Financial Risk and Network Theory Seminar 13 September 2016

Trillion Dollar Shocks to the Financial System

Centre for Risk Studies



Dr Andrew Coburn Cambridge Centre for Risk Studies



Cambridge Centre for Risk Studies Research Team

Centre for Risk Studies Executive Team



Prof Danny Ralph Academic Director



Dr Michelle Tuveson *Executive Director*



Dr Andrew Coburn Director of Advisory Board



Simon Ruffle Director of Research & Innovation

Centre for Risk Studies Research Team



Dr Andy Skelton Research Associate



Jennifer Copic Research Assistant



Jessica Tsang Research Assistant



Kayla Strong Research Assistant

Reviewers and Advisors



Dr Duncan Needham *Risk Researcher*



Dr Kimmo Soramaki Founder, FNA Ltd.



Centre for Risk Studies



Dr Ali Shaghaghi Research Assistant



Tamara Evan Research Assistant



Arjun Mahalingam Research Assistant



Shaheera Asante Editorial Assistant

Dr Fabio Caccioli Risk Affliate



Eugene Neduv VP Solutions, FNA Ltd.



Dr Jay Jung Risk Researcher



Dr Edward Oughton Research Associate



Dr Shahzeb Malik Research Associate



Eireann Leverett Senior Risk Researcher



Dr Scott Kelly Risk Affiliate



Dr Louise Pryor Senior Risk Researcher

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 setllement
- Wells Fargo Collusion
- 'Lazarus' \$1Bn attempted
 Cyber Attack on SWIFT



Property Bubbles Continue to Threaten to Burst





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



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Sovereign Crises: Ratings Downgrades Now More Common

Movements in sovereign credit ratings, 2007–15 Table 1							
		Number of	Ave	Notch change, ¹			
		countries	Mid-2007	October 2015	2007–15		
Overall	AE	28	AA+	AA-	-2.1		
	EME	69	BBB-	BB+	-0.2		
Asia-Pacific	AE	5	AA+	AA+	-0.2		
	EME	12	BBB-	BBB	0.6		
Americas	AE	2	AAA	AAA	-0.2		
	EME	20	BB	BB	0.2		
Europe	AE	20	AA+	A+	-2.9		
	EME	20	BBB	BBB-	-0.9		
Sub-Saharan Africa	EME	8	BB	BB	-0.3		
Middle East and North Africa	AE	1	A–	A+	1.3		
	EME	9	BBB+	BBB	-0.5		

Foreign currency ratings; the average of Moody's, Standard & Poor's and Fitch; the means of these averages are taken across subsamples. Numerical values for ratings are attached to ratings as follows: Ca/CC = 1, Caa3/CCC- = 2, Caa2/CCC = 3, Caa1/CCC+ = 4, B3/B- = 5 and so on up to Aaa/AAA = 20. The ratings symbols of S&P and Fitch – eg BBB+ as opposed to Baa1 – are used to communicate results throughout the paper.

¹ A notch is the difference between A and A-, A- and BBB+ etc.

Sources: Bloomberg; BIS calculations.

The frequency of credit agency reassessments of sovereign ratings (currency and bonds) has increased annually throughout 2010s

Most reassessments are currently negative



Scenario: Eurozone Meltdown

- 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





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Donald Trump just threatened to cause an unprecedented global financial crisis

There's a big difference between government debt and private debt.

The Improving Resilience of Banks

Average Basel III capital ratios, capital shortfall and leverage ratios

Fully phased-in Basel III, samples of large internationally active banks¹



- 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

	Basel III			Compen- sation	Over-the-counter (OTC) derivatives			Resolution#			Shadow banking			
Reform Area	Risk-based capital	Liquidity coverage ratio (LCR)	Higher loss absorbency for G-SIBs (home jurisdictions)	Requirements for domestic systemically important banks (D- SIBs)		Trade reporting	Central clearing	Platform trading	Margin	Availability of transfer / bail-in / temporary stay powers for banks	Recovery planning for systemic banks	Resolution planning for systemic banks	Money market funds (MMFs)	Securitisation
Agreed phase-in (completed) date	2013 (2019)	2015 (2019)	2016 (2019)	2016		end-2012	end-2012	end-2012	Sep 2016 (2019)					
Argentina	Δ				\bigtriangleup								**	**
Australia	С												*	*
Brazil	С			&	Δ									**
Canada	С					D, F							**	
China	С	Δ			Δ	R, D, F					Δ		**	
France	MNC	Δ											**	*
Germany	MNC	Δ											**	*
Hong Kong	С	С											**	
India	С	LC			Δ	D, F								
Indonesia	Δ					R							**	
Italy	MNC	Δ										Δ		*
Japan	С					D								
Mexico	С	С				D							**	*
Netherlands	MNC	Δ											**	*
Rep. of Korea						D							**	
Russia	Δ				Δ								**	**
Saudi Arabia	С	LC				R, D							*	
Singapore	С	Δ											**	
South Africa	С	С			Δ	D, F							**	
Spain	MNC	Δ												*
Switzerland	С				Δ						Δ	Δ	**	
Turkey		Δ				D, F							**	
United Kingdom	MNC	Δ											**	*
United States	LC	Δ			\triangle	D								



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?



Centre for Risk Studies Network Model of Financial System

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



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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

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Extending the Model to Multi-Layer Networks





Coupling Between Financial Crises and Economic Loss





Investment Portfolio Performance in Different Scenarios



Cambridge Scenarios: GDP@Risk

	GDP@Risk US\$ Trillion	S1	S 2	X1	
	Geopolitical Conflict China-Japan Conflict	17	27	34	
	Asset Bubble Shock Global Property Crash	11	16	23	
၀ို	Pandemic Sao Paolo Virus	7	10	23	
	Sovereign Default Shock Eurozone Meltdown	6	13	20	
2	Food and energy price spiral High Inflation World	5	8	11	
	Cyber Catastrophe Sybil Logic Bomb	4	7	15	
	Social Unrest Millennial Uprising	2	5	8	
	De-Americanisation of Financial System Dollar Deposed	2	2	-2	
2007-	2012 Great Financial Crisis	18			
Great	Financial Crisis at 2016	21			

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





Risk Studies

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

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- Defined severity ranges
- Representative events of coherence
- We have defined a methodology to develop a catalogue of potential future Multi-Trillion Dollar Shocks

The science of surprises

'Black Swans'



'Dragon Kings'



Cambridge Taxonomy of Economic & Financial Threats

Labour Dispute

Trade Sanctions

Geopolitical Conflict

External

Force

Environmental Catastrophe

Externality







Financial Irregularity



Run



Sovereign Default



Market

Crash





Flood Tsunami

Volcanic







Human Epidemio



Plant

Epidemic

Zoonosis



Epidemic







Cartel

Catastrophe

Climatic

Humanitarian Crisis

Tornado &

Hail

Child

Povertv

Pressure











Heatwave

Electric Storm







Welfare System Failure Crisis









Space

Threat



Ozone Laver Collapse





Solar Storm







Conventional War

Nuclear

Sea Level Rise

EcoCat

War



Crime





Unrest

Nuclear Meltdown

9

Hated

Terrorism

Senaratisr





Catastrophe













Other



































Civil

War



Pollution

Event





CCRS Research Outputs: Explorations of individual threats





Emerging Risk Scenario

Taxonomy of Threats



Financial Catastrophes



Cyber Accumulation **Insurance Risk Report**



Summer.

NatCat FinCats **Clash Report**



Pandemic Emerging Risk Scenario



Eurozone Meltdown Financial Risk Scenario



Business Blackout Lloyds Emerging Risk Report



Cyber Catastrophe Emerging Risk Scenario





Climate Change World City Risk 2025 Investor Sentiment Shock



Stonak

Financial Risk Scenario

Lloyds Co-Branded Report



Social Unrest Ebola **Emerging Risk Scenario** Emerging Risk Scenario



Historical Crises Financial Risk



Solar Storm Emerging Risk Scenario 22



Imposing a Standardized Approach to All Threats





Example Multi-Trillion Dollar Scenarios

Financial (Endogenous)

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

Geopolitical and Natural (Exogenous)

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

Indicative only - Not a comprehensive listing



Illustrative Investment Portfolio Risk Profile

Exceedance Probability [EP] Curve Showing Tail Risk on Log Scale





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..."

