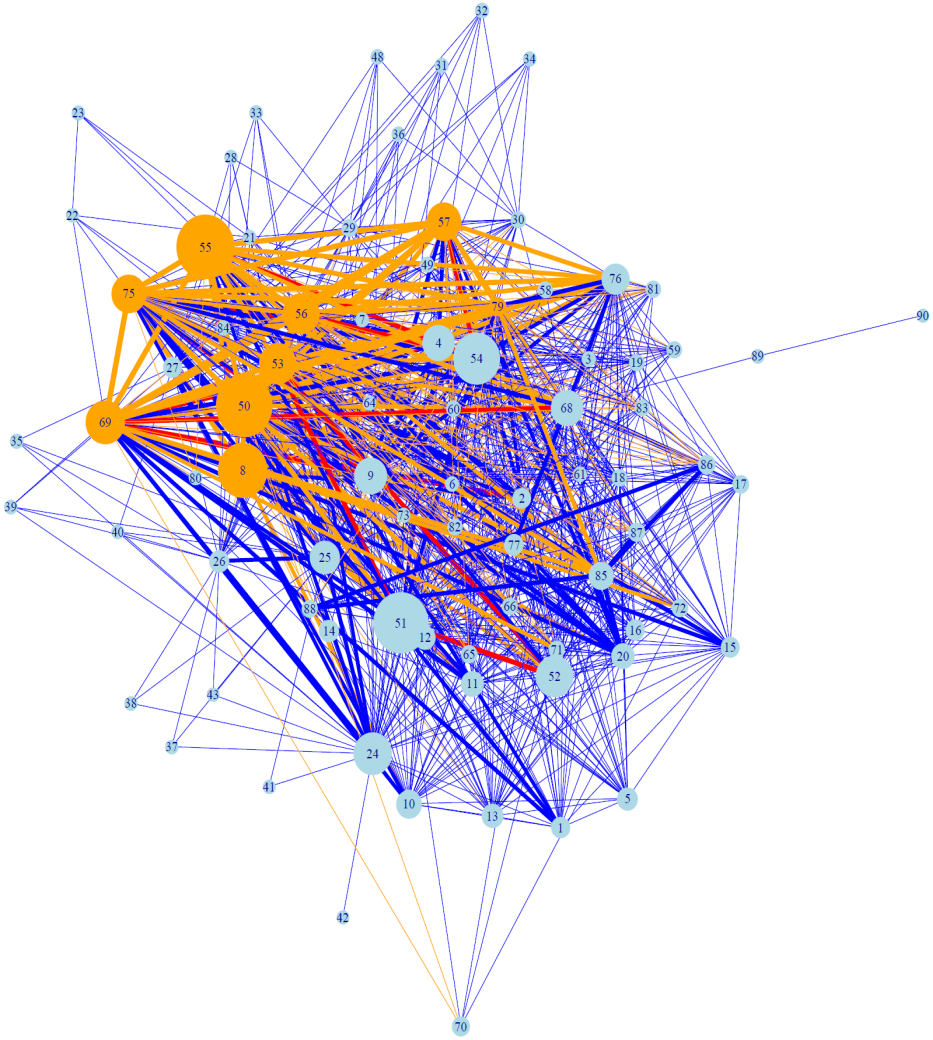
Risk amplification mechanisms in the financial system

Rama CONT



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Stress testing and risk modeling: micro to macro

- 1. **Microprudential stress testing:**
  -exogenous shocks applied to bank portfolio to assess adequacy of capital/ liquidity
- 2. **"Macro stress testing":**
  -shocks to macroeconomic variables affect all banks;
  -shocks to asset values derived from shocks to macroeconomic variables
  -accounts for systematic risk/ common exposures
  -does not account for contagion effects/ loss amplification
- 3. **Systemic / Macroprudential stress testing:**

-initial stress applied to macroeconomic variables

-shocks to asset values derived from shocks to macroeconomic variables

-focus on mechanisms which lead to systemic risk/ financial instability

-explicit modeling of contagion channels and loss amplification mechanisms

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Channels of loss amplification which contribute to systemic risk

- 1. Counterparty Risk: loss contagion through asset side
- 2. Funding channel: loss contagion through liability side
- 3. Feedback effects from fire sales: loss contagion through mark-to-market losses in common asset holdings
- These loss contagion mechanisms may arise before any default occurs (unlike earlier default contagion models).
- Regulatory measures have focused on 1 (large exposure limits, central clearing, CVA, ring-fencing) or 2 (LCR, NSFR).
- There are strong arguments for including such channels in supervisory bank stress tests.
- Most studies focus on a a single channel but channels do/may/ will interact and amplify each other.
- Most models focus either on (in)solvency or (il)liquidity but not on their interaction.

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Illiquidity: cause or symptom?

- The legal definition of ‘default’ corresponds to ‘default on payments’= illiquidity.
- Yet credit risk models often define failure as insolvency.
- Most recent bank failures involved failure to meet a margin call due to lack of liquid assets/cash/funding.
- This has prompted a regulatory focus on liquidity regulation and liquidity stress testing, separately from capital adequacy.
- But liquidity arises from repo or asset-backed borrowing, which links it back to asset value/ solvency: liquidity and solvency are intimately linked and cannot be modeled/ regulated independently.
- Bagehot principle: Lender of last resort should lend to *solvent* banks, at a penalty.
- More work is needed on the interaction of liquidity and solvency and the implications for realistic stress testing.

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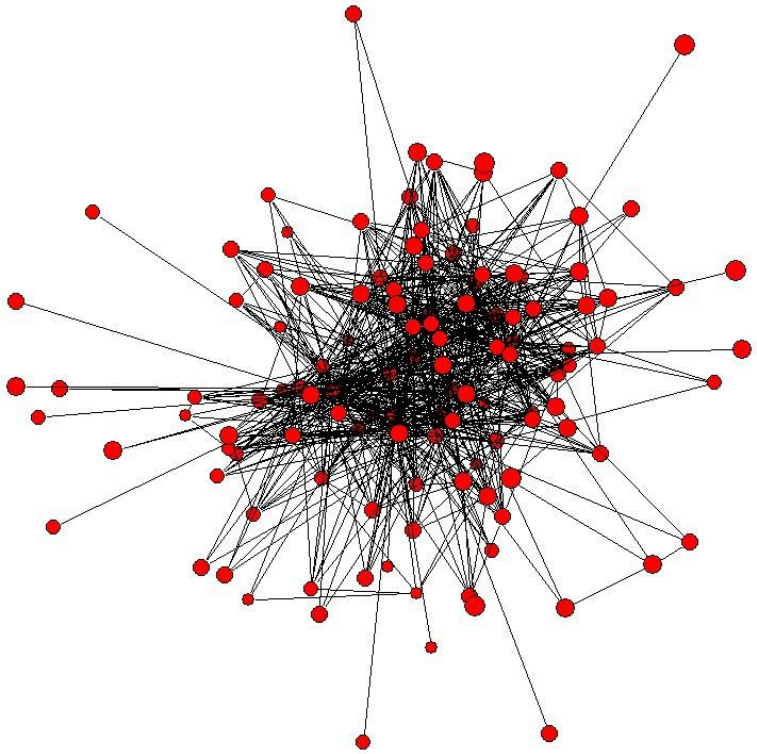
Direct contagion: exposure and liability networks

- Balance sheet contagion through

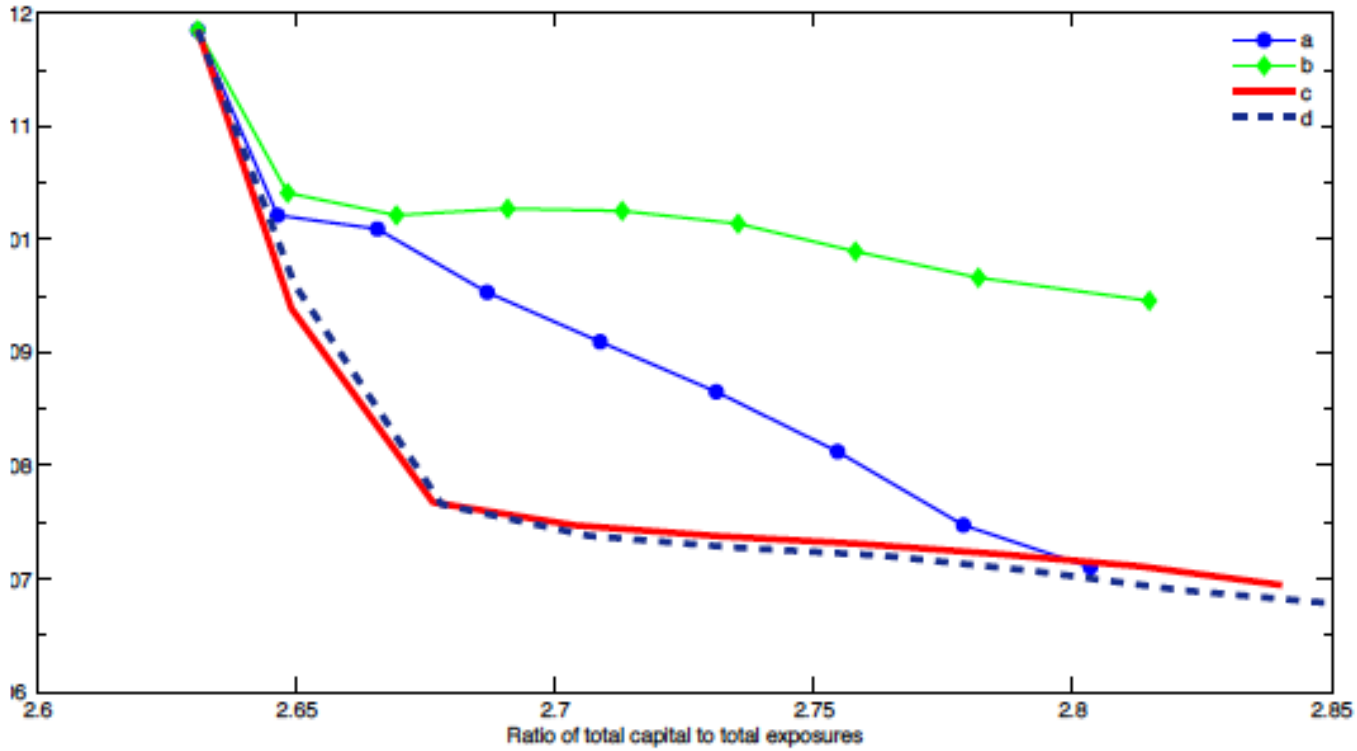
1. Exposures, which result in counterparty risk and lead to insolvency cascades
2. Funding relations, which result in funding risk and may lead to illiquidity contagion (institutional bank runs)

- Focus of new regulations:Large exposure limits, collateral requirements, CVA, LCR and diversification of funding (NSFR)
- Discounted in academic literature
- **Targeted capital requirements:** Due to the heterogeneity of exposure networks, loss transmission is channeled through "large exposures" and suggest limits/charges on large exposures. (Cont, Moussa, Santos 2013)



The Brazilian financial network
(Cont, Moussa, Santos 2013)

Focusing on weak links: targeted capital requirements



Comparison of various capital requirement policies: (a) uniform capital ratio for all institutions in the network, (b) higher capital ratio for the 5% most systemic institutions (SIFIs), (c) uniform capital-to-exposure ratio (d) capital-to-exposure ratio for the 5% most systemic institutions.
(Cont Moussa Santos 2013)

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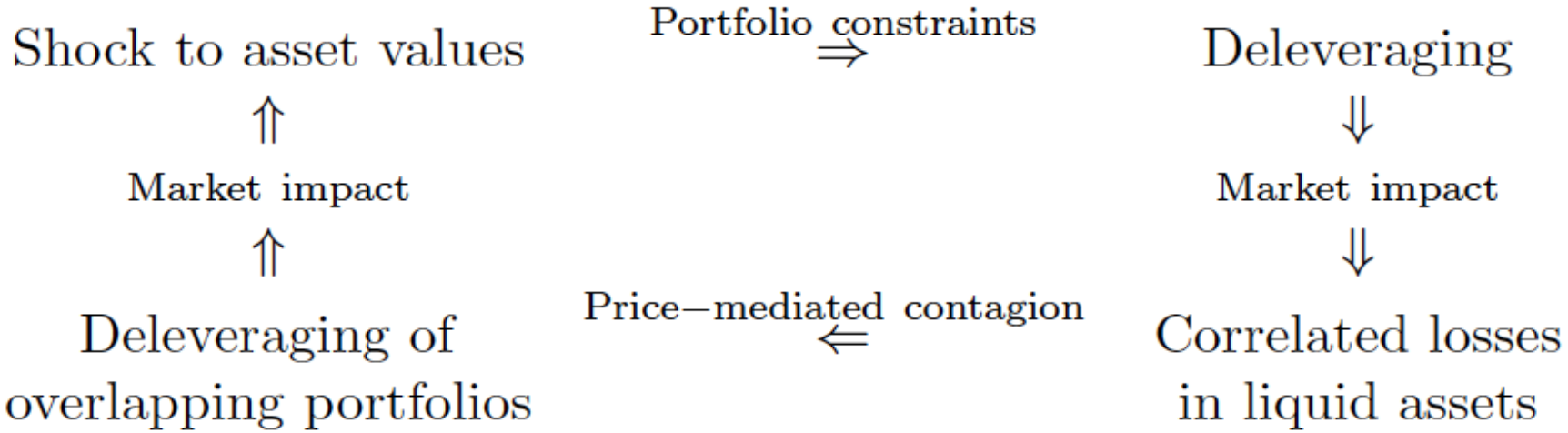
Indirect contagion: fire sales and feedback effects

- Distressed institutions subject to (capital, liquidity, leverage) constraints sell assets according to liquidity.
- Asset sales by distressed institutions pushes down prices and generates mark-to-market losses for institutions holding similar assets.
- This may trigger further deleveraging and generate a destabilizing feedback loop:



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Systemic stress testing with fire sales spillovers (Cont & Schaanning 2015)

- N institutions (banks or not) with holdings across k assets
- Inputs: Holdings of institutions by asset class
- Macro-economic shock ε affects (some) asset values
- If loss of portfolio j exceeds a threshold, institution deleverages by selling assets.
- Assumption: Proportional deleveraging to restore portfolio leverage to a buffer level: $Q_{ij}(\varepsilon)$= vol of sales of asset i by j
- Total volume of fire sales in asset i: $Q_i(\varepsilon) = \Sigma\, Q_{ij}(\varepsilon)$
- Fire sales affect prices through market impact:

$$S_1^i = S_0^i \left(1 - \frac{Q_0^i(\epsilon)}{\delta_i}\right)$$

- These price changes generate losses in all portfolios exposed to these assets and may generate further deleveraging

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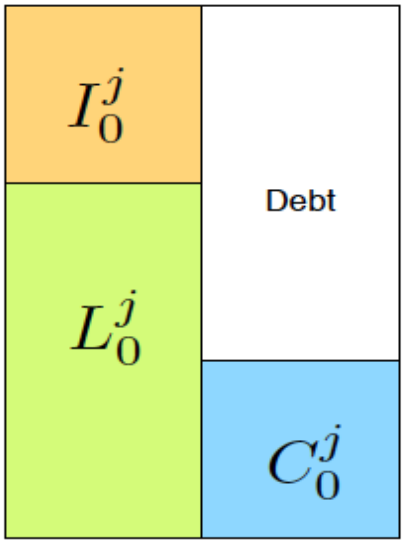
A systemic stress test with indirect contagion



- J leveraged institutions;
- N classes of liquid assets: Π_0^{ji} is the number of shares in asset i held by j;
- Liquid assets value is $L_0^j = \sum_{i=1}^{N} \Pi_0^{ji} S_0^i$;
- Illiquid assets: I_0^j (loans, etc.)
- Core Tier 1 capital C_0^j;
- The initial leverage is

$$\lambda_0^j = \frac{I_0^j + L_0^j}{C_0^j} \leq \lambda_{\max}$$

- Leverage constraint: $\lambda_{\max}$

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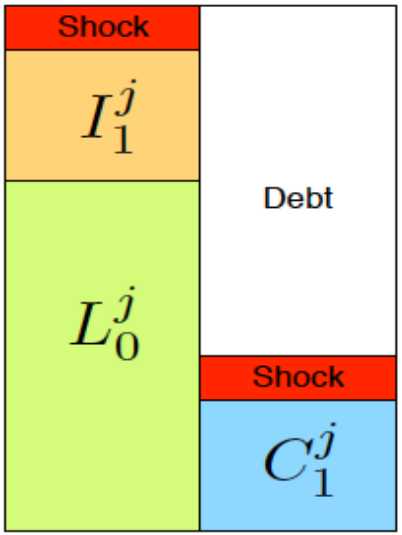
A systemic stress test with indirect contagion



- Illiquid assets subject to a loss of $\epsilon\%$
- Impulse-response analysis of system to external shock: no statistical assumption on shock distribution.
- Scenario can be a regulatory stress test with joint shocks to several asset classes;
- Deleveraging occurs when

$$\lambda_1^j = \frac{L_0^j + I_0^j(1-\epsilon)}{C_0^j - \epsilon I_0^j} > \lambda_{\max}$$

$$\iff \epsilon > \frac{C_0^j(\lambda_{\max} - \lambda_0^j)}{I_0^j(\lambda_{\max} - 1)} = \epsilon_j^*.$$

- Deleveraging is **asymmetric** wrt loss vs gain $\neq$ 'leverage targeting'.

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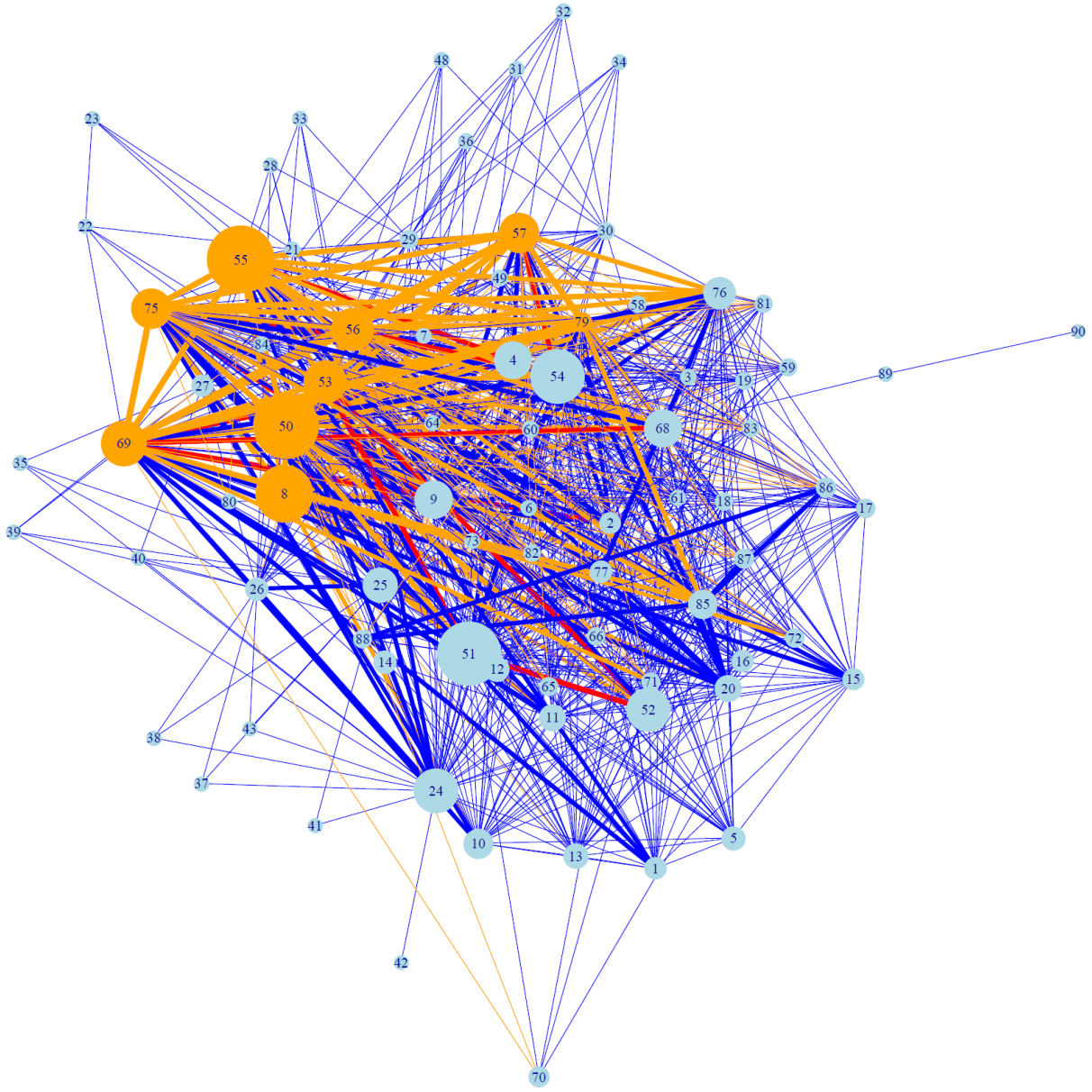
The EU indirect contagion network



Node sizes are proportional to balance sheet size. Edge widths are proportional to the liquidity weighted overlap with the largest values in red.

(Cont Schaanning 2015)

Data: EBA.

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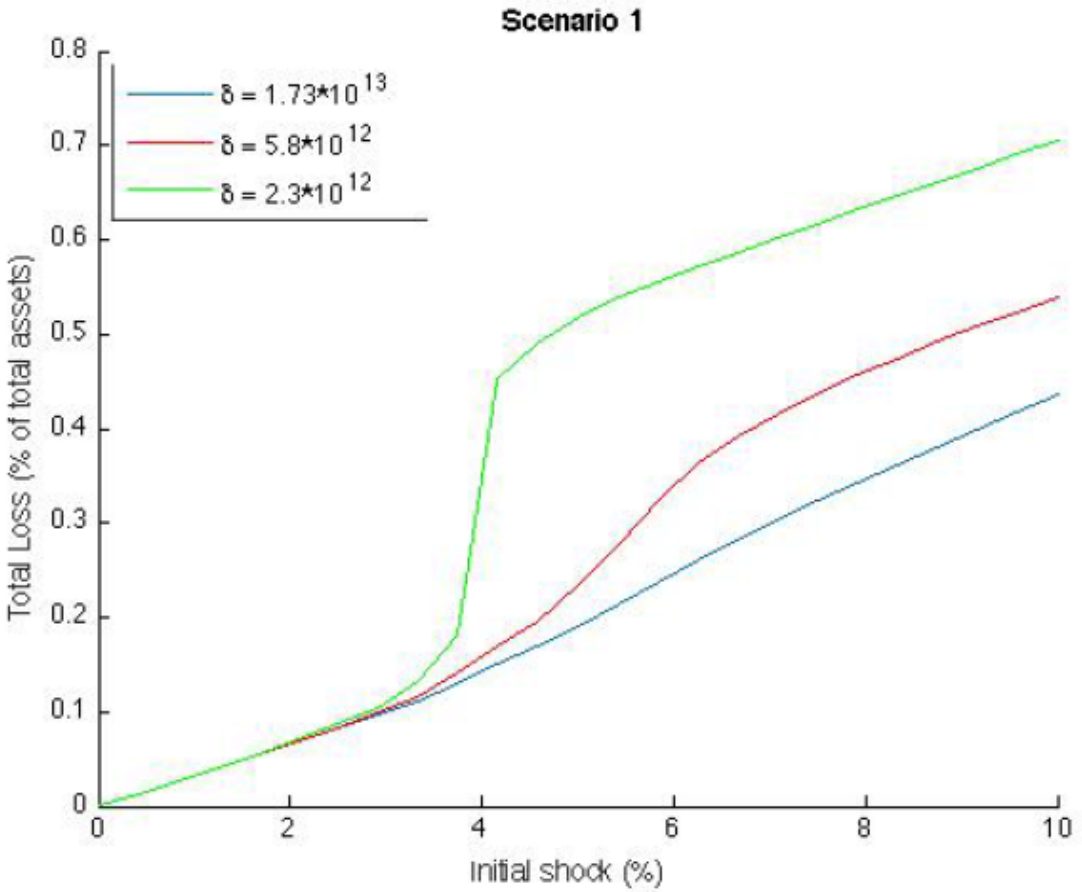
Threshold nature of fire sales contagion



Magnitude of the fire sales loss as % of total EU bank equity.

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Fire sales lead to indirect exposures

- Consider two institutions, a non-bank (A) and a bank (B).
- A and B hold a common financial asset (1). A holds an illiquid asset (2) that B does not hold.
- Notional exposure of B to 2 is zero.
- However, in the event of a large shock to the value of the illiquid asset (2), A may be forced to sell some of its financial assets, pushing down its market price, resulting in a market loss for the bank B. So:
- B experiences a loss following a large shock to the illiquid asset: B has an (indirect) exposure to an asset it does not hold
- The magnitude of this indirect exposure is directly linked to the overlap between B and institutions holding this asset.
- **Large diversified institutions increase overlaps across system and become nodes for price-mediated contagion**.

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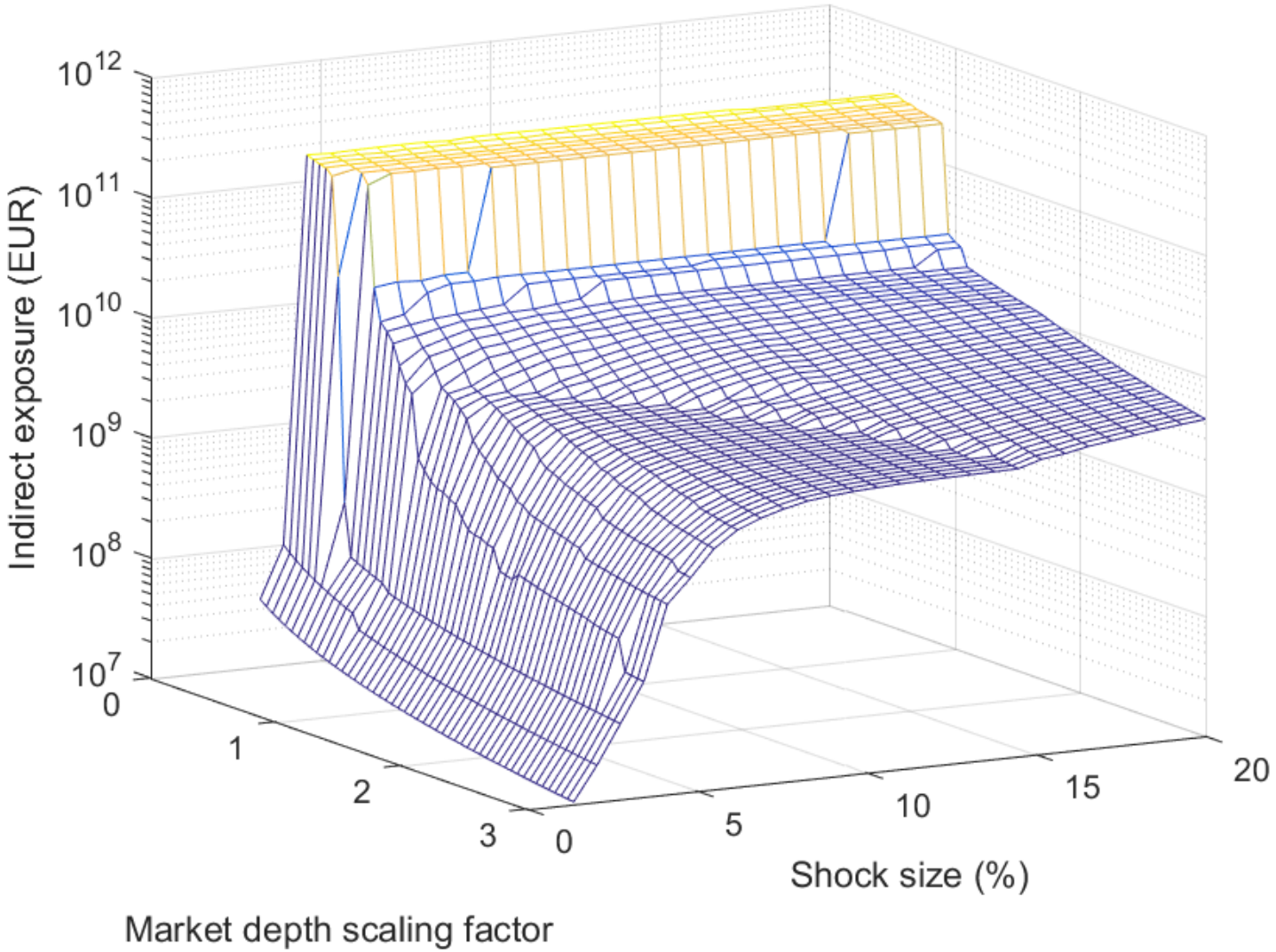
Indirect exposures

The **effective exposure** of institution i to asset class κ is given by

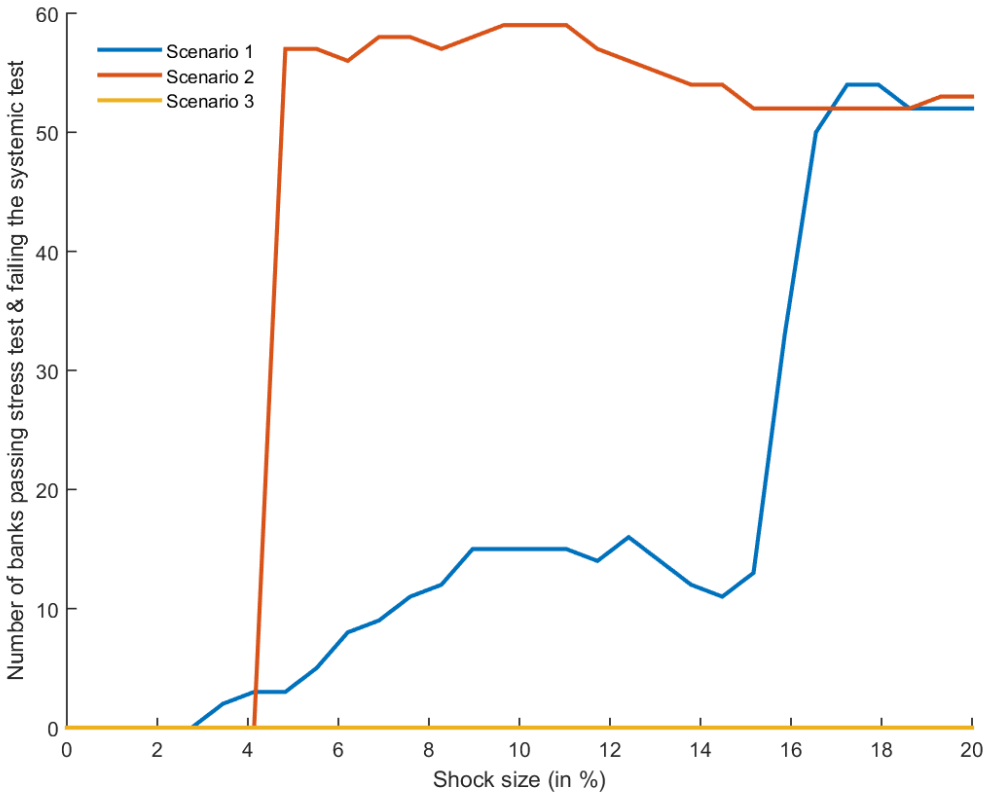
$$E^{i,\kappa}(\epsilon_\kappa) := \frac{\text{Loss}(i,\epsilon_\kappa)}{\epsilon_\kappa} = \underbrace{\Theta^{i,\kappa}}_{\text{Notional exposure}} + \underbrace{\frac{FLoss(i,\epsilon_\kappa)}{\epsilon_\kappa}}_{\textbf{Indirect exposure}},$$

where $FLoss(i,\epsilon_k)$ is the *total fire sales loss* that i suffers as a result to the shock ϵ_κ to asset class κ.

Indirect exposures of UK to Spanish mortgages



Indirect exposures are significant: banks can pass stress test but fail systemic stress test



Number of EU banks which pass the (stand-alone) stress test but the fail to have enough capital to face fire-sales losses due to indirect contagion
(Cont & Schaaaning 2015) Data: EBA.

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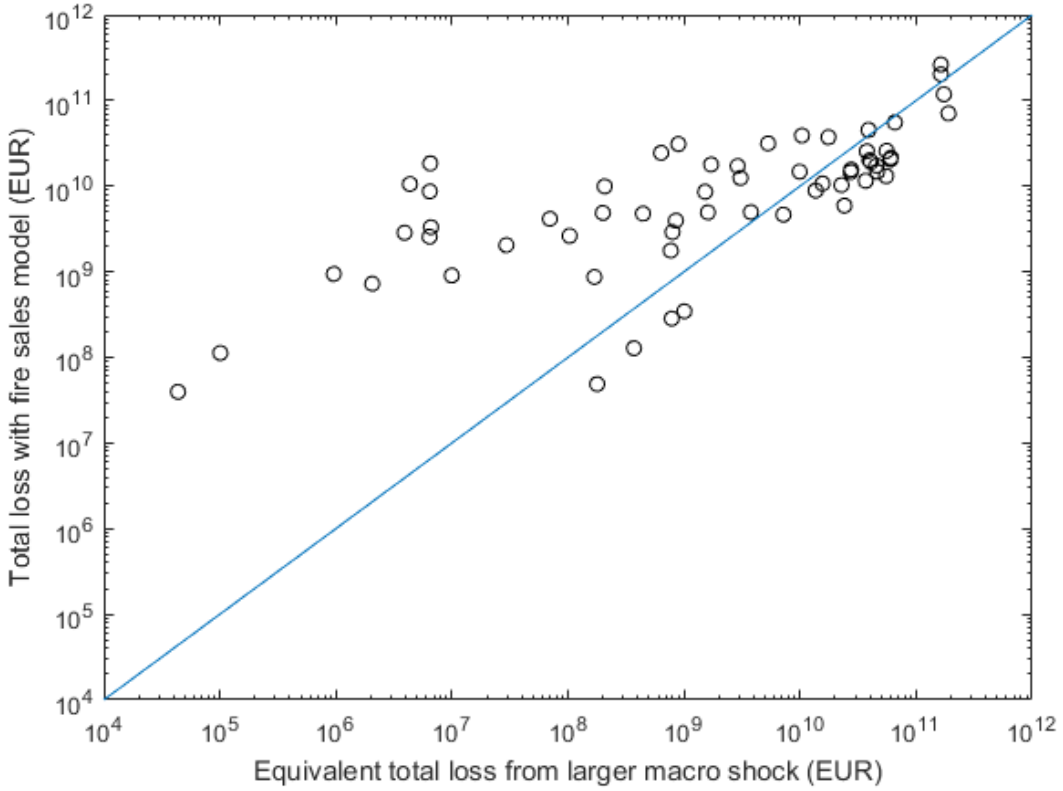
Can the effects of indirect contagion be replicated by more severe stress scenarios without contagion effects?



Bank-level losses in a systemic stress test with fire sales (vertical axis) compared with losses in a stress test without fire sales whose severity is scaled to match total loss (horizontal axis). Total system-wide loss is same for both scenarios but losses for some banks are 10 to 100 times larger (Cont & Schaaaning 2015) Data: EBA 2011.

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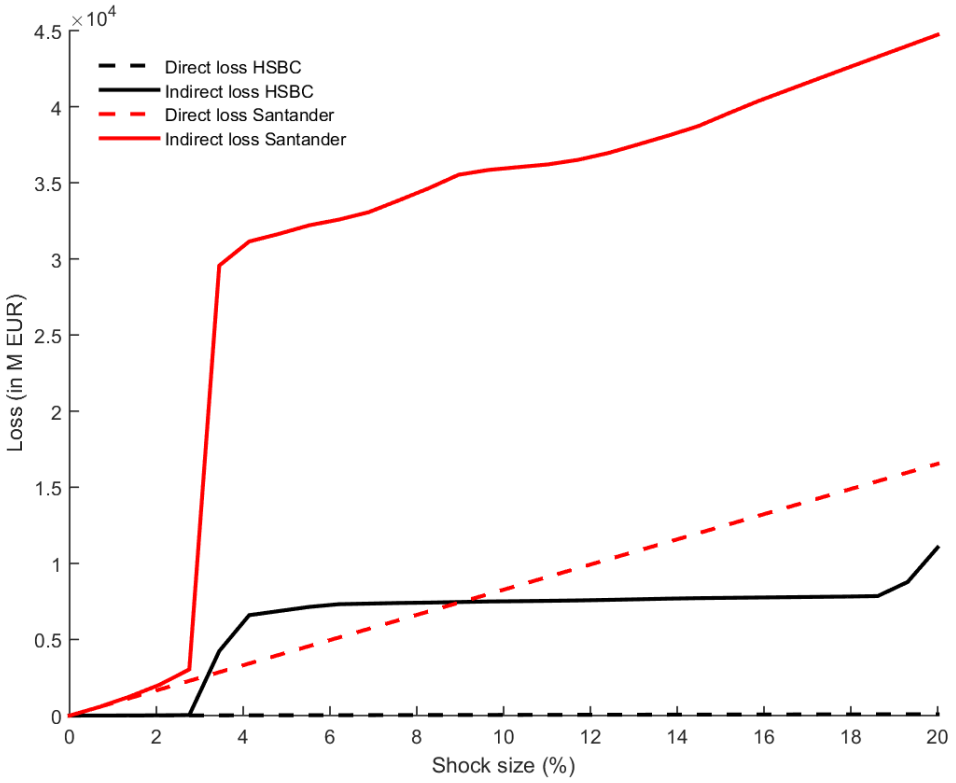
Dissemination of indirect exposures can be useful

- Indirect exposures are significant in magnitude: EU banks have significant indirect exposure to non-domestic housing prices.
- This means that the risk of a bank portfolio cannot be computed simply from its notional positions but is the outcome of a network-wide stress test depending on the configuration of portfolios of other large financial institutions.
- Disclosure of indirect exposures, computed in a systemic stress test, to each institution gives them an extra element which they can subsequently use to internalize /manage this risk.



Direct and indirect exposures to the Spanish housing market for two EU banks.
(Cont Schaanning 2015) Data: EBA.

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Financial stability beyond the banking system

- The majority of assets in the world financial system is held **outside the banking system**: insurance, asset managers, pension funds.
  Example: European insurance sector holds 6.8 Trillion EUR in assets
- Tighter bank regulation has pushed many activities outside banking sector.
- The distinction between banks and non-banks is related to their supervisory and legal regime but loss contagion mechanisms also affect non-banks;
- Losses outside the banking system can destabilize banks (AIG 2008).
- This pleads for inclusions of major non-bank financial institutions in any system-wide stress test focused on financial stability.
- **Diversity of business models**: Non-banks have different business models and different reactions to stress so policy tools used for banking regulation (in particular: capital requirements) may not be relevant or meaningful.
  Ex: CCPs, insurance (ALM constraints), asset managers (redemption risk)
- **Diversity of business models and regulatory regimes as a stabilizing factor:** institutions with same constraints tend to react similarly to stress scenarios -> argument against uniform/ overly prescriptive regulations.
  Example: Solvency II/ Basel III

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Governance of Macroprudential stress tests

•Beyond the consensus of the 'usefulness' of macroprudential /systemic stress tests, of **policy implications** We propose here three avenues:

1.Dissemination of results: making invisible risks visible

-to regulators: more realistic assessment of systemic risk and financial stability (bank stress tests, IMF FSAP)

-to financial institutions: Financial institutions are not necessarily aware of the magnitude and nature of their exposures to systemic risk, since it requries information only available to regulators.

Dissemination of information on the outcome of systemic stress tests to financial institutions, in the form of their own exposures to various stress scenarios and contagion channels, can help them improve risk governance.

2. Implications for capital adequacy:

Capital adequacy should be reexamined by accounting for all risks, not just 'microprudential' stress tests.

3. Cost-benefit analysis of macroprudential regulation:

'Macroprudential' stress tests can offer a meaningful approach to assessing costs and benefits of new regulatory measures and their interactions.

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Summary

- Empirical studies point to the importance of loss amplification by direct and indirect contagion and the importance of including them in macroprudential stress tests.
- Loss contagion mechanisms do not distinguish between banks and non-banks, which pleads for extending the data collection and supervisory mechanisms to all financial institutions.
- Indirect contagion through fire sales can affect all financial institutions, banks or not, and lead to indirect exposures across banks mediated by other banks or non-banks.
- Communicating the results of systemic stress tests to financial institutions in terms of their indirect exposures can help them internalize and manage their systemic risk exposures.
- This requires data on institutional asset-class holdings, of the type used for bank stress tests.
- Capital adequacy criteria should incorporate a realistic assessment of systemic risk exposures,

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