EUROPEAN CENTRAL BANK

EUROSYSTEM

Christoffer Kok

Deputy Head of

Stress Test Modelling Division /

Directorate General
Macroprudential Policy and
Financial Stability

Applications and usage of network-based tools for macroprudential analysis at the ECB

IMF/Bank of Russia Workshop on

RECENT DEVELOPMENTS IN MACROPRUDENTIAL STRESS TESTING
Moscow, 4-5 September 2018

Motivation: Why are network tools useful for central banks?

- Before the Global Financial Crisis (GFC) not much attention was paid by central banks to financial stability risks related to intra-financial linkages

- The GFC has revealed the intertwined nature of modern financial systems
- Shocks hitting one part of the system can easily propagate to the broader financial system
- Risks stemming from interconnectedness can be systemic
- It became clear that the consequences of such interconnected and complex systems are particularly hard to predict

- Highlighted the need to develop analytical tools and indicators that could support central banks identifying and monitoring cross-sectional systemic risks
  - See also ECB Financial Stability Reviews: special feature B in Dec. 2009; special feature D in June 2010; special feature C in June 2011; special feature C in June 2012; special feature A in Dec. 2012; special feature C in Nov. 2013

Motivation: Why are network tools useful for central banks?

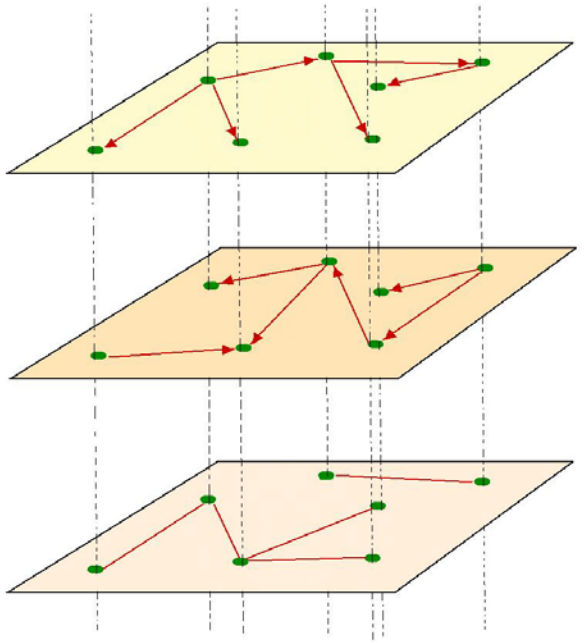
- Network-based models and indicators became part of the analytical toolkit of most advanced central banks
- Macroprudential policy tools to address interconnectedness
- Macroprudential stress tests with scope to account for 2nd round contagion effects due to interconnectedness

  - Henry and Kok (2013), "A Macro Stress Testing Framework for assessing Systemic Risk in the Banking Sector", ECB Occasional Paper No. 152 (http://www.ecb.europa.eu/pub/pdf/scpops/ecbocp152.pdf?17d6e36b7272c2fb172d6bf35b97ef03)
  - ECB (2016), Macroprudential Bulletin, Ch. 1, October (http://www.ecb.europa.eu/pub/pdf/other/ecbmpbu201610.en.pdf?70a35bebd8f8cdbac149c82875a3b076)
  - Dees et al. (2017), "Stress Test Analytics for Macroprudential Purposes in the euro area: STAMP€" (https://www.ecb.europa.eu/pub/pdf/other/stampe201702.en.pdf)

Scope and purpose of interconnectedness analysis

- **Model complexity:** financial institutions are high interconnected, at multiple layers
- **Assess contagion risk:** scope and magnitude of propagation, stress testing
- **Identify systemic institutions:** those that transmit or amplify shocks
- **Beyond banks:** interconnectedness with non-banks (e.g. insurers, shadow banks) and real economy
- **Policy implications:** Use contagion models to inform macroprudential policy decisions

Financial institutions are connected in a number of market segments



Source: Montagna and Kok (2016), "Multi-layered interbank model for assessing systemic risk", ECB Working Paper No. 1944 (and forthcoming in Journal of Financial Stability); and Hałaj, Kok and Montagna, ECB FSR special feature, November 2013.

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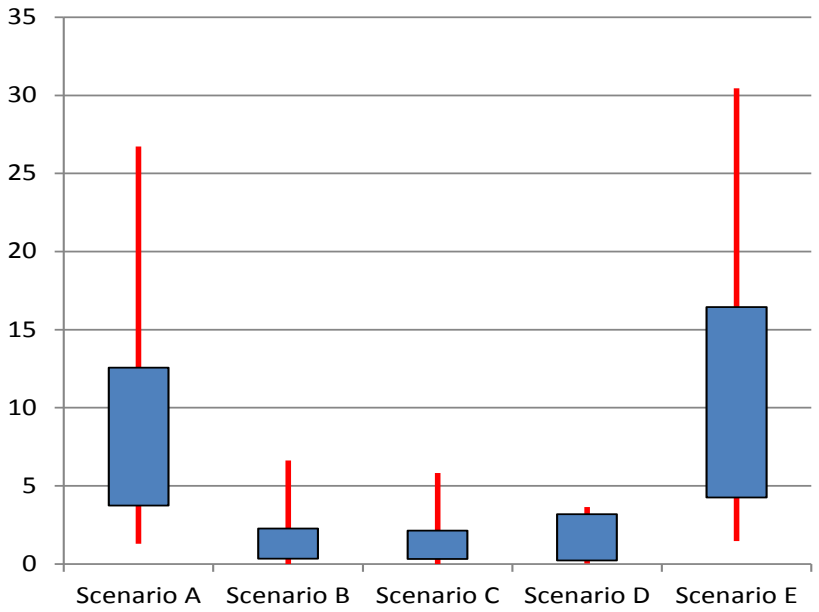
System-wide losses to capital due to interbank contagion under different scenarios *(bps CET1 ratio, interquartile range)*



Source: ECB and ECB calculations based on Henry and Kok (2013) and Hałaj and Kok (2013).

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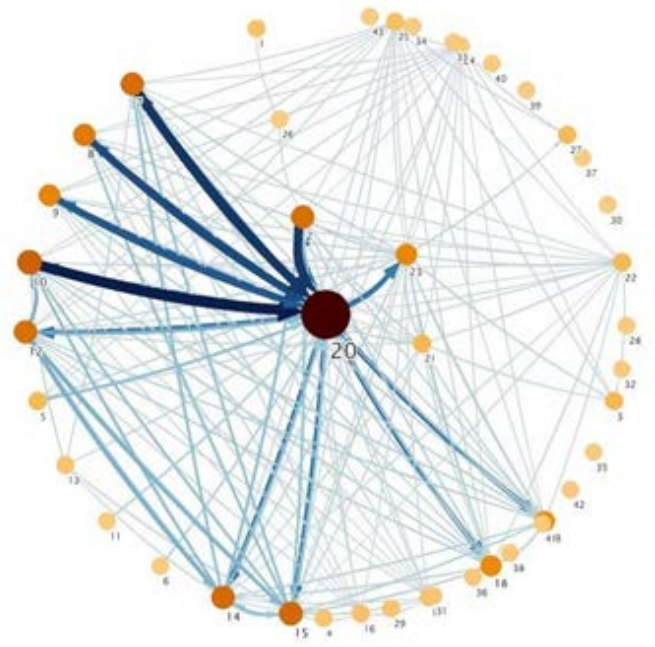
Systemic risk: network of overlapping portfolios *(links: if overlapping portfolios; colour and size of the nodes highlight centrality)*



Source: Cappiello, Fache Rousovà and Montagna, ECB FSR special feature, November 2015.

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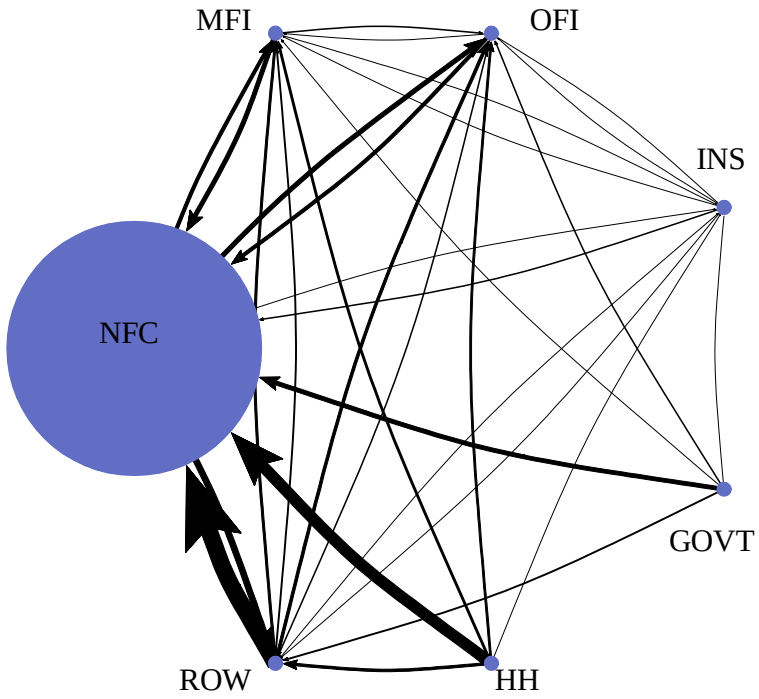
Cross-sector share holdings based on financial accounts *(size of nodes: intra-company holdings within sector; thickness of links: size of cross-sector holdings)*



Source: ECB and ECB calculations based on Castren and Kavonius (2009), ECB Working Paper No. 1124.

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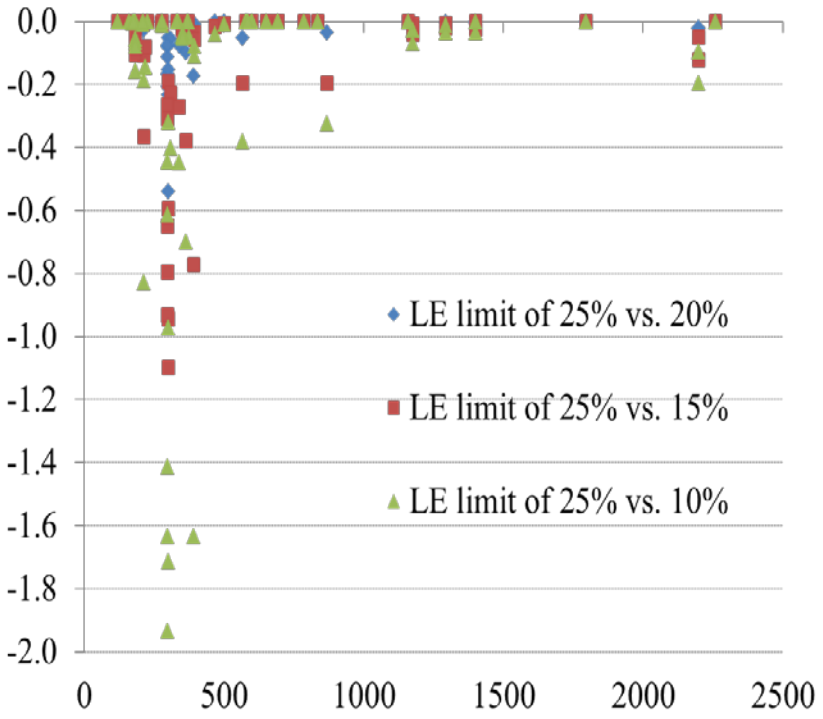
Reduction in contagion losses due to lowering of large exposure limit *(y-axis: impact on capital ratio in bps; x-axis: bank CDS spread in p.p.)*



Source: Halaj and Kok 2015. "Modelling the emergence of the interbank networks", *Quantitative Finance,* vol. 15(4), pp. 653-671; and Hałaj, Kok and Montagna, ECB FSR special feature, November 2013.

Network contagion models: data sources and methodologies

Data

- Data availability is key to assess interconnectedness and implied contagion risk
- More granular data have become available to macroprudential authorities – but much scope for further improvements
- Often it is necessary to rely on simulations, which limits the practical policy use of analytical contagion tools/models

Methodologies

- Suite of model approach
  - **Balance sheet / exposure based models** vs. **price-based models** of statistical dependence
  - **Direct interconnectedness** (bilateral interlinkages) vs. **indirect contagion** (overlapping portfolios, news based)
  - **Static models** (simple cascading mechanism) vs. **dynamic models** of complex interactions between agents (endogenous network formation, agent-based models)

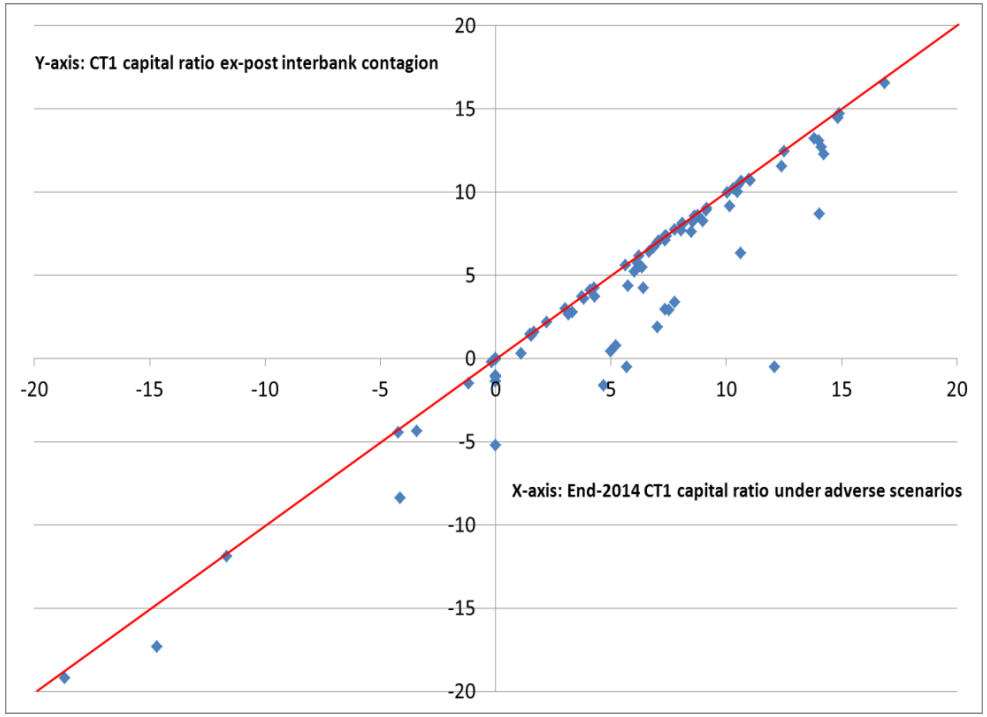
Some practical applications

Applications: (1) Assessing contagion in bank stress tests

➢ Accounting for interbank contagion effects amplifies the initial stress test impact on bank solvency

- What are the **potential knock-on contagion** effects following a common shock to the banking system?
- Banks with capital shortfall are assumed not to repay their interbank liabilities
- Simulations can encompass simple cascades, fire sales, liquidity hoarding, etc.

First-round losses under the adverse scenario vs. second round losses taking into account interbank contagion

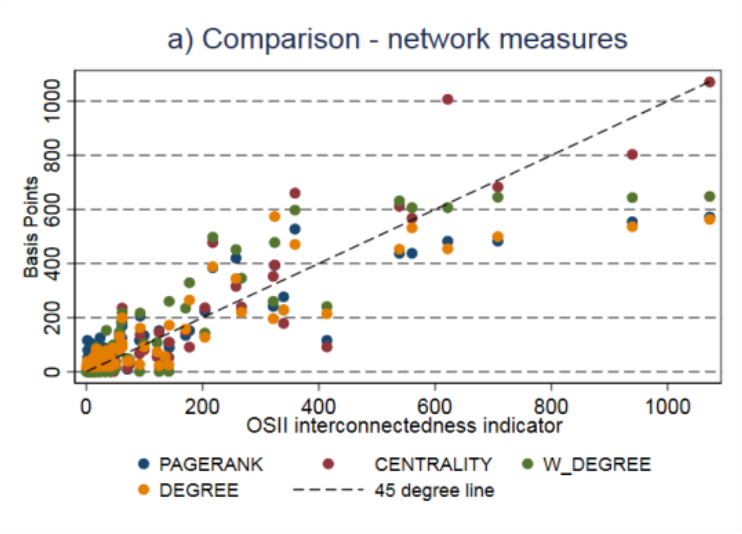


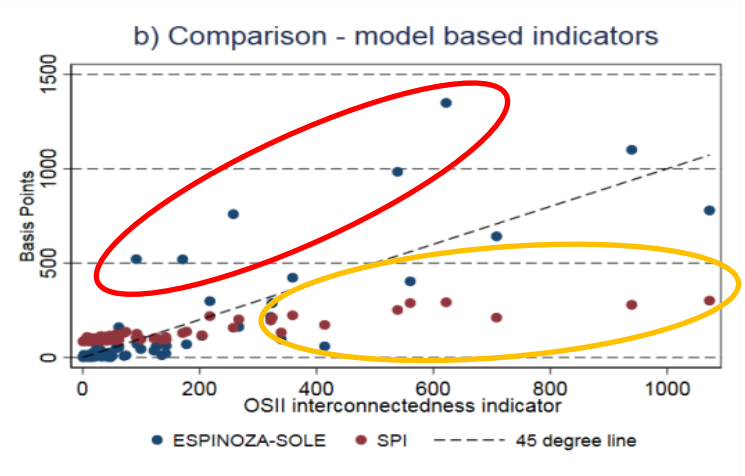
Source: Henry and Kok (eds.), ECB Occasional Paper No. 152, October 2013.

Applications: (2) Gauging "systemicness" of individual banks

O-SII buffer calibration

- Using large exposure reporting we construct comprehensive interbank network on a quarterly basis
- …to derive network-based measures of **individual banks' systemic risk due to interconnectedness**
- Network measures correlate highly with the more simple size-based interconnectedness indicators, constructed following the EBA guidelines on the calibration of O-SII buffers
- There is nevertheless value for policymakers to take into account network-based measures
- …as for some individual banks those measures can deviate considerably



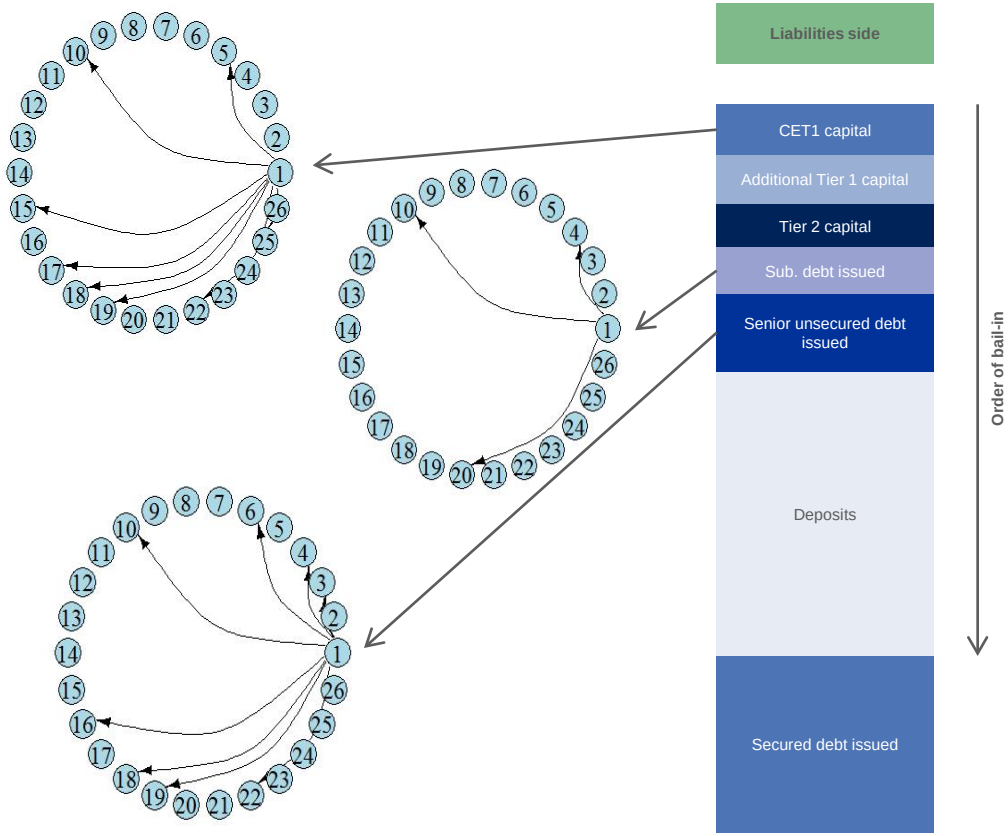


Source: Covi, Kok and Meller (2018), "Using large exposure data to gauge the systemicness of SSM Significant Institutions", ECB Macroprudential Bulletin No. 5, April.
Note: Espinoza-Sole estimates are calculated following the methodology used by Covi, Gorpe and Kok (2018), which builds on the framework by Espinosa-Vega and Sole (2010), while the Systemic Probability Index is based on Hałaj and Kok (2013).

Applications: (3) Contagion risk due to bail-in under the BRRD

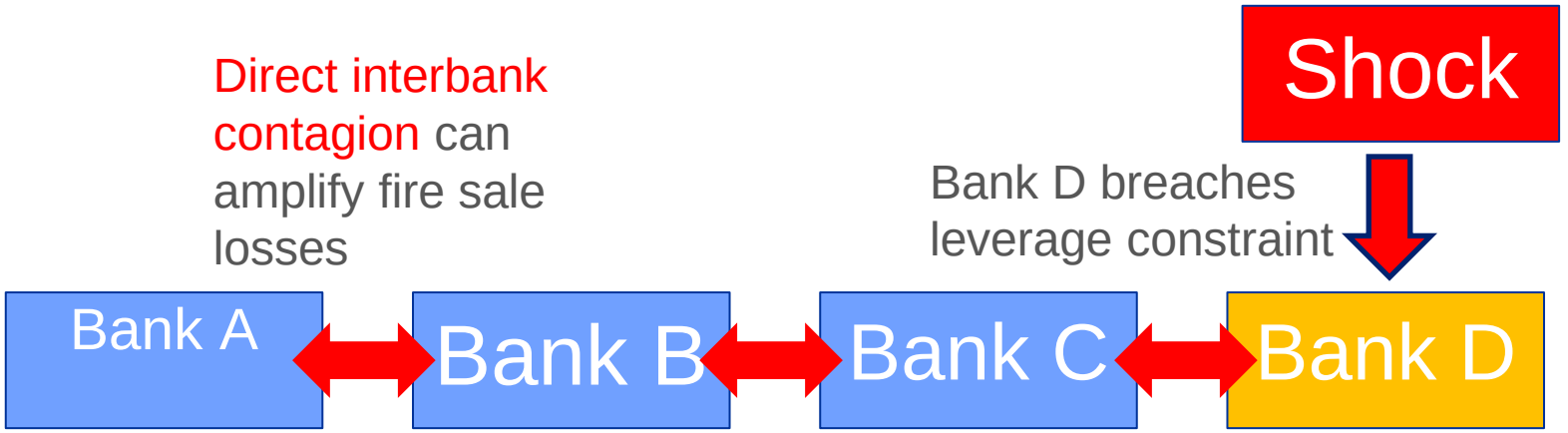
- An important element of the resolution toolkit embedded in the BRRD is the bail-in tool
- …enabling the resolution authority to write down and/or convert into equity the claims of a broad scope of creditors
- With the aim of reducing taxpayer burden and moral hazard
- But **unintended consequences** may arise
- …as other banks holding securities of the bank being resolved could face losses that may in turn impair their viability

Creditor hierarchy in a bail-in and potential direct contagion channels via cross-holdings

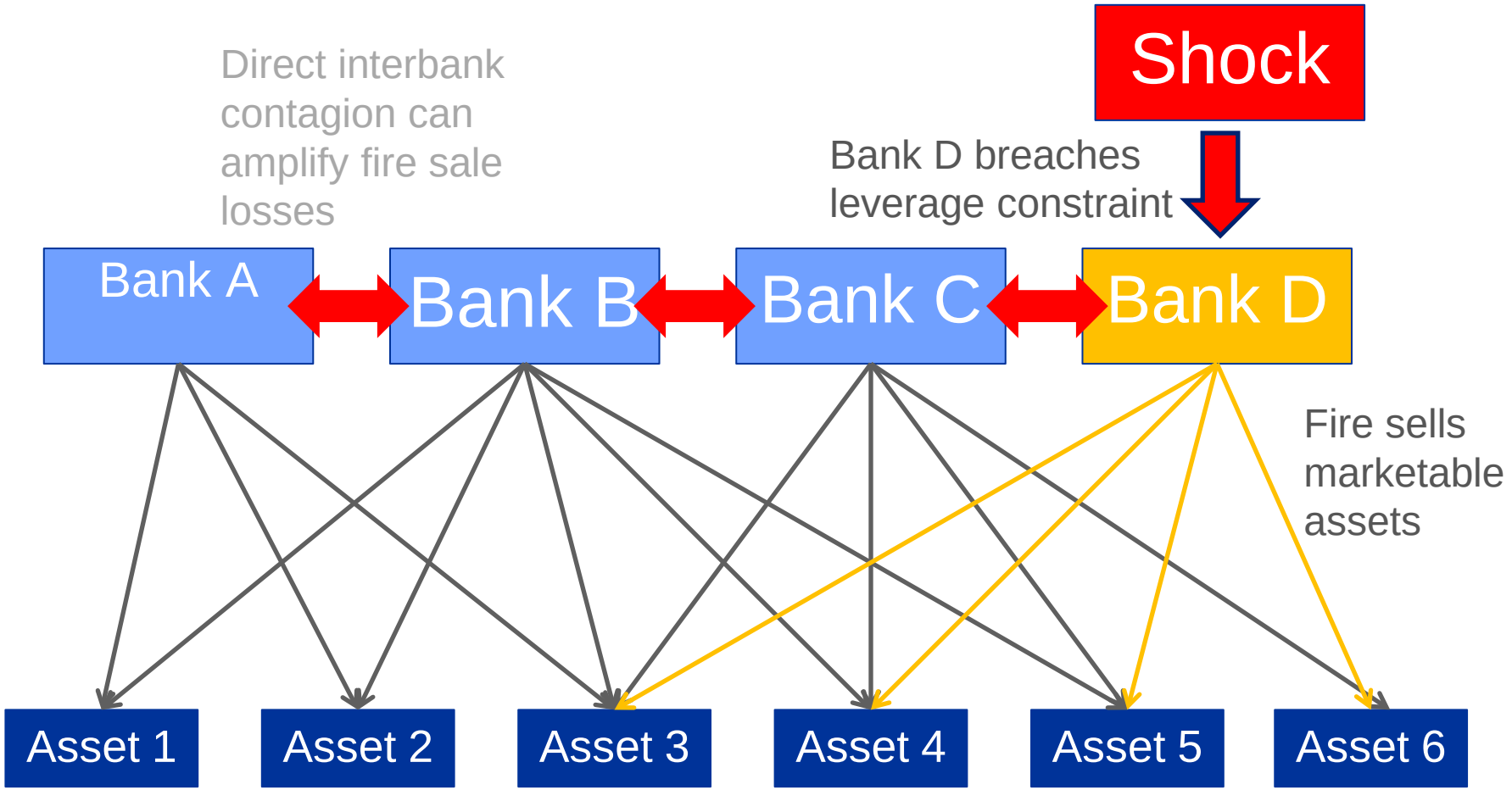


Source: G. Hałaj, A.-C. Hüser, C. Kok. C. Perales and A. van der Kraaij (2017), "The systemic implications of bail-in: A multi-layered network approach", Journal of Financial Stability (https://doi.org/10.1016/j.jfs.2017.12.001)
Note: Larger circles represent networks of cross-holdings between 26 largest euro area banks in different layers of the creditor hierarchy.

Applications (4): Direct contagion via interbank exposures



Applications (4): Indirect contagion via overlapping portfolios



Applications: (4) Contagion risk due to overlapping portfolios

- Applying EBA 2016 ST credit losses to interbank network with overlapping portfolios
- Indirect effects due to asset commonalities (here 1st round losses) can be sizeable
- …and get amplified via direct interbank connections (2nd round)

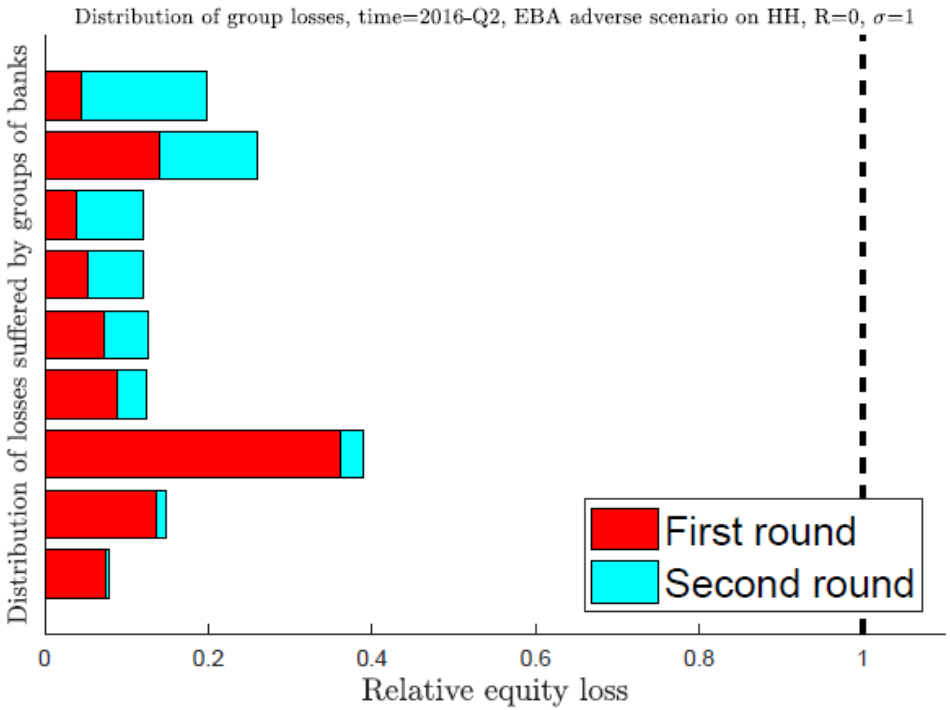


Figure 6: Distribution of relative equity losses suffered by banks in a consistent macro-financial scenario designed for the EBA 2016 EU-wide stress test exercise. Recovery rate R is assumed to be 0 and market volatility σ is assumed to be equal to 1. Due to confidentiality issues, banks have been aggregated into 9 groups sorted by second round relative losses, i.e. banks that have the largest second round losses are in the first group shown on the top and so on until banks that have the lowest second round relative losses on the bottom of the chart.

Roncoroni, A., S. Battiston, M. D'Errico, G. Hałaj and C. Kok (2018), Interconnected Banks and Systemically Important Exposures, work in progress.

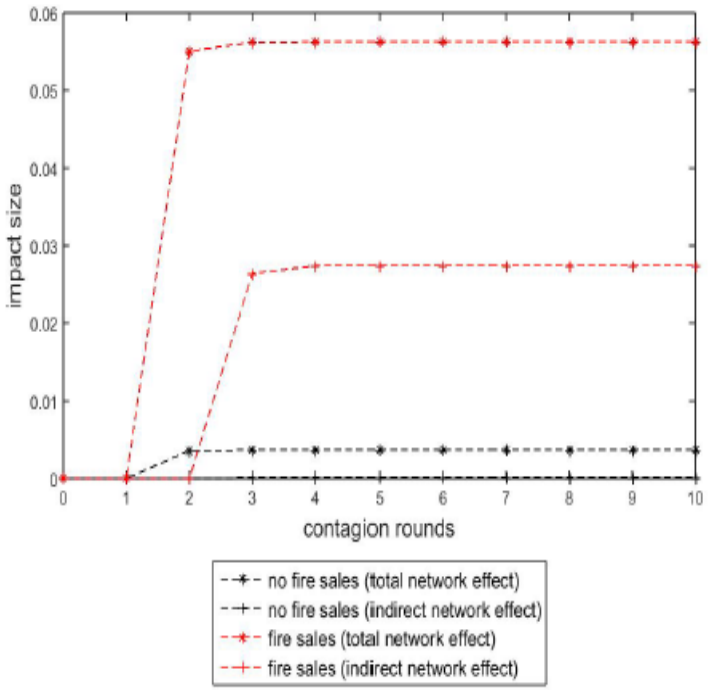
Applications: (4) Contagion risk due to overlapping portfolios

- Decomposing direct and indirect network effects

- With no 'fire sales':
- limited direct network effect and negligible additional loss induced by indirect linkages

- With 'fire sales':
- direct network-induced losses wipe out 5.5% of system equity, and indirect contagion adds another 2.7%

Figure 10: Additional loss induced by the network (ratio to total system equity)



Aldasoro, I., Hüser, A.-C. and C. Kok (2018), Contagion Accounting, work in progress.

Macroprudential policies

- The macroprudential policy toolkit includes a variety of measures that could help contain contagion risk
- Most of them focused on banking sector
- …fewer instruments targeting non-bank financial sector

  - **Sectoral capital requirements**: aiming at increasing banks' resilience and curbing the financial cycle through higher funding costs
  - **Systemic risk buffer, G-SIB/O-SII buffers**: Improve banks' resilience
  - **Large exposure limits**: limit counterparty concentration
  - **Liquidity requirements** (LCR/NFSR): reduce the build-up of systemic liquidity risk due to interconnectedness
  - **Restrictions on margins/haircuts** for securities transactions
  - **Transparency**: Disclosure requirements

Conclusion

- Central banks are devoting considerable analytical resources to improve the measurement of cross-sectional systemic risks
- …but still work in progress and regular usage in the policy process is still in its infancy

- To confidently use network models in policy-making, real time granular data are of the essence
- Still some work to convince policy makers (central bankers and supervisors) that network effects are measurable and can be acted upon
- Policy assessments should account for “costs” of contagion risk but also “benefits” of financial interlinkages: so far efforts have mainly focused on the former!