**Cambridge Centre for Risk Studies** 

Research Showcase 22 June 2015

# UNDERSTANDING FINANCIAL CATASTROPHES

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Director of Advisory Board, Centre for Risk Studies and Senior Vice President, RMS Inc.





Without financial catastrophes the world's economy would grow a third faster than it does today

Financial crises impose burden of 1 percentage point on economic growth per year

Financial catastrophes are the single greatest risk to economic output in our threat universe

Everyone should care about them, not just banks and regulators

The tools for practitioners to understand and manage financial catastrophes are currently inadequate

 The Centre for Risk Studies is assisting in the development of better analytics for financial catastrophe risk management

Contagion' is the key unknown in understanding financial catastrophe risk

Maps of the financial universe need to be combined with laws of human behaviour

# **The Economic Burden of Financial Catastrophes**

- The Great Financial Crisis of 2008 destroyed an estimated **\$18 Trillion** of world economic output
  - It was the most recent crisis, and the most severe, for some time
- Financial crises occur periodically, with different causes, and different severities
  - In the past generation, we have had a financial crisis every 8 years on average
- We estimate that the financial burden of crises averages \$0.5 Trillion of lost economic output per year
  - This is around **1 percentage point** of global economic output
  - Without financial catastrophes global growth could be 4% a year instead of 3%
- Financial catastrophes are the single greatest economic risk for society
  - Why don't we understand them better?

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#### We Don't Have Tools to Understand Financial Catastrophes

#### Mario Draghi: Grexit would lead to "uncharted territory"

European Central Bank governor Mario Draghi said that should Greece exit the eurozone, the European Union would be entering "uncharted territory".



"Should Greece exit the Eurozone, the European Union would be entering "uncharted territory". What will the consequences on the EU be? This we are unable to predict..."

Mario Draghi, Governor of the European Central Bank 15 June 2015



## 'Normal' Financial Models Don't Work in Crises

#### Bank of England modelled estimates of UK GDP November 2007



Dynamic stochastic general equilibrium (DSGE) models work well under normal conditions but not during a crisis



- "We suffered adverse 25-standard deviation events, several days in a row according to our models."
  - CFO of Brevan Howard, one of the world's largest hedge funds, after it had suffered huge losses in 2008
  - "according to our models this just could not happen"
    - Robert Merton, one of the nobel-prizewinning architects of the Black-Scholes model, 1998 on the day after Long-Term Capital lost \$4.4 Billion
  - "The 1987 'Black Monday' has a likelihood of 10<sup>-148</sup> in traditional 'random walk' mathematics."
    - Economist Gene Stanley, Boston University

#### **Even Underlying Theory Isn't Very Helpful**



Graphic from the front cover of The Economist, July 18, 2009, encapsulating the rethink in economic theory needed after the 2008 financial crisis



#### **Financial Practitioners Need to Measure their FinCat Risk**

Quantification of Market Risk ('Financial Catastrophe') is a key regulatory and risk management need:

- Banks
  - Basel I to III require banks to quantify reserves needed for a run on the bank and other tail risk events
- Insurers
  - Solvency II requires insurers to quantify 1-in-200 market risk for their investment portfolios, on the same basis as their underwriting risk
- Institutional Investors
  - Historical asset class performance data is no longer adequate for crisis management, when correlations increase across investment portfolio



#### What a Financial Catastrophe Model Would Look Like



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# **Research Objectives of Cambridge FinCat Project**



#### **Causes of Future Crises**

 What might trigger future FinCats? Defining a full taxonomy; Developing an authoritative historical catalogue; How often and how bad?



# **Developing Stress Test Scenarios**

 What toolkit do we need to model the impacts of potential events? Can we ensure 'coherence' in their effects?



# **Developing a Model of Global Financial System**

 Understanding the structure of the financial universe and how crises propagate through it



# **Understanding Financial System Behaviour**

- Understanding systemic contagion in financial networks, interconnectivity, behaviour, critiquing common modelling approaches, social behaviour



### **Financial Crises Through History**

#### **History of General Financial Crises**

Reinhart and Rogoff (2009)



Average interval between crises 17C to late 20C: 21 years
Average interval between crises post 1970s: 8 years

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- 182 Sovereign defaults since 1810
   one every 1.2 yrs
- Usually come in cascading waves of defaults

#### **Sovereign Defaults are Contagious**

- 120 sovereign defaults in past 100 years
  - More than one default a year on average
- Main threat is cascades of sovereign defaults
  - Where multiple countries default under similar conditions or from follow-on consequences
  - Size of the economy defaulting is a key component
- A cascades involving 4 or more countries has occurred on average every 14 years





### What Causes Financial Crises?

Qualitatively different causes of endogenous financial shocks



#### **Financial Shock**



Asset Bubble



Sovereign Default





Based on Allen & Gale 2009, Understanding Financial Crises



Financial Irregularity





# **Cambridge Financial Stress Test Scenarios**



#### **Global Property Crash**

Sudden collapse of property prices in China followed by many other emerging and developed markets triggers a cascading crisis throughout the global financial system



#### **Eurozone Meltdown**

Unexpected default of Italy is followed by a number of other European countries, leading to multiple cession from the Union and causing an extensive financial crisis for investors



#### **High-Inflation World**

A series of world events puts pressure on energy prices and food prices in a price increasing spiral, which becomes structural and takes many years to unwind



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#### **Dollar Deposed**

US dollar loses its dominance as the default trading currency as it becomes supplanted by the Chinese Renminbi, with rapid unwinding of US Treasury positions and economic chaos



#### Disclaimer: Extreme events "Just Plausible and Highly Unlikely"

- Scenarios are not predictions
- Scenarios are stress tests for risk management purposes
  - They are not forecasts of what is likely to happen
  - They are hypothetical: Illustrate an extreme but plausible event in a particular threat class
  - Used for 'what-if' studies
  - Intended to improve business resilience to shocks



# **Stress Testing: Recent Controversy**

#### The New York Times

#### U.S. Banks Pass Stress Tests, Some With an Asterisk

By PETER FAVIS MARCH 11 2015

All the large United States banks passed an annual regulatory test that aims to assess whether they can make it through a financial and economic calamity, the <u>Federal Reserve</u> said on Wednesday.

revelations about Europe's biggest banks. But some wondered whether the relatively sanguine results meant that the health exam was not tough enough, despite the central bank's promises that the assessments would be rigorous.

#### The New Hork Eimes

INVESTMENT BANKING | LEGAL/REGULATORY NYT NOW

Just 13 Banks Fail E.C.B. Stress Test, in Possible Economic Turning Point

By JACK EWING October 26, 2014 7:00 am

28 COMMENTS

#### FINANCIAL TIMES

June 17, 2015 11:01 pm

Banking sector stress tests lambasted as 'fatally flawed'

Martin Arnold and Caroline Binham

The Bank of England's stress tests of the banking sector have been attacked as "fatally flawed" for setting hurdles that are too easy

#### The New Hork Eimes

European Bank Stress Tests Worked: Sort Of

In Britain, the major banks all passed the stress test comfortably.

#### stress tests, widely criticized as too easy

"The banks have been working hard to pass the stress tests just like any other examination," said Bert Ely, an independent banking analyst. "That is one of the criticisms of the tests — that they've become too predictable."



## **Stress Testing Issues**

The current debate includes

- How severe should stress tests be?
  - What levels of severity reassure the market?
- What probability do these represent?
- What levels of security do we want our financial institutions to represent?
- What narratives are useful as plausible tests for different users?



Riccardo Rebonato author of *Coherent Stress Testing* is our keynote speaker at our 6<sup>th</sup> Risk Summit on **Risk Testing Stressing the Boundaries** 





#### **Scenario Development Process**





#### **Comparing Cambridge Scenarios with US Stress Tests**

		Stock Market Drop	House Price Crash	Unemploy- ment Rate	Markets Worst Impacted
Dodd Frank Stress Test 2015		60%	25%	10%	US
Eurozone Meltdown	S1	55%	10%	9%	Germany/UK/Euro
	S2	80%	15%	10%	
	X1	95%	20%	12%	
Global Property Crash	S1	70%	30%	8%	China/Emerging Markets
	S2	85%	40%	9%	
	X1	90%	60%	10%	
High Inflation World	S1	24%	30%	7%	China/Japan
	S2	30%	40%	8%	
	X1	40%	55%	9%	
Dollar Deposed	S1	30%	15%	8%	US
	S2	45%	18%	9%	
	X1	60%	30%	10%	



### **Different Investment Portfolios**



#### Conservative



Balanced



Aggressive





#### **Investment Portfolio Performance in Different Scenarios**

S1 Scenario Variant Based on Max Downturn, Real USD %





# **Understanding Contagion and Systemic Shock**

- The financial system is increasingly interconnected and integral to the economic system
  - Understanding the structure of the financial system and all its connections is vital
  - 'Financial Cartography'
- Financial instability spreads through a variety of mechanisms
- Contagion amplifies:
  - severity of the shock impact
  - extent of who is affected
- It is behavioural
  - issues of trust, perception, and self-interest drive the collapse
  - Can we model 'confidence'?
- This is a key research field
  - Working with the community of researchers on networks in finance
- Cambridge is seeking to build a practitioner model of global financial system





#### **Centre for Risk Studies Network Model of Financial System**





#### **The 2015 Financial Risk and Network Seminar**



- Wednesday September 9, 2015
- Venue: University of Cambridge, UK
- In collaboration with Journal of Network Theory in Finance
- Many papers from key players in the field presenting cutting-edge research
- Attendees include
  - Regulators
  - Financial practitioners
  - Academics
- Keynotes include central banks presenting their techniques for assessing systemic risk and capital requirements in their market









### Conclusions

- We are making good progress in understanding financial catastrophes
  - We have an improved historical perspective on past crises
  - We understand the broad structure of the financial system
  - We are beginning to assemble tools to represent the contagion of shocks through the financial system
  - We can survey the landscape of financial cartography and apply stress tests to investment portfolios
- We have developed stress test scenarios that incorporate the key principles of coherence
  - In the process of being published
- We intend to consolidate these components into a financial catastrophe model for assessing systemic tail risk





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# CAMBRIDGE BANKING MODEL

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 $q^2(x) = 1 + \cos(2x)$ 

 $\sin(\pi - x) = \sin(x)$ 

