Financial Risk and Network Theory
Seminar 13 September 2016

Trillion Dollar Shocks to the Financial System

Dr Andrew Coburn
Cambridge Centre for Risk Studies
### Cambridge Centre for Risk Studies Research Team

#### Centre for Risk Studies Executive Team

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof Danny Ralph</td>
<td>Academic Director</td>
</tr>
<tr>
<td>Dr Michelle Tuveson</td>
<td>Executive Director</td>
</tr>
<tr>
<td>Dr Andrew Coburn</td>
<td>Director of Advisory Board</td>
</tr>
<tr>
<td>Simon Ruffle</td>
<td>Director of Research &amp; Innovation</td>
</tr>
</tbody>
</table>

#### Centre for Risk Studies Research Team

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Andy Skelton</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Dr Ali Shaghaghi</td>
<td>Research Assistant</td>
</tr>
<tr>
<td>Dr Jay Jung</td>
<td>Risk Researcher</td>
</tr>
<tr>
<td>Jennifer Copic</td>
<td>Research Assistant</td>
</tr>
<tr>
<td>Tamara Evan</td>
<td>Research Assistant</td>
</tr>
<tr>
<td>Dr Edward Oughton</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Jessica Tsang</td>
<td>Research Assistant</td>
</tr>
<tr>
<td>Arjun Mahalingam</td>
<td>Research Assistant</td>
</tr>
<tr>
<td>Dr Shahzeb Malik</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Kayla Strong</td>
<td>Research Assistant</td>
</tr>
<tr>
<td>Shaheera Asante</td>
<td>Editorial Assistant</td>
</tr>
<tr>
<td>Dr Scott Kelly</td>
<td>Risk Affiliate</td>
</tr>
</tbody>
</table>

#### Reviewers and Advisors

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Duncan Needham</td>
<td>Risk Researcher</td>
</tr>
<tr>
<td>Dr Fabio Caccioli</td>
<td>Risk Affiliate</td>
</tr>
<tr>
<td>Dr Kimmo Soramaki</td>
<td>Founder, FNA Ltd.</td>
</tr>
<tr>
<td>Eugene Neduv</td>
<td>VP Solutions, FNA Ltd.</td>
</tr>
<tr>
<td>Dr Louise Pryor</td>
<td>Senior Risk Researcher</td>
</tr>
<tr>
<td>Simon Ruffle</td>
<td>Senior Risk Researcher</td>
</tr>
</tbody>
</table>
Changes in Financial Risk Landscape

**Asset Bubble Risk**
- Property bubbles continue to build
- “DotCom 2.0” TechStock decline
- ZIRP - the ‘Everything’ Bubble’

**Price Shock Risk**
- Oil price collapse
- Commodity pricing slump
- Food price volatility

**Sovereign Crisis Risk**
- BREXIT UK Rating Downgrade
- Continuing Eurozone strain
- Could US opt for default?

**Technological Risk**
- Aug 2015 ‘Flash crash’
- Growth in algorithmic ‘black box’ trading

**Banking Crisis Risk**
- Italian banking crisis
- Basel III progress – close to TLAC
- Central banks less likely to bail out

**Fraud Risk**
- LIBOR Scandal settlement
- Wells Fargo Collusion
- ‘Lazarus’ $1Bn attempted Cyber Attack on SWIFT

**Inflation**
Property Bubbles Continue to Threaten to Burst

UBS Global Real Estate Bubble Index
Latest index scores for the housing markets of selected world cities

Bubble Risk
Overvalued
Fair-valued
Under-valued
Depressed

London
Hong Kong
Sydney
Vancouver
San Francisco
Amsterdam
Geneva
Paris
Frankfurt
Tokyo
Singapore
New York
Boston
Chicago


China’s Property Bubble Echoes Subprime Crisis
Harry Dent - © August 3, 2016

The warning fury of economic triggers that began piling up after the Great Recession are only getting larger and we can’t do much but watch it unfold and stay alert.

I wrote about this in a letter late last year, but now here we are more than halfway through the year and it’s only getting worse. So much worse that the Chinese property bubble is now

China Has The Mother of All Bubbles
Shanghai Real Estate Price Index

Source: China Real Estate Index, Bloomberg, Dent Research

Hong Kong
London
Sydney
Vancouver
San Francisco

Bubble Risk
Overvalued
Fair-valued
Under-valued
Depressed


+69% Rise
+63%
-97% Worst Case
-97%
-97% Best Case

0 50 100 150 200 250 300 350 400 450
Scenario: Global Property Crash

- CCRS Stress Test Scenario explores impact of rapid collapse of property prices
- Cascading collapse of overheated property markets in 9 regions of the world
- Value collapse exposes mortgage lending and property assets on balance sheets
- Contagion through interbank lending, asset fire-sales, and cross-holding mechanisms
- Systemic spread destroys 15% of value of balance sheets in financial system
- Causes lost economic output (GDP@Risk) of $11 Trillion
- Extreme scenario of $23 Trillion GDP loss
- Investment portfolios see shock losses of 7-23% of value, depending on structure of portfolio
The frequency of credit agency reassessments of sovereign ratings (currency and bonds) has increased annually throughout 2010s

Most reassessments are currently negative
CCRS Stress Test Scenario explores impact of sovereign crises in major economies

Scenario sees cascading collapse of multiple countries through debt and trading relationships

Government debt is the trigger for crisis, with political constraints on national response

Anti-European sentiment is created by Eurozone financial rules that limit spending

Electoral surprises return political parties that defy rules, devalue currencies and reschedule debts

Devaluation of government bonds leads to shock impact on investment portfolios

Contagion through bond holding investments

Causes lost economic output (GDP@Risk) of $6 Trillion

Extreme scenario of $20 Trillion GDP loss

Investment portfolios see shock losses of 6-13% of value, depending on structure of portfolio
Could Even the United States Default?

“I would borrow knowing that if the economy crashed you could make a deal… I think there are times for us to refinance. We refinance debt with longer term, because you know we owe so much money… I could see renegotiations, where we borrow long-term at very low rates and, frankly, we do need money to rebuild the infrastructure of our country.”

- The greatest Sovereign Default shock scenarios in our event set are for the default of major economies
- US treasury bonds form the core of many institutional investment portfolios
- US government debt is rising to $21 Trillion
- The revaluation or rescheduling of US government debt is highly unlikely but not unfeasible
- S&P credit rating of AA+ for US
The Improving Resilience of Banks

TLAC (Total Loss Absorbing Capacity) of G-SIBs is near completion

But eight large US banks downgraded by S&P in December because now less likely that Federal Reserve will bail them out if they get into difficulties
# Reforms and Regulatory Progress

<table>
<thead>
<tr>
<th>Reform Area</th>
<th>Basel III</th>
<th>Compensation</th>
<th>Over-the-counter (OTC) derivatives</th>
<th>Resolution</th>
<th>Shadow banking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Risk-based capital</td>
<td>Liquidity coverage ratio (LCR)</td>
<td>Higher loss absorbency for G-SIBs (home jurisdictions)</td>
<td>Requirements for domestically systemically important banks (D-SIBs)</td>
<td>Trade reporting</td>
</tr>
<tr>
<td>Argentina</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>C</td>
<td>&amp;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>C</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>MNC</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>MNC</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hong Kong</td>
<td>C</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>C</td>
<td>LC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>MNC</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>C</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>MNC</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rep. of Korea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>C</td>
<td>LC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td>C</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>C</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>MNC</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>C</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>MNC</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td>LC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reform Areas:
- **A**: Advanced
- **C**: Comprehensive
- **Δ**: Divergent
What Effect Will This Have on the Next Crisis?

- What will the effect be of adding capital buffers to a number of major financial institutions?
- How much risk will it take out from the financial system?
- Will it prevent crises from occurring?
- Or just mitigate the contagion?
18,516 banks
- Total market value of $214 Trillion
- Total equity value of $17.4 Trillion

Mortgage assets total $18.1 Trillion
- Mortgage lending exceeds the equity value of banks
Simulated Contagion of Property Market Crash
How Adding Capital Reduces Contagion Risk

- The capital buffer reduces the threshold at which contagion is transmitted to the next institution.
- Asset fire-sales are reduced in number and severity.
- This acts as a virtual circle in limiting cascade processes.
- With minor shocks it can prevent a crisis occurring.
- With major shocks it has a non-linear damping effect on contagion.
- Capital buffers act like a vaccine in preventing epidemic spread.
Extending the Model to Multi-Layer Networks
Coupling Between Financial Crises and Economic Loss

The diagram shows the coupling between financial crises and economic loss over time, with key financial crises marked on the GDP trajectory. The crises are:

- **1873 Long Depression**: GDP dropped significantly, indicating a severe economic downturn.
- **1907 US ‘Bankers’ Panic’**: GDP fell sharply, reflecting a significant financial crisis.
- **1893 Baring Bank Crisis**: GDP experienced a noticeable decline, highlighting financial instability.
- **1929 Wall St Crash**: GDP suffered a major blow, showing another instance of financial turmoil.
- **2008 Great Financial Crisis**: GDP saw the most significant drop, marking the worst financial crisis in modern history.

The GDP values at risk (GDP@Risk) are presented in US$ Trillion and are as follows:

<table>
<thead>
<tr>
<th>Crisis</th>
<th>GDP@Risk US$ Trillion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1893 Baring Bank Crisis</td>
<td>5</td>
</tr>
<tr>
<td>1873 Long Depression</td>
<td>7</td>
</tr>
<tr>
<td>1907 US ‘Bankers’ Panic’</td>
<td>14</td>
</tr>
<tr>
<td>2008 Great Financial Crisis</td>
<td>20</td>
</tr>
<tr>
<td>1929 Wall Street Crash</td>
<td>30</td>
</tr>
</tbody>
</table>
Investment Portfolio Performance in Different Scenarios

- High Inflation World
- Eurozone Meltdown
- Global Property Crash
- Dollar Deposed

High Fixed Income
Conservative
Balanced
Aggressive

Performance:
-25%
-20%
-15%
-10%
-5%
0%
# Cambridge Scenarios: GDP@Risk

<table>
<thead>
<tr>
<th>Scenario</th>
<th>GDP@Risk US$ Trillion</th>
<th>S1</th>
<th>S2</th>
<th>X1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geopolitical Conflict</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China-Japan Conflict</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset Bubble Shock</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global Property Crash</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pandemic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sao Paolo Virus</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sovereign Default Shock</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eurozone Meltdown</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food and energy price spiral</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Inflation World</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyber Catastrophe</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sybil Logic Bomb</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Unrest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Millennial Uprising</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>De-Americanisation of Financial System</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dollar Deposed</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007-2012 Great Financial Crisis</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Great Financial Crisis at 2016</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Trillion Dollar Shocks

- The financial system is relatively robust to minor and localized shocks.
- A shock that destroys **a trillion dollars or more** of economic output is sufficiently large to trigger significant stockmarket equity devaluations.
- We have a research objective to define all the likely causes of trillion dollar shocks to the global economy.

**Stockmarket Shock**
Reduction of S&P500 Index in One Quarter

**GDP@Risk**
$ Economic Output Loss from Event
What Other Shocks Could Damage the Economy?

- The hunt for ‘Trillion Dollar’ shock events is a task of imagineering
- There could be causes that are inconceivable but we believe that it is philosophically possible to identify:
  - All causal categories
  - Defined severity ranges
  - Representative events of coherence
- We have defined a methodology to develop a catalogue of potential future Multi-Trillion Dollar Shocks
Cambridge Taxonomy of Economic & Financial Threats

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

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

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

**Political Violence**
- Organized Crime
- Assassination
- Social Unrest
- Terrorism
- Separatism

**Natural Catastrophe**
- Earthquake
- Windstorm
- Volcanic Eruption
- Flood
- Tsunami
- Drought
- Freeze
- Tornado & Hail
- Electric Storm
- Heatwave

**Climatic Catastrophe**
- Tornado & Hail
- Electric Storm
- Heatwave
- Wildfire
- Pollution Event
- Atmospheric System Change
- Ocean System Change
- Sea Level Rise

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

**Technological Catastrophe**
- Nuclear Meltdown
- Industrial Accident
- Cyber Catastrophe
- Technological Accident
- Infrastructure Failure

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

**Externality**
- Space Threat
- Ozone Layer Collapse
- Satellite System Failure

**Other**
- Meteorite
- Solar Storm

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

**HealthCat**
- HealthCat
- FinCat
- NatCat
- WeatherCat
- EcoCat
- SpaceCat
- TechCat
- Other

**Centre for Risk Studies**
- University of Cambridge Judge Business School

---

21
CCRS Research Outputs: Explorations of individual threats

- Taxonomy of Threats
- Geopolitical Conflict: Emerging Risk Scenario
- Pandemic: Emerging Risk Scenario
- Cyber Catastrophe: Emerging Risk Scenario
- Social Unrest: Emerging Risk Scenario
- Ebola: Emerging Risk Scenario
- Financial Catastrophes
- Global Property Crash: Financial Risk Scenario
- Eurozone Meltdown: Financial Risk Scenario
- High Inflation: Financial Risk Scenario
- Dollar Dethroned: Financial Risk Scenario
- Historical Crises: Financial Risk
- Cyber Accumulation: Insurance Risk Report
- NatCat FinCats: Clash Report
- Business Blackout: Lloyds Emerging Risk Report
- Climate Change: Investor Sentiment Shock
- World City Risk 2025: Lloyds Co-Branded Report
- Solar Storm: Emerging Risk Scenario
Imposing a Standardized Approach to All Threats

**Finance and Trade**
- Market crash
- Sovereign default
- Oil price shock

**Geopolitics and Society**
- Interstate Conflict
- Separatism Conflict
- Terrorism
- Social Unrest

**Natural Catastrophe and Climate**
- Earthquake
- Tropical Windstorm
- Temperate Windstorm
- Tsunami
- Flood
- Volcanic eruption
- Drought
- Freeze
- Heatwave

**Technology and Space**
- Nuclear accident
- Power outage
- Cyber attack
- Solar storm

**Health and Humanity**
- Human pandemic
- Plant epidemic
## Example Multi-Trillion Dollar Scenarios

### Financial (Endogenous)

<table>
<thead>
<tr>
<th>Threat Type</th>
<th>Event ID</th>
<th>Event Name</th>
<th>Severity</th>
<th>Origin Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Bubble</td>
<td>AB005</td>
<td>Property Crash China &amp; Emerging</td>
<td>S1</td>
<td>Emerging</td>
</tr>
<tr>
<td>Asset Bubble</td>
<td>AB006</td>
<td>Property Crash China &amp; Emerging</td>
<td>S2</td>
<td>Emerging</td>
</tr>
<tr>
<td>Asset Bubble</td>
<td>AB007</td>
<td>Property Crash China &amp; Emerging</td>
<td>X1</td>
<td>Emerging</td>
</tr>
<tr>
<td>Asset Bubble</td>
<td>AB008</td>
<td>Property Crash UK &amp; Commonwealth</td>
<td>S2</td>
<td>Developed</td>
</tr>
<tr>
<td>Asset Bubble</td>
<td>AB009</td>
<td>Property Crash UK &amp; Commonwealth</td>
<td>X1</td>
<td>Developed</td>
</tr>
<tr>
<td>Asset Bubble</td>
<td>AB010</td>
<td>Property Crash US &amp; Americas</td>
<td>X1</td>
<td>Developed</td>
</tr>
<tr>
<td>Asset Bubble</td>
<td>AB011</td>
<td>Property Crash Global</td>
<td>S1</td>
<td>All</td>
</tr>
<tr>
<td>Asset Bubble</td>
<td>AB012</td>
<td>ZIRP Crash Multi-Asset Developed</td>
<td>S1</td>
<td>Developed</td>
</tr>
<tr>
<td>Asset Bubble</td>
<td>AB013</td>
<td>ZIRP Crash Multi-Asset Emerging</td>
<td>S1</td>
<td>Emerging</td>
</tr>
<tr>
<td>Asset Bubble</td>
<td>AB014</td>
<td>ZIRP Crash Multi-Asset Frontier</td>
<td>S1</td>
<td>Frontier</td>
</tr>
<tr>
<td>Bank Run</td>
<td>BR017</td>
<td>European Bank Run</td>
<td>X1</td>
<td>Developed</td>
</tr>
<tr>
<td>Bank Run</td>
<td>BR018</td>
<td>China Bank Run</td>
<td>X1</td>
<td>Emerging</td>
</tr>
<tr>
<td>Bank Run</td>
<td>BR019</td>
<td>North Americas Bank Run</td>
<td>X1</td>
<td>Developed</td>
</tr>
<tr>
<td>Bank Run</td>
<td>BR020</td>
<td>Latin Americas Bank Run</td>
<td>X1</td>
<td>Emerging</td>
</tr>
<tr>
<td>Bank Run</td>
<td>BR021</td>
<td>Middle East Bank Run</td>
<td>X1</td>
<td>Frontier</td>
</tr>
<tr>
<td>Bank Run</td>
<td>BR022</td>
<td>SE Asia Bank Run</td>
<td>X1</td>
<td>Emerging</td>
</tr>
<tr>
<td>Bank Run</td>
<td>BR023</td>
<td>Indian Subcontinent Bank Run</td>
<td>X1</td>
<td>Emerging</td>
</tr>
<tr>
<td>Bank Run</td>
<td>BR024</td>
<td>Australasia Bank Run</td>
<td>X1</td>
<td>Developed</td>
</tr>
<tr>
<td>Sovereign Crisis</td>
<td>SC031</td>
<td>Sovereign Default - 6th Europe Bloc</td>
<td>S2</td>
<td>Developed</td>
</tr>
<tr>
<td>Sovereign Crisis</td>
<td>SC031</td>
<td>Sovereign Default - Estn Europe Bloc</td>
<td>S2</td>
<td>Emerging</td>
</tr>
<tr>
<td>Sovereign Crisis</td>
<td>SC031</td>
<td>Sovereign Default - SE Asia Bloc</td>
<td>S2</td>
<td>Emerging</td>
</tr>
<tr>
<td>Sovereign Crisis</td>
<td>SC031</td>
<td>Sovereign Default - UK</td>
<td>S1</td>
<td>Developed</td>
</tr>
<tr>
<td>Sovereign Crisis</td>
<td>SC031</td>
<td>Sovereign Default - US</td>
<td>S1</td>
<td>Developed</td>
</tr>
<tr>
<td>Commodity Shock</td>
<td>CS191</td>
<td>Oil Price Hike - Severe sudden shock</td>
<td>X1</td>
<td>All</td>
</tr>
<tr>
<td>Commodity Shock</td>
<td>CS192</td>
<td>Commodities Price Hike - Moderate</td>
<td>S2</td>
<td>All</td>
</tr>
<tr>
<td>Commodity Shock</td>
<td>CS193</td>
<td>Food Price Hike - Severe</td>
<td>X1</td>
<td>All</td>
</tr>
</tbody>
</table>

### Geopolitical and Natural (Exogenous)

<table>
<thead>
<tr>
<th>Threat Type</th>
<th>Event ID</th>
<th>Event Name</th>
<th>Severity</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geopolitical Conflict</td>
<td>IW023</td>
<td>China-Japan War</td>
<td>S1</td>
<td>SE Asia</td>
</tr>
<tr>
<td>Geopolitical Conflict</td>
<td>IW024</td>
<td>Korean Pensinsular War</td>
<td>X1</td>
<td>SE Asia</td>
</tr>
<tr>
<td>Geopolitical Conflict</td>
<td>IW025</td>
<td>Middle East Regional War</td>
<td>S2</td>
<td>Middle East</td>
</tr>
<tr>
<td>Geopolitical Conflict</td>
<td>IW026</td>
<td>Russia Eastern Europe Conflict</td>
<td>S2</td>
<td>Eastn Europe</td>
</tr>
<tr>
<td>Geopolitical Conflict</td>
<td>IW027</td>
<td>Pakistan-India War</td>
<td>X1</td>
<td>Indian Sub</td>
</tr>
<tr>
<td>Social Unrest</td>
<td>SU002</td>
<td>SE Asia ‘Arab Spring’ Youth Uprising</td>
<td>S2</td>
<td>SE Asia</td>
</tr>
<tr>
<td>Social Unrest</td>
<td>SU003</td>
<td>Southern Europe Youth Uprising</td>
<td>X1</td>
<td>South Europe</td>
</tr>
<tr>
<td>Terrorism</td>
<td>TR045</td>
<td>European severe terrorism campaign</td>
<td>S2</td>
<td>West Europe</td>
</tr>
<tr>
<td>Terrorism</td>
<td>TR056</td>
<td>Terror WMD attacks on West</td>
<td>S1</td>
<td>US &amp; Europe</td>
</tr>
<tr>
<td>Earthquake</td>
<td>EQ024</td>
<td>Tokyo Mw8.3 Earthquake &amp; Tsunami</td>
<td>X1</td>
<td>Japan</td>
</tr>
<tr>
<td>Volcanic Eruption</td>
<td>VE128</td>
<td>Mount Rainer Volcanic Eruption VEI VII</td>
<td>S2</td>
<td>US</td>
</tr>
<tr>
<td>Freeze Event</td>
<td>FR004</td>
<td>Europe &amp; NE US 6 week freeze</td>
<td>X1</td>
<td>US &amp; Europe</td>
</tr>
<tr>
<td>Drought</td>
<td>DR002</td>
<td>US Dustbowl Drought</td>
<td>S2</td>
<td>US</td>
</tr>
<tr>
<td>Nuclear Accident</td>
<td>NP206</td>
<td>Three Mile Island NPP Meltdown INES 7</td>
<td>X1</td>
<td>US</td>
</tr>
<tr>
<td>Power Outage</td>
<td>PO122</td>
<td>Europe Electricity Generation Shortfall</td>
<td>S2</td>
<td>Europe</td>
</tr>
<tr>
<td>Solar Storm</td>
<td>SS001</td>
<td>North America Solar Storm -1200 dst</td>
<td>S1</td>
<td>N America</td>
</tr>
<tr>
<td>Solar Storm</td>
<td>SS002</td>
<td>Europe Solar Storm -1200 dst</td>
<td>S2</td>
<td>Europe</td>
</tr>
<tr>
<td>Solar Storm</td>
<td>SS003</td>
<td>SE Asia Solar Storm -1200 dst</td>
<td>S2</td>
<td>SE Asia</td>
</tr>
<tr>
<td>Solar Storm</td>
<td>SS004</td>
<td>World Solar Storm -2500 dst</td>
<td>X1</td>
<td>Global</td>
</tr>
<tr>
<td>Cyber</td>
<td>CY022</td>
<td>Systemic cyber attack &quot;IT Malaise&quot;</td>
<td>S1</td>
<td>Global</td>
</tr>
<tr>
<td>Cyber</td>
<td>CY043</td>
<td>Cyber attack Critical Infrastructure</td>
<td>X1</td>
<td>US &amp; Europe</td>
</tr>
<tr>
<td>Pandemic</td>
<td>HE074</td>
<td>Virulent Infectious Disease SE Asia</td>
<td>S1</td>
<td>SE Asia</td>
</tr>
<tr>
<td>Pandemic</td>
<td>HE092</td>
<td>Global pandemic influenza Genetic Shift</td>
<td>X1</td>
<td>Global</td>
</tr>
<tr>
<td>Pandemic</td>
<td>HE049</td>
<td>Emergent Infectious Disease S America</td>
<td>S2</td>
<td>S America</td>
</tr>
<tr>
<td>Plant Epidemic</td>
<td>PE003</td>
<td>Wheat Rust Blight North America</td>
<td>S1</td>
<td>N America</td>
</tr>
<tr>
<td>Plant Epidemic</td>
<td>PE007</td>
<td>Rice disease epidemic Asia</td>
<td>X1</td>
<td>Asia</td>
</tr>
</tbody>
</table>

Indicative only - Not a comprehensive listing
Illustrative Investment Portfolio Risk Profile
Exceedance Probability [EP] Curve Showing Tail Risk on Log Scale

Probability of Occurrence in the next 12 months

Investment Portfolio Impact

- All
- NatCat Events
- FinCat Events
- PolitiCat Events
- Pandemics
- CyberCats
What Do You Do With an EP Curve?

- An exceedance probability distribution curve defines risk as a quantitative probability of loss level.
- EP curves provide a structure for integrating risk from many different sources and across multiple investment portfolios.
- The analysis tells you how much risk capital you need to support shocks for a given probability threshold (‘return period’).
- It provides key metrics to analyse portfolio optimization, rebalancing strategies, hedging and risk transfer decisions.
The financial risk landscape is changing rapidly
  – The likelihood of future crises is constantly evolving

Asset bubble threats are the main driver of risk
  – Market shocks should be expected at least as often as they have historically

Better banking stability has reduced contagion risk
  – Future crises will be damped while the regulations remain in force

Multi-Trillion Dollar Shocks are the major threat to the world’s economy
  – The Centre for Risk Studies is on a mission to hunt them down and model them
  – “Gotta catch ’em all…”