Fedwire Interbank Payment Network (Fall 2001) was one of the first network views into any financial system.

Of a total of around 8000 banks, the 66 banks shown comprise 75% of total value. Of these, 25 banks completely connected.

The research was subsequently used e.g. in congressional hearings to showcase the type of information that should be collected by financial institutions after the financial crisis.

## Recent Developments in Systemic Risk Analytics

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### Recent Developments in Systemic Risk Analytics

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</table>
| **Increased Focus on Non-Financial Risks**       | - Cyber security  
- Cyber resilience  
- Climate change / disruption       |
| **Enhanced Collaboration**                       | - FSB, BCBS, CPMI, IOSCO  
- CCP12  
- Financial Systemic Analysis & Resilience Center (FSARC)  
- Euro Cyber Resilience Board (ECRB) |
| **Regulator - FI Interoperability**              | - APIs  
- Stress testing  
- Model validation  
- FMI oversight |
**Use Case: Understanding Interconnectedness**

**Bank of England** maps Interbank Exposures in the United Kingdom

**Background**
During the 2008 financial crisis, many banks ran into difficulties at the same time as shocks spread rapidly across the financial system. One of the main reasons for this was that the global financial system had become highly interconnected.

**Objective**
Measure bank interconnectedness and associated systemic risk in the UK.

**Insights**
Direct interconnectedness such as interbank credit exposures, have decreased materially since the financial crisis. On the other hand indirect interconnectedness such as correlations in banks’ CDS premia remain elevated. The analysis helps to define the case for policy interventions to reduce the associated risks.

Bank of England: [Banking sector interconnectedness: what is it, how can we measure it and why does it matter?](#)
Research paper: [Interbank Exposure Networks](#)
Use Case: Understanding Interconnectedness

Hong Kong Monetary Authority maps derivatives exposures based on TR data

**Background**
As part of global regulatory reforms, the Hong Kong Monetary Authority (HKMA) started in 2013 to collect derivatives data through the Hong Kong Trade Repository.

**Objective**
Bring more transparency to derivatives markets using the data collected by trade repositories.

**Insights**
Initial framework for analysing this new data source to assess the financial stability of the market and potential risks. This includes development of maps for the chain of exposures between institutions.

HKMA: A first analysis of derivatives data in the Hong Kong Trade Repository
Importance of Network Analytics for TR Analytics

- Understanding complex interconnections - across products & counterparties
- Gaining a clear view of risk concentrations, both through direct & indirect exposures
- Visualising changes in risk concentrations over time (using a time-series of graphs)
- Aggregating & dis-aggregating exposures (using multi-layer networks)
Chicago Mercantile Exchange identifies risk concentrations

Background
CCPs concentrate large amounts of risks by becoming seller to every buyer and buyer to every seller in the market. Their members play different roles of custody banks, liquidity providers and settlement members and it is not obvious how these roles are concentrated.

Objective
Identify risk concentrations across multiple roles members are playing in the system. Monitor changes over time and alert about outliers.

Outcomes
Proof-of-value project identifies previously unknown risk concentrations which prompt the development of a simulation model to evaluate impact of operational failures (e.g. cyber scenarios) on the CCP's ability to complete settlement.

Loan-Level Data Repositories

Objectives

- Automation of reporting
- Real-time information
- Greater market coverage - atomic loan level data
- Automation of analytics
- Automation of monitoring
- Early warning mechanisms

Examples

- ECB’s “AnaCredit”
- HKMA’s “Granular Data Reporting”
- Bank of England

Analytics Focuses

- Banks & borrowers across products & facilities
- Banks’ portfolios as they evolve from borrower, loan type, collateral type, and geographic perspectives
- Banks, borrower & guarantor relationships
- Systemic risk vulnerabilities, specific scenarios & impacts on individual borrowers and banks
- Regional economic variables & bank portfolios
- Credit quality dispersion across borrowers and borrower subtypes
- Concentration risk across categories and movement along a time series
Use Case: Understanding Foreign Banking Exposures

**Background**
The BIS consolidated banking statistics provide internationally comparable measures of national banking systems’ exposures to country risk. The statistics have been used to provide transparency into offshore banking in the 70’, the Asian Crisis 1997–98 and Global Financial Crisis 2007-08.

**Objective**
Develop an always up to date visual monitoring solution to assist measuring global financial contagion.

**Outcome**
Validation of available data and prototype for dashboards that enable systematic and transparent understanding of complex derivatives.
Data: BIS Consolidated Banking Statistics, Table 9D

Contains exposures among reporting countries + exposures to non-reporting countries.

These statistics measure banks' country risk exposures.

They capture the worldwide consolidated claims of internationally active banks headquartered in BIS reporting countries.

- Nodes = Banking sector of the country
- Directed Links = Value of loans to entities in the other country

Use Case: Understanding Foreign Banking Exposures
Case Study: Eurozone Debt Crisis - Greece

Context
- Time frame: Early 2009 – Late 2018
- After the GFC, Greece and its banks found it increasingly difficult to sustain their positions and to access liquidity, which led to the beginning of the Euro Crisis.

Visualization
- Greek banking exposure dynamics before and after the Eurozone debt crisis
- Prior to the crisis, Greek banks’ aggregate claims held and issued grew steadily on a gross basis and relative to GDP

Insight
- French and German banks had the largest exposures to Greek banks, and they also have large overall exposures reflected in the node sizes
- This might explain why these two governments were keen to restructure Greek debt
Case Study: Eurozone Debt Crisis - Greece

Visualization
○ Aggregate claims issued by Greek banks declined sharply
○ Aggregate claims held by Greek banks kept rising

Insight
○ Greek banks were lending more but borrowing less cross borders
○ French and German banks were driving down their exposures to Greek banks (see charts below)
Case Study: Eurozone Debt Crisis - Greece

Visualization
- After the crisis, the aggregate claims held by Greek banks dropped abruptly
- Greece’s aggregate claims issued, which means the total claims issued by its bank, stayed low

Insight
- British banks are among those whom Greek banks held a large portion of their claims on
- German and US banks became the main debtors of Greek banks
- This might signal a new paradigm after the crisis
Case Study: Eurozone Debt Crisis - Spain

**Context**
- Time frame: 2008 - 2014
- Spain was unable to bail out its financial sector after the 2008 financial crisis and had to apply for a €100 billion rescue package from the ESM
- Its 10-year bond interest rate spiked to 7% in 2012

**Visualization**
- Spain banking exposure dynamics before and after the Eurozone debt crisis
- Prior to the crisis, Spanish banks’ aggregate claims held and issued grew steadily on a gross basis and relative to the country’s GDP

**Insight**
- French and German banks had the largest exposures to Spanish banks, just like to Greek banks
Case Study: Turkey - a Looming Problem?

**Context**
- Time frame: 2018 - ?
- Political instability in Turkey
- The lira having fallen by over 40% against US$ since mid-2017
- Moody’s expecting a 2% economic contraction in 2019

**FNA Visualization**
- Turkish debt dynamics since 2017
- Spanish banks have the largest exposure to Turkish banks, followed by French banks

**FNA Insight**
- Understand new potential systemic risk in the financial system
- Could a Turkish banking default trigger a cascade that deteriorates the Spanish economy?
By using the BIS Consolidated Banking Statistics we can:

- Visualize international credit exposures
- Gain a better understanding of risk propagation through the financial system
- Improve policy decisions relating to systemic risk and financial stability
- Identify direct and indirect exposures
- Identify opportunities for credit expansion

The same type of analysis can be extended to other data sets (including national / intra-country data):

- Interbank lending
- Other interbank credit exposures - direct & indirect
- Bank <> corporate network monitoring
FNA

Exposure Networks - Scripting Example

www.fna.fi
system.reset_db

# import data
arc.property.define -property value -type numeric
arc.import -table bis_links.csv

# calculate degree
vertex.centrality.degree

# calculate layout for networks
vertex.layout.circle -sort_vertices vertex_id -correction false

# save series on file
series.save -file bis
## Exposures - Create Dashboard

```bash
# create dashboard
dashboard.new
dashboard.view.network -x x -y y

# add mappings
dashboard.mappings.vertex -size degree -color :red
dashboard.mappings.arc -width value -opacity value
dashboard.mappings.vertex.label -text vertex_id

# show 10 years on time bar
dashboard.timebar -days 3650

# save dashboard
dashboard.save -file bis -series bis
```
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