication or transport networks. Particular interests have been dynamic routing and resource allocation in communication networks, including the Internet. He is Professor of the Mathematics of Systems in the University.

He spent the academic year 2001-2002 as a Visiting Professor at Stanford University in the USA. From 2003 to 2006 he served as Chief Scientific Adviser to the UK Government's Department for Transport. He was chair of the Council for the Mathematical Sciences from 2010 to 2013, and a member of the RAND Europe Council of Advisors from 2008 to 2015.

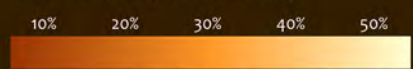
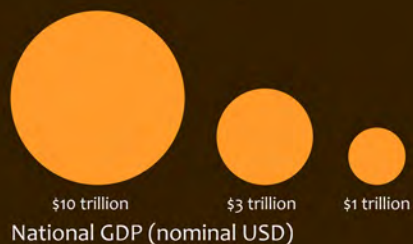
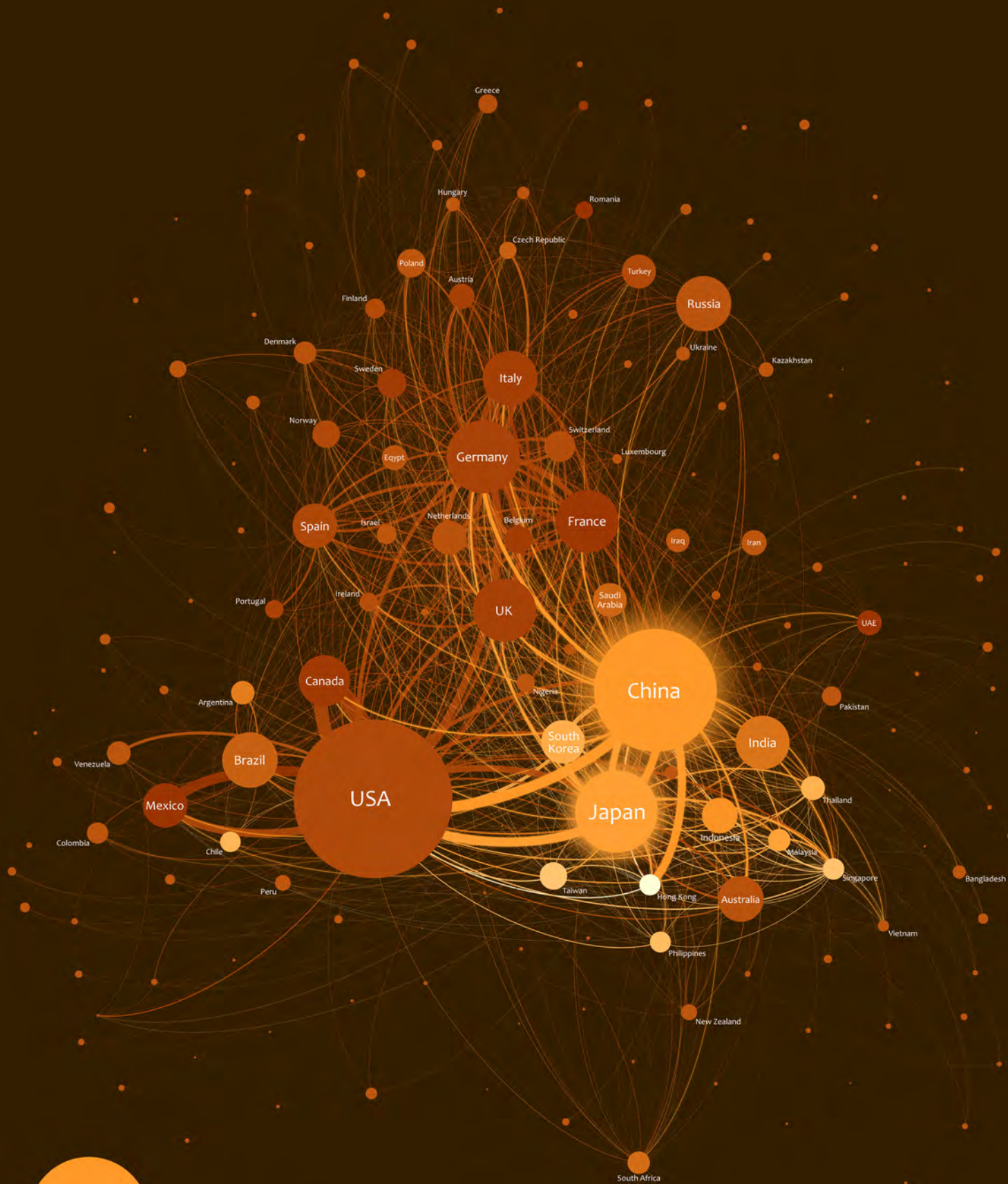
Frank Kelly was elected a Fellow of the Royal Society in 1989, a Foreign Member of the (US) National Academy of Engineering in 2012, and he was awarded a CBE in the 2013 New Year's Honours List for services to mathematical sciences.

Professor John Rees



Head of Risk and Resilience Research, Natural Environment Research Council (NERC)

Professor John Rees heads Risk and Resilience research at the Natural Environment Research Council (NERC). Previously he was Risk Research Champion at the UK Research Councils - during which time he co-led the UN Science and Technology Group, leading to the Sendai Framework - following a period as the Natural Hazards Theme leader at NERC. He is based at the British Geological Survey (BGS) where he is Director of Earth Hazards and Observations. Before this he was Head of Corporate Policy and Science Coordination - after 15 years primarily researching urban and coastal hazards. His interests, though, are extremely broad ranging across much of science and technology. He has a major interest in enhancing the use of science, particularly in policy development and is an advocate of modelling interoperability. He has collaborated extensively across sectors, disciplines and internationally. He was educated in Sussex, at Sheffield University and at Trinity College Dublin.



Economic impact of geopolitical conflict scenario: Reduction in national GDP

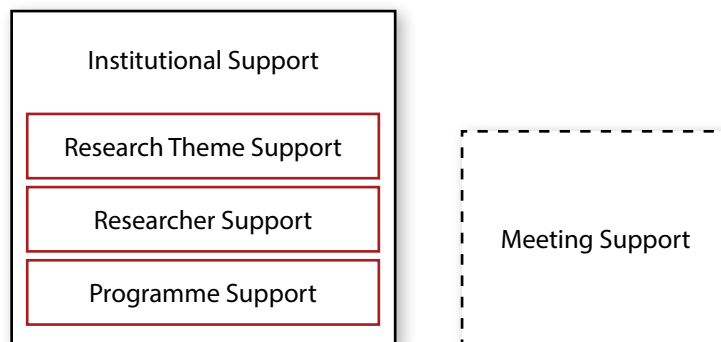
“Systematic Impact of War”; impact of Sino-Japanese War stress test on global imports and exports networks; *created by Dr Andrew Skelton*

Funding Opportunities and Support Contribution Structure

Confidential

The Cambridge Centre for Risk Studies is grateful for the financial support from its contributing funders as well as the University of Cambridge Judge Business School. The Centre is privileged to be part of the Cambridge Judge Business School infrastructure. The Centre is also grateful to the many individuals and institutions who provide in-kind support.

The Centre for Risk Studies works with external supporters of our research through funding donations that guide components of an overall programme of work towards understanding the risks faced by international businesses. External supporters can participate at different levels according to their interests and degree of involvement they are willing to engage in, and level of support that they are willing to provide. This document is an indicative guide



Institutional Support

The Centre is actively seeking institutional funding – a single company or individual interested in having a named centre or professorial chair and prepared to make an endowment to support the longer term sustainability of the research work at the Centre for Risk Studies. We would welcome the opportunity to discuss this if this might be of interest.

Research Theme Support

Within the overall research directions of the Centre for Risk Studies, there are several themes of focus, Research themes involve a multi-member research team exploring an issue within the Cambridge Risk Framework. Where a funder has interest in driving a particular research agenda or exploring a specific theme within our risk framework, the Centre for Risk Studies can accommodate this by dedicating a research team to that topic. A research team typically consists of a Project Investigator (a tenured academic project lead) supported by a Senior Research Associate, a Research Associate, and others where appropriate. Other senior academics are likely to participate on a part time basis in contributing subject matter expertise. The Centre for Risk Studies can facilitate and coordinate research themes involving a range of University departments, such as the Faculty of Economics, Centre of Applied Mathematics, Computer Laboratory, etc. If appropriate, the research theme can be based in a specific department, and managed by CRS.

As a Research Theme Supporter:

- Funder is invited to nominate two members of the Centre for Risk Studies Advisory Board
- Funder oversees progress review meetings specifically held for that research theme, and guide the prioritization of the current and future research agenda.
- Funder is invited to participate in the progress review meetings of the overall research activities of the Centre, and to assist with the prioritization of the current and future research agenda of the Centre for Risk Studies.
- Funder benefits from having the research team participate with company staff, disseminate current research understanding, and involve the broader company membership in emerging risk issues.
- The Project Investigator and the research team discuss the Funder's priorities with the funder's senior managers and ensure that these objectives are fully reflected in the research.

Researcher Support

Our typical level of engagement from supporting companies on our advisory board is a donation to fund an individual researcher who is added to the research team in order to progress the overall objectives of the System Shock, and who focuses on the areas of most benefit for that funder. Our ability to attract good post-doctoral research associate candidates is greatly increased by being able to offer three year contracts, so our strong preference is to secure multi-year commitments by funders where possible.

- Funder is invited to nominate a member of the Centre for Risk Studies Advisory Board, to attend the progress review meetings and to assist with the prioritization of the current and future research agenda.
- Funder benefits from having the researcher visit the company, disseminate current research understanding, and involve the broader company membership in risk issues.
- The researcher will discuss the Funder's priorities with the funder's senior managers and ensure that this is reflected in the research activities of the researcher and the broader team.

Programme support

Our ongoing research programme entails maintaining a team of technical specialists, editorial contributors and subject matter experts, and administrative support staff. Programme support provides resources for core research projects.

As a Programme Supporter:

- Funder is invited to nominate a member of the Centre for Risk Studies Advisory Board, to attend the progress review meetings and to assist with the prioritization of the current and future research agenda.
- Funder has access to the various subject matter specialists involved in the system shock project and access to information on technologies deployed, such as RSS data feeds and specifications that might be of interest.

Meeting support

The Centre for Risk Studies seeks supporters for its annual Risk Summit conference. We attract over 200 attendees from corporate risk management professionals, academia, and government policy-makers. We offer packages of support including Meeting Partner status, Principle Knowledge Partner or Sustaining Meeting Partner status.

As a Meeting Supporter:

- Funder is recognized as a corporate sponsor, with co-branding on the annual conference collateral with other meeting supporters
- Funder will be part of the organizing committee of the annual conference, and asked to propose speakers and content.
- We can offer space for display materials and incorporation of corporate materials in the attendee handout packs
- Other meetings can also be arranged with co-branding, for a private seminar on a relevant theme for funder and its guest invitees, on terms to be arranged.

Contact information for all support enquiries

Michelle Tuveson, M.S., Ph.D
Executive Director, Cambridge Centre for Risk Studies
University of Cambridge Judge Business School
Trumpington Street, Cambridge, CB2 1AG, UK
PA Tel in UK: +44 1223 766330
m.tuveson@jbs.cam.ac.uk

Cambridge Centre for Risk Studies

Cambridge Judge Business School
University of Cambridge
Trumpington Street
Cambridge
CB2 1AG

T: +44 (0) 1223 766330

F: +44 (0) 1223 339701

enquiries.risk@jbs.cam.ac.uk

www.risk.jbs.cam.ac.uk

Join our LinkedIn group at Cambridge
Centre for Risk Studies

Follow us @Risk_Cambridge