

Beyond NatCat Developing Scenarios for Use in Insurance Risk Management

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Centre for
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Judge Business School

https://www.jbs.cam.ac.uk/fileadmin/user_upload/research/centres/risk/downloads/170906_coburn.pdf
(retrieved 18 August 2018)



GLOBAL EXPOSURE ACCUMULATION AND CLASH (GEAC) INITIATIVE

- Insurers are increasingly consolidating and standardizing exposure management across all their lines of business
- The GEAC initiative is to develop a standardized exposure data schema for classes of insurance that account for at least 80% of global insurance premium
- This is seen as an enabler of transfer of exposure data between market players
 - Reinsurance; intermediation; co-share; bordereau;
- **It is also an enabler of scenario development**
 - Encourages third party development: an eco-system of
 - Most insurers develop internal and proprietary scenarios
 - A standardized data schema means that scenarios can be shared and results replicated

USE CASES OF MULTI-LINE EXPOSURE MANAGEMENT

■ Single policyholder aggregation risk

- How many lines of cover do you provide to the same policyholder?
- What are your worst aggregations for a single policyholder?
- Tracing the chain of connected risks for a major corporation



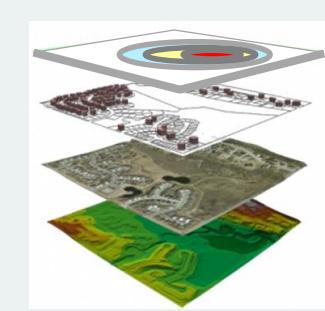
■ Enabling exposure analytics in more lines of business

- Ability to explore scenarios for PMLs in additional insurance lines
- e.g. casualty liability, aviation, marine
- Enable accumulation management beyond NatCat



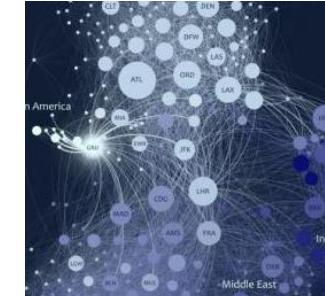
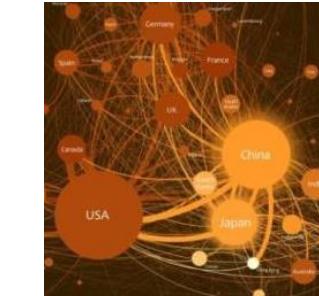
■ High value single location aggregation risk

- e.g. Deep Water Horizons, World Trade Centre losses
- Where are my concentrations of multiple insureds on same risk?
- Are “non-modeled” lines at risk?



■ Multi-line clash in complex loss events

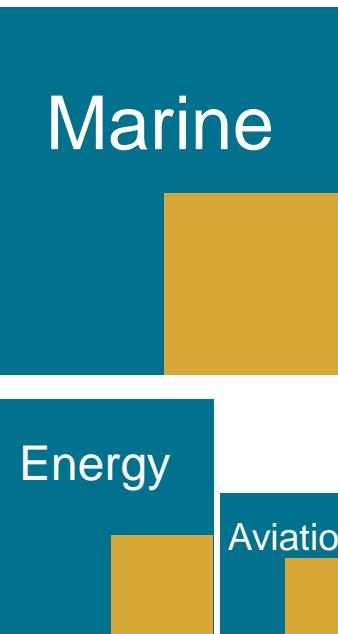
- Consequences impact many different lines of insurance
- Commercial interconnectivity and liability relationships between counterparties causes non-intuitive losses



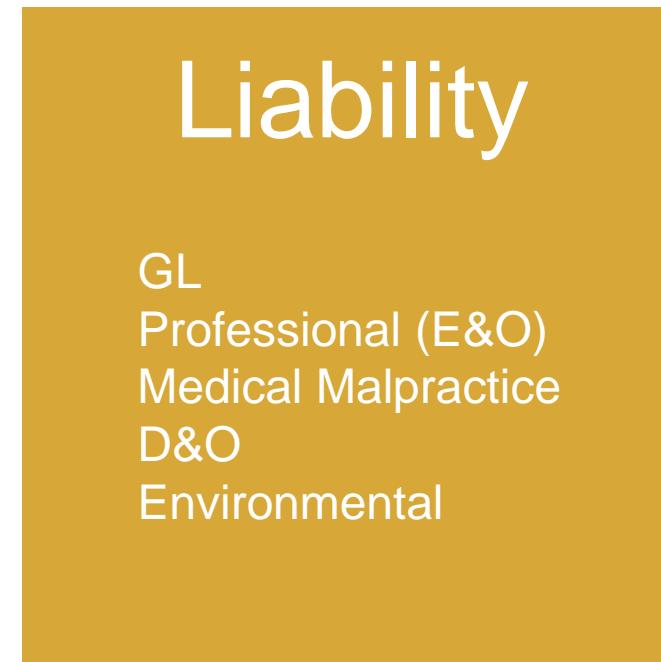
TOTAL EXPOSURE VALUE: COMMERCIAL LINES

Aggregate limits, Asset value under management

Property



Casualty Liability



Personal Accident



\$10,000
Trillion
To Scale

Physical Damage

Duty of care 3rd party

Injury, illness or death

Financial Asset Devaluation

Revenue Loss. Business Interruption

Digital asset loss (cyber)

No specific limit for compulsory auto 3rd party liability; average upper limits assumed

Estimated total insured exposure values, aggregate limits. Pension asset value under management



Distribution of **\$105 Quadrillion**
(\$105,000 Trillion)
Insured Exposure Worldwide



MULTI-LINE DATA SCHEMA DEVELOPMENT PHASES

Aggregate limits, Asset value under management

Property

Phase 1

Casualty Liability

Personal Accident

Commercial Property

BI

Phase 2

Marine

Energy

Liability

GL
Professional (E&O)
Medical Malpractice
D&O
Environmental

Group Personal Accident

\$10,000 Trillion To Scale

Physical Damage

Duty of care 3rd party

Injury, illness or death

Financial Asset Devaluation

Revenue Loss.
Business Interruption

Digital asset loss
(cyber)

Specialty

Cyber

Agriculture

Terrorism,
War &
Political Risk

Financial Credit & Surety

Other

Workers Comp

Auto

Group Auto

Distribution of \$105 Quadrillion
(\$105,000 Trillion)
Insured Exposure Worldwide

No specific limit for compulsory auto 3rd party liability; average upper limits assumed

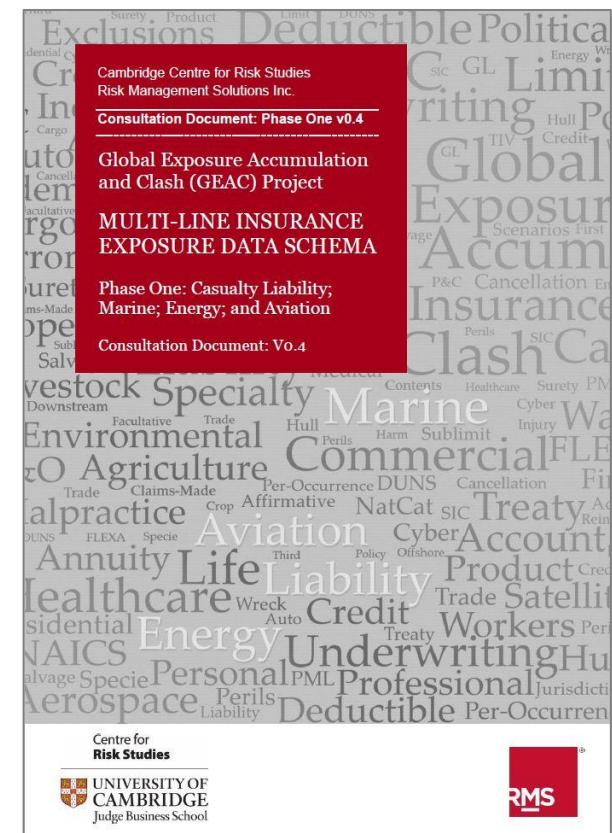
Estimated total insured exposure values, aggregate limits.
Pension asset value under management



CURRENT STATUS OF DATA SCHEMA DEVELOPMENT PHASE 1

		Casualty Liability	Marine	Energy	Aviation
1	Insured Policyholder	■	■	■	■
2	Financial Structure	■	■	■	■
3	Lines of Insurance	■	■	■	■
4	Asset Types	■	■	■	■
5	Asset Attributes	■	■	■	■
6	Geographical Locations	□	■	■	■
7	Coverage Wordings	□	■	■	■
8	Exclusions	■	■	■	■

- Well defined (90%)
- Still being developed (70%)
- In development (50%)



v0.9
Consultation Document

SCENARIOS DEVELOPED BY CAMBRIDGE CENTRE FOR RISK STUDIES



Freeze Event: US-Europe



Marine Piracy: Horn of Africa



Interstate Conflict: China-Japan War



Systemic Cyber: Sybil Logic Bomb



Pandemic: São Paulo Virus



Social Unrest: Millennium Uprising



Financial: Global Property Crash



Financial: Eurozone Meltdown



Financial: High Inflation World



Financial: Dollar Deposed



Power Outage Cyber: US Business Blackout



Power Outage Cyber: UK Regional Blackout



Systemic Cyber: Data Exfiltration



Systemic Cyber: Denial of Service



Systemic Cyber: Extortion



Systemic Cyber: Cloud Outage



Systemic Cyber: Financial Theft



Power Outage: Solar Storm



Cyber-Physical: Commercial Property Laptop Fires



Cyber-Physical: Industrial Facilities Explosion



Cyber-Physical: Oil Rig Fire and Explosion



Cyber-Physical: Marine Cargo Theft



Cyber-Physical: Aviation Spoofing Attack



Cyber-Physical: Terrorism Cyber Attacks



Investment Risk: Climate Change



Marine Realistic Disaster Scenarios

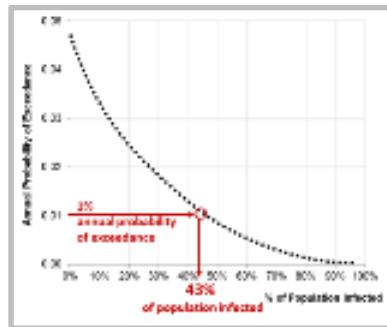


Project Pandora Scenario Suite



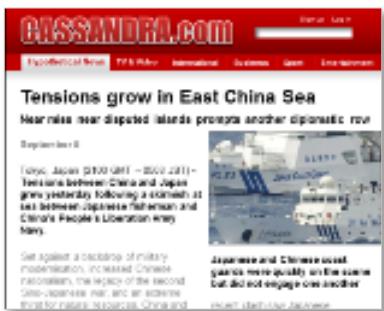
Trillion Dollar NatCats

CAMBRIDGE SCENARIO DEVELOPMENT METHODOLOGY



Context

A justification and context e.g. for a 1% annual probability of occurrence worldwide

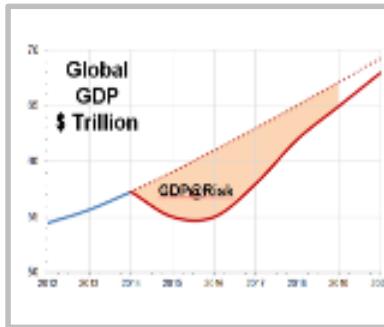


Narrative & Variants

Detailed description of events

Multiple Variants of events

S1; S2; X1



Macroeconomic Consequences

GDP@Risk: Quantification of effects on many variables in the global economy

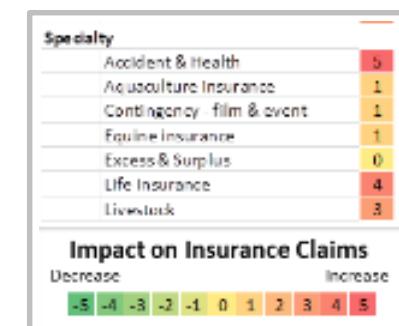
Timeline & Footprint

Sequencing of events in time and space in hypothetical scenario



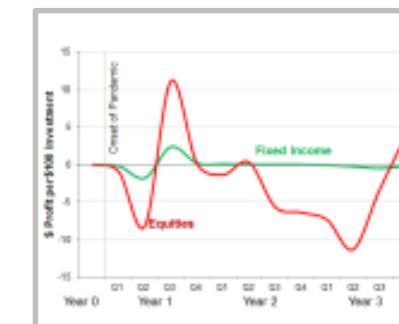
Loss Assessment

Metrics of underwriting loss across standardized lines of insurance business



Investment Portfolio Impact

Returns and performance over time of a range of investment assets

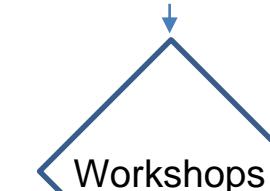


CAMBRIDGE SCENARIO DEVELOPMENT PROCESS

Research and Context Preparation



Scenario Specification



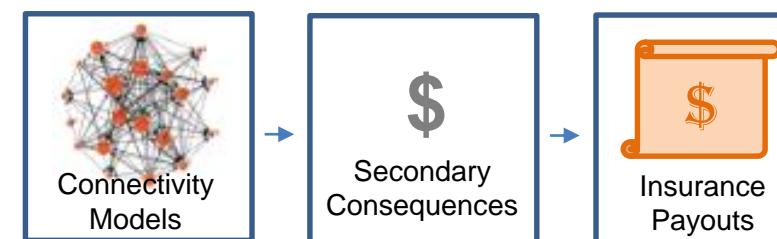
Primary Impacts and Insurance Loss



Imagineering & Scenario Design

Schedule of Losses

Secondary Impacts and Insurance Loss



Consequential Losses

Macroeconomic Consequences and Investment Portfolio Impact

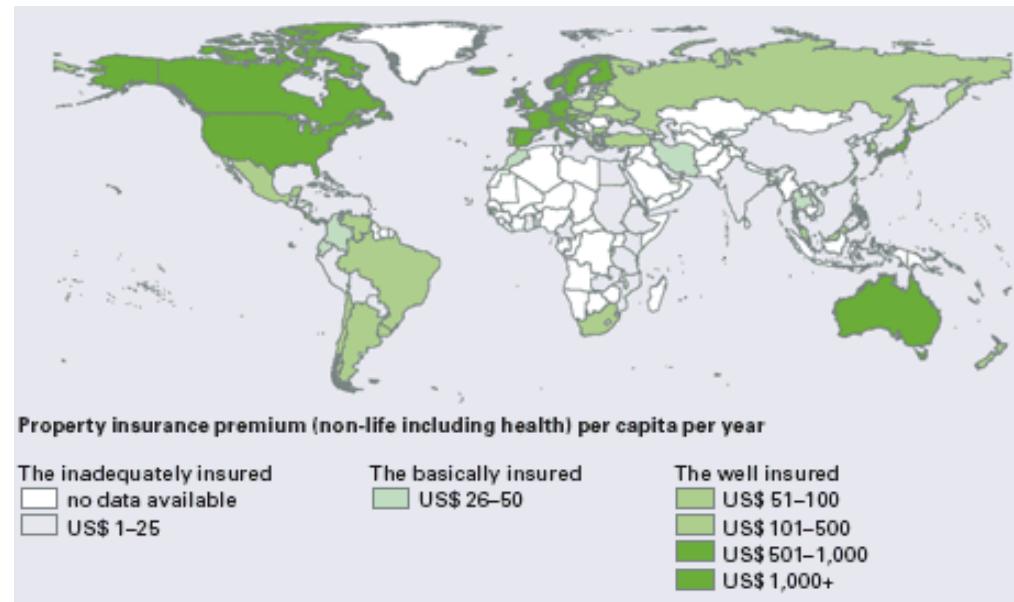


Market Impact Modelling

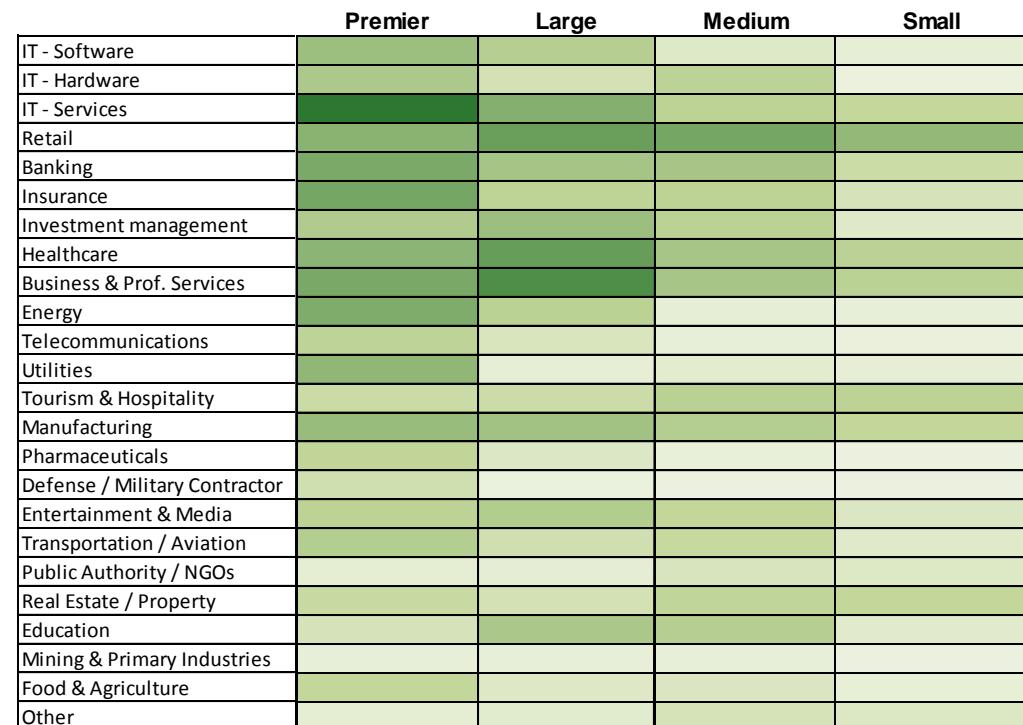
START WITH UNDERSTANDING THE EXPOSURE

- Identify the main exposure types
 - Geographical markets and locations of main exposure
 - Business sectors, company size, and characteristics
 - Insurance coverage inclusions, exclusions, T&Cs
- Identify the levels of loss that would be material
 - What are average annual loss rates?
 - What is an exceptional loss?
 - What would be catastrophic?

Property Insurance Penetration



Cyber Insurance Exposure by Business Sector and Company Size



THREAT IDENTIFICATION

- Identify the threats to that exposure type
 - Historical precedents; Technical principles; Expert Opinion
- ‘Reverse engineer’ how the main classes of and geographies of exposure could be highly impacted
- Develop a list of loss causes (‘Threat Taxonomy’)
- ‘Imagineer’ potential causes of those levels of loss
 - ‘Red Team’ – how could you maximize loss?
 - What are the upper bounds of loss?
 - What prevents a loss from being even larger?
 - How does loss scale up? What are the step functions?
- Cascades: How might an event trigger other events?

Threat Taxonomy Global Economy



Threat Taxonomy Cyber Insurance



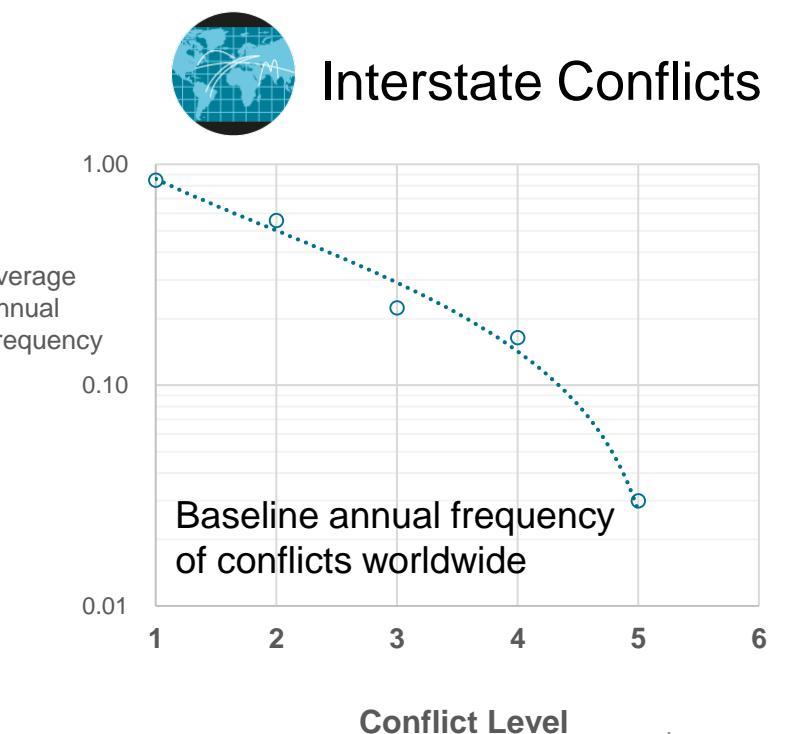
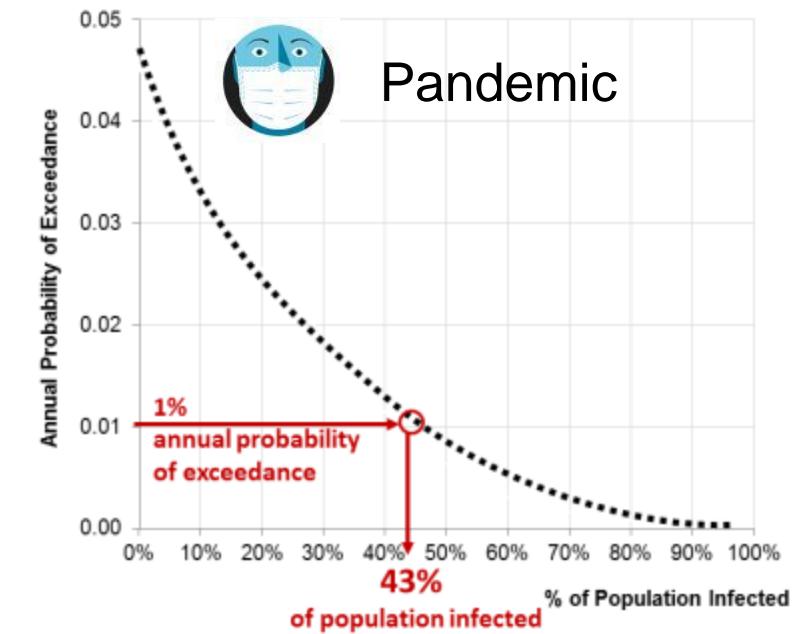
SCENARIO DEVELOPMENT WORKSHOPS

- Stakeholder engagement
- Interaction between subject matter specialists and the business users
- Plausibility testing
 - Can you ‘sell’ this scenario to senior management?
 - Answering the “well that would never happen” response
- Severity level sanity check



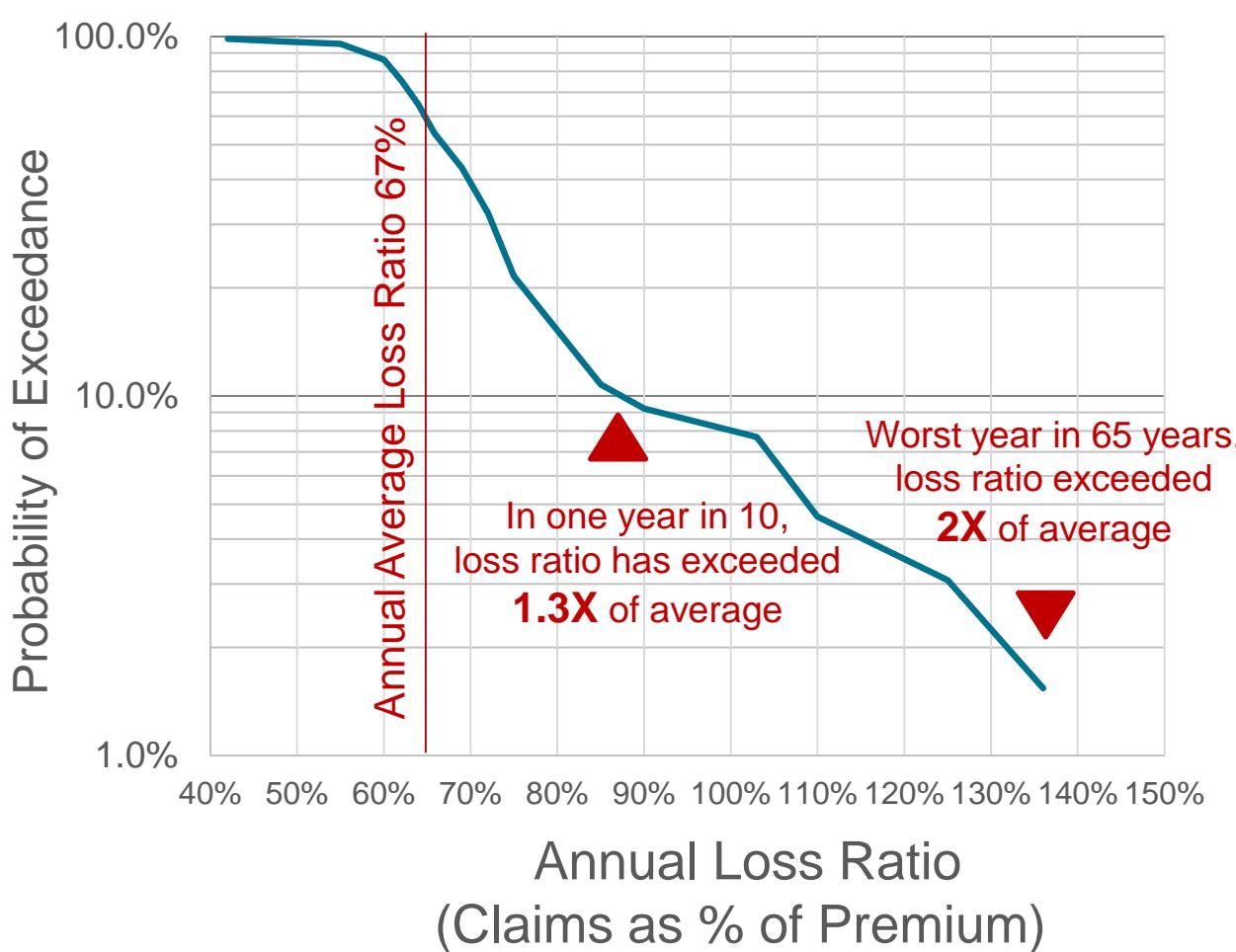
SETTING THE SEVERITY LEVEL

- A specified scenario has no inherent return period
 - Only the loss has a probability of exceedance
- Physical, behavioural or technical processes are usually being reflected in the extreme scenario
 - Is there an objective para-metric that can be assessed as a frequency-severity distribution of the causal trigger? e.g.:
 - Virulence and infectiousness metrics for a pandemic
 - dB/dt for a solar storm
 - Gbps/hours for denial of service cyber attacks on businesses
- CCRS has typically attempted to identify the para-metric severity of the causal trigger with a global return period of 1-in-100 for the S1 variant

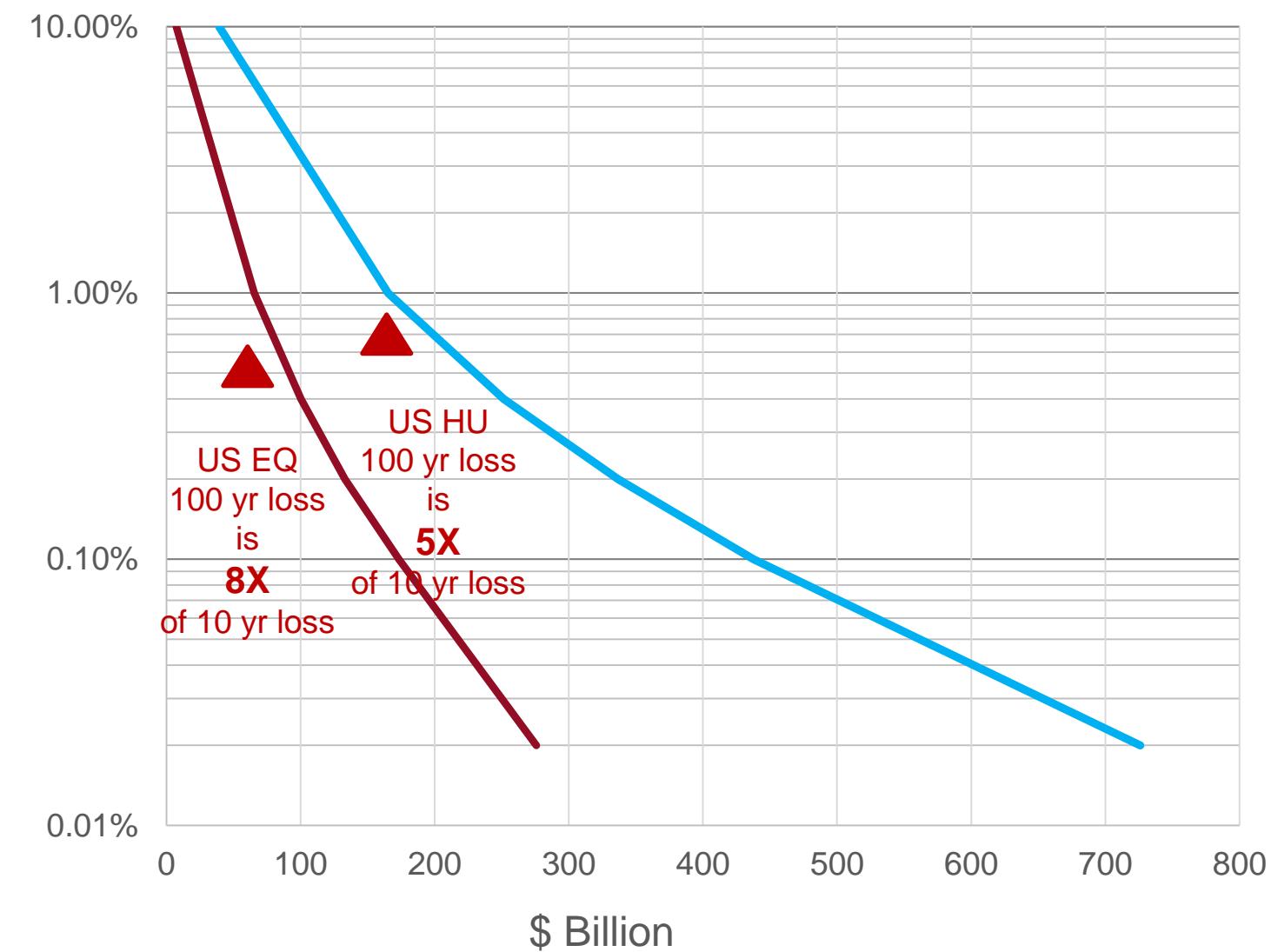


BENCHMARKING TO EP CURVES OF OTHER PERILS

US Homeowner Fire Insurance
Probability of Exceedance
Distribution of Industry Annual Loss Ratios
1950-2015

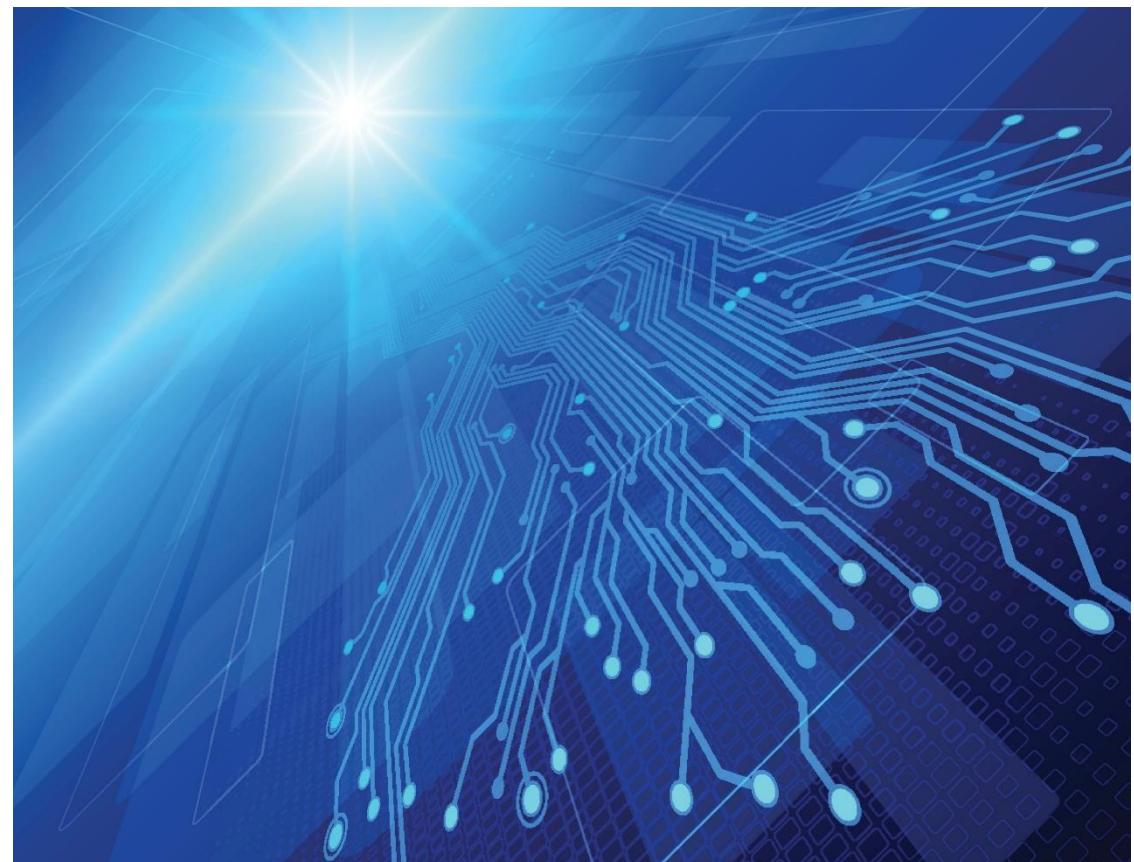


US Modeled NatCat Industry Loss
Probability of Exceedance
RMS EQ and HU Models, US Res+Comm

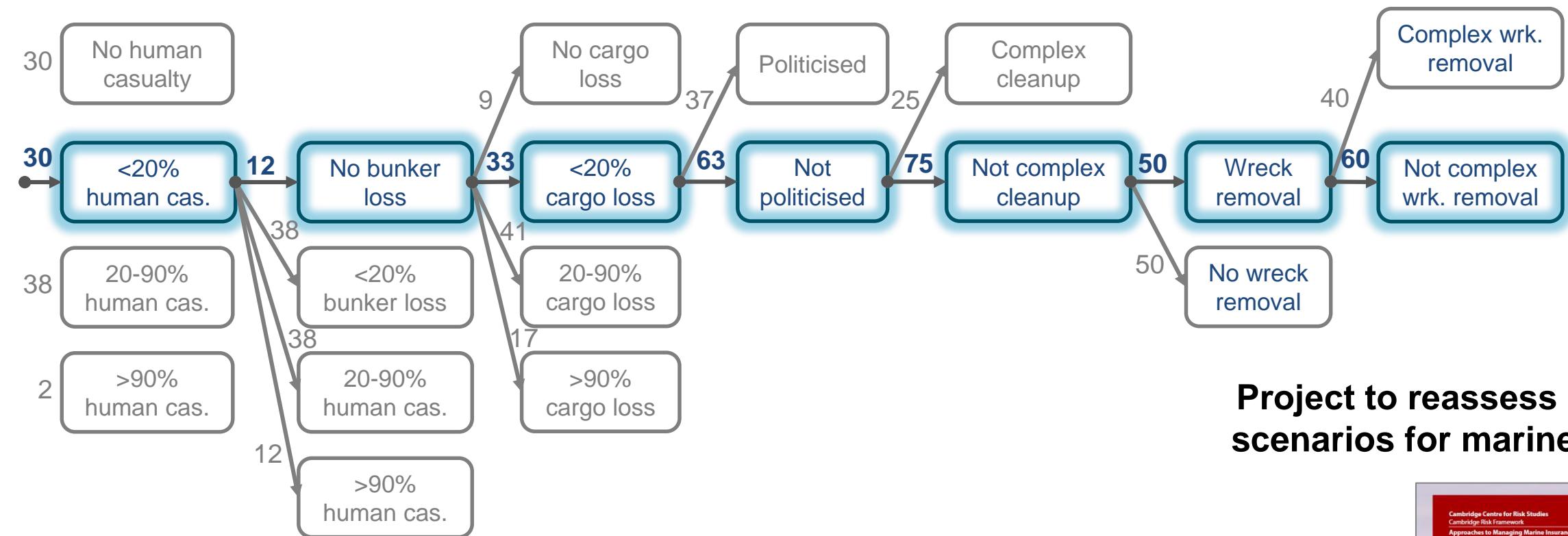


IMAGINEERING THE EVENT TREE

- From the ideation we develop a narrative
 - Identify a timeline and event sequence
- Plausibility is a major issue
 - Identify the near-precedents or counter-factual
- Various nodes where large variables can occur
 - Stress the key variables
- CCRS has typically developed three variants:
 - S1: 1-in-100 parametric trigger occurrence with ‘best estimate’ assumptions of consequences
 - S2: Significantly worse assumption set for the same event
 - X1: Worst case assumptions for same event

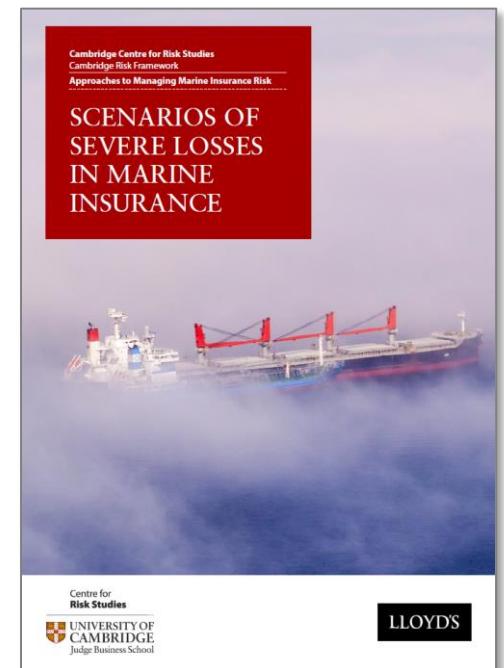


IMPROVING SCENARIOS WITH EVENT TREES



Project to reassess Lloyd's RDS scenarios for marine vessel loss

- A Bayesian variant event tree enables a much clearer assessment of potential permutations of outcomes
- It generates thousands of scenario variants, which improves assessments of uncertainty and extremes
- An insurance PML, stress test, or accumulation scenario needs to explore uncertain extremes



LOSS CALCULATION

- Loss estimation is the most complex, resource intensive, and important part of the scenario development
- It might be possible to make top-down high level loss estimates, but the only way to try to make an assessment with any confidence is to build a ground-up loss estimate from component parts
- There are two stages
 - Primary impact (Direct loss)
 - Secondary, consequential losses as a result of direct losses
- Secondary losses in systemic events can exceed primary losses (by a multiple)
- Go through a checklist of each of the categories of exposure and test whether they would have a loss
- Estimating losses has to be carried out transparently
 - What is the evidence-base for the loss ratio being applied?
 - It is OK to make experienced guesses as long as these are flagged and can be adjusted by others

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Summer blackout hits Northeastern US

City residents in New York City, Washington DC, try to keep cool while officials seek an urgent solution

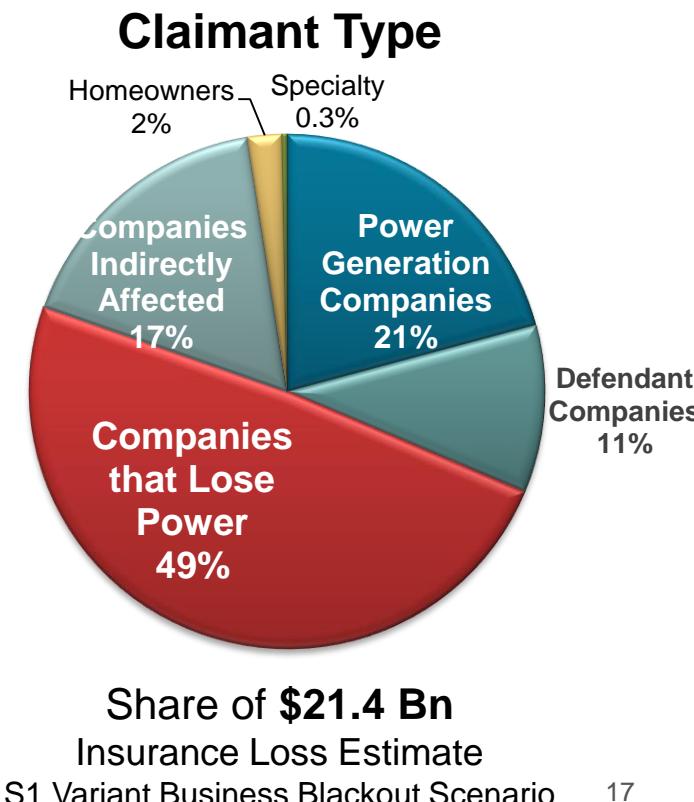
Wednesday, July 8th
NEW YORK CITY, NY (0732 EST) –
The massive blackout has struck the region during the hottest summer in a decade, causing chaos for an estimated 50 million Americans.

The outage spread westward from Washington DC to Chicago and south to the Tennessee border in the early hours of Tuesday morning, leaving millions stranded and unable to fight the in the heat.

The White House is due to issue an official statement later this morning once the full extent of the blackout is reported.

The cause of the outage is yet to be confirmed but official theories suggest a generator malfunction

Traffic systems have been shut down and emergency teams are struggling to free those stuck on subway cars beneath the city streets.



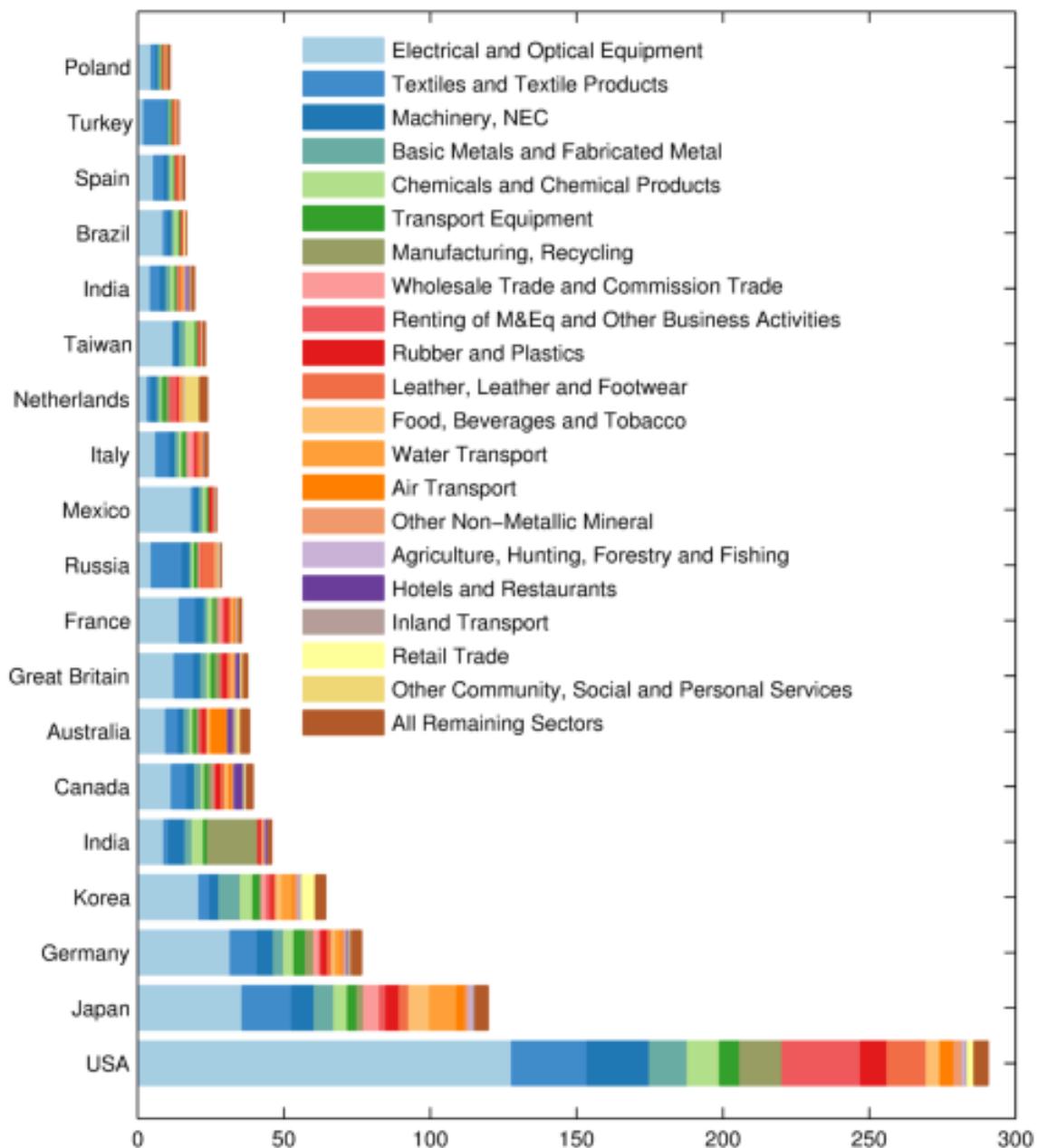
LOSS MODELLING: EXHAUSTIVE ANALYSIS OF ALL EXPOSURES

- Work through a check-list of exposed assets
- Direct loss estimates require a collation of global exposure
- Insurance industry loss estimation requires both an estimation of uninsured assets and their insured penetration
- Ground-up uninsured direct loss is often (confusingly) called an 'economic loss' estimate

GICS Sector	GICS Industry Group	Boreas Day Scenario Facilities Affected	High/Low	CBI Insurance Penetration (Cyber covered or silent)		
				Penetration	Ave payout	Deductable
				No. Days outage	Total Days	
10 Energy	1010 Energy	Large administrative operations buildings (non-generating)	1 - Low	\$??	3	21
15 Materials	1510 Materials	Large mining and mineral processing facilities	1 - Low	\$??	3	21
20 Industrials	2010 Capital Goods	Large manufacturing factories & despatch warehouses	2 - Moderate	\$??	3	21
	2020 Commercial & Professional Services	Large commercial buildings	2 - Moderate	\$??	3	21
	2030 Transportation	Airports, Railways, Port facilities	3 - High	\$??	3	21
25 Consumer Discretionary	2510 Automobiles & Components	Auto manufacturing plants & warehousing	2 - Moderate	\$??	3	21
	2520 Consumer Durables & Apparel	Manufacturing facilities and large commercial operations	2 - Moderate	\$??	3	21
	2530 Consumer Services	Manufacturing facilities and large commercial operations	2 - Moderate	\$??	3	21
	2540 Media	Broadcasting and headquarters operations	2 - Moderate	\$??	3	21
	2550 Retailing	Large shopping malls and major retail outlets	2 - Moderate	\$??	3	21
30 Consumer Staples	3010 Food & Staples Retailing	Large supermarket, cold storage facilities, warehousing & despatch	2 - Moderate	\$??	3	21
	3020 Food, Beverage & Tobacco	Large factories and food processing plants, storage & despatch	2 - Moderate	\$??	3	21
	3030 Household & Personal Products	Large factories, warehouses & despatch	1 - Low	\$??	3	21
35 Health Care	3510 Health Care Equipment & Services	Large hospitals and healthcare facilities	3 - High	\$??	3	21
	3520 Pharmaceuticals, Biotechnology & Life Sciences	Large pharma production facilities, R&D Labs, headquarters campuses	3 - High	\$??	3	21
40 Financials	4010 Banks	Headquarters and financial operation hubs	2 - Moderate	\$??	3	21
	4020 Diversified Financials	Headquarters and major commercial buildings	2 - Moderate	\$??	3	21
	4030 Insurance	Headquarters and major commercial buildings	2 - Moderate	\$??	3	21
	4040 Real Estate	Headquarters and major construction projects	1 - Low	\$??	3	21
45 Information Technology	4510 Software & Services	Headquarters, Cloud server farms	3 - High	\$??	3	21
	4520 Technology Hardware & Equipment	Manufacturing/assembly plants, warehousing, despatch	2 - Moderate	\$??	3	21
	4530 Semiconductors & Semiconductor Equipment	Manufacturing/assembly plants, warehousing, despatch	1 - Low	\$??	3	21
50 Telecommunication Services	5010 Telecommunication Services	Control centres, server farms, phone/data exchanges	3 - High	\$??	3	21
?? Education	???? Education	Universities and large educational facilities	2 - Moderate	\$??	3	21
55 Utilities	5510 Utilities	Major water processing plants, sanitation facilities	1 - Low	\$??	3	21
00 Public Sector	0010 National Government departments	Department main offices, storage and operational centres	0 - None	\$??	3	21
	0020 Local Authority/Municipal	Admin HQs, Fire/police HQs, emergency facilities	1 - Low	\$??	3	21
	0030 Military	Army navy airforce bases	0 - None	\$??	3	21
ZZ General Public	ZZZZ Homeowners/Personal Lines	Residential properties & homeowners	0 - None	\$??	3	21

Checklist of facilities potentially impacted by Business Blackout scenario

CONNECTIVITY: WHAT HAPPENS IF CHINA STOPS EXPORTING?



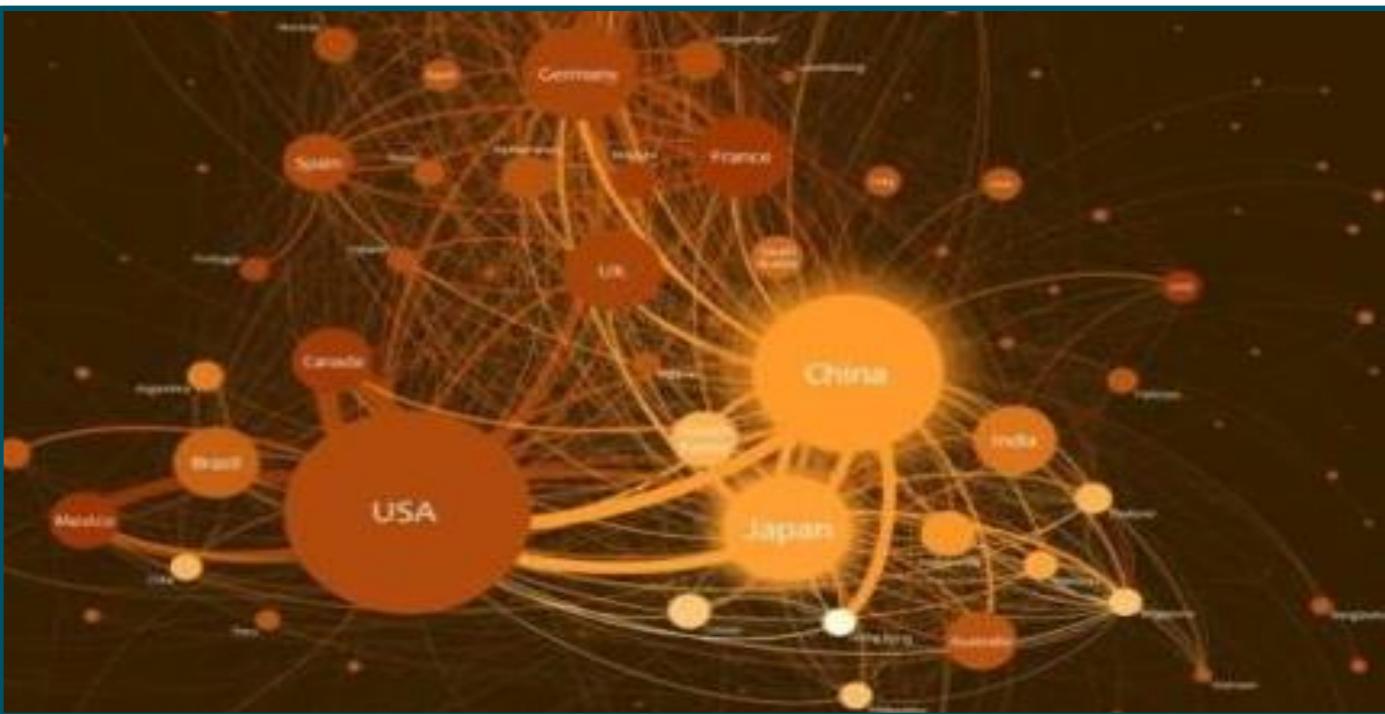
Total value of Chinese exports: \$1.33 Trillion (\$US 2009)

China Export Value by Economic Sector (US\$ Billions 2009)

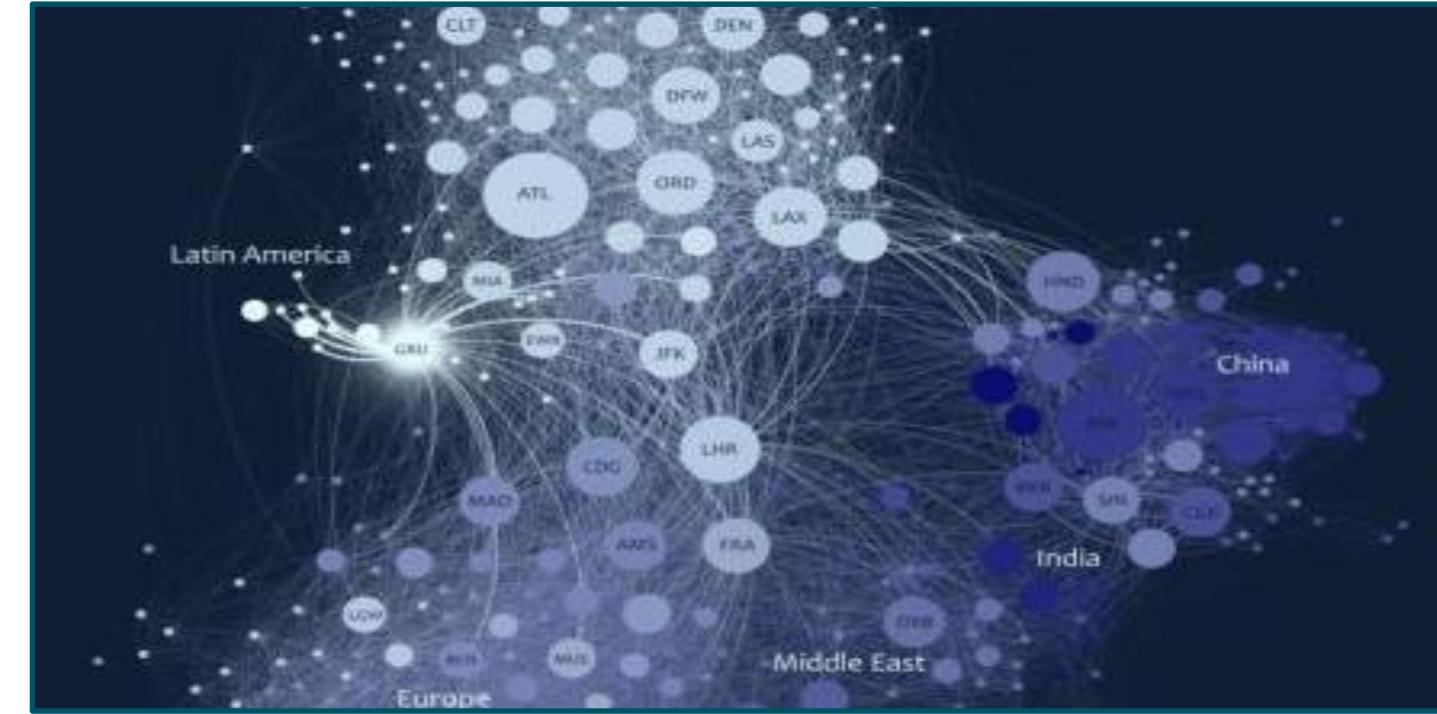
* Excludes exports to the Rest of World

MANY CHANNELS OF CONNECTIVITY IN GLOBAL ECONOMY

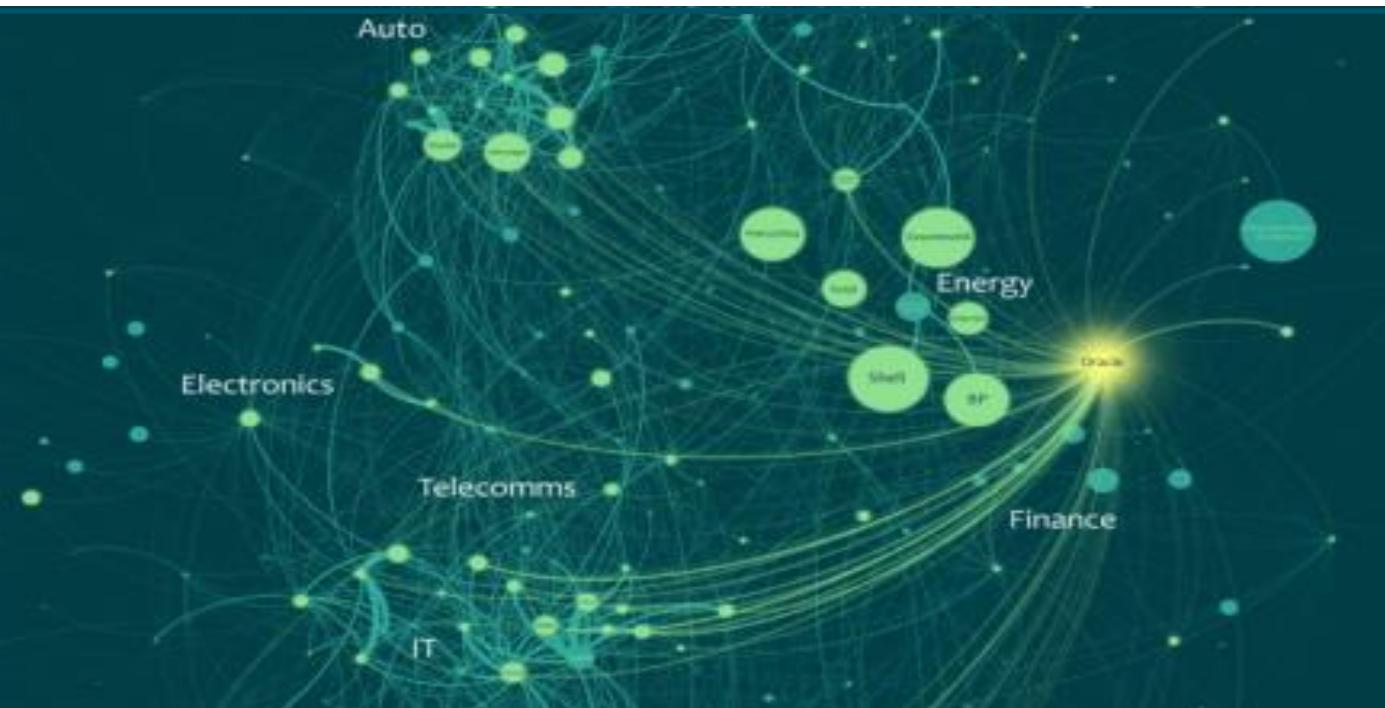
International Trading Networks



Travel Flows of People and Goods



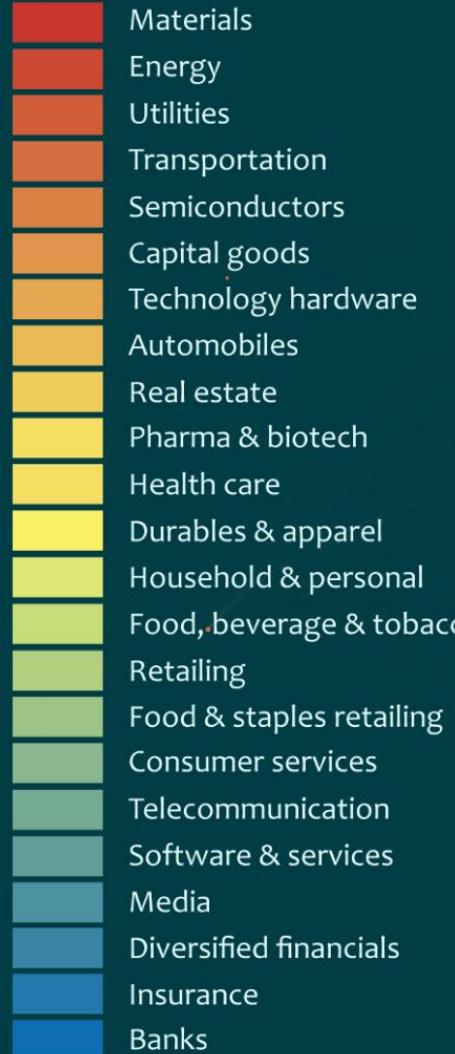
Business Relationships between Companies



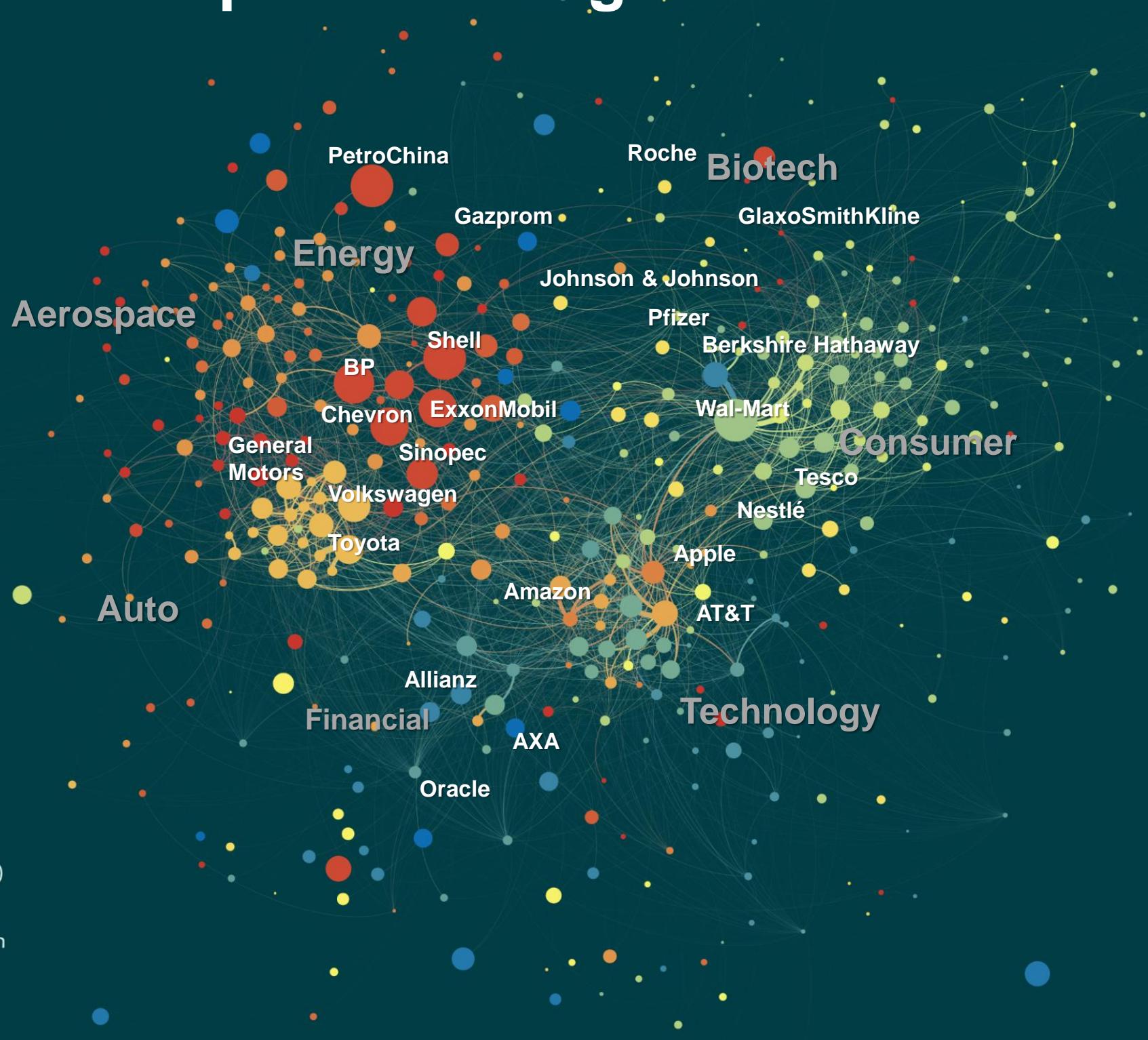
Communications and Social Media



Global Enterprise Trading Network

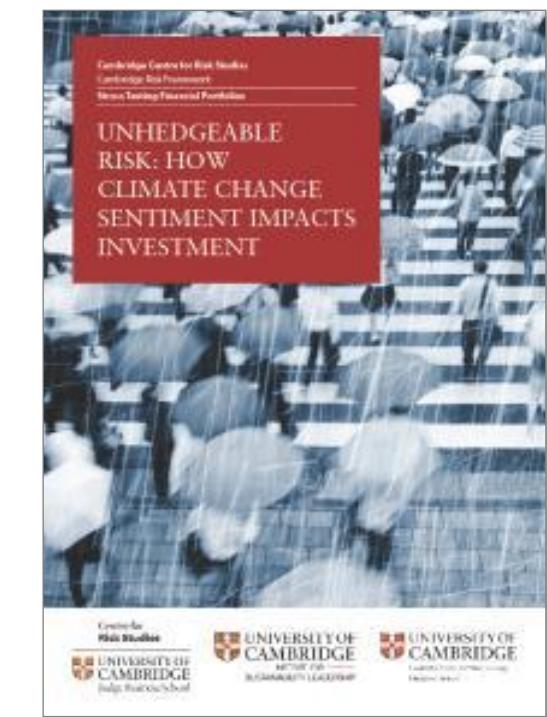
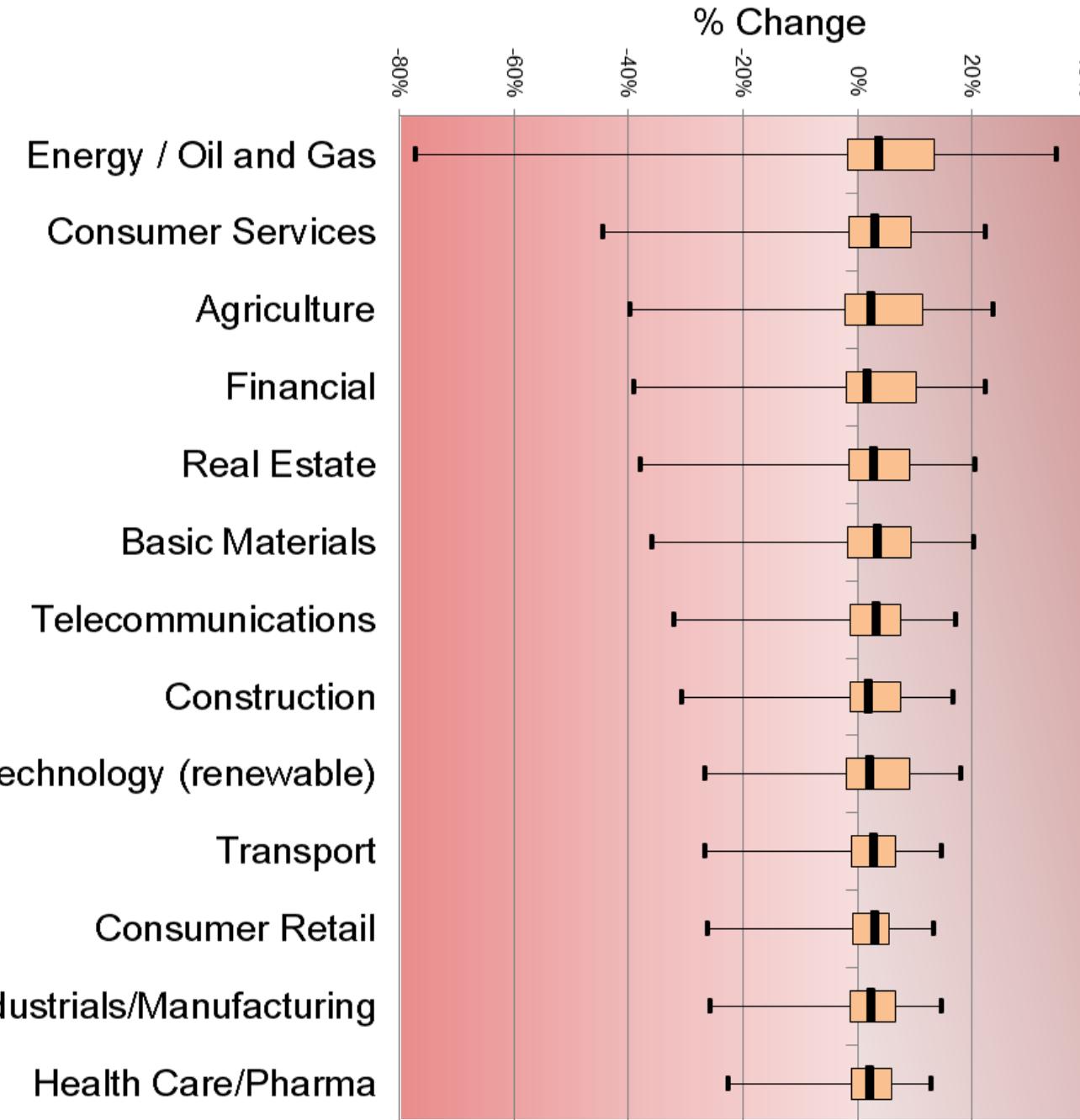


Enterprise revenue (USD)
\$450 bn \$200 bn \$100 bn

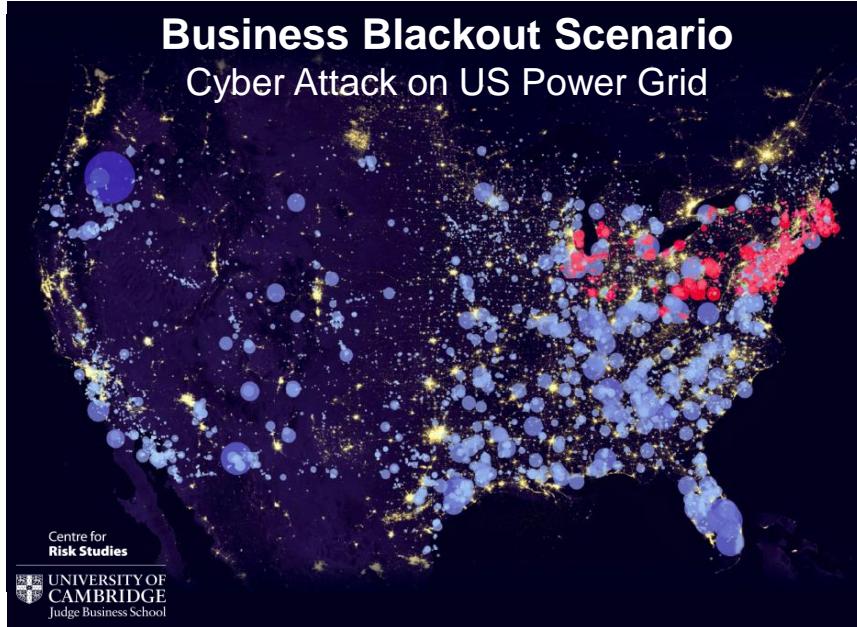


GRANULARITY OF OUTPUTS: E.G. LOSS MODELLING BY SECTOR

- Granularity of loss estimation is important in some scenarios
- May not be vital for overall accumulation management
- But differentiating by business sector is a common requirement for insurers
 - Usually manage their exposure by business sector
- Individual company or account differentiation is not usually a requirement for scenarios
 - More advanced modelling required for risk selection



INSURANCE LOSS BREAKDOWN BY LINE OF BUSINESS



- Important to iterate from the loss numbers back to the scenario design to converge on a useable scenario
- Variants of the scenario explore different aspects of the threat
- Impact of scenario on macroeconomy, investment portfolio and business context is also important for holistic estimate

		\$ millions
	Power Generation Companies	
	Property Damage (Generators)	633
	Business Interruption (Generator Damage)	3,817
	Incident Response Costs	3
	Fines - FERC/NERC	4
	Other liabilities	-
	Defendant Companies	
	Liability	2,253
	Companies that Lose Power	
	Perishable Contents	595
	Contingent Business Interruption - Suppliers Extension	6,769
	Liability	3,120
	Companies Indirectly Affected	
	Contingent Business Interruption - Critical Vendor	2,928
	Liability	749
	Homeowners	
	Household Contents	465
	Specialty	
	Event Cancellation	63
Total	For variant S1	\$ 21,398

CONCLUSIONS

- The Cambridge Centre for Risk Studies methodology for scenario development has proven versatile and produced many scenarios for a wide range of applications
- We will be adapting this framework to develop the multi-line clash scenarios for the GEAC project
- Aspects of this methodology may be a useful framework for others to produce their own scenarios
- We look forward to getting the feedback of today's attendees on what constitutes 'Best Practice' in scenario development

