Cambridge Centre for Risk Studies

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FINANCIAL RISK & NETWORK THEORY

Network Theory in Finance

Journal of Network Theory in Finance is an interdisciplinary journal publishing rigorous and practitioner-focused research on the application of network theory in finance. The journal connects academia, regulators and practitioners in solving important issues around financial risk.



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Program

I, II. Perspectives from Academia, Industry and Regulators

III. Systemic Risk	IV. Interbank Networks	V. SNA in Finance
VI. Correlation Networks	VII. Networks in Banking	VIII. Macro Networks



Last minute updates

Session II: "Macro Networks" by Olli Castren is replaced by "Adaptive Stress Testing: Amplifying Network intelligence by Integrating Outlier Information" by Alan Laubsch

Session VIII: "Competitive & Mutualistic relationships in Financial Ecosystems" by Daniel Fricke is replaced by "Transmission of Shocks in the Integrated Accounting Framework" by Ilja Kavonius

Session VIII: Correct title for Peter Sarlin's paper & presentation is "Interconnectedness of the banking sector as a vulnerability to crises"



Deadline for submission to inaugural issue is: 30 September



December 2014 First issue out







APPLICATIONS IN NETWORK THEORY IN FINANCE

Financial Risk and Network Theory 23 September 2014

Dr. Kimmo Soramaki Founder and CEO, FNA Ltd.

Why?

Taking into account the network aspect makes many risk models better.

Network visualizations (or maps) are intuitive. Financial data is currently not presented efficiently for decision makers (traders, regulators, senior management).

Network models are the basis of new dynamic/predictive models that take place within the network.

Financial Risk and Network Theory

For example:

Risk	Nodes / Links	Application
Liquidity & Operational Risk	Banks / Payment or trade flows	Oversight of payment systems, System design
Counterparty & Systemic Risk	Banks / Counterparty exposures	Financial stability analysis
Market Risk	Assets / Correlations	Portfolio & risk management
Macroeconomic Risk	Economic states / Transitions	Macroeconomic analysis
Casualty Risk	Industries / Trade flows	Developing risk scenarios, modeling losses

Application: Oversight of FMI's





Identifying Important Banks in BoK-Wire+



Key issue in payment system is that each bank is dependent on incoming funds to make their own payments.

Bank of Korea's BoK-Wire+ network. Each node is a bank. Links are payment flows.

Node color reflects bank type:

- Blue=Domestic banks
- Green=Financial Intermediaries
- Red=Foreign Banks
- · Orange=Other

Baek, Soramäki and Yoon (2014).

Identifying Important Banks in BoK-Wire+



Banks are divided into core (inner circle) and periphery (outer circle) based on Craig and von Peter (2013).

The fit with the model is good.

The layout has two rings. Banks are placed on

- inner ring in fixed places, and on the
- outer ring based close to the banks in the inner ring with whom they have strong relationships

For layout we use algorithm by Bachmaier, Buchner, Forster and Hong (2009)

Identifying Important Banks in BoK-Wire+



We identify important banks with SinkRank algorithm (Soramaki and Cook, 2014).

More important banks are shown with a larger node size in the visualization.

Application: Oversight of FMI's





Application: Portfolio Management

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Time series of asset returns



Example: Daily returns of asset prices (ETFs)

Difficult to understand large-scale correlation or other dependence structures of financial assets.

How to put the correlations and their changes in context with changes/returns and volatility?

Objective is to efficiently represent a complex system moving in time

Correlation Networks

A sparse matrix is often well represented as a network.

We encode correlations as links between the correlated nodes/assets.

Red link = negative correlation Black link = positive correlation

Absence of link marks that asset is not significantly correlated.



Dimensionality Reduction & Filtering

Next, we identify the Minimum Spanning Tree (MST) and filter out other correlations.

Rosario Mantegna (1999) 'Hierarchical Structure in Financial Markets'

This shows us the backbone correlation structure where each asset is connected with the asset with which its correlation is strongest.



Coordinate System

We use a radial tree layout algorithm by

Bachmaier & Brandes 2005

that places the assets so that:

- Shorter links in the tree indicate higher correlations
- Longer links indicate lower correlations

As a result, we also see how the assets cluster (analogous to single linkage clustering).



Encoding non-spatial data

Node color indicates last daily return

Green = positive

Red = negative

Node size indicates magnitude of return



"Here be Dragons"

Didier Sornette (2009) Dragon King: "Extreme events can be predicted"

Benoit B. Mandelbrot (1963) Volatility Clustering: "Large changes tend to be followed by large changes"

-> Identify VaR exceptions (return outside 95% VaR bounds)

-> Map them as bright green or red nodes



Highlight outliers in their context



Track the number of outliers each day

Application: Portfolio Management

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23

Application: Macroeconomic Analysis



Application: Casualty Analytics



25

Wrap-up

Many risk models can be improved by taking into account links in the data, interconnections, covariances, flows, ...

Major challenges that we face are related to filtering signal from noise in large networks and presenting the information efficiently

Much of the work can be summed up as: Creating a Map - Placing you on map - Providing directions

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