Fire sales, price-mediated contagion and systemic risk.

Financial Risk & Network Theory - Cambridge September 2016

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Joint work with Rama Cont[a]

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Disclaimer

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Overview

1. Introduction: Price-mediated contagion and endogenous risk
2. Modelling fire sales
3. Empirical application: European Banking Network
4. Conclusion

Stress testing 3.0

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Goal: Develop models for macro stress testing that can quantify such second round effects in a realistic and robust way.

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  5. The price impact function and liquidity models (Klye & Obizhaeva (2011 - 2016), BoE: RAMSI)

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Mechanism:

1. **Shock** to illiquid assets
2. **Deleveraging** of marketable assets by some institutions
3. **Feedback effects** via price-mediated contagion
   $\rightarrow$ potentially triggers more deleveraging (cascade).

Model balancesheet

Illiquid assets
Residential mortgage exposures
Commercial real estate exposure
Retail exposures: Revolving credits, SME, Other
Indirect sovereign exposures in the trading book
Defaulted exposures
Residual exposures

Marketable assets
Corporate bonds
Sovereign debt
Direct sovereign exposures in derivatives
Institutional client exposures: interbank, CCPs,...

Table: Stylized representation of asset classes in bank balance sheets.

- A stress scenario is defined by a vector $\epsilon \in [0,1]^K$ whose components ϵ_μ are the percentage shocks to asset class μ.
- Gradual increase of the shock from 0% to 20%.
- Four scenarios:
  1. Spanish residential and commercial real estate losses
  2. Northern Europe residential losses
  3. Southern Europe commercial real estate losses
  4. Eastern Europe commercial real estate losses

Response functions

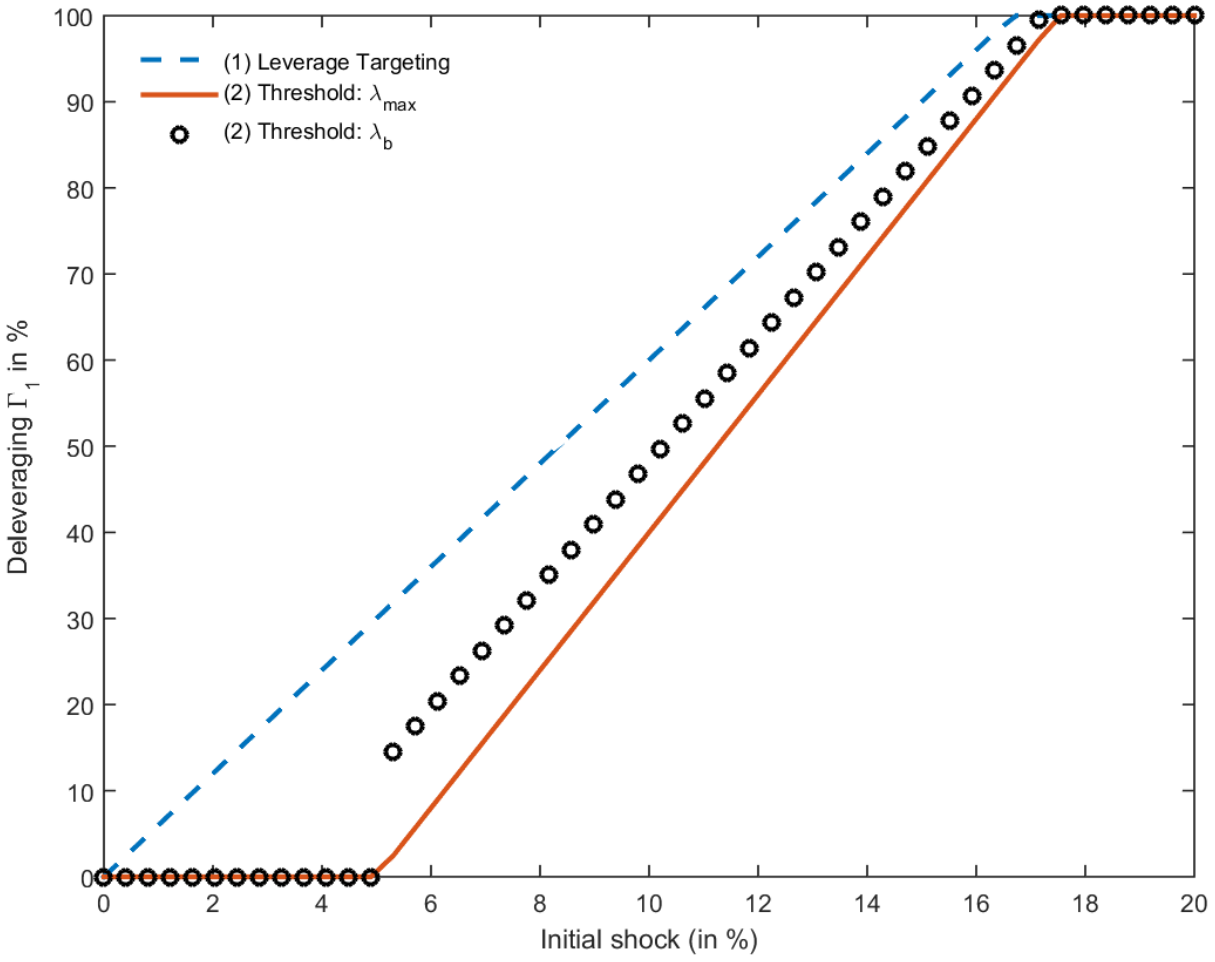

Figure: Leverage targeting response function (dashed) and two variants of the threshold (full and circles) response functions.

Price impact

The price of an asset undergoing a forced liquidation at t:

$$S^{\mu}_{t+1} = S^{\mu}_{t} \exp\left(-\delta_{\mu}^{-1} \sum_{j=1}^{M} \Pi^{j\mu}_{t} \Gamma^{j}_{t+1} \right) \tag{1}$$

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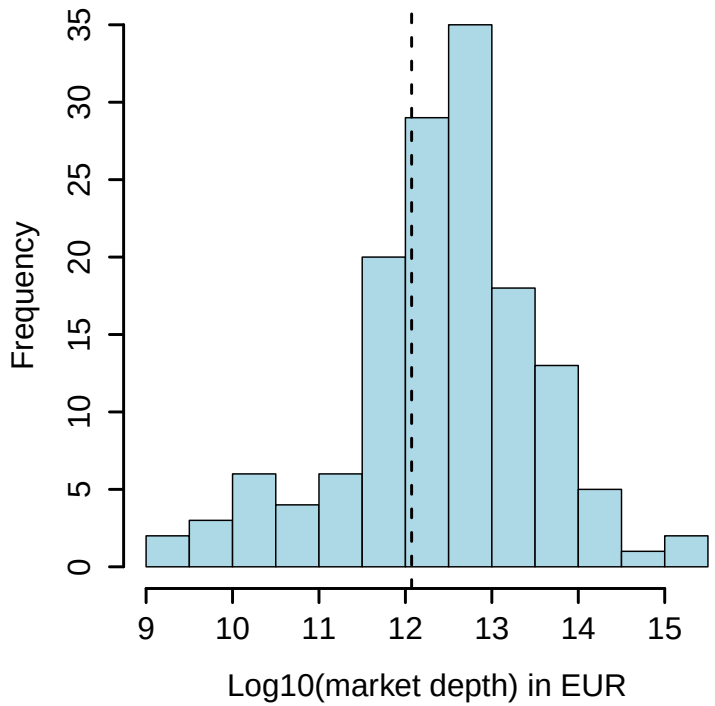

Figure: Large variation in estimated liquidity of different assets.

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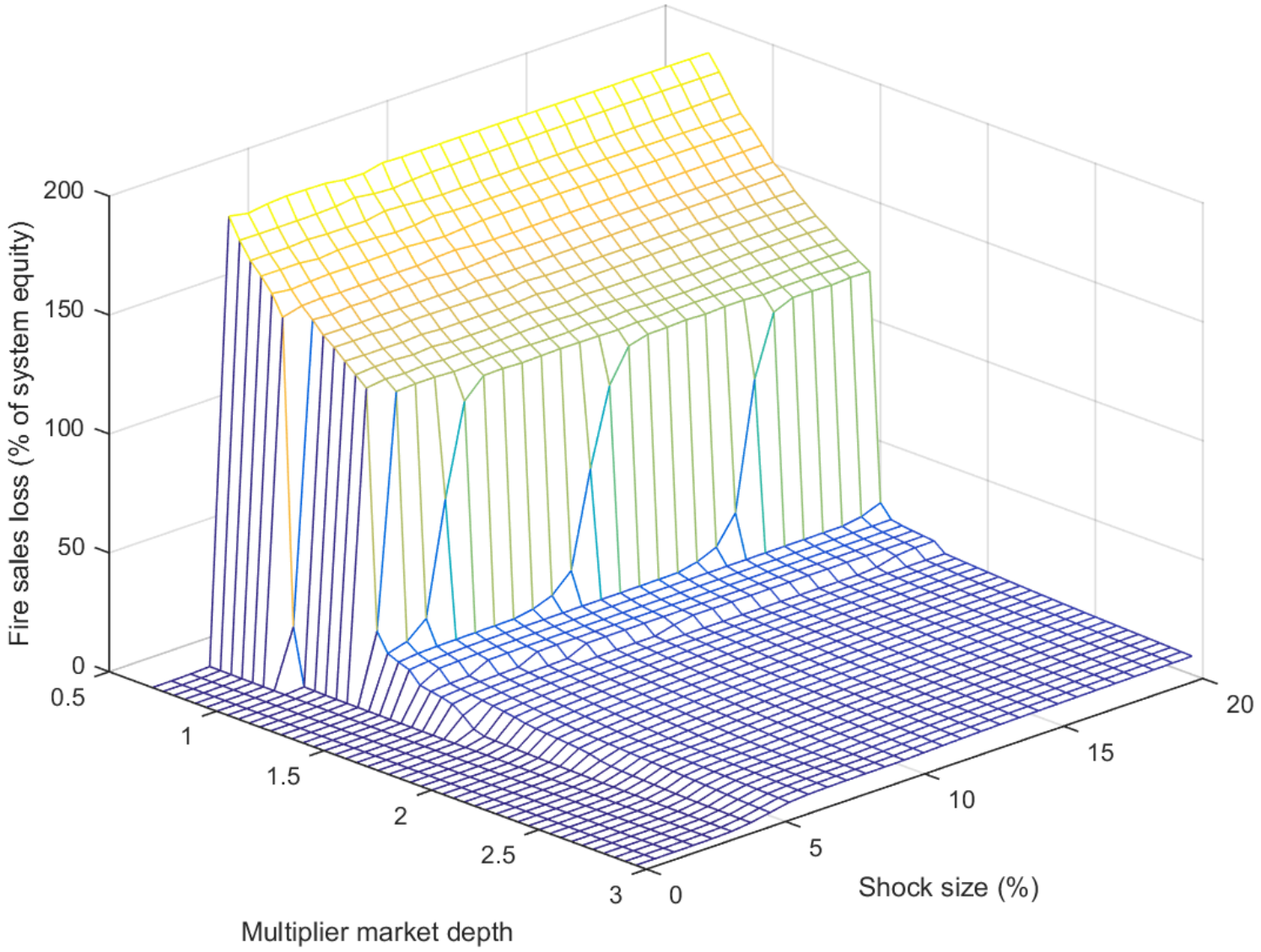
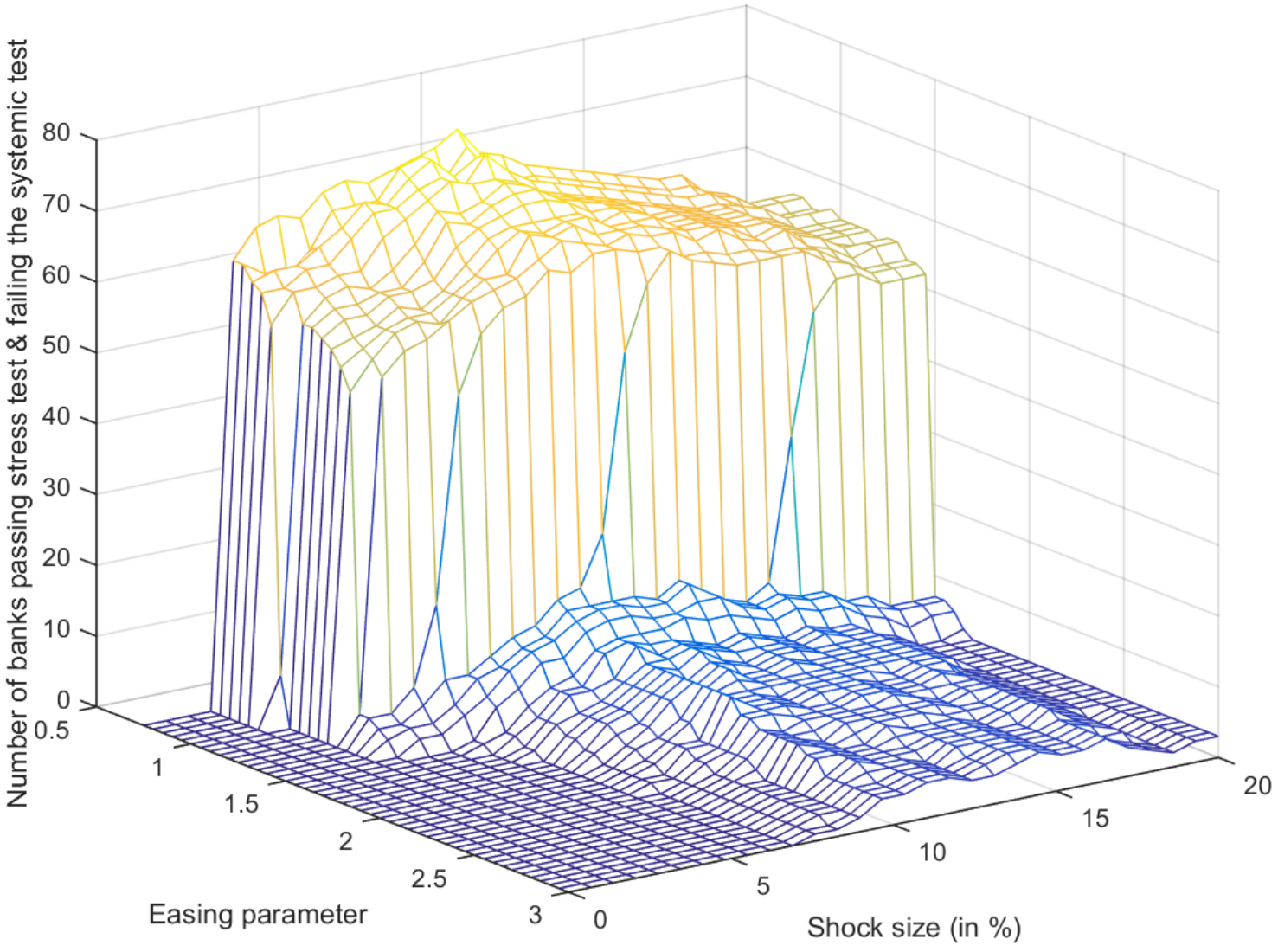
Fire sales losses and market depth



Indirect exposures and stress test outcomes



Liquidity weighted overlap

Our model shows that losses are proportional to the liquidity weighted overlap

$$\omega_{ij} := \sum_{\mu=1}^{M} \frac{\Pi_{i\mu}\Pi_{j\mu}}{\delta_\mu} \tag{2}$$

This leads to a network of portfolio overlaps:

$$\Omega := \Pi D^{-1} \Pi^\top, \tag{3}$$

which can can be studied with network analysis tools.

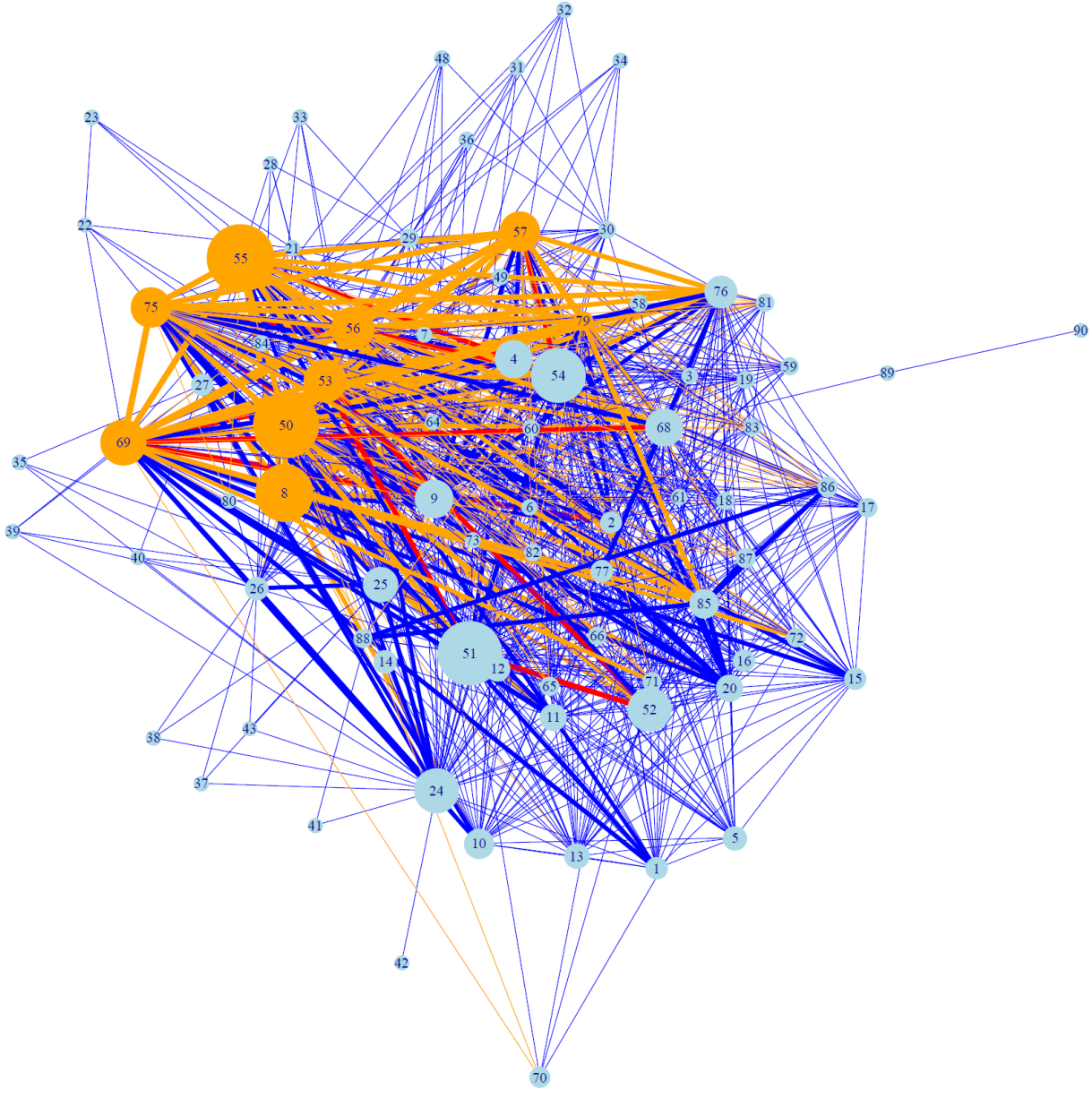


Figure: European banking system: liquidity weighted overlap network

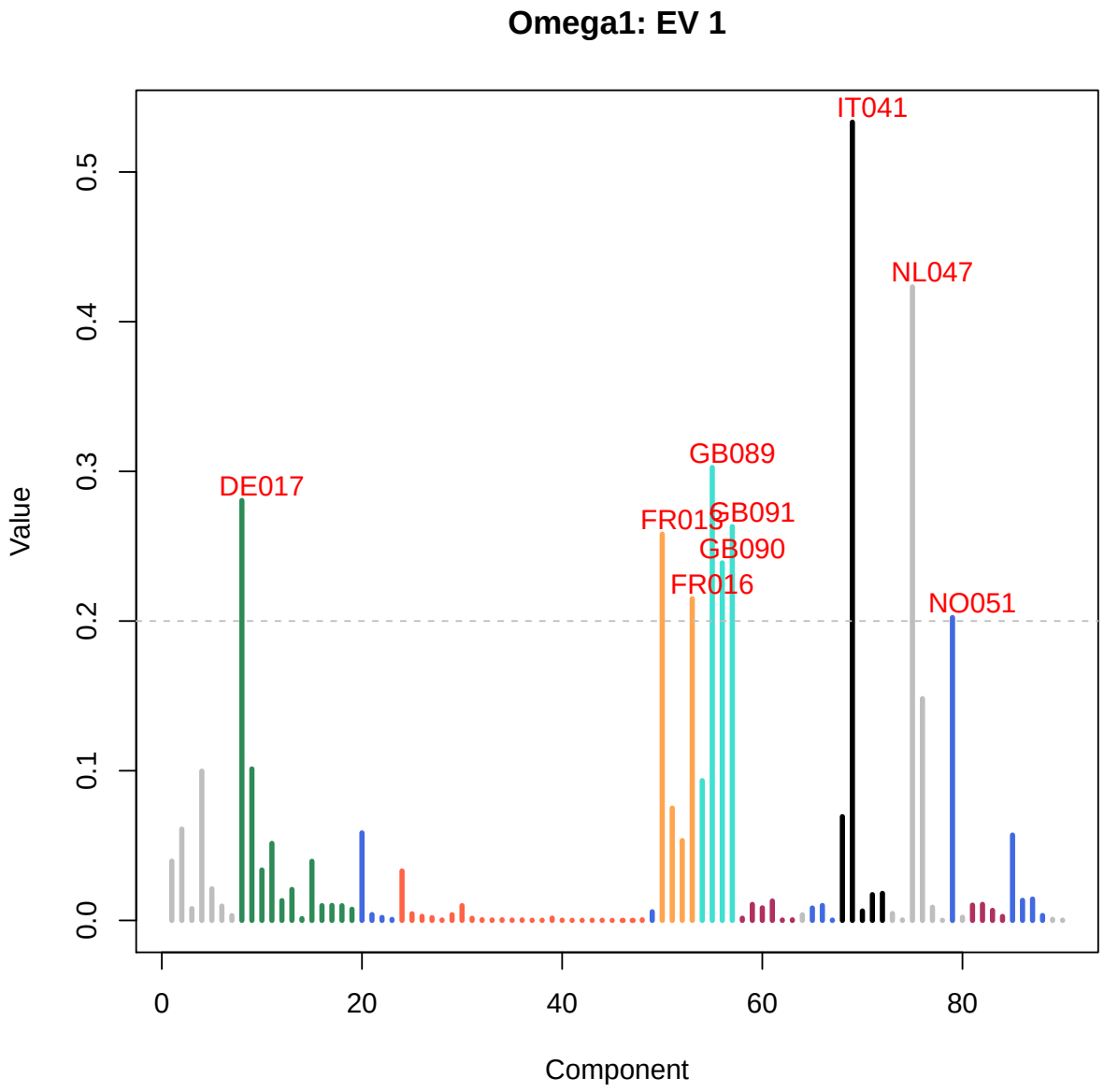


Figure: European banking system: Liquidity weighted overlaps

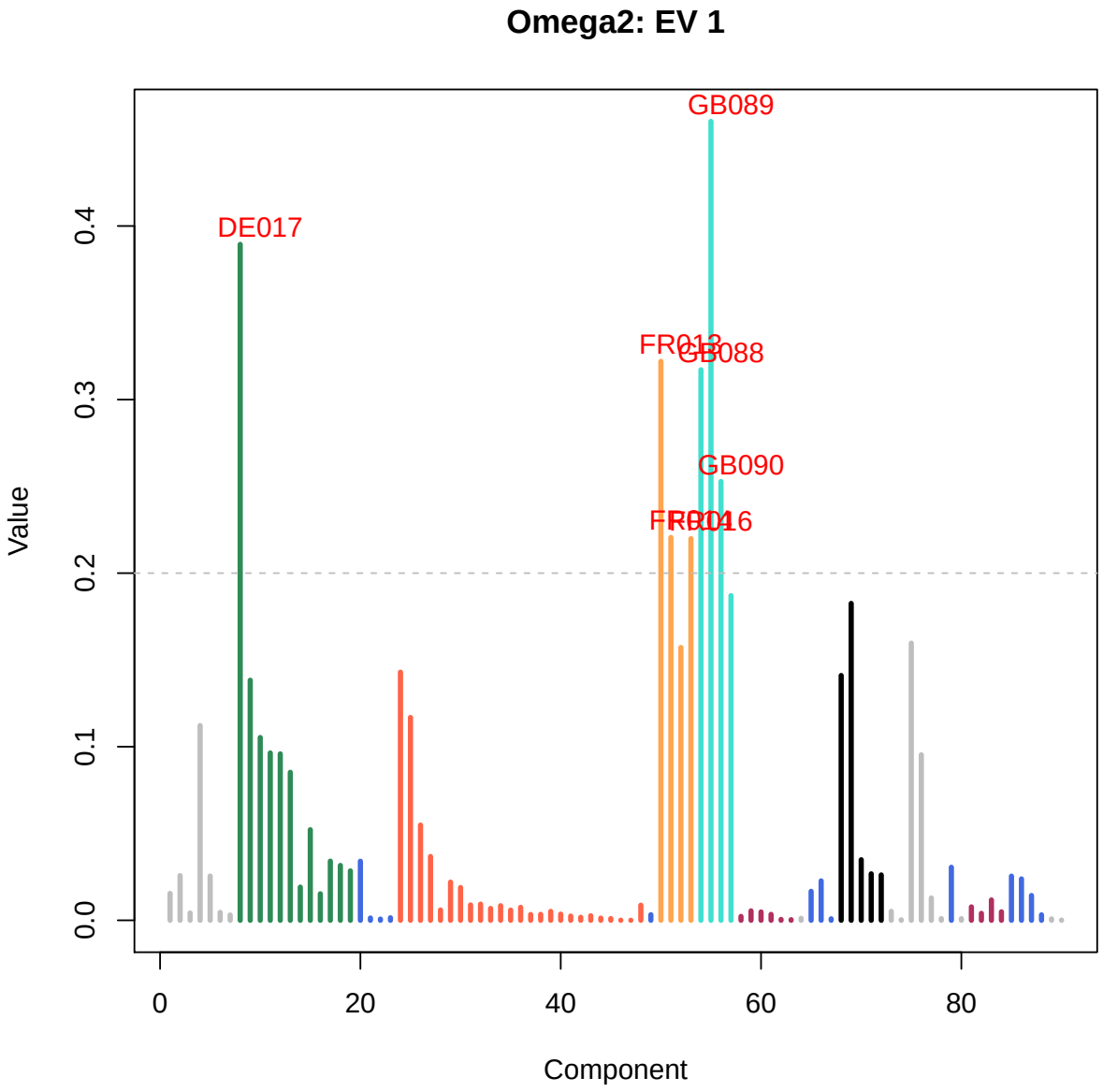


Figure: European banking system: Nominal overlaps

Distribution of fire sales losses

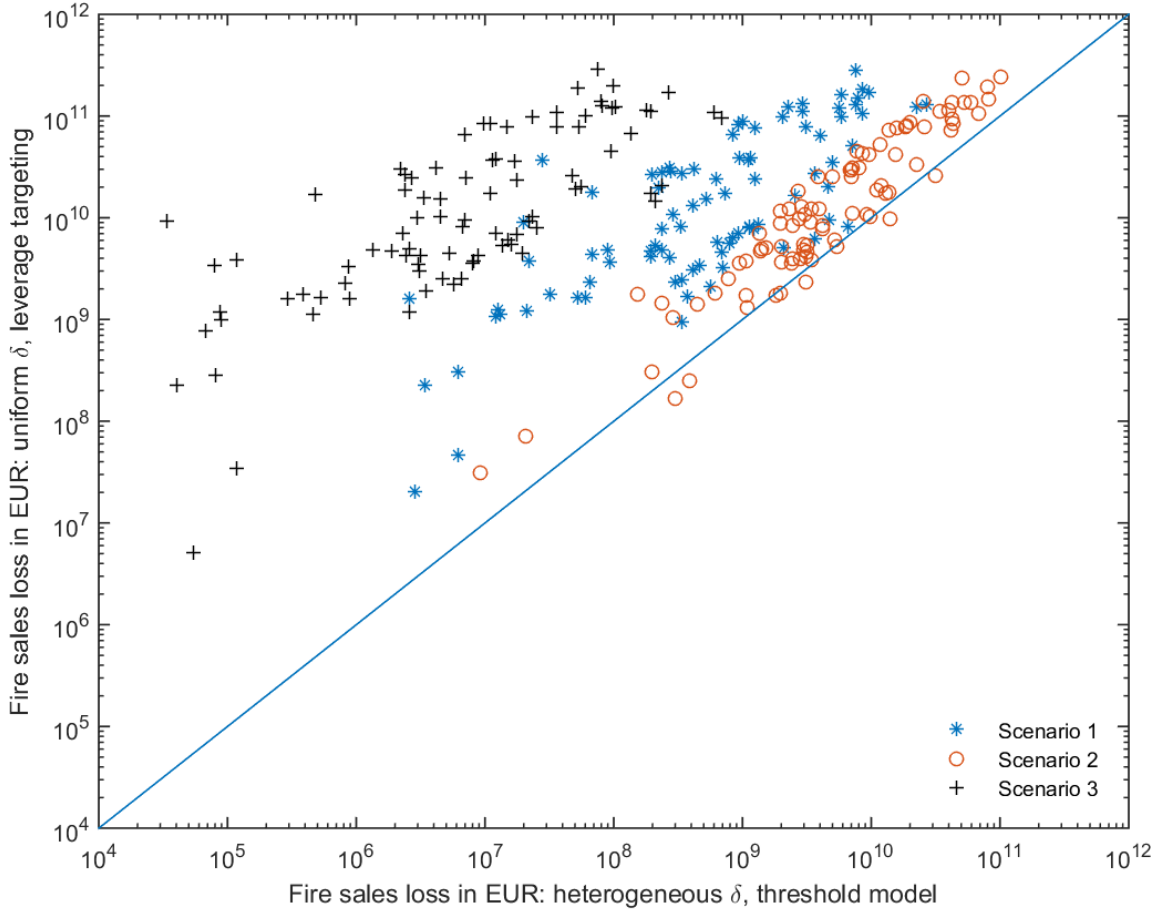


Figure: $\log_{10}$(fire sales loss) for different scenarios and different model combinations.

Sensitivity to initial stress scenario

Scenario combination	Sample correlation coefficient
1 & 2	0.0840
1 & 3	0.2130
1 & 4	-0.1449
2 & 3	-0.0509
2 & 4	0.0394
3 & 4	-0.0149

Table: Sample correlations between the initial loss vectors from the stress scenarios. The four stress scenarios are very different in terms of which banks are hit by the corresponding shock.

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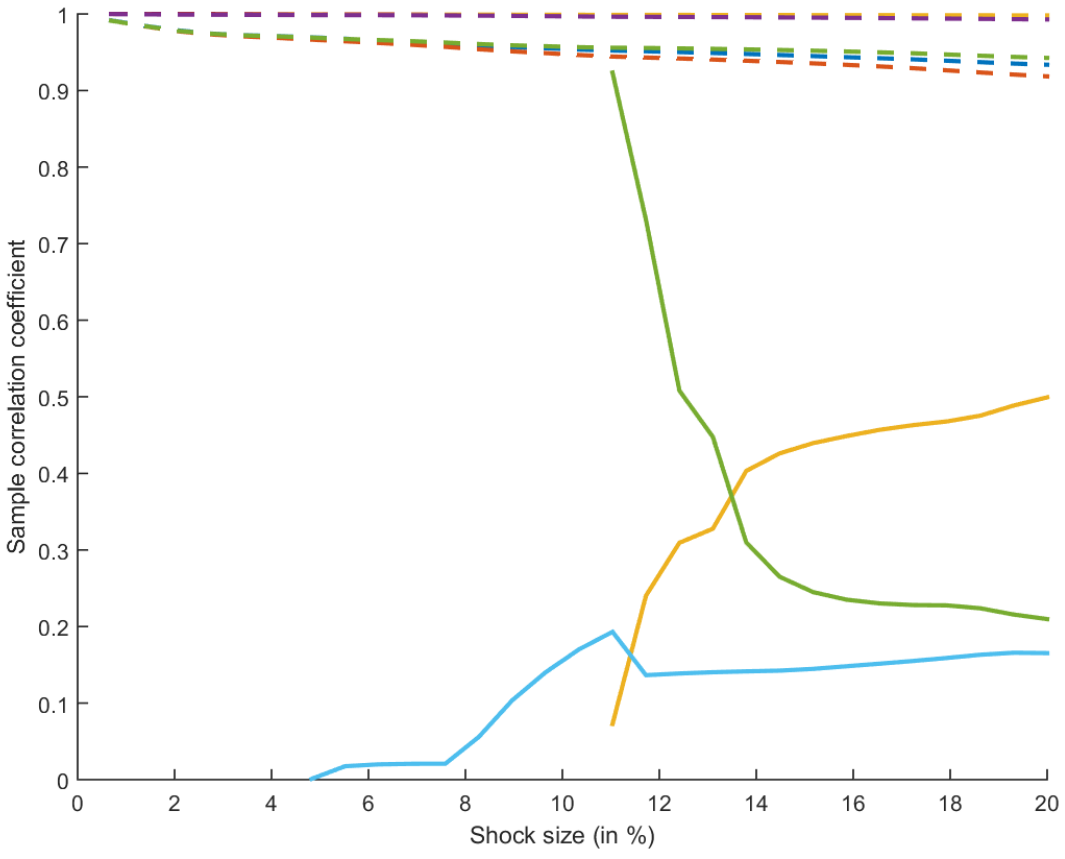

Figure: The pairwise sample correlation between the fire sales loss vectors of different scenarios as a function of the initial shock. Threshold model full lines - leverage targeting dashed lines.

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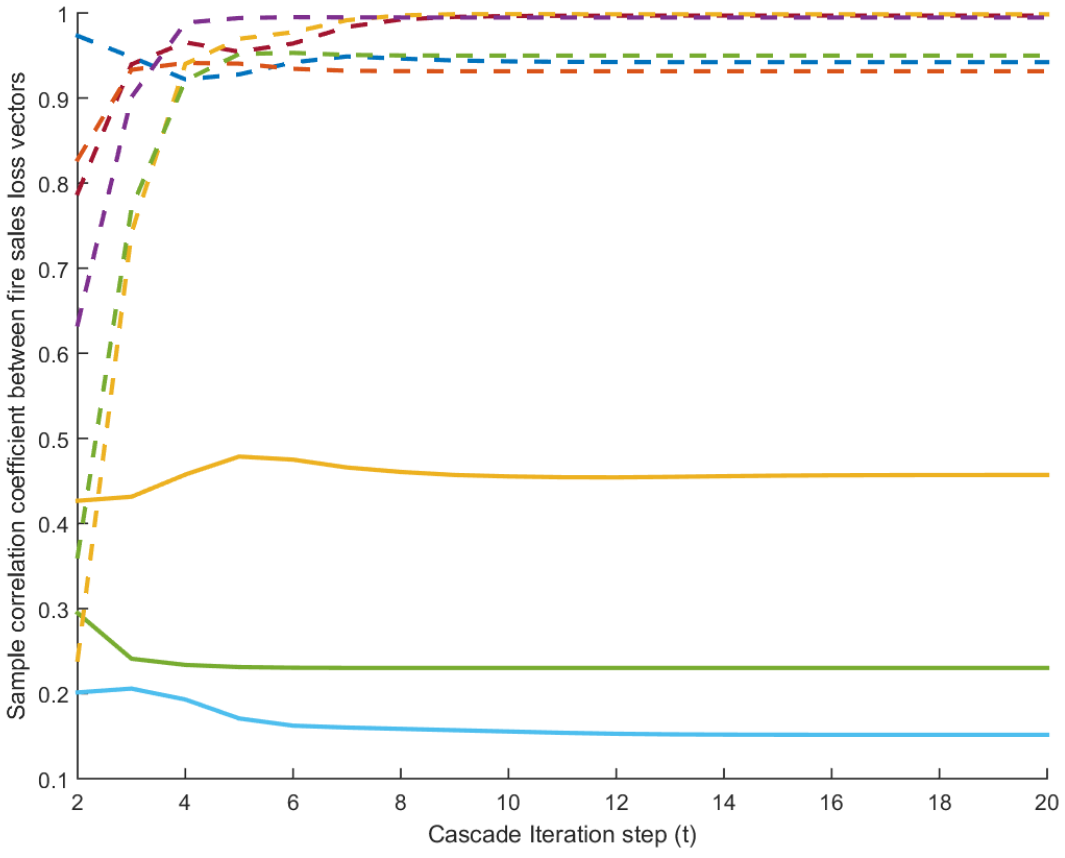

Figure: The evolution of the pairwise sample correlation during the fire sales cascade for a given scenario. Threshold full - leverage targeting dashed.

Risk management for whales (Cont and Wagalath 2016)

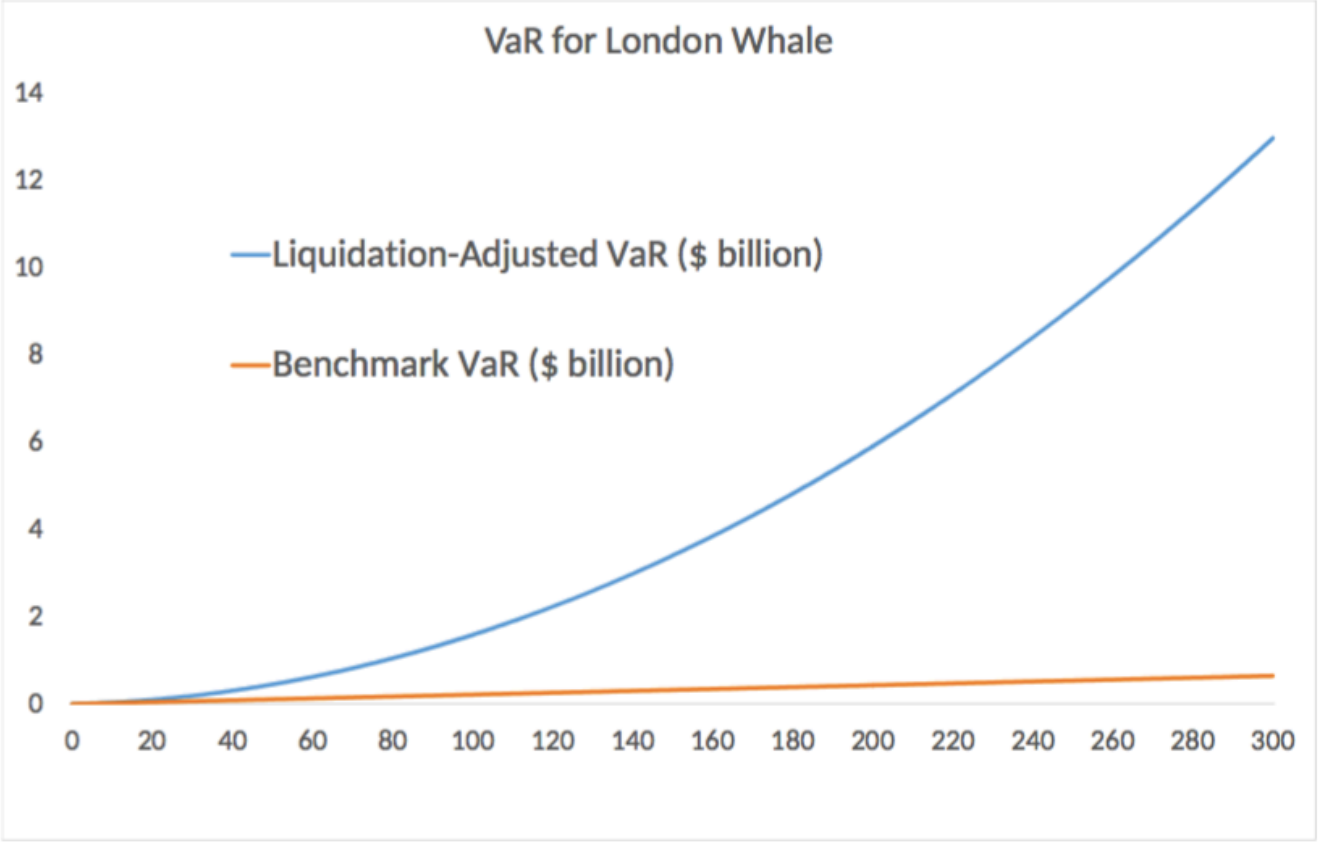

Figure 6: 95% 5-month VaR for positions in CDX IG9 (size in Bn $).

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- Including fire sales and endogenous mechanisms (with realistic parameter estimates) can change the outcome of stress tests: Next generation stress testing models must include such feedback effects.
- Seemingly innocent modelling choices on response functions and liquidity estimates have a significant effect on results!

Conclusions for modelling

- Important to account for heterogeneity in agent resilience and asset liquidity. Any meaningful fire sales stress test needs to include a sensitivity analysis on the market depth parameter.

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- The threshold model generates more realistic short term dynamics under stress. Leverage targeting models seem better suited to capture long term dynamics.
- Leverage targeting models produce counter-intuitive short term dynamics.
- Singular value decompositions of liquidity weighted overlap matrices can provide valuable information for monitoring purposes and policy responses.

Thank you!


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