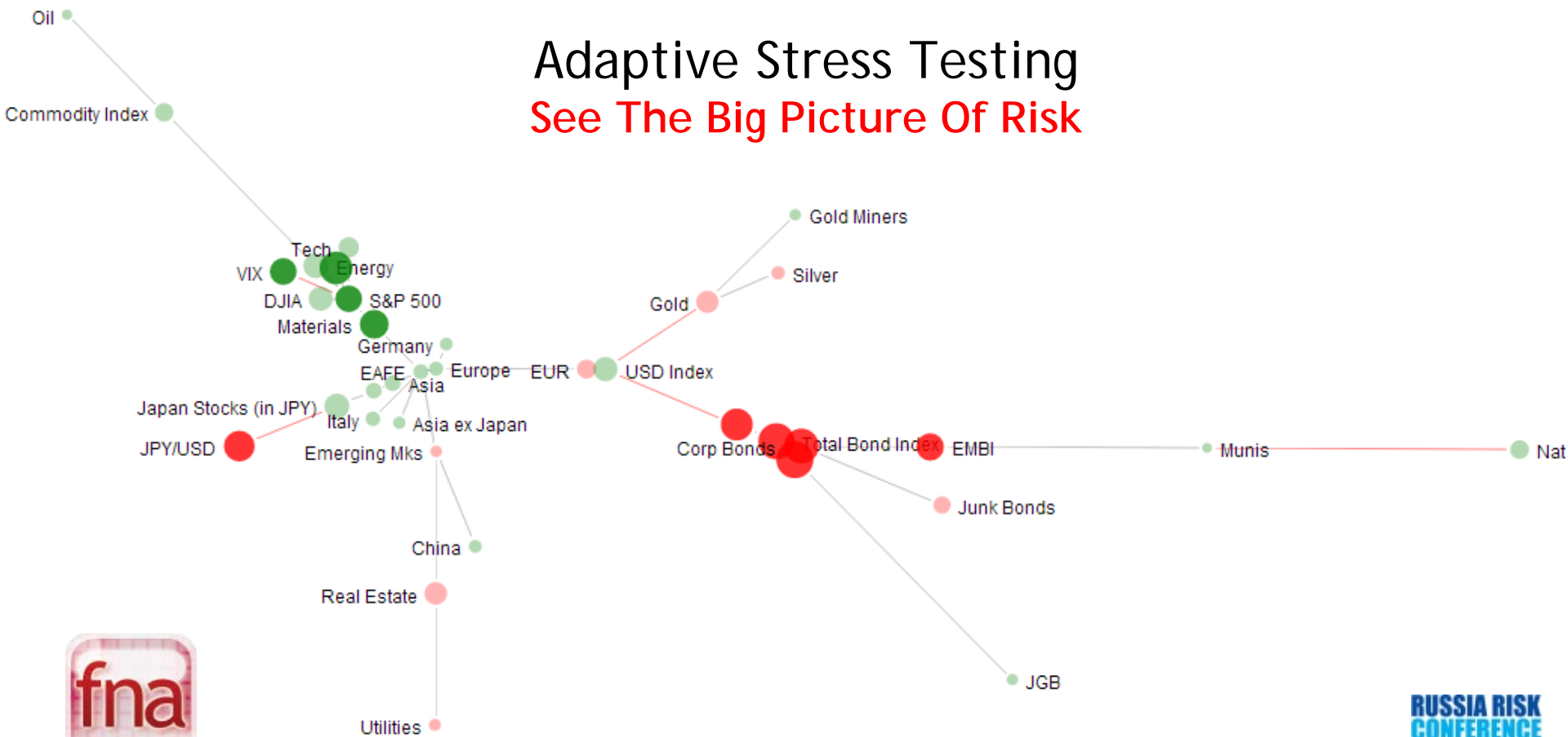




Adaptive Stress Testing

See The Big Picture Of Risk



Agenda

1. Adaptive Stress Testing

- Outliers: Signal or Noise?

2. Mapping Systemic Risk

- HeavyTails™ for Russia

3. Lessons From Nature & Conclusions

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 potential risks (hidden, structural)

- *Stress Library based on Thought Leaders* (Innovators / Visionaries)
 - Focus on cycles (e.g., credit bubbles), amplifiers, imbalances, critical points
 - *E.g., Robert Shiller: (a) tech bubble (2000), (b) housing bubble (2005)*



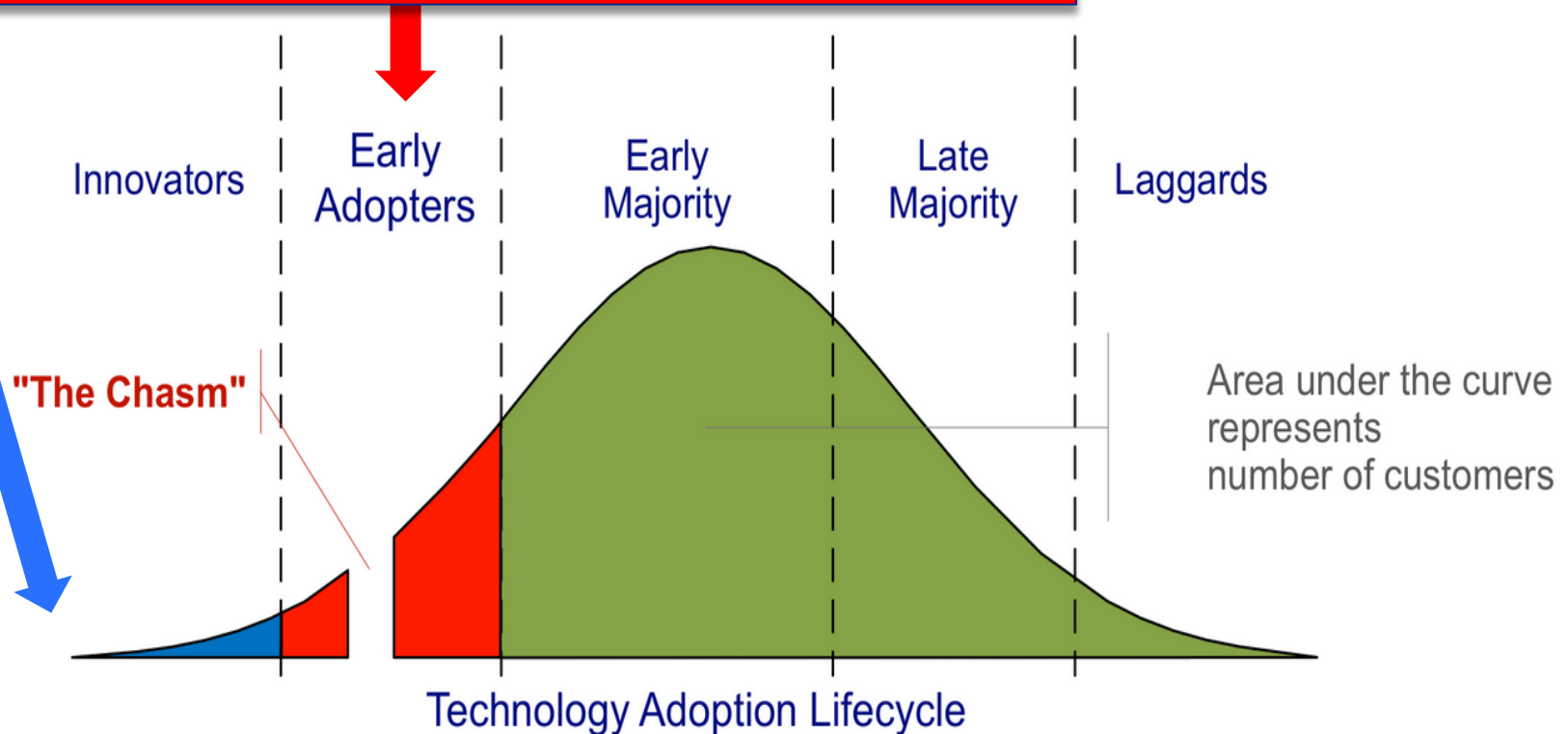
II. Micro: monitor market signals (visible risk)

- Construct Stress Indices using traded factors to represent scenarios
- Monitor market signals, focusing on outliers and critical points
 - *Examples: vol spike in (a) tech stocks and (b) US mortgage securities & financials*

Social Diffusion of Disruptive Innovation: 2 key stages

1. Macro: Stress Scenario Library from Innovators

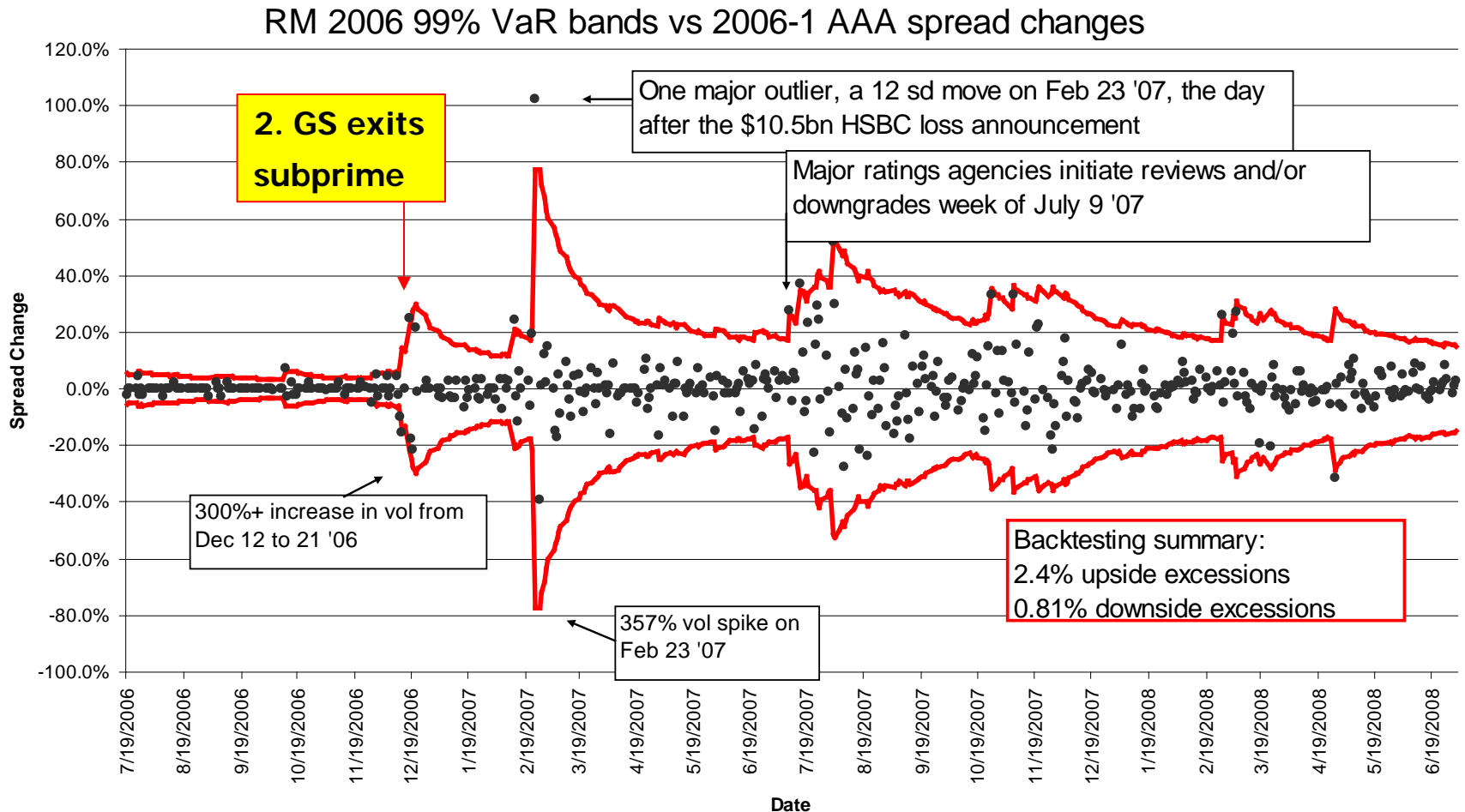
2. Micro: Market signals from Early Adopters



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

U.S. Subprime Bonds

1. Robert Shiller had warned of housing bubble since 2005...

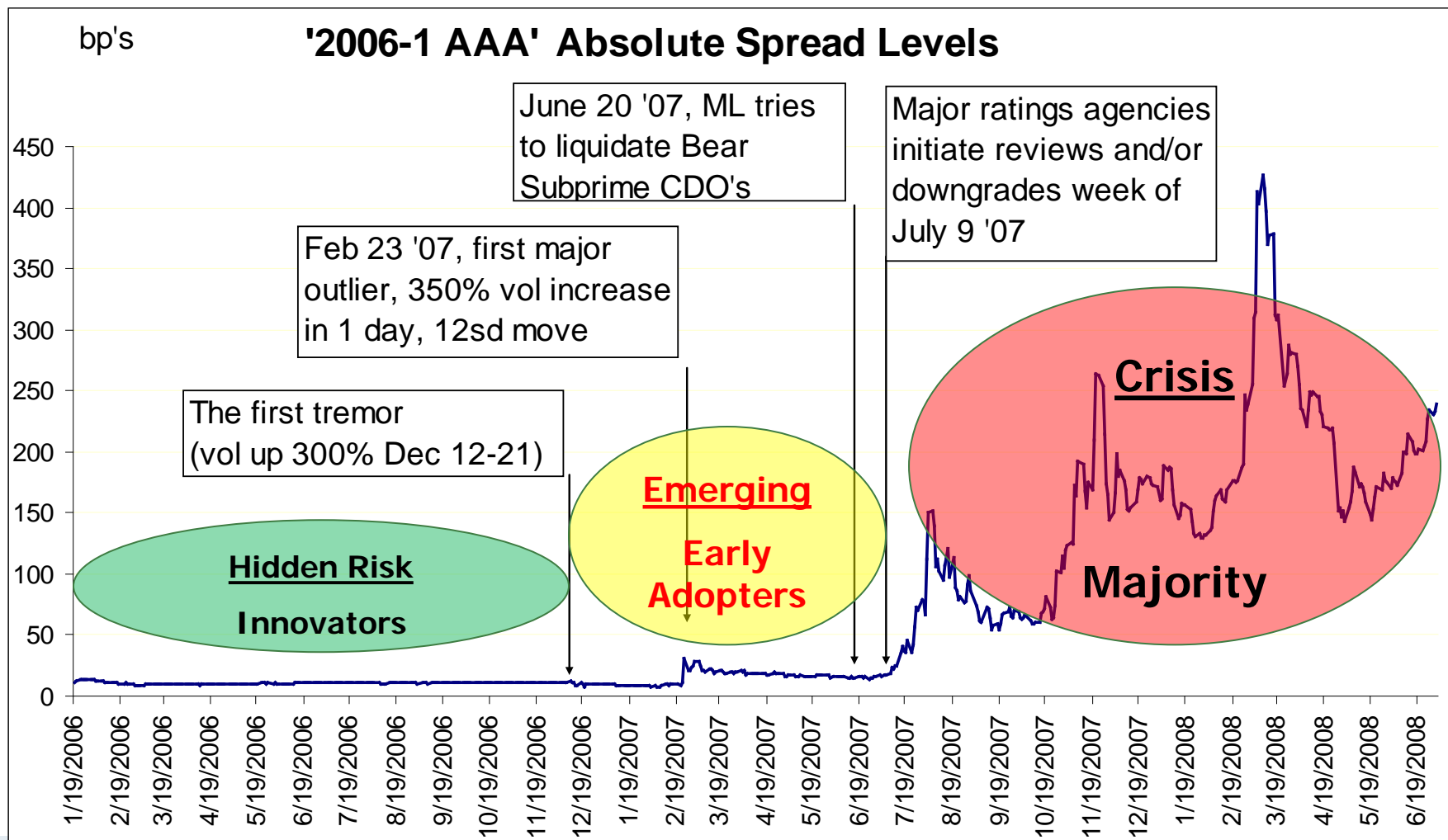


Source: Alan Laubsch "Subprime Risk Management Lessons", RiskMetrics

3 Key Stages of Risk: From Hidden to Emerging to Crisis

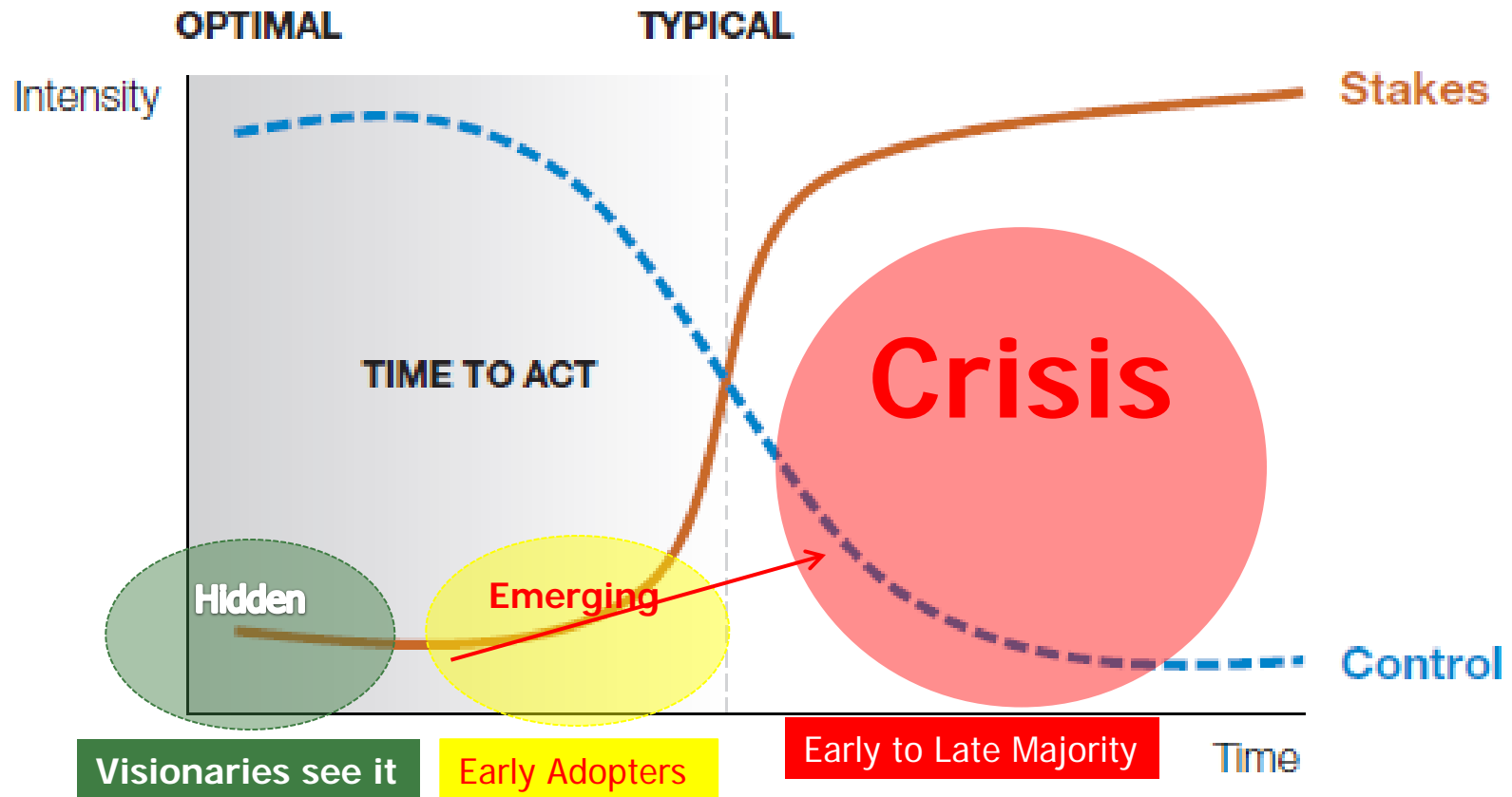
1. When was the biggest risk?

2. And the biggest surprise?



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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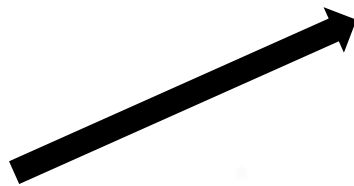
- HeavyTails™ for Russia

3. Lessons From Nature & Conclusions

Two theories of crises and a synthesis

Black Swan

(Taleb 2001, 2007)



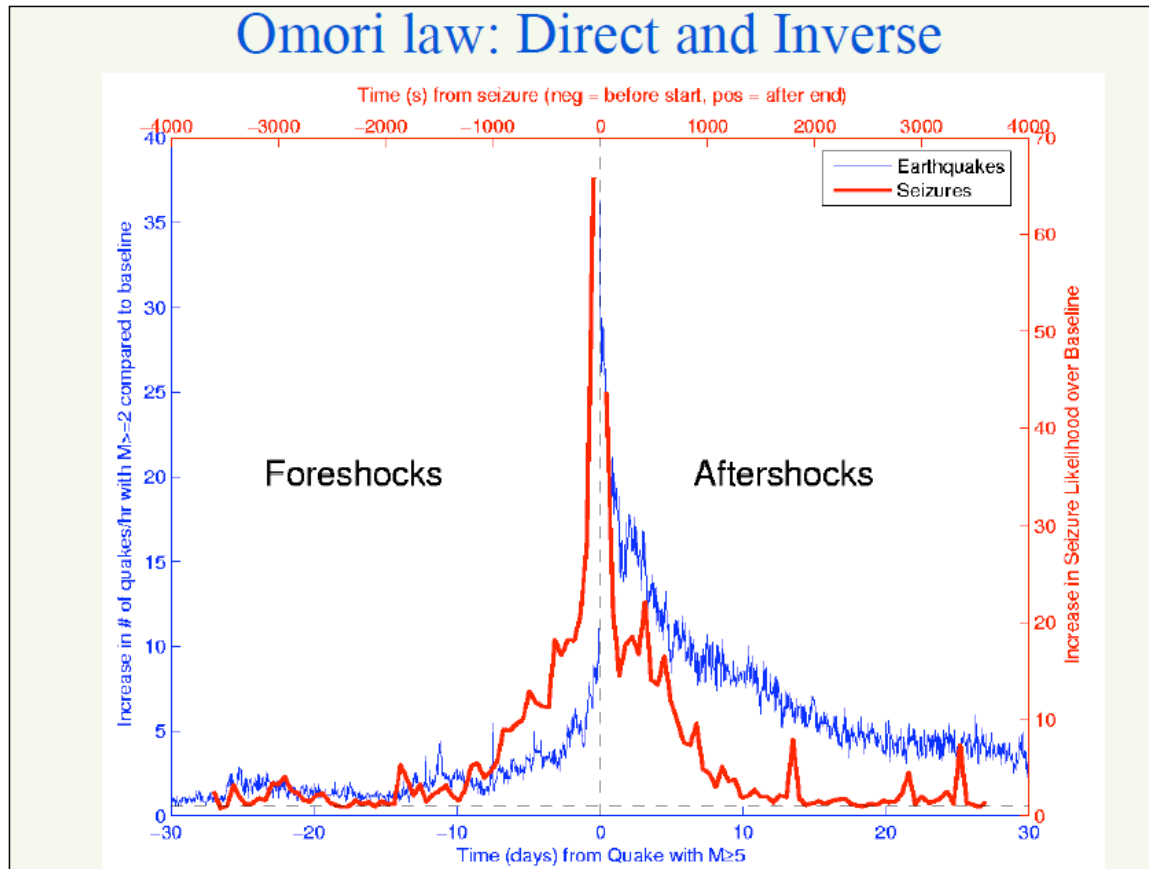
Dragon King

(Sornette 2009)



Phase transitions can result from amplifying feedback

- Super-exponential instability and change characterizes phase transitions

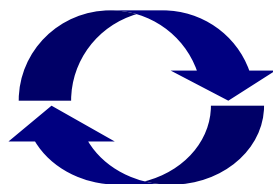


Source: Sornette et al., Endogenous versus Exogenous Origins of Crises (2008)

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

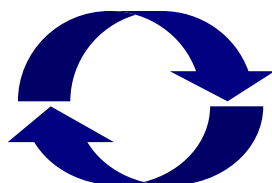
Amplification mechanisms & feedback loops characterize finance

Asset Prices



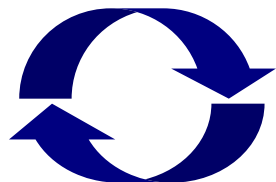
Leverage

Asset Prices



Risk
Aversion

Real Economy



Financial Markets

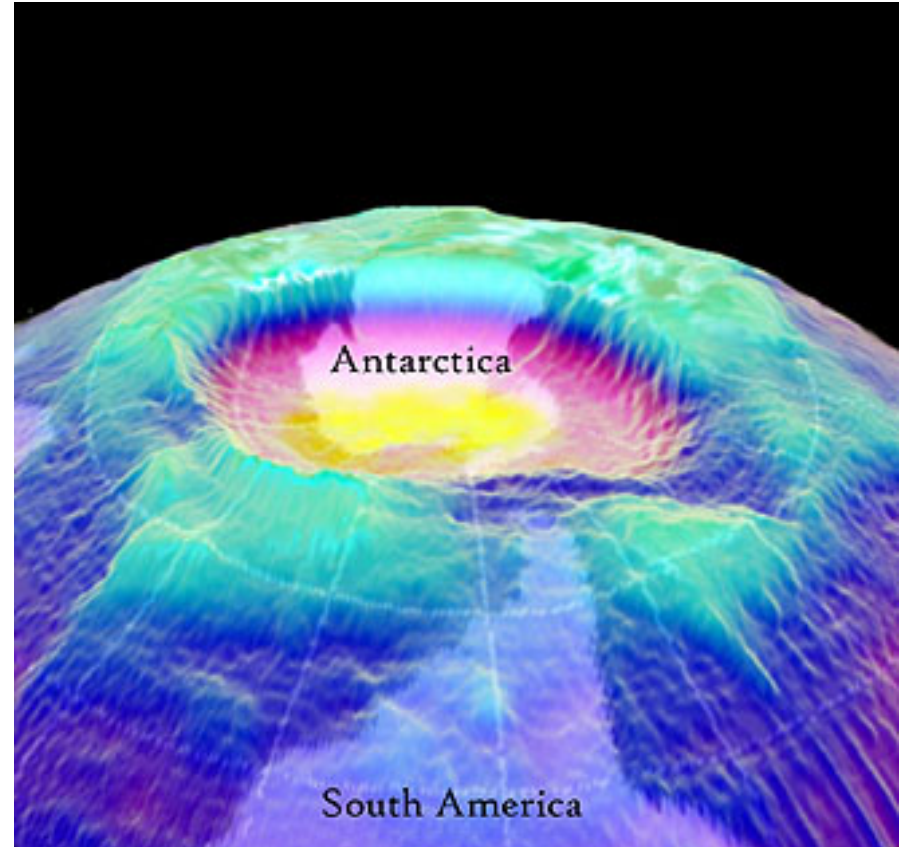
Imitation... especially when information is limited



Outliers as early warning signs

Learning from extreme circumstances

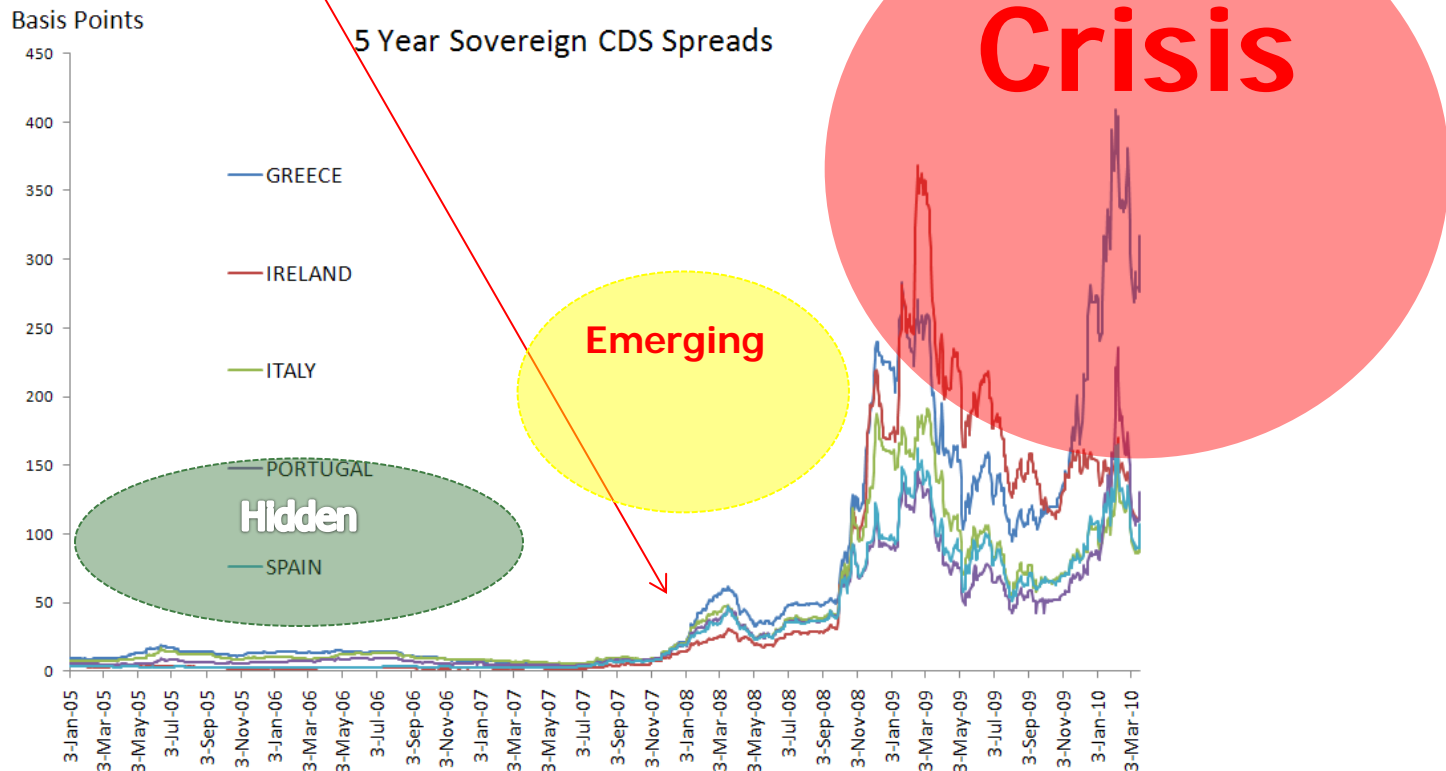
- **Ozone Hole discovery by Joe Farman (1980-1985)**
 - Missed by NASA satellites, which were programmed to ignore outliers...
- **Outliers can signal important changes: phase transitions**
 - Spurious data... or has the distribution changed?
- **Escalation of outlier activity heralded the GFC**
 - Large outliers
 - Outlier clustering



...scientists expect the first signs of recovery of springtime ozone depletion in the polar stratosphere around the year 2065. (*Quirin Schiermeier*, [“Ozone: The patient is not getting sicker”](#))

Escalating sovereign spreads signaled Eurozone risk in 2008

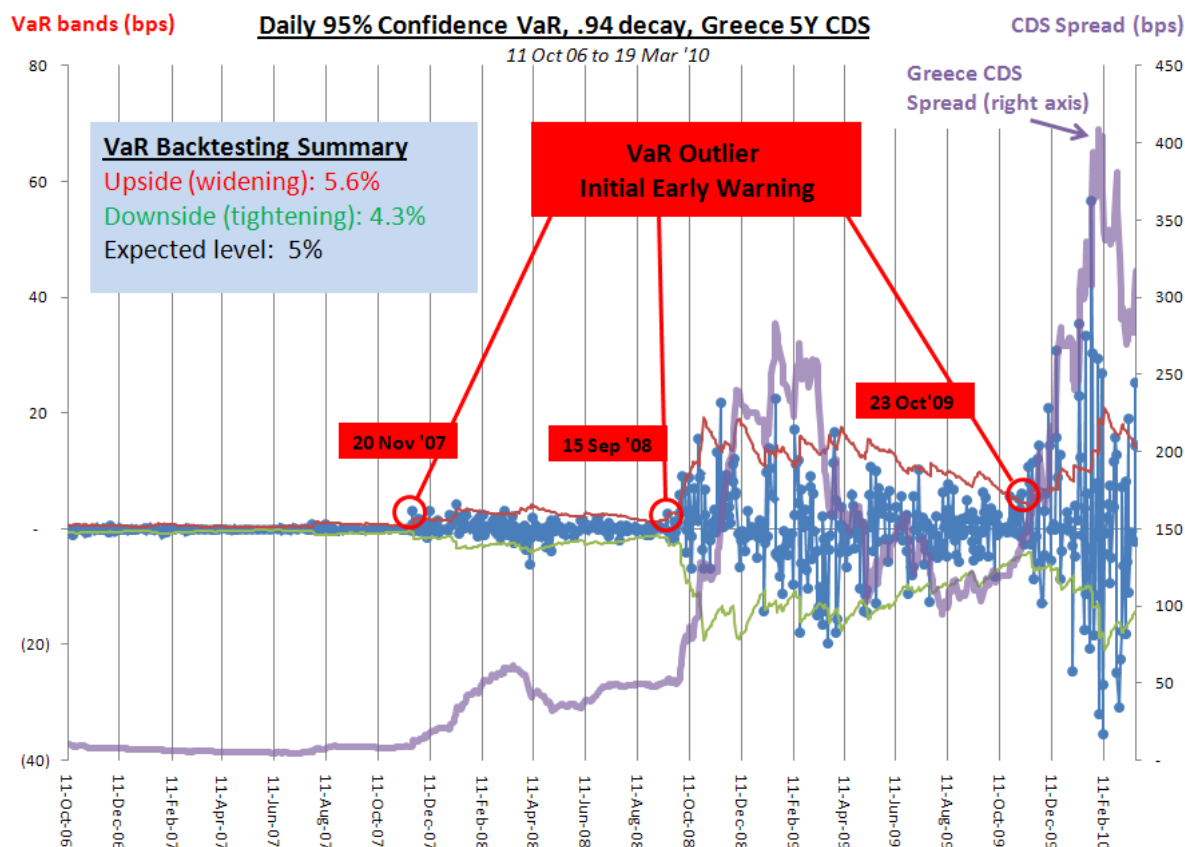
Early Adopters: European Divergence (PIGS) scenario pitched by HF's in 2008



Source: Alan Laubsch "Integrated Risk Management - Early Overview", 2011, RiskMetrics

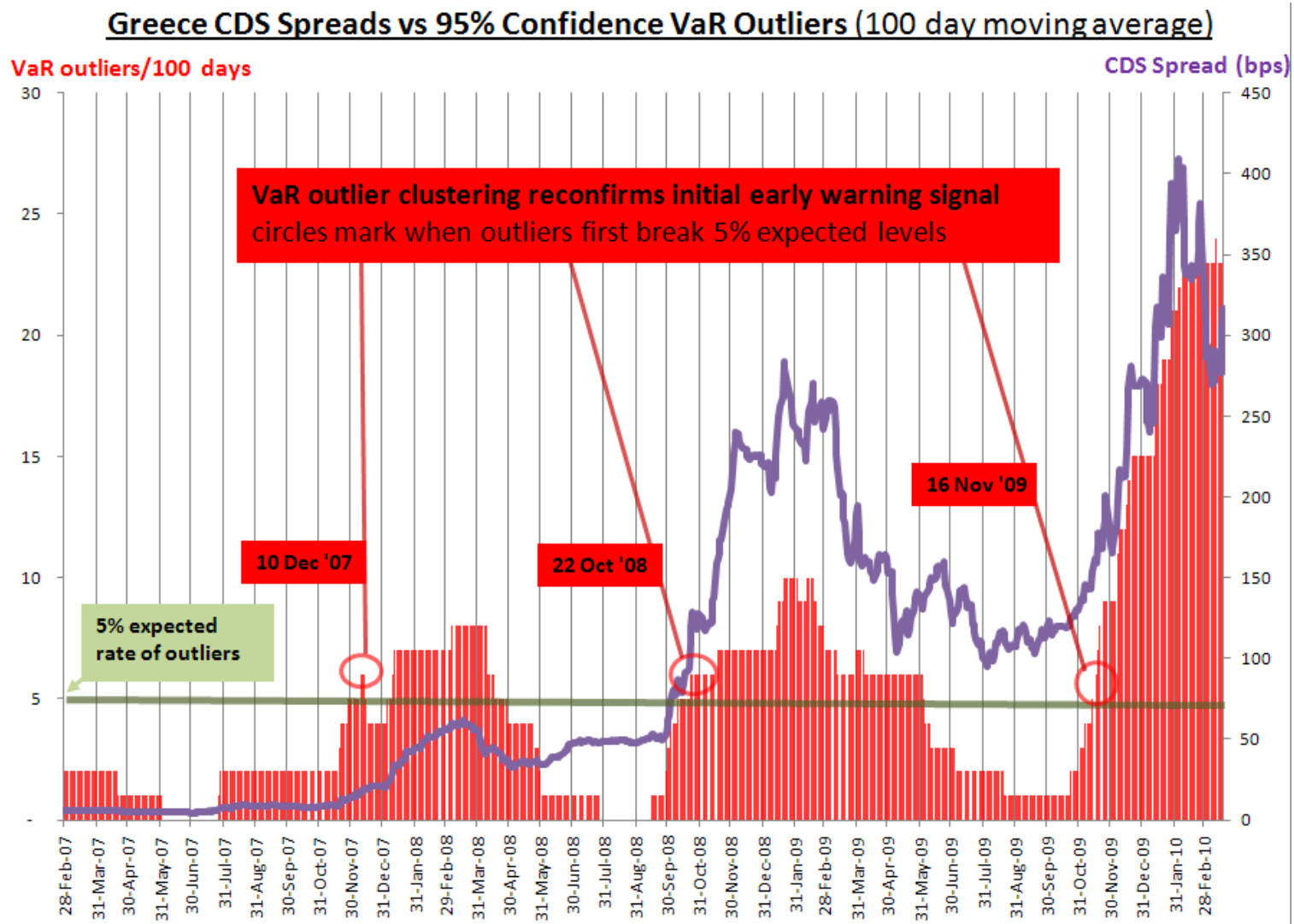
Outliers are key early warning signals

- Every wave of increasing spreads commenced with a 95% confidence daily VaR outlier and spike in volatility from relatively stable levels



Source: Alan Laubsch "Integrated Risk Management - Early Overview", 2011, RiskMetrics

Outlier clusters reconfirm early warning



Source: Alan Laubsch "Integrated Risk Management - Early Overview", 2011, RiskMetrics

Top ten DJIA outliers (1900 to 2008)

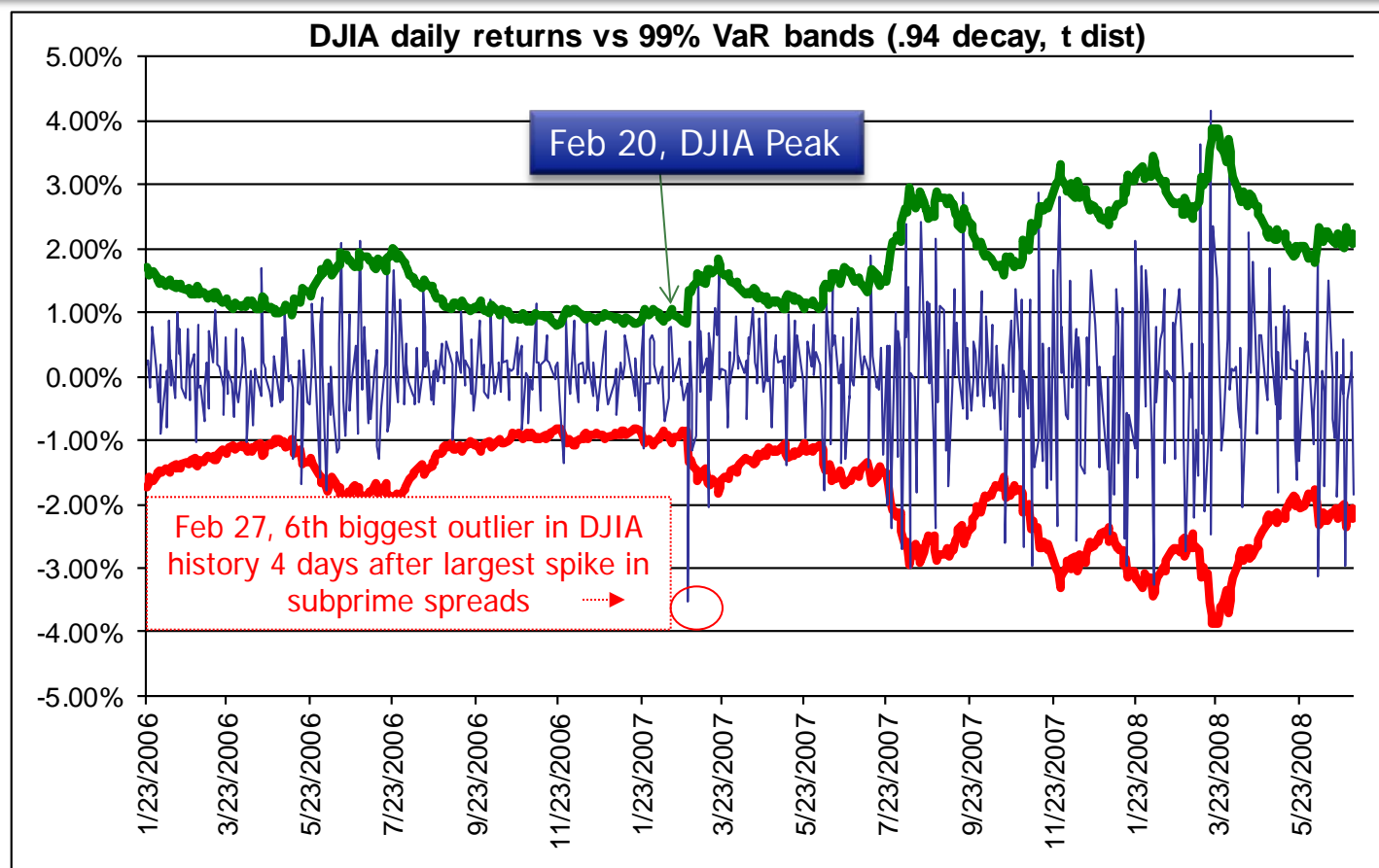
<u>Date</u>	<u>Residual</u>	<u>Return (%)</u>	<u>Volatility (%)</u>	<u>Comment</u>
26-Sep-1955	-13.3	-6.5	8.1	Eisenhower heart attack
19-Oct-1987	-12.6	-22.6	32.4	Black Monday
29-Jul-1927	-10.1	-5.2	8.3	? [May 13 German economy collapsed; rise of Hitler]
13-Oct-1989	-10.0	-6.9	11.4	Collapse of junk bond market
26-Jun-1950	-8.1	-4.7	9.3	Start of Korean War
27-Feb-2007	-7.8	-3.3	6.8	Beginning of subprime, China worries
20-Jan-1913	-7.0	-4.9	11.4	?
30-Jul-1914	-6.7	-6.9	16.9	NYSE about to close, WW1
28-Jul-1914	-6.7	-3.5	8.5	Austria's ultimatum to Serbia, war looming
15-Nov-1991	-6.6	-3.9	9.6	Program trading losses due to options/futures expiry

6th biggest outlier in history of DJIA 4 days after largest spike in AAA subprime... a tipping point in contagion

Source: Finger. Doomed to Repeat It? RiskMetrics Research Monthly (NOV 2008)

The biggest surprise of the entire GFC was the 7.8 sd move on Feb 27

Just one week after the DJIA's all time closing high, Feb 27 '07 outlier marks start of a slow motion subprime infection of equities: Markets resume rally to hit new highs in April '07 and only turn bearish after peaking in Oct '07. Abundant time to raise capital and liquidity.



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

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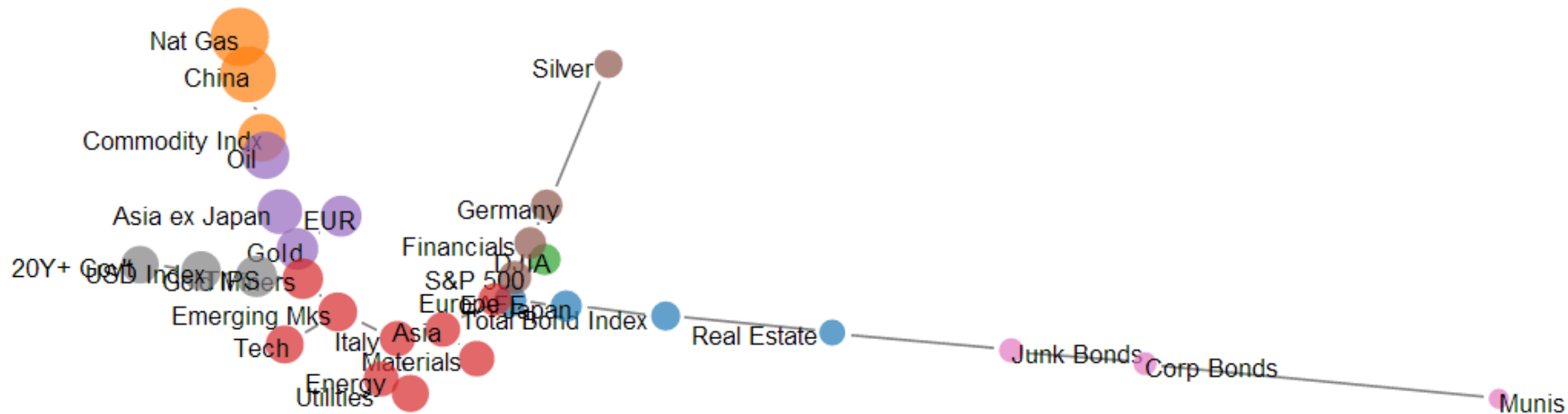
3. Lessons From Nature & Conclusions

Maps Reveal The Big Picture



See the Big Picture with Financial Cartography

1. Identifying cascading risks **before** critical points
2. Understanding dynamic **inter-connections**



[illegible]

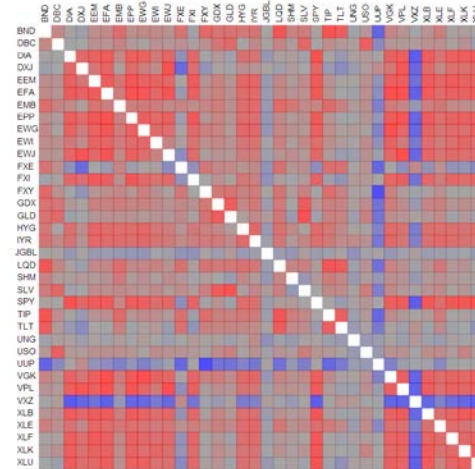
Commodities

Significant Correlations

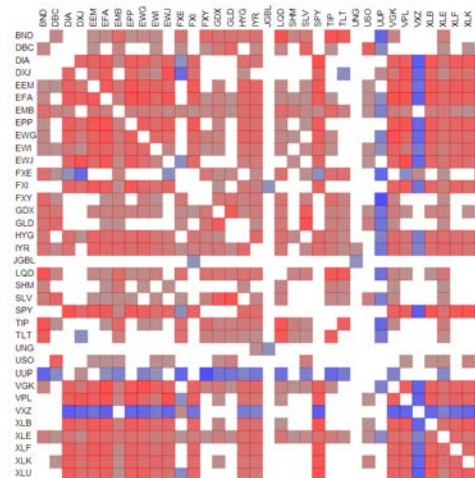
Common method to visualize large correlation matrices is via heat maps

Keep statistically significant correlations with 95% confidence level

Carry out 'Multiple comparison' - correction -> Expected error rate <5%



All correlations
(last 100 days)



Statistically
significant
correlations
(last 100 days)

Correlation Network

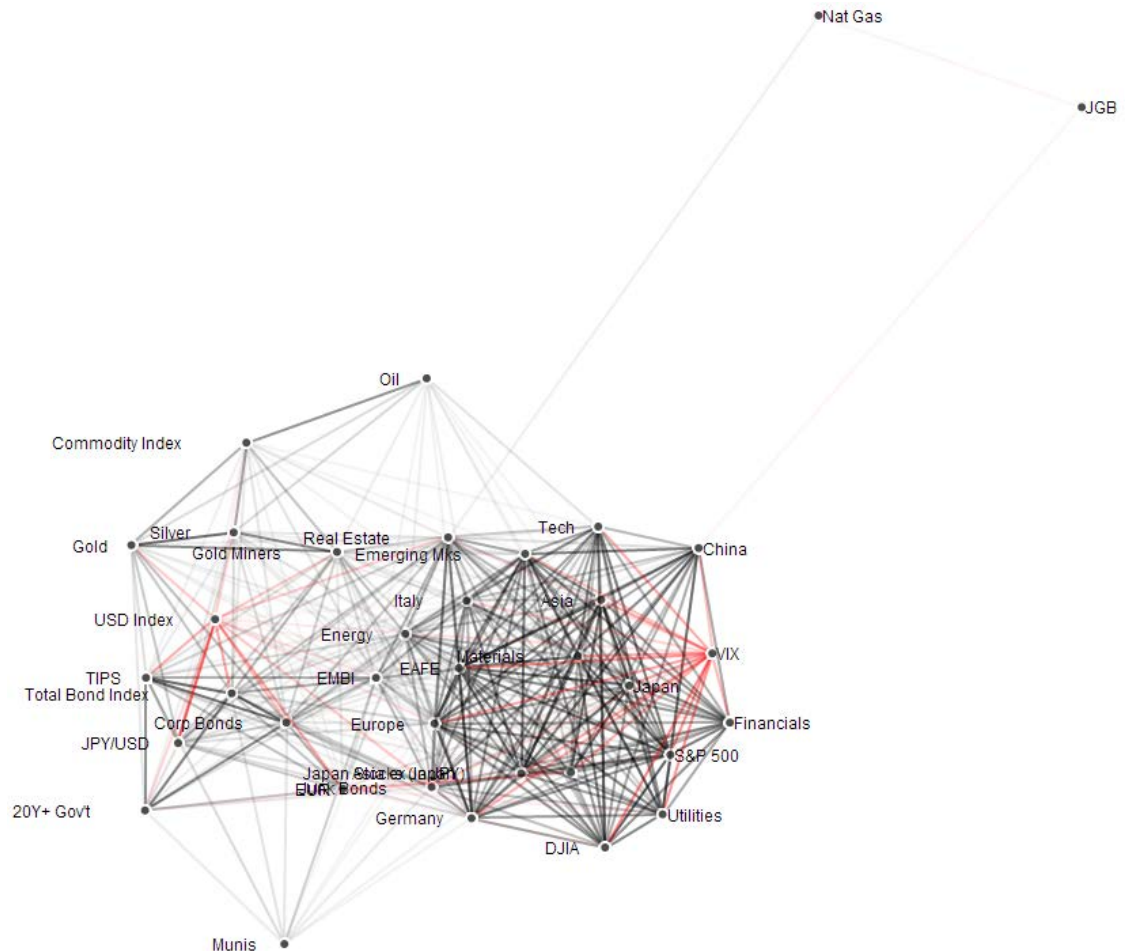
Nodes are assets

Links are correlations:

Red = negative

Black = positive

Absence of link marks
that asset is not
significantly correlated

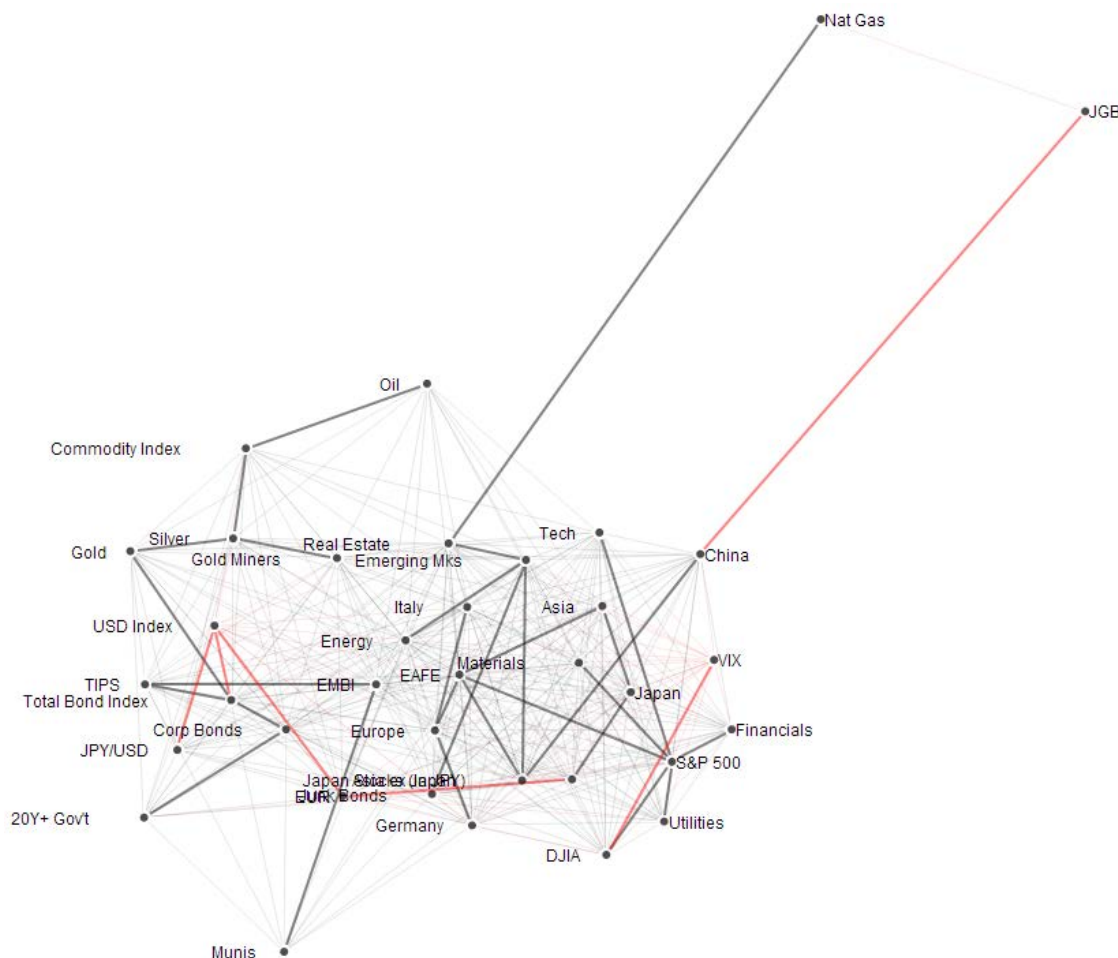


Hierarchical Structure in Financial Markets

Rosario Mantegna (1999):

"Obtain the taxonomy of a portfolio of stocks traded in a financial market by using the information of time series of stock prices only"

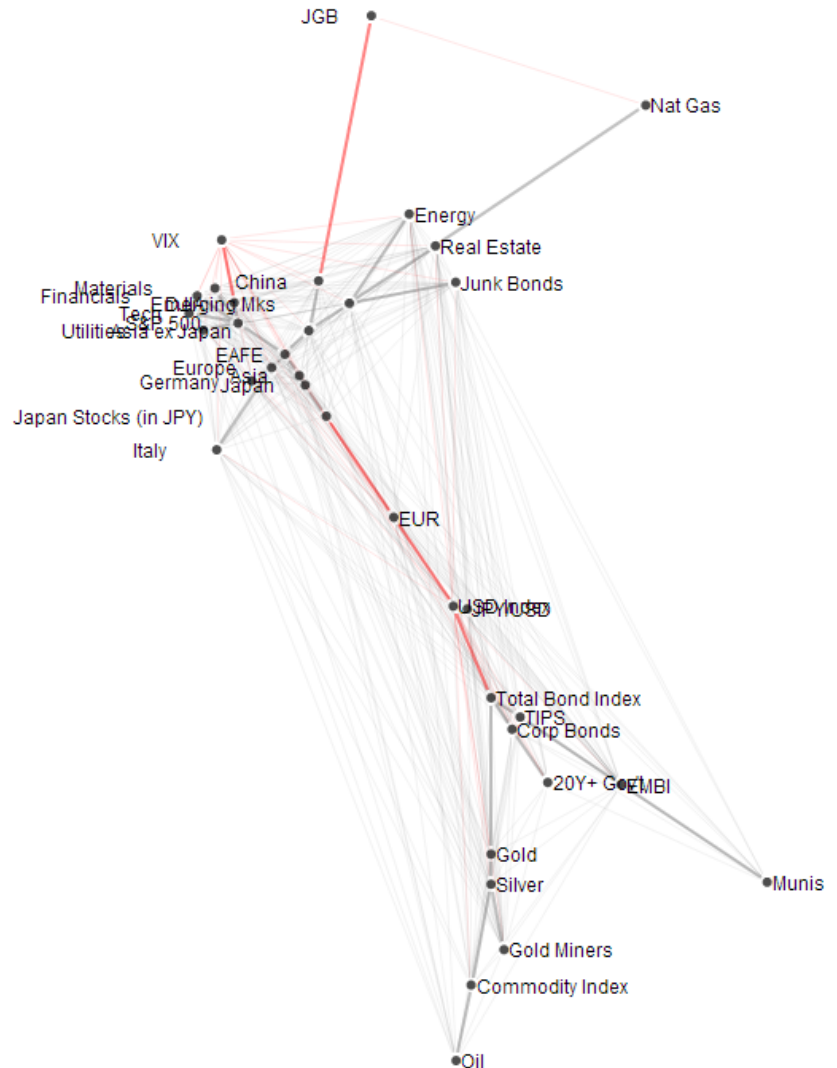
We use the Minimum Spanning Tree (MST) of the network to filter signal from noise.



Re-positioning the Assets

We lay out the assets by their hierarchical structure using Minimum Spanning Tree of the asset network.

Shorter links indicate higher correlations. Longer links indicate lower correlations.



Mapping Returns and Outliers

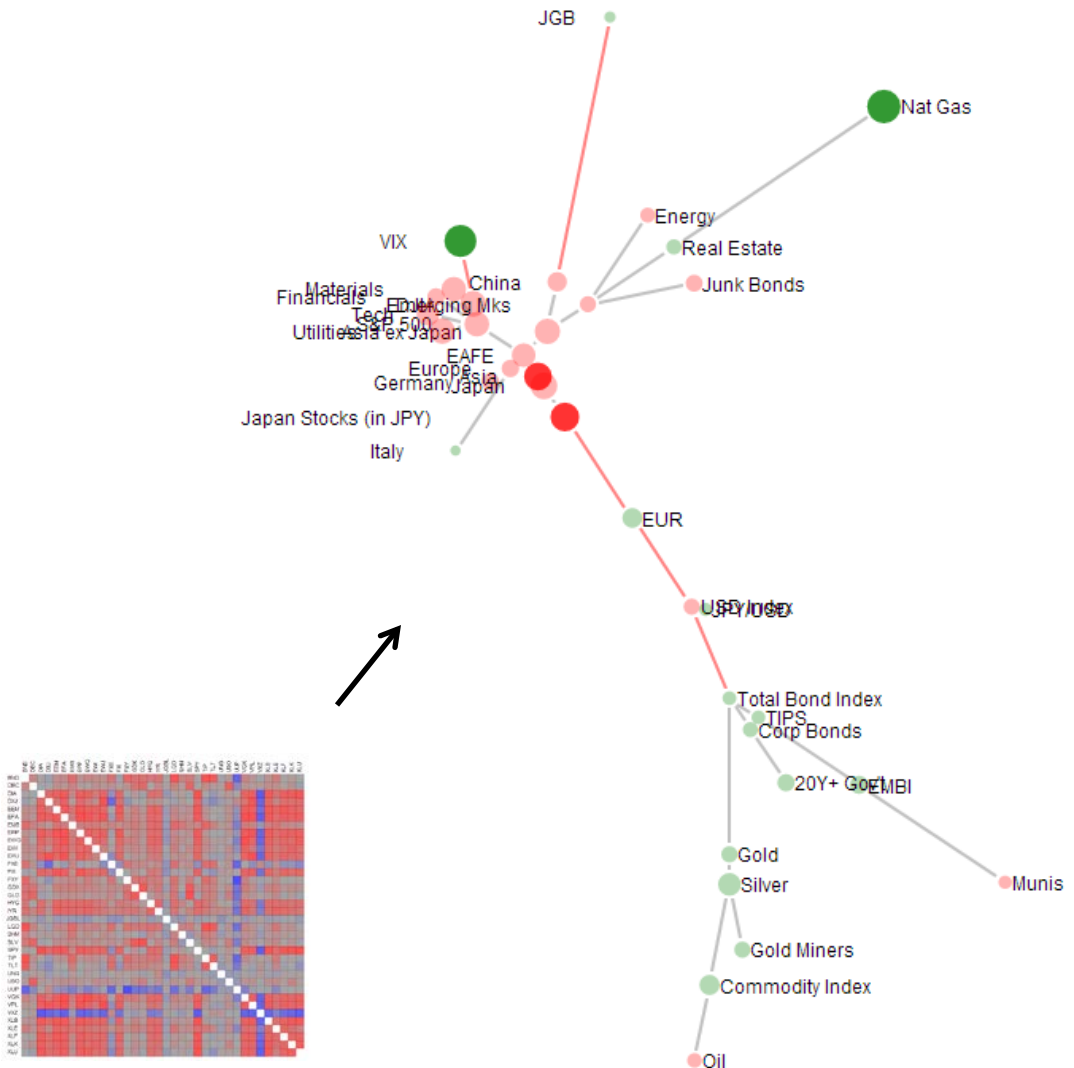
Network layout allows for the display of multiple dimensions of the same data set on a single map:

Node color indicates latest daily return

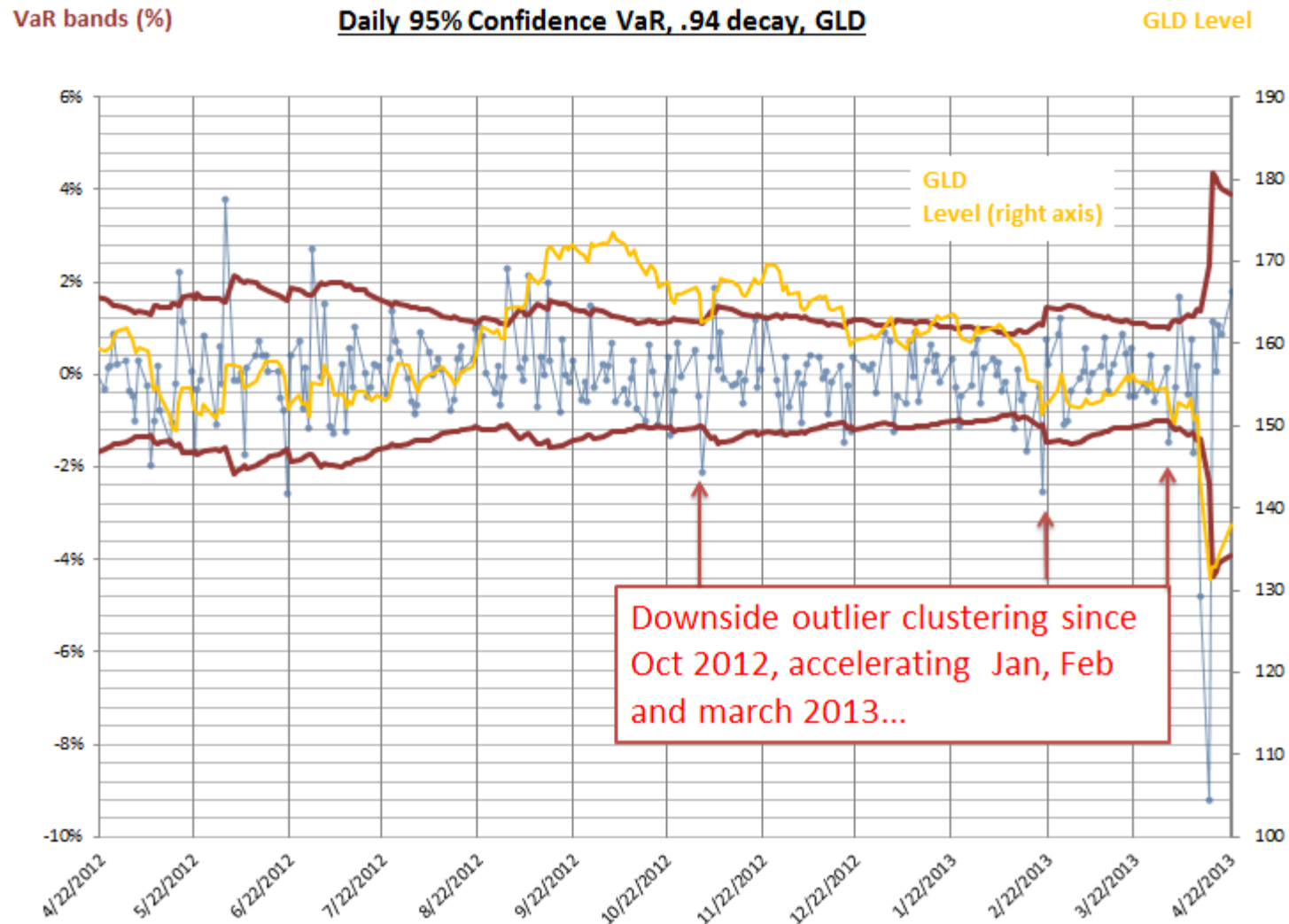
- Green = positive
- Red = negative

Node size indicates magnitude of return

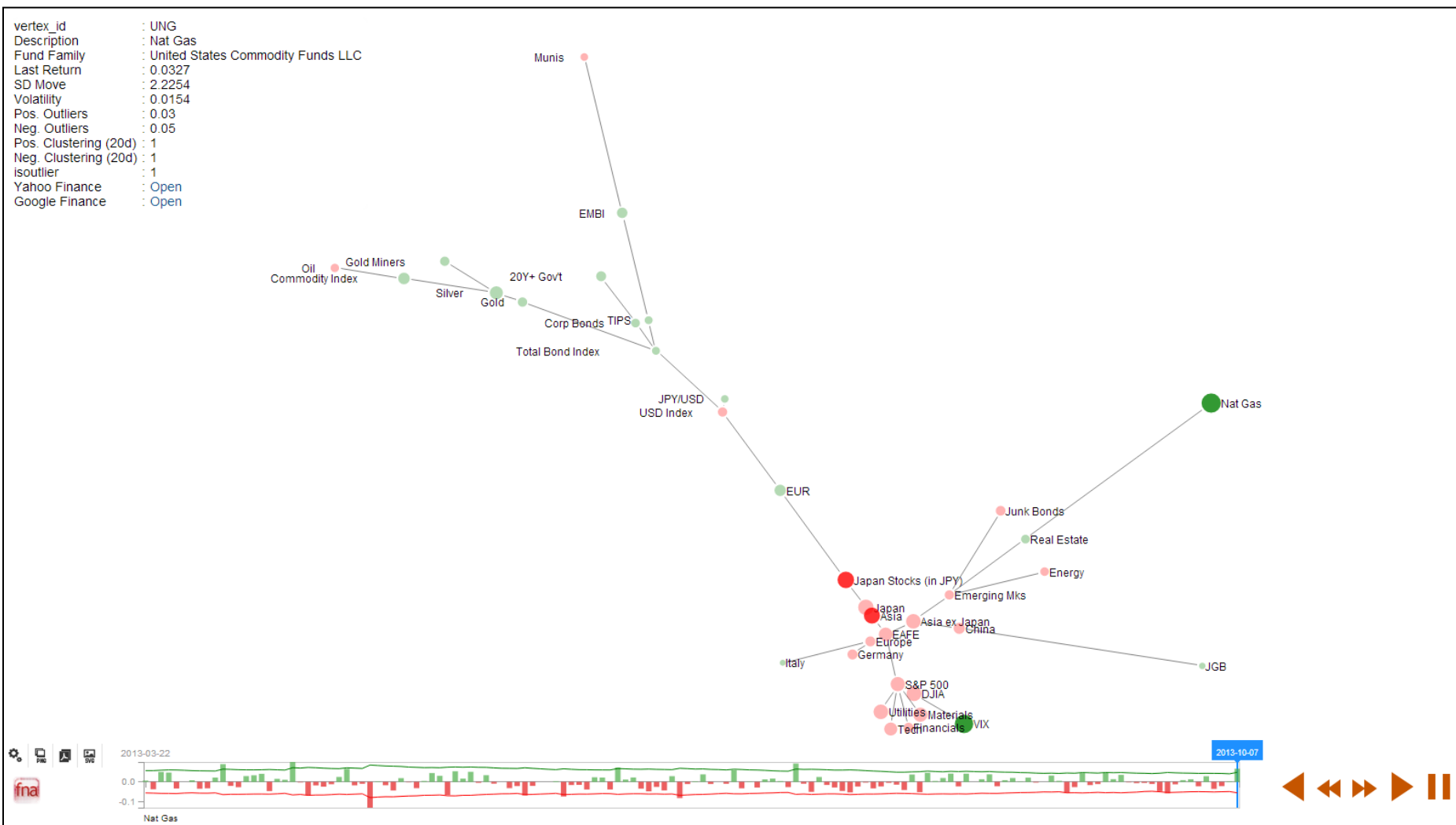
Bright green and red indicate an outlier return



Gold Early Warning Case study: downside outlier clustering

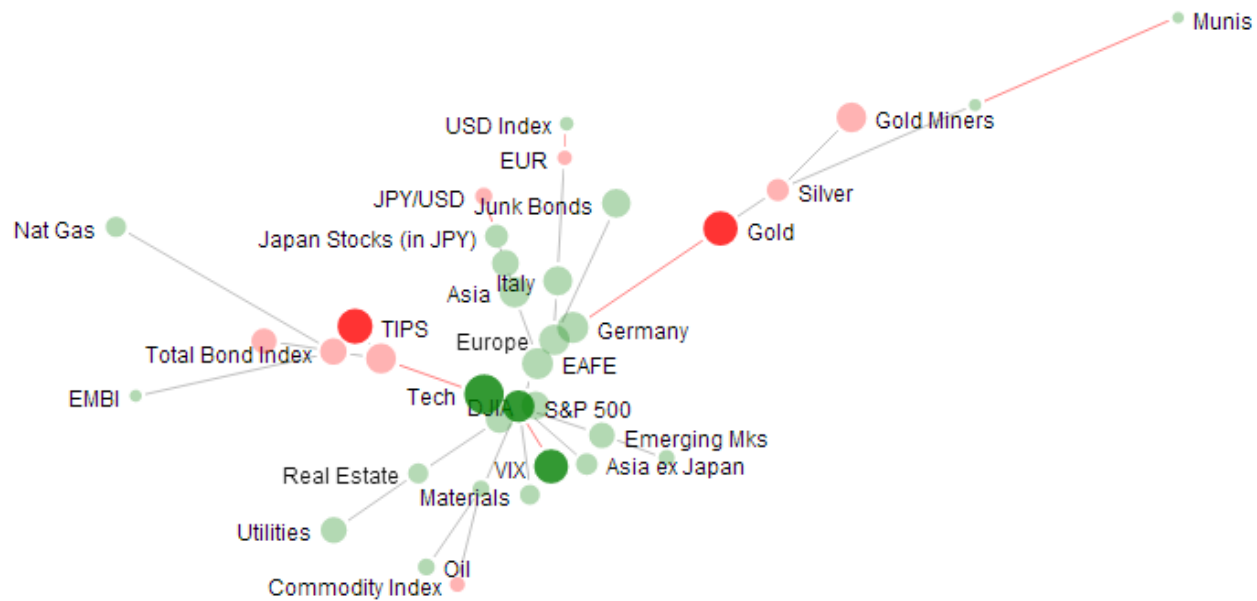


Stress Scenarios (Demo using www.heavytails.com)



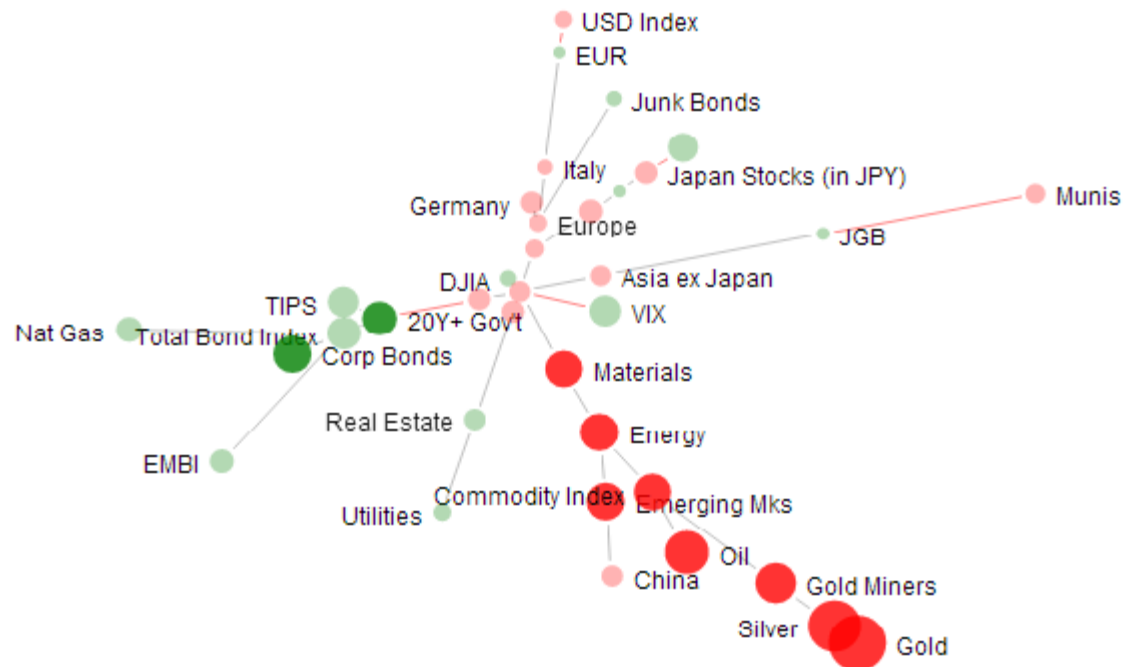
http://trunk.fna.fi/fna/data/heavytails/charts/public/heavytails_series.html

Aprils 10

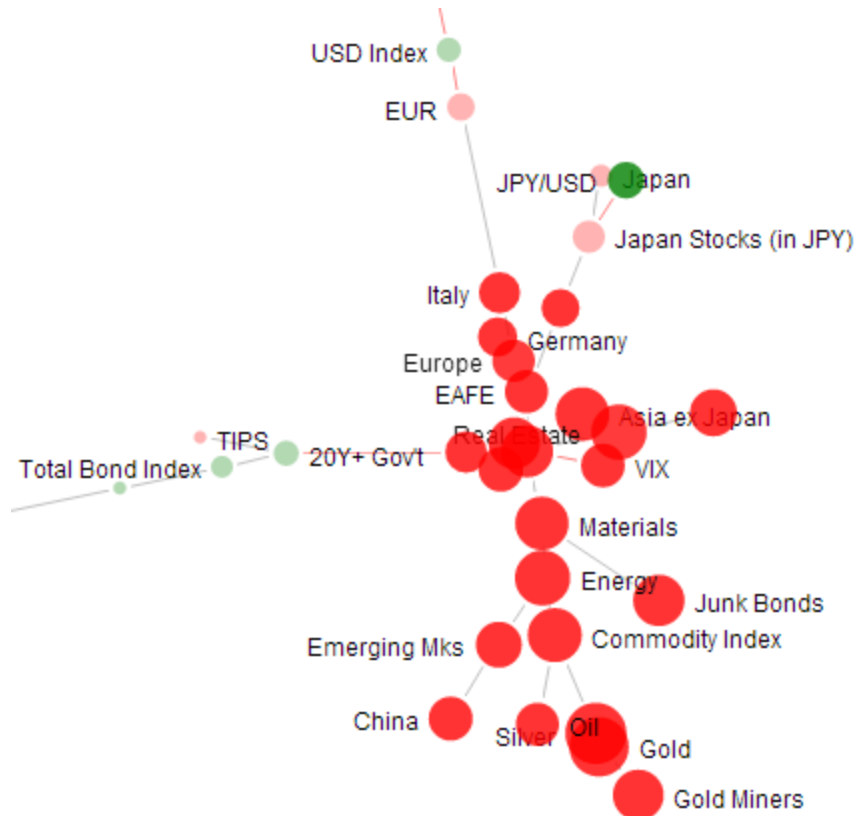


[Click for visualization](#)

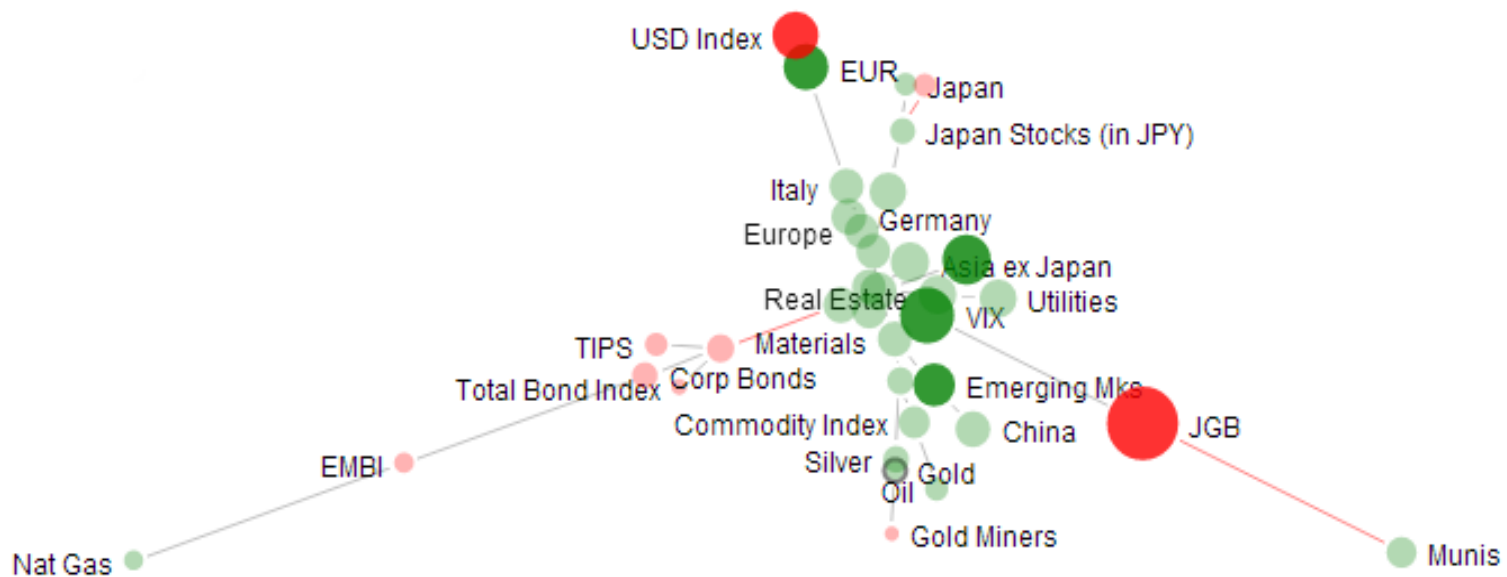
April 12



April 15



April 16: JGB -3.5sd residual



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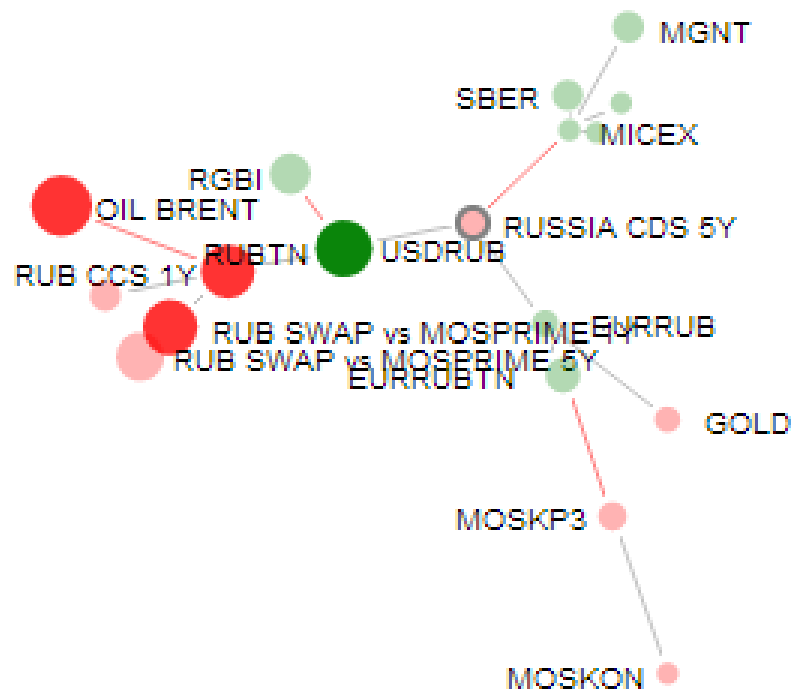
- HeavyTails™ for Russia

3. Lessons From Nature & Conclusions

Introducing Russia HeavyTails™

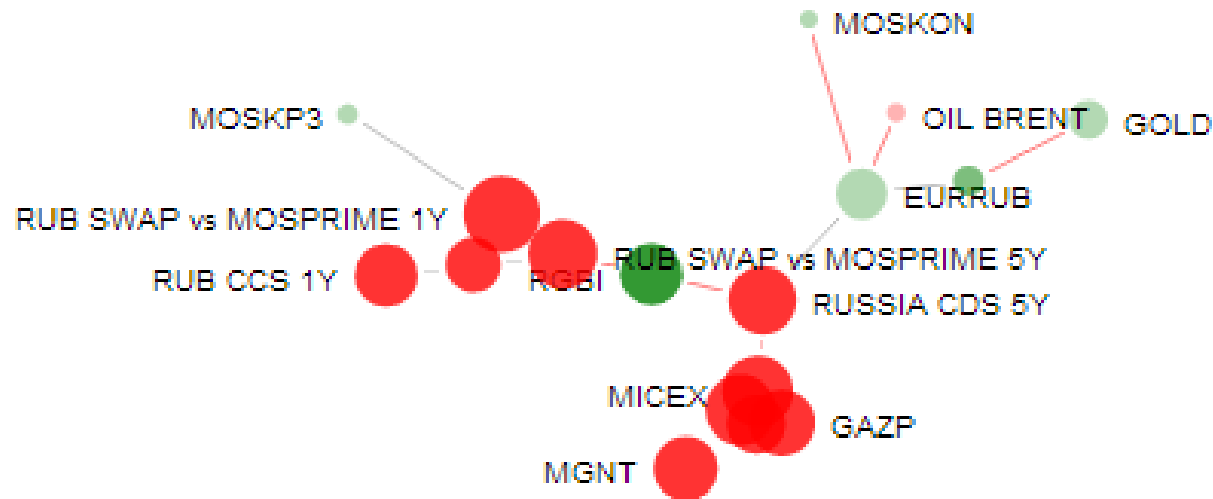
- Thank you to Sergey and his Prognoz team

http://trunk.fna.fi/fna/data/heavytails/charts/public/heavytails_russia_2011-2013.html



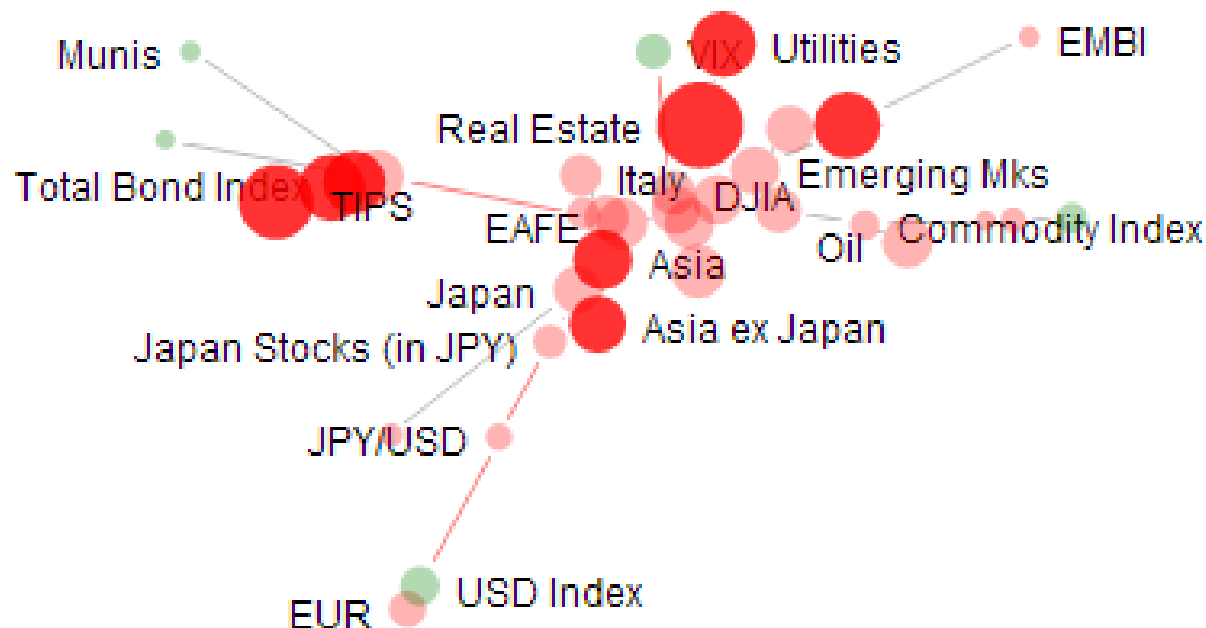
May 23 Russia

- Contagion to Russia
- 99% VaR excession for RUSSIA CDS: 2.4 sd move



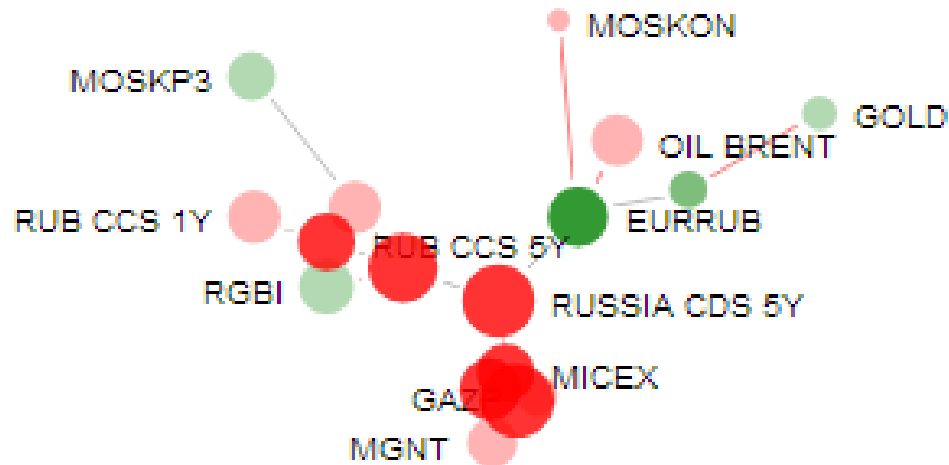
May 22 Global Markets

- Bad day for US bonds & real estate (-3sd)



May 29 Russia

- 2nd 99% VaR outlier for RUSSIA CDS 5Y (2.4sd)



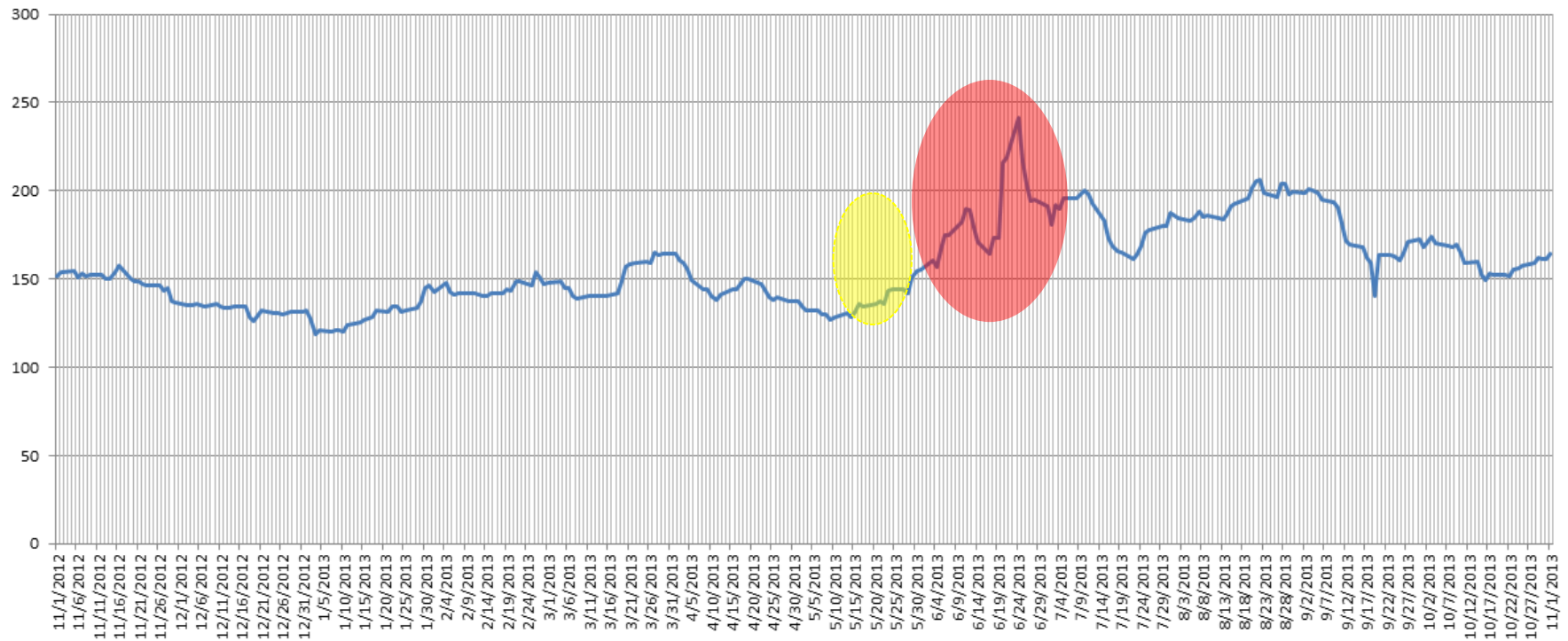
June 5 Russia

- 3rd 95% VaR outlier for RUSSIA CDS 5Y (2.2sd)



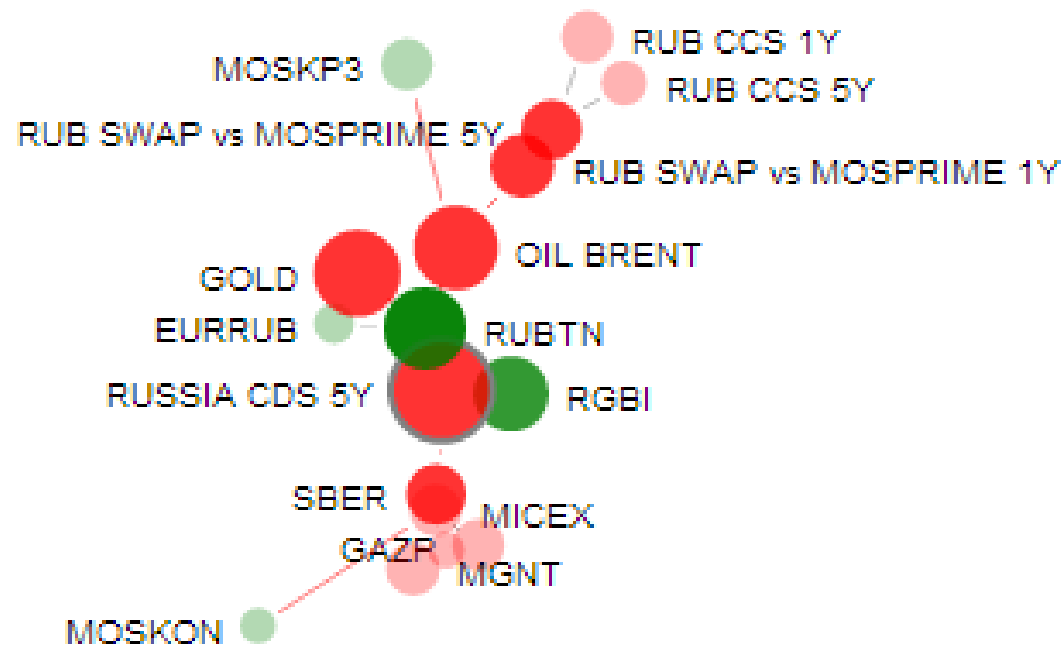
Russia 5Y CDS Early Warning Summar

- VaR Outlier Cluster May 23 & 29 & June 5
- Spreads peak June 24

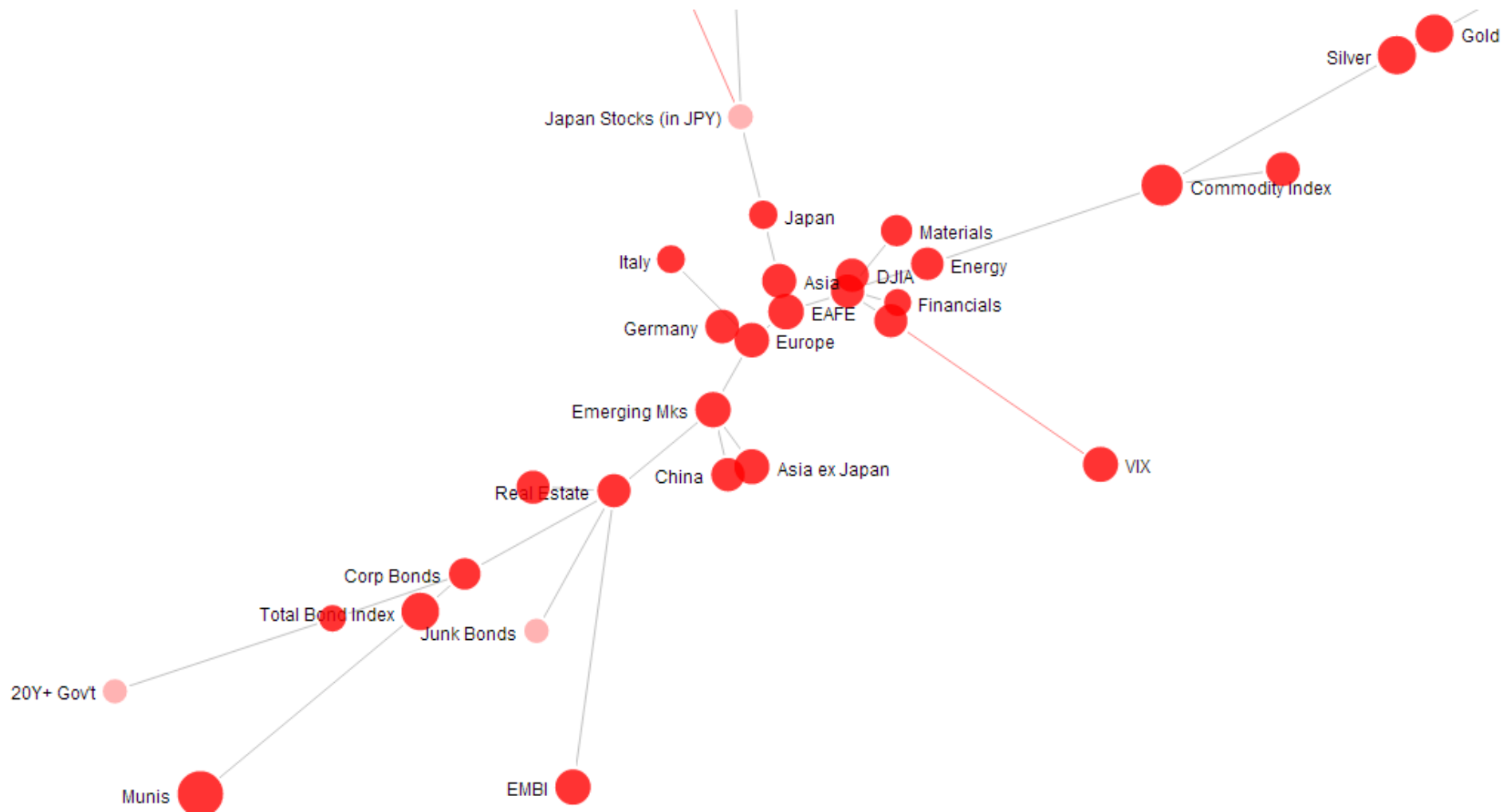


June 20 - Russia

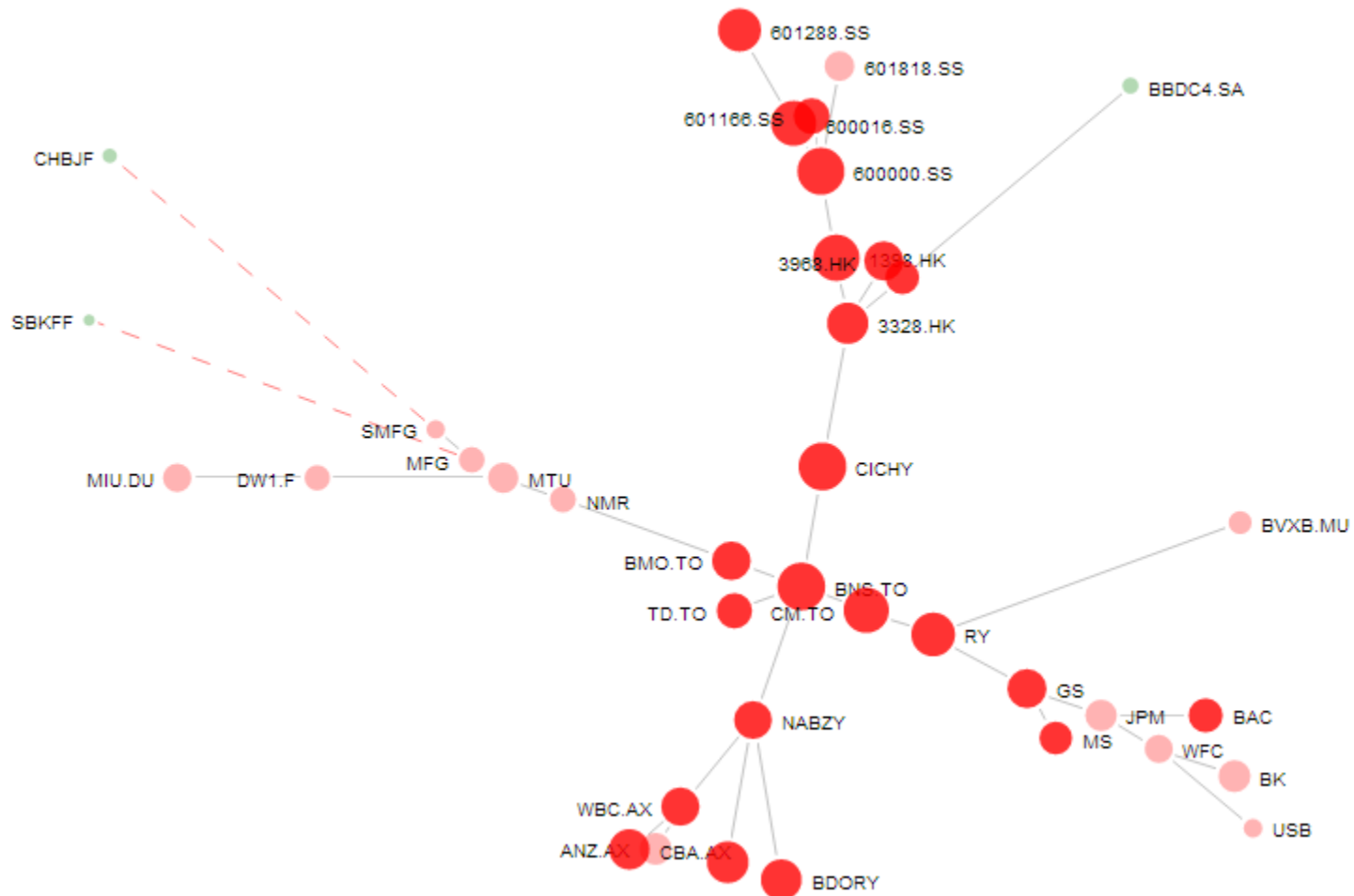
- Biggest Outlier for Russia CDS: 3.4SD



June 20 - ETF view: tapering fears



June 20 - Global Banks



Summary: sense and respond to emerging risks

- Use algorithms, visualization, and human intelligence to detect signals amidst noise (e.g., super-exponential rates of change)
- Model a credible sequence of shocks from key nodes into the rest of the network
- Keep your eyes open to the periphery, which is often the source of disruptive innovation and information

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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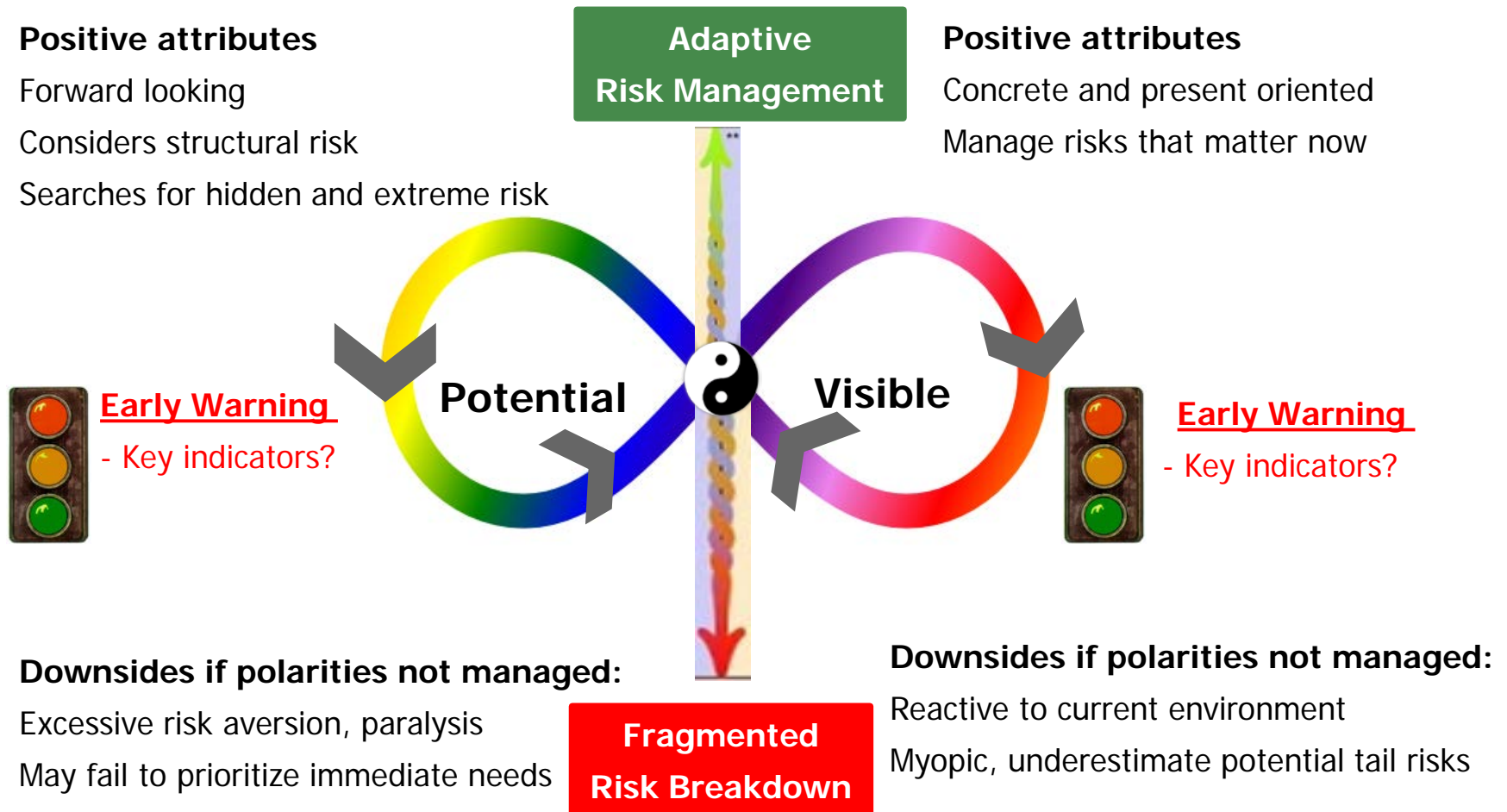
- HeavyTails™ for Russia

3. Lessons From Nature & Conclusions

Evolutionary lessons from nature

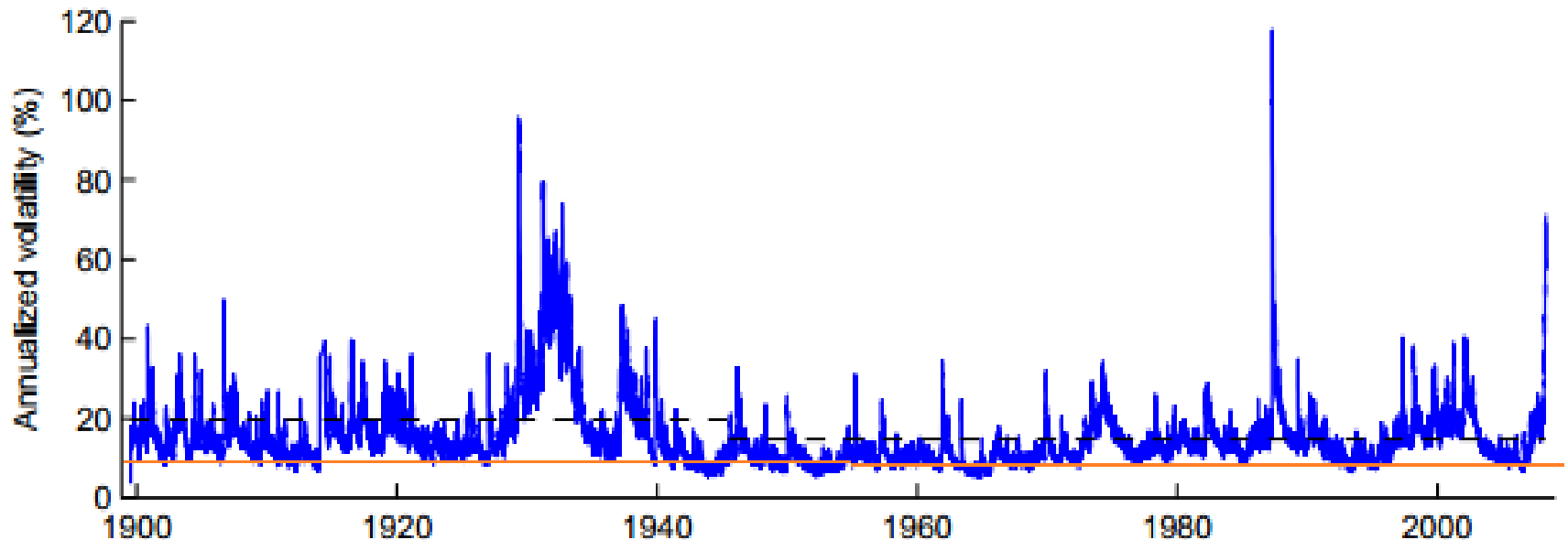
- Outcomes reflect **compounding feedback loops** which create virtuous cycles or death spirals (“Rethinking capitalism,” Nick Hanauer and Eric Liu, 2012)
- Evolution is powered by **polarities**
- Nature recycles. It learns to use everything.

Potential vs Visible risk



Volatility is dynamic, non-linear, and cyclical

- 15-20% annual volatility for DJIA



Christopher Finger, RiskMetrics Group, (2008)

Stability breeds Instability (Hyman Minsky)

Don't minimize volatility. Learn and grow from it.

The Value of Risk

- We learn from volatility (J-curve effect)
- Stressors strengthen systems (Antifragile, Taleb 2012)



The Danger of Stability

“When the range of natural variation in a system is reduced, the system loses resilience.” (Holling & Meffe, 1995).



Collectively, we focus too much on measuring visible risks while ignoring the potential risk of monocultured global systems

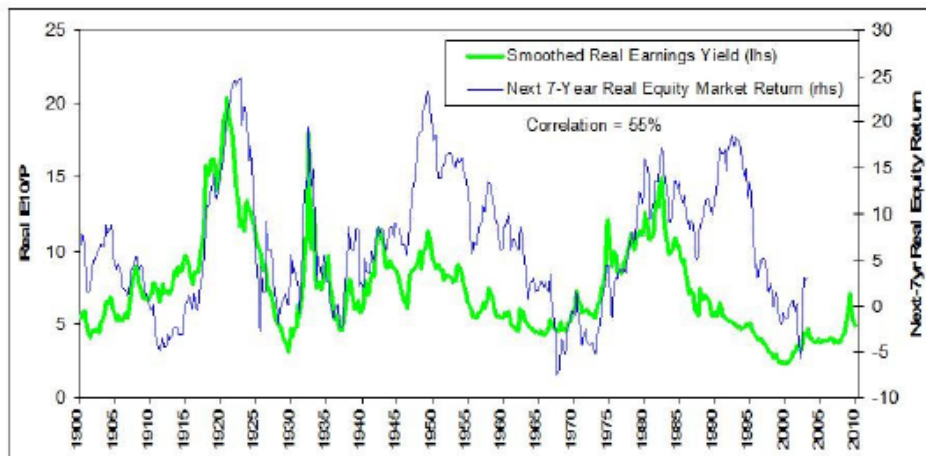


Implications of highly coupled global risks

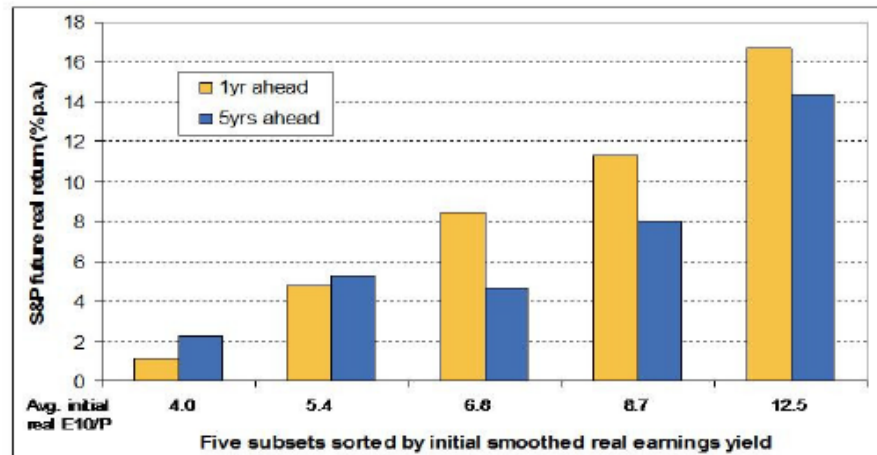
Prepare for breakdowns, respond rapidly to mitigate worst effects

Investment Strategy: contribute to decoupling through long term profitable contrarian strategies

Equity markets: Time varying reward for risk



Future equity returns are higher when market's starting valuations are cheap, 1900-2009

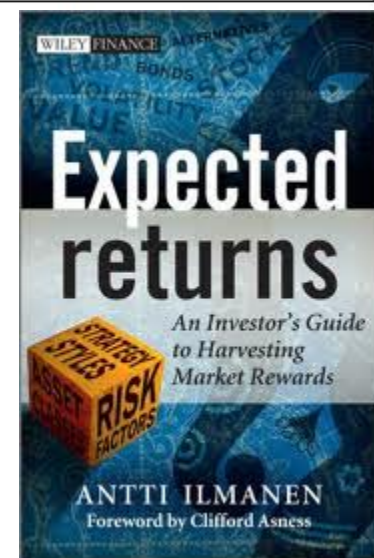


Charts: Anti Ilmanen →

“The (future) reward for risk may be at the highest when the market sentiment for risk taking is at the lowest”

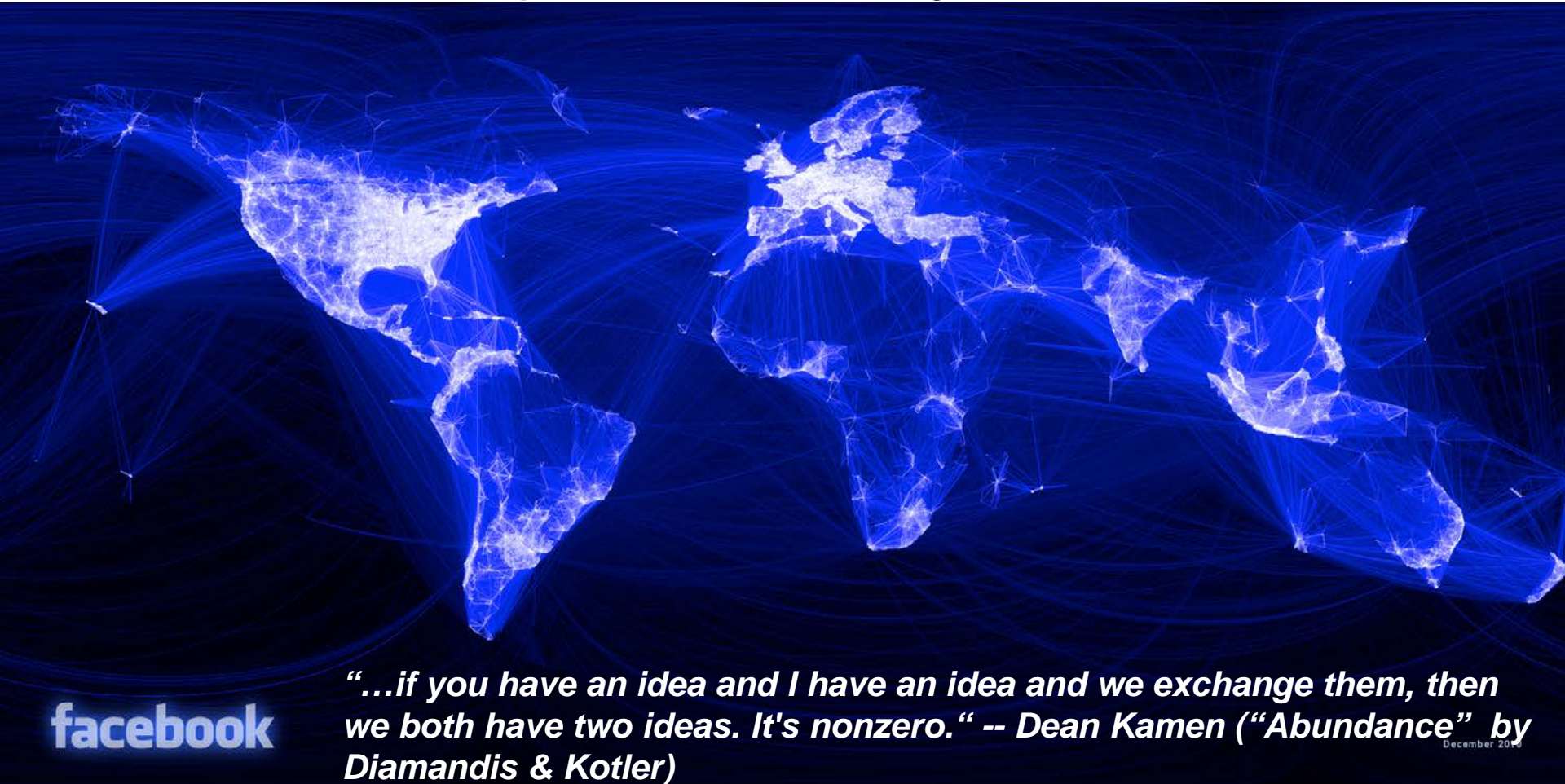
“The biggest pitfall in investments is herd behavior. Large gains in performance can be achieved by investors with ability to consistently act contrarian”

Source: Knut N Kjaer, “New Ideas on Future Portfolio Design”, 4 May 2011



The Sharing Economy: Global Network Intelligence

- Build collaboration platforms to exchange risk information



facebook graph of social relationships

Maps are great mass collaboration platforms



Conclusions

- Early detection and adaptation is crucial for managing systemic risks, which affect us all
- Visualization, and especially social maps can help us better navigate risks
- Spark Global Network Intelligence

Thank You

Please join our “Emerging Stress Themes” community on LinkedIn

Email us for discounts on the [PRMIA Adaptive Stress Testing](#) online course

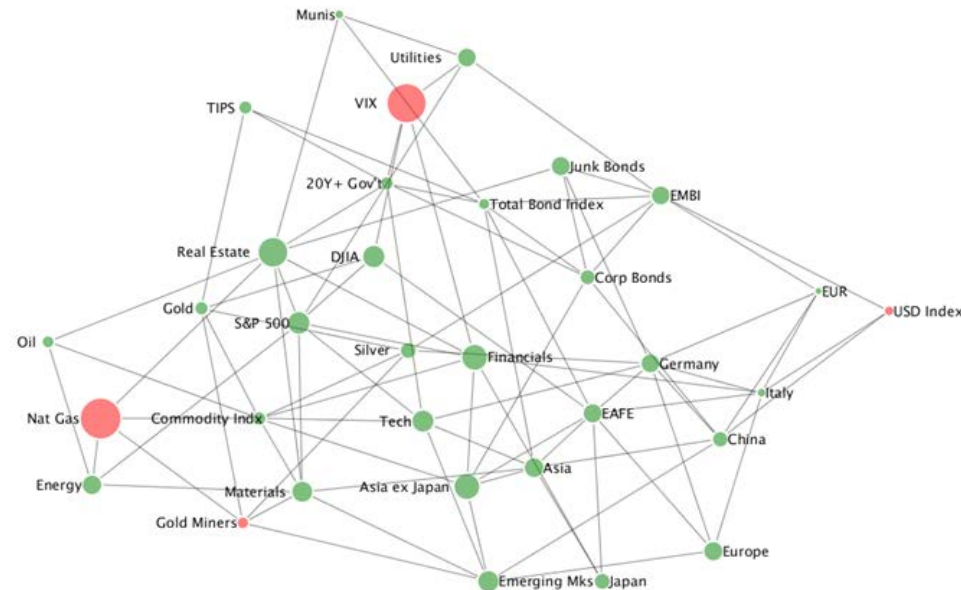
Free beta trial of HeavyTails™ for Russia Risk Conference Attendees

Stress Testing a Portfolio - Opening up the Black Box

Partial correlation measures the degree of association between two random variables, controlling for other variables

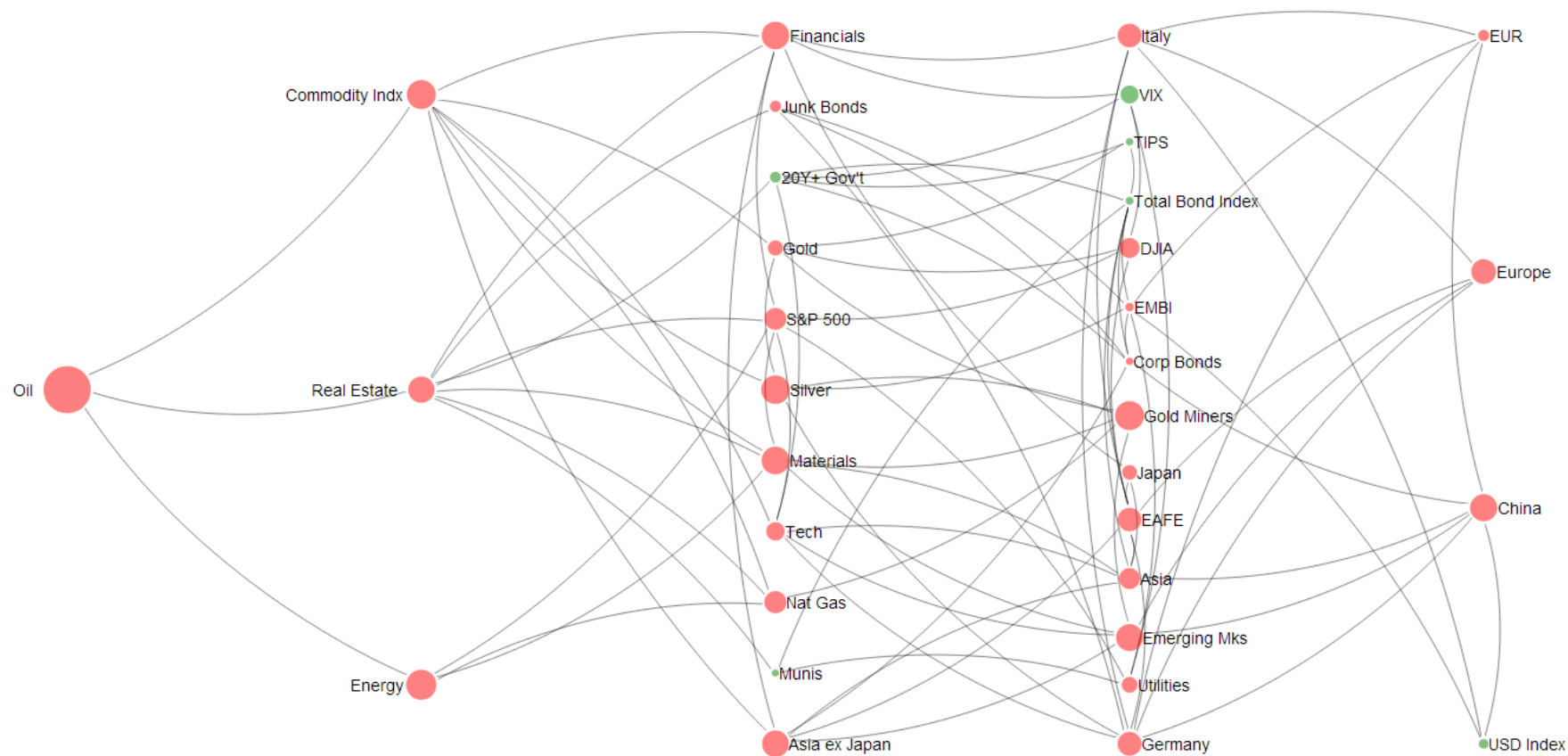
Network of statistically significant partial correlations of daily returns for a wide set of ETFs during 2009-2013

- link = partial correlation
- green node = positive return
- red node = negative return
- node size scales with absolute return



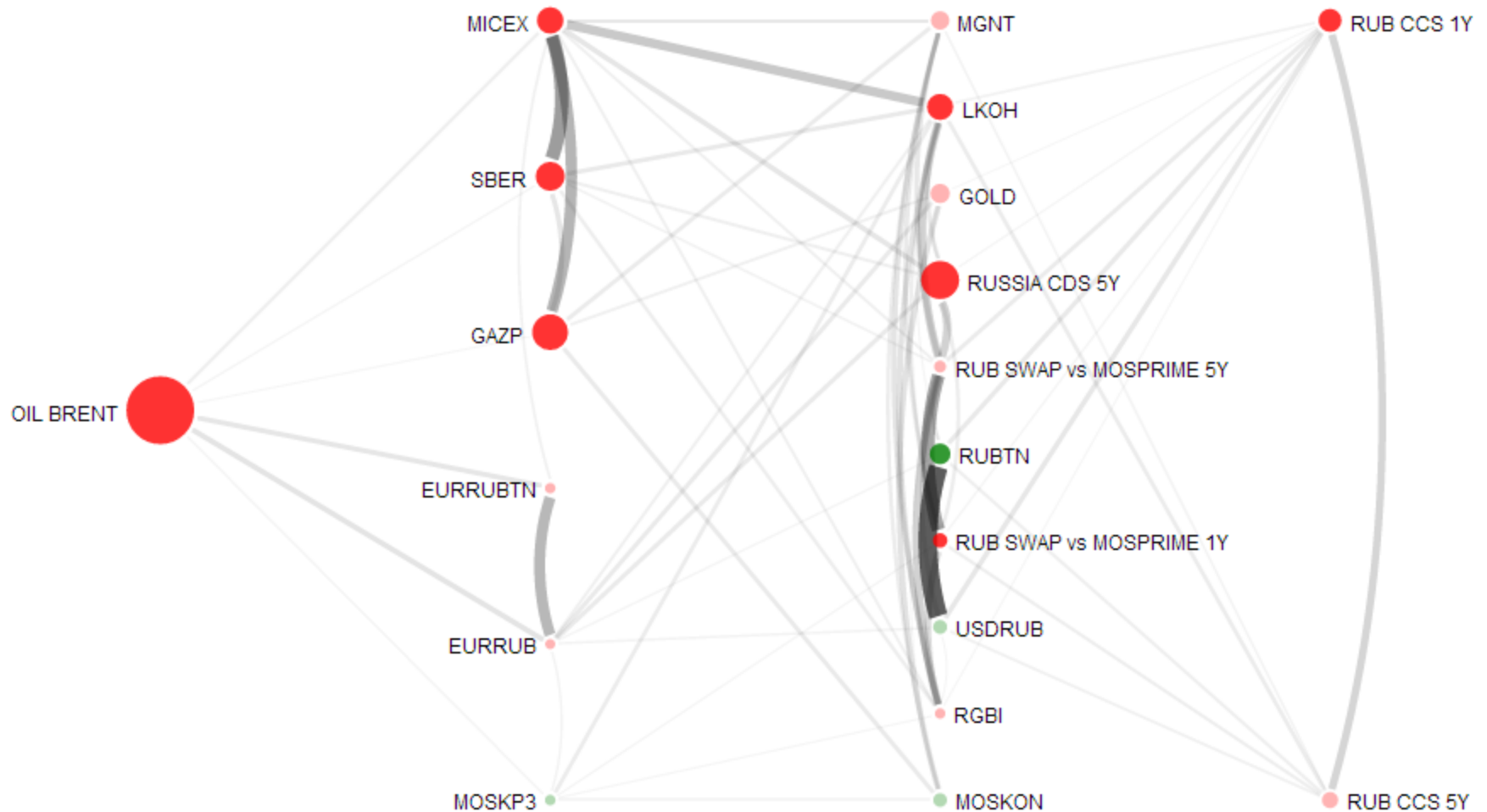
We can use the partial correlations to understand linkages within a standard portfolio stress test model

Network of an Oil Shock



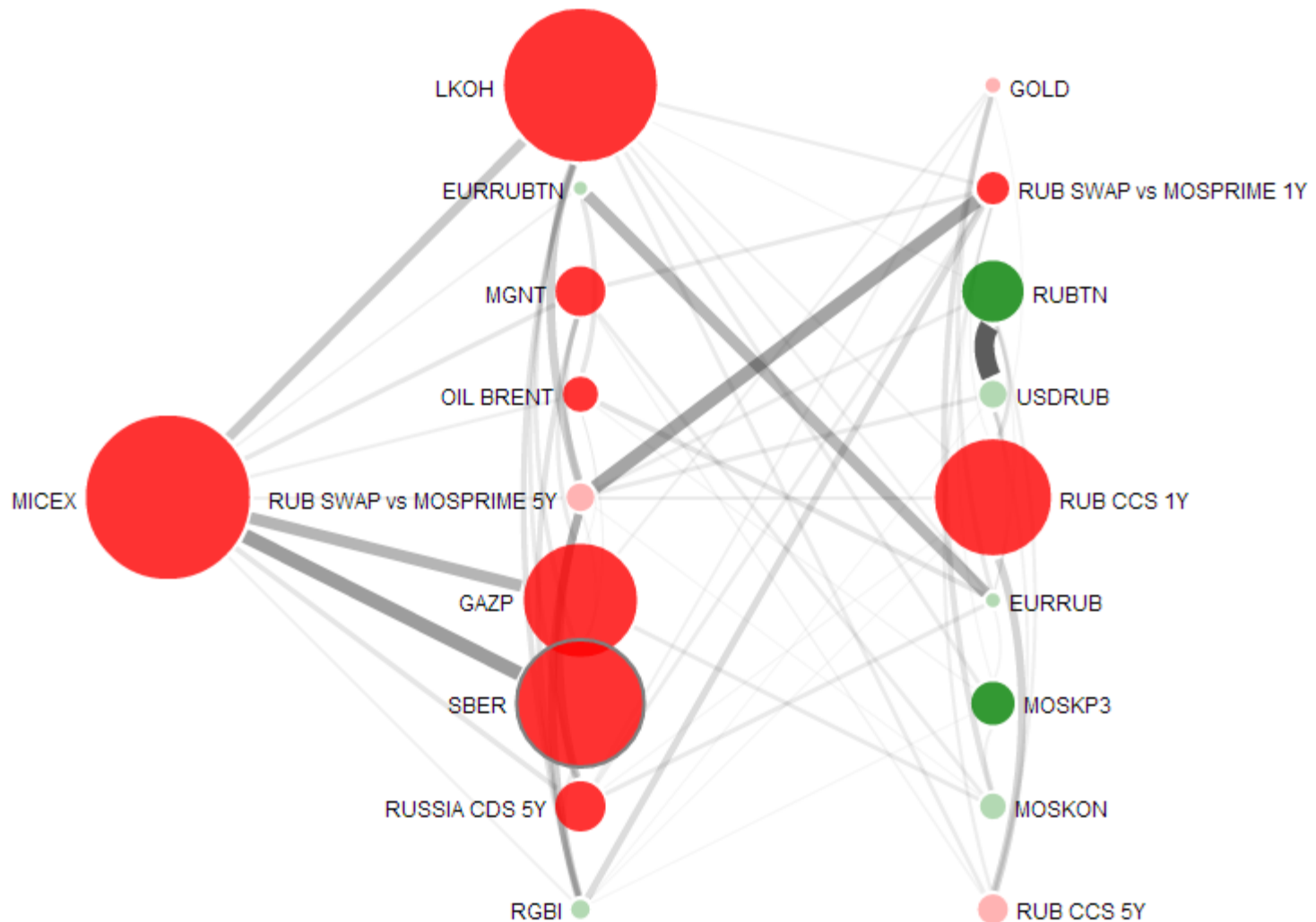
<http://www.fna.fi/demos/erm/cascade-oil-01.html>

Oil shock impact on Russian Markets



[Click for visualization](#)

Impact of 10% MICEX on Russian Assets



[Click for visualization](#)