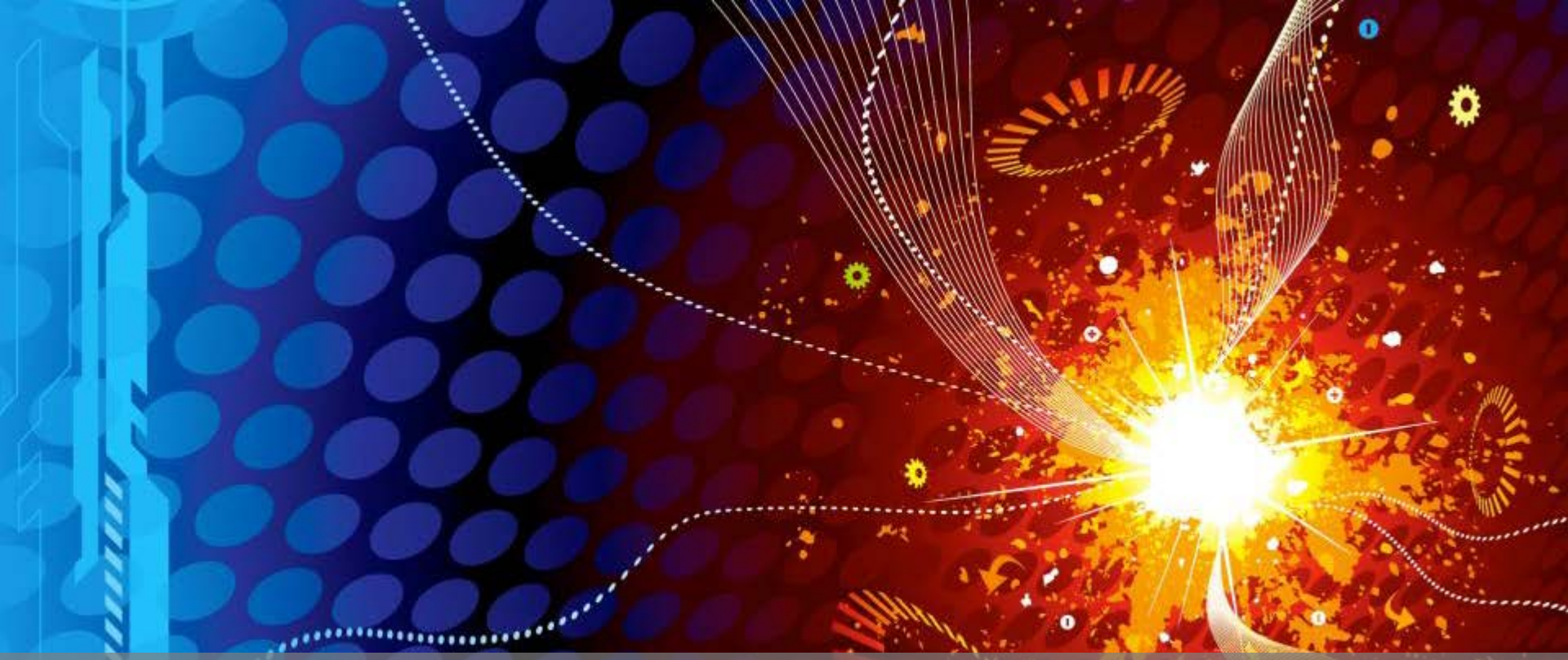


Cambridge Centre for Risk Studies – New York Risk Briefing

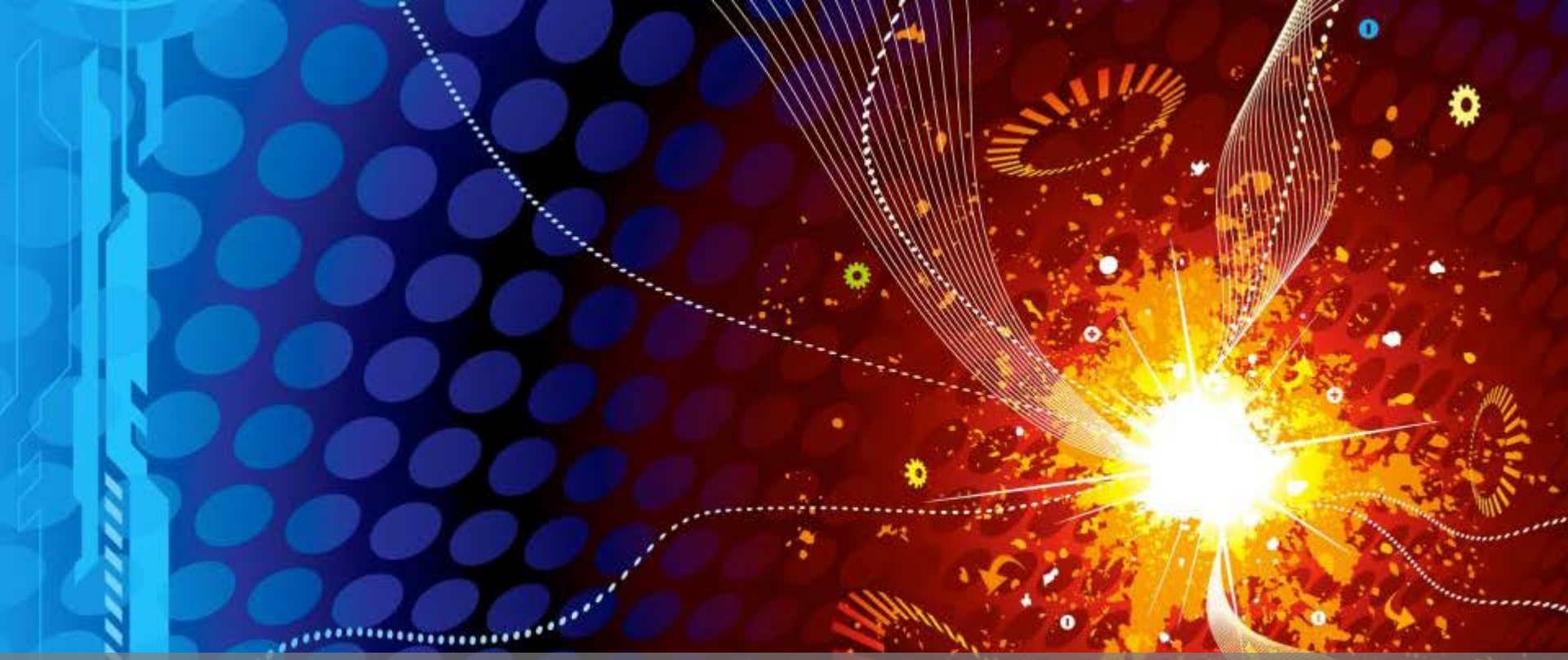
April 30, 2015

Financial Risk Scenarios

Could Your Portfolio Hold Up?

Centre for Risk Studies

UNIVERSITY OF CAMBRIDGE
Judge Business School



Financial Risk Scenarios: Could Your Portfolio Hold Up?

Cambridge Centre for Risk Studies - New York Risk Briefing - April 30, 2015

Welcome

Centre for Risk Studies

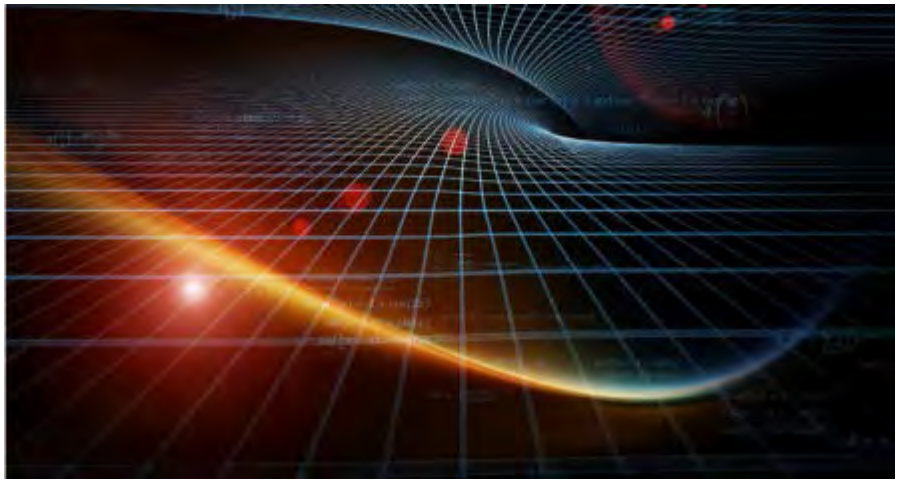
UNIVERSITY OF CAMBRIDGE
Judge Business School

Dr Michelle Tuveson
Executive Director
Centre for Risk Studies

Agenda

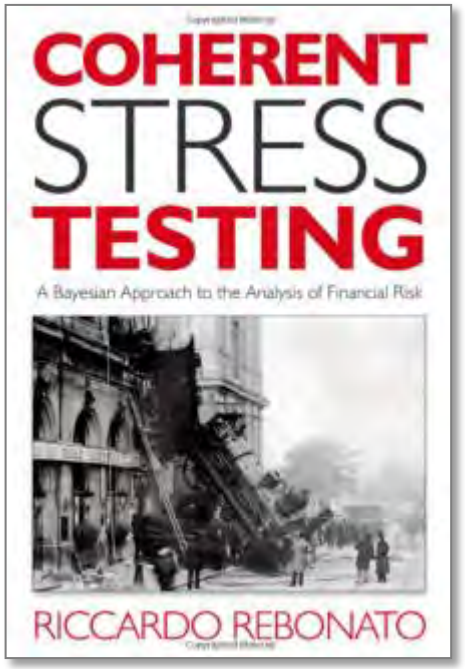
Welcome	*Dr Michelle Tuveson*
Financial Stress Testing	*Dr Andrew Coburn*
Global Property Crash: Narrative and Impacts	*Mr Simon Ruffle*
Global Property Crash: Financial Market and Portfolio Impacts	*Dr Eugene Neduv*
Managing a Multiplicity of Financial Market Catastrophes	*Prof Danny Ralph*
Audience Q/A	

Stress Testing Focus for Our Annual Conference

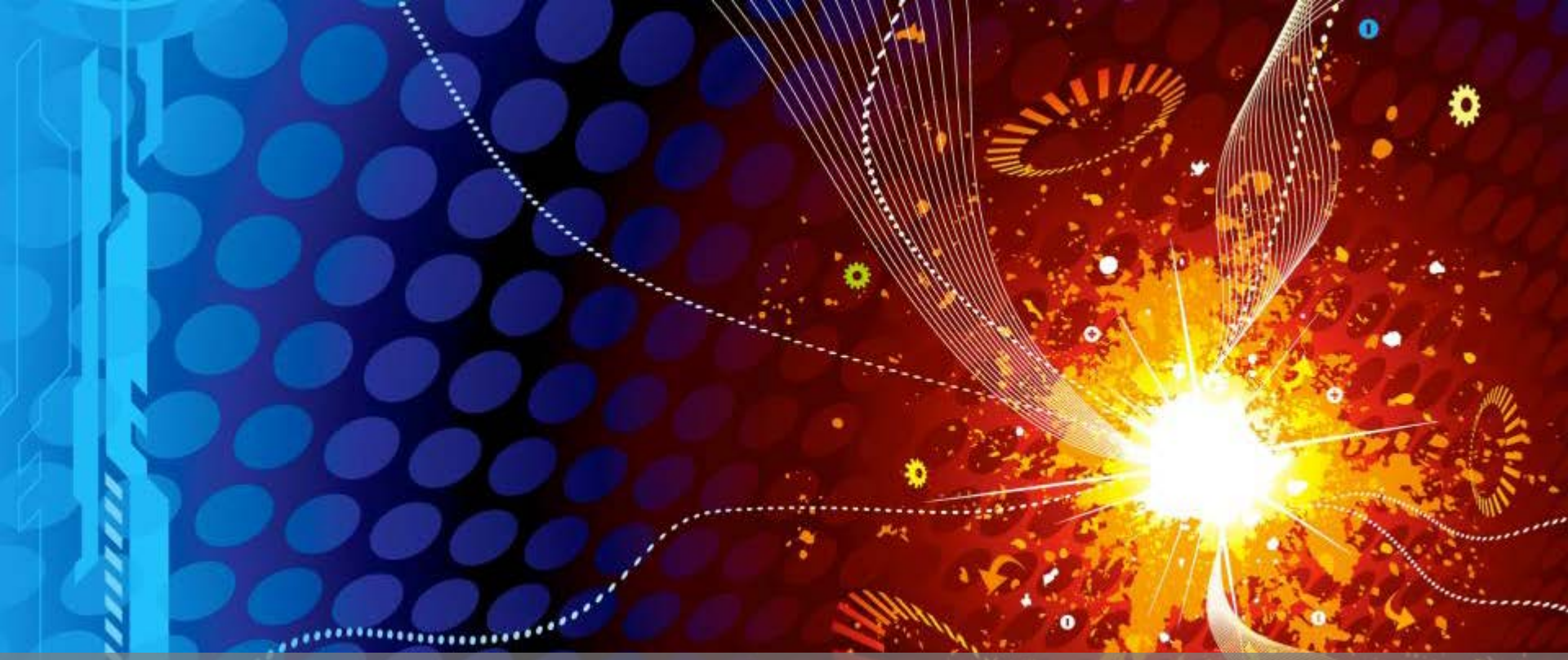


- Cambridge Centre for Risk Studies 2015 Risk Summit
- June 22 & 23, 2015
- Cambridge, United Kingdom
- '**Risk Testing: Stressing the boundaries**'

- Venue for discussions about new approaches to stress testing



Guest speakers include Riccardo Rebonato author of ***Coherent Stress Testing***



Financial Risk Scenarios: Could Your Portfolio Hold Up?

Cambridge Centre for Risk Studies - New York Risk Briefing - April 30, 2015

Financial Stress Testing

Centre for Risk Studies

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Judge Business School

Dr Andrew Coburn
Director of Advisory Board
Centre for Risk Studies

Stress Testing: Recent Controversy

The New York Times

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

By PETER EAVIS 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 Federal Reserve said on Wednesday.

The New York Times

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

November 3, 2014 10:59 pm

Stress test assumptions were not particularly stressful

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 York Times

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

- Stress tests are criticized for being
  - Not tough enough
    - Just a marketing exercise to increase public confidence in banks
  - Unrealistic
    - One-dimensional
    - Not ‘coherent’
    - Poor assumptions
  - Extremely time consuming and resource intensive to perform
  - Too predictable
  - Out of date by the time they are done

Stress Testing Issues

The current debate includes

- How severe should stress tests be?
- What levels of severity reassure the market?
- What levels of security do we want our financial institutions to represent?
  - We have explicit standards of failure tolerance in many other aspects of society's critical infrastructure
  - What should our 'failure tolerance' standard be for banks?
- Can stress tests tell us about lower returns that result from lower risk?
- What can financial institutions learn from other disciplines about their use of stress testing?

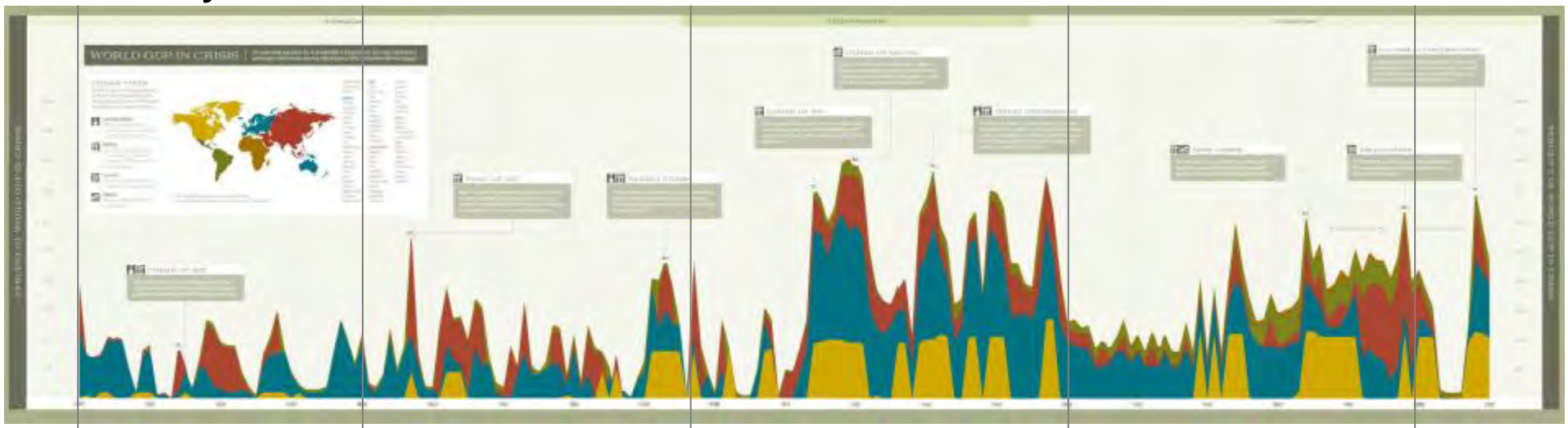
Historical Financial Crises

Financial Crises: Stock Market Loss

UNIVERSITY OF CAMBRIDGE Judge Business School | Centre for Risk Studies

Some Crises are More Common than Others

History of General Financial Crises



History of Sovereign Defaults

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

Financial Crises Have Become More Common

	Start Date	End Date	No. Events	Duration	Average Interval
All catalog	1720	1792	17	288	**16.9**
17C-late 20C	1720	1973	12	253	**21.1**
Post 1970s	1973	2014	5	41	**8.2**

- Globalization is making crashes more systemic
  - National markets have always had their own crises periodically
  - Globalization has tended to mitigate localized crises – fewer small local crises
  - But bigger local crises now infect more markets, drawing on capital from many other markets
- Interconnectedness is increasing correlation and the potential for global crashes

What Causes Financial Crises?

- Qualitatively different causes of **endogenous** financial shocks

Financial Shock

Asset Bubble

Sovereign Default

Bank Run

Market Crash

Financial Irregularity

Flash Crash

Based on Allen & Gale 2009,
Understanding Financial Crises

Plus ‘Exogenous’ Causes of Financial Crises

Endogenous

Financial Shock

Asset Bubble

Financial Irregularity

Market Crash

Sovereign Default

Bank Run

Trade Dispute

Labour Dispute

Trade Sanctions

Cartel Pressure

Nationalization

Tariff War

Geopolitical Conflict

Conventional War

Asymmetric War

External Force

Civil War

Nuclear War

Political Violence

Terrorism

Separatism

Organized Crime

Assassination

Social Unrest

Natural Catastrophe

Earthquake

Windstorm

Volcanic Eruption

Flood

Tsunami

Climatic Catastrophe

Drought

Freeze

Tornado & Hail

Electric Storm

Heatwave

Environmental Catastrophe

Sea Level Rise

Ocean System Change

Wildfire

Pollution Event

Atmospheric System Change

Technological Catastrophe

Nuclear Meltdown

Industrial Accident

Cyber Catastrophe

Technological Accident

Infrastructure Failure

Disease Outbreak

Human Epidemic

Animal Epidemic

Waterborne Epidemic

Zoonosis

Plant Epidemic

Humanitarian Crisis

Famine

Water Supply Failure

Child Poverty

Welfare System Failure

Refugee Crisis

Externality

Meteorite

Solar Storm

Space Threat

Ozone Layer Collapse

Satellite System Failure

Other

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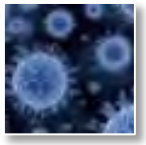
Cambridge Stress Test Scenarios for Portfolios

Exogenous

Geopolitical Conflict
China-Japan War



Pandemic
Sao Paolo Virus

Cyber Catastrophe
Sybil Logic Bomb

Social Unrest
Millennial Uprising

Endogenous

Asset Bubble
Global Property Crash

Sovereign Default
Eurozone Meltdown

High-Inflation
Food and Energy Price Spiral

De-Americanization
Dollar Deposed

Historical

1929 Crash
Wall Street Crash

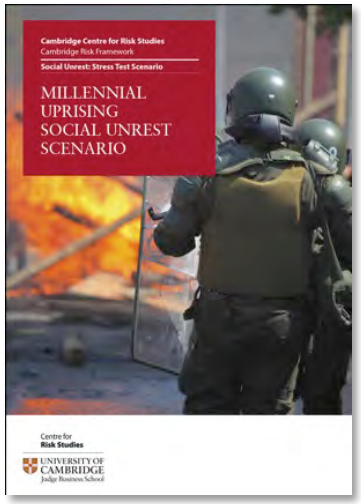
1907 Bankers Panic
Knickerbocker Crisis

1980s Debt Crisis
Latin American Debt Crisis

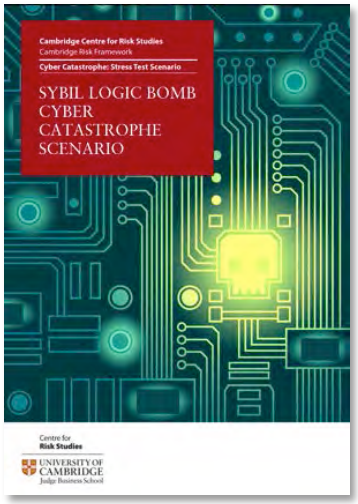
Panic of 1893
Baring Bank Crisis

Published Reports on Stress Test Scenarios

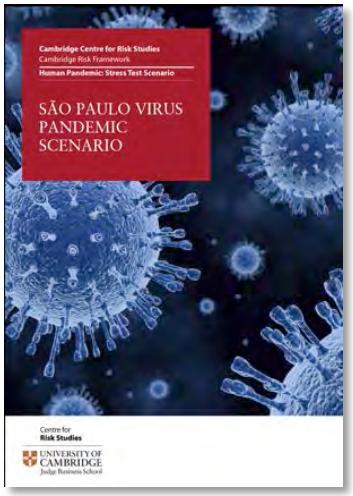
Taxonomy of Threats



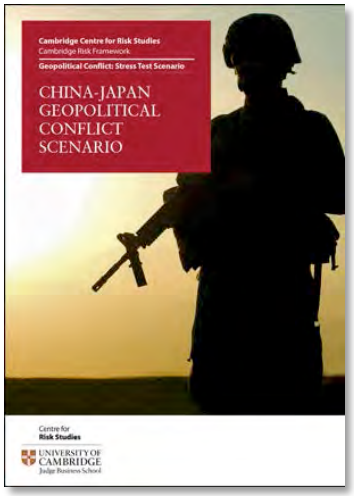
Social Unrest
Stress Test Scenario



Cyber Catastrophe
Stress Test Scenario



Pandemic
Stress Test Scenario



Geopolitical Conflict
Stress Test Scenario

Available for Download from Website:
CambridgeRiskFramework.com

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

Financial Stress Test Scenarios

Global Property Crash

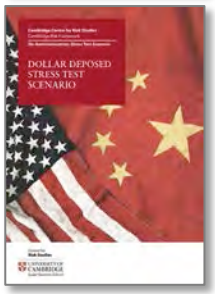
Sudden collapse of property prices in China followed by many other emerging and developed markets triggers a cascading crisis throughout the global financial system

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



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"

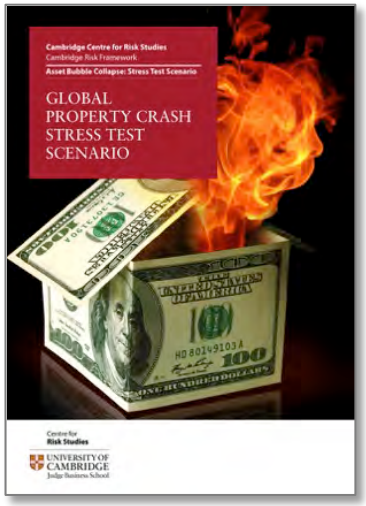
- Scenarios are not predictions
- Scenarios are stress tests for risk management purposes
  - These are not forecasts of what is likely to happen
  - These are hypothetical: Illustrate an extreme but plausible event in a particular threat class
  - Used for 'what-if' studies
  - Intended to improve business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

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%	

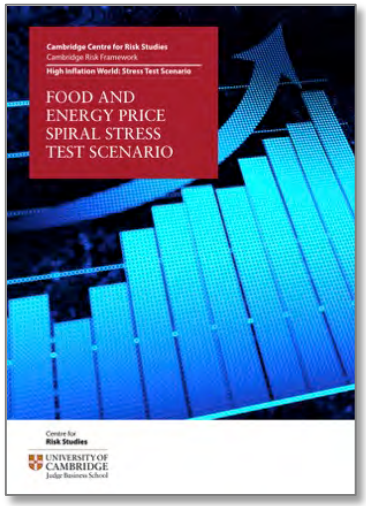
Financial Catastrophe Scenario Reports

Overview

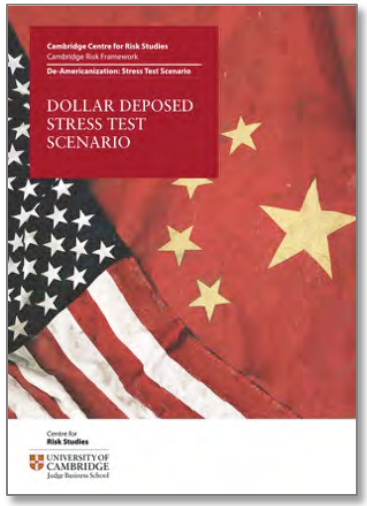


Global Property Crash

Eurozone Meltdown



High Inflation World



Dollar Deposed

Available from
Cambridge Centre for Risk Studies

Target Publication Date June 2015

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Centre for Risk Studies

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Mr Simon Ruffle
Director of Technology Research and Innovation
Centre for Risk Studies

Bubble Babble

theguardian

Bank of England governor warns of a bubble as UK house prices rise 10.5%

Mark Carney told MPs that high levels of mortgage debt can lead to overstretched owners cutting back on other purchases

Hilary Osborne and Angela Monaghan
The Guardian, Tuesday 15 July 2014 17.42 BST

CNBC

HOME U.S. NEWS MARKETS INVESTING TECH SMALL BIZ VIDEO SHOWS

Australia central bank warns about housing prices

CNBC.com staff
13 Hours Ago

FINANCIAL TIMES

Property bubble is 'major risk to China'

By Jamil Anderlini in Beijing

FINANCIAL POST

TRENDING

Canada in 'significant' housing bubble

JONATHAN RATNER

The Nordic Housing Bubble

By Jesse Colombo

The Nordic Housing Bubble or Scandinavia during the past decade in Norway, Sweden, F... Western European Housing Bubble, which is a...

The Norwegian Housing Bubble

175 150 125 100 75 50 25

93 95 97 99 01 03 05 07 09 11

GLOBAL INDONESIAN VOICES

Housing Bubble Forming in Indonesia, Here are the Signs

Posted On 07 Apr 2014 By : Global Indonesian Voices

Europe

Ireland house prices raise fears of a new bubble

By Vincent Boland in Dublin

Bloomberg

News Quick Markets Personal Finance Tech U.S. Politics

Shiller Warns of Housing Bubble After 225% Surge: Brazil Credit

By Blake Schmidt and Marisa Castellan Sep 5, 2013 7:41 PM GMT+0100 15 Comments Email Print

Robert Shiller, who predicted the collapse of the U.S. housing market, is warning that a bubble is emerging in Brazil at a time when a sluggish economy and persistent inflation are eroding investor

THE TIMES OF INDIA

Tue, Sep 16, 2014 | Updated 09:00PM IST

THE ECONOMIC TIMES

Increase in real estate prices gi... rise to property bubble

Tags: stocks | secondary market | real estate | property | inflation | Gold | economy | affordable housing

By: Santhosh Kumar, CEO - Operations, JLL India

Hyman Minsky, the noted American economist, linked an economy's life cycle with speculative investment bubbles which are endogenous to it. He stated that during prosperous times when the economy booms, corporate cash flows rise higher than corporate debts, and this leads to speculative euphoria

World Economy

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October 9, 2014 9:59 pm

Fears of housing crash in China raise global alarm

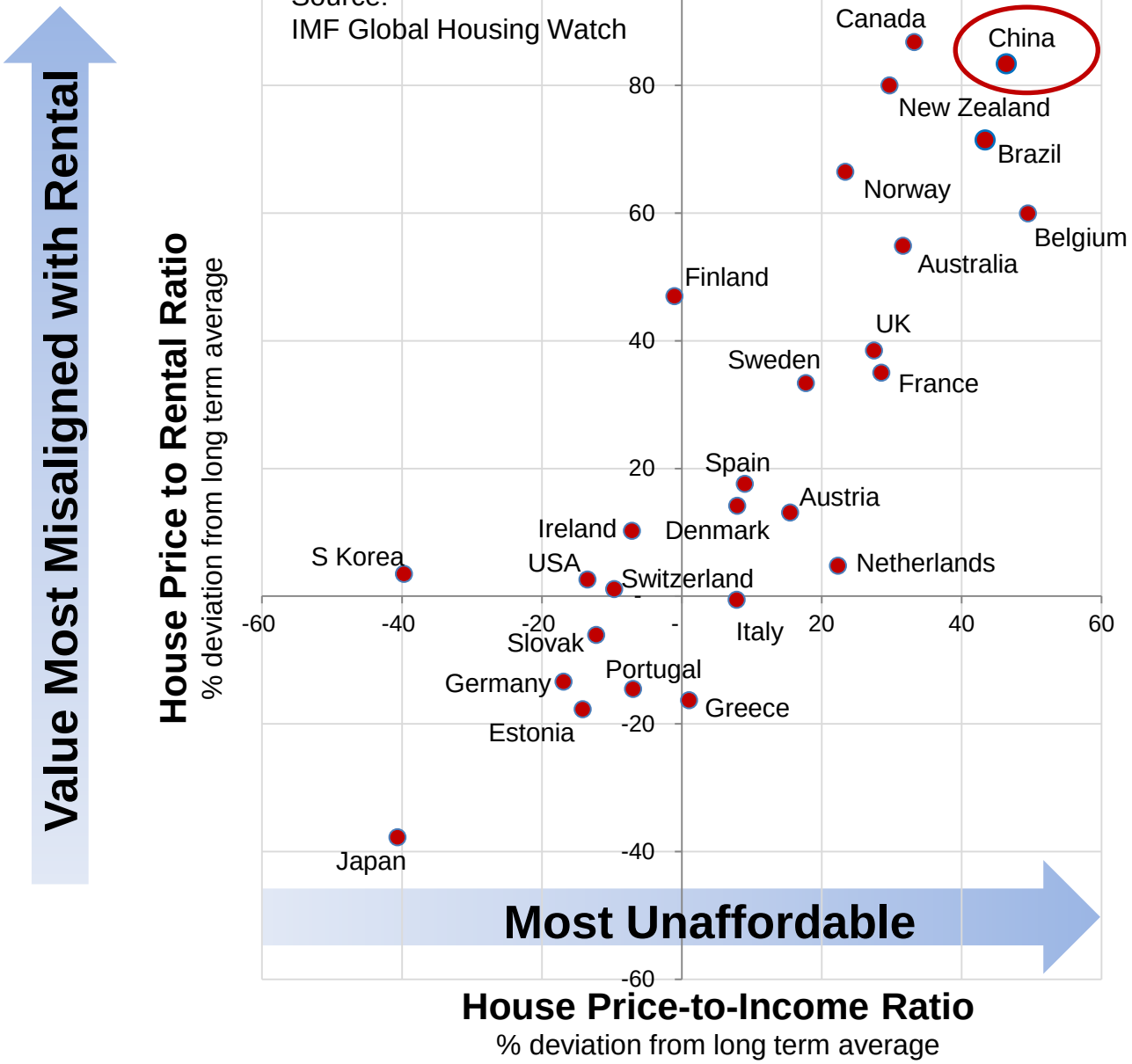
By Emily Cadman Author alerts

Fears of a housing market crash are weighing on forecasts for global growth. But this time it is China, not the US, which is causing concern in a sign of the shift under way

China Property Bubble

- China housing prices have sustained an average annual growth rate of 17% for past decade
- In same period, average growth of real GDP has been 10%
- Great housing boom has generated a large number of empty ('ghost') apartments across major cities in China
- In 2013 the national urban housing vacancy rate in China reached 22.4%

Inflated Housing Markets



Property Market Bubble Risk

Tier 1: China & Emerging Markets
China, Hong Kong, India, Brazil, Philippines, Indonesia, Turkey

Tier 2: Commonwealth
Canada, Australia, New Zealand

Tier 3: Nordics
Norway, Finland, Sweden

Tier 4: UK
United Kingdom

Tier 5: Europeans
France, Belgium, Netherlands

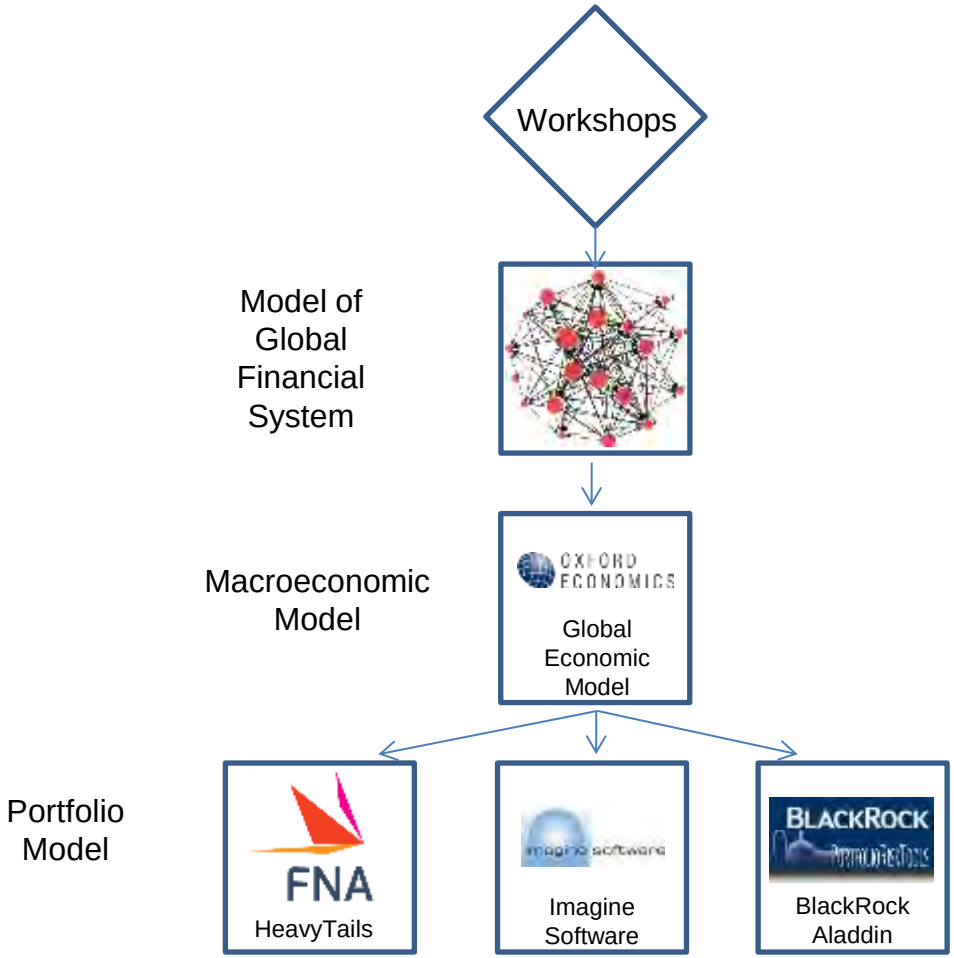
Tier 6: Other Europe
Spain, Portugal, Italy, Greece, Ireland, Austria, Denmark

Tier 7: US
United States

Tier 8: Prudent Europe
Germany, Switzerland

Tier 9 Industrial Asia
Japan and South Korea

Research Process



Scenario Specification

Contagion through the Financial System

Macroeconomic Consequences

Investment Portfolio Impact

Housing Price Index Shocks

	S1		S2		X1	
	Mortgage Shock	Non-Mrtg	Mrtg Shock	Non-Mrtg Shock	Mrtg Shock	Non-Mrtg Shock
Tier 1: China & Emerging Markets CN, HK, IN, BR, PH, ID, TR	**30%**	6%	**40%**	8%	**60%**	10%
Tier 2: Commonwealth CA, AU, NZ	**30%**	6%	**40%**	8%	**60%**	10%
Tier 3: Nordics NO, FI, SE	**30%**	6%	**40%**	8%	**60%**	10%
Tier 4: UK UK	**25%**	5%	**35%**	7.5%	**50%**	8%
Tier 5: Europeans FR, BE, NL	**25%**	5%	**35%**	7.5%	**50%**	8%
Tier 6: Other Europe ES, PT, IT, GR, IR, AT, DK	**20%**	4%	**30%**	7%	**40%**	7%
Tier 7: US US			**10%**	1%	**15%**	2%
Tier 8: Prudent Europe DE, CH			**10%**	1%	**15%**	2%
Tier 9: Industrial Asia JP, KR			**10%**	1%	**15%**	2%

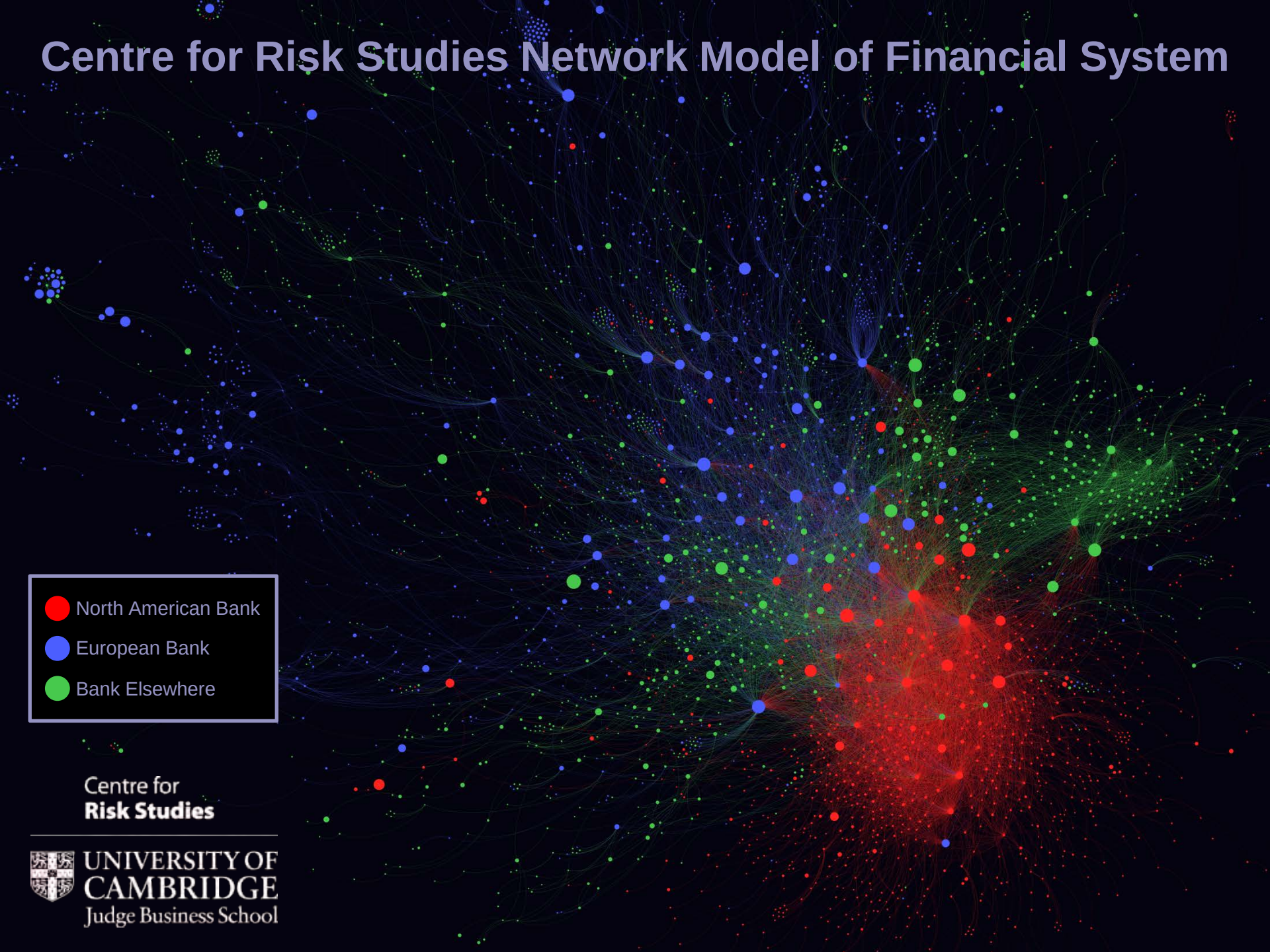
Cambridge Model of Global Financial System

- Integrated multiple sources of data on banks, lending patterns, cross-holdings, and assets
- First practioner model of global financial system
- Currently includes 18,516 banks
  - Important to include all jurisdictions and markets as one global financial system
- Incorporates several mechanisms of financial contagion:
  - Interbank lending (**Counterparty Failure Risk**)
  - Commonly-held asset devaluation (**Fire-Sales**)
  - Ownership equity devaluation (**Cross-Holding**)
  - Repo borrowing calls (**Rollover Risk**)
- Combination of contagion mechanisms is important

Data Sources include:

BUREAU VAN DIJK
bankscope
The Banker Database
A service from The Financial Times
Bloomberg
EUROMONEY
Quandl
Google Finance

Centre for Risk Studies Network Model of Financial System



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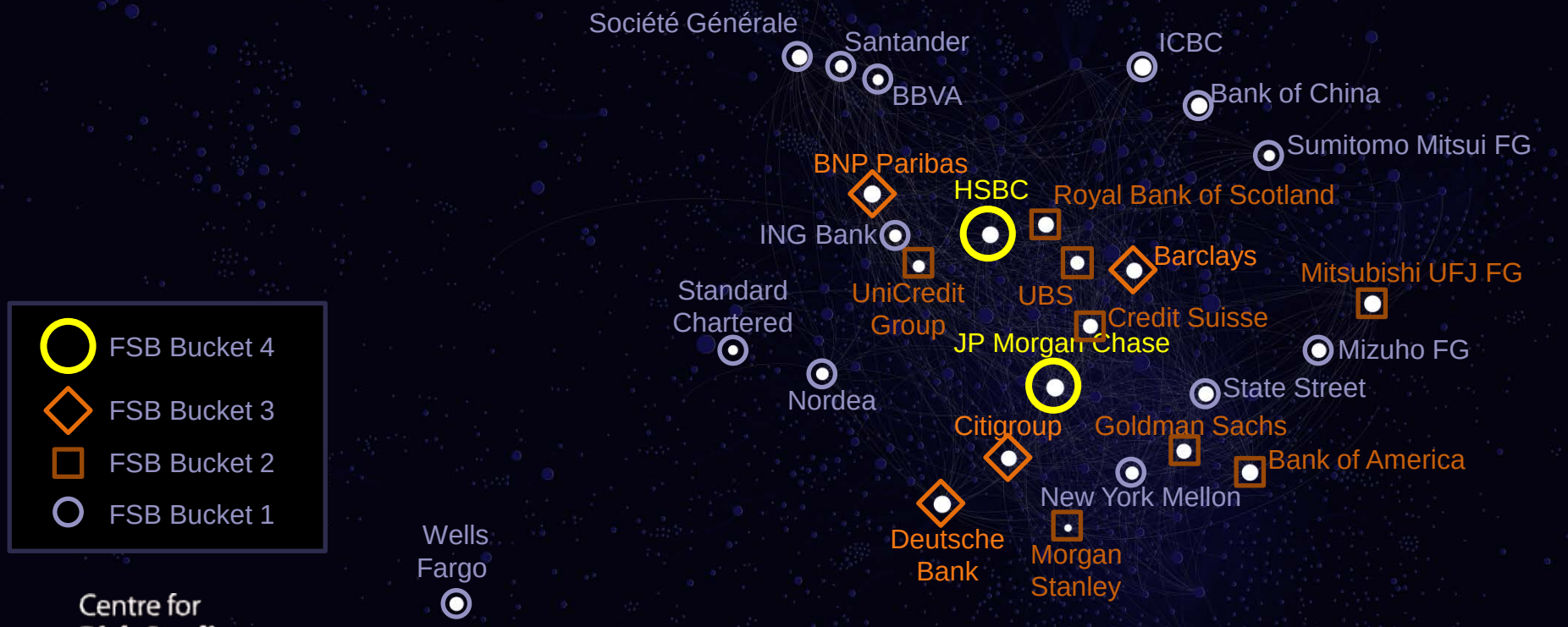
Global Systemically Important Banks (GSIBS)

Star-finder guide



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Summary of Financial System Statistics

- 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

Global Property Bubble Stress Test Scenario

World Economy

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Video | Interactive | Blogs | News feed | Alphaville | beyondbrics | Portfolio | Special Reports

October 9, 2014 9:59 pm

Fears of housing crash in China raise global alarm

By Emily Cadman Author alerts

Fears of a housing market crash are weighing on forecasts for global growth. But this time it is China, not the US, which is causing concern in a sign of the shift under way

- China suffers a property crash
- 40% devaluation of prices in 6 months
- China banks write-off their mortgage assets
- Other property-related investment assets devalue

Chinese Banks Sell Off Assets

- Banks' balance sheets have reduced assets against their liabilities
- To fund their liabilities, they sell off some investment assets
- This 'fire sale' devalues the assets of these investment classes
- Other banks who own the same assets suddenly find their assets are devalued
- These banks' balance sheets also take a hit

European Banks Start to Struggle

- European banks are infected by asset sales from Chinese banks
- Many suffer distressed balance sheets
- They reduce their lending to other banks
- Money flows start to dry up

European Banks Infect the United States

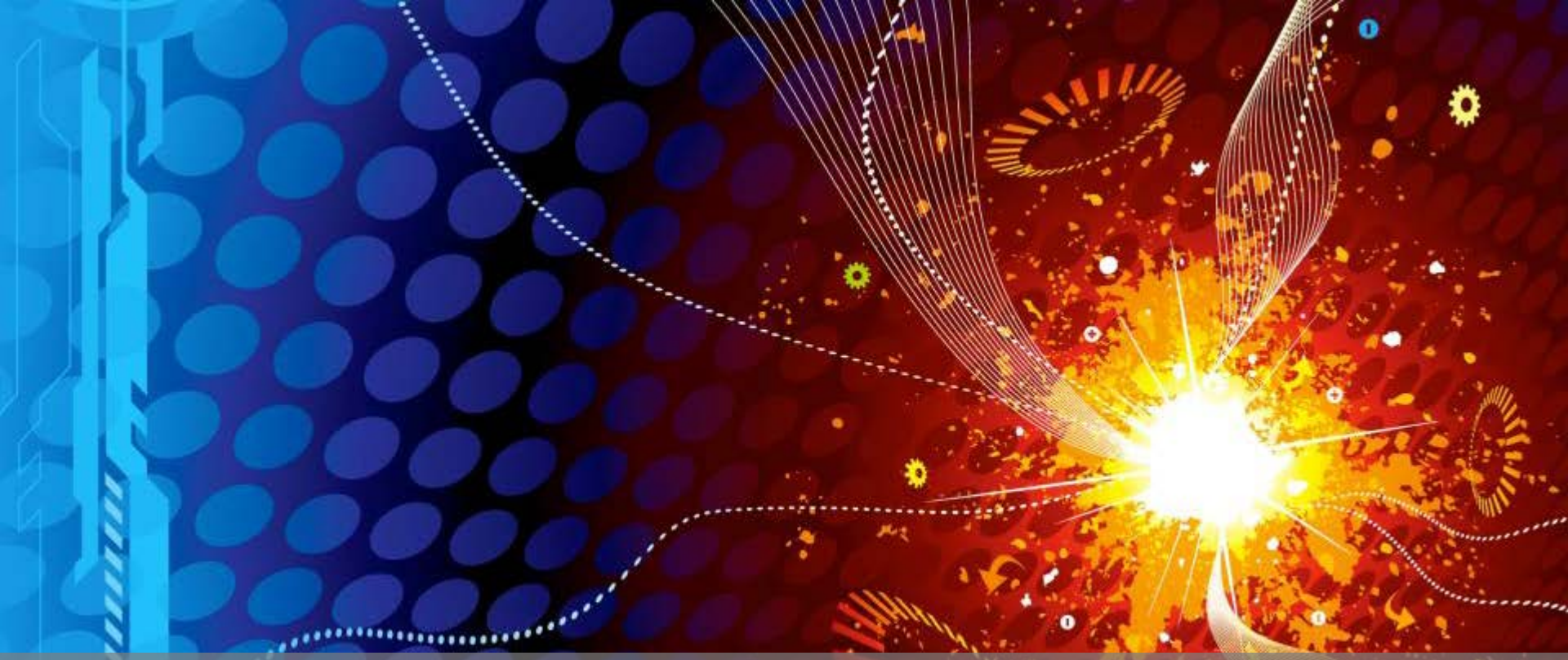
- All major international banks now suffer
- When a bank reduces its lending, counterpart banks reduce their lending to others
- The contagion causes a liquidity crisis
- The crisis in China has caused a global financial catastrophe

A Global Impact from a Financial Shock

Scenario wipes out 15% of the value of the global financial system

Causes a **$32 Trillion value loss**

Four G-SIBs and over 2000 financial institutions fail



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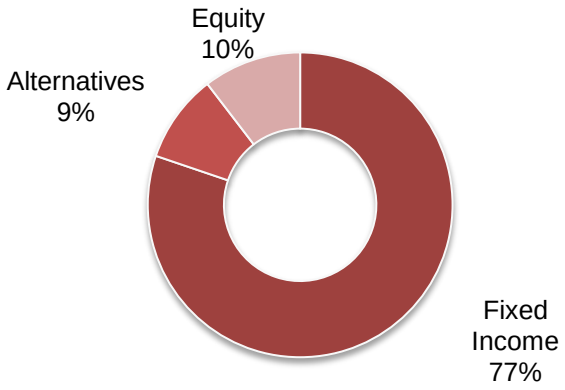
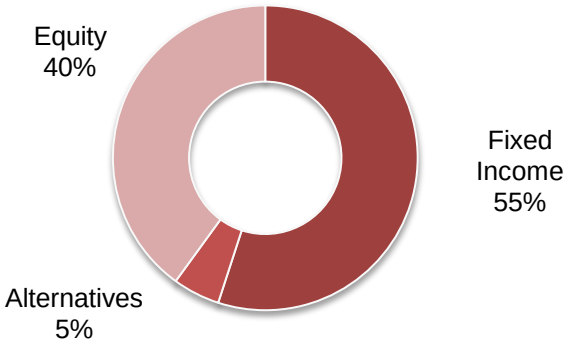
Dr Eugene Neduv
Risk Researcher
Centre for Risk Studies

4 Representative Investment Portfolios

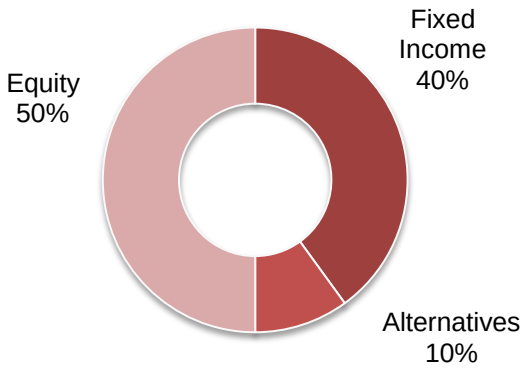
High Fixed Income



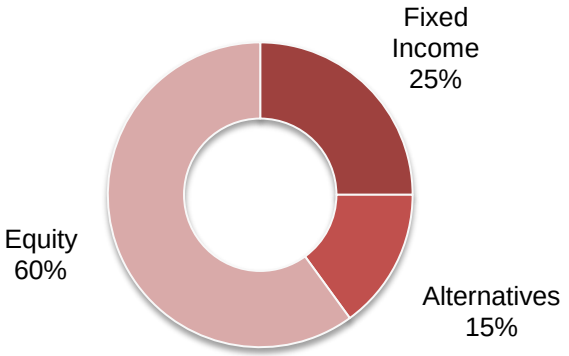
Conservative



Balanced

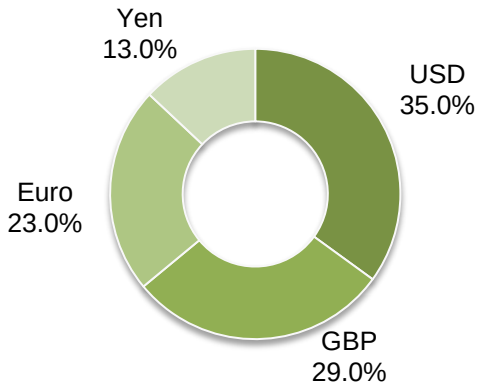


Aggressive

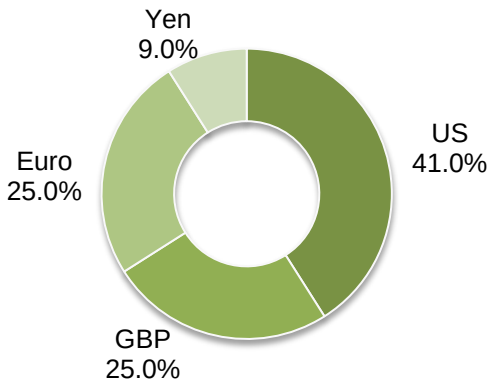


Investment Portfolios by Geography Split

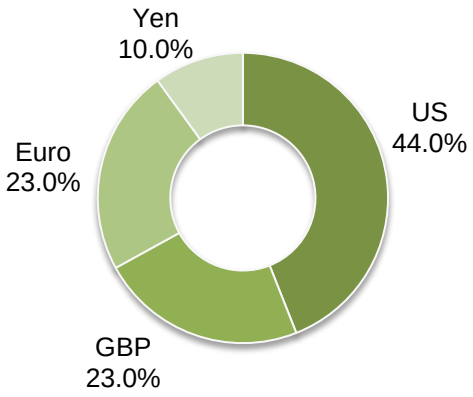
High Fixed Income



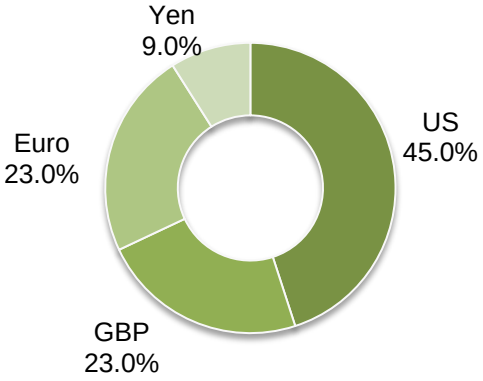
Conservative



Balanced

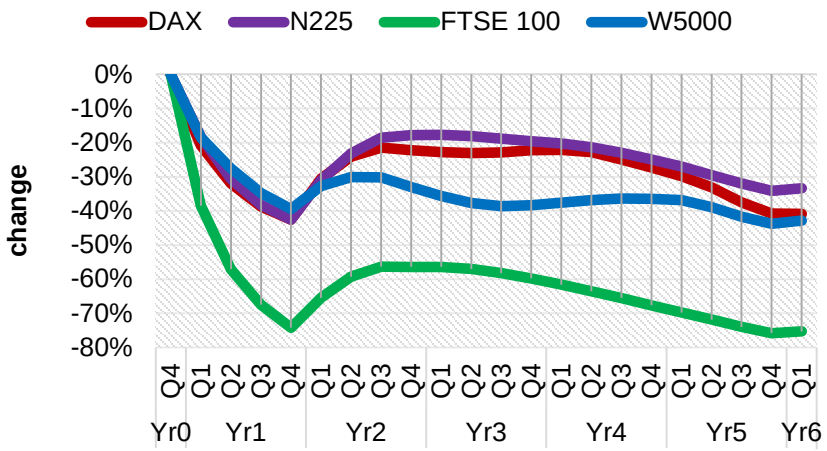


Aggressive

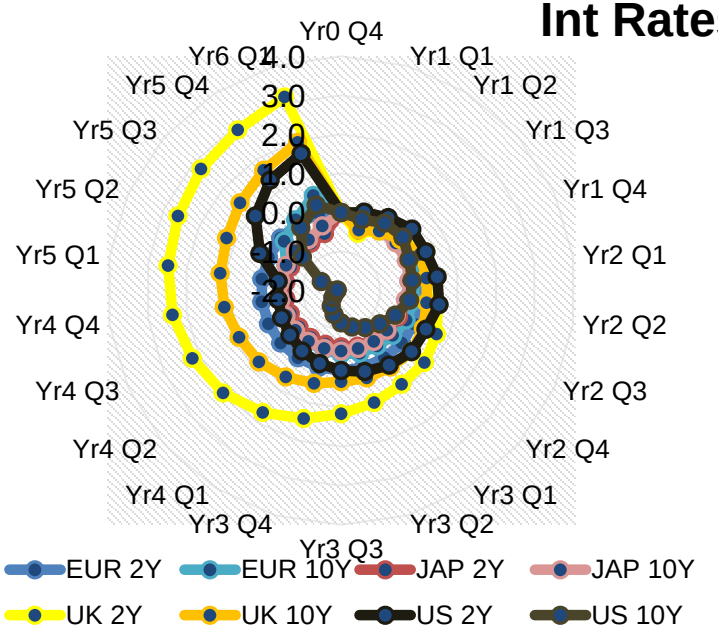


Financial Market Impacts

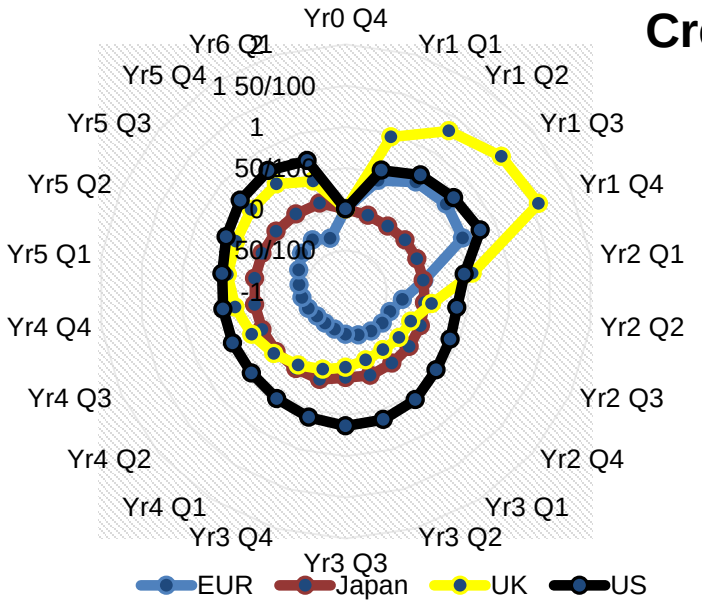
Equity



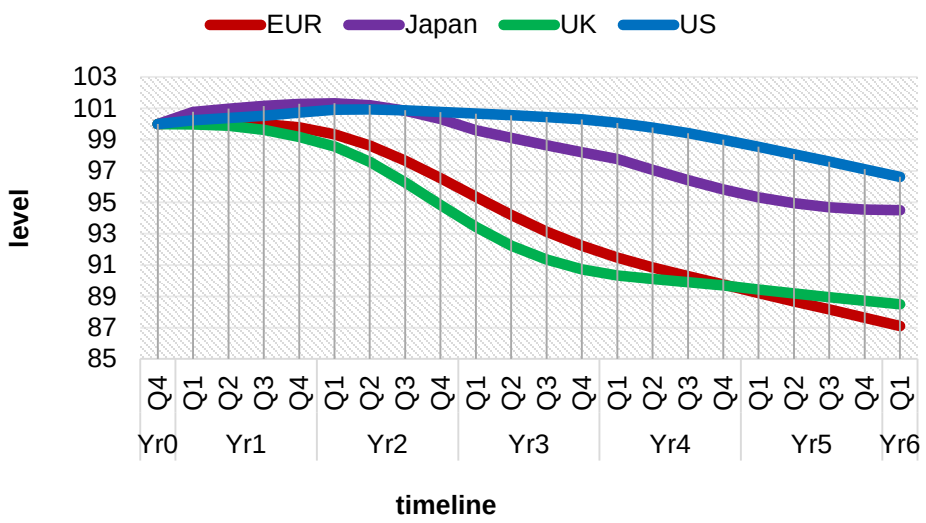
Int Rates



Credit

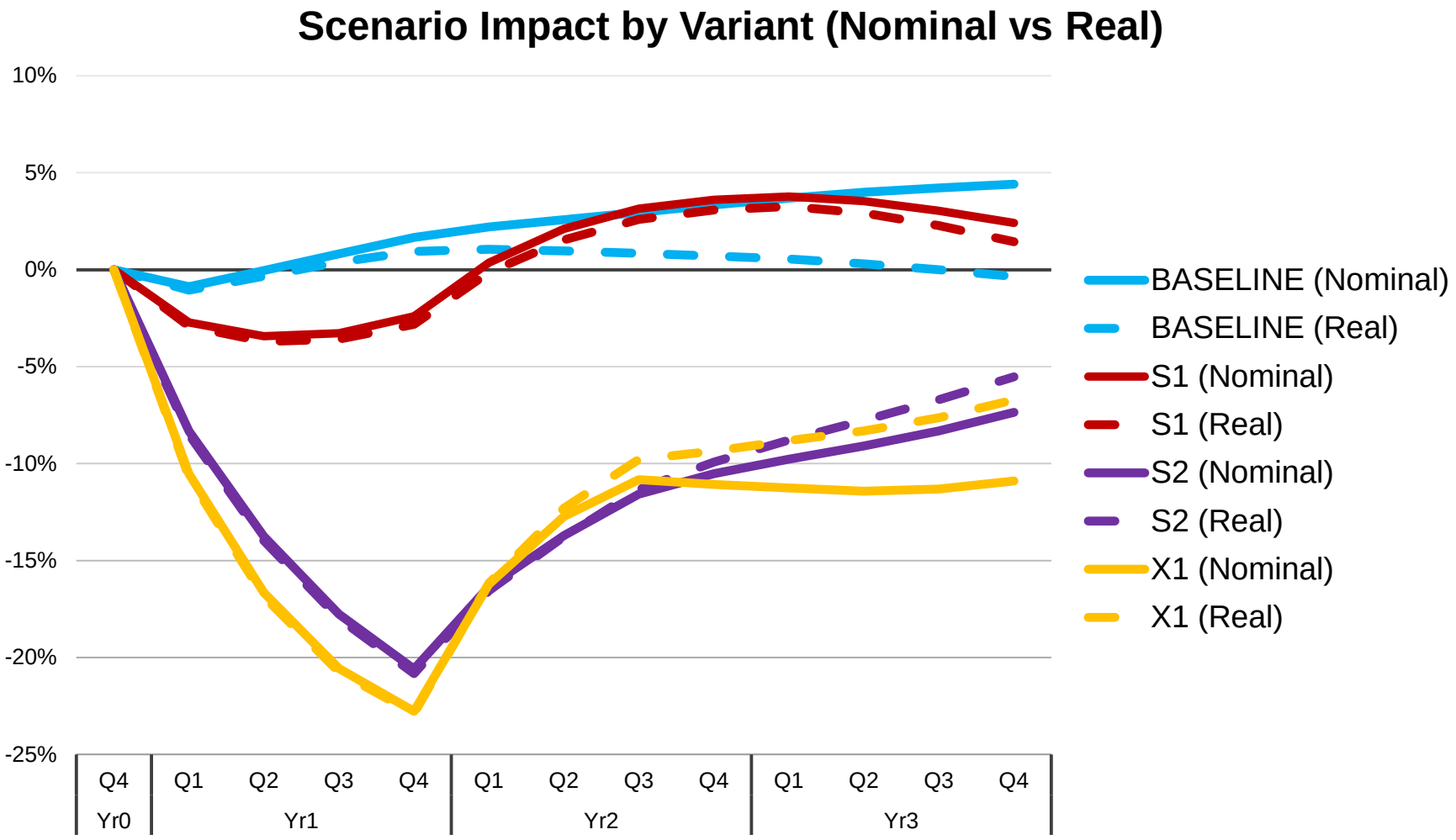


CPI

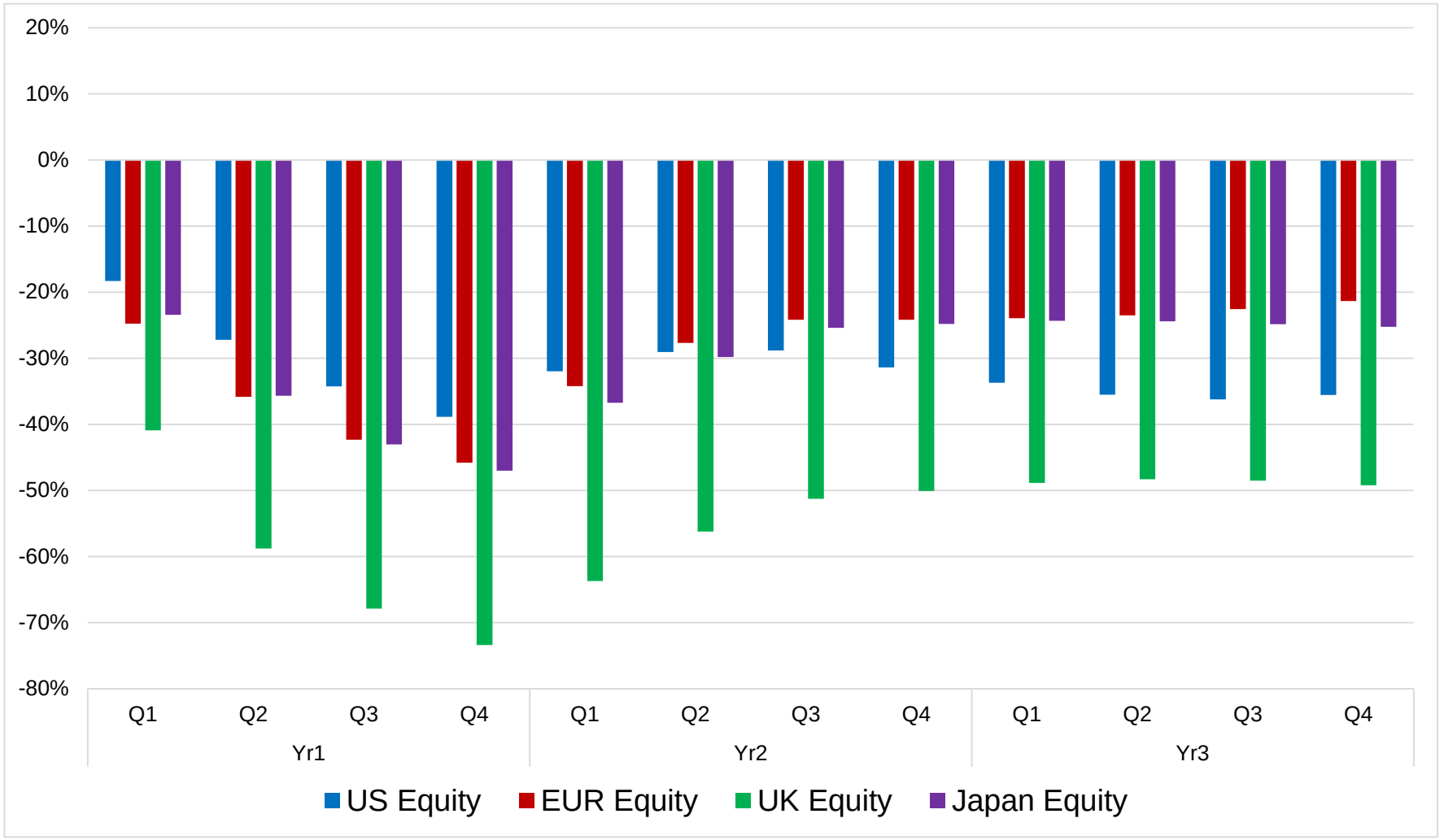


Total Asset Returns by Scenario Variant

Conservative Portfolio

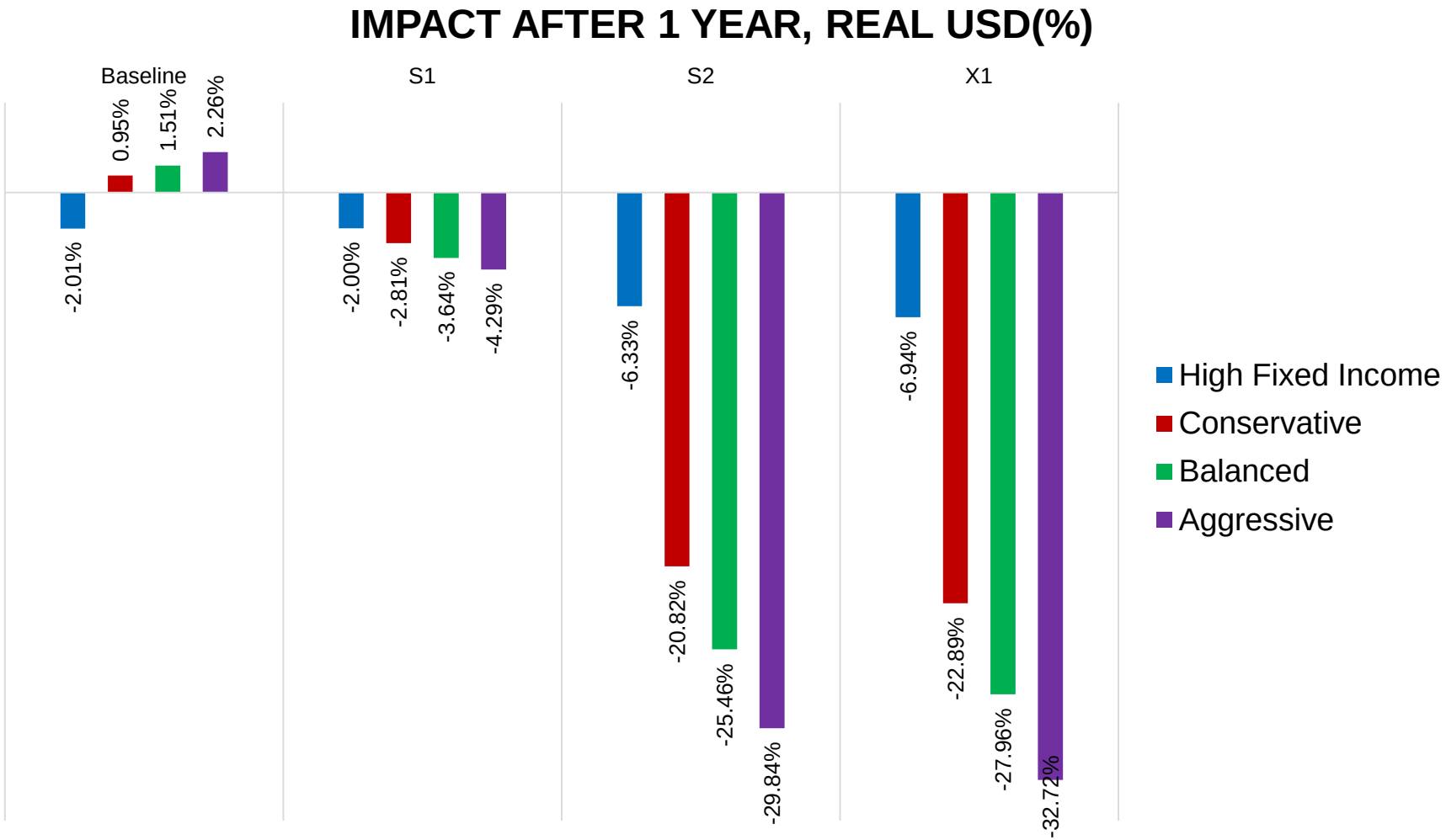


Global Property Crash
Equity Performance



Global Property Crash
Fixed Income Performance

Global Property Crash
Portfolio Performance Comparison



Global Property Crash: Correlation Analysis

Impact on the assets in a standardized investment portfolio of the hypothetical stress test scenario

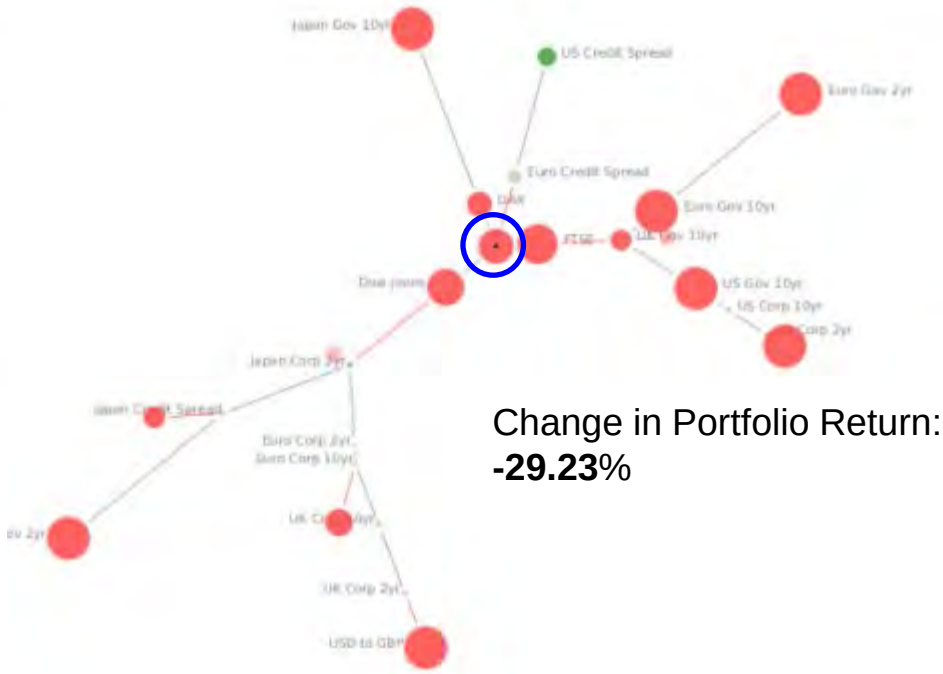
Asset Correlation Structure

FNA

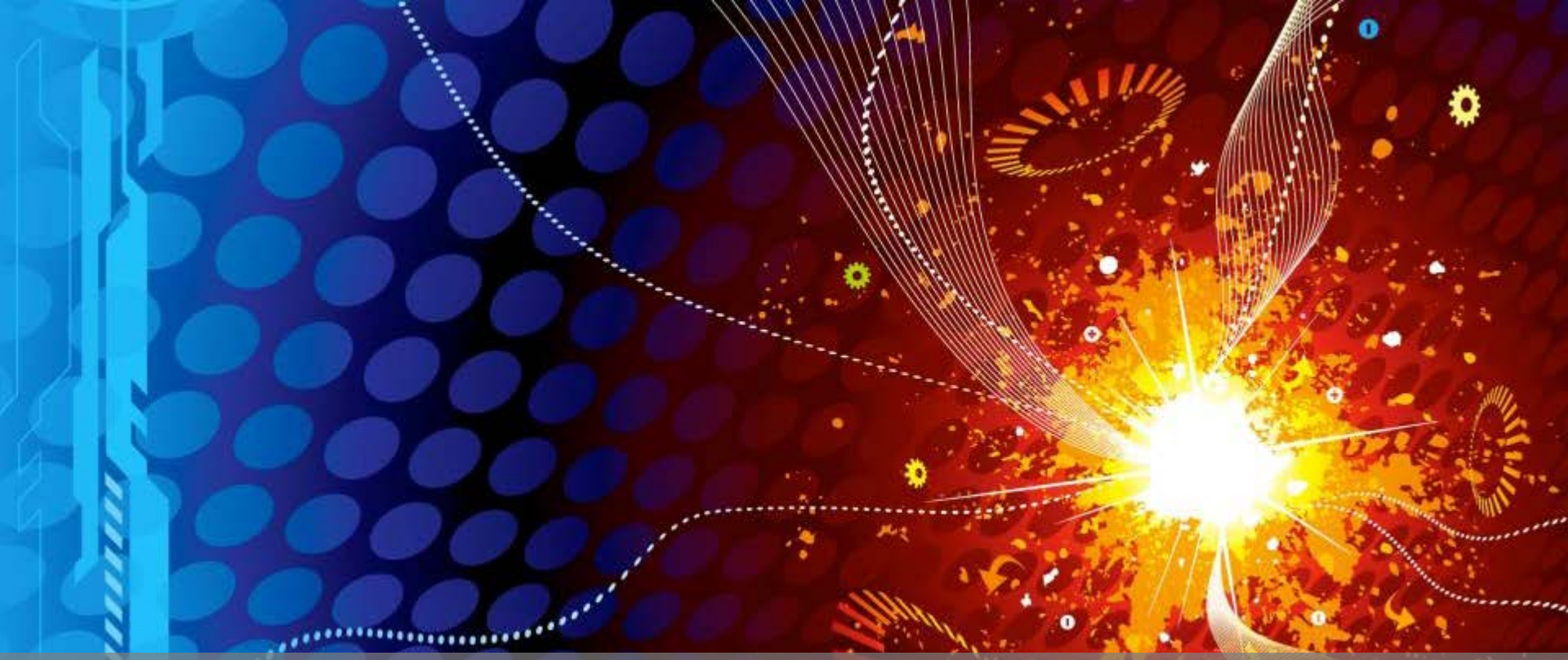
Before Shock

Standard Portfolio

Portfolio After Crisis



Change in Portfolio Return:
-29.23%



Financial Risk Scenarios: Could Your Portfolio Hold Up?

Cambridge Centre for Risk Studies - New York Risk Briefing - April 30, 2015

Managing a Multiplicity of Financial Market Catastrophes

Centre for Risk Studies

UNIVERSITY OF CAMBRIDGE Judge Business School

Professor Danny Ralph

Academic Director

Centre for Risk Studies

2015 Macroeconomic Emerging Risk 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

Dollar Deposed

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

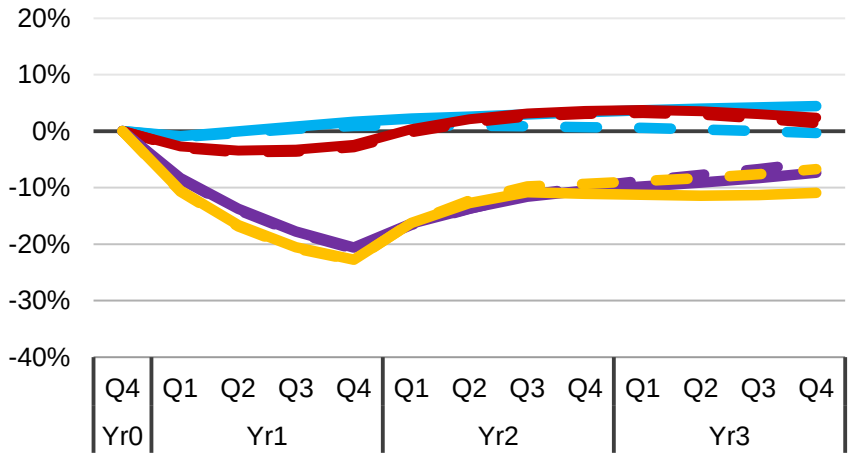
Scenarios with their Variants: Economic Impacts

Global GDP@Risk
US$ Tn

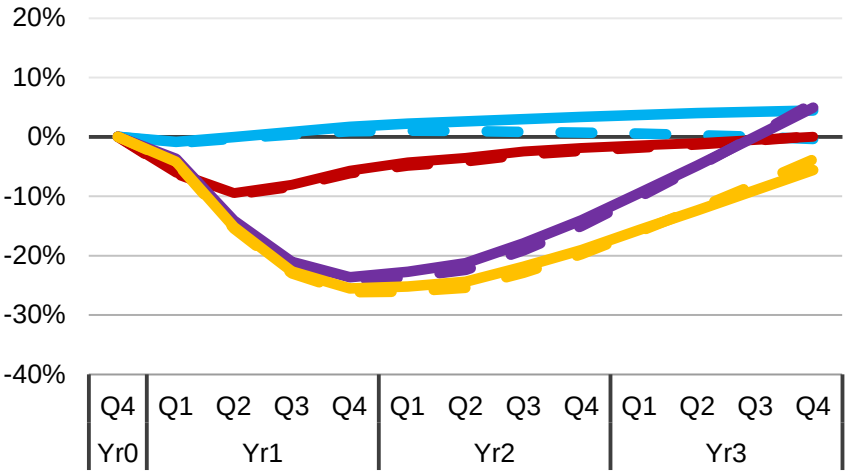
	S1	S2	X1
 Asset Bubble Shock **Global Property Crash**	11 (3%)	16 (4%)	23 (6%)
 Sovereign Default Shock **Eurozone Meltdown**	6 (2%)	13 (3%)	20 (5%)
 Food and Energy Price Spiral **High Inflation World**	5 (1%)	8 (2%)	11 (3%)
 De-Americanisation of Financial System **Dollar Deposed**	2 (0.5%)	2 (0.4%)	-2 (-0.4%)

Total Portfolio Returns by Scenario
Conservative Portfolio

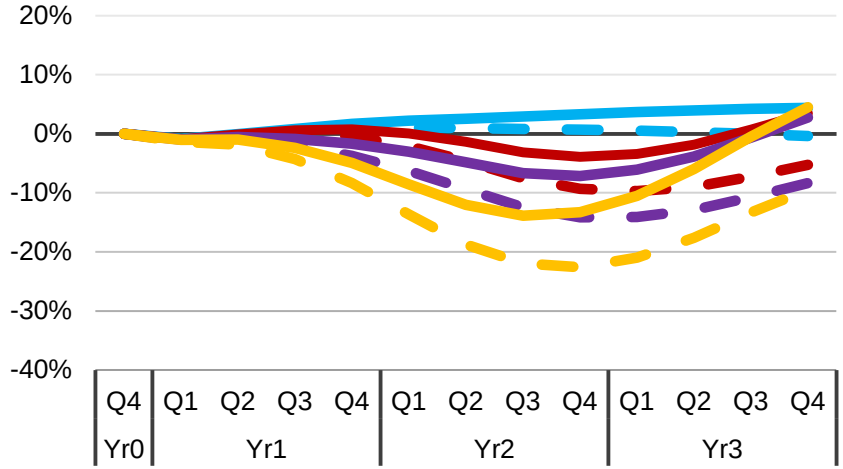
Global Property Crash



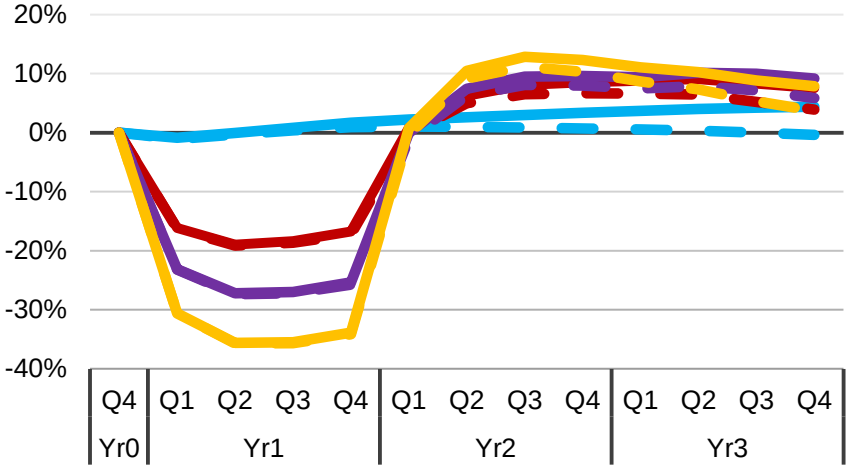
Eurozone Meltdown



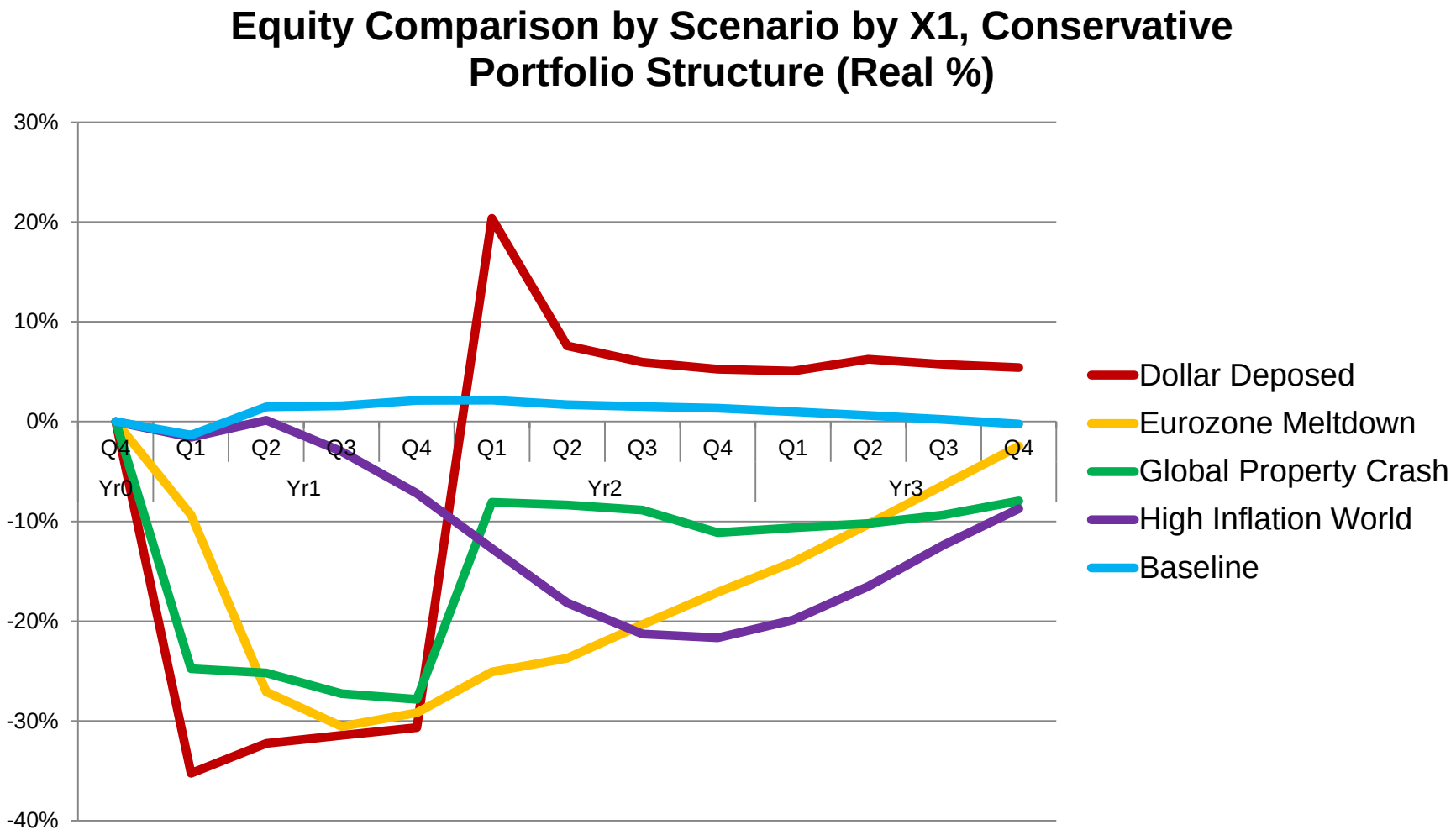
High Inflation World



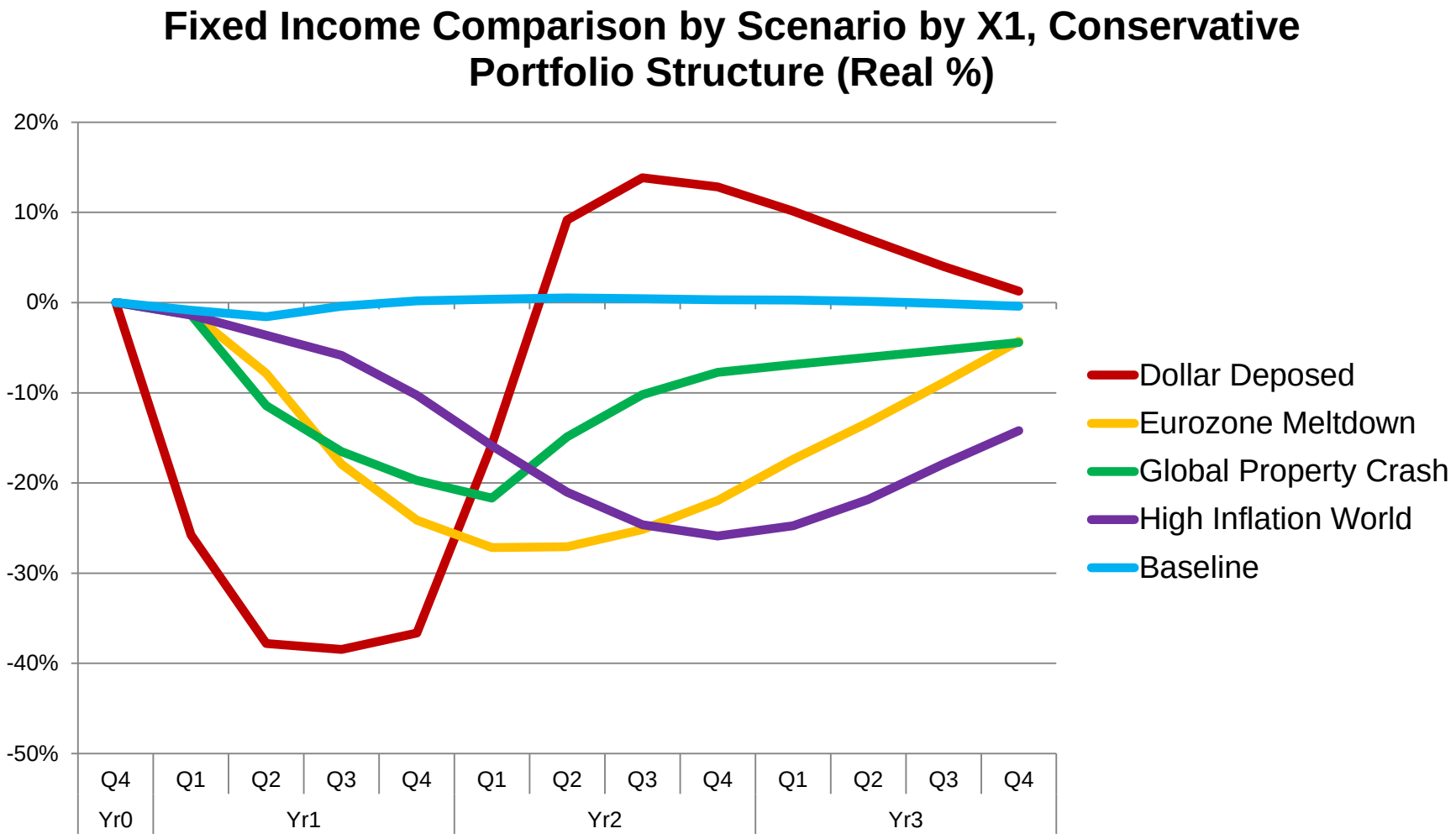
Dollar Deposed



Comparison of Equity Performance for all Scenarios



Comparison of Fixed Income Performance for all Scenarios



Rebalancing Equities

Based on Cumulative Returns for Equity, Real USD %

	Worst Equity Performance	Best Equity Performance
 **Asset Bubble Shock** **Global Property Crash**		
 **Sovereign Default Shock** **Eurozone Meltdown**		
 **Food and Energy Price Spiral** **High Inflation World**		
 **De-Americanisation of Financial System** **Dollar Deposed**		

Rebalancing Fixed Income Bonds

Based on Cumulative Returns for Fixed Income Bonds, Real USD %

	Worst Equity Performance	Best Equity Performance
 **Asset Bubble Shock** **Global Property Crash**		
 **Sovereign Default Shock** **Eurozone Meltdown**		
 **Food and Energy Price Spiral** **High Inflation World**		
 **De-Americanisation of Financial System** **Dollar Deposed**		

Resilience Based on 3 Year Outlook

X1 Scenario Variant
Based on Max Downturn, Real USD %

	High Fixed Income	Conservative	Balanced	Aggressive
 **Asset Bubble Shock** **Global Property Crash**	+	–	– –	– –
 **Sovereign Default Shock** **Eurozone Meltdown**	+	0	0	–
 **Food and Energy Price Spiral** **High Inflation World**	– –	– –	–	–
 **De-Americanisation of Financial System** **Dollar Deposed**	0	+	+	+

Portfolio Resilience

- In order to anticipate the effect and your response to financial crises coherent stress tests are essential
  - These link timing, asset classes and geographies

- Allocation involves timing
- Mitigation entails asset classes
- Rebalancing means geographies

Centre for
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