

A photograph of an iceberg floating in a dark blue ocean under a lighter blue sky with wispy clouds. The visible tip of the iceberg is small and jagged, while the much larger, submerged part is visible below the water line, illustrating the concept of hidden risks or stressors.

Adaptive Stress Testing Harnessing Network Intelligence in Stress Testing and Reverse Stress Testing

Agenda

1. A Framework for Adaptive Stress Testing

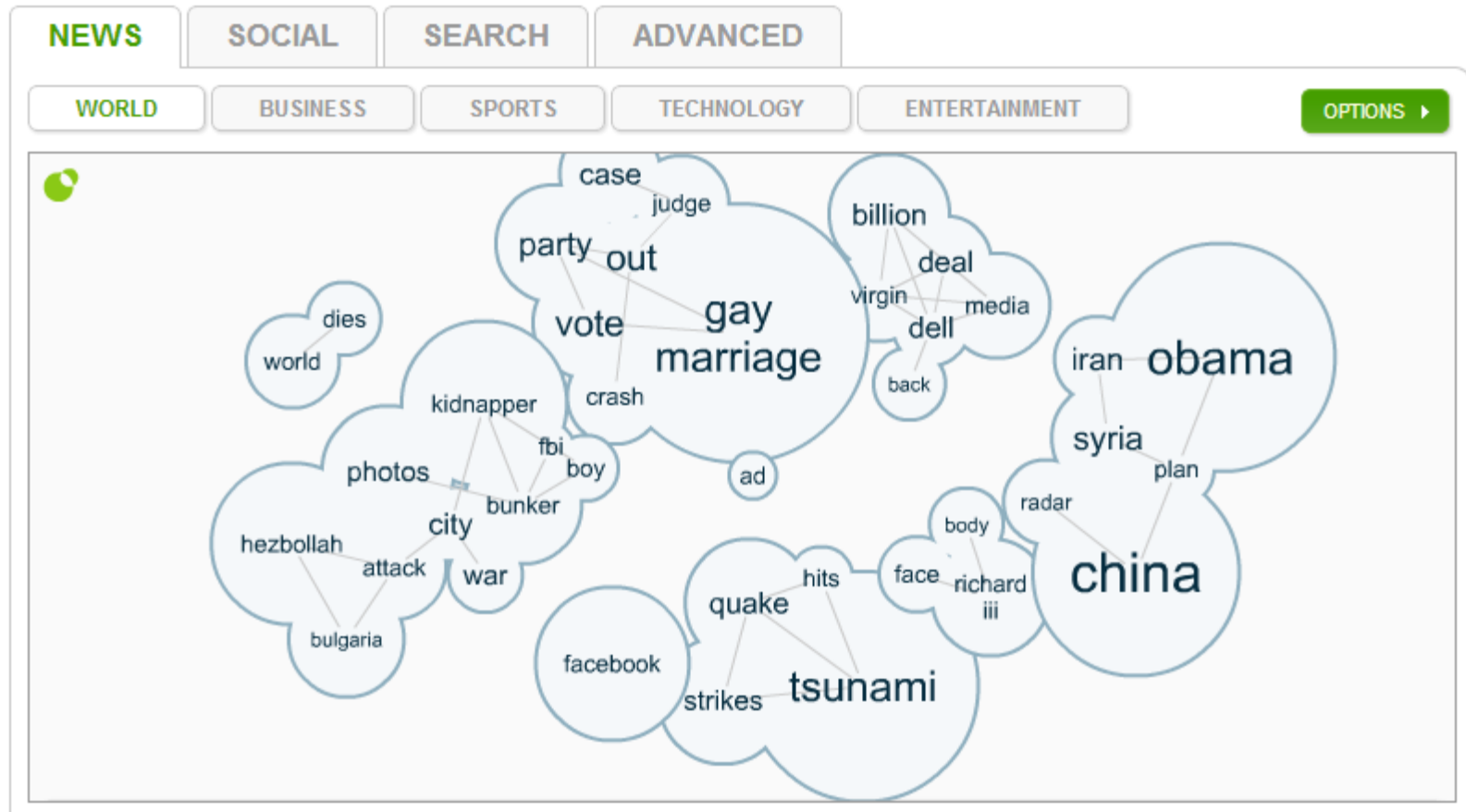
2. Signal or Noise?

3. Introducing StressGrades™

4. Summary and Conclusions

Scenarios are continually emerging and evolving

- Integrate interdisciplinary perspectives



Source: infomous.com/

“Sense and Respond”

Dynamic Steering: continual feedback



Seek to understand systemic fault lines...

- ...and how is your portfolio is positioned relative to fault lines.
- Major challenge: **disaster myopia** (see “Why Banks Failed the Stress Tests” by A. Haldane, 2009)

Earthquake activity vs Nuclear power plants



Source: <http://googlemapsmania.blogspot.com/2011/03/nuclear-power-plants-earthquake.html>

Adaptive Stress Testing Framework

I. Macro: identify structural risks (potential risks)

- *Stress Library based on Thought Leaders (Innovators)*
 - Awareness of systemic cycles, in particular credit and asset bubbles
 - Financial or economic imbalances (e.g., capital flows, consumption vs. saving)
 - *Examples: Shiller - (a) tech bubble (2000) and (b) housing bubble (2005)*



II. Micro: monitor potential precipitating events (visible risks)

- Focus on short term market movements, especially outliers and regime shifts
- Early Warning: identify amplification mechanisms and critical (tipping) points
 - *Examples: vol spike in (a) tech stocks and (b) US mortgage securities & financials*

Designing an Adaptive Stress Library

- Diffusion of ideas and innovation follow a predictable course after a tipping point is crossed

Two key perspectives for stress testing

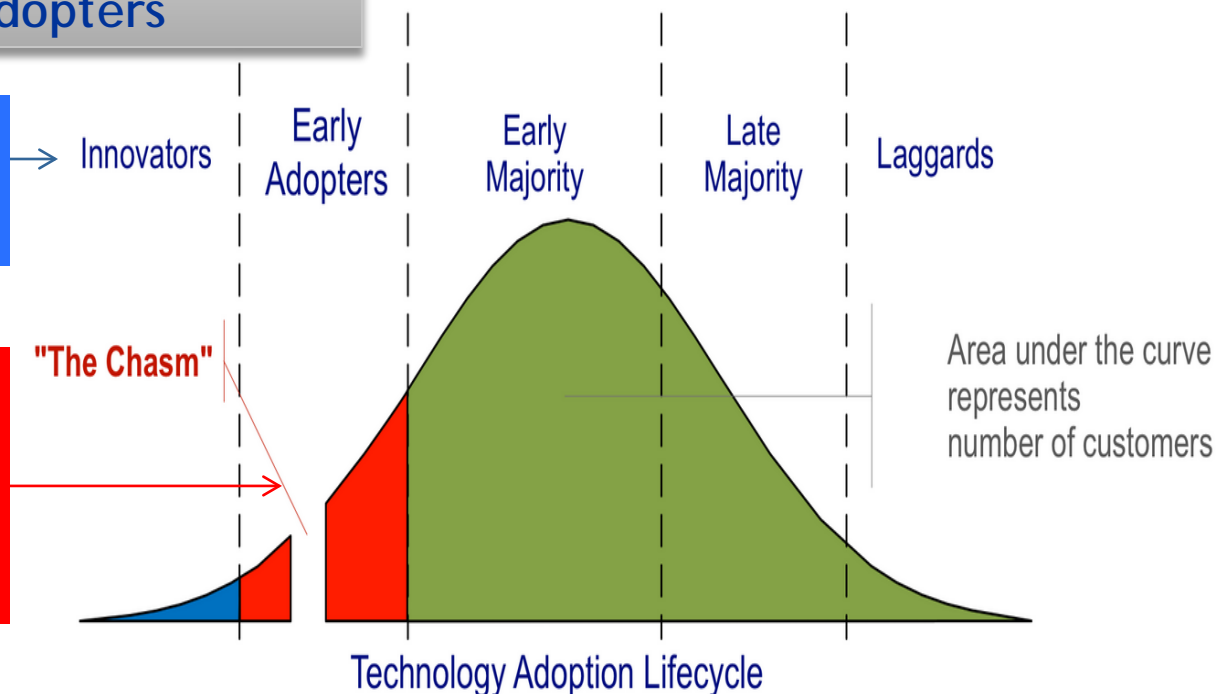
1. Stress Library: **Innovators**
2. Early Warning: **Early Adopters**

Innovators:

Roubini, Rosenberg, Shiller, Rogoff, Reinhart, Ferguson, ...

Key early adoption signals:

- Outliers clustering, vol spikes, super-exponential trends
- Adoption by hedge funds and broker dealers.



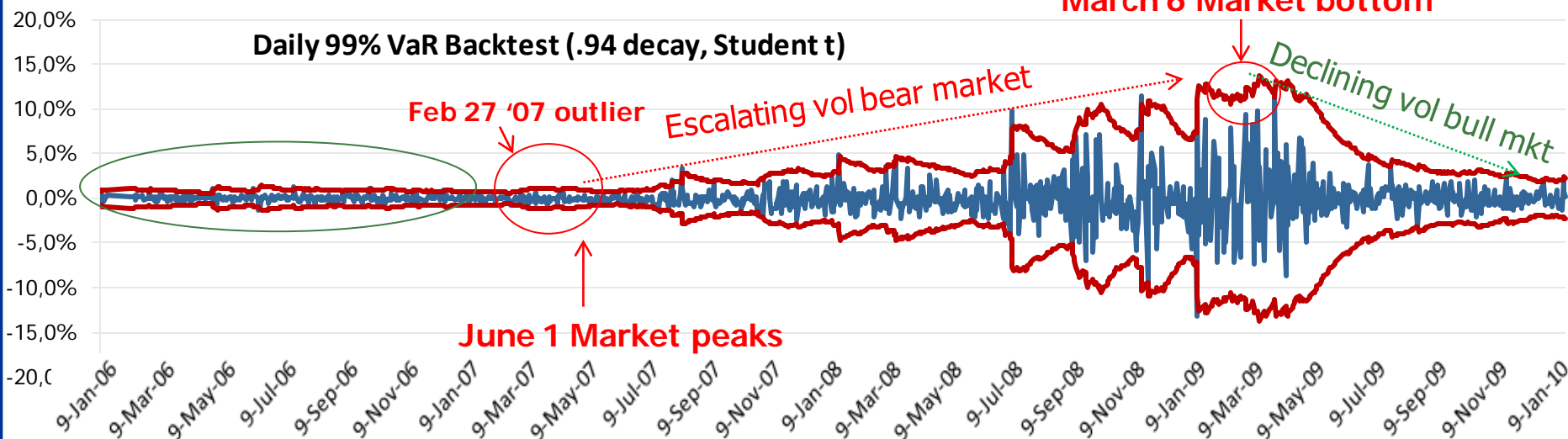
Source: Wikipedia; see Geoffrey Moore's *"Crossing the Chasm"* (1999)

US Financials Case Study

Financial Meltdown (“Roubini”) scenario escalates from '07 and peaks March '09 and then declines... inverse Financial Recovery scenario emerges

Chart: U.S. Financials “death star pulse”

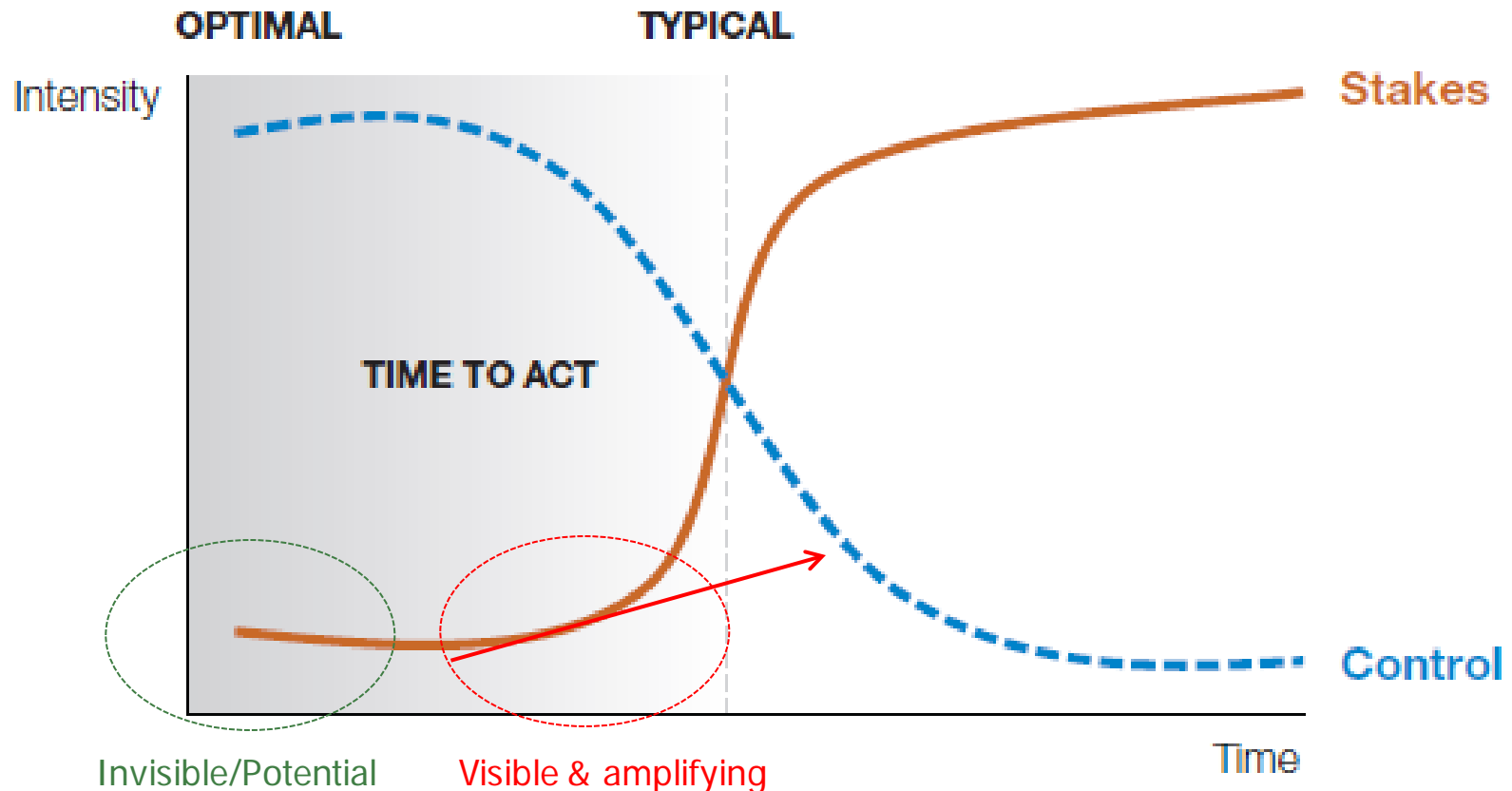
Daily 99% VaR Backtest (.94 decay, Student t)



Source: Alan Laubsch, “Equities as Collateral In U.S. Securities Lending Transactions”,
The RMA Executive Committee on Securities Lending & RiskMetrics, March 2011

Tipping Point Dynamics require early detection and action

- Limited window of opportunity for exerting control
- What are early warning signals of a phase transition?



Source: "Building A Reputation Risk Management Capability", Diermeier & Loeb, 2011

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Exogenous vs Endogenous Crises

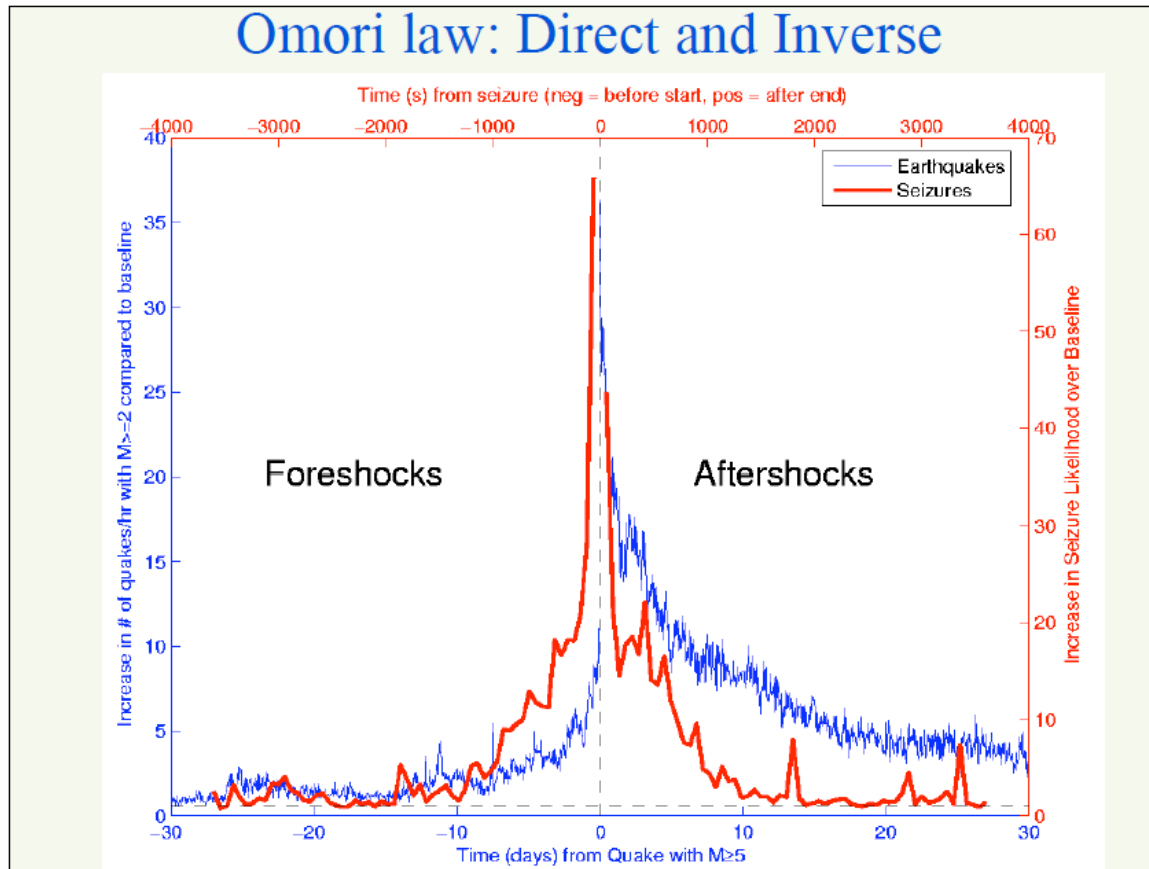


- Nassim Taleb's "Black Swan" claims that crises arise from unknowable events that cannot be quantified or predicted
 - Historical examples: Eisenhower heart attack; Lincoln & Kennedy assassinations; asteroid impact or flood basalt eruptions resulting in mass extinctions; 9/11;
- Didier Sornette's "Dragon King" thesis holds that most financial crises are endogenous in nature and can be diagnosed in advance, can be quantified, and have some predictability
 - Examples of endogenous crises in history: rise of Fascism; rise of dictators (Hitler, Mao); '29 Great Depression, '87 Black Monday, '89 Japan Bubble; '01 Tech Bubble; GFC; current ecological crisis
- Endogenous structural risk combined with exogenous precipitating event is common (e.g., forest fire)

Source: Alan Laubsch "Integrated Risk Management - Early Overview", RiskMetrics

Phase transitions can result from amplifying feedback

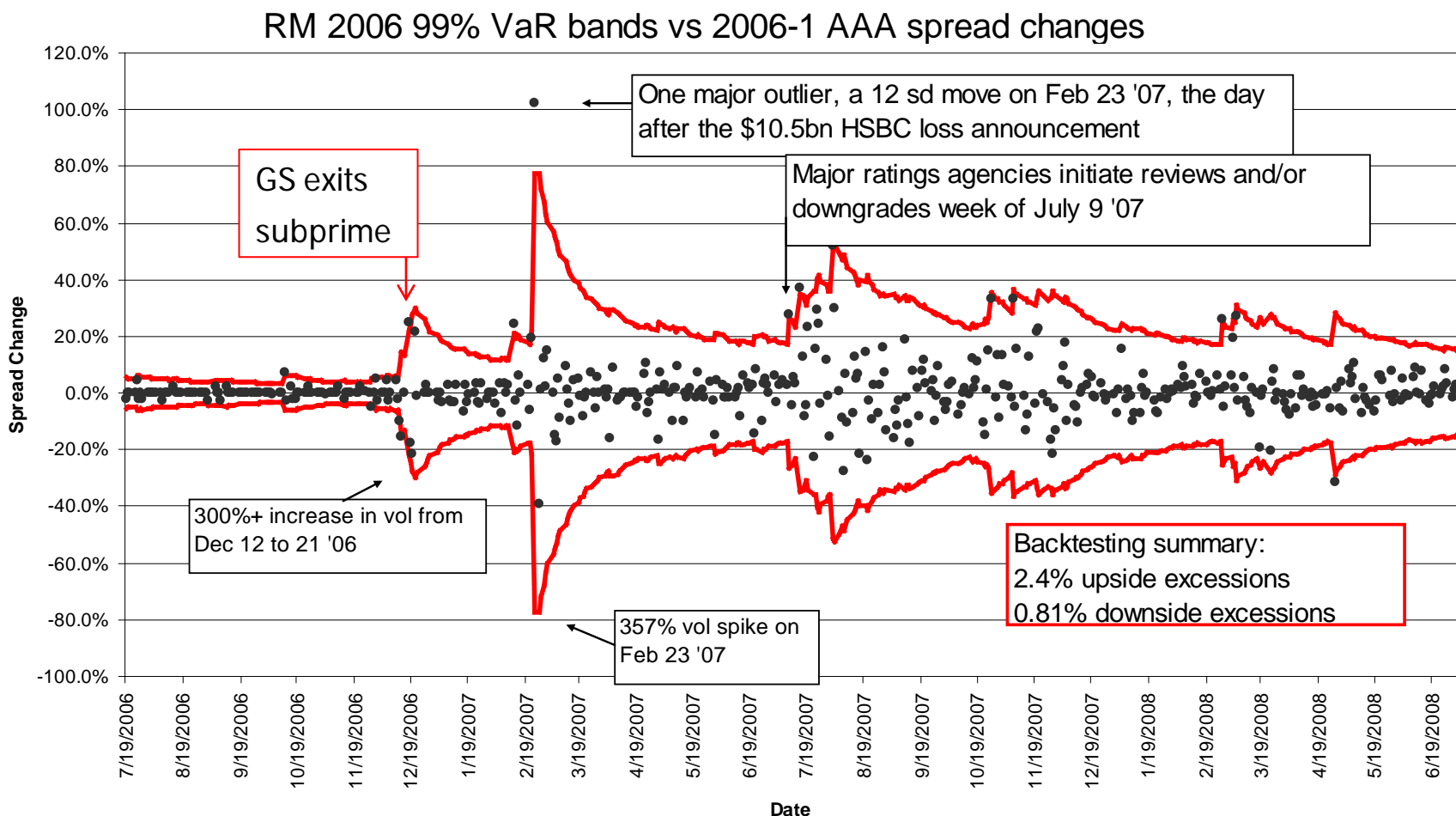
- Super-exponential instability and change characterizes phase transitions



Source: Sornette et al., Endogenous versus Exogenous Origins of Crises (2008)

See: http://www.er.ethz.ch/presentations/Endo_Exo_Oxford_17Jan08.pdf

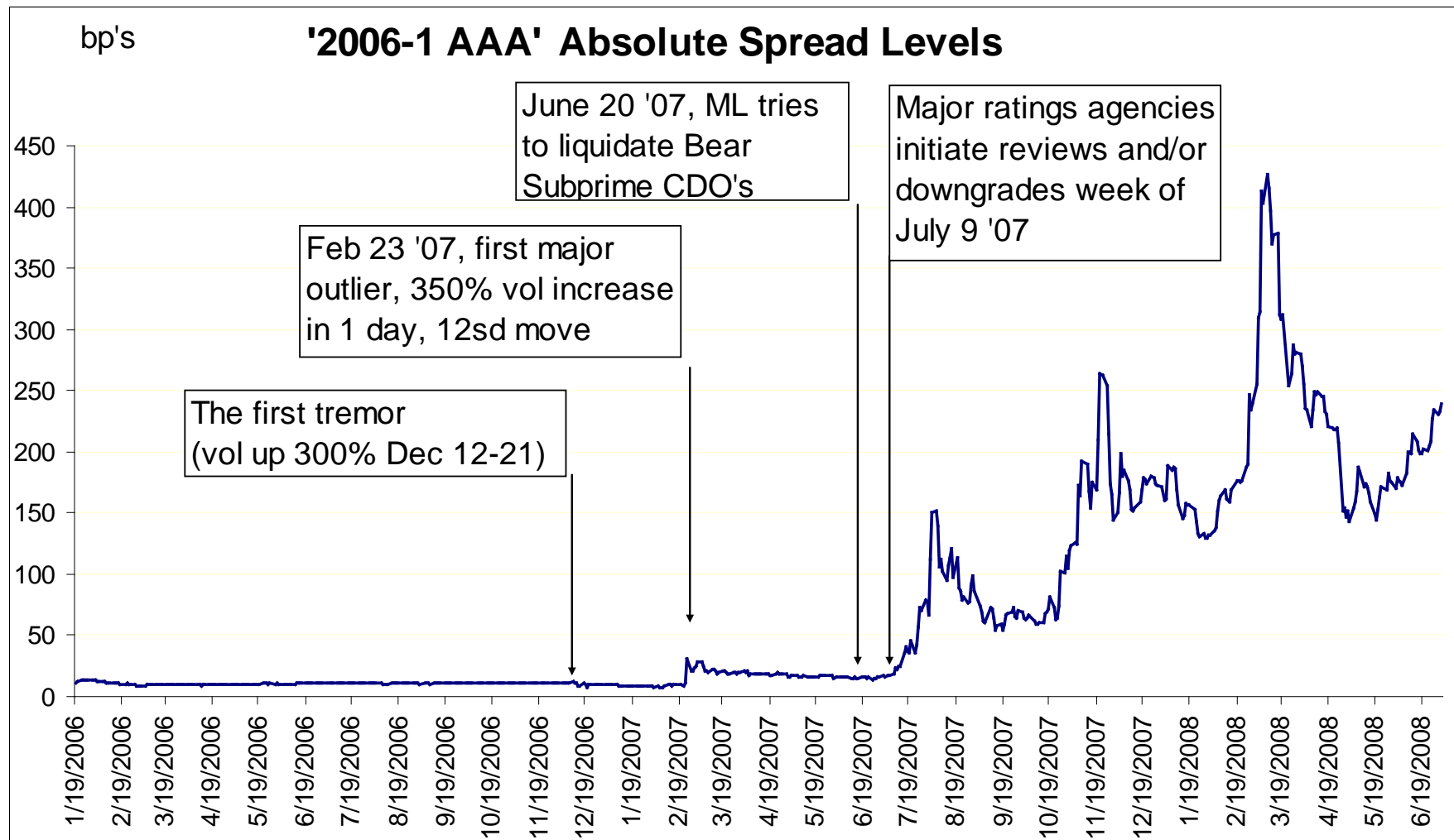
Subprime CDO volatilities spiked 7 & 4 months before the meltdown



Source: Alan Laubsch "Subprime Risk Management Lessons", RiskMetrics

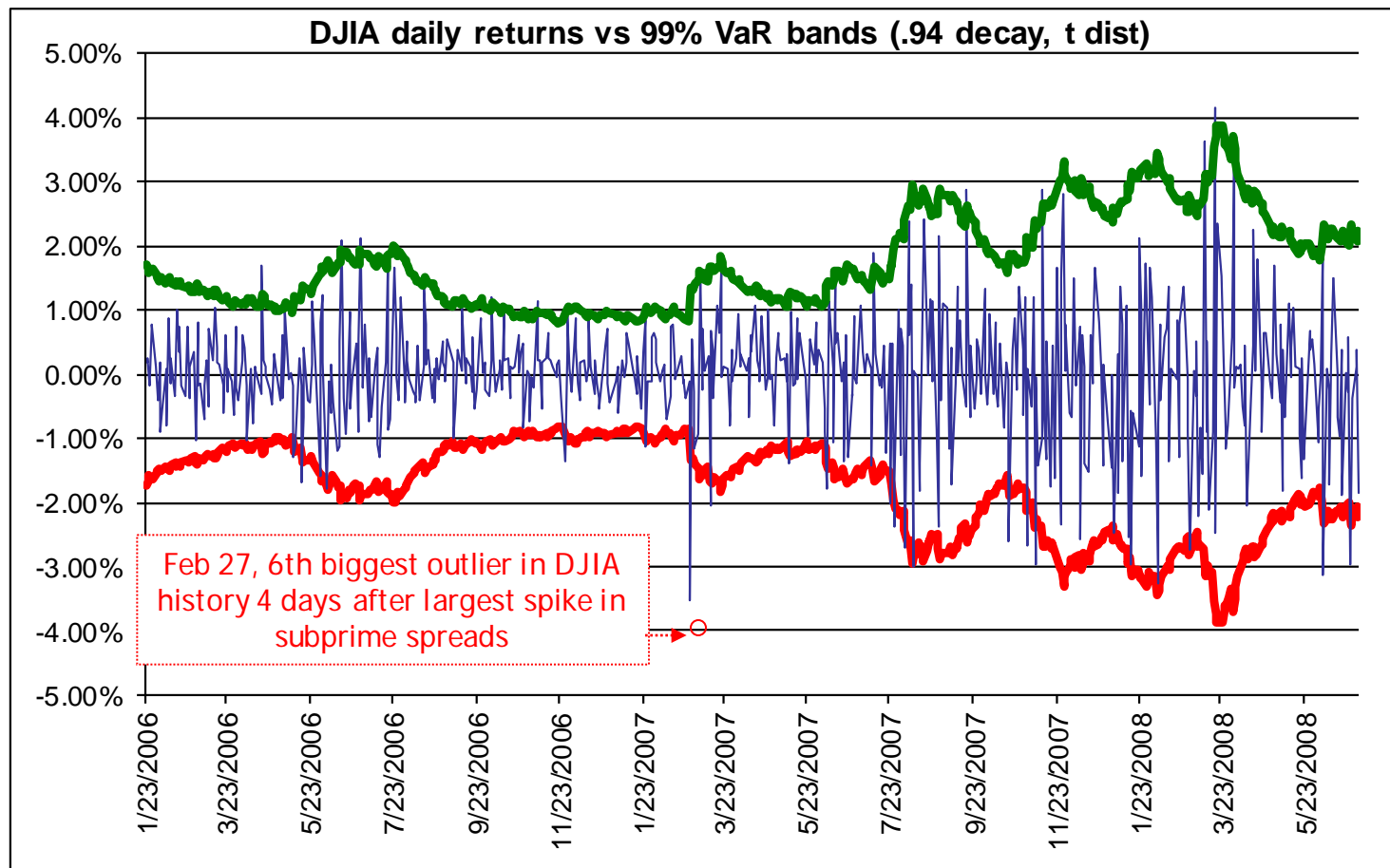
The Dec '06 and Feb '07 spikes in volatility can be seen as tremors (foreshocks) that cascaded into a major earthquake

- Absolute spread moves were small, but rate of change was super-exponential. Parallels to failure and rupture process in material science (pressure to break point)



Feb 27 '07 DJIA outlier marks the beginning of a phase transition with increasing waves of volatility

- Increasing amplitude of volatility is a telltale sign of endogenous crises



Source: Alan Laubsch "Integrated Risk Management - Early Overview", RiskMetrics

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Typical stress testing processes generate much data, but not necessarily intelligence

“We run over 180 stress scenarios against each of our counterparties on a daily basis. But we don’t know what to do with the information” - Risk manager at global bank

Key questions:

- With overwhelming amount of data, which scenarios to focus on?
 - ...given market conditions (systemic)
 - ...given our portfolio exposures (specific)

StressGrades™ harness market intelligence highlight emerging risks

We define three components of StressGrades™:

1. **PStress** = Market Implied Probability of a Stress Scenario
2. **DStress** = Distance to stress scenario in standard deviations (z-score)
3. **StressQ** = Quantile (percentile) historical rank of stress scenario (e.g., StressQ = .82 implies stress levels have exceeded current levels 18% of the time)

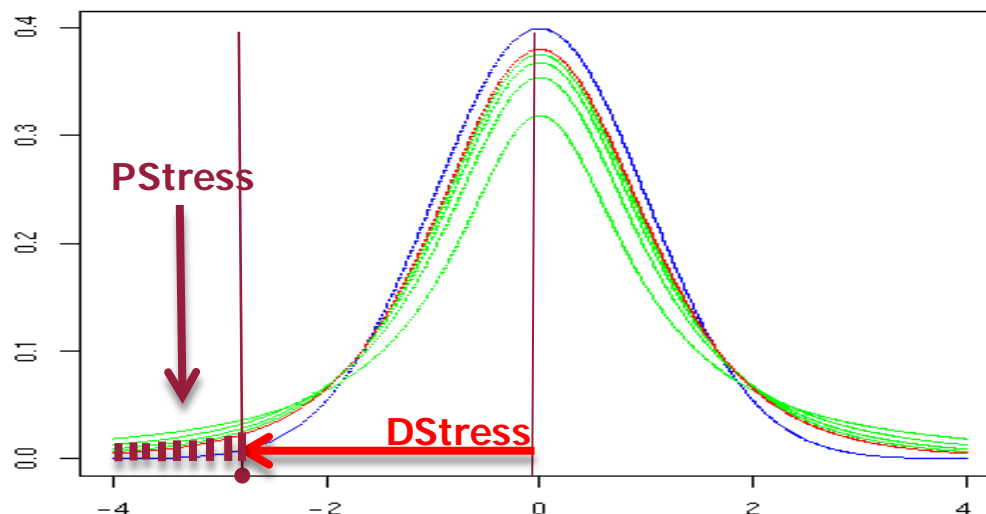


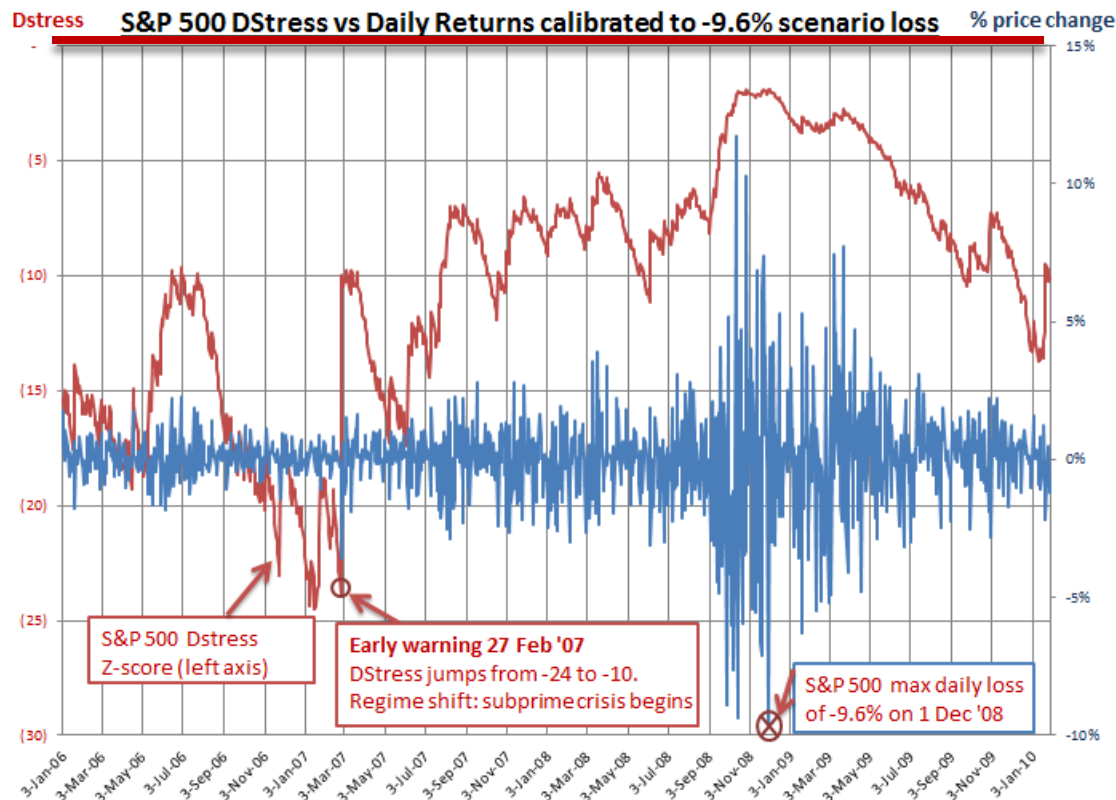
Figure: Student t distributions and Z-scores

We estimate DStress w/market implied vols (and correlations for multi factor scenarios) and PStress using a distributional assumption (e.g., Normal or Student t).

Stress Grades™ provide early warning and can be backtested

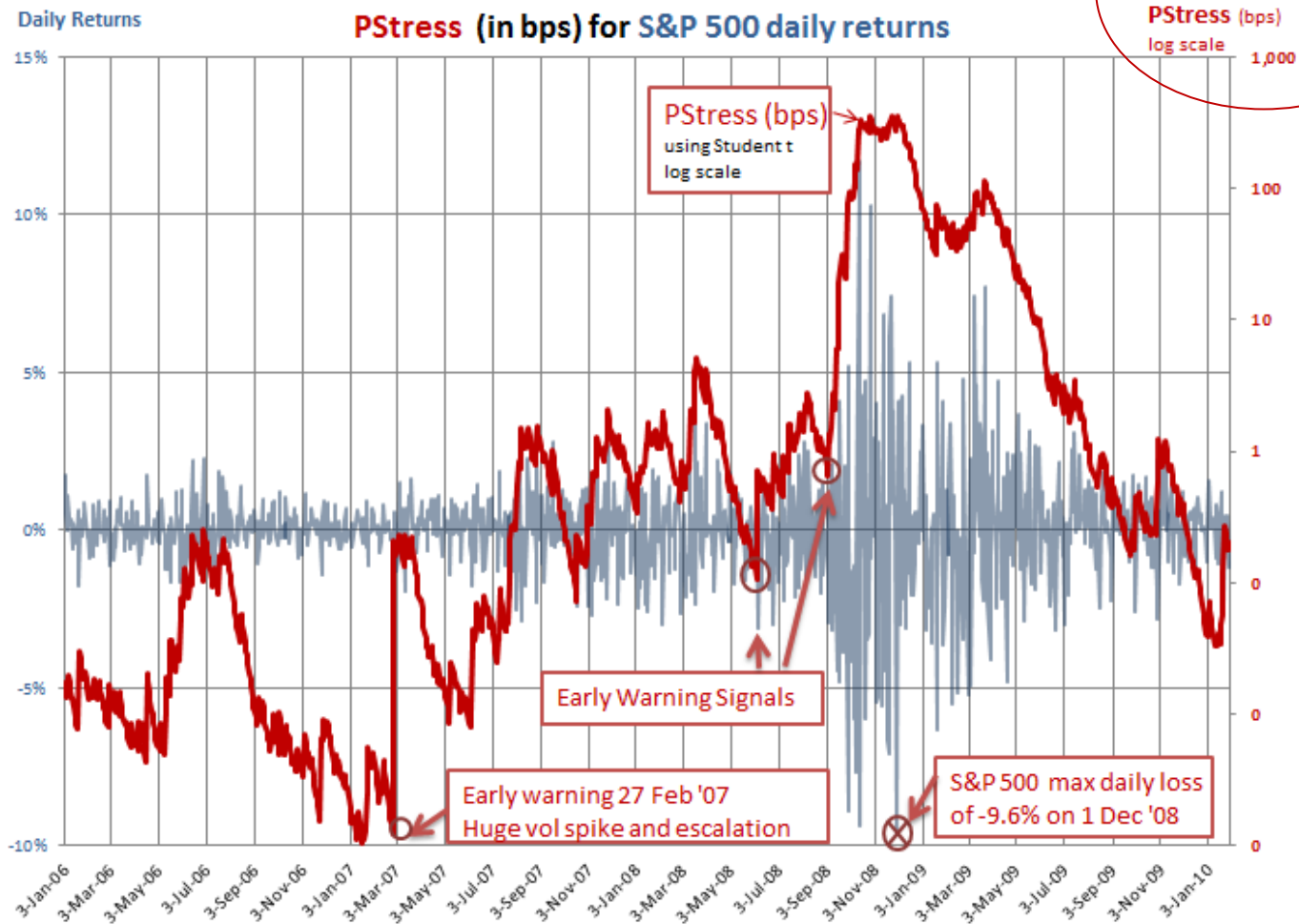
S&P 500 Case Study:

- Since 1987, the biggest one day drop in the S&P 500 was a 9.6% fall on Dec 1 '08, which we use to calibrate and backtest our StressGrade scenario.
- DStress escalates from -24sd to -2sd before Dec '08 drop. Regime shift warning Feb'07



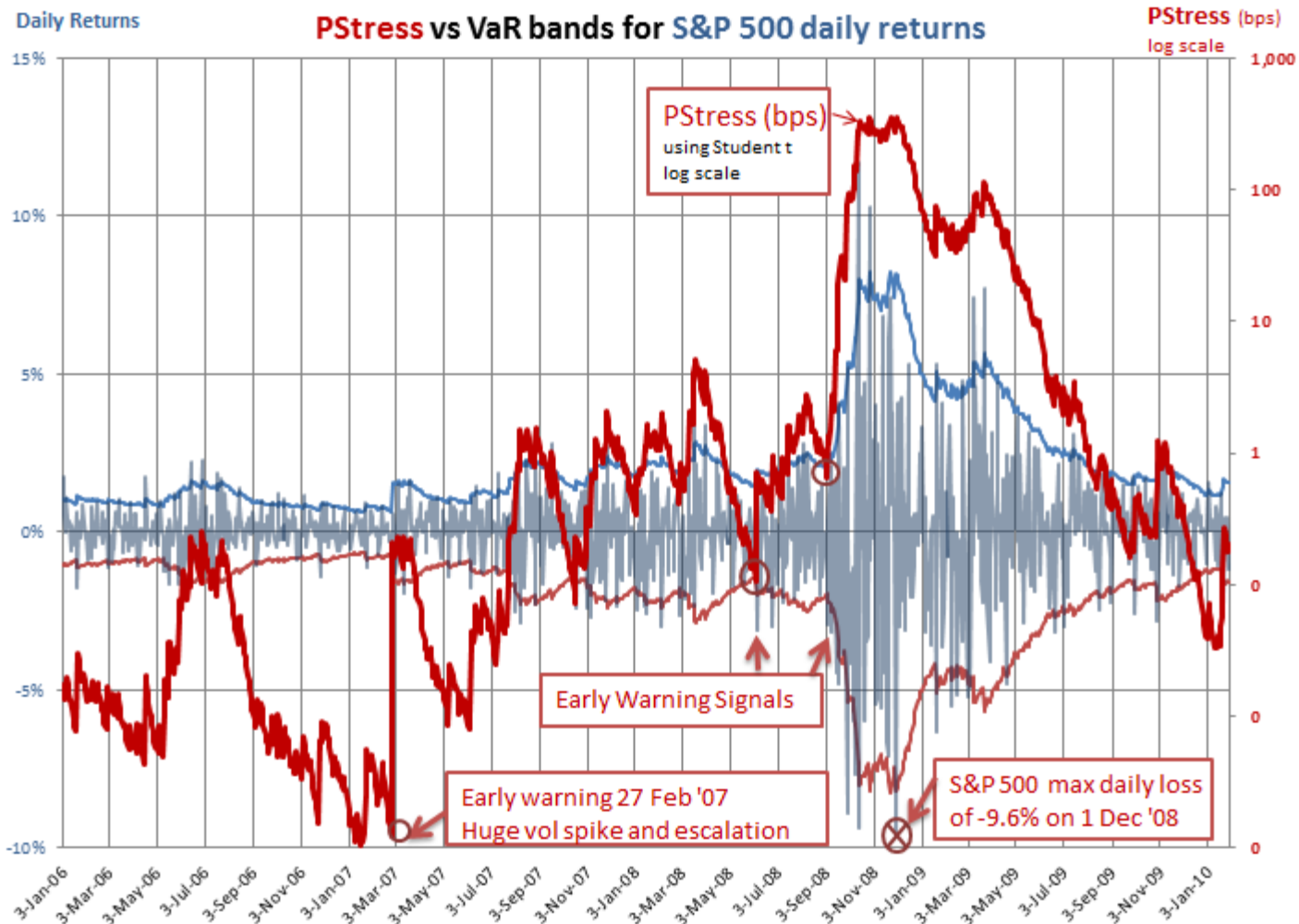
**S&P500 cont'd: Super-exponential increase in PStress:
170x on Feb 27 then another 1300x before Dec 1 '08**

- Note log scale on the PStress Chart below (right scale)



StressGrades can be used in conjunction with other early warning indicators like VaR outliers

- Graph of 95% EWMA VaR vs PStress. Note downside outlier clustering.

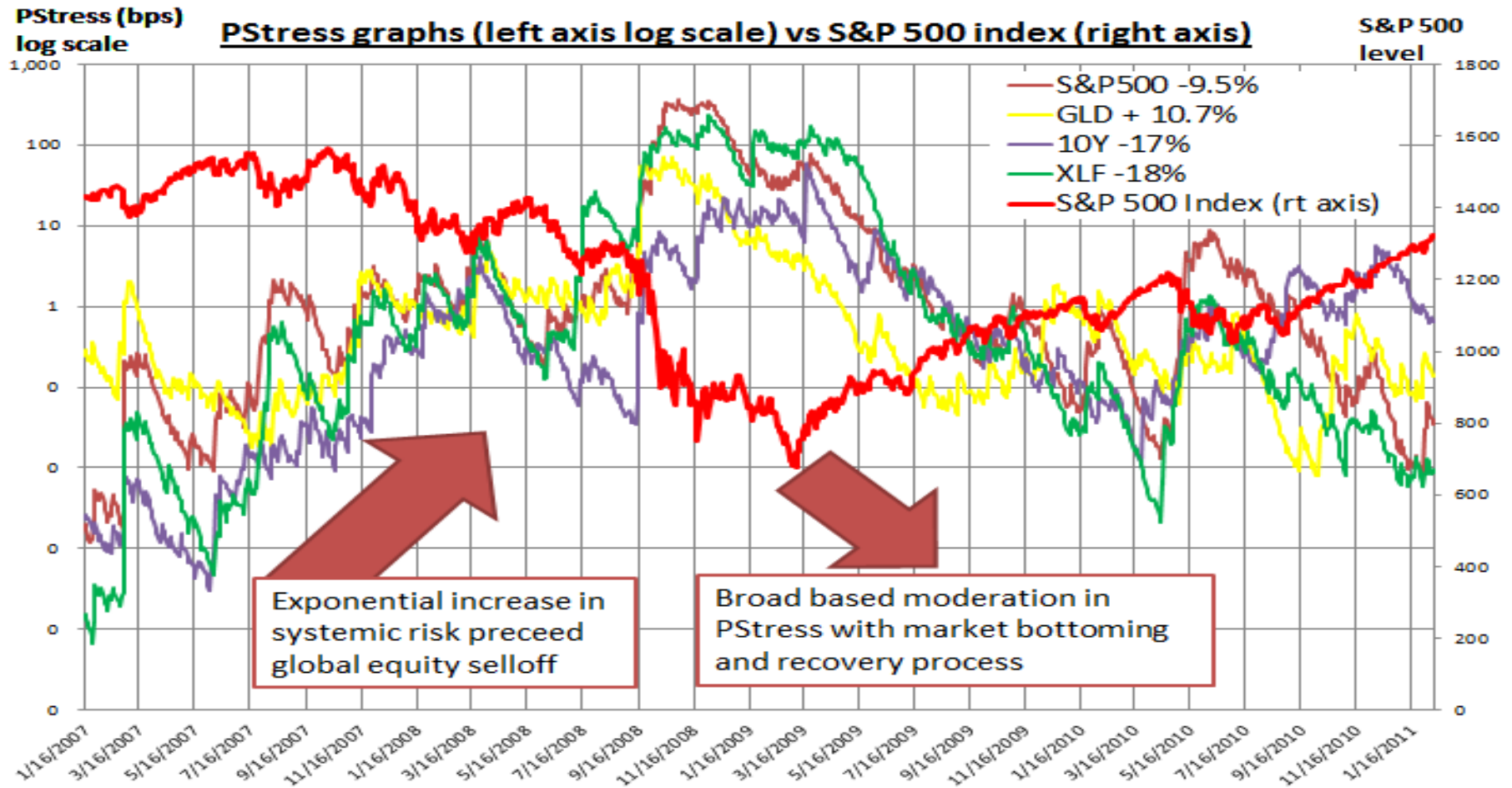




www.riskcommons.org Alan Laubsch alaubsch@gmail.com 2

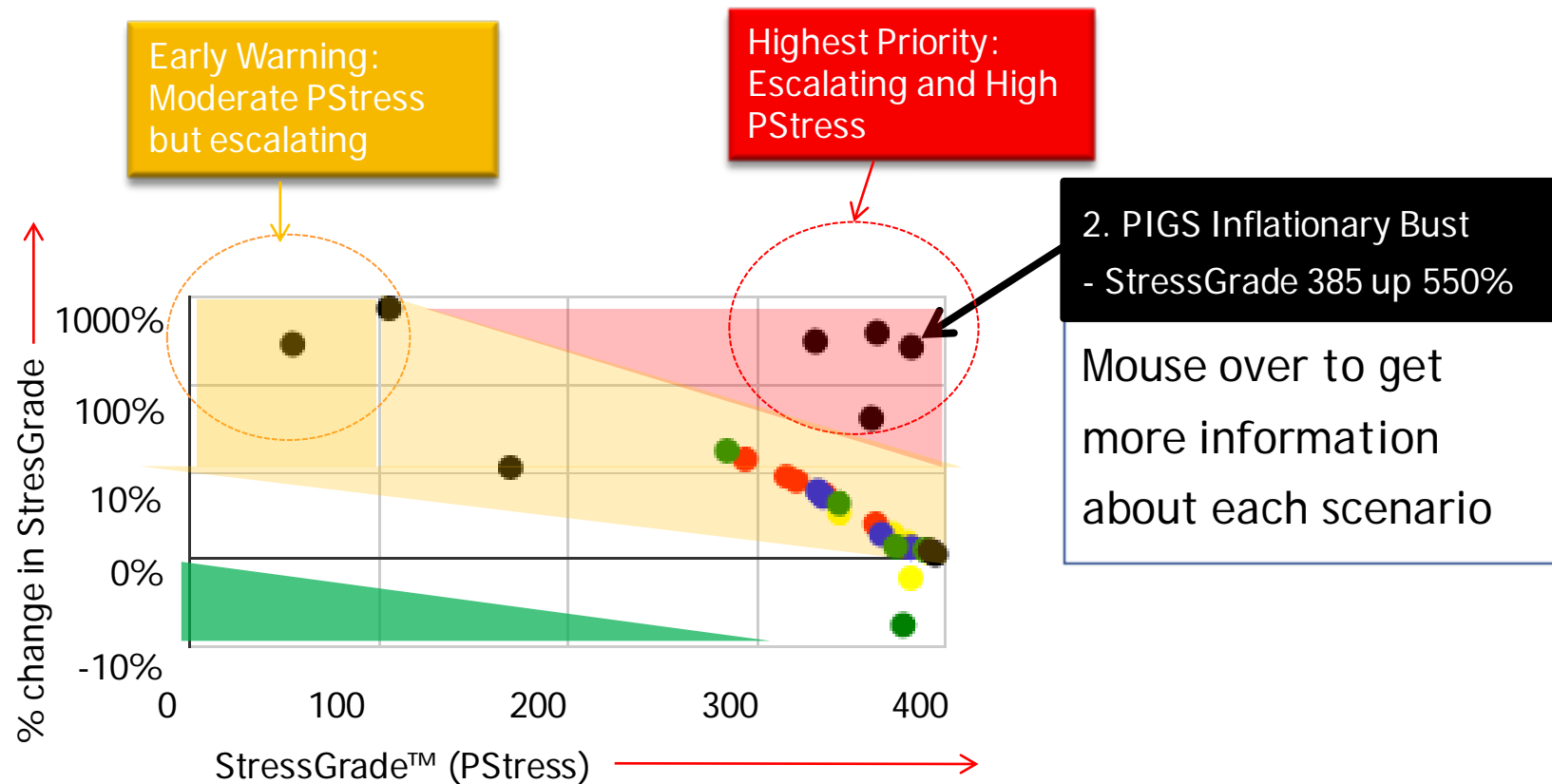
Super-exponential increase in PStress preceded market crash...

- ... and broad declines in PStress from peak levels signaled market recovery



Source: Alan Laubsch, "Introduction to StressGrades©", riskcommons.org, 2011

Highlight escalating and large risks in StressGrades™ HeatMap



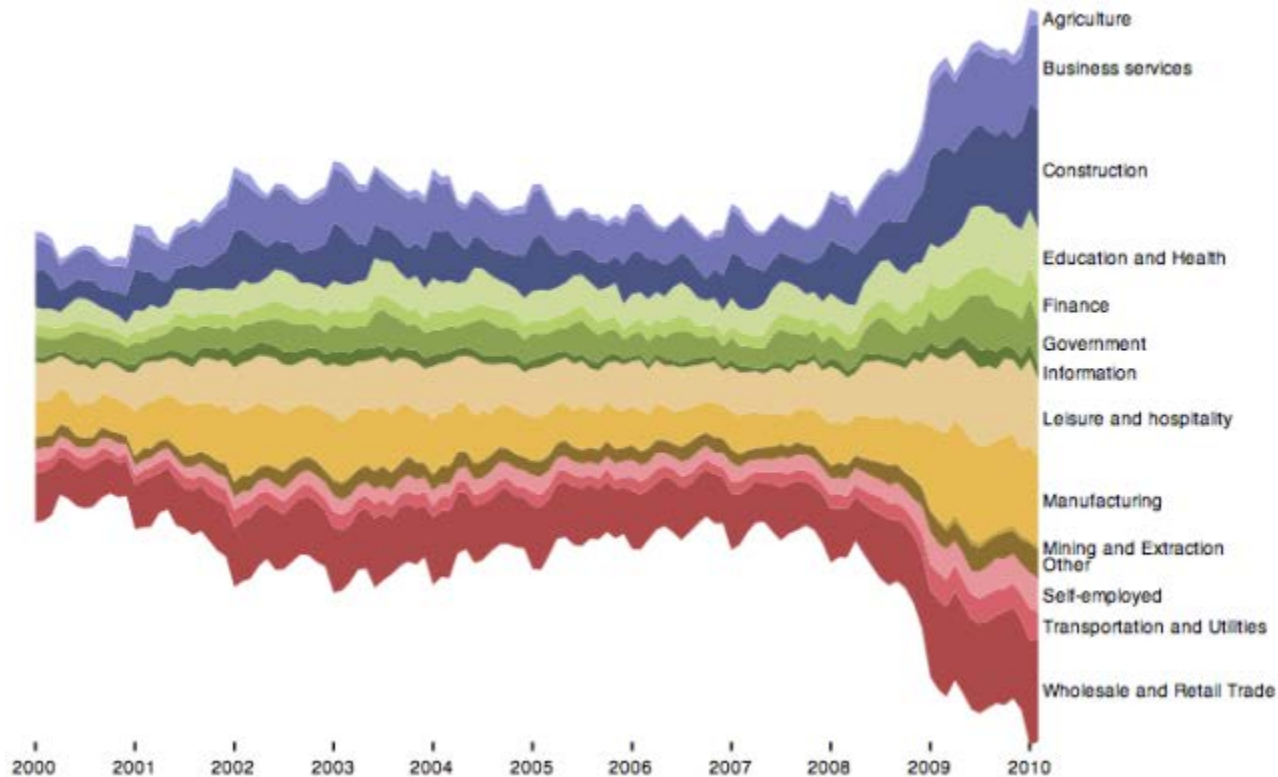
Outlier Analysis can identify regime shifts

- Sample Outlier Analysis: 5% threshold
 - 23 of 80 scenarios were outliers
 - 6 Outliers Average over 12 months

Rank	% Move in PStress	Scenario [each hyperlinked]
1	780% to 389 PStress	Sovereign default
2.	690% to 355 PStress	Deflationary bust
....		
23.	55% to 80 PStress	Gold spike

Systemic Risk Outlier Chart (mock up)

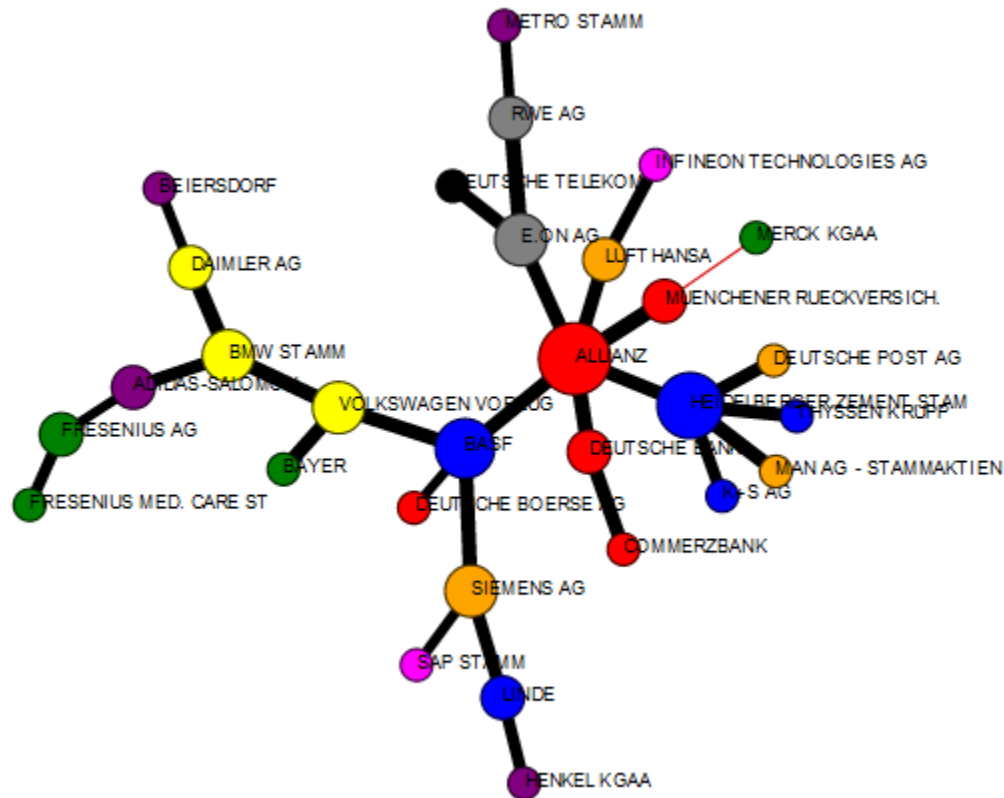
- Provide outlier chart by scenario type (e.g. sector, asset class, etc.) to visualize unusual activity



Graph from <http://hci.stanford.edu/jheer/files/zoo/>

Network Graphs allow visualization of interrelationships

- Potential to integrate stress themes into interactive network graphs and play movie of changing correlation and volatility dynamics over time



Source: <http://fna.fi/>

Summary: sense and respond to emerging risks

- Use algorithms and visualization techniques to detect signals amidst noise (e.g., super-exponential rates of change)
- Prioritize attention to relevant macro fault lines and specific portfolio vulnerabilities

Anticipate

Most of the focus at most companies is on what's directly ahead. The leaders lack "peripheral vision." This can leave your company vulnerable to rivals who detect and act on ambiguous signals.

- 6 Habits of True Strategic Thinkers, Paul Schoemaker, Mar 20, 2012

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Summary: Architect stress tests to adapt to market intelligence

- As early warning signals are observed:
 1. Focus on affected systemic fault lines (and related nodes)
 2. Assign higher probability of stress
 3. Apply more severe stress scenarios
- Proactive response is essential
 1. War game scenarios to better understand potential impacts and consequences over time, and practice playing out various permutations of scenarios across the enterprise
 2. Take advantage of calm periods to reduce concentration risks, increase capital and liquidity buffers. Get prepared to weather more severe storms ahead.

Conclusions

- Adaptive stress testing practices
 - **Experiment:** explore emerging vulnerabilities and seek to uncover risk concentrations
 - **Learn:** intelligent feedback loops: market signals and subjective perspectives (scenarios)
 - **Practice:** play through various scenario permutations
- **Early detection and adaptation is crucial for systemic risks**
- **StressGrades™ harness market intelligence to prioritize attention**