8 December 2015

Market Risk: Understanding and Managing Tail Events

Exploring Tail Risk in Financial Catastrophe

Centre for Risk Studies

UNIVERSITY OF CAMBRIDGE Judge Business School

Dr Scott Kelly

Senior Research Associate

Centre for Risk Studies

OXFORD ECONOMICS

Session Agenda

- Exploring tail risk in financial catastrophe
  - Dr Scott Kelly, Senior Research Associate
- Four Cambridge Financial Catastrophe Scenarios

Asset Bubble Collapse
Dr Olaf Bochmann
Research Associate

Eurozone Meltdown
Dr Ali Shaghagi
Research Assistant

Dollar Deposed
Dr Jay Jung
Risk Researcher

High Inflation World
Jaclyn Zhiyi Yeo
Research Assistant

Cambridge Financial Stress Test Scenarios

Global Property Crash

Sudden collapse of property prices in the inflated property markets and this triggers a cascading crisis throughout the global financial system

Eurozone Meltdown

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

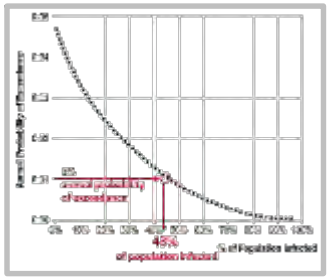
High-Inflation World

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

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

Cambridge Stress Test Scenarios



Context

A justification and context for a 1% annual probability of occurrence worldwide based on historical precedents and expert opinion

Timeline & Footprint

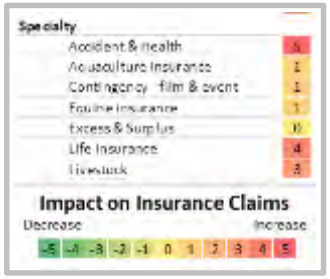
Sequencing of events in time and space in hypothetical scenario

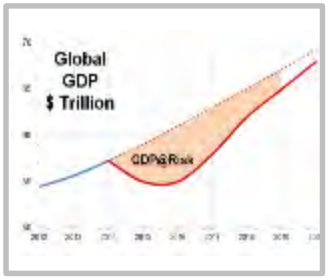
Narrative

Detailed description of events
3-4 variants of key assumptions for sensitivity testing

Loss Assessment

Metrics of underwriting loss across many different lines of insurance business



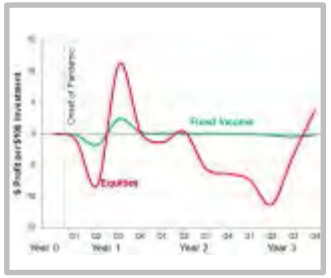


Macroeconomic Consequences

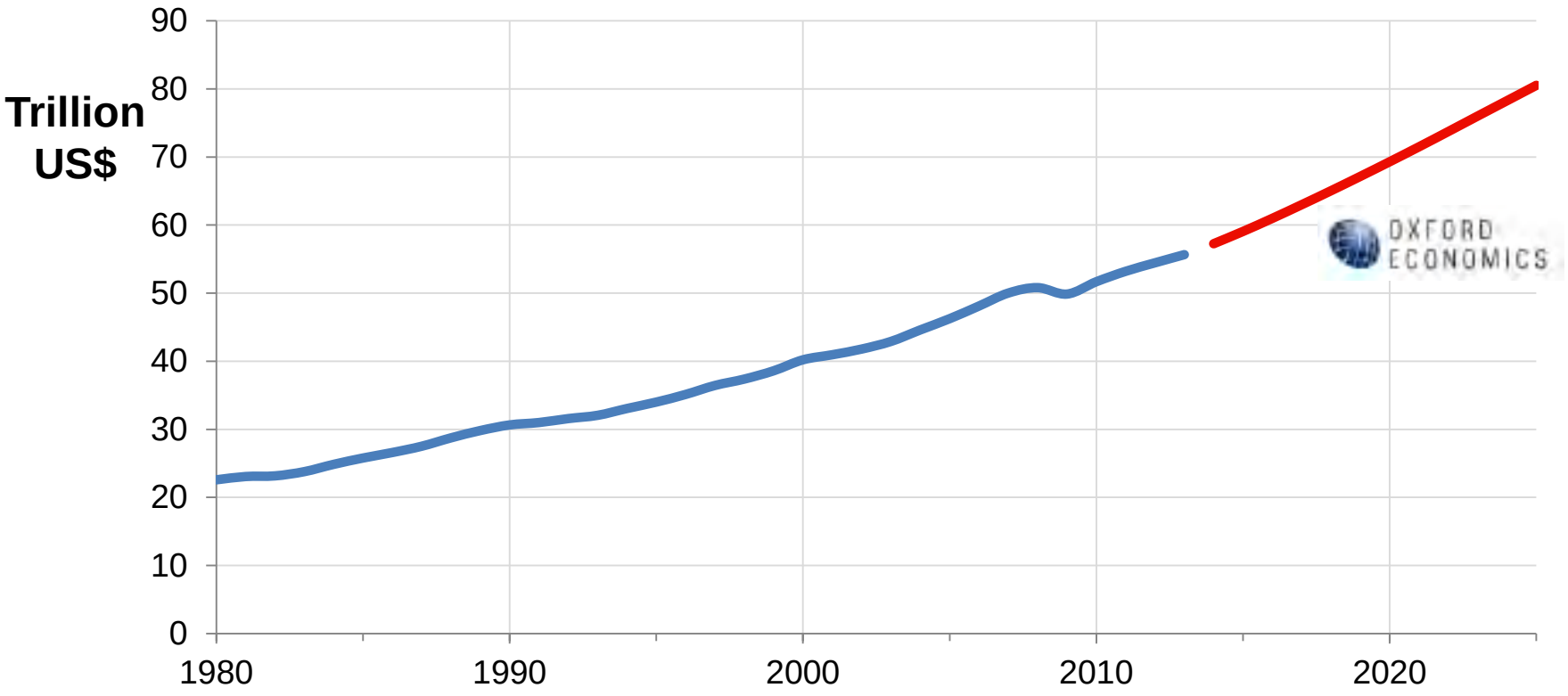
Quantification of effects on many variables in the global economy

Investment Portfolio Impact

Returns and performance over time of a range of investment assets



The Baseline Outlook is Positive



Global GDP 1980:	**$22.5 Trillion**
Historical Average Annual Growth Rate 1980-2006:	**3.0%**
Global GDP 2013:	**$55.6 Trillion**
OE Economic Forecast Global GDP 2025 (US$ 2015):	**$80.5 Trillion**
Forecast Size of Global Economy in 2025, relative to today:	**130%**
Forecast Average Annual Growth Rate 2014-2025:	**3.1%**

But the Road to Growth is Rocky

South Sea Bubble
1720

American Revolution
1775-1783

World War II
1939

Credit Crunch
2008

Spanish Flu Pandemic
1918

100

10

1

1700 1750 1800 18 1950 2000

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

UNIVERSITY OF CAMBRIDGE Judge Business School | Centre for **Risk Studies**

Stock Market Contagion: 24 Aug 2015

Shanghai

New York

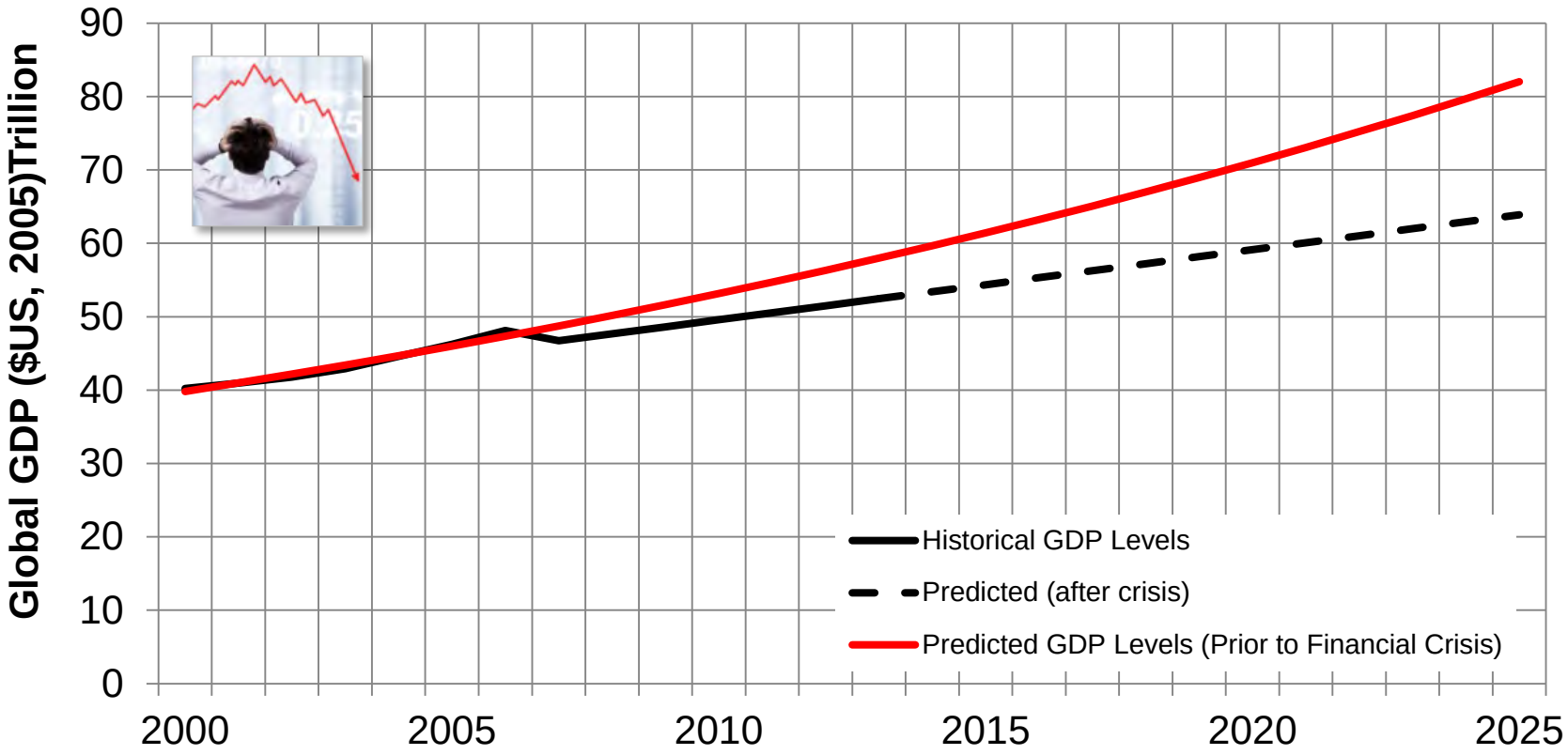
London

Kuala Lumpur

Frankfurt

Mumbai

2007-12 Great Financial Crisis

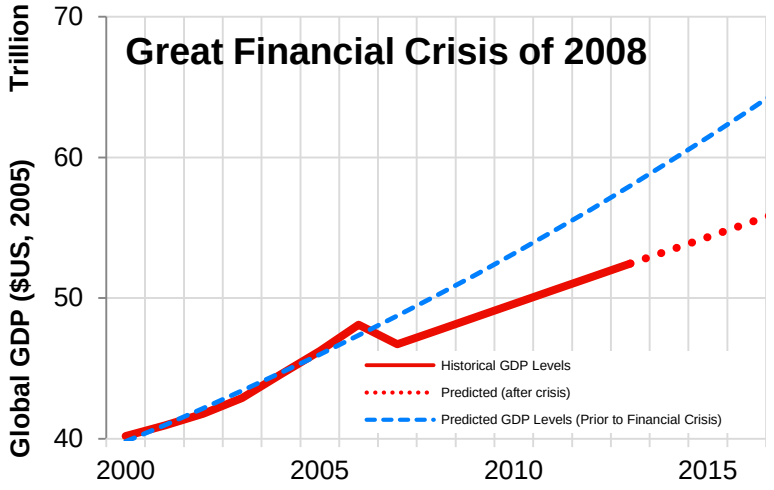


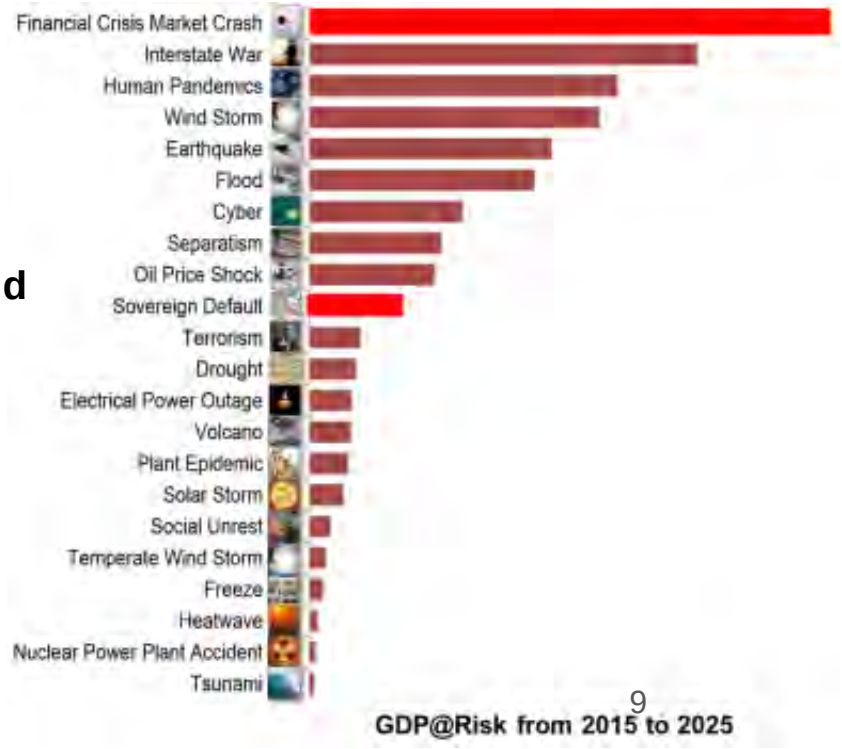
GDP@Risk: 20 Trillion ($US, 2010)

GDP@RR: 6.82%

The Economic Burden of Financial Catastrophes

- The Great Financial Crisis of 2008 destroyed an estimated **$20 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?

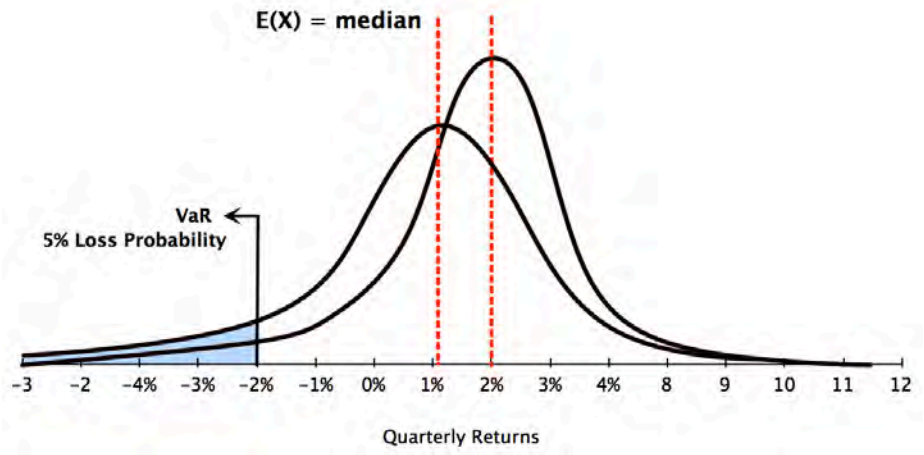




What is Tail Risk?

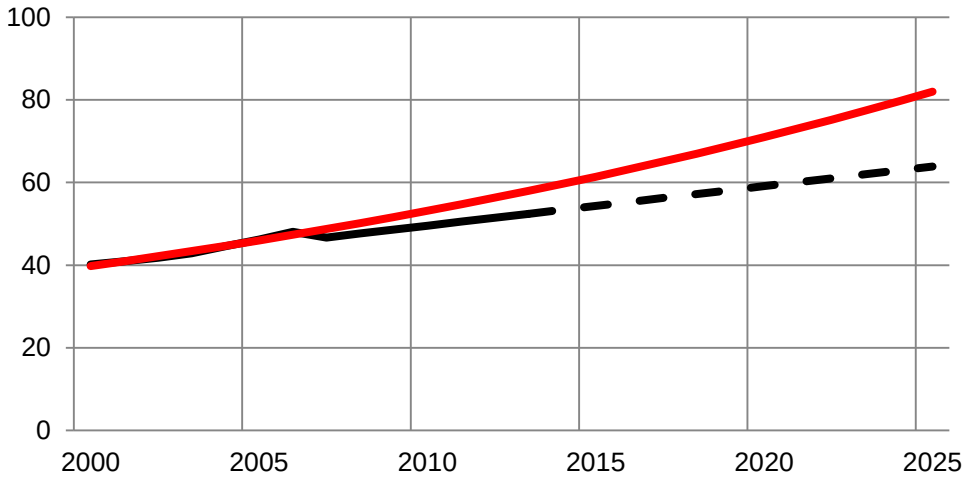
Classical Definition

Type 1 tails…
Short term tail risk

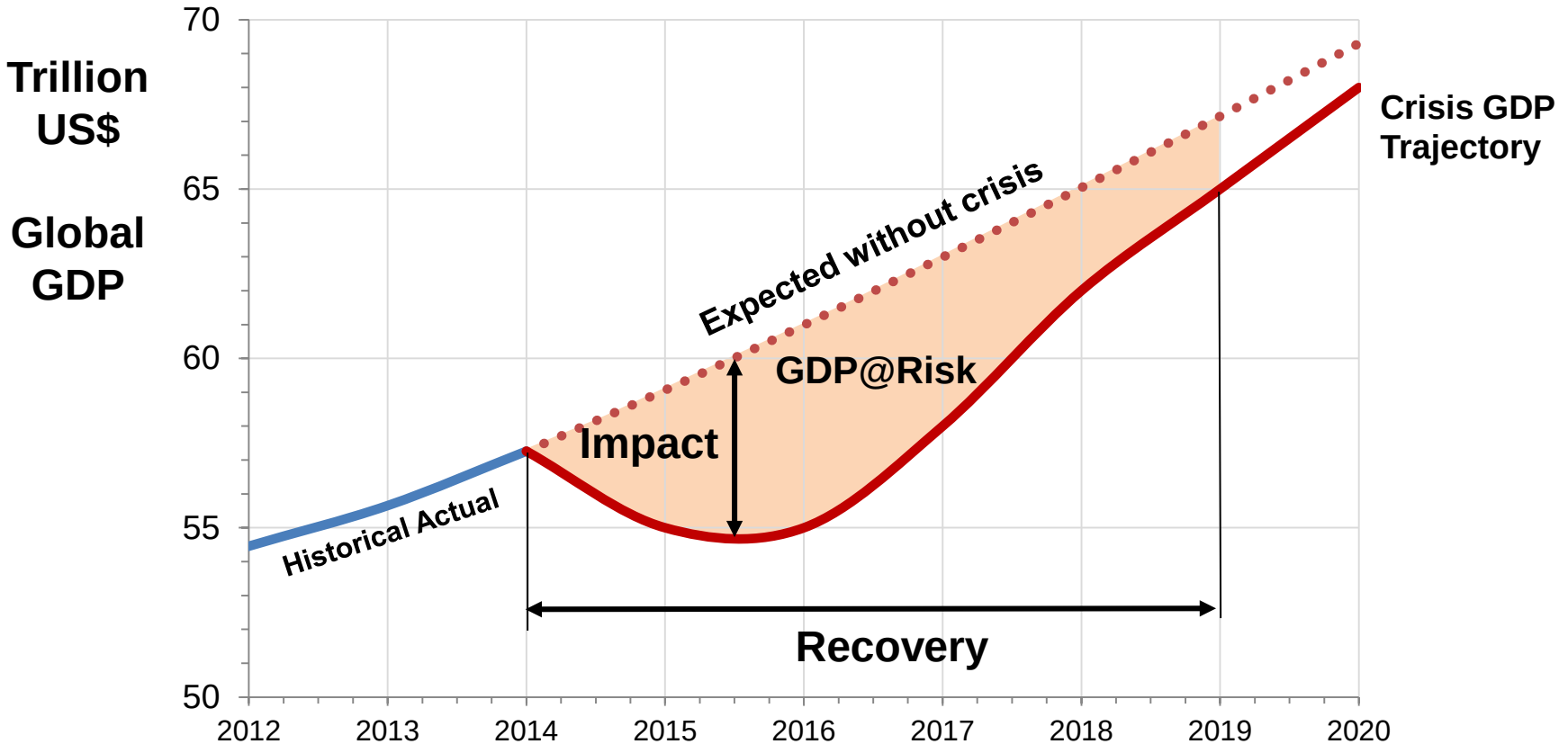


Catastronomics Definition

Type 2 tails…
Long term tail risk



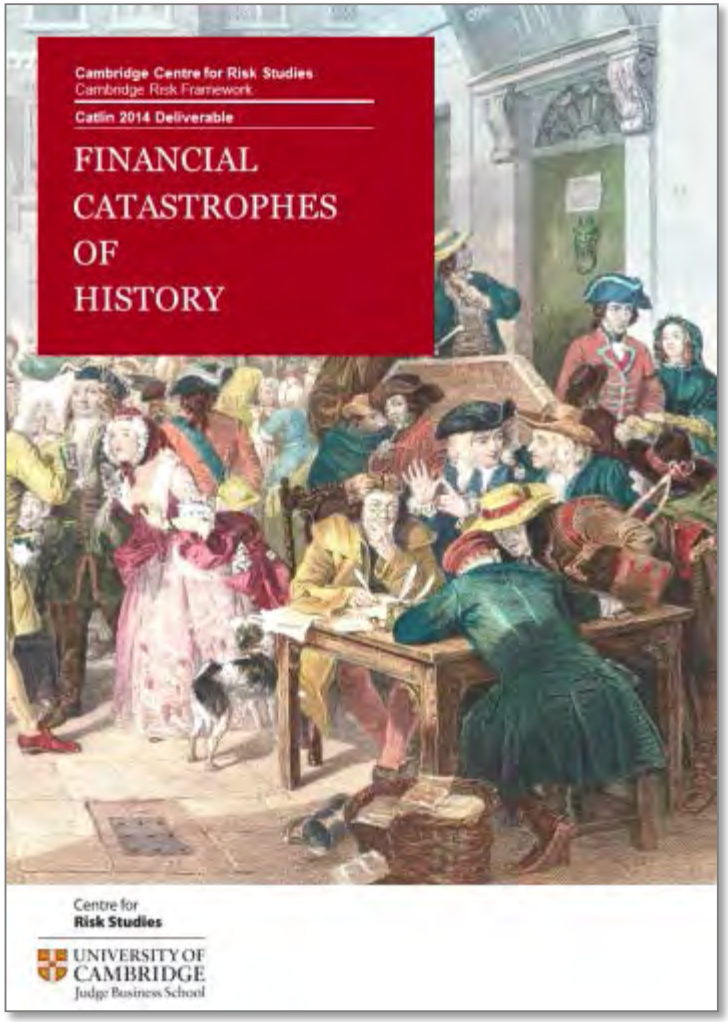
Estimating GDP@Risk



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

Learning from History

- A key component of understanding financial crises is the study of past events
- What happened, and what drove them?
- What-If… they were to happen today?
- Technologies have changed, but human behaviour remains – crowd behaviour
- What does it tell us about the past frequency and severity of crises?
- What might the future frequency and severity of crises be?
- **12 Historical Financial Crisis**



Publication in preparation

Historical Catalogue of Financial Crises

1. 1720s Crises (South Sea, Mississippi Scheme, Windhandel)
2. 1825 UK Country Bank Crisis
3. 1857 Panic (USA)
4. 1866 Collapse of Overend and Gurney
5. 1873 Crisis (USA)
6. 1890 Baring Crisis
7. 1907 US ‘Bankers’ Panic’
8. 1914 Financial Crisis
9. 1931-33 and the Great Depression
10. Early 1980s Latin American Debt Crisis
11. 1997-99 Asia crisis,
12. 2008 Global Financial Crisis

Data Sources

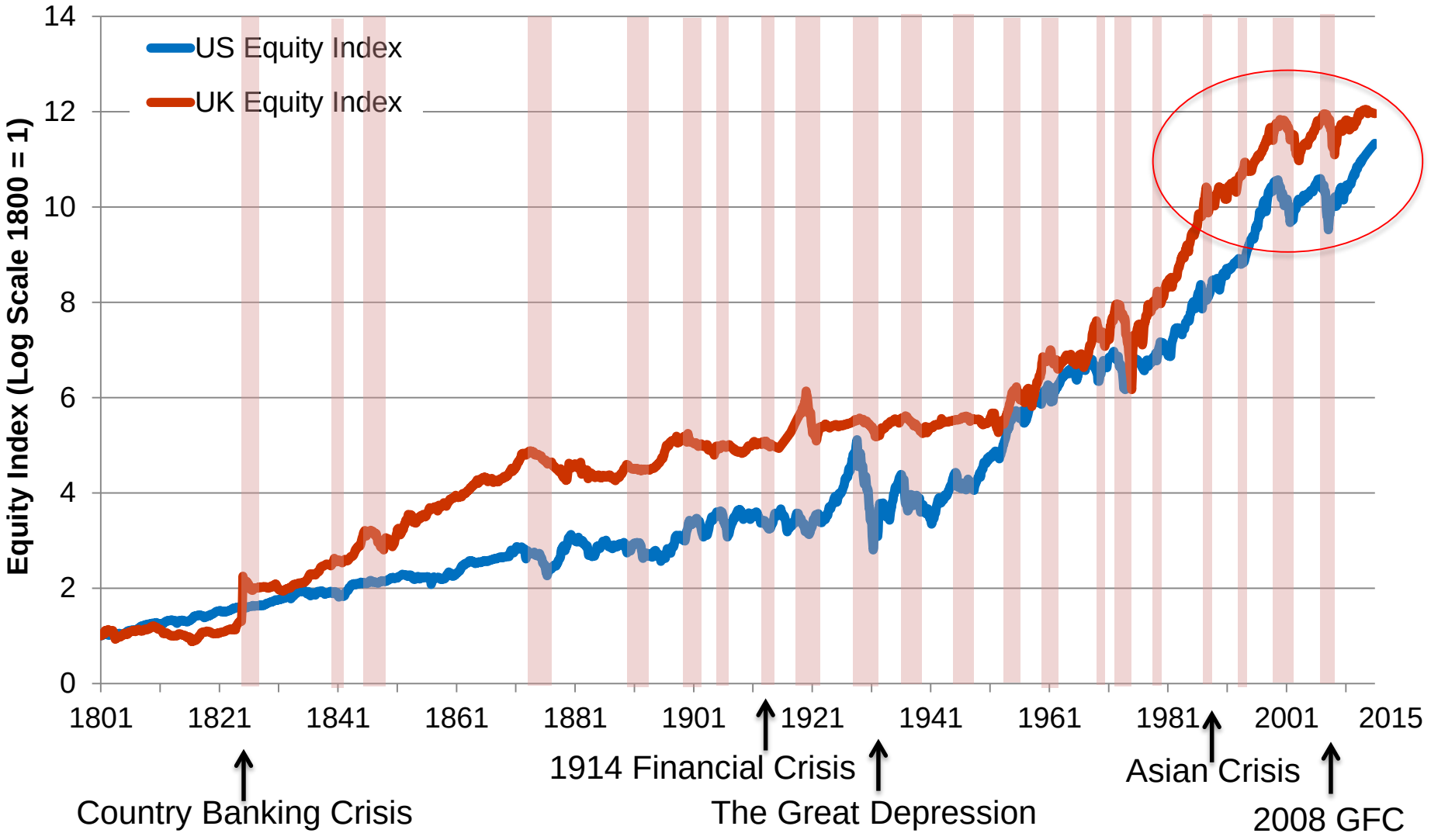
- Collected data over period 1800 - 2015
- Data is problematic – sparse, inconsistent, unconnected, incomplete and sometimes dubious….

Source	Period
Hills, Thomas, and Dimsdale (2015) Website: http://www.centerforfinancialstability.org/hfs.php	1830-2010
Janssen et al (2002), Mitchell (1988).	1703-1755
Bank of England and ONS.	1800-2012
Schumpeter-Gilboy index from Mitchell(1988), 1750-1975 from ONS (O'Donoghue et al (2004)), 1975-2009 CPI (ONS and Bank of England)	1688-1750
Mitchell (1988) and ONS (series code BKQK)	1800-2010
Feinstein (1972), ONS (code BCJE)	1855-2010
Mitchell(1988), Chapter XVI, Table 5 pages 831 to 8350 Sefton and Weale (1995), Table A2ONS: Series Code IKBI	1830-2008
Capie and Webber (1985) and Bank of England/ONS	1870-2009
BP Statistical Review of World Energy 2010	1861-2013
Reinhart, Camen M. and Kenneth S. Rogoff, "From Financial Crash to Debt Crisis," NBER Working Paper 15795, March 2010. Forthcoming in American Economic Review.	1800-2009
www.measuringworth.com	1800-2012
Three Centuries of Data, Bank of England (2012)	1700-2012

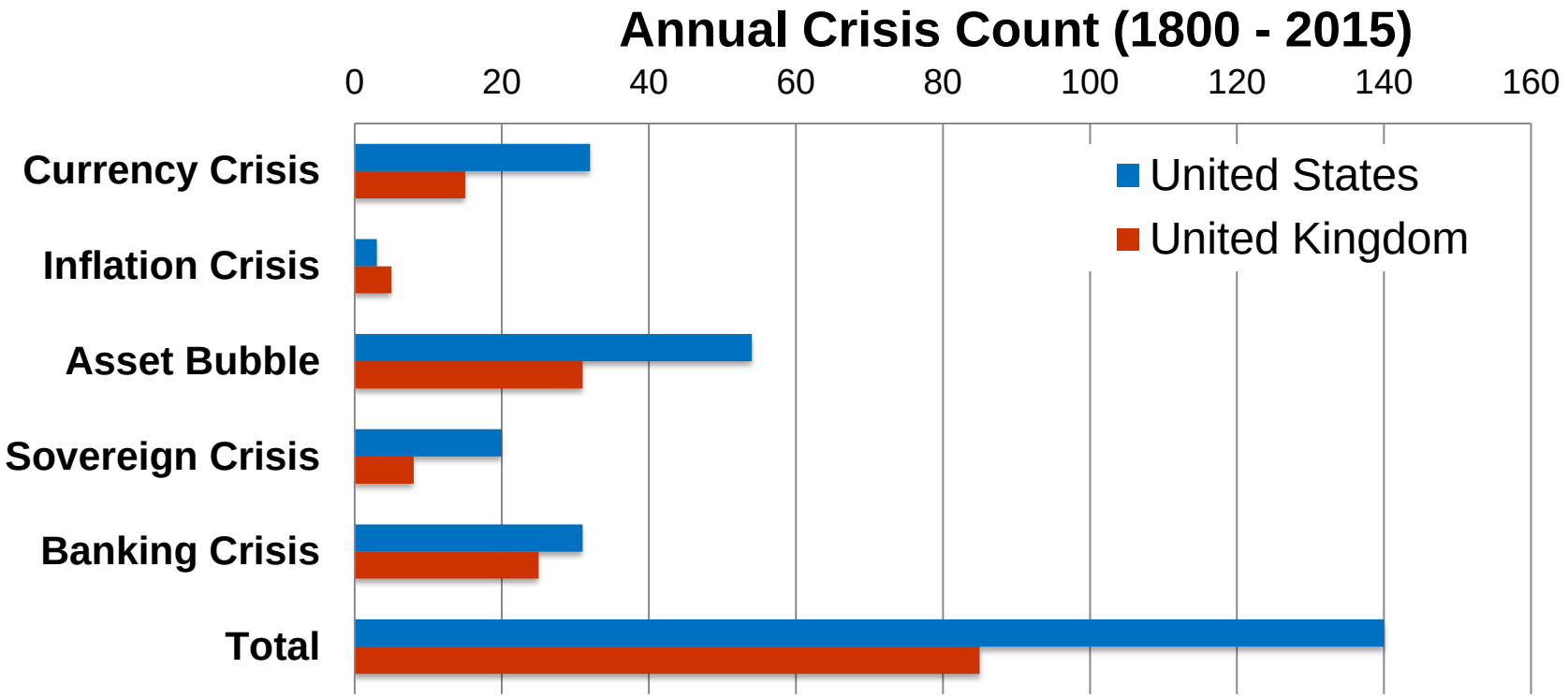
Data Collected:

- GDP
- Inflation
- Unemployment
- Government Debt
- Bond interest rates
- Exchange rates
- HH consumption
- Exports / Imports
- Balance of payments
- Money Supply
- Equity Index
- Population
- Oil Price

US and UK Equity Index (1800-2015)



Two Centuries of Financial Crisis

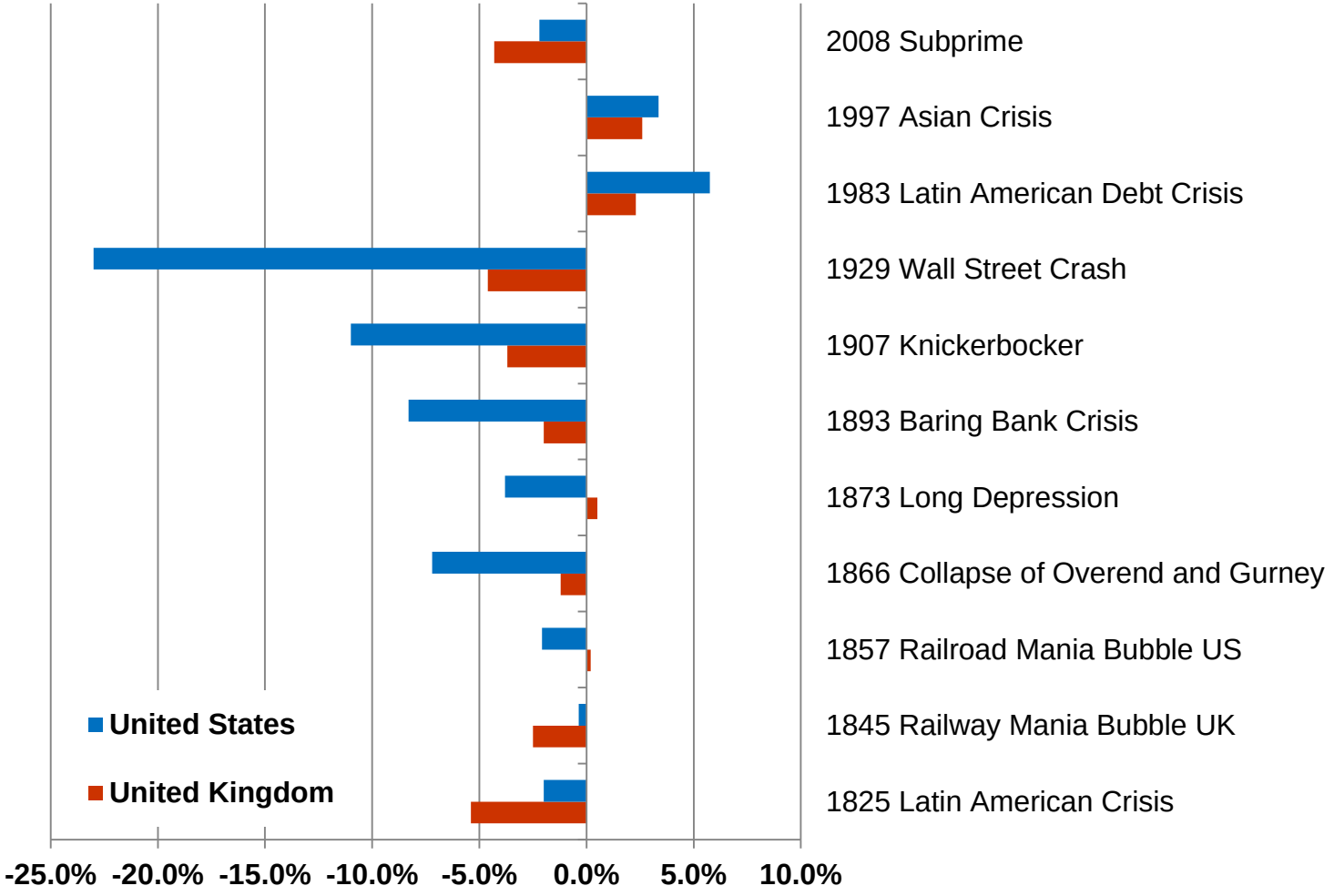


Currency: 15% devaluation
Inflation: 20% Increase in prices
Asset bubble: 25% drop in returns

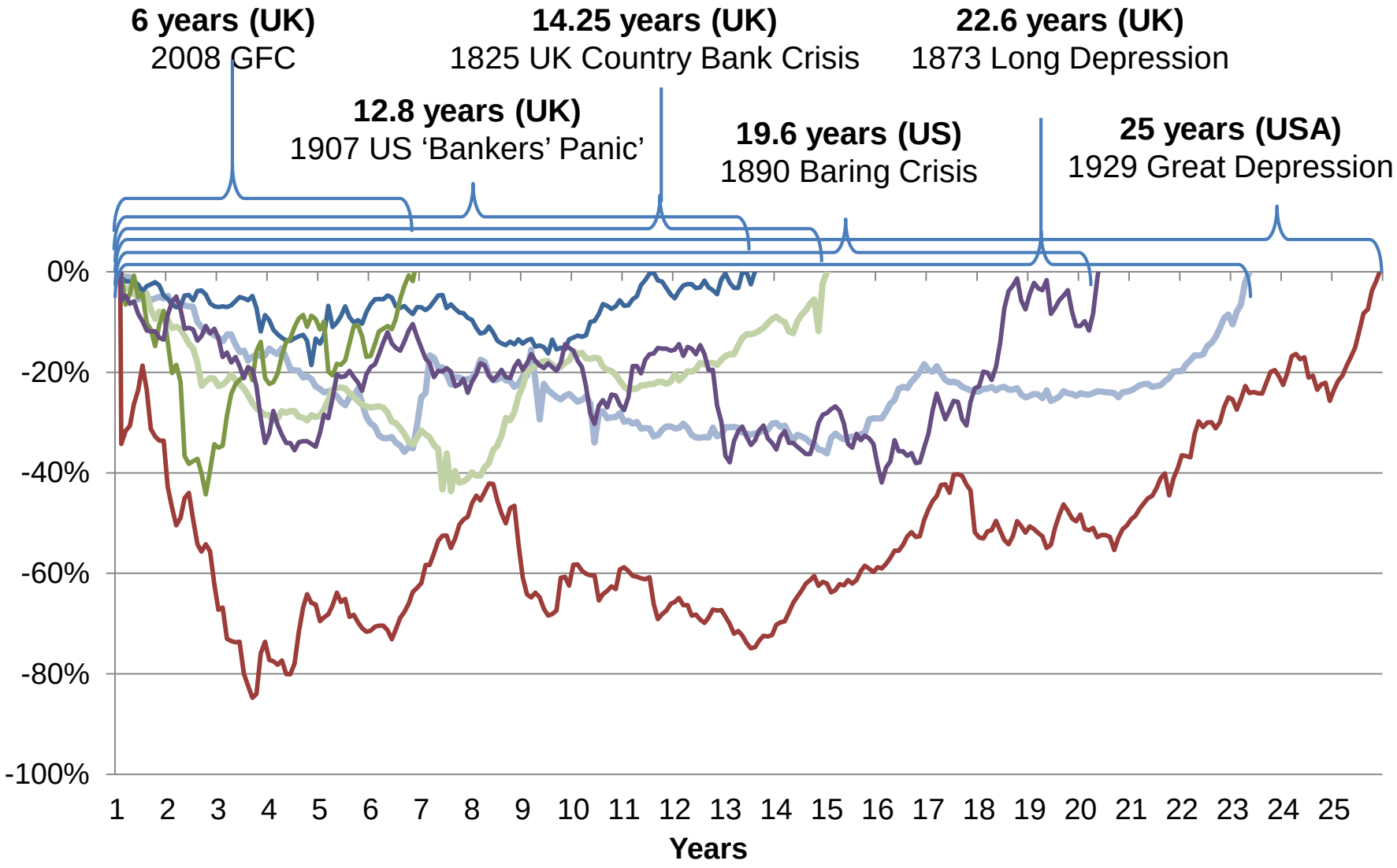
Sovereign crisis: Failure to make payment
Banking crisis: One significant bank fails

Source: Reinhart, Camen M. and Kenneth S. Rogoff, "From Financial Crash to Debt Crisis," NBER Working Paper 15795, March 2010. Forthcoming in American Economic Review.

GDP Growth Rates



Duration of Stock Market Impact from Crises



Multiple Crisis Occur Simultaneously

		Peak to Trough Loss		Crisis Type				
Year	Crisis	UK	US	Asset Bubble	Sovereign Crisis	Currency Crisis	Inflation Crisis	Banking Crisis
1720	South Sea Bubble	80%	-	x				x
1825	The Country Banking Crisis	43%	3%	x	x			x
1845	Railway Mania Bubble UK	9%	5%	x	x			
1857	Railroad Mania Bubble US	13%	23%	x				x
1866	Collapse of Overend and Gurney	7%	6%					x
1873	Long Depression	33%	47%		x			x
1890	Baring Bank Crisis	9%	42%	x		x		x
1907	US 'Bankers' Panic'	19%	26%	x				x
1929	Wall Street Crash	52%	85%	x		x		x
1983	Latin American Debt Crisis	5%	20%		x	x	x	x
1987	Black Monday	31%	30%					x
1997	Asian Crisis	12%	6%	x	x	x	x	x
2008	Great Financial Crisis	44%	48%	x	x			x

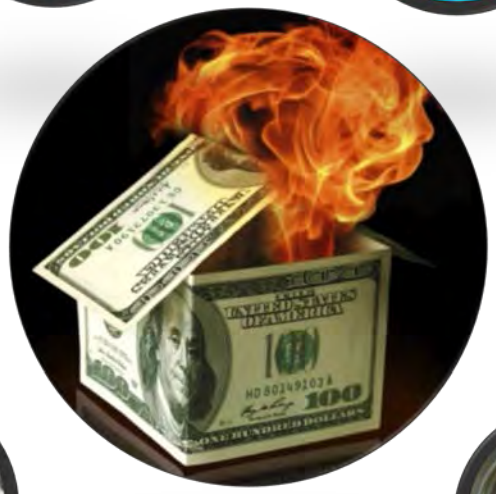
Taxonomy of Financial Crisis

Complex / Technological

- Flash crash
- Black box trading
- Complex derivatives
- Cyber crash

Inflation

- Cost-push inflation
- Demand-pull inflation
- Deflation



Banking Crisis

- Systemic failure
- Bank run
- Credit crunch

Currency Crisis

- Reserve currency
- FX shock

Asset Bubble

- Stock market crash
- Commodity price bubble
- Property price bubble

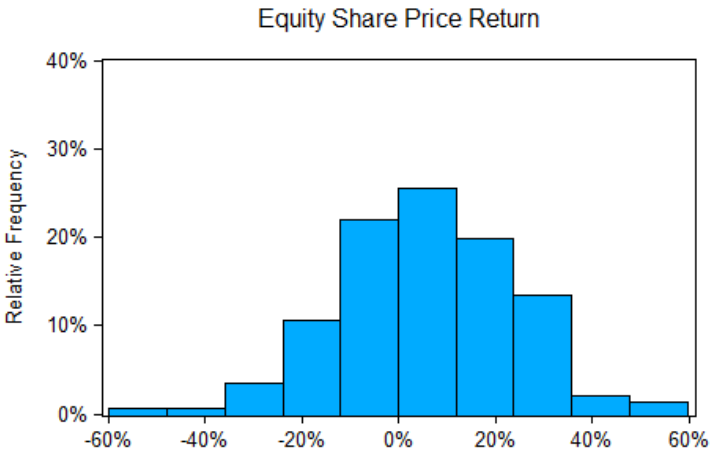
Debt

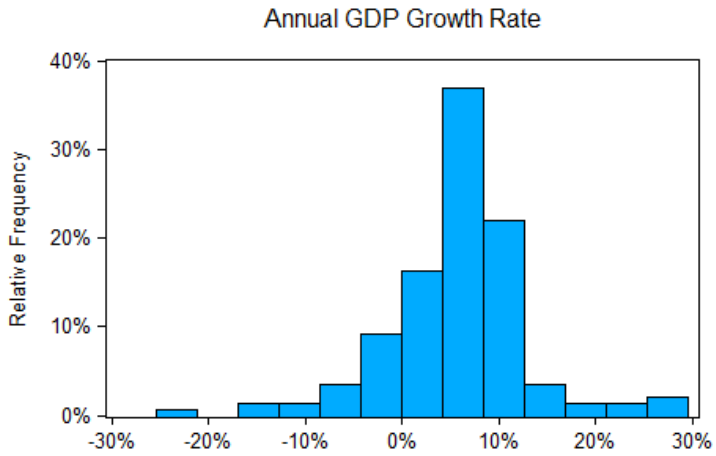
- Sovereign Debt
- Private Debt

Illegal Activity

- Fraud
- Financial irregularity

Equity and GDP at Risk





US Distribution of Returns

Equity Value at Risk (1800 - 2010)

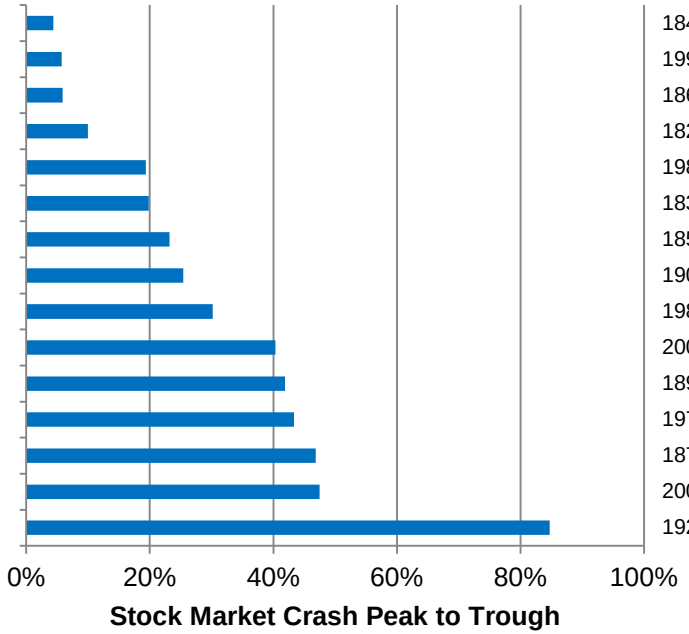
	1%	5%	Mean
US Equity VaR	35.7%	23.6%	5.7%
UK Equity VaR	19.9%	12.8%	4.6%

GDP Value at Risk (1800 - 2010)

	1%	5%	Mean
US GDP at Risk	12.7%	7.4%	5.3%
UK GDP at Risk	5.1%	3.0%	2.0%

Historical Severities of Crashes – Past 200 Years

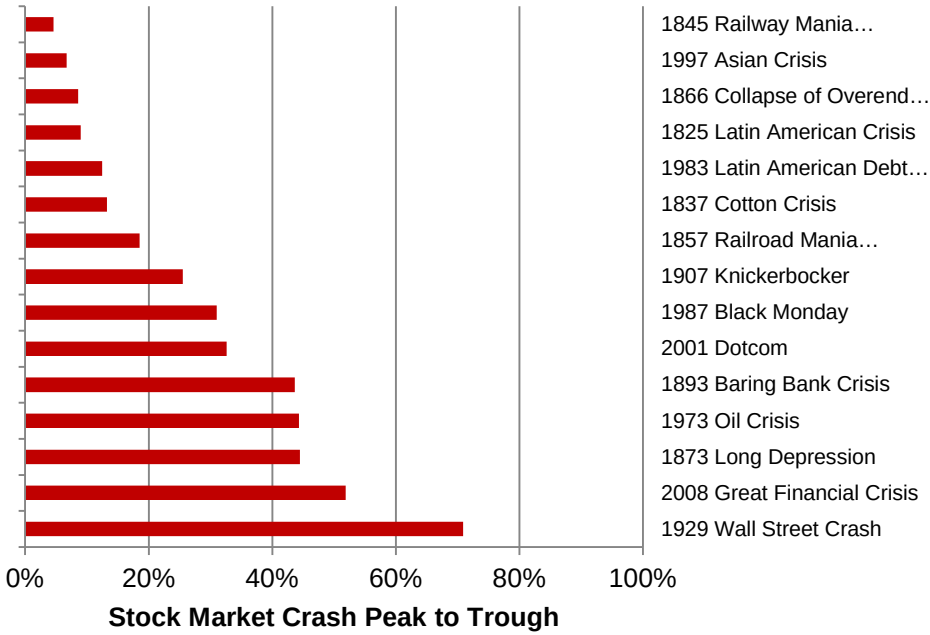
US Stock Market Crashes



Observed, last 200 years

Crashes Greater Than	Number of Crises	Average Interval (Yrs)
10%	12	16
20%	9	21
40%	6	32
50%	1	190

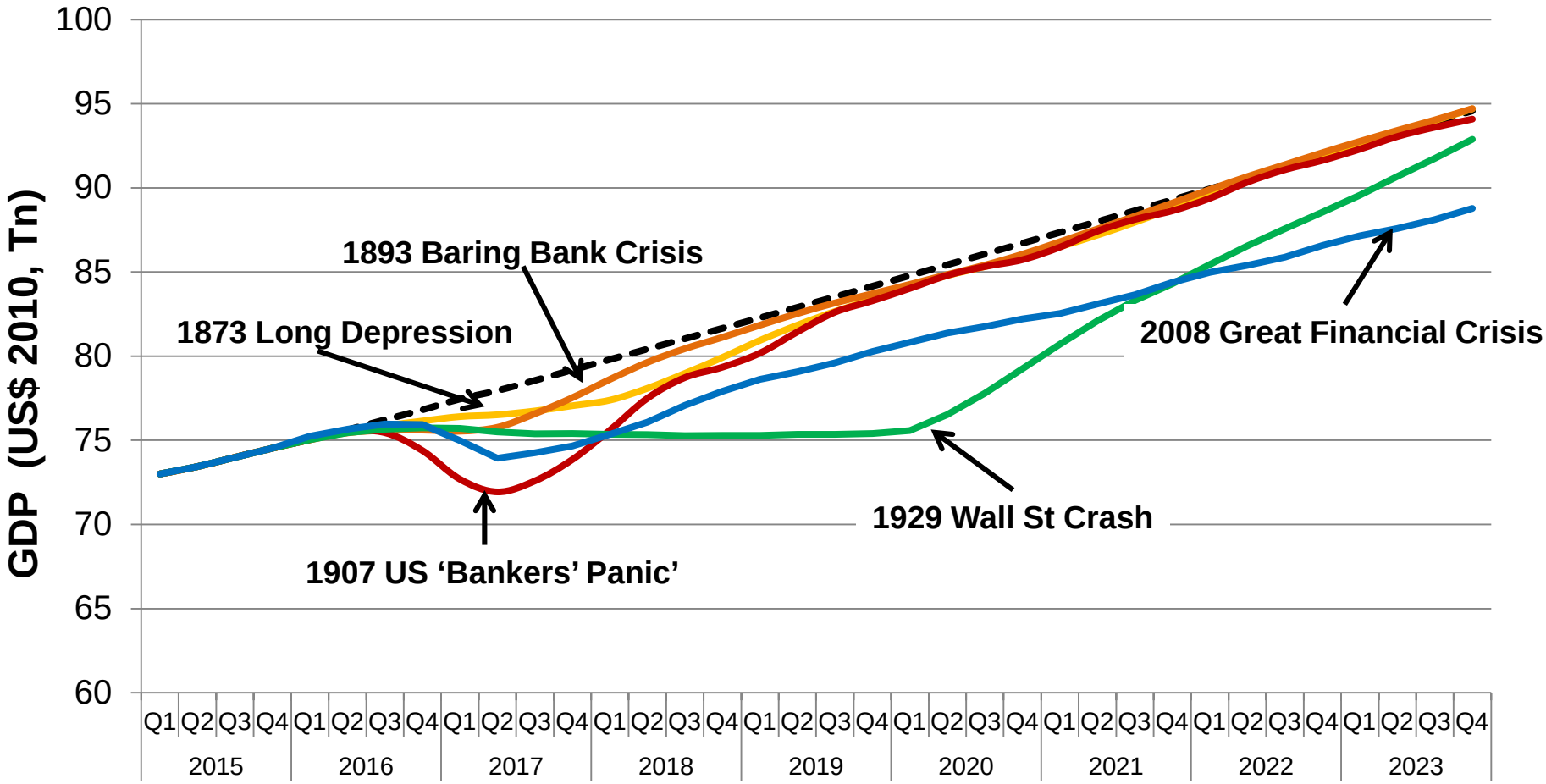
UK Stock Market Crashes



Observed, last 200 years

Crashes Greater Than	Number of Crises	Average Interval (Yrs)
10%	11	17
20%	8	24
40%	5	38
50%	2	95

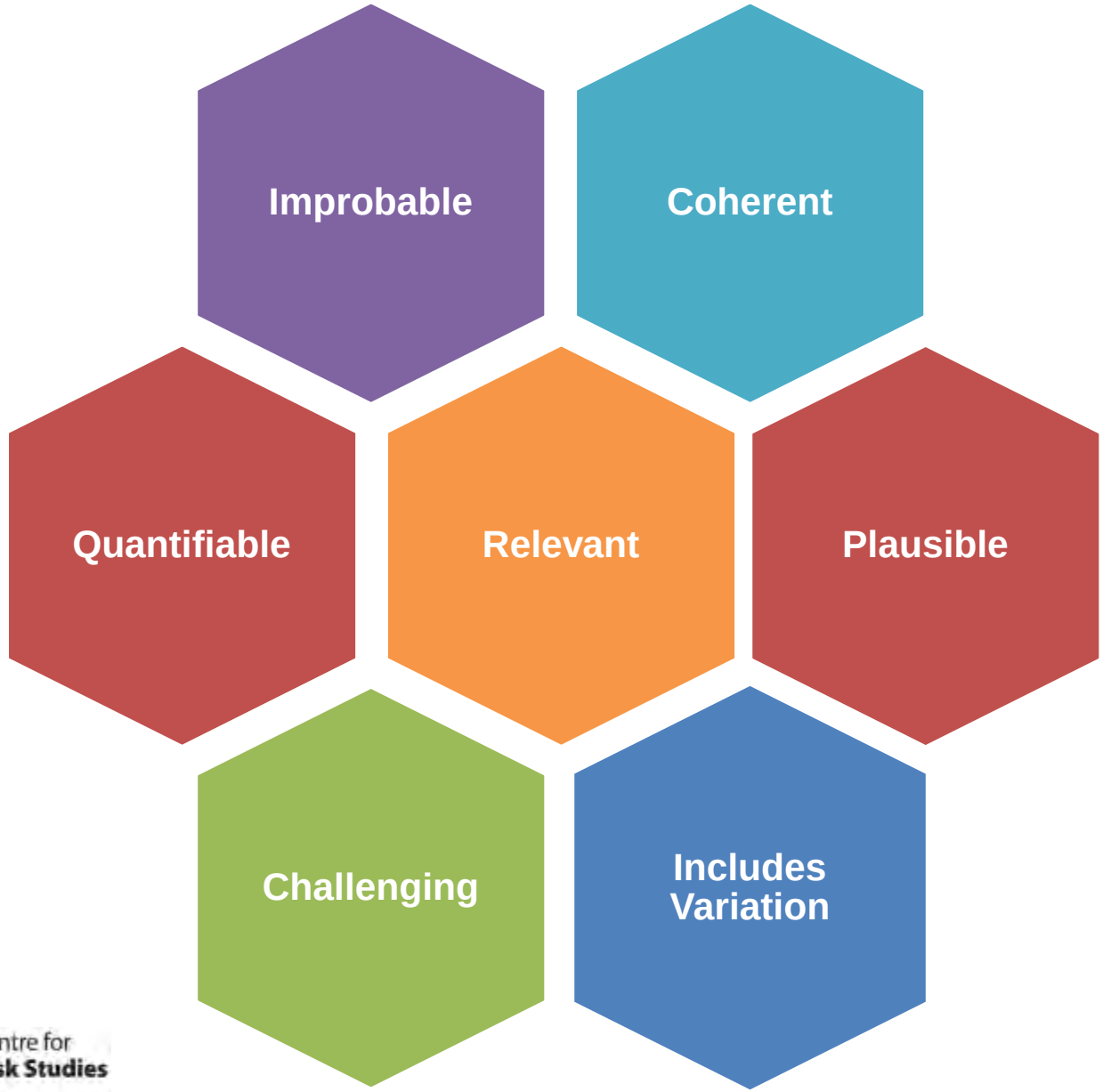
Modelling Historical Financial Crises



What is a scenario stress test?

- Scenarios use **narratives** that pose ‘what if’ questions and explore views about alternative futures.
- Help deal with **complexity** and **uncertainty**
- Release us from conditioning and existing habits that may inhibit new actions and insight
- Bring together creativity and analytics
- **Not predictions, or forecasts**
- **Coherent** and **plausible** expectations about the future
- Used to improve business resilience to shocks

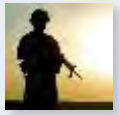
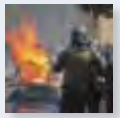
Seven Critical Characteristics of Stress Tests



Historical & Scenarios: GDP@Risk

GDP@Risk US$ Trillion, 2010 prices	GDP@Risk
1893 Baring Bank Crisis	5
1873 Long Depression	7
1907 US 'Bankers' Panic'	14
2007 Great Financial Crisis	20
1929 Wall Street Crash	30
 CRS Dollar Deposed	2-3
 CRS High Inflation World	5-11
 CRS Eurozone Meltdown	6-20
 CRS Global Property Crash	11-33

Cambridge Scenarios: GDP@Risk

GDP@Risk US$ Trillion	S1	S2	X1
 Geopolitical Conflict **China-Japan Conflict**	**17**	27	32
 Asset Bubble Shock **Global Property Crash**	**13**	20	30
 Pandemic **Sao Paolo Virus**	**7**	10	23
 Sovereign Default Shock **Eurozone Meltdown**	**11**	16	23
 Food and energy price spiral **High Inflation World**	**5**	8	11
 Cyber Catastrophe **Sybil Logic Bomb**	**5**	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 2014	**20**		

- 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

Centre for
Risk Studies

UNIVERSITY OF
CAMBRIDGE
Judge Business School