Fire sales, price-mediated contagion and systemic risk.

Bank of Finland Simulator Seminar, August 2016

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Overview

Price-mediated contagion and endogenous risk

- Crisis of 2007-2008: Direct contagion (e.g. counterparty credit risk or funding relations) cannot explain the magnitude and breadth of contagion, across sectors, countries and asset classes that was observed.

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- Market stress can lead institutional investors to unwind positions (constrained by capital, liquidity, leverage...) (Shleifer 2010, Coval & Stafford 2007, Ellul et al 2011).
- Most regulatory macro stress tests do not include any such feedback mechanisms.

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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** by some institutions
3. **Feedback effects** via price-mediated contagion
   $\rightarrow$ potentially triggers new more deleveraging (cascade).

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- Modelling: Agents' response to shock, price-impact function
- Estimation: Liquidity of assets, bank specific resilience
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$$\frac{(1 - \Gamma_1^i)\Pi_0^i + \Theta^i - \Xi_0^i}{C^i - \Xi_0^i} = \lambda_{new}^i,$$

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which yields in the **Threshold model:**

$$\Gamma_0^i = \frac{C_0^i(\lambda_0^i - \lambda_b^i)}{\Pi_0^i} \mathbb{1}_{\lambda_i > \lambda_{\max}},$$

Response functions

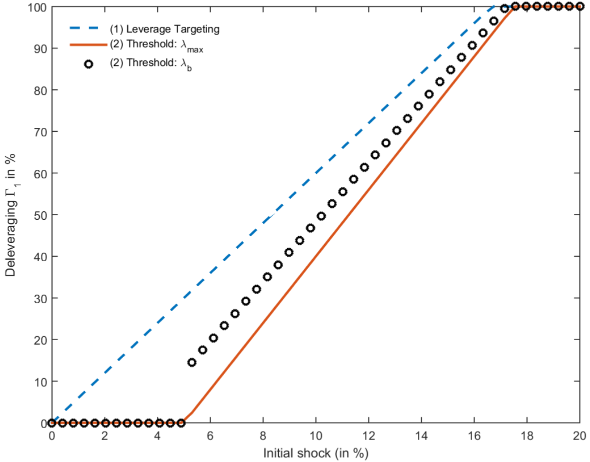

Figure: Leverage targeting response function (dashed) and two variants of the threshold (full and circles) response functions.

Price impact

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

$$S_{t+1}^{\mu} = S_t^{\mu} \exp\left(-\delta_{\mu}^{-1} \sum_{j=1}^{M} \Pi_t^{j\mu} \Gamma_{t+1}^{j}\right) \tag{1}$$

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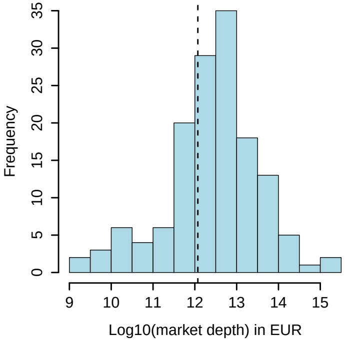

Figure: Large variation in estimated liquidity of different assets.

- A stress scenario is defined by a vector $\epsilon \in \mathbb{R}^K$ 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

Fire sales losses

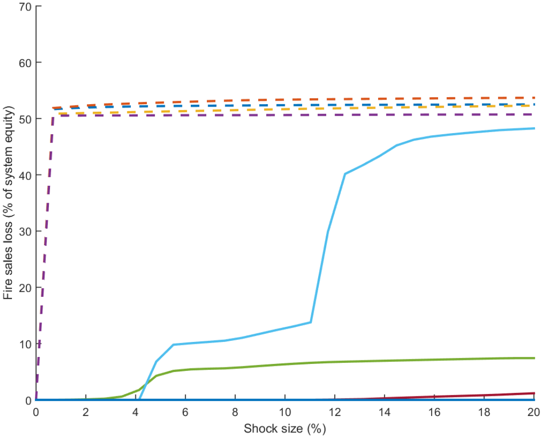

Figure: Fire sales loss in leverage targeting (dashed) and threshold (full) models.

Distribution of fire sales losses

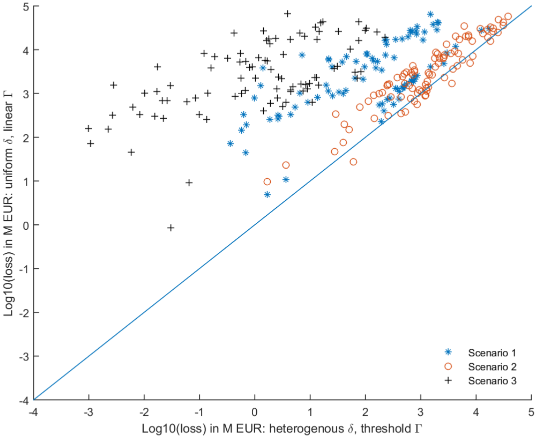

Figure: $\log_{10}$(fire sales loss) for different scenarios and different model combinations.

Distribution of fire sales losses 2

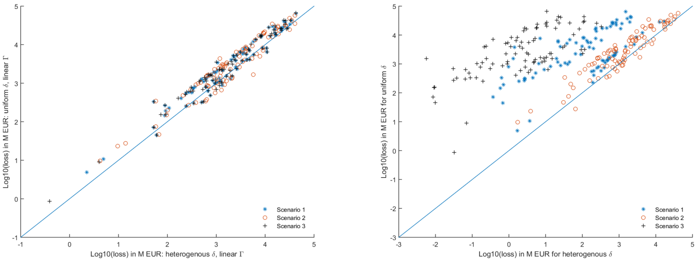

Figure: Relative importance of heterogeneous market depth (left) and different response function (right).

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. As one would expect, scenarios 1 & 3 are the most similar ones.

Sensitivity to initial stress scenario

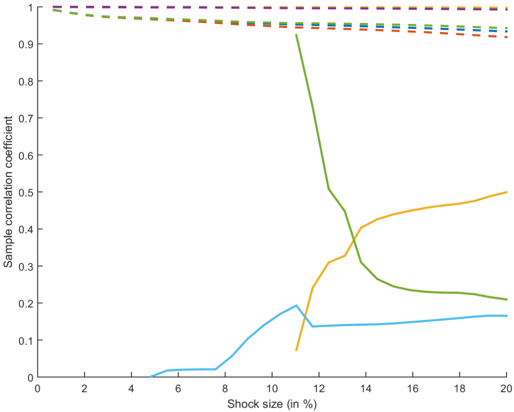

Figure: The pairwise sample correlation between the fire sales loss vectors of different scenarios as a function of the initial shock. Threshold model full lines - leverage targeting dashed lines.

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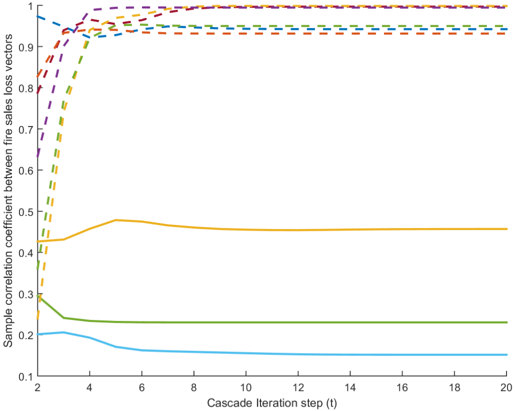


Figure: The evolution of the pairwise sample correlation during the fire sales cascade for a given scenario. Threshold full - leverage targeting dashed.

Individual vs. systemic stress test

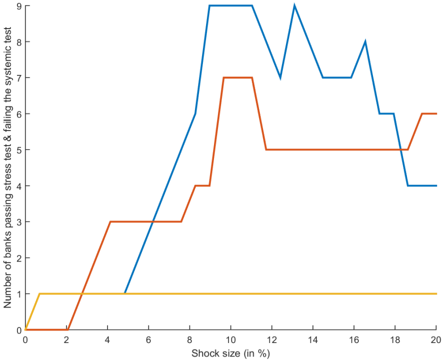
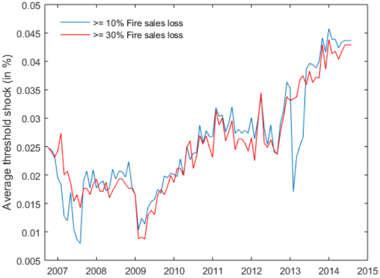


Figure: The number of banks (out of 90) that pass the individual stress test (i.e. initial loss) but fail the systemic stress test (initial + fire sales loss) for scenarios 1 to 3.

Constructing a Systemic Vulnerability Indicator

Figure: Threshold model: Fire sales losses as function of the initial shock and the market depth.

A Systemic Vulnerability Indicator



(a) Minimum shock required to trigger large fire sales cascades, as a function of time and market depth.

(b) Average minimum shock over all market depths.

Conclusions for modelling

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"Traditional" models of default cascades are not appropriate for macro stress testing purposes:

- Leverage targeting models can lead to counterintuitive outcomes when used to generate second-round effects in a stress testing context;
- While leverage targeting models seem better suited to capture long term dynamics, the threshold model seems to generate more realistic short term dynamics under stress.
- Seemingly innocent modelling choices on response functions, liquidity estimation, aggregation level and number of simulated rounds have a significant effect on results!

→ Need to better understand underlying assumptions, and their impact in terms of model risk.

Thank you!

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