Overview of Centre for Risk Studies
Research Agenda 2014

Dr. Andrew Coburn
Research Associate
Risk Centre Background:
Understanding Catastrophic Failure in Complex Systems

- Proceedings:  

- Focus of the Centre for Risk Studies has been an enabler of projects and interchanges on complexity science and emergent behaviour

- Analysis of tightly-coupled systems, non-linear feedback loops, and failure analysis

- Risk Centre conference: Managing the Risk of Catastrophic Failure in Complex Systems

- Triggered a research programme into the effects of shocks on business networks:  
  ‘A Shock to the System’
2012: Cambridge Risk Framework **Threat Taxonomy**

### Financial Shock
- Asset Bubble
- Financial Irregularity
- Market Crash
- Sovereign Default
- Bank Run

### Trade Dispute
- Labour Dispute
- Trade Sanctions
- Cartel Pressure
- Nationalization
- Tariff War

### Geopolitical Conflict
- Conventional War
- Asymmetric War
- External Force
- Civil War
- Nuclear War

### Political Violence
- Organized Crime
- Assassination
- Civil Disorder
- Separatism
- Terrorism

### Natural Catastrophe
- Earthquake
- Windstorm
- Volcanic Eruption
- Flood
- Tsunami

### Climatic Catastrophe
- Drought
- Freeze
- Tornado & Hail
- Electric Storm
- Heatwave

### Environmental Catastrophe
- Sea Level Rise
- Ocean System Change
- Atmospheric System Change
- Pollution Event
- Wildfire

### Technological Catastrophe
- Cyber Catastrophe
- Technology Accident
- Infrastructure Failure
- Nuclear Meltdown
- Industrial Accident

### Humanitarian Crisis
- Famine
- Water Supply Failure
- Child Poverty
- Welfare System Failure
- Refugee Crisis

### Externality
- Space Threat
- Ozone Layer Collapse
- Satellite System Failure
- Meteorite
- Solar Storm

### Disease Outbreak
- Human Epidemic
- Animal Epidemic
- Waterborne Epidemic
- Zoonosis
- Plant Epidemic

### Other
- ?

---

**Centre for Risk Studies**

**University of Cambridge Judge Business School**
Progress During 2013

- Began to populate the threat taxonomy
- Developed a selection of threats into illustrative stress test scenarios
- Developed a methodology to assess the consequences of a scenario on multi-line business, macroeconomy, and investment portfolios
- Collated a large set of databases on the global networks that underpin our economy
- Developed early-stage models of disruption to networks and financial and economic contagion
Risk Centre 2013 Outputs
Cambridge Working Paper Series

Available at
http://cambridgeriskframework.com
Global Landscape of Risk
Insurance Industry Standardization Initiative

- Workshop co-hosted by Munich Re and Cambridge Risk Centre, 10 September 2013
- Attended by a group of major insurers interested in the topic of managing emerging risks
- Included British Standards Institute
  - Testing insurers’ interest in developing a Publicly Available Specification (PAS)
- Workshop concluded that there is need for standardisation of:
  - terminology and concepts
  - scenario data schemas
  - exposure structures
2013: Scenarios Development

Geopolitical Conflict

Sino-Japanese Conflict in the East China Sea
Regional conflict in South China Sea embroiling multiple military powers
*SME: Richard Hartley, Josh Wallace, Cytora;

Cyber Catastrophe

Sybil Logic Bomb Cyber Attack
Major compromise of commercial IT systems by cyber attack
*SME: Rob Watson, Richard Clayton, Frank Stajano, Cambridge Computer Labs; Éireann Leverett, I/O Active

Human Pandemic

Sao Paulo Flu Pandemic
Virulent influenza pandemic causes months of absenteeism and economic disruption
*SME: Mary Chang, Molly Sullivan, RMS

Social Unrest Risk

‘Sack the Bankers’ Worldwide Protest Movement
Austerity-driven riots and strikes across multiple cities in several Eurozone countries
*SME: Ivan Ureta, Geneva Sch of Diplomacy & Richard Hartley, Josh Wallace, Cytora;

Oil Price Shock

Regime Change in Saudi Arabia
Arab Spring event leads to western military intervention triggering major oil price spike
*SME: Ivan Ureta, Geneva Sch of Diplomacy & Richard Hartley, Josh Wallace, Cytora;

Banking Crisis

Bank run in Southern European
Run on banks in Greece and Cyprus causing contagion through European financial system

Climatic Freeze Event

8 week freeze in Northern Hemisphere
Severe and extended winter in Northern Europe and East Coast USA

Piracy Crisis

Severe Piracy Activity in Horn of Africa
Intensity of piracy incidents increases to the point that shipping patterns are impacted
Can We Understand ...

Various types of emerging risks:

- Pandemics
- Social Unrest
- Geopolitical Conflicts
- Cyber

And assess their potential to cause:

- Underwriting Losses
- Non-Underwriting Operational Impact
- Investment Portfolio Impact
Scenario Definition
Process definition, timeline, footprint, sectoral impacts, contagion mechanisms

Loss Estimation
Impact on workforce; means of production; utilities; supply chains; finance; sentiment

Macroeconomic Modelling
Sectoral & regional productivity loss on key metrics such as GDP, Employment

Market Impact Assessment
Valuation of key asset classes, such as equities, fixed income, FX

Specific individual process for each type of threat and process
Create a standardized structure for developing loss estimates
Use state-of-the-art macroeconomic modelling to explore potential outcomes
Project scenario consequences as time-based changes in investment asset returns
Key Methodological Challenges

- Can we construct an extreme fictional scenario that is plausible through using evidence-based precedents?
  - Can these scenarios meet the challenge of being useable by businesses and ultimately adopted for use in risk management?

- Can we estimate the losses that would result from extreme events that haven’t occurred in today’s world?
  - Can we create a robust and transparent estimation process?

- Can we push macroeconomic models outside their comfort zone to model extreme events usefully?
  - How far beyond range of the model’s parameterization?

- Can we model the impact of hypotheticals on investment asset classes and portfolios?
  - How useful are asset value ‘fundamentals’, and how much market sentiment and crisis behaviour do we need to incorporate?
Trading Relationships of Enterprises in Global Economy
Trading Relationships of Enterprises in Global Economy
Trading Relationships of Enterprises in Global Economy
Trading Relationships of Enterprises in Global Economy
Economic Sectoral Trade Networks

35 economic sectors
41 countries + RoW
Substrate Databases Compiled in 2013

World City Database

Air Travel Network

Communications Networks

Cargo Shipping Networks
A Banking Network Liquidity Contagion Model

Co-Pierre Georg, 2012
‘Black Rhino’ model of shocks on a banking network
Cambridge FinCat International Banking Network Model

Topology

India & Central Asia
SE Asia
Latin America
Central & Eastern Europe
Middle East
Africa

Geography

- Inner Core (Tier 0)
- Outer Core (Tier 1)
- Inner Periphery (Tier 2)
- Outer Periphery (Tier 3)
Contagion in International Banking Network from Greek Bank Run

Default (Capital Ratio <0)
Near Default (CR <2%)
Impact (CR <4%)
Compromised (CR reduced)
Unaffected (CR maintained)
State of the Art of Financial Network Models

- Hasn’t yet achieved realistic behaviour in network performance
  - Agent rules, confidence, and psychological behaviour is not well encoded
  - May not behave like a mechanistic system
- Not all the actors (central banks, companies, creditors) are well represented in these models
- Financial actors are a single agent
- Very simplified representation of real-world data

Topology of international banking network as a force-directed graph, from Cambridge FinCat Risk Model
2014 CRS Research Programme Themes

1. Global Complex Risk Landscape

2. Understanding Complex Business Exposure
   – Compiling data on the interconnectivity of the business world, and exploring their propensity for and vulnerability to cascading failure.

3. Financial Catastrophe Risk

4. Insurability of International Supply Chains

5. Understanding the Threat of Cyber Catastrophe
   – Developing a more rigorous framework for the evaluation of extreme cyber risk, as one of the most significant threats in the taxonomy.