Centre for Risk Studies

5th Risk Summit: Special Topics Seminar

Welcome to Special Topics Seminar

Prof Danny Ralph
Academic Director

Centre for Risk Studies
UNIVERSITY OF CAMBRIDGE
Judge Business School

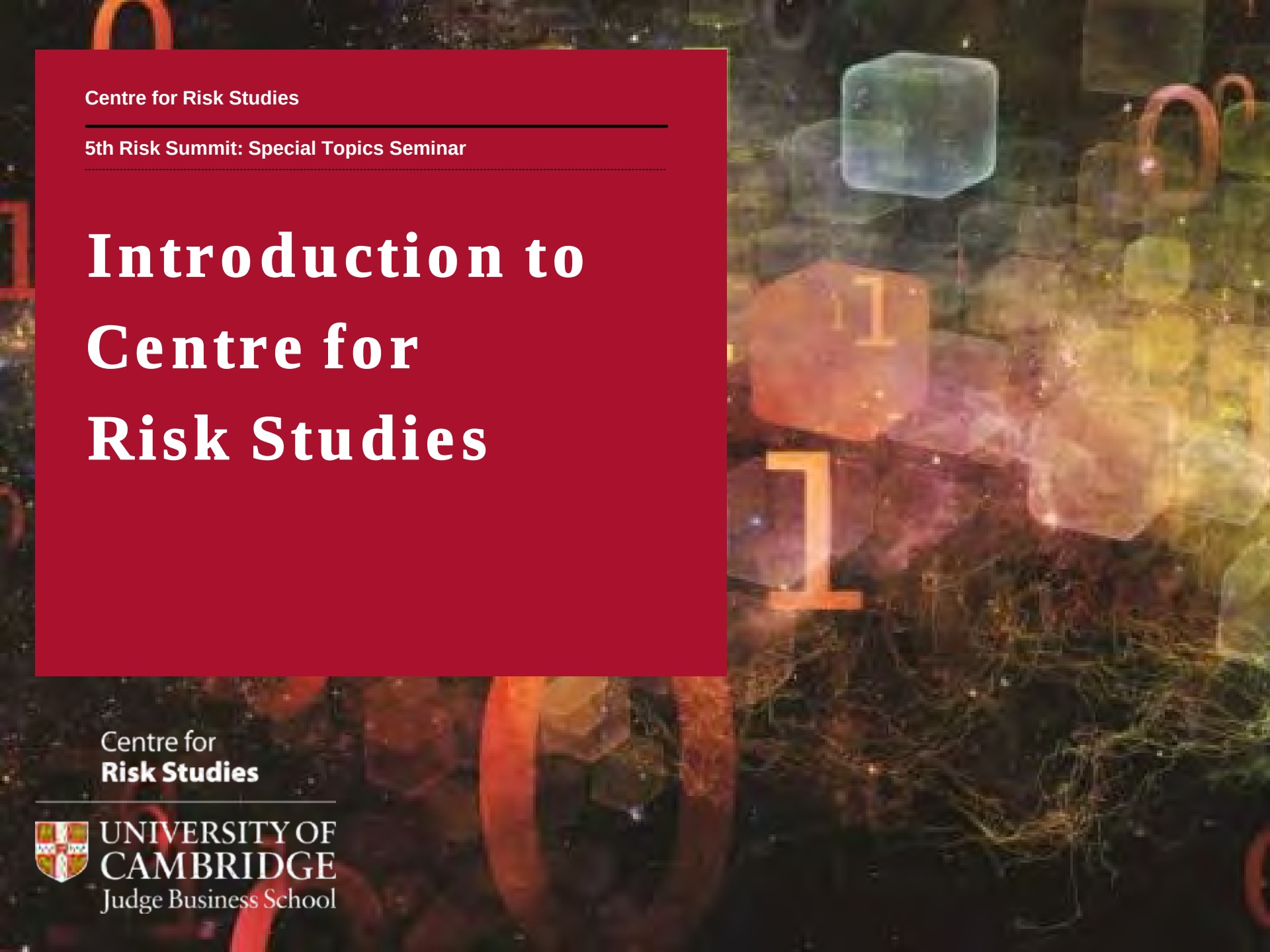
Special Topics Agenda

9:30	**The Cambridge Risk Framework: Scenarios, Threats, &Business Decisions** Professor Daniel Ralph, Academic Director, Cambridge Centre for Risk Studies
10:10	**A System of Systems Approach for Understanding Risk** Dr Andrew Skelton, Risk Researcher, Cambridge Centre for Risk Studies
10:30	**Cyber Catastrophe - an Interlinked Systemic Risk** Simon Ruffle, Director of Technology Research & Innovation, Cambridge Centre for Risk Studies
10:50	Coffee break
11:30	**Catastronomics: The Economics of Catastrophes** Dr Scott Kelly, Research Associate, Cambridge Centre for Risk Studies
11:50	**Understanding Financial Catastrophes** Dr Fabio Caccioli, Research Associate, Cambridge Centre for Risk Studies
12:10	**Data for Risk Analysis: Exposure & Vulnerability** Dr Roxane Foulser-Piggott, Research Associate, Cambridge Centre for Risk Studies
12:30	**Mapping Geopolitical Risk** Joshua Wallace, Cytora
12:50	Lunch
14:00	**Catalysing Risk Management Innovation through Openness** Paul VanderMarck, Chief Products Officer, Risk Management Solutions
14:30	**Cambridge Centre for Risk Studies Research Agenda 2015** Dr Andrew Coburn, Director of External Advisory Board, Cambridge Centre for Risk Studies
15:00	End of pre-conference session

Centre for Risk Studies

5th Risk Summit: Special Topics Seminar

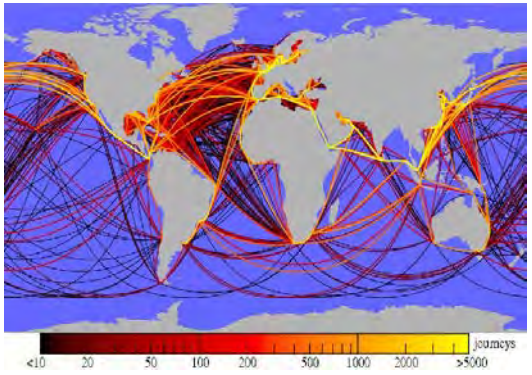
Introduction to Centre for Risk Studies



Centre for
Risk Studies

UNIVERSITY OF CAMBRIDGE
Judge Business School

University of Cambridge Centre for Risk Studies



Overview

- Established in 2009 as a product of activities across the University in Complex Systems
- System-of-Systems view of risk
- Impact oriented research for business, government, and academic communities

Annual meetings

2009 Managing the Risk of Catastrophic Failure in Complex Systems

2010 The Human Dimension of Risk:
Perception, Behaviour & Decision-Making in Risk Management

2011 Anticipating the Future:
Risk Management for Long-term Planning

2013 Risk & Strategy: Returns versus Resilience

2014 **The Pulse of Risk**:
From Big Data to Business Value

University of Cambridge Centre for Risk Studies

Cambridge Risk Framework is an approach and toolkit for researching systemic shocks

- Emerging & systemic risks
- Resiliency in International Supply Chains (RISC)
- Financial crises and systemic risk in banking (FinCat)
- Risk governance and corporate risk strategy

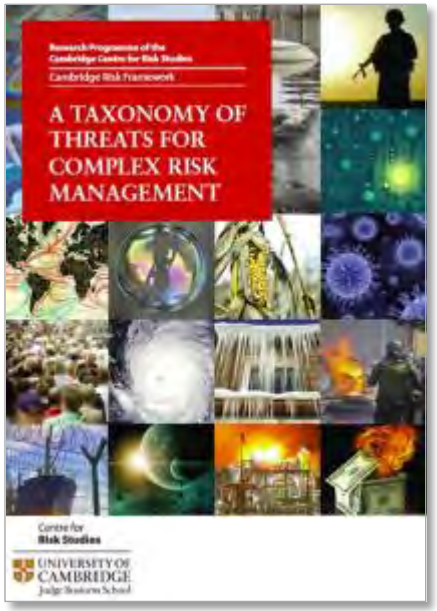
Research Supporters

RMS, Lockheed Martin, E·S·R·C Economic & Social Research Council, HSBC, McKinsey&Company, Catlin, Munich RE, bp

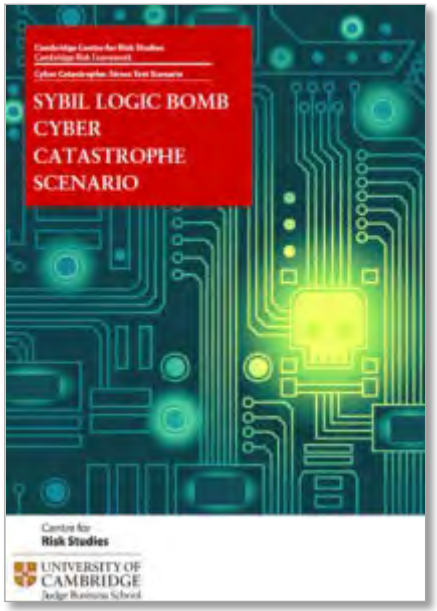
Collaborators

Nanyang Technological University, Oxford Economics, Axco A Wilmington Company, FNA

New Centre for Risk Studies Publications



Taxonomy of Threats



Cyber Catastrophe Stress Test Scenario

Pandemic Stress Test Scenario

Geopolitical Conflict Stress Test Scenario

Available for Download from Our Website:
CambridgeRiskFramework.com

Further Links

- Advisory Board Meeting 2014, Jan 2014
- Emerging Risks Scenarios for Risk Management, Mar 2014
  - Global Risk Landscape publications
- Insurability of Supply Chain Risk, Apr 2014
- Cambridge Risk Framework www.risk.jbs.cam.ac.uk/
  - Publications at http://cambridgeriskframework.com/policy

Risk Centre Scenario Project Team & Roles

Prof. Danny Ralph
Academic Director, Centre for Risk Studies
Resilient International Supply Chains; Review

Dr. Andrew Coburn
Director of External Advisory Board
Research lead; Pandemic & Civil Disorder spec

Dr. Gary Bowman
Research Associate, Centre for Risk Studies
Narratives, operational impacts; Conflict spec

Dr. Fabio Caccioli
Research Associate, Centre for Risk Studies
Financial System and Banking impacts

Dr. Roxane Foulser-Piggott
Research Associate
Global cities at risk and Data management

Benjamin Leslie
Risk Researcher
Mathematical modelling and research platform

Josh Wallace
Co-Founder, Cytora
Conflict monitoring, analytics and technology

Dr. Michelle Tuveson
Executive Director
Project oversight, programme coordination.

Simon Ruffle
Director of Technology Research
Technical architecture & framework; Cyber spec

Dr. Louise Pryor
Actuary and Risk Specialist
Investment portfolio modelling

Dr. Scott Kelly
Macroeconomic Researcher
Macroeconomic modelling

Andy Skelton
Risk Researcher
Enterprise network modelling

Dr. Duncan Needham
Risk Affiliate
Fellow of Centre for Financial History

Antoine Feylessoufi
Visiting Scholar
Research into network datasets

Centre for Risk Studies

5th Risk Summit: Special Topics Seminar

The Cambridge Risk Framework: Scenarios, Threats, &Business Decisions

Prof Danny Ralph
Academic Director

Centre for **Risk Studies**

UNIVERSITY OF CAMBRIDGE
Judge Business School

Can an Insurance Company Understand …

Emerging risks:

Geopolitical Conflicts

Pandemics

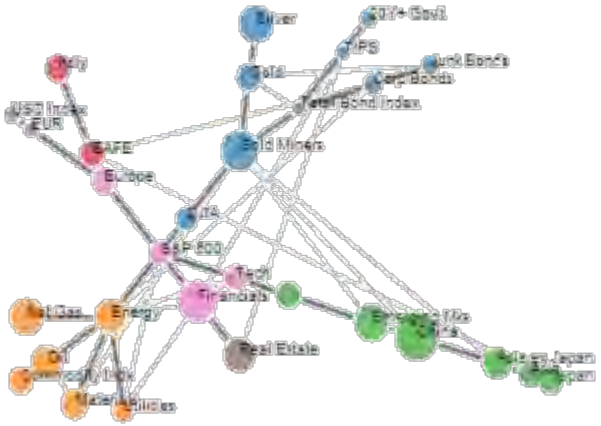
Cyber

And assess their potential to cause:

Underwriting Losses

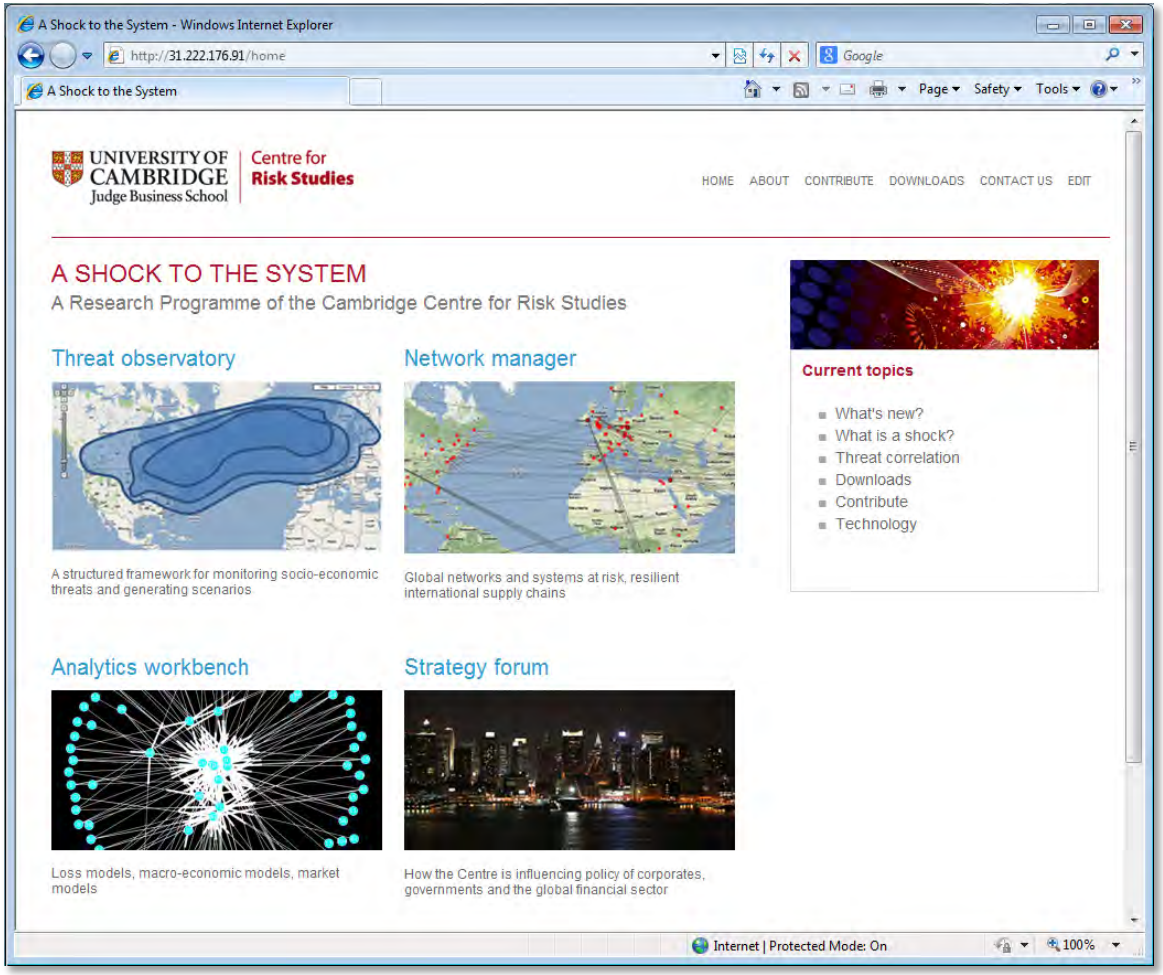
Non-Underwriting Operational Impact

Investment Portfolio Impact



Cambridge Risk Framework: Components of System Shock

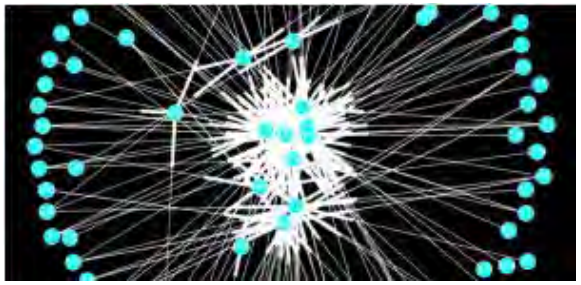
www.risk.jbs.cam.ac.uk



Threat Observatory

Network Manager

Analytics Workbench



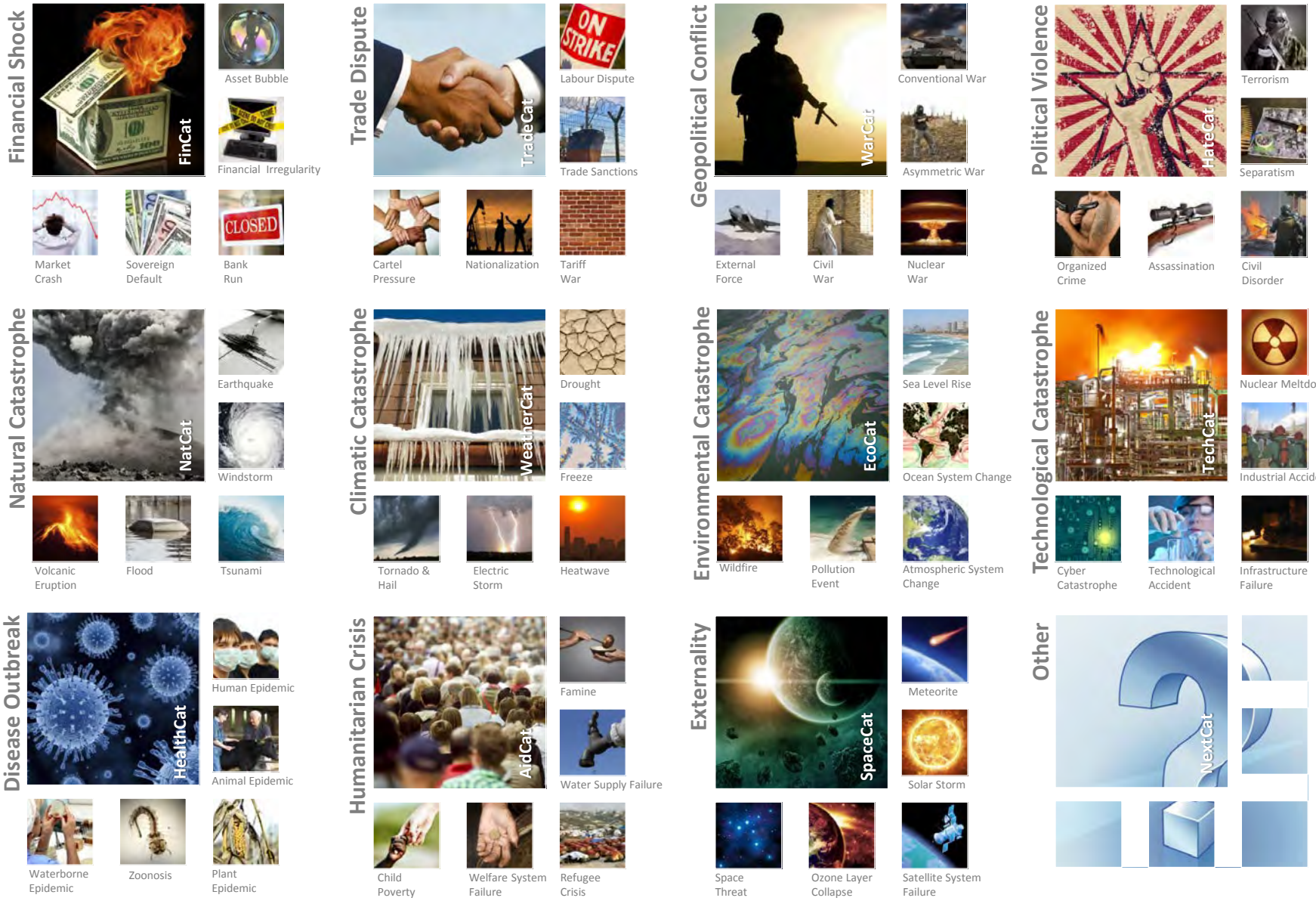
Strategy Forum

UNIVERSITY OF CAMBRIDGE Judge Business School | Centre for Risk Studies

Cambridge Risk Framework Agenda

- Taxonomy of Threats
- Scenarios: Narratives and impacts
- Macroeconomic & financial market consequences
- In progress …

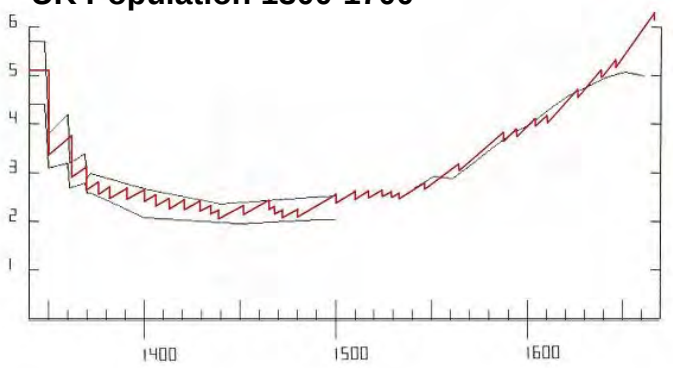
Cambridge Risk Framework
Threat Taxonomy



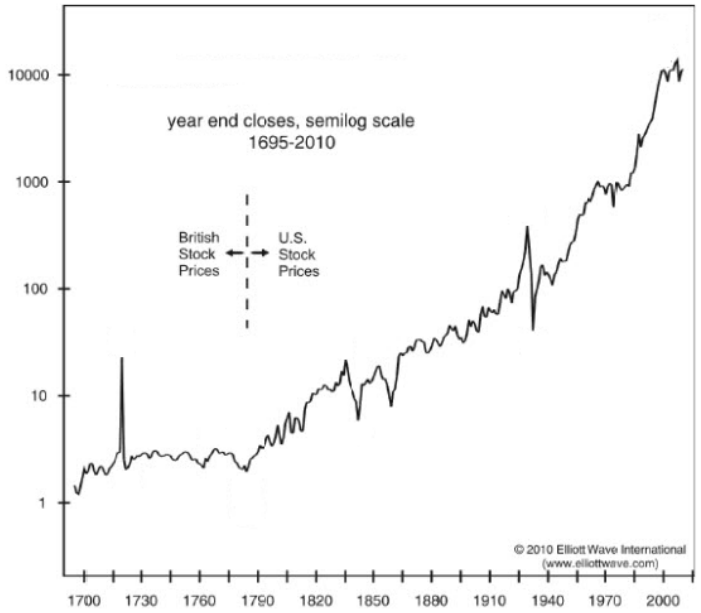
Evidence-Based Approach

- 1000 years of data
- Categorization of causes
  - Primary effort is to ensure that all categories are captured
  - Identify drivers of risk
- Counter-Factual History
  - Near-miss events that could have caused catastrophe with plausible minor deviations from actual events
- Major disruptions that do not appear in the historical records
  - Climate change; new technology hazards; changes in frequency and severity of threats

UK Population 1300-1700



300 years of Stock Market records



Source: Jay (2010)
http://fintrend.com/tag/bear-market/

Definition of Macro-Threat

- A potential cause of a socio-economic catastrophe that would threaten human and financial capital, damage assets, and disrupt the systems that support our society, at a national or international level

Criteria for inclusion:

- Evident in last 1000 years
- Impact (at least one of the following):
  - **Human Injury**: Kills more than [**1,000**] people; or injures or makes seriously ill more than [**5,000**] people
  - **Disruption**: For a major region or nation, or for a particular international business sector, it would cause normal life patterns and commercial productivity to be substantially interrupted for more than [**one week**]
  - **Cost**: Physical destruction of property and infrastructure costing [**$10 billion**] to replace, or similar level of loss of value of assets
  - **Economic impact**: At least one country loses at least [**1%**] of Gross Domestic Production

Looking ahead: 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?

Cambridge Risk Framework Agenda

- Taxonomy of Threats
- **Scenarios: Narratives and impacts**
  - Methodology
  - China-Japan Conflict Scenario
- Macroeconomic & financial market consequences
- In progress …

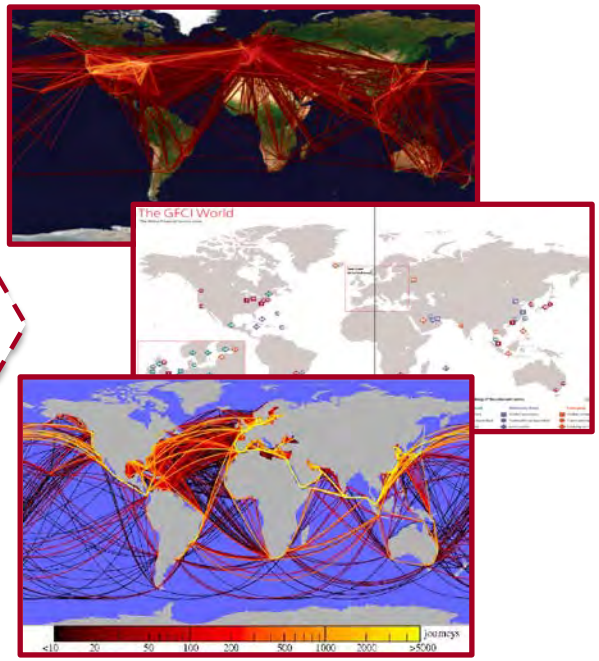
The Role of Scenarios…

Macro-Threats

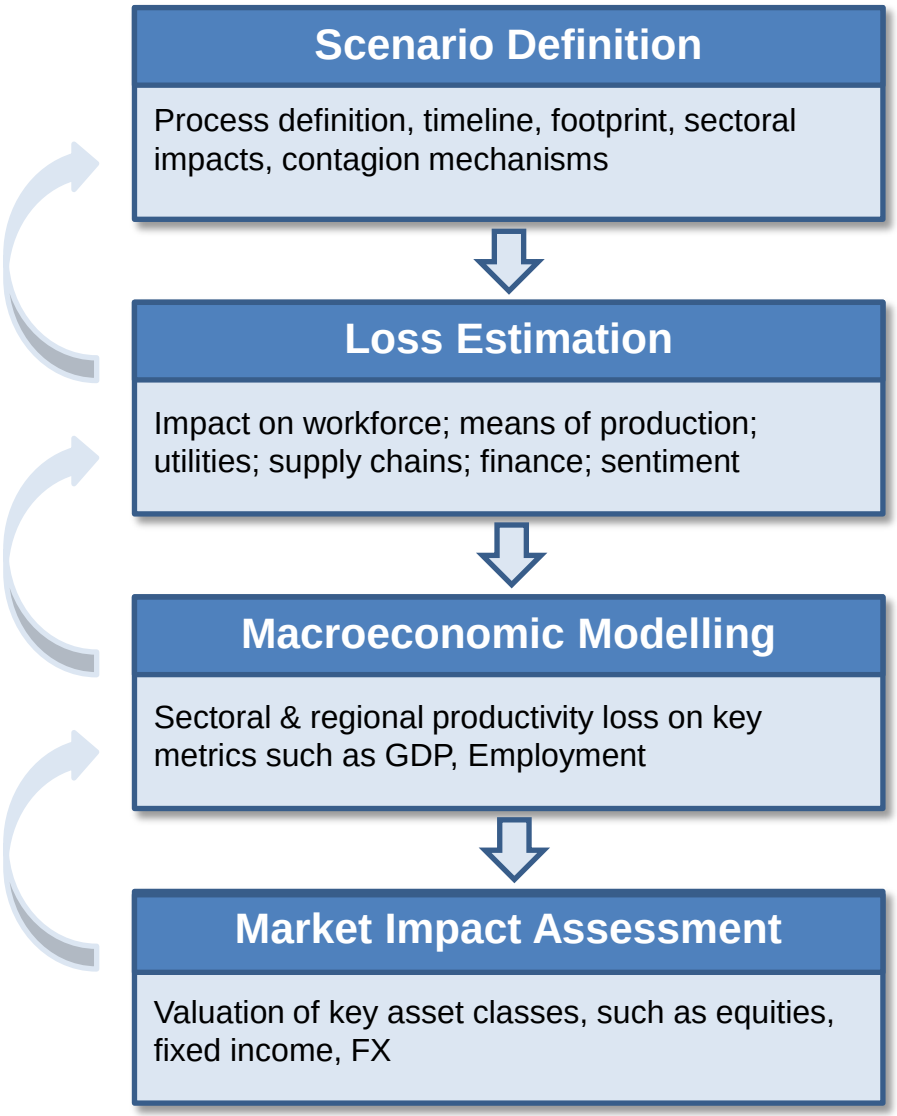
In Cambrige Risk Framework:

Scenarios are STRESS TESTS

Organisations (Networks)



CRS Scenario Development Process



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

‘1-in-100’ Calibration of Perils

- A 1-in-100 year event refers a 1% chance of exceeding a given level of impact in any given year
- Critical aspects
  - Defining impact metrics for different dimensions of an event
  - Understanding uncertainty
    - Is the event “stationary” or “time dependent”?
    - Is the uncertainty essentially physical?
      - ➔ scientific approach to evidence & analysis
    - Is the uncertainty a social phenomenon?
      - ➔ social science approach to evidence & analysis
- Communicating confidence
  - A challenge we are undertaking

Disclaimer

- Scenarios are not predictions
- Our hypothetical scenarios are developed as stress tests for risk management purposes
  - These are contingency scenarios used for ‘what-if’ studies and do not constitute forecasts of what is likely to happen
  - These hypothetical scenarios are intended to improve business resilience to shocks

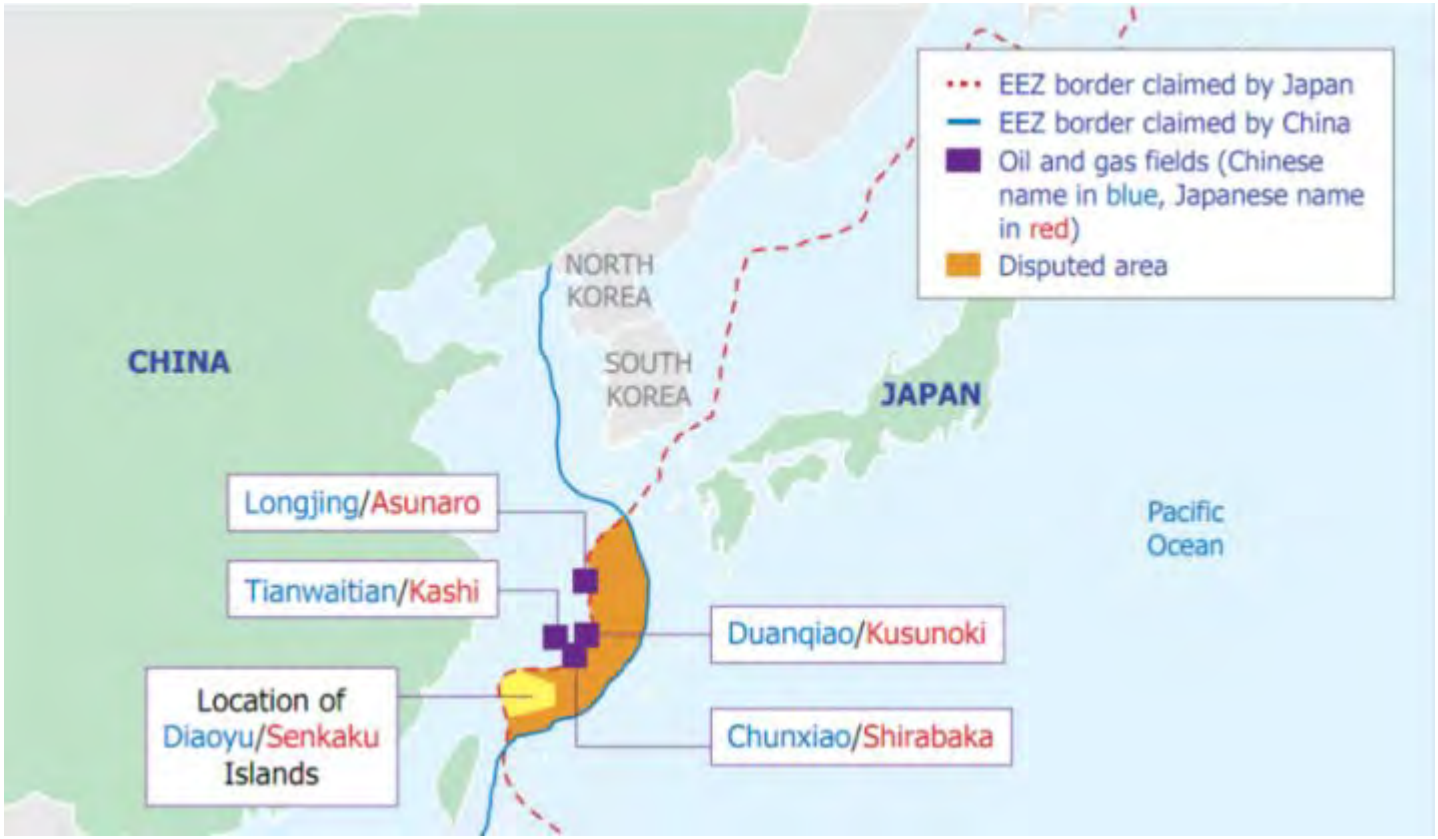
China-Japan Conflict Scenario: Taxonomy of Conflict and Likelihood

	Level 1	Level 2	Level 3	Level 4
Proponents	Conflicts between minor powers – No superpower	One superpower against a minor power	One superpower against regional power/an ally or proxy of another superpower	More than two superpowers engage in direct conflict
Polarity	Any	Any	Shift to Multipolarity	Multipolar
Power Asymmetry	Balanced low level of power	Major asymmetry	Moderate asymmetry	Balanced
Observed Frequency	Several conflicts a decade, and always a minor war somewhere in the world	Expect one or two a decade, as US or allies exert increasing power as global policemen	In modern times, expect only one or two a century as superpowers avoid confronting each other	20th century history does not apply – globalized economy deters world wars
Current Likelihood	Common (>50% a year)	Occasional (10% a year)	Unlikely (1% a year)	Extremely Unlikely (0.1% a year)
Duration of conflict	Long	Short	Short-Medium	Long
Example	Yugoslav wars Congo wars	'Desert Storm' Iraq; Afghanistan invasion;	US-Vietnam War	WWI WW2

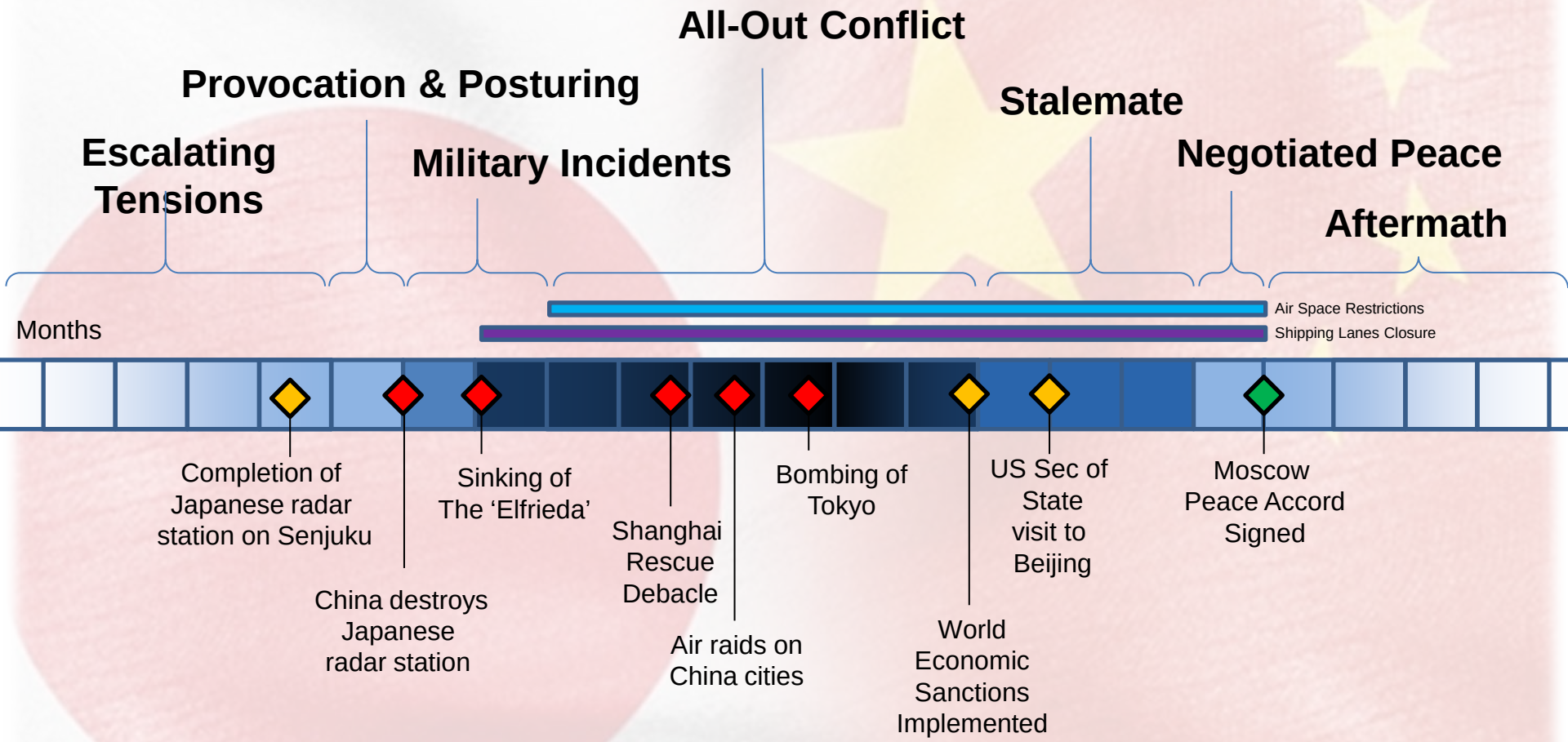
Level Selected

Illustrations from China-Japan Conflict Scenario

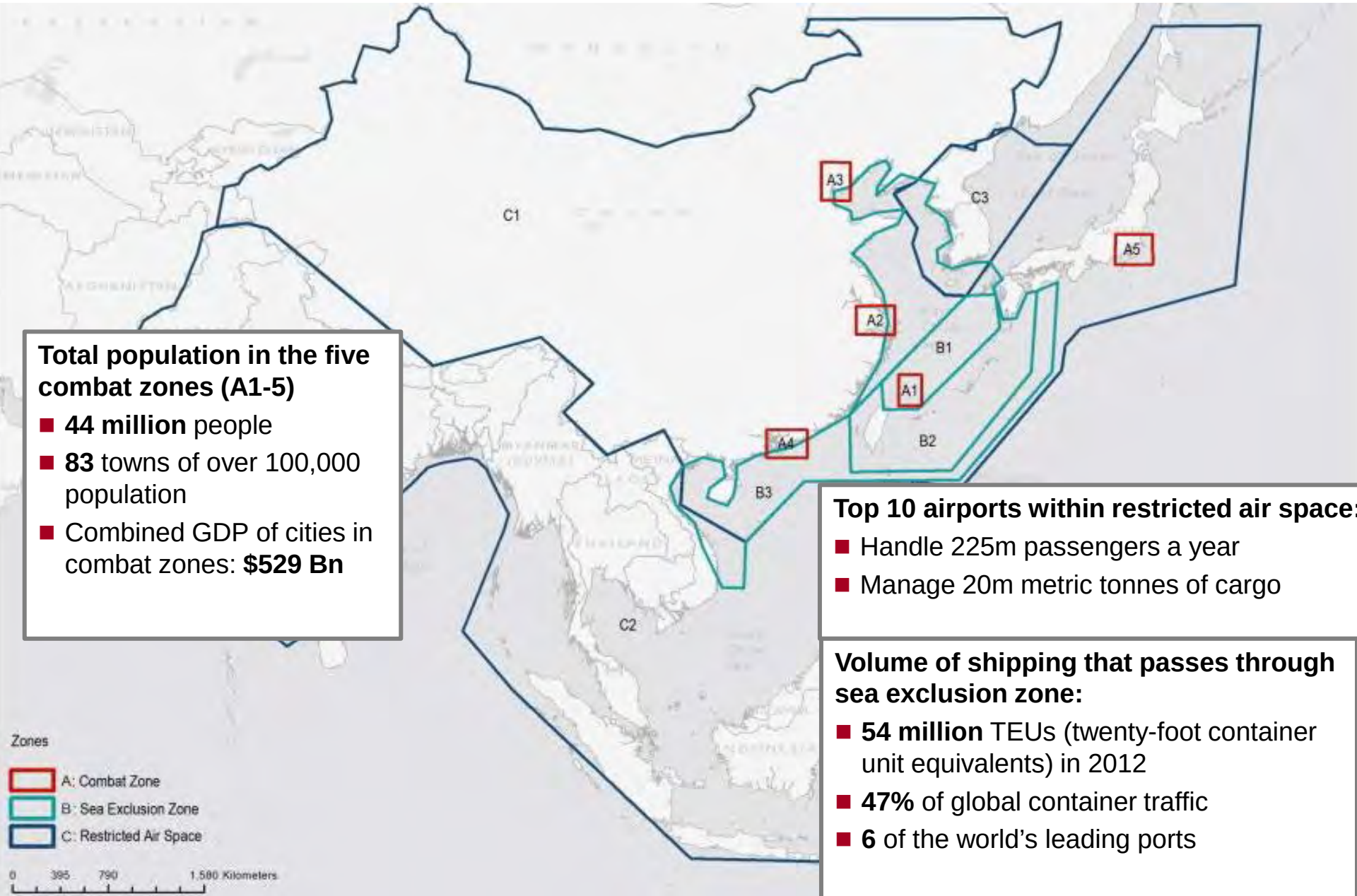
- Historical tension between China & Japan
- Disputed Diaoyu / Senkaku islands a focus



China-Japan Conflict: Scenario Phases over 9 months



China-Japan Conflict Scenario zones



Total population in the five combat zones (A1-5)

- **44 million** people
- **83** towns of over 100,000 population
- Combined GDP of cities in combat zones: **$529 Bn**

Top 10 airports within restricted air space:

- Handle 225m passengers a year
- Manage 20m metric tonnes of cargo

Volume of shipping that passes through sea exclusion zone:

- **54 million** TEUs (twenty-foot container unit equivalents) in 2012
- **47%** of global container traffic
- **6** of the world's leading ports

Direct Losses

Property losses:

- 450,000 properties damaged during military action
- Corporations suffer heavy losses
- Business interruption from power and utility outages
- Evacuation of personnel
- IT infrastructure damaged in cyber attacks

Life, Health & WC losses:

- Factories and office buildings targeted in military action
- c.100,000 people killed
- c.750,000 people injured (75% in China, 25% in Japan)
- Exodus of Western business people

Scenario Variants: S2 & X1

S1 is the standard scenario over 9 months

S2 Scenario

- 2-year duration
- 3-years of trade disruption
- Prolonged conflict and stalemate phase
- 70% trade disruption
- 250,000 dead

X1 Scenario

- 5-year duration
- 5-years of trade disruption
- Prolonged conflict phase
- 90% trade disruption
- 500,000 dead

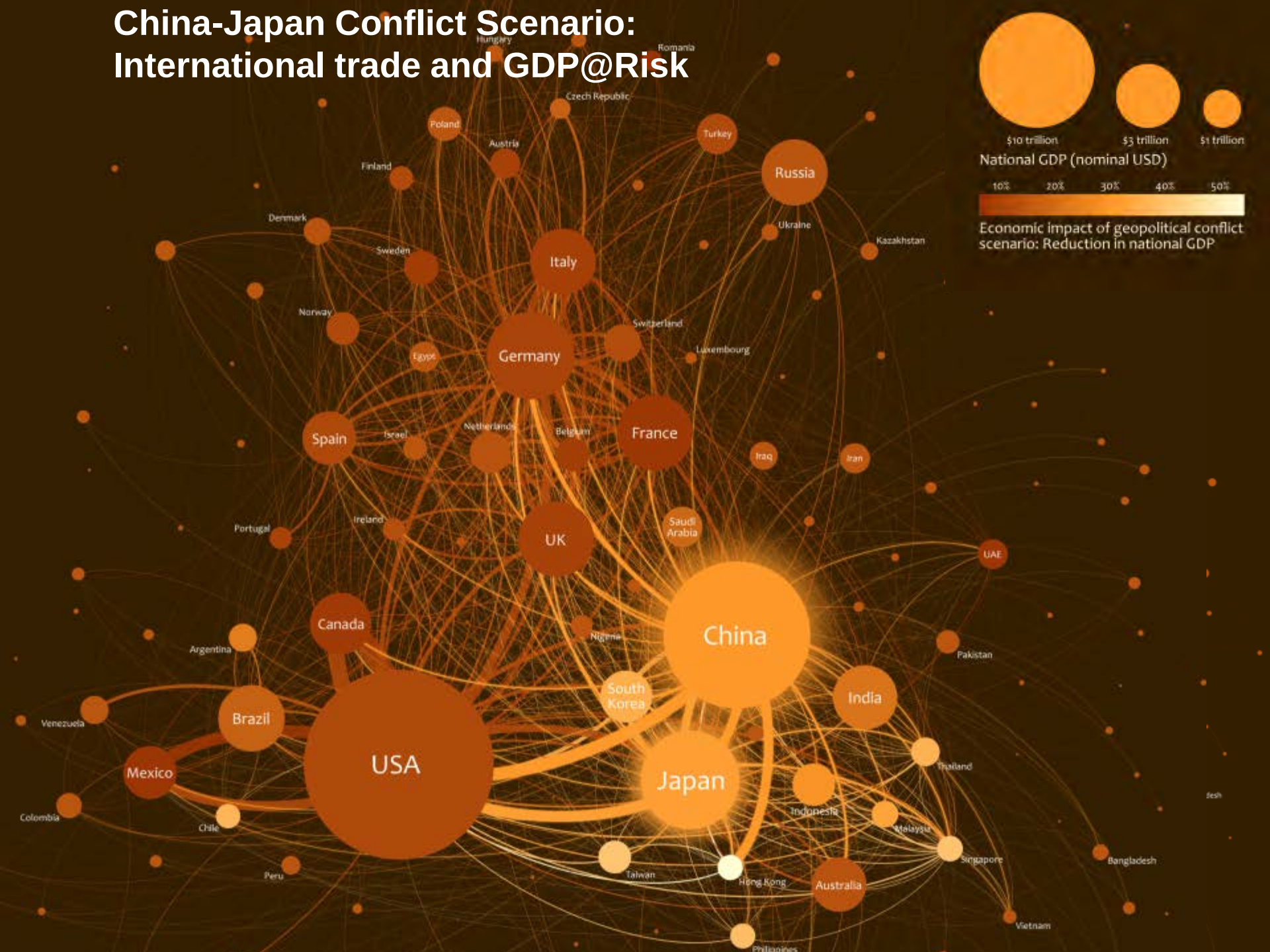
Cambridge Risk Framework Agenda

- Taxonomy of Threats
- Scenarios: Narratives and impacts
- Macroeconomic & financial market consequences
- In progress …

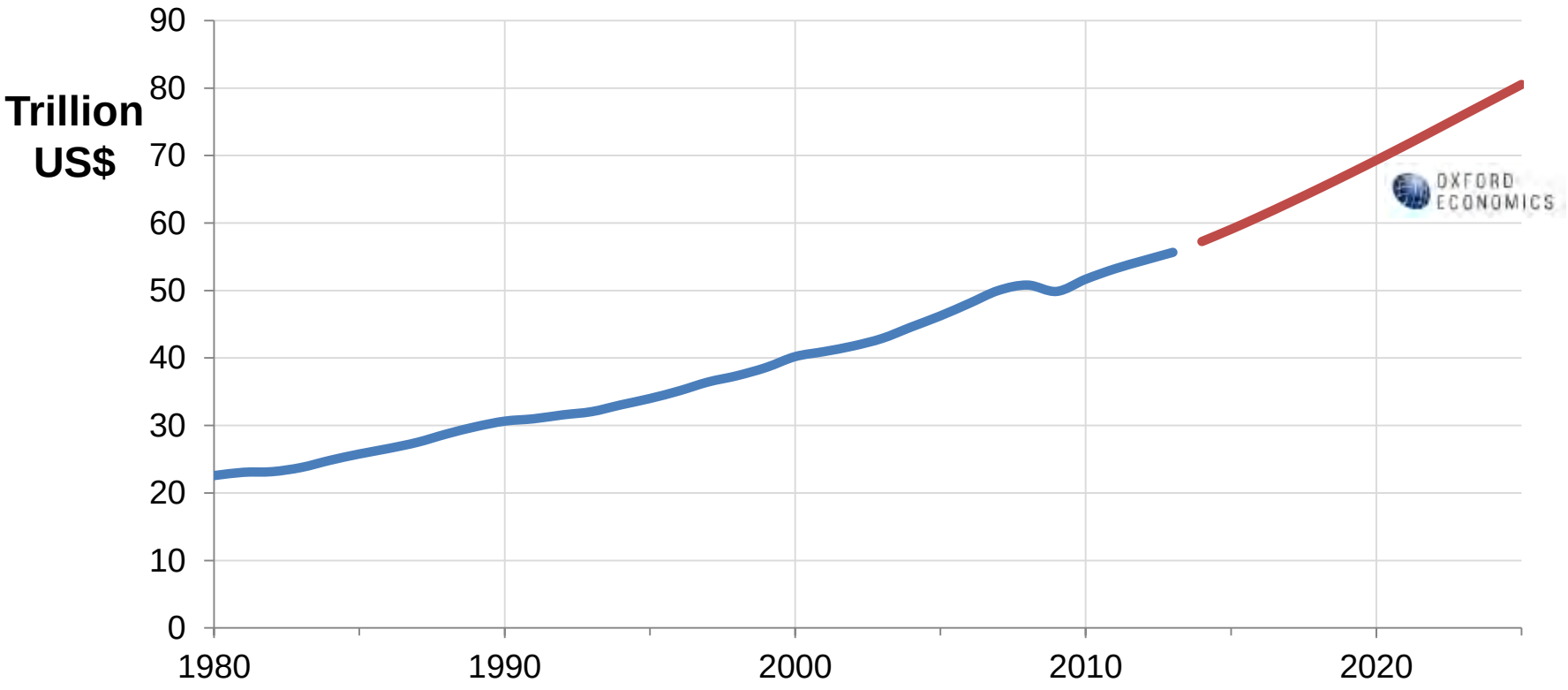
Macroeconomic Modelling

- Global Economic Model of Oxford Economics
- Role of scenarios
  - *Identify* macro economic variables that are most impacted by event; calibrate *scale* of impact
  - Eg, China-Japan Conflict Scenario
    - In China & Japan: Trade ⇩, FDI⇩, Capital ⇩
    - Globally: Oil price ⇧
  - Shock macro econ variables within GEM
- Study outputs of GEM over 5 years post-shock
  - Look at GDP effects on global scale: **GDP@Risk**
  - Eg, China-Japan Conflict Scenario:
    - GDP loss of standard scenario is same scale as Global Financial Crisis
    - GDP loss of USA + EU on same scale as China + Japan

China-Japan Conflict Scenario: International trade and GDP@Risk

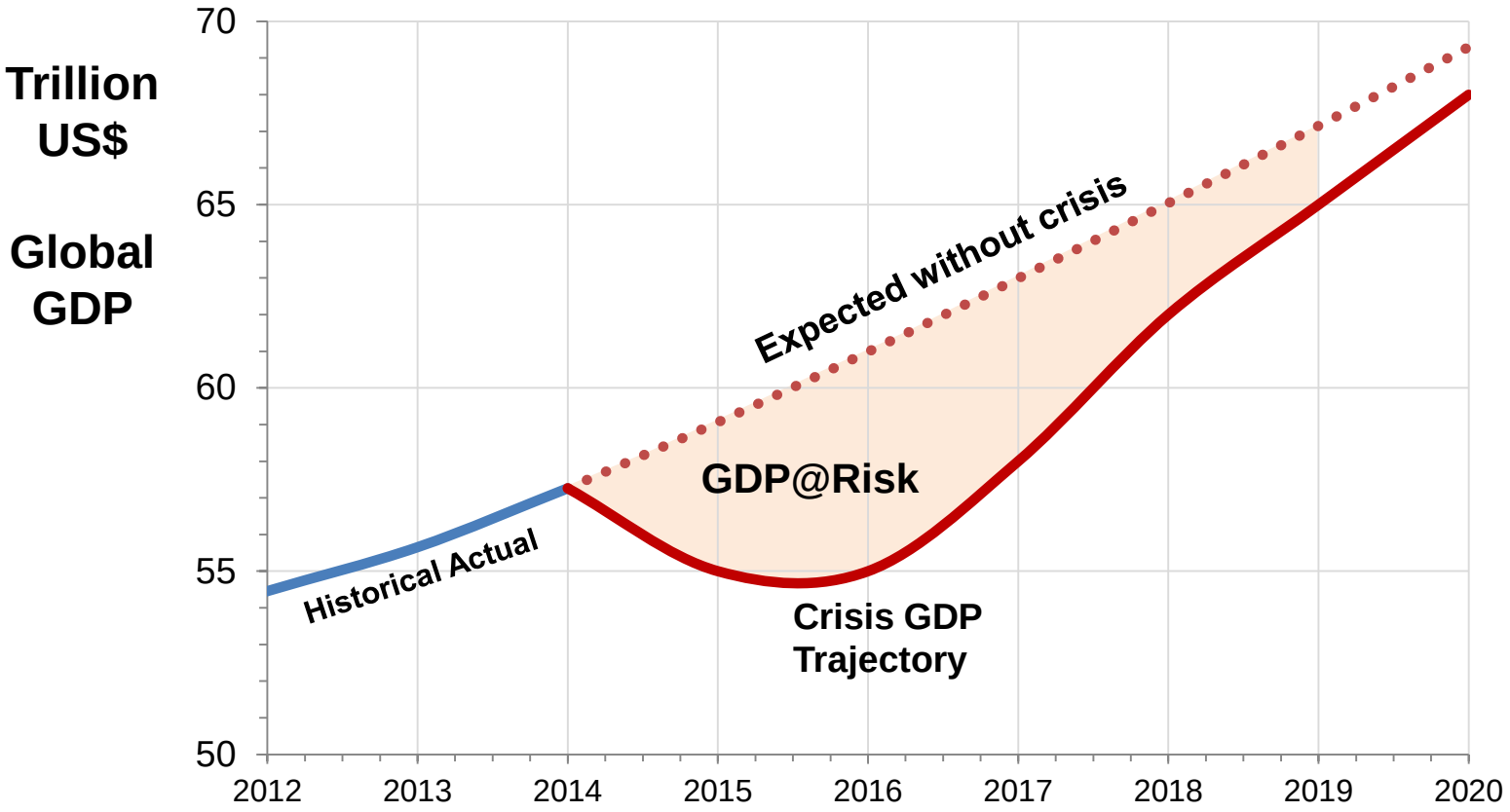


More on GEM: The GDP baseline view is positive



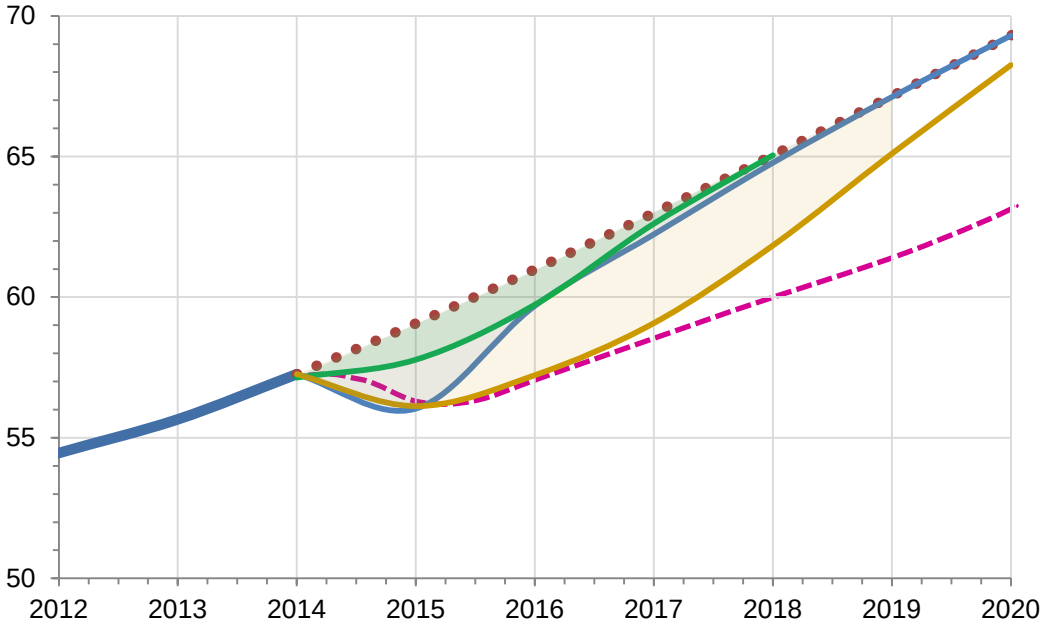
Global GDP 1980:	**$22.5 Trillion**
Historical Average Annual Growth Rate 1980-2006:	**3.0%**
Global GDP 2013:	**$55.6 Trillion**
OE Economic Forecast Global GDP 2025:	**$80.5 Trillion**
Forecast Size of Global Economy in 2025, relative to today:	**145%**
Forecast Average Annual Growth Rate 2014-2025:	**3.2%**

Introducing ‘Catastronomics’

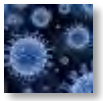


GDP@Risk: Cumulative first five year loss of global GDP, relative to expected, resulting from a catastrophe or crisis

5 Year Global GDP@Risk: 3 Standardised Catastrophe Scenarios



Geopolitical Conflict $US 17.4 Tr



Pandemic 6.8 Tr

Cyber Catastrophe 4.5 Tr

2007-2012 Great Financial Crisis 18.1 Tr

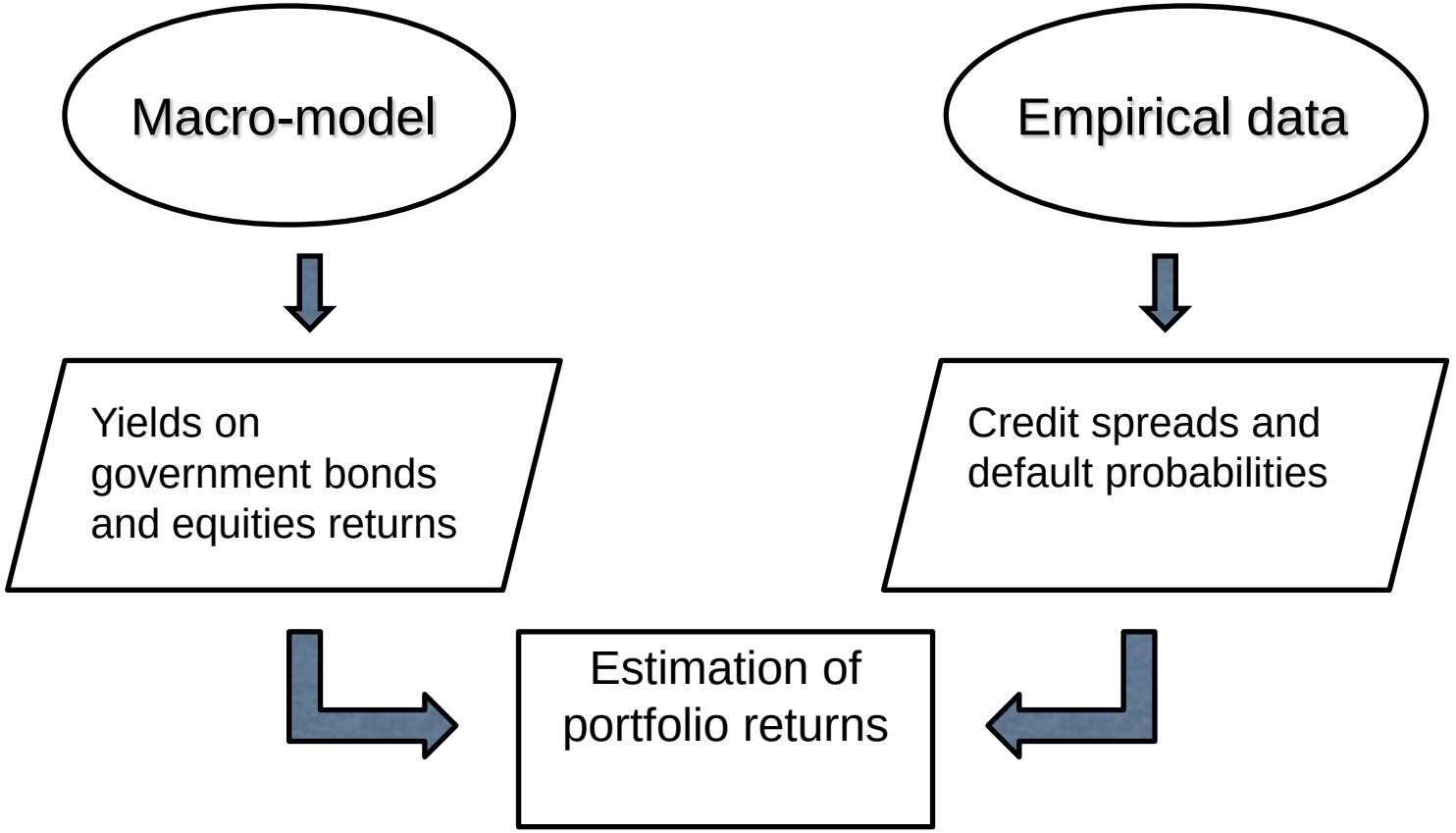
Great Financial Crisis as if at 2014 19.7 Tr

Financial Market Consequences: Standardised High Quality, Low Risk Portfolio

- Financial portfolio, largely fixed income
  - Set up as proxy for mid sized insurance underwriter
  - Mainly gov & commercial bonds in $US, £GB and €Euros
  - Some cash, equities

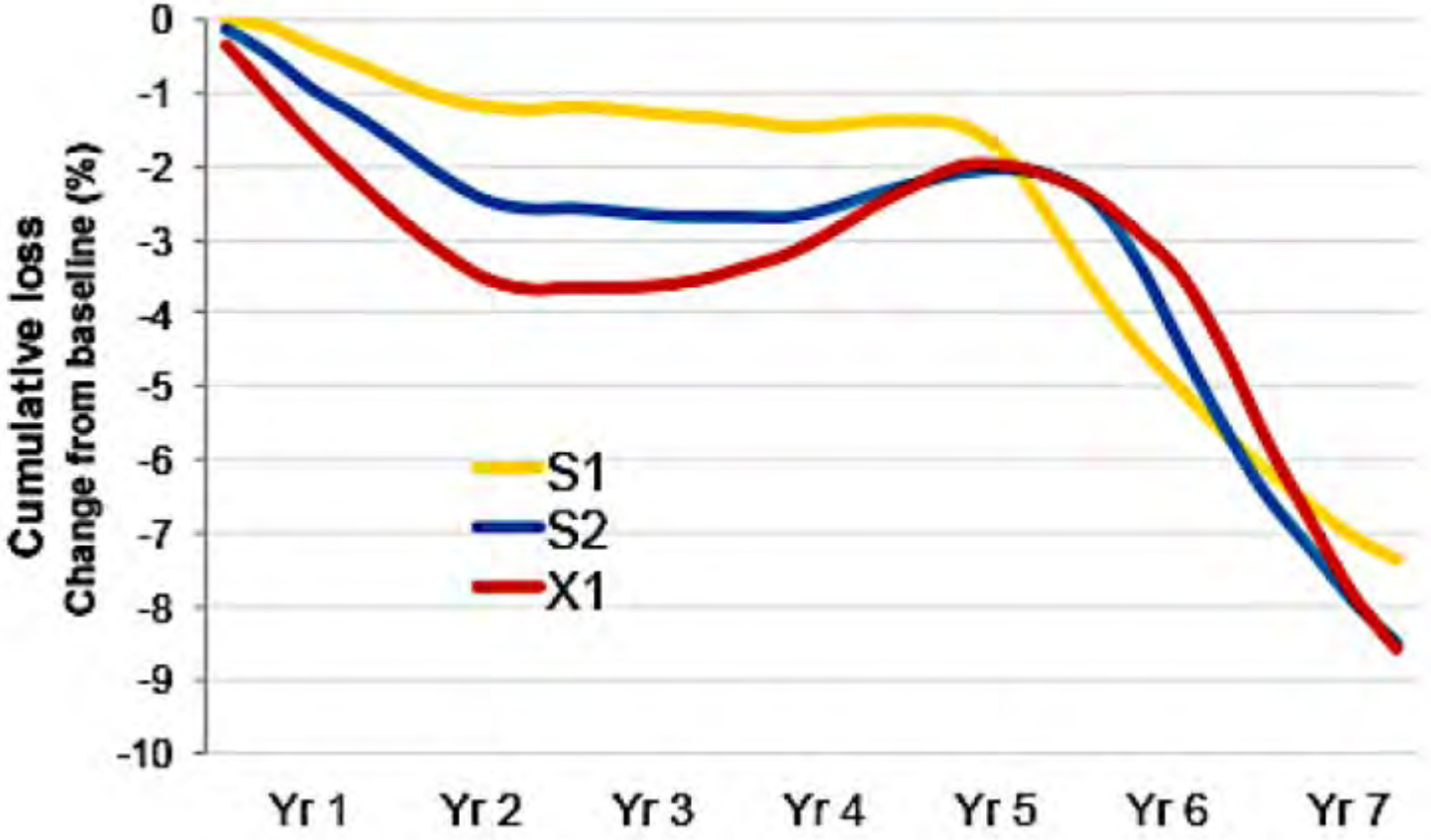
- Technical points, e.g.:
  - Taylor rule used to derive interest rate from inflation rate
  - Estimate default rate on corporate bonds from credit spread

Methodology



China-Japan Conflict Scenario: Macroeconomic impacts

Relative change of cumulative returns



5 year GDP@Risk in $US trillions		
S1	S2	X1
17.4	27.0	30.2

How Can You Use These Stress Tests?

- Insurance companies
  - Multi-line underwriting losses + Operational risks + Investment risk
    - Example data points on correlation
  - Complex accumulations and portfolio management
  - Identify new product offerings and business opportunities
- Corporate businesses
  - Challenging management assumptions about status quo
  - Crisis preparedness and contingency planning
  - Supply chain and counterparty risk
- Financial Risk Managers
  - 'Exogenous shock' stress test scenarios for investment portfolios
- Policy makers
  - Prioritization of resources for civil emergency preparedness
  - National security of food, energy, infrastructure and essential services

Information Compendium – Stress Test Scenarios

- Prioritizing threats for investigation
- Identifying subject matter editors in priority threats
- Exploring whether there is an established frequency-severity distribution for each threat
- Identifying the severity associated with an 1% annual probability of exceedance worldwide of that threat
- Developing a scenario to represent that threat severity

Cambridge Risk Framework Agenda

- Taxonomy of Threats
- Scenarios: Narratives and impacts
- Macro economic & financial market consequences
- In progress …

In Progress

- Guidance notes on uncertainty inherent in quantifying a given scenario
- More scenarios!
  - Scenarios on long term trends versus acute shocks
- Beyond individual scenarios
  - A suite of scenarios
  - Cascading scenarios

Centre for
Risk Studies

UNIVERSITY OF
CAMBRIDGE
Judge Business School

Professor Daniel Ralph
d.ralph@jbs.cam.ac.uk