



Centre for Risk Studies **Research Showcase**
23 January 2014

Understanding financial catastrophe risk:
A research agenda

Centre for
Risk Studies



UNIVERSITY OF
CAMBRIDGE
Judge Business School

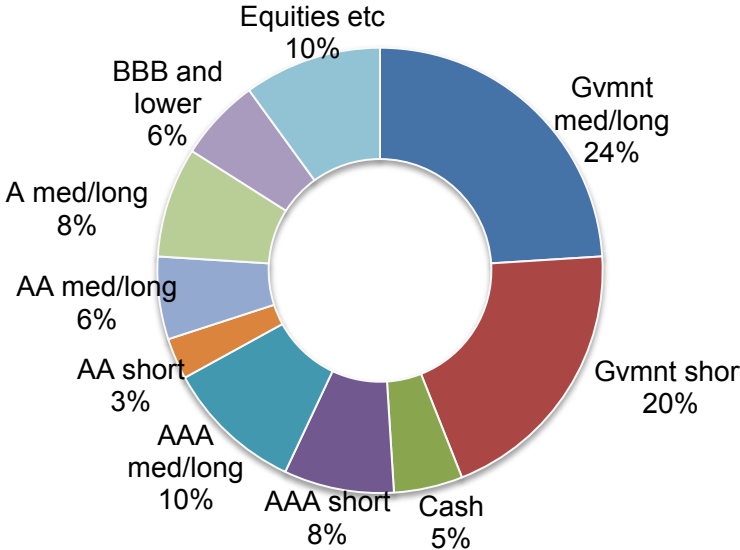
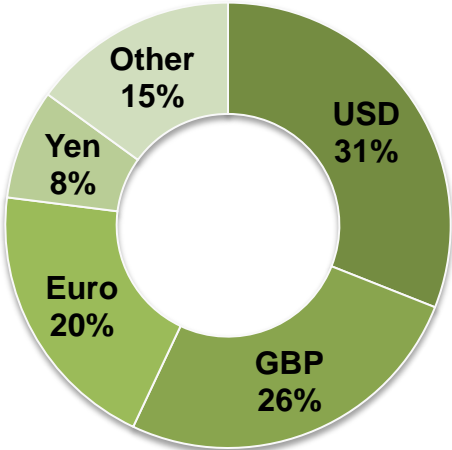
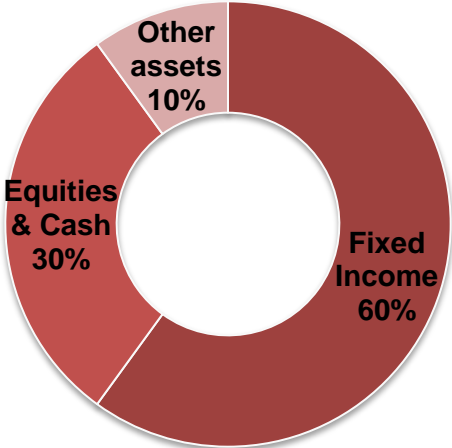
Fabio Caccioli
Research Associate

Hypothetical Investment Portfolio of an Insurance Company

Portfolio structure						
	USD	GBP	Euro	Yen	Other	Total
Government med/long	8%	7%	5%	2%	2%	24%
Government short	6%	5%	4%	2%	3%	20%
Cash	2%	1%	1%		1%	5%
AAA short	2%	2%	2%	1%	1%	8%
AAA med/long	4%	3%	1%	1%	1%	10%
AA short	1%	1%	1%			3%
AA med/long	2%	1%	1%		2%	6%
A short						0%
A med/long	2%	2%	2%	2%		8%
BBB and lower	2%	2%	1%		1%	6%
Equities etc	2%	2%	2%		4%	10%
Total	31%	26%	20%	8%	15%	

Focus on

- high quality
- fixed income



Endogenous Dynamics of Markets

Largest S&P Index moves 1946-87

(Cutler, Poterba, Summers 1989)

Rank	Date	%	NY Times explanation
1	Oct 19, 1987	-20.5	Worry over dollar decline and rate deficit Fear of US not supporting dollar
2	Oct 21, 1987	9.1	Interest rates continue to fall Deficit talks in Washington Bargain hunting
3	Oct 26, 1987	-8.3	Fear of budget deficits Margins calls Reaction to falling foreign stocks
4	Sep 3, 1946	-6.7	"No basic reason for the assault on prices"
5	May 28, 1962	-6.7	Kennedy forces rollback of steel price hike
6	Sep 26, 1955	-6.6	Eisenhower suffers heart attack
7	Jun 26, 1950	-5.4	Outbreak of Korean War
8	Oct 20, 1987	5.3	Investors looking for quality stocks
9	Sep 9, 1946	-5.2	Labor unrest in maritime and trucking
10	Oct 16, 1987	-5.2	Fear of trade deficit Fear of higher interest rates Tension with Iran
11	May 27, 1970	5.0	Rumors of change in economic policy "stock surge happened for no fundamental reasons"
12	Sep 11, 1986	-4.8	Foreign governments refuse to lower interest rates Crackdown on triple witching announced

Subprime Crisis

- Market of subprime mortgages was only 5% of total market for mortgages
- “We will follow developments in the subprime market closely. However [...] the troubles in the subprime sector seem unlikely to seriously spill over to the broader economy or the financial system.”
(Chair Ben Bernanke, 2007)

Need to account for non-linear feedbacks that cause amplification and contagion

Main Threads of the Cambridge FinCat Project 2013



State-of-the-Art Review

- Who is doing what; literature review; leading opinion survey; Workshop



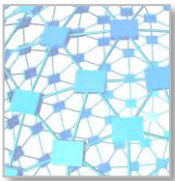
Causes of Future Crises

- What might cause future FinCats? Defining a full taxonomy; Developing an authoritative historical catalogue; What will be different in the future?



Developing Hypothetical Scenarios

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



Understanding Extreme Financial System Behaviour

- Understanding financial network modelling, interconnectivity, network behaviour, critiquing common modelling approaches, social behaviour

Potential Financial Catastrophe Scenarios



Asset Bubble Shock

China Property Bubble Collapse

Sudden collapse of property prices in China mainland

SME: Prof. Michael Dempster, Centre for Financial Research, University of Cambridge



Sovereign Default Shock

Country defaults

Sudden default of a country on its debt

SME: D'Maris Coffman, Centre for Financial History; Prof. Michael Dempster, Centre for Financial Research, University of Cambridge



Hyper-Inflation World

High levels of inflation run for many years

Rampant inflation running in many countries

SME: Prof. Michael Dempster, Centre for Financial Research, University of Cambridge



De-Americanization of Economy

Dollar loses its dominance as a trading currency

US dollar replaced by another or multiple currencies

SME: D'Maris Coffman, Centre for Financial History; Prof. Michael Dempster, Centre for Financial Research, University of Cambridge

Long-Perspective Historical Catalog of Financial Crises



- Partnering with the Centre for Financial History (CFH) at Cambridge University <http://www.centreforfinancialhistory.org/>.
- CFH historians currently researching and documenting several hundreds of crises and providing detailed analysis for 40 selected events
- Covers 1500 to present
- Covers all geographical markets
- Will result in a 4-volume publication by Routledge in 2014



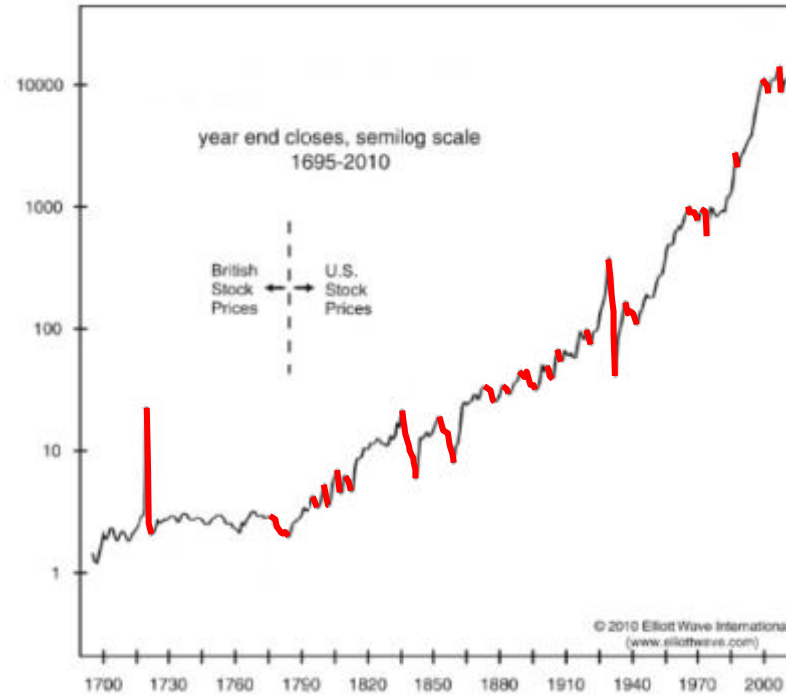
Project lead
D'Maris Coffman
Director of
Centre for Financial History



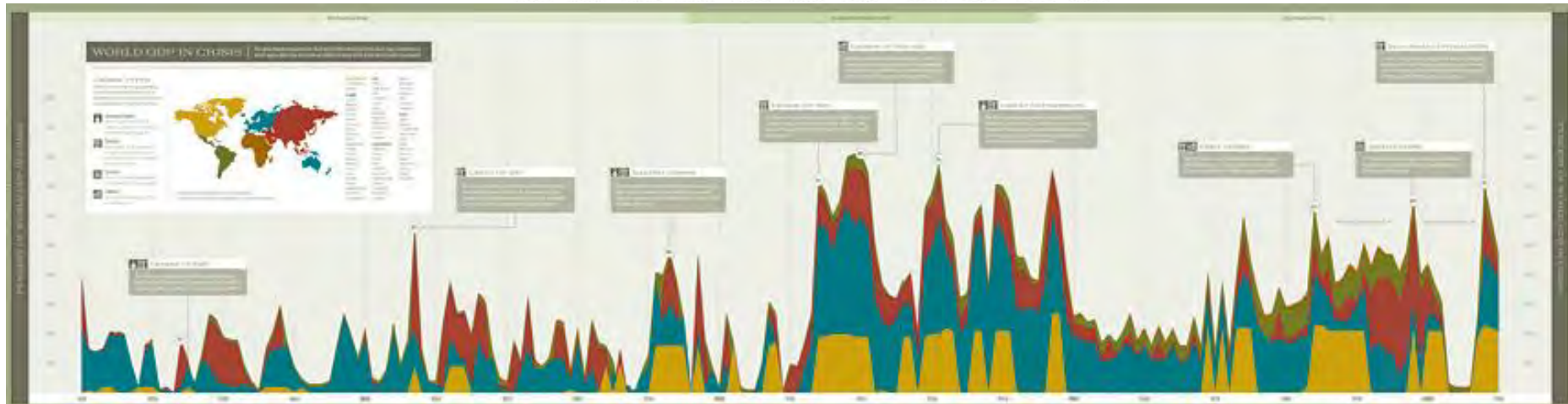
Co-edited by
Larry Neal
Professor of Economics
University of Illinois



Long Term Historical Views of Financial Catastrophes



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



Visual History of Financial Crises based on *This Time Is Different: Eight Centuries of Financial Folly* by Carmen M. Reinhart & Kenneth S. Rogoff. Depicts the cyclical history of financial crisis from 1810 to 2010 for sixty-six countries representing 90% of world GDP

Amplification and Feedbacks

■ Structure

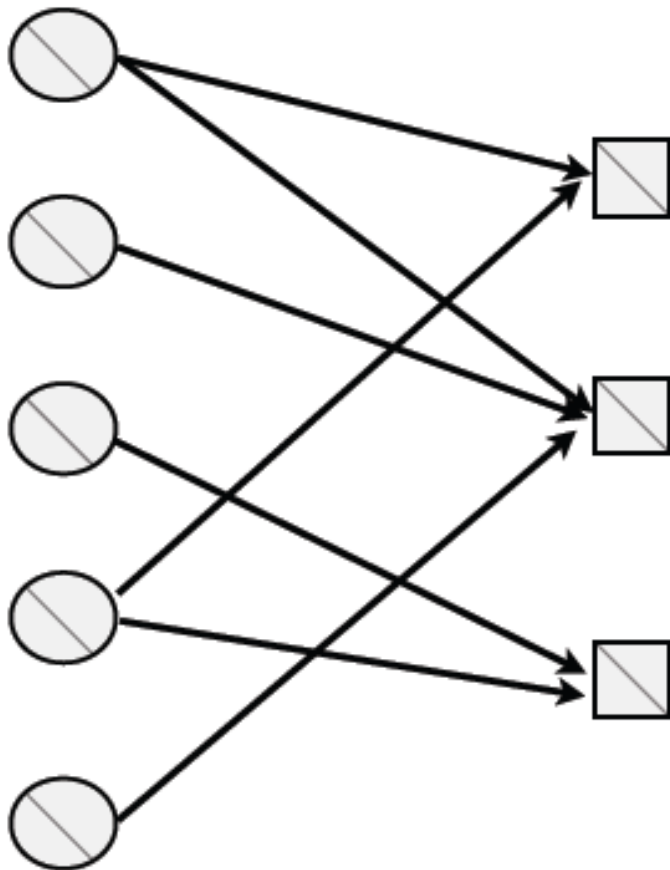
- Networks (e.g. interbank lending, common asset holdings)
- Basic mechanics (e.g. A borrows from B, if A defaults B incurs a loss)

■ Dynamics

- Behavior of players (investment strategies, portfolio rebalancing)
- Interaction with regulatory constraints

Contagion due to Overlapping Portfolios

(Caccioli, Shrestha, Moore, Farmer arXiv:1210.5987)



N banks 

M assets 

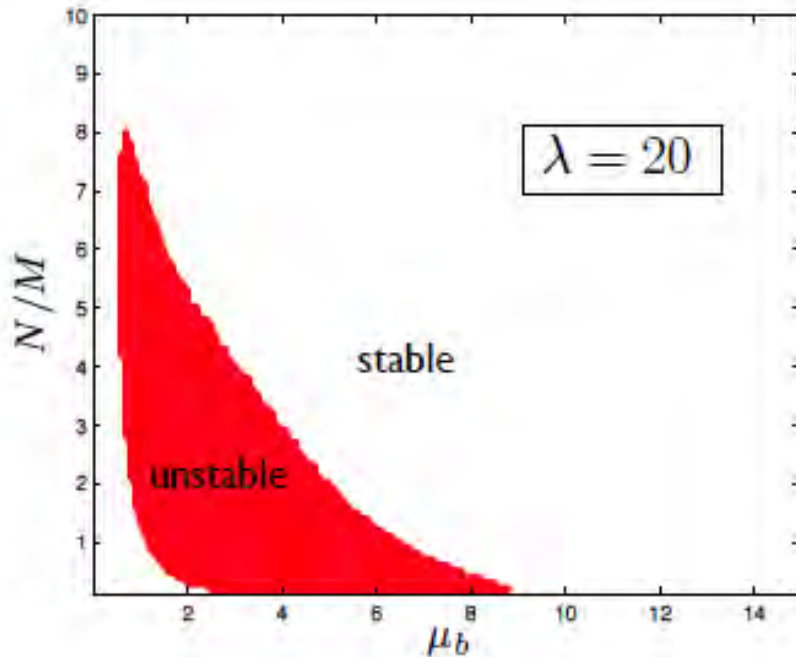
μ_b : average degree
of banks (average
diversification)

Stress Testing

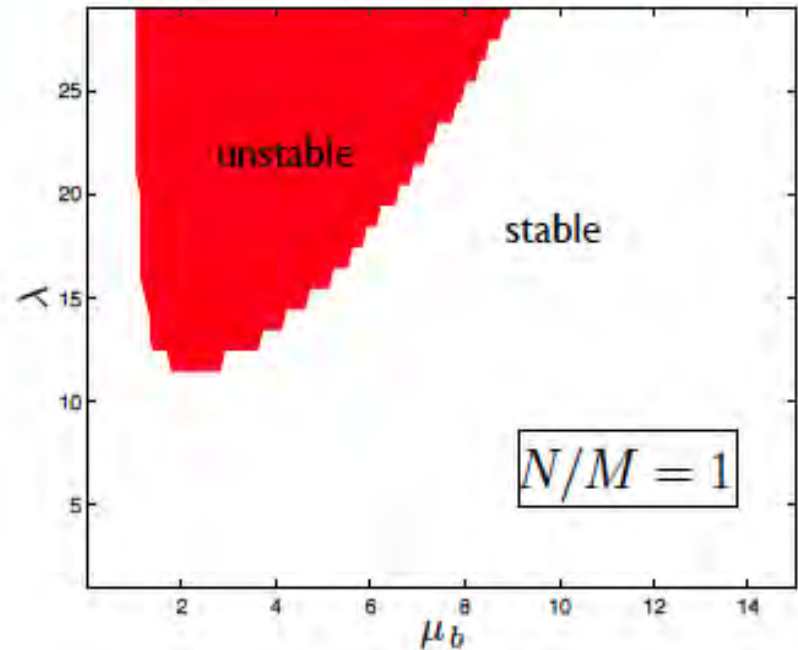
- Leverage: banks borrow money to invest
- We start with a system of solvent banks
- Sudden devaluation of a (toxic) asset
- Mechanics: if a bank goes bankrupt its portfolio is liquidated, which causes prices to further devalue
- Contagion occurs through overlapping portfolios

Under what conditions do we observe cascades of failures?

Results



Contagion probability
is not-monotonic

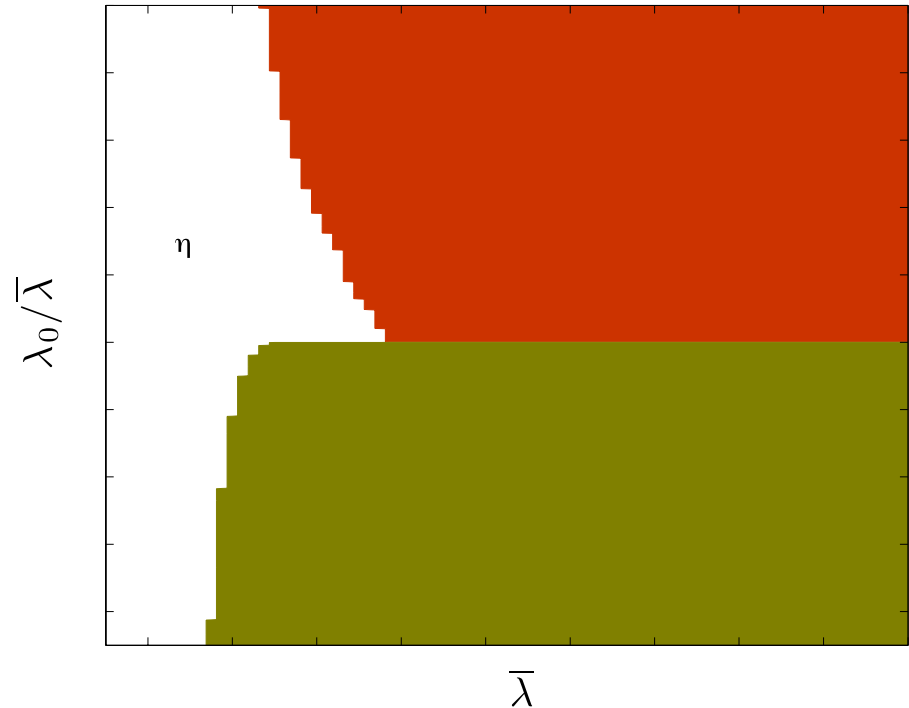


Critical leverage
below which cascades
do not occur

Dynamics: a simple model

(with Christoph Aymanns)

- 1 asset manager
- 1 asset
- Linear market-impact
- Asset manager tries to maintain a target leverage (equivalent to VaR)



Asset manager behavior induces a positive feedback loop that amplifies an initial offset

Structure and Dynamics

- N asset managers and M assets
- Network of overlapping portfolios
- Prices are random variables
- Asset managers rebalance their portfolios in response to price fluctuations (e.g. target leverage)
- Prices also depend on trading (market-impact)

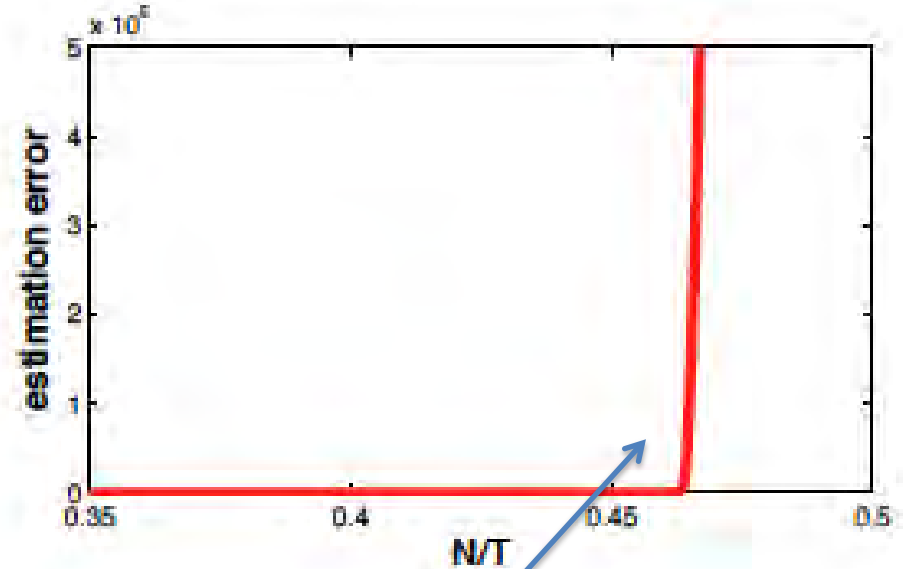
Under what conditions do we observe bubbles and crashes?

Why should an individual investor care about interaction and feedback loops?

- Basel III regulations will (probably) be based on Expected Shortfall as a risk measure
- Expected Shortfall (as all other risk measures) is however characterized by an instability
- Over-fitting may cause estimated optimal portfolios to be very different from true optimal portfolios

Instability of ES

- N assets
- T time observations
- Optimization problem minimize ES
- Example with i.i.d. normal returns (Kondor et al, JBF 2007)



Divergence of estimation error

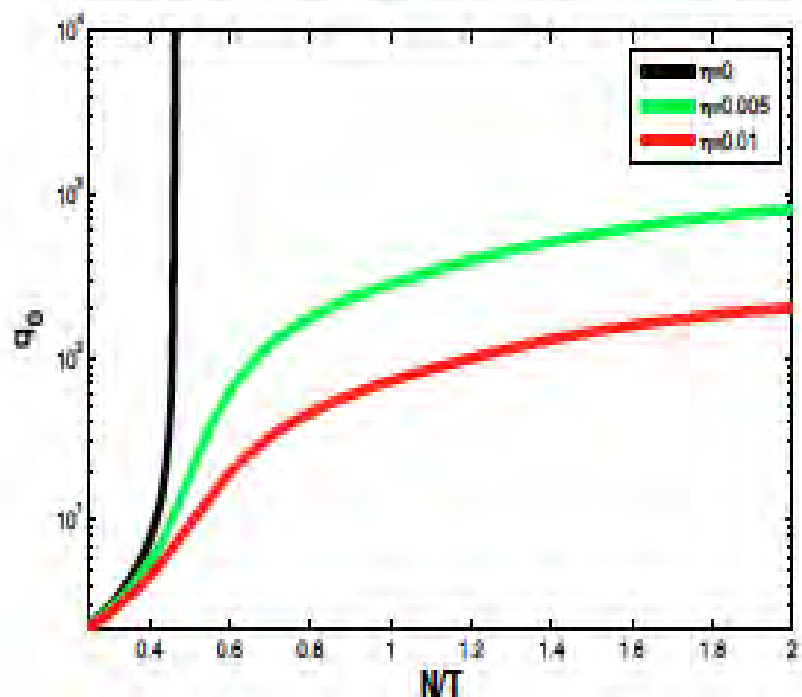
Remedy: regularization

- The instability arises because there are historical arbitrages in the data
- These are just due to poor statistics, but the optimization process interpret these as true arbitrages, while
- Accounting for market-impact takes care of the instability

Market-impact and regularization

(Caccioli, Still, Kondor, Marsili EJF 2013)

- N assets
- T time observations
- Optimization problem: minimize ES
- Linear market-impact



Regularization takes care of the divergence

Conclusions

- Systemic risk is endogenous
- Amplification and contagion due to feedback loops
 - Structure (e.g. overlapping portfolios)
 - Dynamics (e.g. VaR constrained asset manager)
- Awareness of feedbacks is useful for individual investors
 - Better risk assessment tools (e.g. instability of risk measures)