A Survey of Systemic Risk Measures

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What Is Systemic Risk?

- Financial stability is a public good
- No single consensus definition (yet)
- This is one of the reasons for the OFR
- We must define what a "systemic event" is
  - "Any set of circumstances that threatens the stability of or public confidence in the financial system"?
  - LTCM vs. Amaranth, 10/19/87 vs. 5/6/10, failure of regional bank vs. money market fund
- Four "L"s: Liquidity, Leverage, Linkages, Losses
- Can we gauge the likelihood of such events?

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What Is Systemic Risk?

Some General Observations

- No single measure is likely to be sufficient
- Existing measures may become obsolete (Lucas)
- New measures will need to be developed
- Research capability is critical
- Operational challenges are significant
  - LEI initiative; data collection, store, and maintenance; confidentiality and accessibility; relationship with regulators and industry; etc.

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Survey of Systemic Risk Measures

Over 30 Measures Surveyed

- Contents:

1. Introduction
2. Supervisory Perspective
3. Research Perspective
4. Data Issues
5. Conclusions

Appendix

A. Macroeconomic Measures
B. Granular Foundations and Network Measures
C. Forward-Looking Risk Measurement
D. Stress Tests
E. Cross-Sectional Measures
F. Measures of Illiquidity and Insolvency
G. Matlab Program Headers

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Survey of Systemic Risk Measures

Over 30 Measures Surveyed

- Matlab functions:
  - delta_co_var
  - quantile_regression
  - co_risk
  - turbulence
  - turbulence_var
  - marginal_expected_shortfall
  - leverage
  - systemic_expected_shortfall
  - contrarian_trading_strategy
  - kyles_lambda
  - systemic_liquidity_indicator
  - probability_liquidation_model
  - crowded_trades
  - cca
  - distressed_insurance_premium
  - credit_funding_shock
  - pca
  - linear_granger_causality
  - hac_regression
  - dynamic_causality_index
  - dijkstra
  - calc_closeness
  - network_measures
  - absorption_ratio
  - dar
  - undirected_banking_linkages
  - directed_banking_linkages
  - optimal_gap_thresholds
  - joint_gap_indicators
  - stress_scenario_selection
  - fit_ar_model
  - systemic_risk_exposures

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Survey of Systemic Risk Measures

Four Different Taxonomies:

- Supervisory Taxonomy:

Systemic Risk Measure	Section
Microprudential Measures—Securities and Commodities:	
Crowded Trades in Currency Funds	F.4
Equity Market Illiquidity	F.5
Serial Correlation and Illiquidity in Hedge Fund Returns	F.6
Broader Hedge-Fund-Based Systemic Risk Measures	F.7
Microprudential Measures—Banking and Housing:	
Network Analysis and Systemic Financial Linkages	B.2
Simulating a Credit Scenario	B.3
Simulating a Credit-and-Funding-Shock Scenario	B.4
Bank Funding Risk and Shock Transmission	B.6
The Option iPoD	C.3
Multivariate Density Estimators	C.4
Simulating the Housing Sector	C.5
Consumer Credit	C.6
Lessons from the SCAP	D.2
A 10-by-10-by-10 Approach	D.3
Distressed Insurance Premium	E.2
Microprudential Measures—Insurance and Pensions:	
Granger-Causality Networks	B.5
Mark-to-Market Accounting and Liquidity Pricing	B.7

Systemic Risk Measure	Section
Microprudential Measures—General Applications:	
The Default Intensity Model	B.1
Contingent Claims Analysis	C.1
Mahalanobis Distance	C.2
CoVaR	E.1
Co-Risk	E.3
Marginal and Systemic Expected Shortfall	E.4
Risk Topography	F.1
The Leverage Cycle	F.2
Macroprudential Measures:	
Costly Asset-Price Boom/Bust Cycles	A.1
Property-Price, Equity-Price, and Credit-Gap Indicators	A.2
Macroprudential Regulation	A.3
Principal Components Analysis	C.7
GDP Stress Tests	D.1
Noise as Information for Illiquidity	F.3

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Survey of Systemic Risk Measures

Four Different Taxonomies:

- Data-Requirements Taxonomy
- Supervisory Taxonomy
- Event/Decision Time Horizon Taxonomy
- Research Taxonomy

Three Distinct Perspectives:

- Supervisory
- Research
- Data (yesterday's sessions)

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Supervisory Perspective

Issues Surrounding Systemic Risk Supervision

- Financial trends have increased the challenges
- Nonstationarities can make regulation obsolete
- The Lucas critique must be addressed
- Regulators have highly asymmetric Type-I/II payoffs
- Supervision occurs by institution, not by market
- Political considerations always matter
- In this environment, neutral experts are invaluable
- The example of the NTSB and the OFR mandate

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Research Perspective

Consider the Following Basic Framework:

$$\text{Prob}\,(\,E_t \,|\, \mathbf{R}_{t-1}, \mathbf{X}_{t-1}, \mathbf{R}_{t-2}, \mathbf{X}_{t-2}, \ldots) \;\equiv\; \text{Pre-Event Distribution}$$

$$\text{Prob}\,(\,\mathbf{R}_t, \mathbf{X}_t \,|\, E_{t-1}\,) \;\equiv\; \text{Post-Event Distribution}$$

$$\text{Prob}\,(\,\mathbf{R}_t, \mathbf{X}_t, E_t\,) \;\equiv\; \text{Contemporaneous Disbribution}$$

- E_t denotes "systemic event", R_t is asset returns, X_t is economic state variables
- Vacuous without additional structure
  - Cross-sectional measures: CoVaR, Co-Risk, SES
  - Forward-looking measures: Mahalanobis distance
  - Illiquidity/insolvency: risk topography, autocorrelation
  - Network measures: Granger-causality, absorption ratio

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Research Perspective

Topics for Ongoing Research:

- Legal entity identifiers are a critical pre-requisite
- Accurate and comprehensive data are also necessary
- Stationarity will be problematic, especially here
- Institutions and market conditions change over time
- New econometric methods will be needed
  - Time-varying parameters, regime shifts, hidden Markov models, structural breaks, model selection, exponential weighting, etc.

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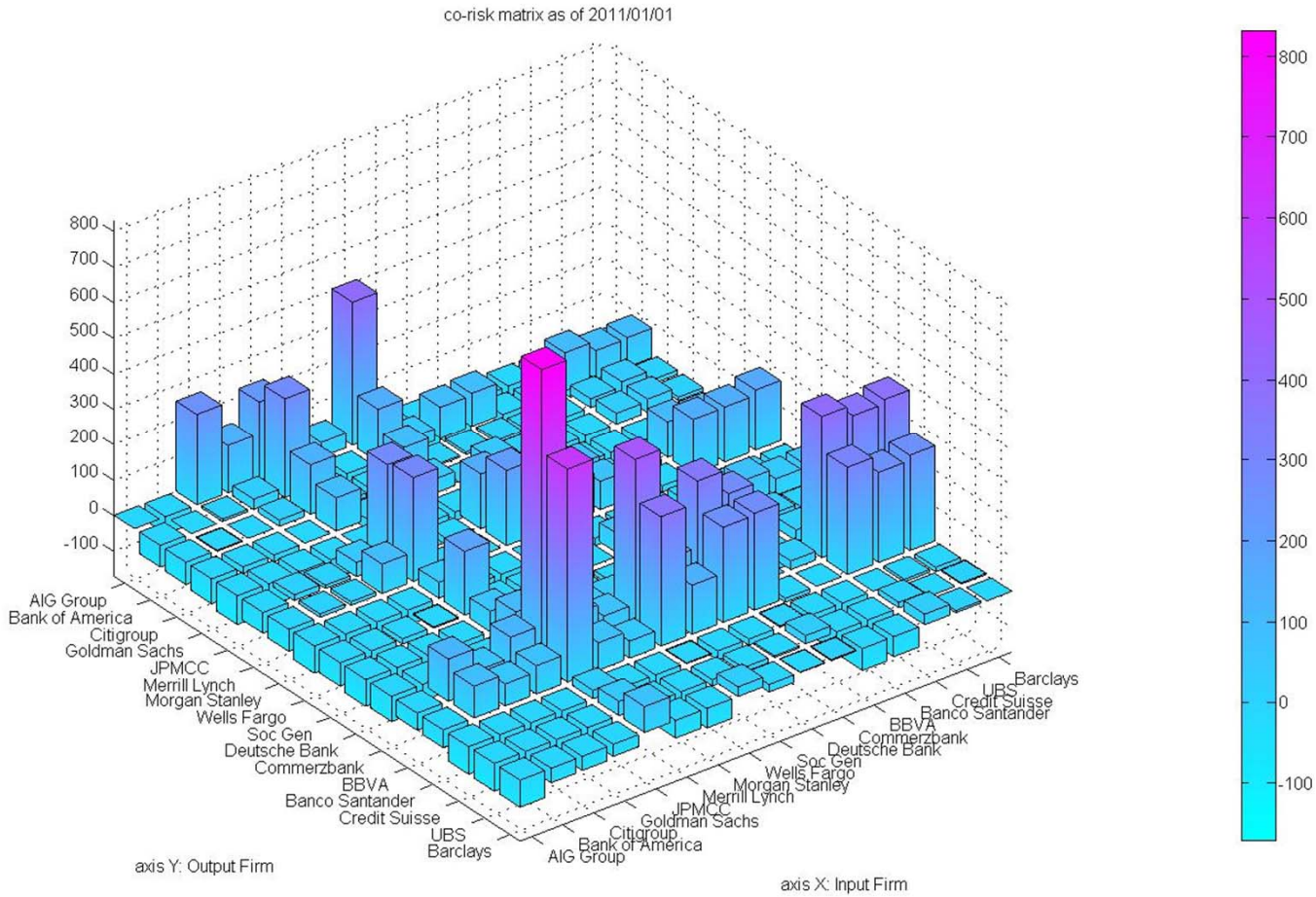
Cross-Sectional Measures

Co-Risk (E.3, IMF, 2009):



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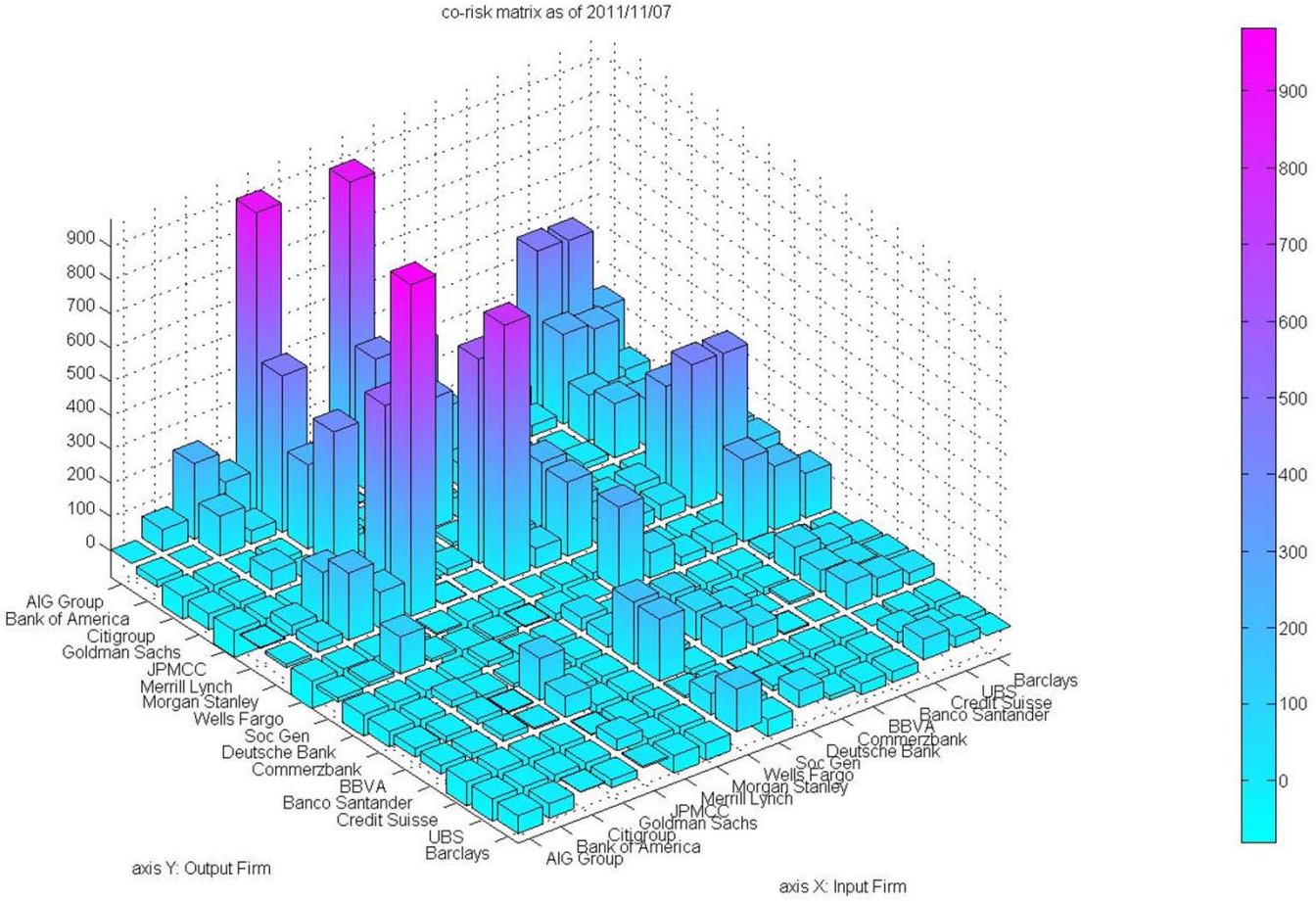

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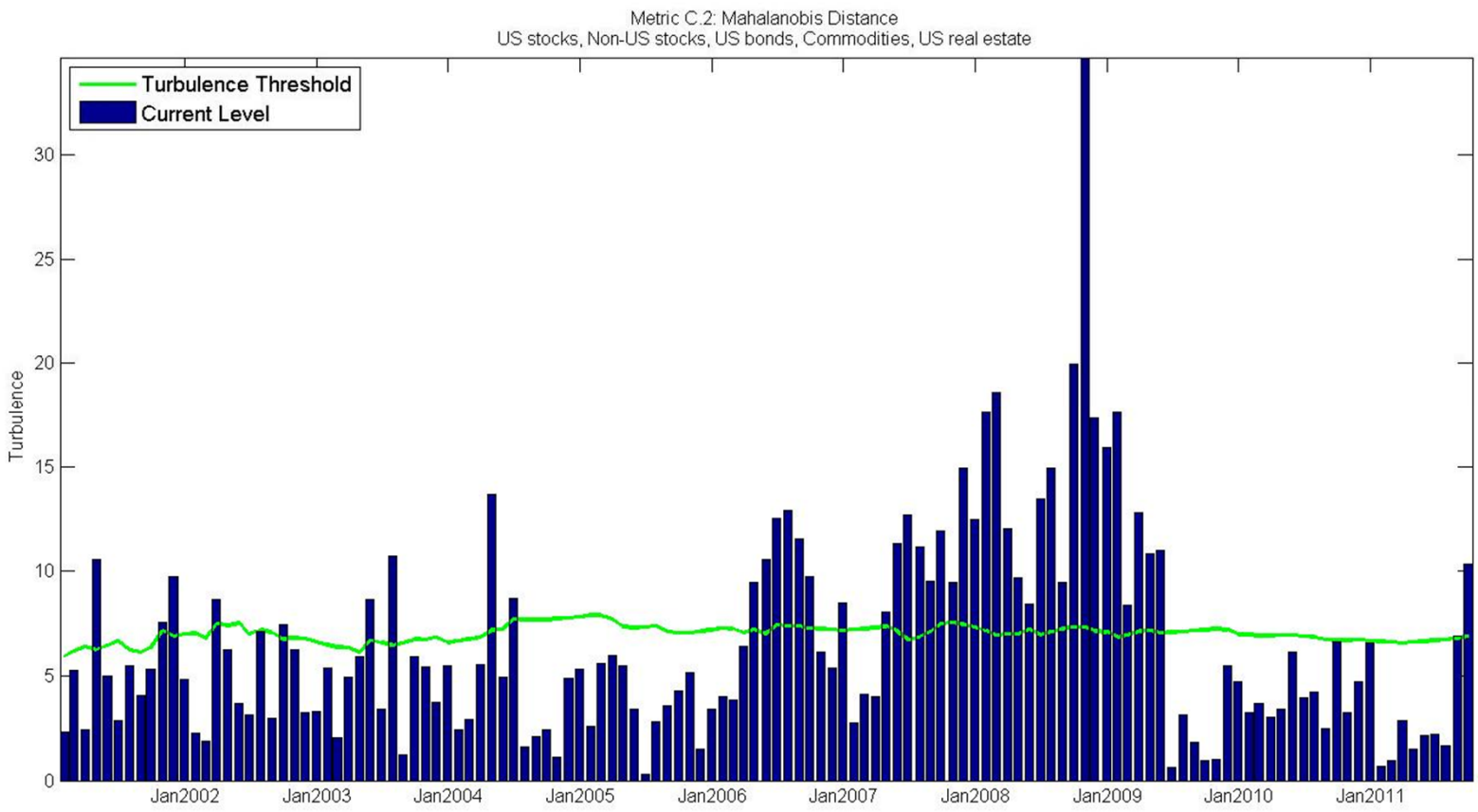
Forward-Looking Measures

Mahalanobis Distance (C.2, Kritzman and Li, 2010):



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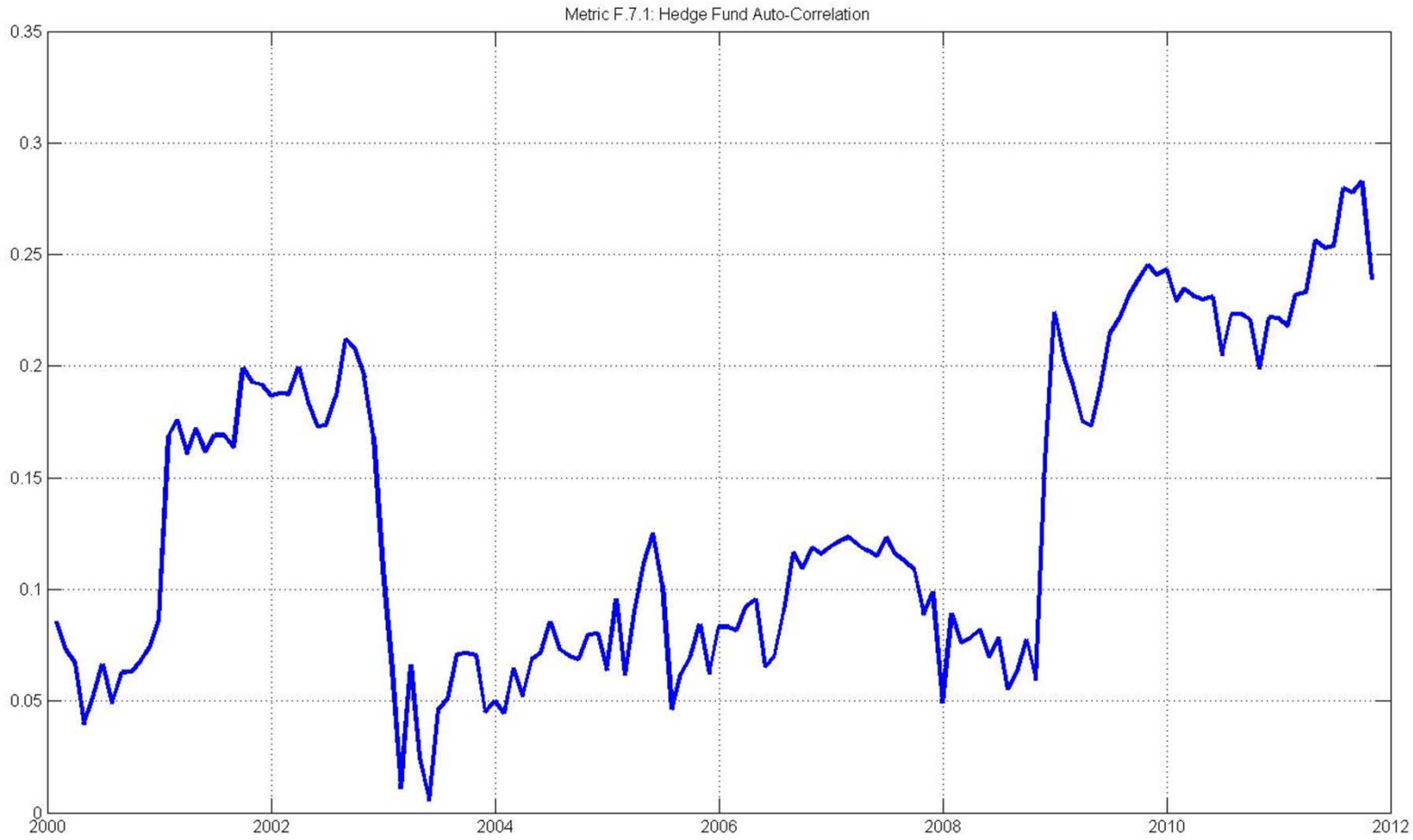
Illiquidity Measures

Asset-Weighted HF Autocorrelation (F.7, Chan et al., 2006):



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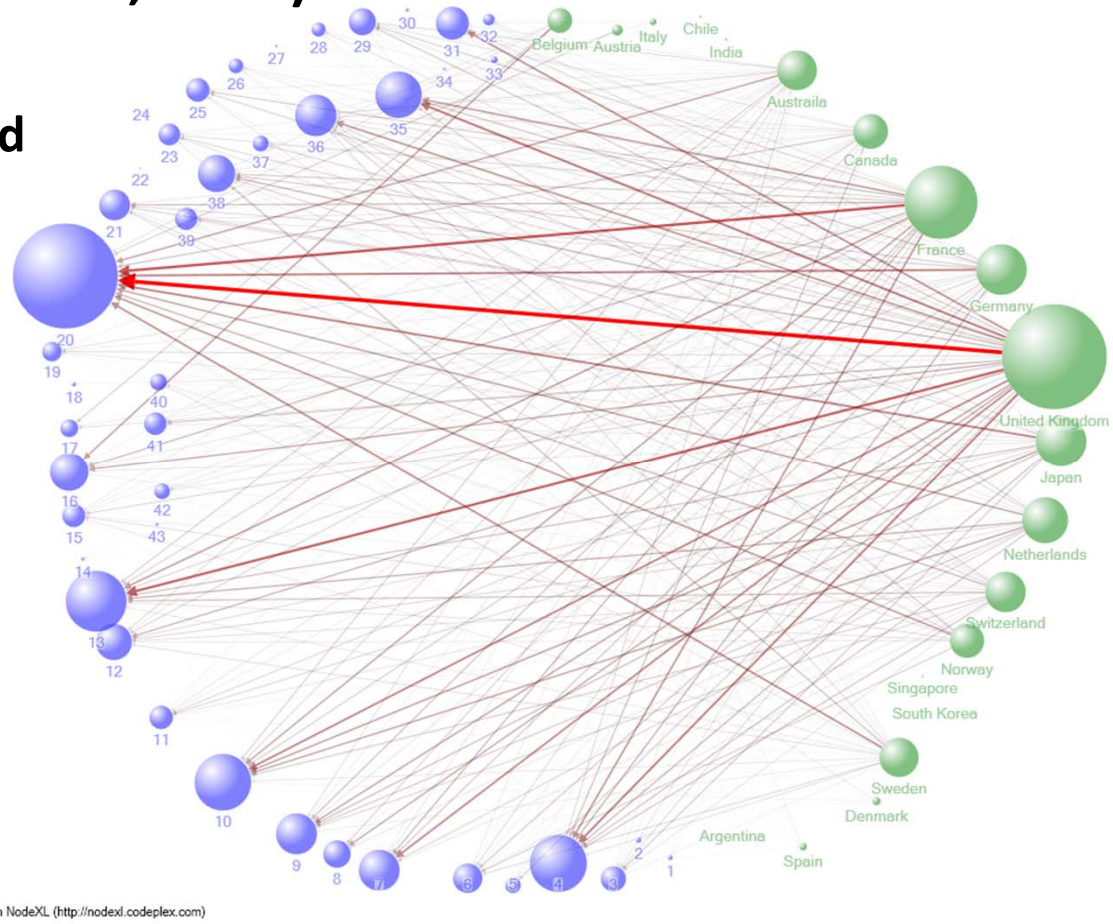
Network Measures

Exposures of Prime (2a-7) MMF to Financial Entity Debt by Country, as of July 2011 (Lo and Stein, 2011):

= **Money Market Fund**

= **Country**



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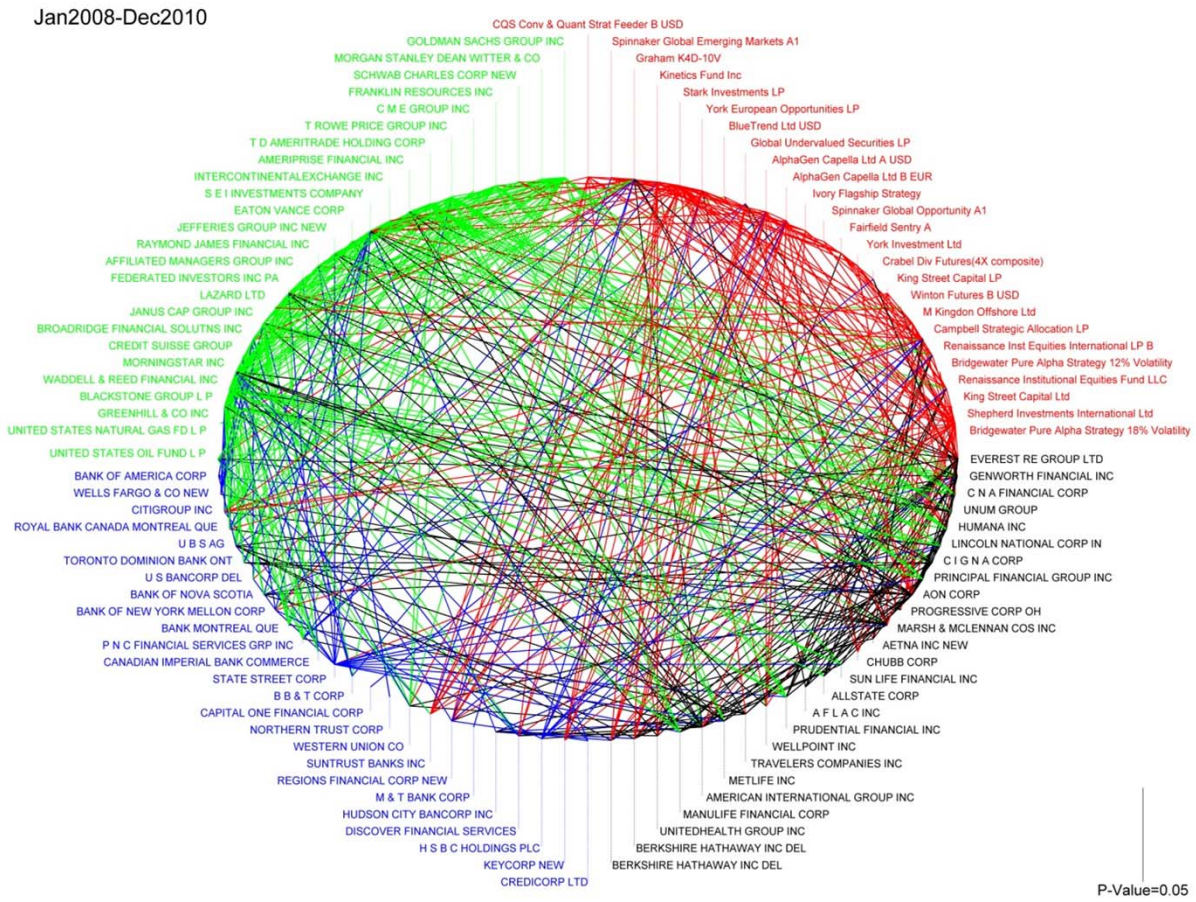
Network Measures

Granger-Causality Network (B.5, Billio et al., 2010):



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Conclusion

- Financial stability is a public good
- Can't manage what you don't measure
- Survey is the first step toward measurement
- Periodic updates to "risk repository"
- Intent is to spur research and collaboration
- Data is key (and will be forthcoming)
- Research is the only way to improve the system
- "Crisis is a terrible thing to waste"

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- Mark Flood, OFR
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- Stavros Valavanis, MIT EECS
- Amy Zhou, MIT Finance
- Roger Stein, Moody's Research Labs
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Thank You!