University of Cambridge Judge Business School

Cambridge Centre for Risk Studies

RESEARCH AND ACTIVITIES PROSPECTUS 2019

Centre for **Risk Studies**

UNIVERSITY OF CAMBRIDGE
Judge Business School

RISK 10

Research Supporters of the Centre for Risk Studies at the University of Cambridge Judge Business School

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Foreword

The Cambridge Centre for Risk Studies celebrates ten years of accomplishments and enters its second decade with a promising research agenda, a strong community of business supporters, and increasing recognition for the thought leadership that we provide.

Since the Centre was formed in 2009 in the wake of the great financial crisis, we have seen ten years of radical change in the field of risk management. We are proud of our role in identifying the full range of risks that the global economy is subject to. We can identify positive contributions that our research outputs have made to the improved understanding of a number of poorly-understood emerging risks, including cyber risk, geopolitical threats, and financial crises. We have championed the use of evidence-based science to benchmark risks of widely different characteristics using consistent metrics, epitomised by our Cambridge Global Risk Index whose 2019 publication marked the fifth year of consistently monitoring a changing risk landscape.

As the Centre faces its next ten years, we inevitably contemplate what further changes we are likely to see and how we can best play an effective role in catalysing improvements in risk management practices. We propose to be explicit in our conferences, research, and publications this year about the next ten years – risk outlooks, potential changes to the threat landscape, and possible new thinking in risk management practices – that could materialise by the end of our second decade.

Businesses are facing a risk management revolution to analyse, declare, and manage the risks to their balance sheets. They need tools and frameworks to achieve it. They are increasingly required by regulators and shareholders to be more explicit about the risks that they face. Companies are now required to publish their risk registers and be more explicit about the procedures they follow for identifying and managing their emerging risks. These are welcome developments but there is no consensus on how best to do this. The Cambridge Centre for Risk Studies intends to be at the forefront of the conversations, consultations and methodology developments that will lead to business resilience.

The risks of the next decade will represent a wide range of business conditions and internal and external operational challenges for organisations. How can a business identify all the wide range of threats to its own activities and profitability? Can these threats be articulated as scenarios and evaluated for their impact on a business? Is it possible to assess the likelihood of occurrence of these different outcomes with any confidence? How can you systematically spot and evaluate new emerging risks on the landscape? Most importantly, if businesses were equipped with these insights and analytics, could they run their operations more resiliently and (billion-dollar-question) be rewarded for it by their shareholders?

If the past ten years has positioned us as one of the leading risk research institutions in one of the world's leading business schools, then we hope we can leverage that position to address some of these questions with our prospective research agenda.

This prospectus describes our ongoing research programme and its objectives for the next several years. We welcome inputs and partners in this process.

We thank our supporting organisations for their ongoing inputs and guidance, for sharing our vision and engaging with us on the problems they face. Our triple mission of engagement, risk research and academic output could not be sustained without you.

Professor Danny Ralph, Academic Director

Dr Michelle Tuveson, Executive Director

Simon Ruffle, Director of Research and Innovation

Dr Andrew Coburn, Chief Scientist

Strategy of the Centre for Risk Studies

The mission of the 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 Systemic and Complex Risks

The Centre for Risk Studies originated from a fusion of specialised research interests into both complex systems and catastrophe risk analysis. Being located in the Judge Business School at the University of Cambridge 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 systemic and complex risks – i.e. processes where loss occurs through the disruption of business, infrastructure and social systems and cascades through interrelated networks in complex and non-intuitive ways. This poses a wide range of analytical and methodological challenges for the risk management community to tackle. 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. These different stakeholders form the community served by the Centre for Risk Studies.

Demonstrating Impact through Engagement

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, ensures that our research is relevant and has real impact.

The Centre leads 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 Programme

A full research programme is being pursued, with a multidisciplinary 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.

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 Centre contributes to the educational priorities of the Judge Business School and engagement with the students through its MBA elective in Risk Management and the award of the annual Cambridge-McKinsey Risk Prize. The current research programme is intended to produce high quality management science publications as well as contribute to the MBA/MPhil teaching curriculum and the school's Research Excellence Framework Assessments.

Risk Research at the Centre for Risk Studies

The Centre continues to produce world leading research on understanding and managing systemic risk. This includes scenario development, network analysis techniques, and macroeconomic modelling of shock events.

The Cambridge Risk Framework

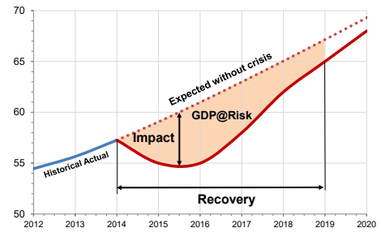
The Cambridge Risk Framework is a foundational element of the research programme of the Centre for Risk Studies. It provides an extensive set of objectively-defined scenarios of potential external shocks that could arise from a wide range of causes of risk to businesses and economic output across the world. The macro risks and threat types include financial crises, geopolitical risks, environmental challenges, technology risks, social sustainability and governance threats, along with other issues that constitute emerging systemic risks. The research focusses on business applications of management science to reduce risk and improve resilience.

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 is the standardisation of scenario selection (e.g. 1% annual probability of exceedance as a '1-in-100' event) for emerging risks. An innovative methodology has been developed to assess the different facets of scenario impact, ranging from direct loss, to macroeconomic consequences, to investment portfolio effects. This involves developing techniques of network analysis, including gathering and visualising data on the interconnectivity of the global economy.

GDP@Risk: A 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. A key research output is a metric – 'GDP@Risk' indicating 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

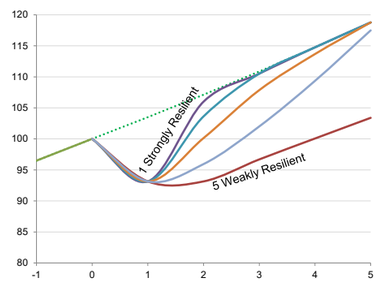


GDP@Risk - measuring economic output loss

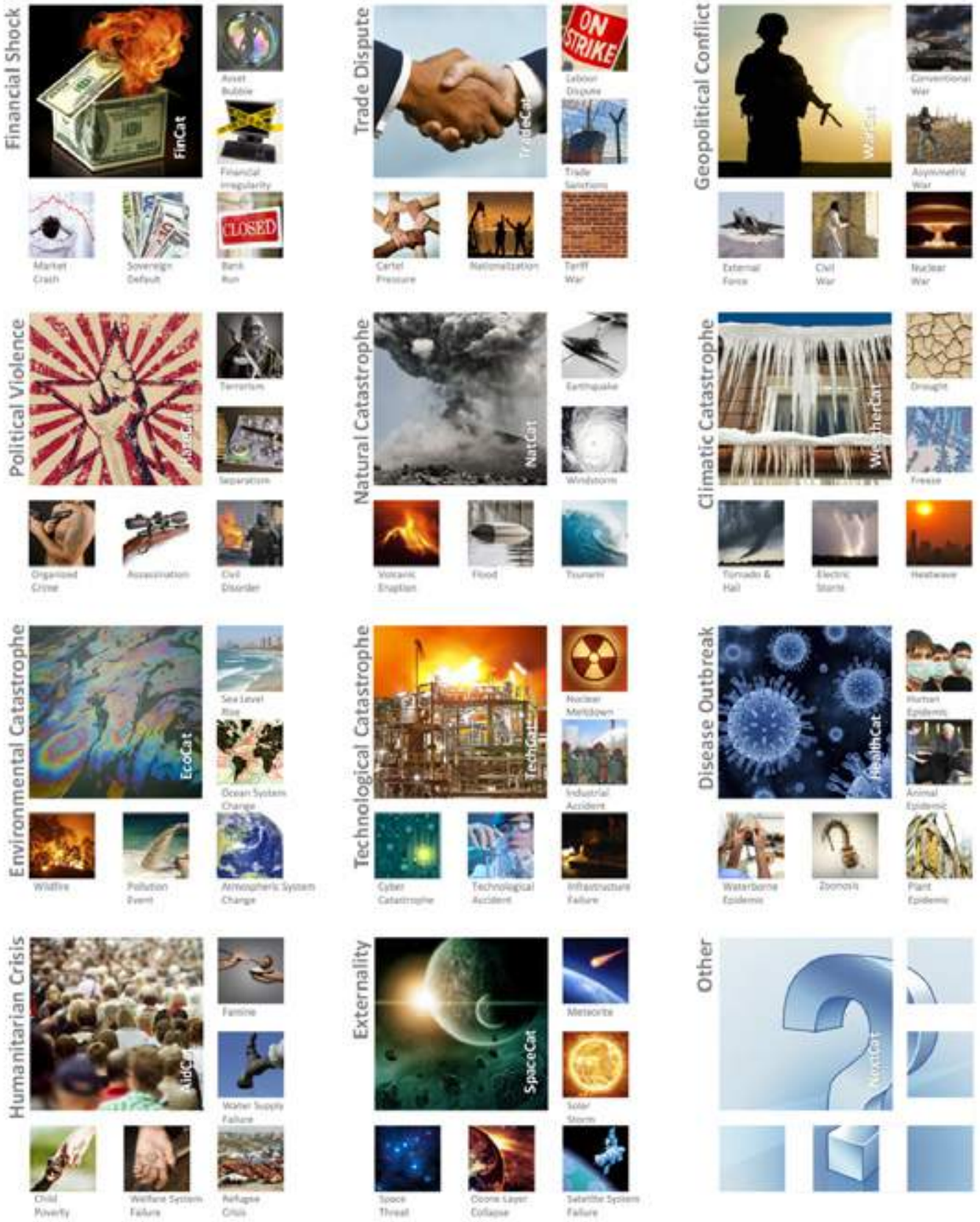
Catastronomics: the Economics of Catastrophe

Assessing the macroeconomic impact of catastrophes involves understanding how shocks cause output loss, how different types of threats influence specific macroeconomic variables, and how these flow through the economic system, as well as 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 to various catastrophe classes. Modelling the economic impact of catastrophes is a key area of focus for this research.



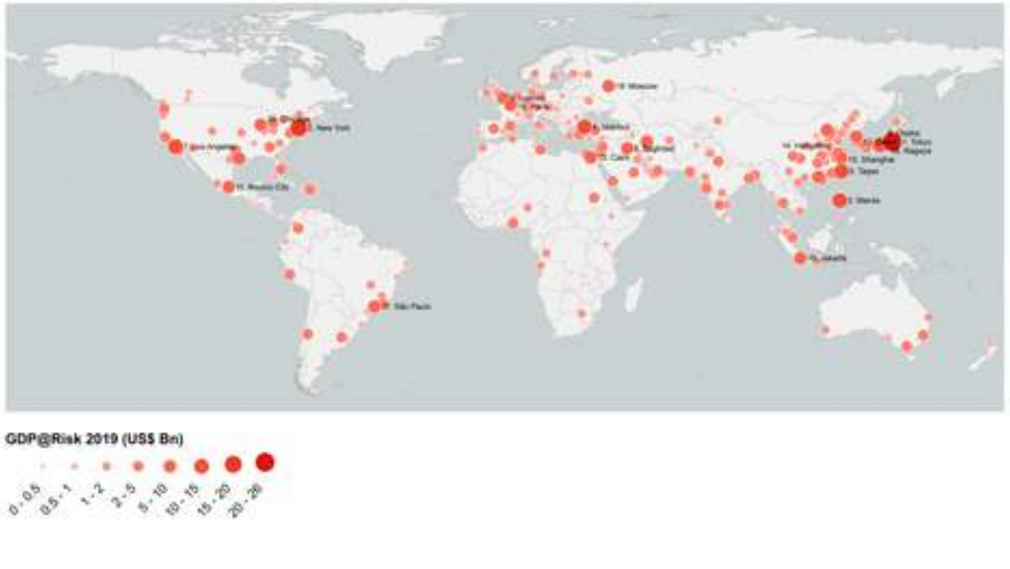
'Catastronomics': resilience of an economy determines recovery speed and affects total GDP@Risk



Cambridge Risk Framework. The Taxonomy of Threats.
Source: Centre for Risk Studies

A 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 cities of the world, responsible for over half of global GDP.



Cambridge Global Risk Index, overall GDP@Risk per city. Source: Centre of Risk Studies

An Integrated Threat Taxonomy

The index makes use of an extensive data set collated on the economic output and business activities in major cities around the world, threat maps, and historical precedents for a wide range of 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. This provides an innovative and objective way of widely different threats and provides a platform for the Centre's research. The integration of datasets and multiple threat models constitutes Project Pandora – a specific research track on multi-threat analytics.

Identifying, Managing, and Mitigating Emerging Risks

The Cambridge Risk Framework provides an objective way of identifying and prioritising the potential significance of emerging risks. Emerging risks are identified from horizon-scanning and recognising rapidly changing threats. These are prioritised by estimating their potential impact on projected business activities. Emerging risks range from technology challenges and cyber risk, through to changing consumer preferences, regulatory pressures, disruptive technologies, and a rapidly changing competitive landscape, through to climate change and issues of environmental, sustainability and governance.

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 organisations to apply these research areas to find ways of improving the resilience of an organisation. Expressing the risk metrics for management monitoring, regulatory reporting, and other decision-support is a key area of exploration with our business support partners.

Risk Research Application Areas

Research application areas explored through the Cambridge Risk Framework are described in more detail in the following pages. For 2019, we envision leveraging the Centre's past work to focus on four main research application areas: Integrated Risk Assessment, Risks and the Digital Economy, Trend Risks, and Understanding Corporate Risks.

A. Integrated Risk Assessment Updating, improving, and extending the framework, datasets, and analytics of the Cambridge Global Risk Outloook, developing standardised risk metrics for multiple threats to individual organisations and to the global economy.	**B. Risks and the Digital Economy** Research into the risks inherent in the growth of the digital economy, examining themes such as cyber threats from social, political, economic or ideological actors, role of nation states, and proliferation of big data.
C. Management of Emerging Risks Continuing the research into individual threats, developing scenarios, and improving the understanding of emerging and rapidly changing risks such as climate change, conflict, social inequality, digital economy, 4th industrial revolution, and rise of general liability.	**D. Understanding Corporate Risks** Aligning the research activities and outputs to business decisions and practical applications in improving risk management practices in business and policy-making.

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. One track of research is to improve methodologies of catastronomics and expand 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 specialisations, 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; and macroeconomic consequences of extreme natural catastrophe events.

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 supporters 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: 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 Centre for Risk Studies since its inception. We have an annual cycle of updating and improving the analysis of threats, and integrating the risk assessment into decision-support applications. The analysis framework and its updates are geared to making the outputs more useful to business decision makers.

Project Pandora: A Global Risk Outlook

The Centre is continuing to develop a platform for comprehensive risk analysis of major shocks to the global economy, financial markets and the insurance industry. Our multi-threat integrated scenario-based risk assessment, Project Pandora, encompasses over 12,000 scenarios in 22 different threat categories across a set of major world cities representing about half of global GDP. The consequences of these scenarios are quantified in terms of their 'GDP@Risk'.

We are continuing to develop and improve our underlying models and optimise our data sources. We are carrying out case studies and developing proof of concept tools to carry out risk assessments of individual companies and exploring the risk mitigations available through a range of insurance products.

Global Risk Index 2019

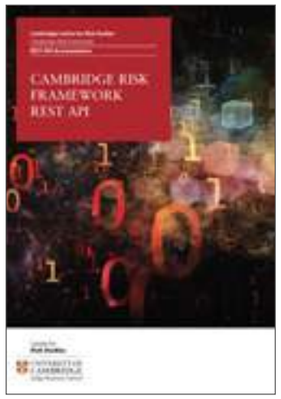
The 2019 update of our annual Global Risk Index sees a rise in overall GDP@Risk from 2018. The drivers of this increase include growth in the economy (there is more output to be lost by catastrophes), increasing likelihood of loss from emerging threats such as cyber, and shifts in the patterns of potential loss to threaten higher growth economic regions. The 2019 update sees an increase in risk from Cyber Attacks, Social Unrest, Commodity Price Shocks, Heatwave, Freeze and to a lesser extent Solar Storms, while Sovereign Default saw a decrease in risk. A major theme in this year's update is the growing significance of cyber threats.

Consistent with 2018, the top three classes of threat types in the 2019 Index are Natural Catastrophes; Financial, Economics and Trade; and Geopolitics & Security. The top three individual threat types are Market Crash, Interstate Conflict and Tropical Windstorm. Cyber Attack rose to sixth amongst the threat rankings at $40bn, 7% of total risk. Cyber Attack has moved up one ranking surpassing Civil Conflict in the 2019 Index. The capacity for cyber attacks to cause severe economic damage continues to rise. This is a threat to be closely monitored as the increasing number and severity of attacks is countered by capabilities to protect against them.

The Global Risk Index is now presented as a single year outlook, rather than a three year outlook as in previous years.

Research Application Area A: Integrated Risk Assessment

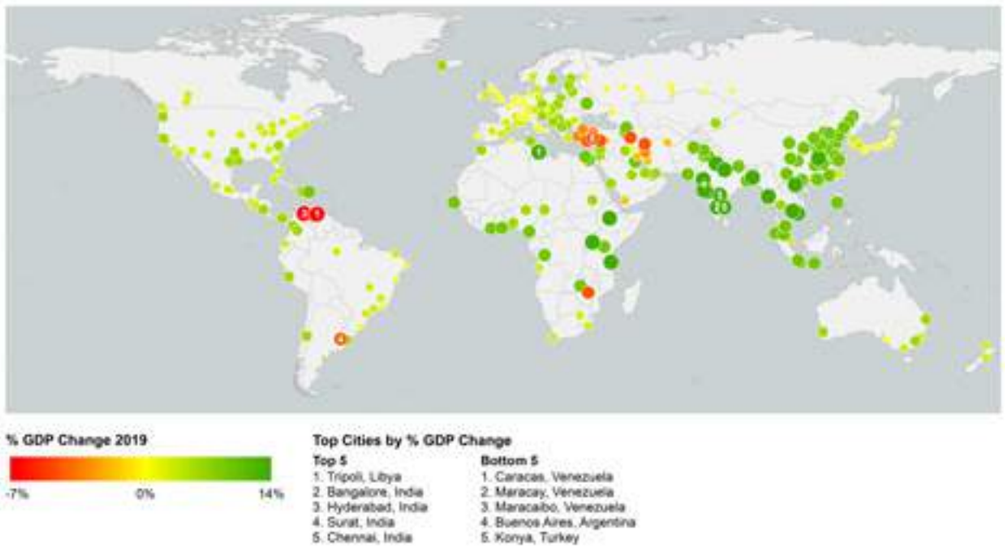
The Cambridge Risk Framework API



The Cambridge Risk Framework Application Programming Interface (API) is available to our development partners. The API allows programmatic access to data and models within Project Pandora and makes possible direct integration with corporate systems, apps, and web viewers. Partners get access to underlying model assumptions, which they can then calibrate for their own organisations to produce bespoke risk assessments. The API gives programmatic access to our data and models allowing our research supporters to quickly and conveniently obtain up-to-date data to integrate with their internal systems.

Business Use Cases and Project Partners

The Cambridge Centre for Risk Studies works with selected organisations as part of a multi-year partnership to develop and exploit Project Pandora. The Centre works with a steering committee of research supporters 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 output towards business applications.

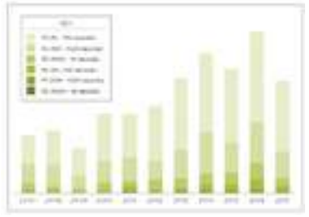


Cambridge Global Risk Index, change in risk as % of GDP. Source: Centre of Risk Studies

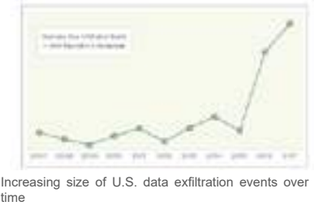
Research Application Area B: Risks and the Digital Economy

The Cambridge Centre for Risk Studies continues to research the risks inherent in the growth of the digital economy, examining themes such as cyber threats from social, political, economic or ideological actors, role of nation states, and proliferation of big data, big data risks, and social inequality.

Risks range from society and businesses' vulnerability to cyber attacks, to social transformation problems, privacy and rights issues, and potential geopolitical instabilities.



Number of U.S. data exfiltration events over time. Source: RMS Cyber Loss Experience Database



Increasing size of U.S. data exfiltration events over time

Risks and the Digital Economy

The 'fourth industrial revolution', embracing big data, artificial intelligence, robotics, and machine learning, is likely to be disruptive, with new winners and losers in the economy, societal shifts in productivity, changes to the nature and characteristics of employment, and possible structural differences in the way wealth is distributed. The Centre's research is exploring the potential nature of a future digital economy, and the risks that the transformation to this new economy could pose, to provide risk management guidance for business managers and policy-makers in navigating through the coming changes.

Cyber Risk Research

The Cambridge Centre for Risk Studies continues to be a leader in cyber risk research, analysing patterns of cyber loss, monitoring and publishing annual assessments of the cyber risk landscape, and developing scenarios and stress tests for regulators and practitioners. The Centre has contributed to the growth of the cyber insurance market through its work in designing an open source cyber insurance exposure data standard, publishing scenarios of potential cyber accumulation risk, and addressing issues such as probability assessment of cyber loss.

Cyber risk research at the Centre continues with monitoring latest developments in the cyber threat landscape and interpretation of new incidents, assessment of global differences in international cyber risk and loss patterns, and improving techniques for understanding the cyber risk profile of individual businesses and sectoral characteristics. The impact of cyber losses on businesses and the economy overall is a continuing theme, improving the understanding of the full cost of cyber risk to the global economy, its impact on business operations, balance sheet and viability, and its multipliers in the economy through suppliers and counterparties. Our cyber risk research increasingly addresses corporate solutions to managing cyber risk, together with societal and policy-making measures to reduce cyber threat overall.

Cyber Terrorism Research

Cyber is becoming an increasingly significant component of geopolitical risk, as national cyber operations teams in many countries act as extensions of military and national security capability, and target the information infrastructure of potential adversaries.

The Centre's research explores potential future consequences of digital conflict as a dimension of geopolitical risk, tracking threat actors, capabilities, and motivations. This continues past work at the Centre on cyber terrorism and asymmetrical threats to society, financial services, and the economy. Cyber capabilities are transforming the traditional landscape of geopolitical risk and creating new orders and polarities of potential international conflict. Helping businesses and policy-makers understand this new risk environment and manage it appropriately is the focus of this programme of research at the Centre for Risk Studies.

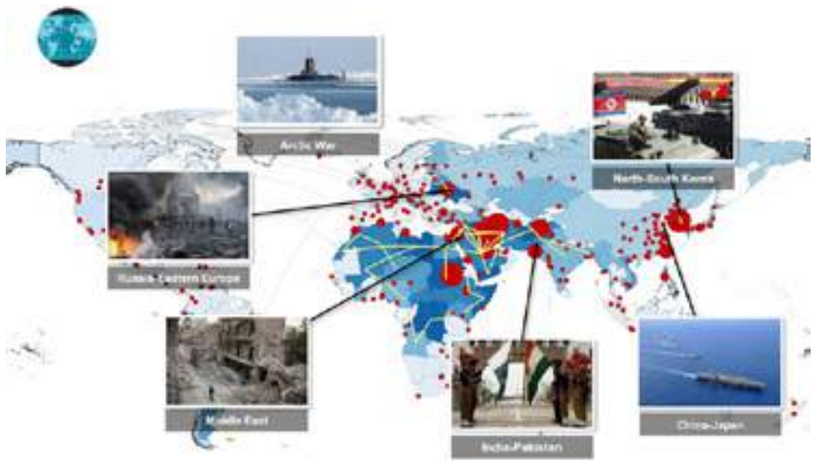
Research Application Area C: Management of Emerging Risks

Businesses are increasingly having to demonstrate explicit procedures for identifying, managing, and mitigating emerging risks. This research track explores robust methods for horizon-scanning and identifying emerging and rapidly changing risks, such as climate change, conflict, social inequality, technology, digital economy, gender risk, and rise of general liability. It looks at trend risk and how to develop scenarios to improve the understanding of key emerging trends.

Trend Risks and Possible Futures

The consequences of global warming, though increasingly nearer and more cogent, have not been at the forefront of political debate since the optimism and consensus of the Paris agreement at COP 21 in December 2015. Yet continued pressure at the micro level, worldwide, seems to be increasing. Shareholders are forcing firms to account for their role in CO_2 emissions and develop urgent management plans for decarbonisation. Advocacy against cutting greenhouse gas emissions has caused even a coal producer to withdraw from the World Coal Association. Legal challenges against large multinational corporations over local manifestations of climate change are becoming widespread as case law becomes more established. International NGOs and central banks are stepping forward to help set standards for the financial services sector in their financing practices and decarbonisation of their portfolio holdings.

The impact of weather catastrophes and how climate change is impacting extreme events is part of the Centre's ongoing analytics development for quantifying corporate risk.



Changes in Interstate War Landscape. Source: Cambridge Centre of Risk Studies

Tension and Conflict

Geopolitical and Security risks are rapidly changing in many regions, and threaten international business activities in many parts of the world. Iran maintains a proxy presence in several conflicts through the region, namely in Yemen, Iraq, Israel, Syria and Lebanon. Iran vs. Syria still remains the top concern in terms of interstate conflict. Territorial disputes in the East and South China Seas continue.

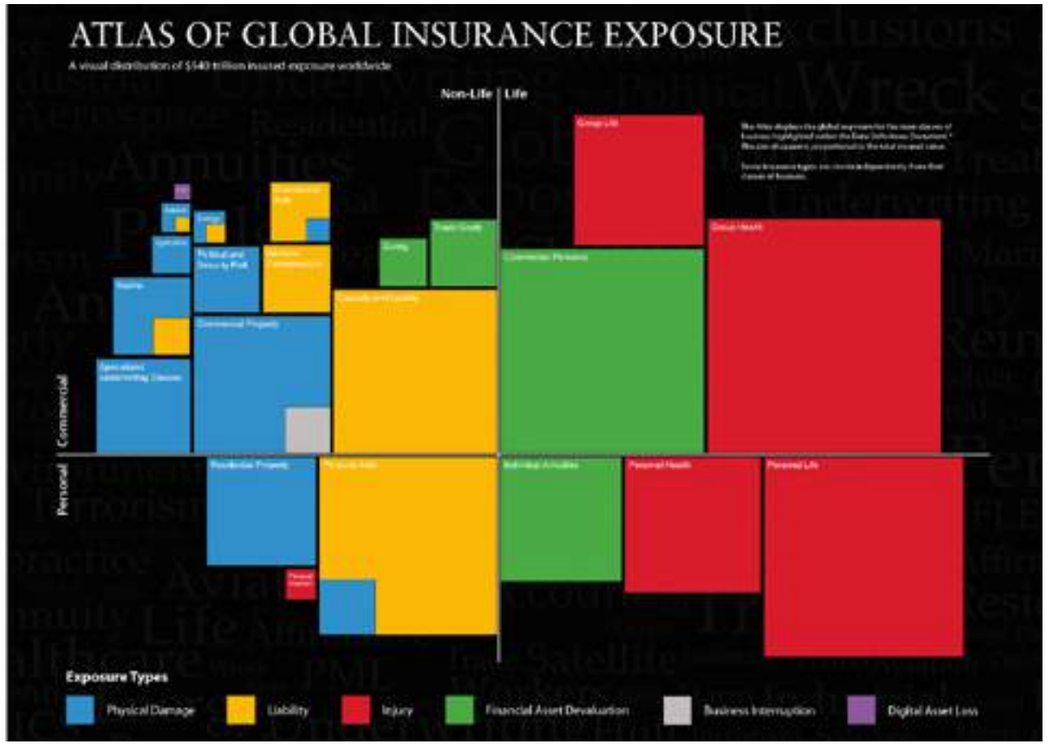
Violent terrorist activity continues to be a feature in regions such as the Sahel, Afghanistan, Syria and Iraq. Two of the worst humanitarian crises of the year include the mistreatment and forced exodus of the Rohingya population from Myanmar and the UN has called for an investigation into possible war crimes. The conflict in Yemen has led to the displacement of at least 3 million, with malnutrition and food shortages due to price instability leading to a cholera outbreak.

Geopolitics and Security remains a priority for the Centre given the lack of standardised quantitative methodologies for risk assessment and risk management for this threat class.

Research Application Area C: Management of Emerging Risks

Rise of Liability

Emergent liability risks include the health impacts of widespread industry practices. In food preparation, for instance, refined carbohydrates including sugars have been linked to an obesity epidemic and rising rates of diabetes, a portent of a major public health challenge. The nature of liability is also changing depending on the issue and the regulatory region. In Europe, professional liability is becoming an increasingly significant risk exposure for medical professionals and senior officers of firms, while a vast eruption of gender discrimination cases is possible in the USA on the basis of salary discrepancies over many years. Liability is one of the four main pillars of the Global Exposure Accumulation and Clash (GEAC) Project which includes a subschema covering medical malpractice, directors and officers insurance, and professional indemnity.



Technology as an Emerging Risk

Cyber risk as "threat du jour" has overshadowed other technology threats of which biological and material sciences are two main areas undergoing rapid and radical development. In biology, the ability to manipulate genes has far reaching consequences, evidenced by three FDA approvals of new gene therapies since August 2017. The darker side of gene manipulation is multifarious, including a warning from Microsoft founder Bill Gates, "The next epidemic could originate on the computer screen of a terrorist intent on using genetic engineering to create a synthetic version of the smallpox virus ... or a super contagious and deadly strain of the flu." The threat of pandemic, which is key to the Cambridge Global Risk Index, is updated annually.

Nanotechnology remains the poster child for material science with well-articulated fears about its emergence as a systemic threat. The analogy between carbon nanotubes with asbestos has made the insurance industry acutely aware of health risks posed by new materials.

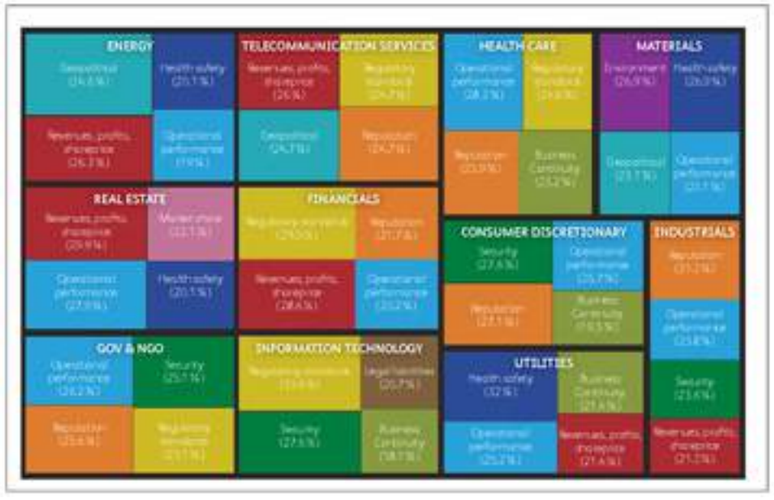
Research Application Area D: Understanding Corporate Risks

Expectations of businesses by shareholders and wider society are increasing on many levels. The ability to understand and quantify the true state of a corporation's collective risks at any moment in time is becoming more pressing. The risks might be internally focussed such as those related to talent and culture or be driven by external exogenous events. This track of research explores the methodologies and applications of the Centre's research for risk profiling of corporations and focusses on the use of research outputs in improving business decision-making.

Enterprise Risk Management

Global corporations today face very different threats to their businesses than in previous decades when dominant forms of risk and compliance practices were formed. Active areas of research support the hypothesis that corporations' overall risk profiles have increased, simply from the effects of a more globalised and closely networked world. The Centre's corporate engagement activities have validated that corporations are seeking to improve their risk management practices by adopting a more comprehensive and quantifiable threat assessment framework.

The Cambridge Risk Framework provides an extensive set of objectively defined scenarios of potential external business shocks that could arise from a wide range of different threats and emerging risks, to principal locations of business activity all across the world. The macro risks and threat types include financial crises, geopolitical risks, natural catastrophes, technological threats, and disease and external threats which identify emerging and systemic risks to business operations. The framework can help gain insights into the macro risks posed to an overall sector.



Sector View of Top Enterprise Risks for Companies. Source: Cambridge Centre for Risk Studies 2018 ERM Survey

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 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.

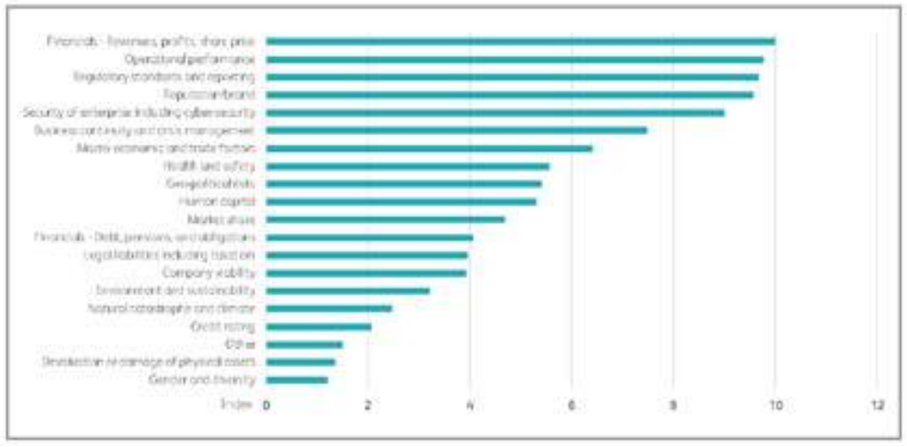
Research Application Area D: Understanding Corporate Risks

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 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 are developing 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. Applying a multi-line exposure data schema for clash scenarios is a priority for the insurance use cases of research at Centre.

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



Top Enterprise Risks of Potential Concern for Companies in the Next 12 Months. Source: Cambridge Centre for Risk Studies 2018 ERM Survey

Risk Reporting

Reminiscent of efforts leading up to the development of the Solvency II and Basel directives, governments and corporations are seeking to incorporate concepts related to viability and de-risking insolvency into regulatory frameworks for corporations. This includes the mandatory filing of viability statements for corporations in the UK and expanded risk factor disclosures in the 10-K public filings in the US.

Companies can 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 10-K 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.

The field of risk management and its supporting research will need to expand to address the demand for greater clarity in modelling and communicating collective risks and foreseeable harm that corporations might face in the future, and better understanding their financial implications. Organisations taking the lead in identifying and assessing risks that today are both nonstandardised and foreseeable are creating a competitive advantage for themselves.

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Use Case: Enterprise Risk Management for a Global Corporation

Enterprise Risk Management for a Global Corporation

The Centre for Risk Studies believes that companies that base their risk management activities on a comprehensive threat assessment with strategic contingency plans will be more resilient, with improved credit ratings, investor confidence, and shareholder value.

The Cambridge Risk Framework provides an extensive set of objectively defined scenarios of potential external business shocks that could arise from a wide range of potential threat types, to principal locations of business activity all across the world. The macro risks and threat types include financial crises, geopolitical risks, environmental challenges, technology risks, social, sustainability and governance threats, along with other issues that constitute emerging and systemic risks to business operations. The framework can help gain insights into the macro risks posed to an overall sector.

The Cambridge Pandora Project integrates and harnesses Cambridge's Global Risk Index such that the multi threat research can further important business decision making within a multinational corporation such as one within the commodity or energy sector. The Pandora Project identifies the risks of catastrophic disruptions to the business activities of the corporation from extreme systemic risks.

In addition to identifying meaningful comparative metrics, the research provides analytics to address the following manner of question:

- Which threats cause the maximum revenue losses?
- Which type of assets are most at risk with respect to revenue loss?
- If company assets were better able to withstand impacts of threats how much additional revenue could be earned?
- If company assets were better able to withstand impacts of threats how much cost would you save on plant repair and replacement?
- If climate change increased intensity or frequency of certain threats, what effects could this have on average revenue and physical damage?

Figure 9: 1-in-100 year coastal flood event flooding extent, incorporating Avocado's Alpha Supply Centre (Source: Muis et al., 2016; Cambridge Centre for Risk Studies analysis).

Use Case: Insurance Purchasing Framework

Insurance Purchasing Framework

The Centre for Risk Studies is researching the types of events that could cause severe loss to a company and risk mitigation strategies for these threats. This specific use case of the Cambridge Pandora Project integrates and harnesses the Centre's Global Risk Index research to support important business decision making within a corporation in managing its overall risk.

The Insurance Purchasing Framework helps identify the risk of catastrophic disruptions to the business activities of a corporation from extreme systemic risks. The use of analytical outputs from the Pandora Project helps provide a holistic view of risks to a corporation's assets operating in defined geographical regions.

This research provides meaningful metrics for comparison across asset types such as Revenue@Risk. The research also provides a framework to address questions such as:

- Which threats cause the maximum revenue losses?
- Which kinds of assets are most at risk with respect to revenue loss?
- If a corporation's assets were better able to withstand impacts of threats, how much additional revenue could be earned or how much cost would be saved on plant repair and replacement?
- If climate change increased intensity or frequency of certain threats, what effects could this have on revenue and physical damage?
- Identify potential insurance products that could mitigate identified risks.

This research will provide visualisation and quantification approaches to overlaying insurance products, their policy terms and exclusions to get a consolidated picture of a company's exceedance probability (EP) curves.

Risk profile for a particular facility at a location. Source: Centre for Risk Studies

Use Case: Importance of Resilience in Economic Recovery

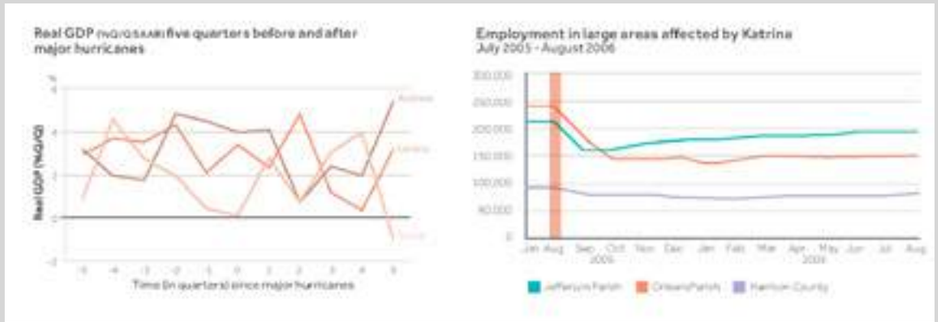
Importance of Resilience in Economic Recovery

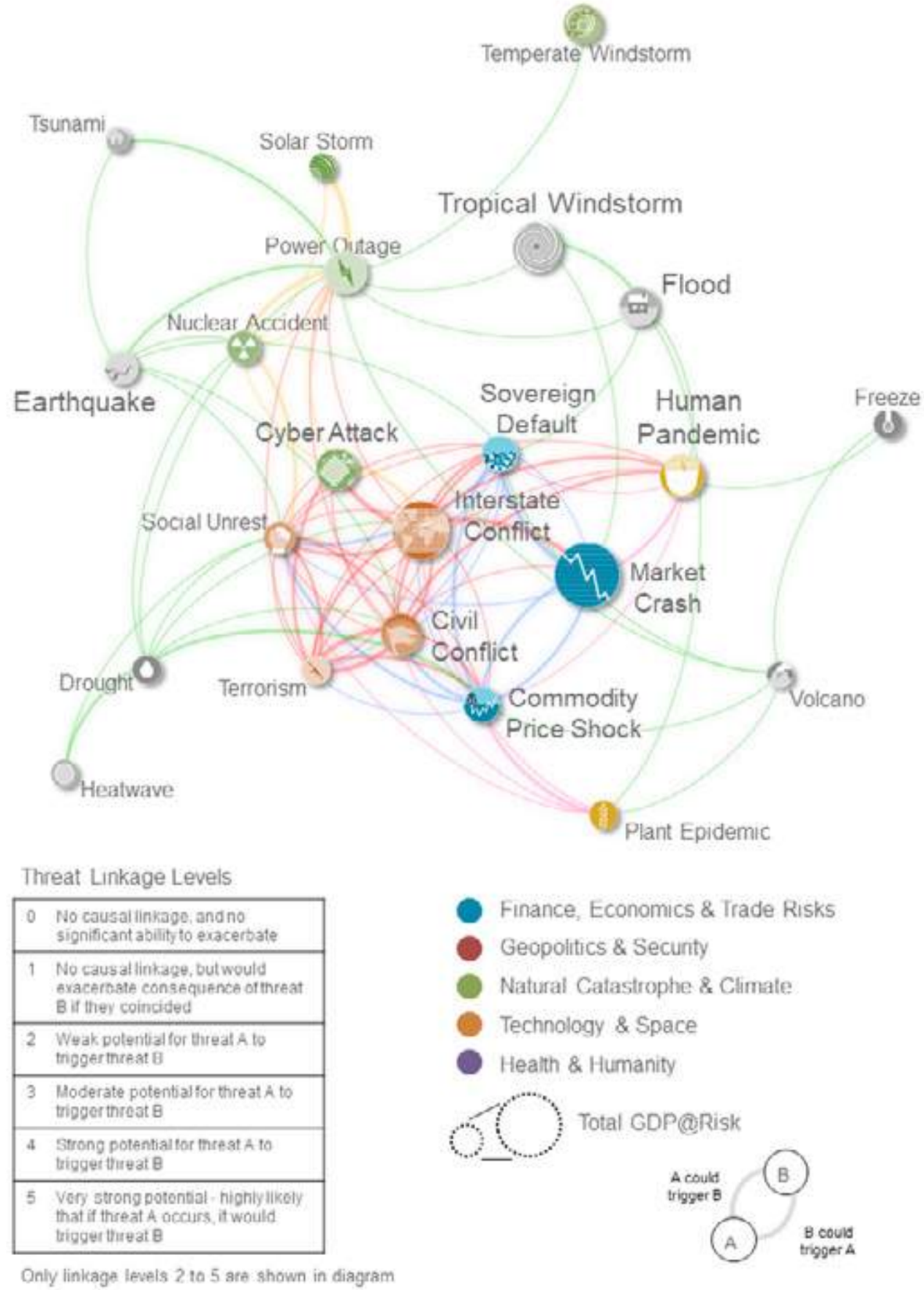
The Cambridge Risk Framework provides a foundation for modelling interconnected risks in a disaster. Improved quantification and modelling of risks allows for more efficient consideration of market solutions. In the case of developing countries, the use of GDP as a broad measure of economic recovery and growth may not adequately assess the welfare of the population and other consequences after a disaster. The interconnected nature of risks is particularly evident in understanding conflict dynamics in relation to other risks such as ocean risk, flooding, food security, terrorism, and geopolitics.

The Centre for Risk Studies is researching the processes that allow for greater resilience after major events and risk management actions which promote increased economic and social recovery. The Centre uses a case study approach to study recovery dynamics spanning regions across both developing and developed countries.

Our analysis seeks to answer questions such as the following:

- How does the destruction of physical assets translate to output losses (flow), and what are the factors affecting the respective response functions?
- Are there country-level similarities or differences in the recovery dynamics?
- What is the value of insurance and other financing mechanisms in the reconstruction and recovery processes?





Visualisation of Interconnected risks within the Cambridge Global Risk Index. Source: Centre for Risk Studies

2019 Planned Event Calendar for the Cambridge Centre for Risk Studies

8 January - 28 February

Book Launch: *Solving Cyber Risk* - Cambridge, London, New York, Washington DC

We will be holding launch event for a new book from researchers at the Centre that sets out a risk management framework for considering cyber risk to any individual organisation at the University of Cambridge Judge Business School. Launch events will take place throughout January and February in four locations: Cambridge, London, New York and Washington DC.

29 January

Report launch: "Bashe attack: Global infection by contagious malware" - Singapore

As part of the Singapore-based public-private initiative assessing cyber risk, CyRim, and in association with the Insurance Risk and Finance Research Centre at Nanyang Technological University and Lloyd's of London, the Centre will be releasing a new report, presenting a cyber attack scenario with worldwide effects.

29 January

CambridgCentre for Risk Studies Advisory Board & Research Showcase

The 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 research strategy of the Centre.

30 January

Chief Risk Officer's Council Roundtable - Leading Ideas in Risk: Insights into Enterprise Risk Management for Corporations

12 February

"Top Risks and Their Consequences to the Consumer Sectors" Workshop - London

A workshop with enterprise risk managers from consumer sector companies to review trends in corporate risk management and to discuss the top risks to their value chain. The sector study is being done in collaboration with IRM.

29 March

The 2019 Cambridge-McKinsey Risk Prize

The deadline for submission for the Centre's annual Cambridge-McKinsey Risk Prize.

20-21 June

Cambridge Centre for Risk Studies 2019 Risk Summit - Cambridge

2019 marks the Centre's 10th anniversary. The Centre will be holding its 10th Anniversary Risk Summit on 20-21 June 2019. The conference programme will bring a wider focus to current research activities and related themes. Presentations covering research topics will be presented by the Centre's research staff as well as other experts in the field.

The conference will be held at the Cambridge Judge Business School, followed by a black-tie gala dinner at Christ's College, University of Cambridge.

24 July

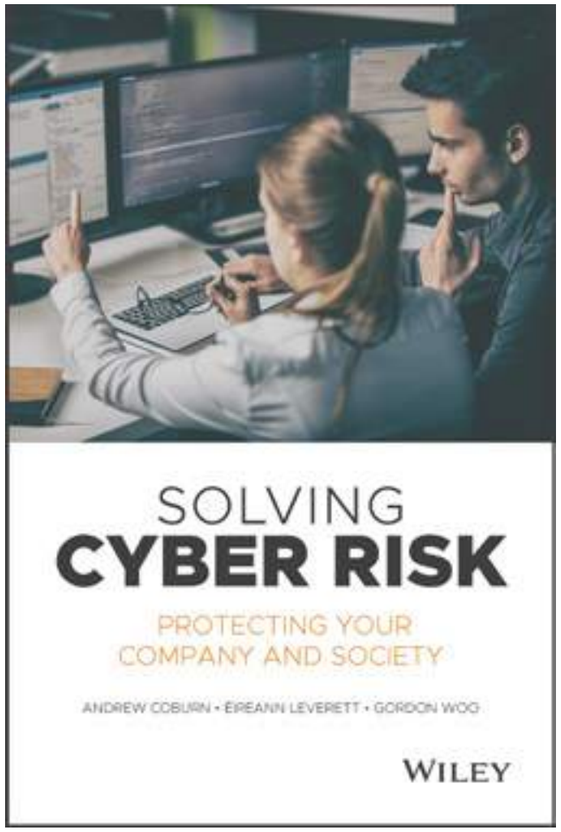
Cambridge Cyber Risk Conference: The Future of Cyber Risk

This conference will cover how to manage cyber risk in a 5 to 10 year business cycle.

Solving Cyber Risk: Protecting Your Company & Society

Cambridge Centre for Risk Studies has been a leading pioneer of research into cyber as an emerging risk. Now a new book from researchers at the Centre sets out a risk management framework for considering cyber risk to any individual organisation, and the principles involved in protecting society from cyber threat.

Book Summary



Cyber risk presents a clear and present danger to the functioning of our society and the well being of our economy. Information technology has played a major role in boosting economic growth for the advanced economies, but it now threatens the prosperity it created. Using data compiled over many years of analysing cyber risk and working with companies battling on the front line of cyber risk management, the authors of *Solving Cyber Risk* estimate that cyber losses cost over $1.5 trillion a year to the global economy - eroding a steady tax of around 2% on our economic output. Cyber attacks could trigger massive economic shocks of potentially trillions of dollars. State-sponsored cyber attacks on each other's countries threatens democracy and geopolitical stability.

Solving this risk will not be easy, but the authors dissect the problem. They review the role that companies can play in improving their own cyber security and cyber threat awareness. They characterise the principal causes of cyber loss and explain the best methods of combating them. They show that the production of software produces inherent exploitable vulnerabilities, and discuss methods of reducing them at source. They profile the black market of malicious cyber hackers and their 'business models', showing that they can be combated by changing the calculus of their reward systems. They argue that law enforcement, regulation, and litigation systems need radical overhaul to meet the new threat. They highlight the role of government and policy-makers in making us safer.

The authors apply techniques of risk assessment – analysing the likelihood and severity of loss – to assess the costs and benefits of cyber risk management. They provide practical exercises for companies to improve their cyber risk management cost-effectively.

Cyber is an unprecedented threat. It will need radically new approaches to solving this risk. This book proposes that we need to take a fresh view at cyber risk, and not be afraid of challenging orthodox approaches.

Past Year at a Glance - 2018

Centre for Risk Studies Research Outputs and Publications

A diverse look at the shifting risk landscape

In 2018, the Centre for Risk Studies had a thriving year for its research programme, producing a high volume of papers and reports. Selected titles are featured below:

Multi-Line Insurance Exposure Management Data Definitions Document v1.0

This document was produced as part of the Global Exposure and Accumulation and Clash (GEAC) project, accompanied by a companion guide, 'Challenges and Solutions for Enterprise Exposure Management'.

Steering the Course: An Emerging Risk Report

"Steering the Course" presents an alternative model to help insurers understand the 'tail risk' of potential losses they might experience in their marine portfolio.

Risk Management Perspectives of Global Corporations

This report is informed by views from risk management specialists representing both private and public sectors, obtained through a combination of individual interviews; surveys and real-time polls and the in-depth online 2018 Enterprise Risk Management survey.

Cyber Risk Outlook 2018

This report explores the rapidly changing cyber landscape. The dimensions of cyber loss are increasingly international as losses due to cyber attacks are being reported in almost every country in the industrialised world.

Cambridge Global Risk Index 2019: Executive Summary

This is the 2019 update of the Cambridge Global Risk Index. Cyber risk has seen a rise from seventh to sixth place among global threats in this year's Index.

Impacts of Severe Natural Catastrophes on Financial Markets

This report explores the potential for very large natural catastrophes to trigger market shocks. It includes six natural catastrophe scenarios.

Disaster Recovery Case Studies: US 2005 Storms Katrina, Rita and Wilma

These case studies seek to understand and quantify the key controls on the speed and quality of disaster recovery, including the role of insurance. This case study's findings include the fact that the Hurricane Katrina disaster revealed several issues with the management of catastrophes in the US.

Disaster Recovery Case Studies: US Storms 2012 Superstorm Sandy

This report focuses on the US east coast region impacted by Superstorm Sandy in 2012, as a case study of a high-income economy with relatively high GDP per capita and non-life insurance penetration.

Past Year at a Glance - 2018

Selected Press Features

Integrated Risk Assessment

Business Weekly, "Cyber attacks a growing threat to cities globally", 2 January 2019

The Telegraph, "Man-made disasters are now a much greater threat than natural ones," 23 June 2018

Forbes, "Coming soon to a city near you - $320 billion in economic losses", 6 June 2018

Reuters, "Tokyo is world city facing greatest risks", 6 June 2018

Risks and the Digital Economy

BBC Click (World Service Radio), "Congo Internet Shutdown", 12 January 2019

BBC Click (World Service Radio), "Cyber Attack Risk Up by 9%", 15 December 2018

The Times, "Solar blast could knock out the power grid - and your computer," 18 November 2018

CNBC, "Cybercrime the fastest developing risk globally", 6 June 2018

Managing Emerging Risks

You Talk Insurance, "Managing the rising threat of geopolitical risks", 24 July 2018

Asia Insurance Post, "Report: Threats from conflict and terrorism account for more than half of Indian cities' risks", 6 June 2018

Reinsurance News, "Pool Re upsizes retrocession program to £2.1bn, includes cyber terror", 1 May 2018

Understanding Corporate Risks

Strategic Risk Europe, "Traditional risk management concerns prevail in global corporations", 19 November 2018

Past Year at a Glance - 2018

Selected Calendar of Events

23 January	**Cambridge Centre for Risk Studies Advisory Board & Research Showcase** Research strategy review by the members of the Centre for Risk Studies Advisory Board. The team presented on the latest research output being produced at the Centre.
25 January	**Chief Risk Officer's Council Roundtable - Leading Ideas in Risk: Market Transitions in a De-carbonised Future**
Deadline: 5 March	**The 2018 Cambridge-McKinsey Risk Prize** An award presented for the best submission on risk management by a current graduate student at the University of Cambridge at the 2018 Risk Summit in June.
April	**Pathfinder Webinar Series** As a related part of the GEAC initiative, in collaboration with RMS, the Centre for Risk Studies presented a webinar in the spring of this year, showcasing ongoing research tracks at the Centre.
6 June	**Lloyd's City Risk Index 2018 Launch - London** The Centre for Risk Studies launched the 2018 update of the Global Risk Index, in collaboration with Lloyd's of London and launched as the Lloyd's City Risk Index 2018.
20 June	**Cambridge Centre for Risk Studies 2018 Risk Summit - London** In June 2018 the Centre for Risk Studies held its annual Risk Summit conference, which for the first time took place in London. The theme of the 2018 conference was "Risks Beyond Boundaries".
25 June	**Enterprise Risk Management Workshop** This workshop in collaboration with IRM gathered enterprise risk management directors from major companies and financial service professionals to review the trends in corporate risk management.
6 September	**Challenges and Solutions for Enterprise Exposure Risk Management** This event marked the publication of the *V1.0 Data Definitions Document* for multiple classes of insurance. The event invited various speakers and panels to discuss current industry initiatives, and reflect on the data definitions document's use within the insurance market.
18 September	**"Top Risks and Their Consequences to the Energy Value Chain" Workshop - London** In September, we brought together professionals from energy, manufacturing and finance backgrounds, to discuss the top risks to the energy value chain, from production to usage.
8 November	**City Risk Index workshop - London** This workshop explored the uses of the Lloyd's City Risk Index to enhance underwriting, modelling and sales activities.
21 November	**Launch Event for Cambridge-McKinsey Risk Prize** The Centre for Risk Studies launched the 2019 Cambridge-McKinsey Risk Prize competition in conjunction with McKinsey & Company.
4 December	**Launch Event for Cambridge Global Risk Index 2019** This event launched the 2019 update of the Cambridge Global Risk Index.

Past Year at a Glance - 2018

Head of Cyber Risk research Dr Jennifer Daffron presents on CRS cyber risk research at Instech London, October 2018

Director of Research and Innovation Simon Ruffle presents at IFTRIP Conference in Moscow, October 2018

Dr Andrew Coburn and head of Cyber Terrorism research Tamara Evan at InsuranceDay Market Awards, November 2018

Chief Scientist Dr Andrew Coburn presents at Supply Chain Risk Management Conference, December 2018

Past Year at a Glance - 2018

Risk Summit 2018 at One Birdcage Walk in London, June 2018

Panellists at Cambridge Global Risk Index 2019 launch event at Willis Towers Watson in London, December 2018

Challenges and Solutions for Enterprise Exposure Risk Management, September 2018

Dr Andrew Coburn and Dr Michelle Tuveson with guests Matthew Grant and Stephen Coates, at the London Market Awards, June 2018

The Cambridge-McKinsey Risk Prize

The Cambridge Centre for Risk Studies in partnership with McKinsey & Company will present the 2019 Cambridge-McKinsey Risk Prize at our annual Risk Summit in June. The Risk Prize entries are open to all postgraduate candidates from any academic department within the University of Cambridge. We believe that submissions from different disciplines and fields bring fresh and unique perspectives on risks.

The Centre launched the 2019 Cambridge-McKinsey Risk Prize and invited interested students to discuss their ideas with Centre staff and Directors.

The three finalists will be announced in June 2019. The winner will be awarded a prize at the Centre's annual conference on 20-21 June 2019. The prize award ceremony will be at a plenary session attended by finance, industry and academic delegates. Judges will include members of both McKinsey & Company and the Centre for Risk Studies.

Past McKinsey Risk Prizes

In 2018, the Cambridge-McKinsey Risk Prize was awarded to PhD candidate at the Faculty of Law, University of Cambridge, Ann Sofie Cloots, for her paper on the legal, operational and systemic risks associated with the acceptance and use of cryptocurrencies and blockchain technology: *Cryptocurrencies, blockchain and risk management: legal, operational and systemic risks*. Honourable mentions went to Sean Day, MPhil Technology Policy candidate at the University of Cambridge and Sipke Shaughnessy, PhD Candidate at the Department of Geography at the University of Cambridge. The three finalists' papers are available to be read at: **https://www.jbs.cam.ac.uk/faculty-research/centres/risk/the-risk-prize**

2018 Risk Prize Finalists with Dr Aleksander Petrov, MCKinsey & Co and Professor Daniel Ralph, Centre for Risk Studies

10th Anniversary Cambridge Risk Summit - 2019

2019 marks the Centre's 10th anniversary. Over the past decade, the Centre is proud to have developed into a world leading research centre providing impactful research and thought leadership in risk management. The Centre will be holding its annual Risk Summit on 20-21 June 2019. The upcoming conference programme will bring a wider focus to current research activities and related themes. Presentations covering research topics will be presented by the Centre's research staff as well as other experts in the field.

The conference will be held at the Cambridge Judge Business School, followed by a black-tie gala dinner at Christ's College, University of Cambridge.

Past Cambridge Risk Summits

The Centre for Risk Studies has successfully held annual Risk Summit conferences since its inception. During these conferences, topics pertinent to the evolving risk landscape are explored and discussed by the Centre's research team and external stakeholders from corporate, industry, policy and academic backgrounds. Previous years' topics have included risks that transcend national and physical boundaries, risks associated with a 'smart' technological world, risk culture in organisations, the application of stress tests to financial institutions and business management, and the implications of big data and greater information access for individuals and businesses.

Proceedings, speaker biographies, presentations and photos of the event are available here: **https://www.jbs.cam.ac.uk/faculty-research/centres/risk/news-events/risk-summits**

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, Chief Scientist

Simon Ruffle, Director of Research & Innovation

Research Associates

Jennifer Copic, Research Associate

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.

Dr Jennifer Daffron, Research Associate

Dr Jennifer Daffron focuses on modelling the impact of cyber threats on global business and socioeconomics.

Risk Researchers

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 Centre for Risk Studies and an associate of the Centre for Climate Change Mitigation Research.

Éireann Leverett, Senior Risk Researcher

Éireann conducts research that focuses upon technological disasters and the economic impacts of computer security failures or accidents.

Dr Andrew Skelton, Senior Risk Researcher

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.

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 Dean and Senior Tutor, Darwin College.

Research Assistants

James Bourdeau, Research Assistant

James researches cyber terrorism at the Centre of Risk Studies. He has a background in political science and international relations.

Phillip Cameron, Research Assistant

Philip is a Research Assistant at the Centre for Risk Studies, University of Cambridge, and has a background in mathematics and physics.

Oliver Carpenter, Research Assistant

Oliver's primary focus at the Centre is on Project Pandora, which aims to develop a risk analysis framework to understand and model impacts from various natural and man-made global catastrophes.

Ken Deng, Research Assistant

Ken is a Research Assistant at the Centre for Risk Studies and has a background in corporate finance, asset pricing and economics in general.

Tim Douglas, Research Assistant

Tim is a Research Assistant at the Centre for Risk Studies where he works on the risk modelling of multiple cyber threats to insurance.

Tamara Evan, Research Assistant

Tamara oversees the completion and final production of the Centre's research publications. She also assists in social sciences research, holding an MA from UCL in Historical Studies.

Olivia Majumdar, Research Assistant

Olivia assists in the editorial production of the Centre's research content and with social science research at the Centre. She has an academic background in North Indian languages, culture and literature.

Kelly Quantrill, Research Assistant

Kelly supports research in multi-line insurance exposure, cyber risk, and Project Pandora, which models the risks of multiple threats to global and city-level economies. Her primary interests are in data management, catastrophe preparedness and planning, and the risk management of natural hazards.

Andrew Smith, Research Assistant

Andrew has a background in economics and data modelling. Andrew's independent research has focused on international macroeconomics with an emphasis on fiscal policy. At the Centre for Risk Studies, he is working on multi-line insurance exposure and cyber risk.

Kayla Strong, Research Assistant

Kayla 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.

Advisors and Fellows

Professor Kern Alexander, Risk Fellow

Lee Coppack, Senior Advisor, Insurance & Risk Media

Andrew Freeman, Risk Fellow

Administration

Jayne Tooke, Administrator

Ruth Newman, Web Editor

Georgina Cohen, Communications Officer

Cambridge Judge Business School, Finance, Legal and Administration Offices

Awards and Recognition for the Centre

2018 Cyber Risk Innovation of the Year

- CCRS and Pool Re, shortlisted by the Advisen Cyber Risk Awards committee

2018 Risk Modeller of the Year

- CCRS, shortlisted by the Reactions London Market Awards committee

ACORD selected the Cambridge-RMS Cyber Exposure Schema to provide to their membership

- The data schema was developed by the Centre for Risk Studies, in collaboration with RMS, Inc., and published in 2016

ISO 31050 Emerging Risk Standards

- CCRS was invited to participate as a member of the British Standards Institution Working Group on scoping the proposed ISO 31050 standard for identifying and managing Emerging Risks in business

Cambridge Centre for Risk Studies 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 Ali Rais Shaghahi, Research Assistant, 2017**
  Data Scientist, McLaren Applied Technologies
- **Viktorija Kesaite, Research Assistant, 2016**
  PhD Candidate in Economics at the University of Exeter
- **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, 2016**
  VP Business Solutions, Financial Network Analytics, Ltd.
- **Siobhan Sweeney, Risk Fellow, 2016**
  Founder and CEO of Cambridge Legal Risk Analytics
- **Jaclyn Zhiyi Yeo, Research Assistant, 2016**
  Senior Risk Analyst at Marsh & McLennan Companies
- **Ganchi Zhang, Risk Researcher 2016**
  Associate in Market Risk Capital Analysis at Goldman Sachs
- **Arjun Mahalingam, Research Assistant, 2018**
  Bank of England
- **Dr Grace Campbell, Risk Researcher 2015**
  Geologist at Arup Group
- **George Cooper, Risk Intern 2015**
  Risk Analyst, Model Development & Evaluation, SCOR Global P&C
- **Dr Fabio Caccioli, Research Associate 2014**
  Lecturer, Financial Computing and Analytics, Faculty of Engineering Science, University College London
- **Dr Roxane Foulser-Piggott, Research Associate 2014**
  Model Application Specialist, Suncorp Group; Brisbane, Australia
- **Dr Gary Bowman, Research Associate 2013** *Assistant Professor of Global Strategy, Faculty of Business, Bond University, Australia*
- **Jessica Tsang, Research Assistant, 2018**
  Goldman Sachs

Executive Committee of the Cambridge Centre for Risk Studies

Professor Daniel Ralph

Academic Director, Cambridge Centre for Risk Studies

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

Daniel 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.

Daniel'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 brings 20+ years of corporate experience within the technology and consulting sectors to further the development of better risk models for the future. During Dr Tuveson's tenure, the Centre for Risk Studies has become a world leading provider of research and thought leadership in scenario-based modelling of multi-disciplinary risks to businesses. 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 Chief Risk Officers Council, chairs the Centre's Annual Risk Summits, is Director of the advisory board member to Elevate City, is a former IEEE Standards Committee Member on the General Principles for Artificial Intelligence and former advisory board member to the World Economic Forum's Global Risk Report. She is a frequent commentator and speaker and her articles have been published in reports such as Banking & Financial Services Policy Report (Wolters Kluwer) and Financial Times Special Report on Risk Management. 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 research topics include risk culture and governance, corporate risk profiling, and 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) and continues to be a champion for gender diversity. She earned degrees from the Massachusetts Institute of Technology, Johns Hopkins University, and University of Cambridge.

Executive Committee of the Cambridge Centre for Risk Studies

Dr Andrew Coburn

Chief Scientist, Cambridge Centre for Risk Studies

Andrew oversees the research agenda at the Centre for Risk Studies and coordinates programme activities to ensure alignment with the business objectives of supporting organisations. Andrew's principal interests are in catastrophe risk management, emerging risks, and the resilience of business to external shocks.

Andrew also works as a consultant to Risk Management Solutions (RMS), the leading catastrophe risk modeller, with whom he worked for 20 years on creating new classes of risk models. Andrew is recognised as one of the pioneers of natural catastrophe models that have become an accepted part both of business management in financial services and of public policy making for societal risk.

Andrew's books include *Solving Cyber Risk* (2019); and Earthquake Protection (1990), both published by Wiley. Andrew is an Editorial Board Member of Journal of Network Theory in Finance. He is a Bye-Fellow at Christ's College, Cambridge.

Simon Ruffle

Director of Research & Innovation, Cambridge Centre for Risk Studies

Simon plays a key management role in the Centre's research programme. He is a member of the Centre's Executive Team and manages external sponsor relationships. He advises government and speaks regularly at seminars and conferences.

He is researching the impact of catastrophes in a globalised world, on companies, cities and countries, supply chains, insurance and banking. He is developing an integrated platform for storing and applying the Centre's stress test scenarios and other risk assessment tools to business, macro-economics, financial markets and insurance loss aggregation.

He is working on multi-threat integrated scenario-based risk assessment, encompassing over 12,000 scenarios in 22 different threat categories across almost 300 cities around the world representing about half of global GDP. The consequences of these scenarios are quantified in terms of their 'GDP@Risk' – a unified metric that can be used to compare and standardise different types of threat.

He is working on data interchange standards for multi line insurance and is developing proof of concept tools to carry out risk assessments of individual companies and explore the risk mitigations available through a range of insurance products.

Simon has spent most of his career in the insurance 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.

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 world'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

Steve Coates, Chief Underwriting Officer, Pool Re
Brad Fischtrom, Commercial Risk Officer, AIG
Rowan Douglas CBE, CEO Capital, Science and Policy Practice, Willis Towers Watson and Willis Research Network
Jonathan Gale, Chief Executive, AXA XL
Anna-Marie Greenaway, Director of International University Relations, BP
Dr Aleksander Petrov, Partner, McKinsey & Company
Dr Trevor Maynard, Head of Innovation, Lloyd's
Andrew Pitt, Global Head of Citi Investment Research, Citigroup
Dr Mohsen Rahnama, Chief Risk Modeling Officer, Risk Management Solutions, Inc.
Alan Smith, Global Head of Risk Strategy and Chief of Staff, HSBC Holdings PLC
Matthew Swibel, Director, Enterprise Risk and Sustainability, Lockheed Martin
Dickie Whitaker, CEO, The Lighthill Risk Network
Carolyn Williams, Director of Corporate Relations, Institute of Risk Management

Academic Advisors

Professor Michael Barrett, Professor of Information Systems & Innovation Studies and Director of Research, Cambridge Judge Business School
Professor John Rees, Risk Research Coordinator, UK Research Councils (RCUK)

Advisory Board Member Biographies

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 exposure 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.

Brad Fischtrom

Commercial Risk Officer, AIG

Brad Fischtrom is the Chief Risk Officer for AIG's Commercial Insurance business. He is accountable for design and facilitation of AIG's Enterprise Risk Management (ERM) framework across the firm's global Commercial Insurance operations and legal entities, including the effective management of all key insurance, market, credit, operational, and strategic risks. Since joining the company in May 2010, Brad has led several diverse ERM teams and initiatives, covering AIG's stress testing and scenario analysis process, risk aggregation, and management of AIG's risk officers stationed within the Americas region.

Brad's background represents all aspects of ERM, with particular focus in the areas of economic capital / risk modeling, risk governance, catastrophe risk management, and operational risk management. He also has substantial experience in Property Casualty (PC) insurance underwriting, broking, and actuarial science. Prior to AIG, Brad has held positions within Willis Towers Watson's risk management consulting unit and at Aon Risk Services.

Brad holds a Bachelor of Science degree in Finance and Business Administration from the University of Richmond. He is a Chartered Property Casualty Underwriter (CPCU) and an Associate in Risk Management (ARM).

Rowan Douglas CBE

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

Rowan Douglas is CEO of the 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.

Advisory Board Member Biographies

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.

Jonathan Gale

Chief Executive, AXA XL

On 1 January 2017, Jonathan assumed the role of Chief Executive at Bermuda Reinsurance for the XL Catlin group of companies. When the XL Group acquired Catlin in July 2015, Jonathan was installed as Chief Executive of Reinsurance London for the newly formed XL Catlin, and Joint Active Underwriter of Syndicate 2003, the largest Syndicate at Lloyd's.

During his career he worked for a spell in the US broker market and spent almost five years in the Bermuda market running Catlin's nascent Bermudian underwriting business from 2003 to 2008. The majority of his time has been spent in the Lloyd's market. Jonathan started in the London and Lloyd's market in 1987 specialising in US medical malpractice and in particular reinsurance of PIAA companies and specialist risk retention groups.

Dr Aleksander Petrov

Senior Partner, McKinsey & Company

Aleksander Petrov is a Partner at McKinsey and Leader of the UK Risk Practice. He has broad experience in capital markets, derivatives pricing and portfolio management, supporting clients on a variety of risk topics focused on asset analysis, stress testing and recovery planning. Prior to joining McKinsey & Co in 2009 Aleksander spent approximately 10 years in various quant and trading roles within the European fixed income and structured finance industry.

Dr Petrov holds a PhD in Finance, University of Vienna, Austria, focusing on derivatives use in CEE markets. He was a Research Associate at the London School of Economics and is a CFA charter holder. He has held teaching assistantship positions at the University of Vienna and Sofia.

Advisory Board Member Biographies

Dr Trevor Maynard

Head of Innovation, Lloyd's

Trevor Maynard is the Head of Innovation at Lloyd's within the Commercial Function at Lloyd's, having served as Head of Exposure Management and Reinsurance at Lloyd's since 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.

Andrew Pitt

Global Head of Research, Citi Investment Research, London

Andrew has been Global Head of Citi Research since 2008 where he is responsible for managing all of Citi's independent investment research across Economics, Politics, Equities, Fixed Income, FX and Commodities. Citi Research employs over 1,100 staff in almost 30 countries and publishes around 65,000 research reports per annum. Andrew launched the publically available Global Perspectives & Solutions (Citi GPS) research series in 2011 which has become an industry leading research brand addressing the key challenges and opportunities of the 21st century. Analysis of the global risk landscape is a key part of the Citi GPS research framework.

Between 2003 and 2008 Andrew ran Citi's European Equity Research team. Between 1991 and 2003 he worked in investment research as an Insurance sector analyst, joining Citi in 1996. Andrew was regularly top rated in public surveys of investment analysts and held the number one position in the 2003 Thomson Extel poll just before he moved into a management role.

Andrew has a BA and a Masters' degree (M.St.) from Pembroke College, Oxford University. He taught as a full time College Lecturer at Keble College, Oxford, before joining the Banking industry.

Dr Mohsen Rahnama

Chief Risk Modeling Officer, 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 design, 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

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, Manufacturers and Commerce.

Matthew Swibel

Director, Enterprise Risk and 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. 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.

Advisory Board Member Biographies

Carolyn Williams

Director of Corporate Relations, Institute of Risk Management

Carolyn Williams is Director of Corporate Relations at the Institute of Risk Management, the leading international educational and training body for the risk management profession. She is responsible for communicating the work of the IRM to a variety of audiences and for building partnerships with risk teams.

She joined IRM in 2006 from Lloyd's of London, where she was responsible most recently for training and communication for the risk management team. This followed several years as Secretary to the Lloyd's Regulatory and Market Boards and many years supporting various Lloyd's committees and working parties through interesting times.

She has an MA in Politics, Philosophy and Economics from Oxford University, is a Chartered Insurance Risk Manager and also a Certified Member of the Institute of Risk Management. In her spare time she helps run a local arts festival and wonders how her son became a rock drummer.

Dickie Whitaker

CEO, The Lighthill Risk Network

Dickie Whitaker has 30 years' experience in the Re(In)surance business and for the last 20 years has specialised in risk and innovation, linking academia, government and finance. He co-founded The Lighthill Risk Network, Oasis Palm Tree Ltd, The Oasis Hub and is chief executive of Oasis Loss Modelling Framework Ltd. He provides advisory roles to: UK's Satellite Applications Advisory Board, Expert Group for the Global Risk Assessment Framework (GRAF), UNISDR and Cabot Institute advisory board.

Academic Advisors

Professor Michael Barrett

Professor of Information Systems & Innovation Studies and Director of Research, Judge Business School University of Cambridge

Michael is the 2016 Distinguished Scholar for the OCIS Division at the Academy of Management. As part of the ESRC's Expert Advisory Group, he helps inform their strategic engagement of the Global Challenges Research Fund (GCRF); a £1.5 billion fund distributed across multiple delivery partners to be spent on international development research over the next five years. He has served as head of the Organization Theory & Information Systems group, Director (Associate Dean) of Programmes, and Director of the MPhil in Innovation, Strategy & Organisation (ISO) programme at Cambridge Judge Business School. He is currently Academic Director of Cambridge Digital Innovation and has served on the Steering Board of the Cambridge Service Alliance. Michael has also served as a member of the Management Executive Group of the knowledge translation research group. Collaborations for Leadership in Applied Health Research and Care (CLAHRC).

He has had several editorial responsibilities including: Senior Editor of MIS Quarterly, Associate Editor of Information Systems Research, Senior Editor of Information & Organization and Senior Editor of the Journal of the Association of Information Systems. Michael has also served as a member of the Editorial Board of Organization Science. He has contributed to articles in The Economist, The Times, and The Financial Post, and has served as an external examiner at Oxford University, the University of Edinburgh and the London School of Economics.

Michael has worked as an industrial engineer for Colgate Palmolive and won the Most Valuable Employee award for consulting and business development at Oracle Canada. He continues to work closely in research and executive education for a number of organisations, including Thomson Reuters, Statoil, Bank of China, China Mobile, BT, IBM, HP, PricewaterhouseCoopers, Coventry Building Society, Shell Exploration, and the World Health Organization.

Professor John Rees

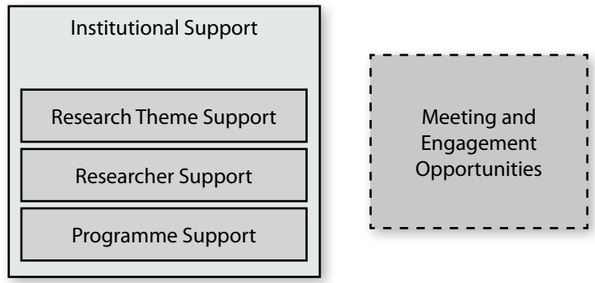
Head of Risk and Resilience Research, Natural Environment Research Council (NERC)

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.

Funding Opportunities and Support Contribution Structure

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 with quality organisations aligned with the Centre's strategic goals.

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 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 the Centre.

As a Research Theme Supporter:

- Funder is invited to nominate a member of the Centre for Risk Studies Advisory Board
- Funder oversees progress review meetings specifically held for that research theme, and guide the prioritisation 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 prioritisation of the current and future research agenda.
- 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

Research Support levels have been a successful entry point for organisations to get involved with the Centre's research. This level of funding allows individual researchers to be hired as part of the research team and focus on an area aligned with the research interests of the funder. Our ability to attract and retain qualified research candidates is greatly increased by being able to offer three year contracts, thus the majority of the Centre's funders have provided multi-year funding commitments.

- 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 prioritisation 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

General programme and research seed funding support. Our ongoing research programmes allow the Centre to sustain a team of technical specialists, editorial contributors, subject matter experts, and administrative support staff. This level of support also provides resources to initiate exploratory seed projects to enhance the research and engagement activities related to the core research projects.

Meeting support

The Centre for Risk Studies seeks supporters for its meetings and engagement activities. The annual Risk Summit is the Centre's flagship event attracting over 200 attendees from corporate risk management, academic, and government policy-making backgrounds. We offer packages of support including Meeting Partner status, Principle Knowledge Partner or Sustaining Meeting Partner status. Other meetings, workshops, roundtables, focus groups 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.

As a Meeting and Engagement Supporter:

- Funder is recognised as a corporate sponsor, with co-branding on the conference collateral, social media, and other outlets.
- Opportunities to participate as part of the organising committee, propose speakers and content and provide general input.

Contact information for all support enquiries

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