Macroprudential oversight, risk communication and visualizations: The case of mapping techniques

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Motivation

- Macroprudential oversight
  - Surveillance and supervision of the financial system as a whole
  - Surveillance tools: risk identification & assessment
  - Mandate: issue warnings and recommendations & to follow-up
  - Surveillance tools: no explicit focus on risk communication

- Risk communication: disseminate info internally and externally

- Is there potential in visualization methods?
  - Tap into policymakers’ domain intelligence and experience
  - Intuitive representations for the general public
This talk

1. Macroprudential oversight and risk communication
2. Information visualization and visual analytics
3. Visualizations in macroprudential oversight
4. The case of mapping techniques
1. Macroprudential oversight

- Three types of systemic risks (adapted from ECB 2010):
  - Unravelling of imbalances
  - Aggregate shocks
  - Contagion

- Three types of tools for surveillance:
  - Early-warning models
  - Macro stress-testing models
  - Contagion and spillover models
1. Macroprudential oversight

Macroprudential oversight process (adapted from ECB 2010)

Potential sources of systemic risk

Market imperfections behind systemic risk

Risk identification

Vulnerability

Yes

No

Risk assessment

Material risk

Yes

No

Policy assessment

Risk warnings

Policy recommendation

Policy implementation

Impacts of policy and follow-up recommendations

Impacts of internal and external risk communication
2. Visualization

- Information Visualization
  - Human perception & cognition (Ware 2004, Card et al. 1999)
  - Data graphics design (Bertin 1983, Tufte 1983)
  - Visualization & interaction methods (Zhang et al. 2012, Keim and Kriegel 1996)

- Visual information seeking mantra (Shneiderman 1996): "Overview first, zoom and filter, then details-on-demand".
  - have a high-level overview of the entire collection
  - to zoom in on a portion of items that are of particular interest
  - to filter out or to eliminate uninteresting and unwanted items
  - to select an item/group of items for further details-on-demand
2. Visualization

- Visual analytics (Thomas and Cook 2005): "the science of analytical reasoning facilitated by interactive visual interfaces".
- Visual analytics mantra (Keim et al. 2006): "Analyze first, show the important, zoom, filter and analyze further, details on demand".

![Diagram of the visualization process]

- Data preparation
- Visual data exploration
- Automatic analysis
- Feedback loop
- Visualizations
- Knowledge
- Models
3. Visualizations in macroprudential oversight

- Within the framework for macroprudential oversight, visualizations are used for two purposes:
  1. Internal communication: Decision support for analysts and policymakers overall
     - Visual Analytics, but also IV
  2. External communication: Means for disseminating information to the public
     - Information Visualization, but also VA
3. Visualizations in macroprudential oversight

- Visual means to support three surveillance tasks:
  - early warning of build-ups of widespread imbalances
  - stress-testing resilience to exogenous aggregate shocks
  - modeling contagion to test resilience to cross-sectional shocks

- Systemic risk along two dimensions (Borio 2009):
  - Time: risk builds-up in tranquil times and abruptly unravels in times of crisis
  - Cross-sectional: risk at a given point in time can be transmitted through various channels
3. Visualizations in macroprudential oversight

Data spaces
- Entities
- Time
- Variables
- Links

Data slices
- A multivariate cross-section (e.g. countries)
- A cross-sectional time series
- A multivariate time series
- A cross-section of interlinkages

Entities (e.g. equity exposures)

Links (e.g. equity exposures)

Variables (e.g. GDP)

Time (e.g. years)
4. The case of mapping techniques

1. A map to visualize country-specific risks (external)
   ▶ Build-up of imbalances over time OR across countries

2. A map to visualize how risks evolve in the system (internal)
   ▶ Build-up of imbalances over time AND across countries
4. The case of mapping techniques

▶ Also called dimension reduction, projection, manifold learning, embedding, etc. (see Lee and Verleysen 2007)

▶ Facilitate the visualization of high-dimensional data
  ▶ represent data in two dimensions such that similar high-dimensional data are nearby and dissimilar distant

▶ Examples of mapping techniques
  ▶ Principal Component Analysis
  ▶ Force-directed graphs
  ▶ Multidimensional scaling
  ▶ Self-Organizing Maps
4.1 Self-Organizing Financial Stability Map

- Self-Organizing Map
  - Reduce large amounts of high-D data to fewer mean profiles
  - Provide a low-D representation of the high-D mean profiles

A multivariate cross-section over time

Country-quarter observations (e.g. US & 2010Q1)

Risk indicators (e.g. government deficit, credit growth)

Reduced number of mean profiles

Mean profile 1

Mean profile 2

Mean profile 24

Reduced dimensionality of mean profiles
4.1 Self-Organizing Financial Stability Map

4.1 Self-Organizing Financial Stability Map

- Evolution of macro-financial conditions (14 indicators) for the United States and the euro area (2002–11, first quarter)

Sarlin and Peltonen (2013)
4.2 Self-Organizing Time Map

- Self-Organizing Time Map
- Focus on individual cross-sections

A multivariate cross-section
Reduced number of mean profile
Reduced dimensionality of mean profiles

Countries (e.g. US)

Risk indicators (e.g. government deficit, credit growth)

\[ x_1, x_2, \ldots, x_{N(t)} \]
4.2 Self-Organizing Time Map

- Self-Organizing Time Map
- One more step: Illustrate how mean profiles change over time

Reduced number of low-dimensional mean profiles

Self-Organizing Time Map: visual dynamic clustering
4.2 Self-Organizing Time Map

- Evolution of macro-financial conditions (14 indicators) in the cross-section (2005Q2–2010Q2, 28 economies)

The Global Financial Crisis of 2007-2009

Sarlin (2013)
A key task in macroprudential oversight is communication
Why not integrate visual means into surveillance tools?
Visualizations provide means for
- Risk communication: disseminate info internally and externally
- Tap into policymakers’ domain intelligence and experience

The future of visual representations
- Network data are seldom static, so how do they evolve?
- Can we better look into emergence in agent-based models?
- How do we illustrate the process of shock absorption in risk assessment tools?
- How interactive are visuals in macropru?
Thanks for your attention!

Comments? Questions? Discussion?


