Systemic Risk Management in Financial Networks with Credit Default Swaps

Matt V. Leduc, Sebastian Poledna and Stefan Thurner

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Introduction

- **Systemic Risk (SR):**
  - Property of systems of interconnected components:

    Failure of a single entity (or small set of entities) can result in a cascade of failures jeopardizing the whole system.

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- This happens in financial (i.e. interbank) systems:
  $\Rightarrow$ Failure to manage systemic risk (SR) can be extremely costly for society (e.g. financial crisis of 2007-2008)
- Regulations proposed fail to address the fact that SR is a network property (BASEL III. e.g. Tobin taxes, capital requirements)

Insolvency Cascades in Networks

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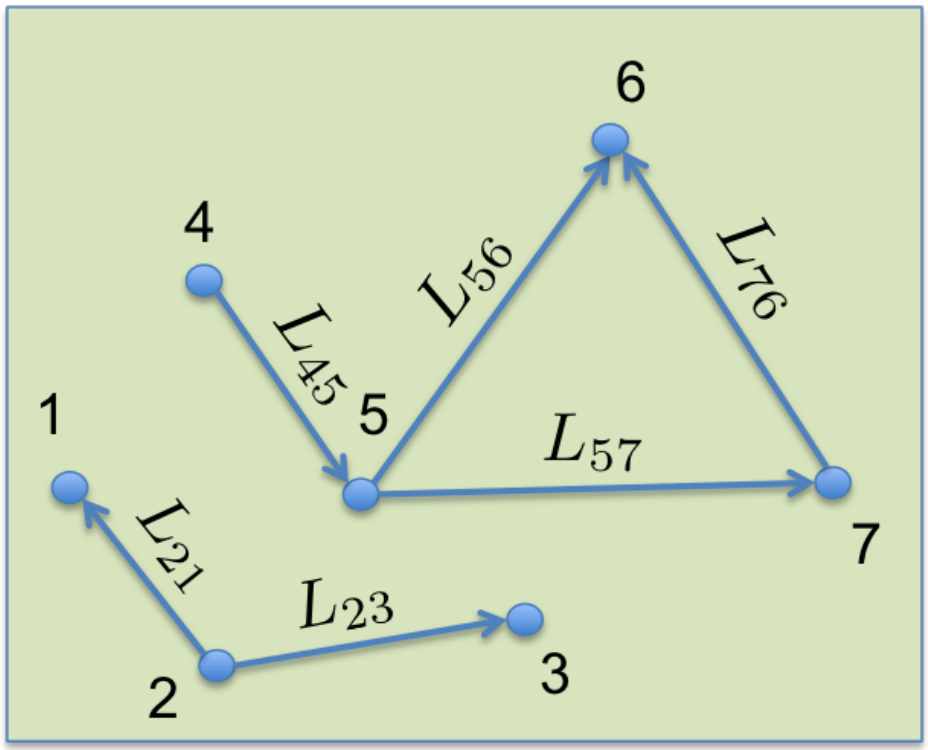

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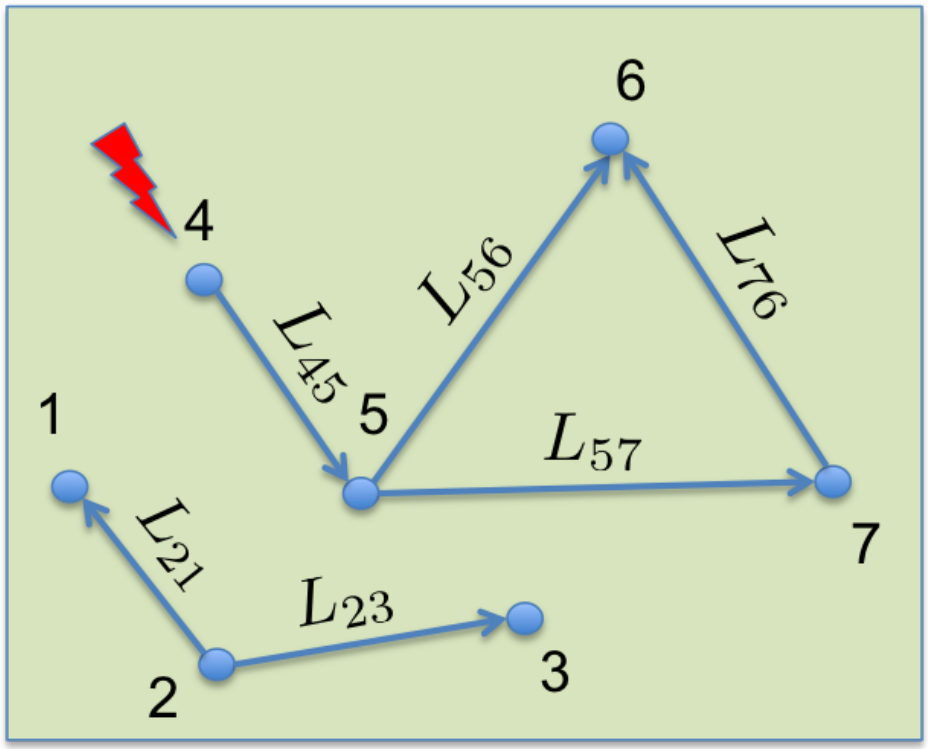

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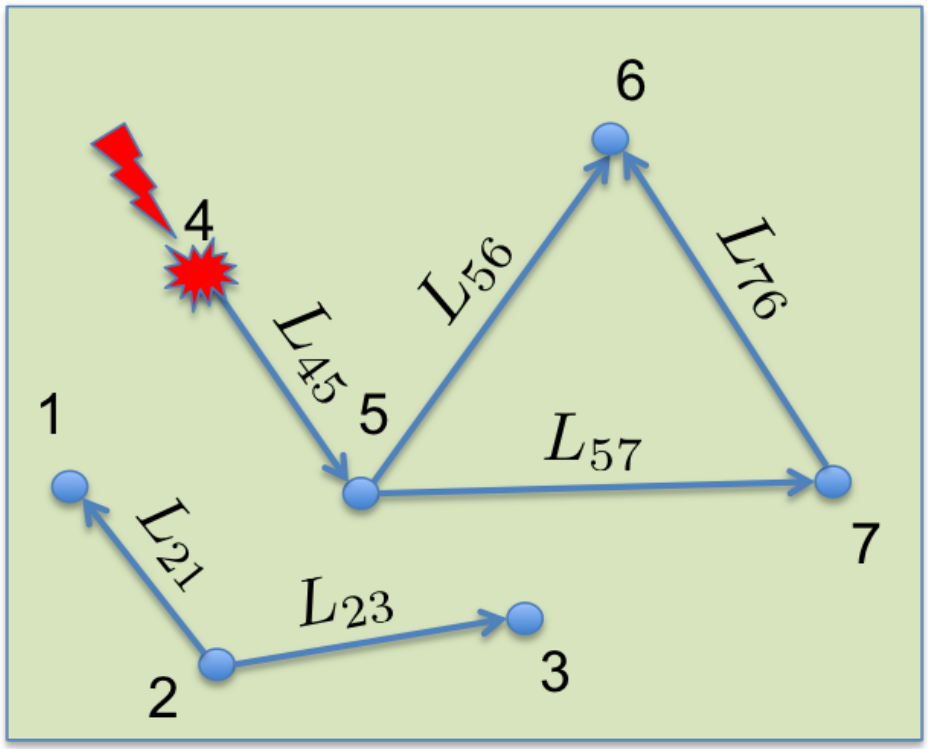

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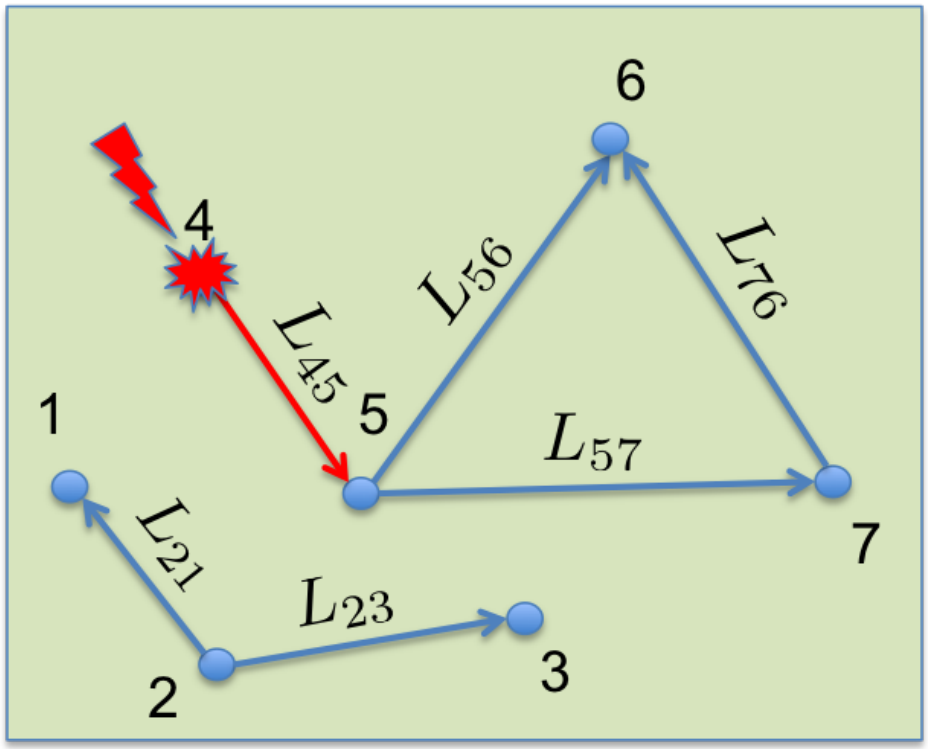

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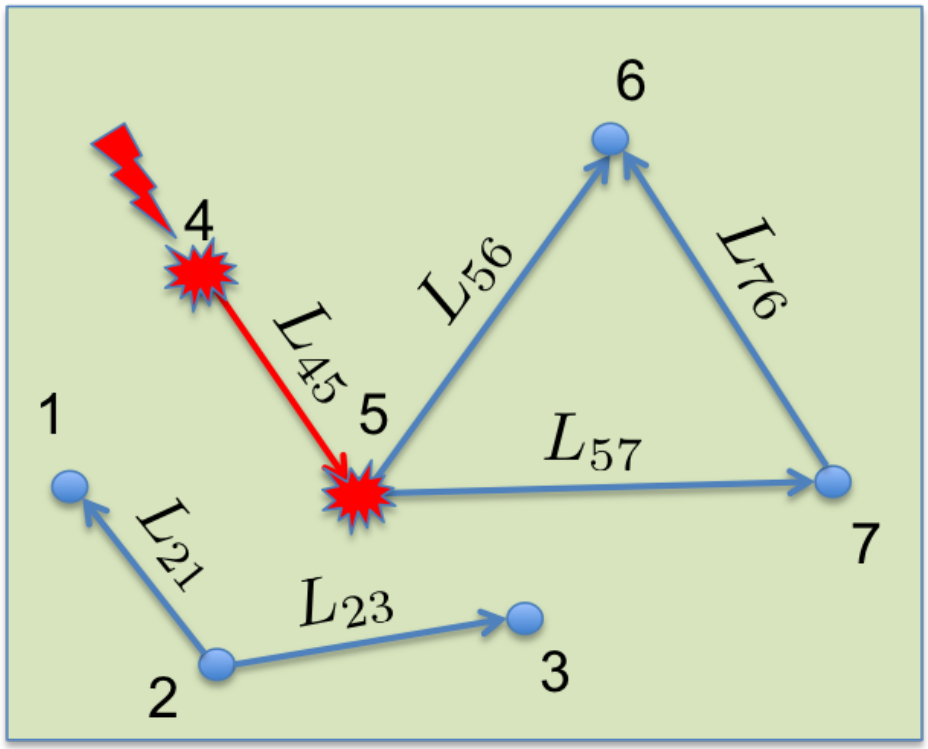

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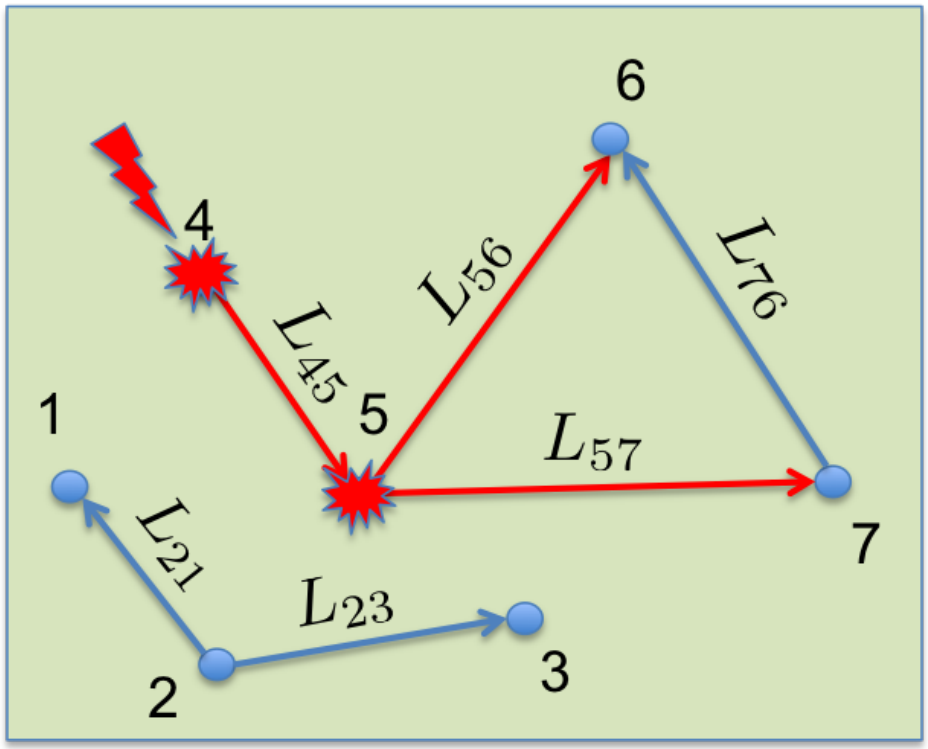

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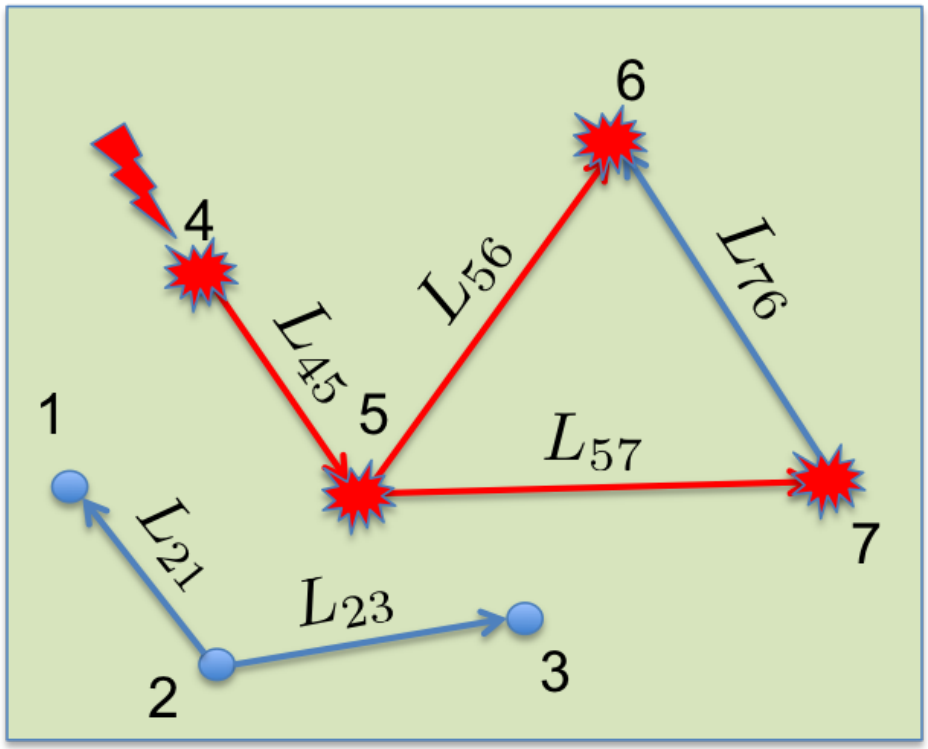

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Insolvency Cascades in Networks

- Different topologies have different effects on size of insolvency cascades (e.g. Boss et al. (2004), Gai & Kapadia (2010), Amini et al. (2013), Poledna et al. (2015))
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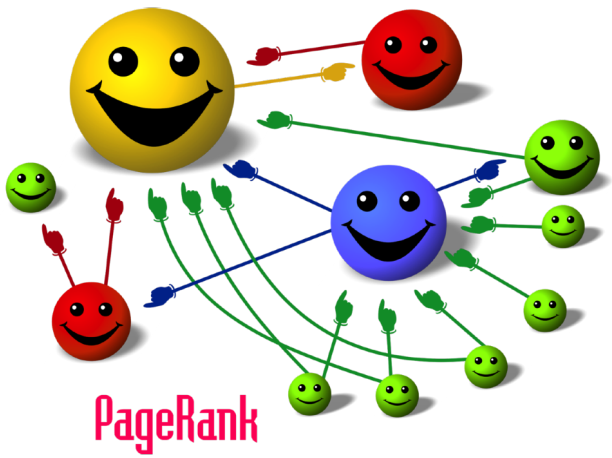
- Systemic risk can be quantified by DebtRank (Battiston et al. (2012))
- Similar to PageRank:



source Wikipedia cc-license

$\Rightarrow$ A page is important if many important pages point to it

Systemic Risk: DebtRank

- DebtRank: An institution is *Systemically Risky* if many *Systemically Risky* institutions are exposed to it

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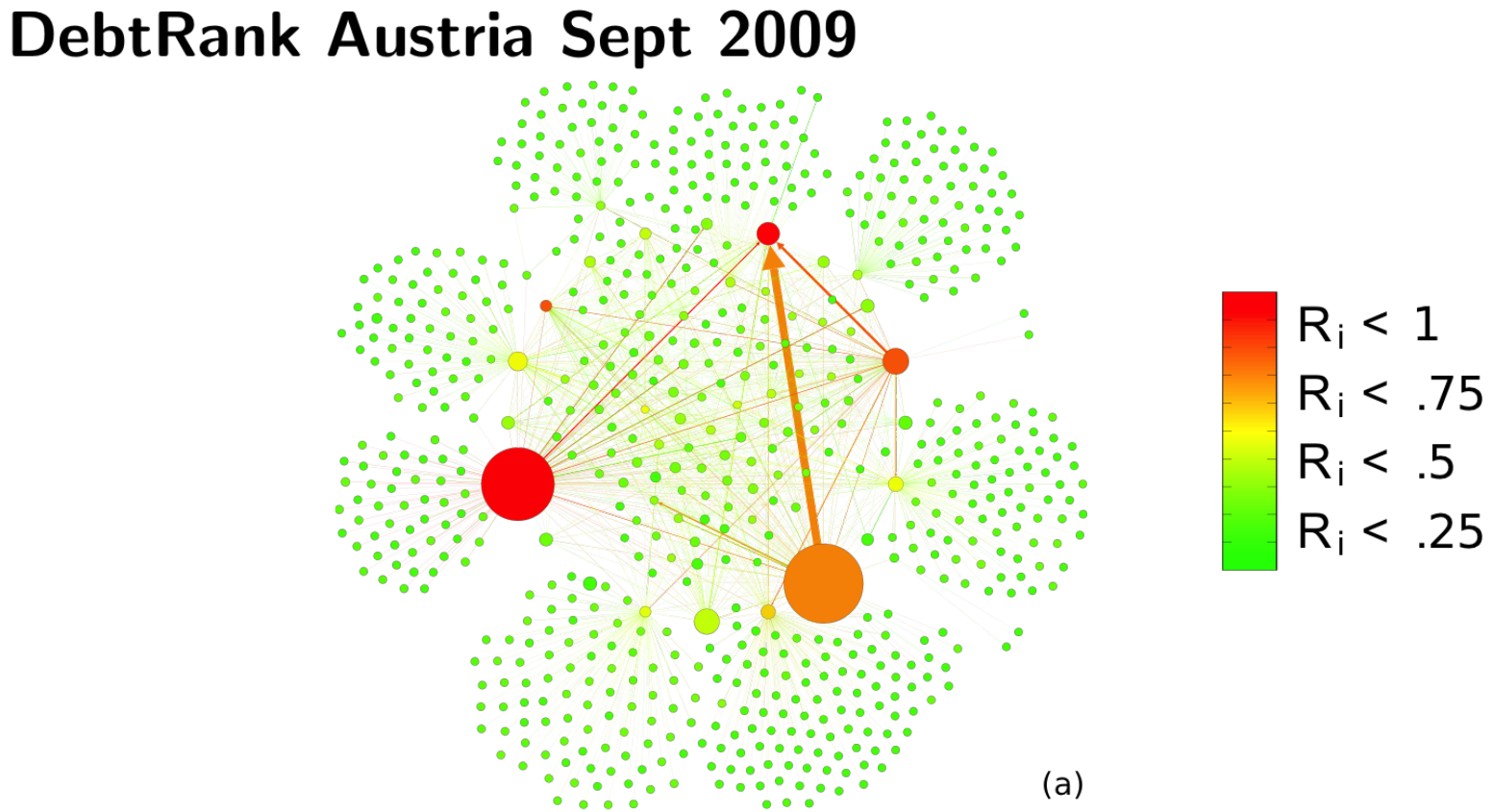
- DebtRank: An institution is *Systemically Risky* if many *Systemically Risky* institutions are exposed to it
- DebtRank R_i of bank i: fraction of economic value in the financial network that is lost following i's default



Systemic Risk: DebtRank

- A meaningful measure of a network's systemic risk:

$$EL^{\text{syst}} = \sum_i p_{default}(i) \cdot R_i$$

Effect of a Particular Loan Exposure

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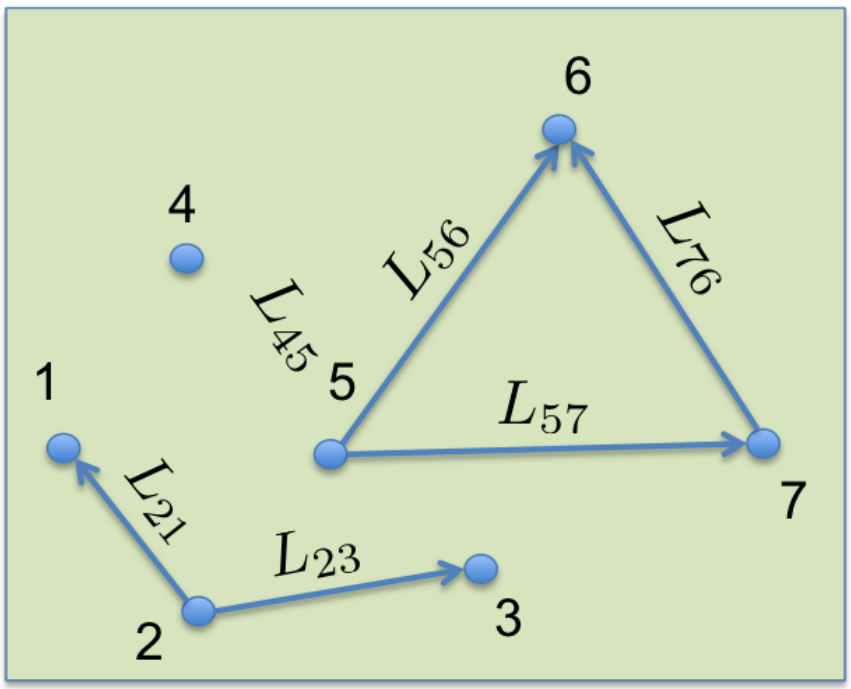

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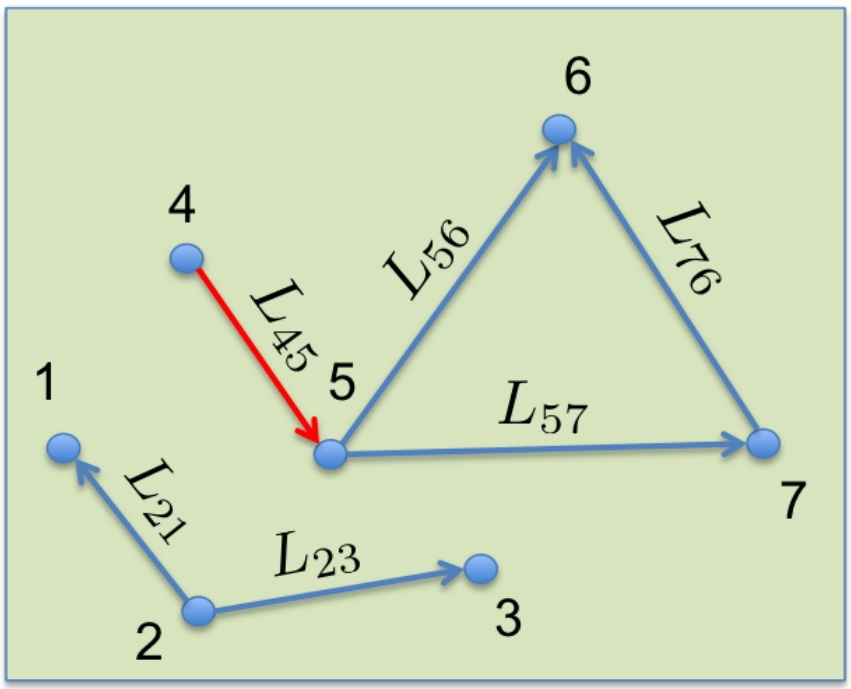

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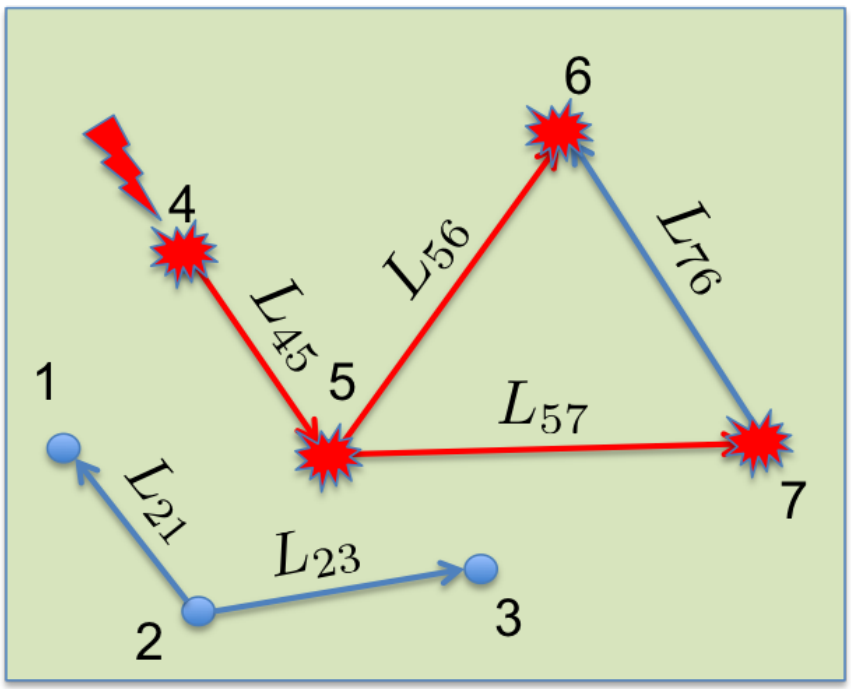

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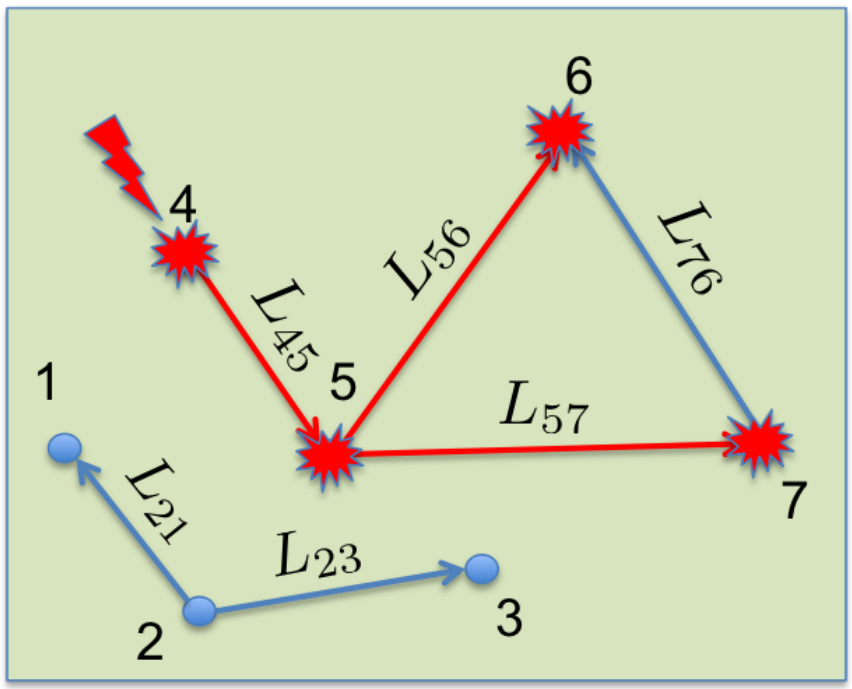

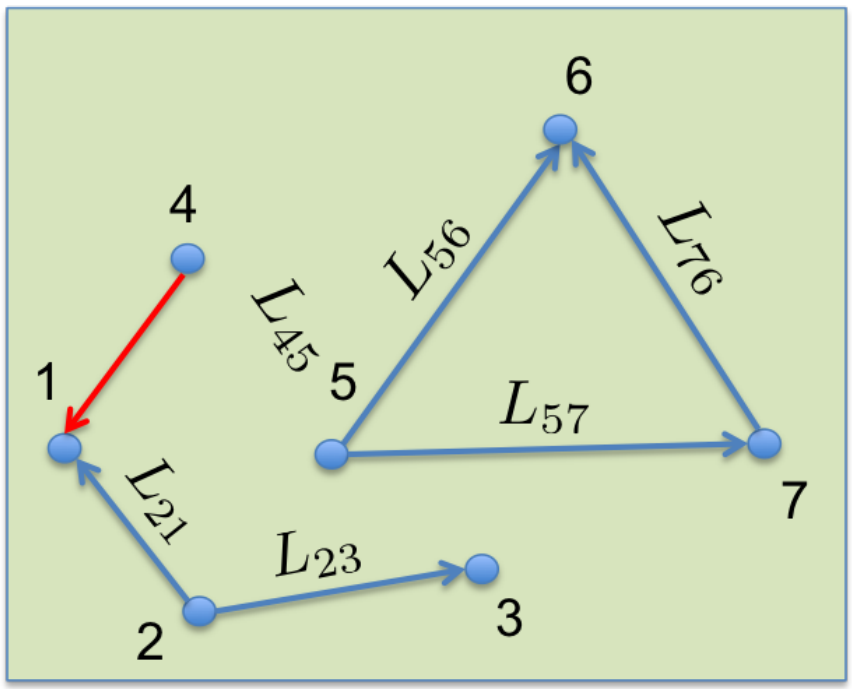

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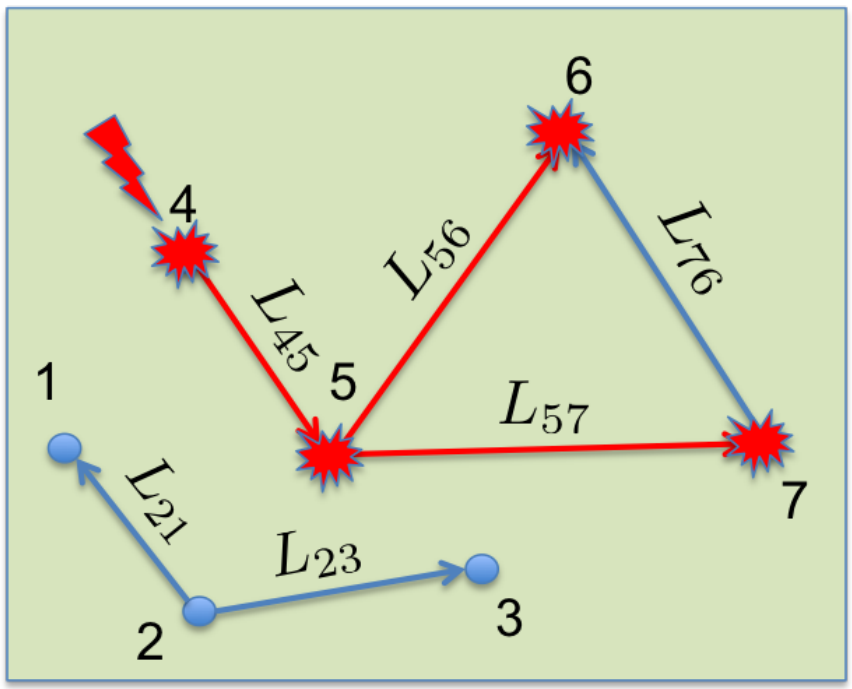

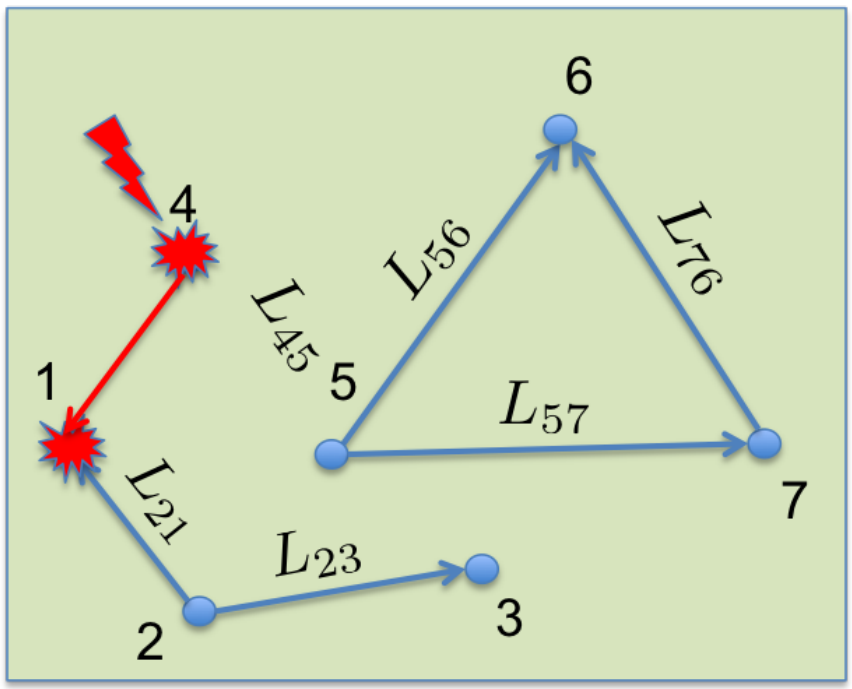

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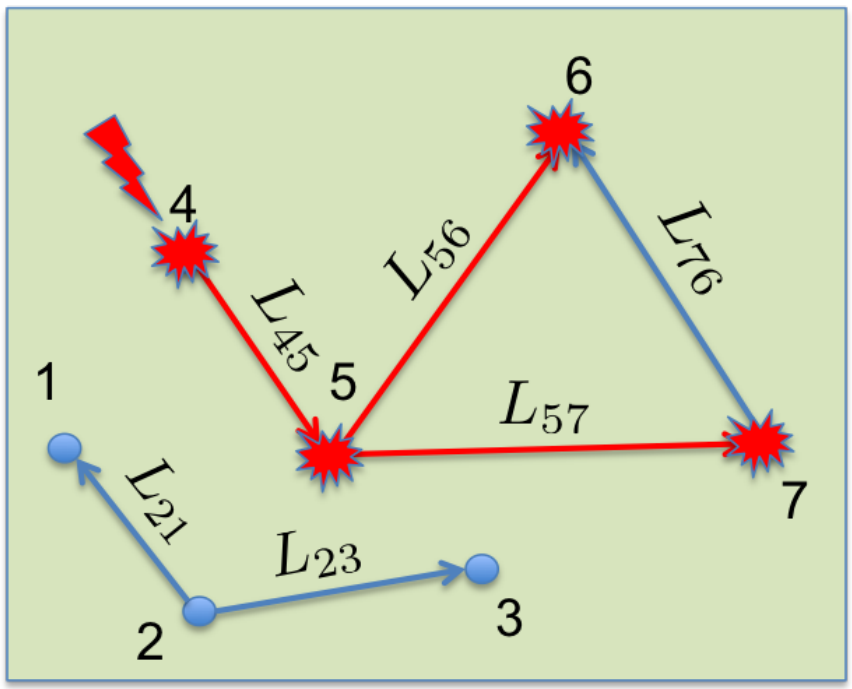

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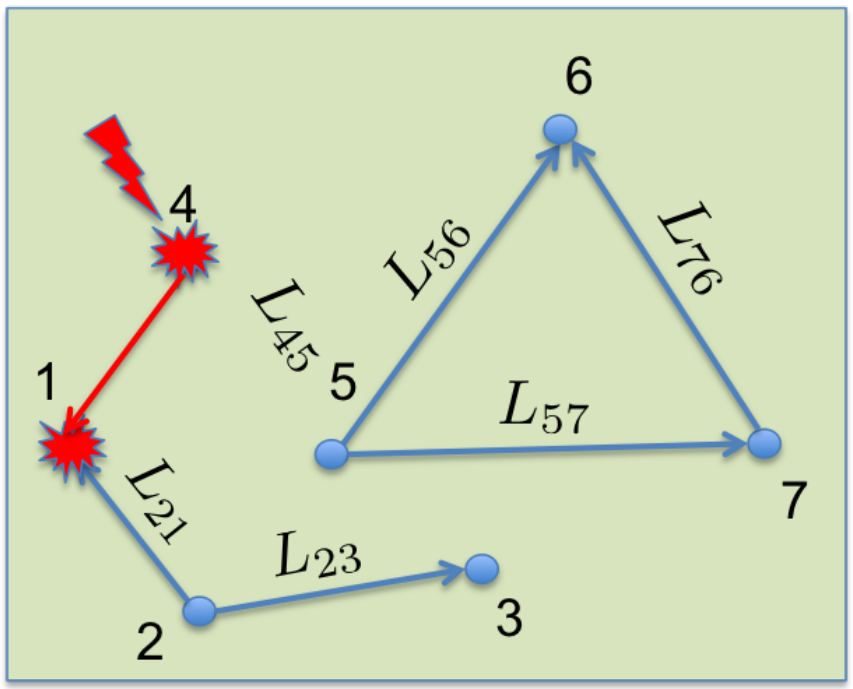

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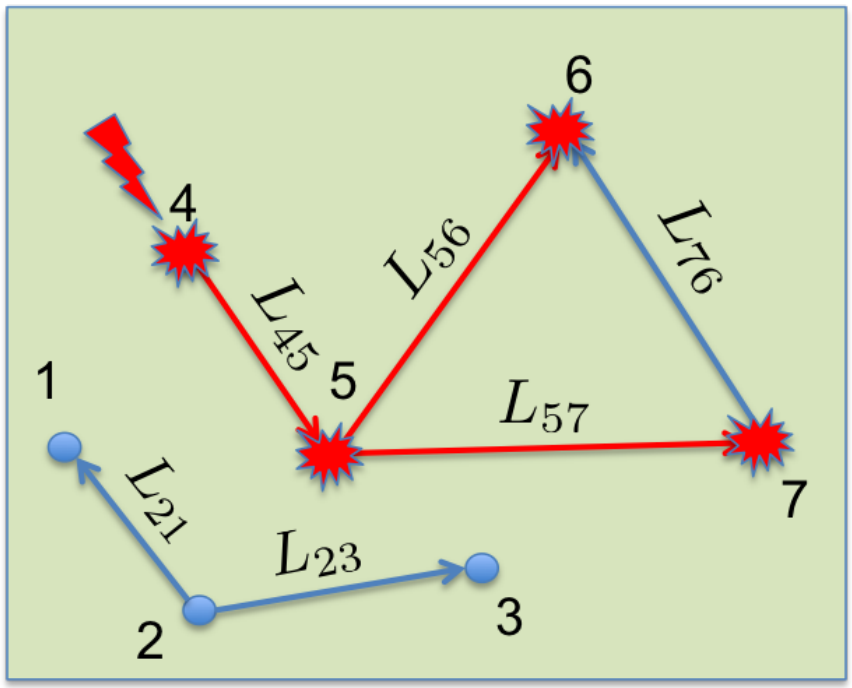
Effect of a Particular Loan Exposure

- **Observation**: different loans (directed edges) have different incremental effects on systemic risk
- **Question**: how can we reorganize the network of exposures?



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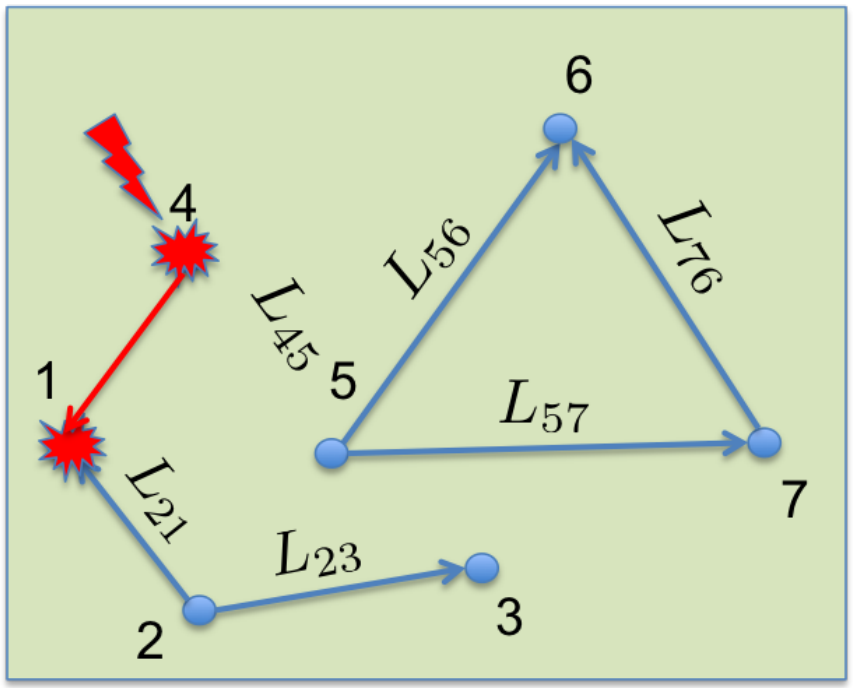
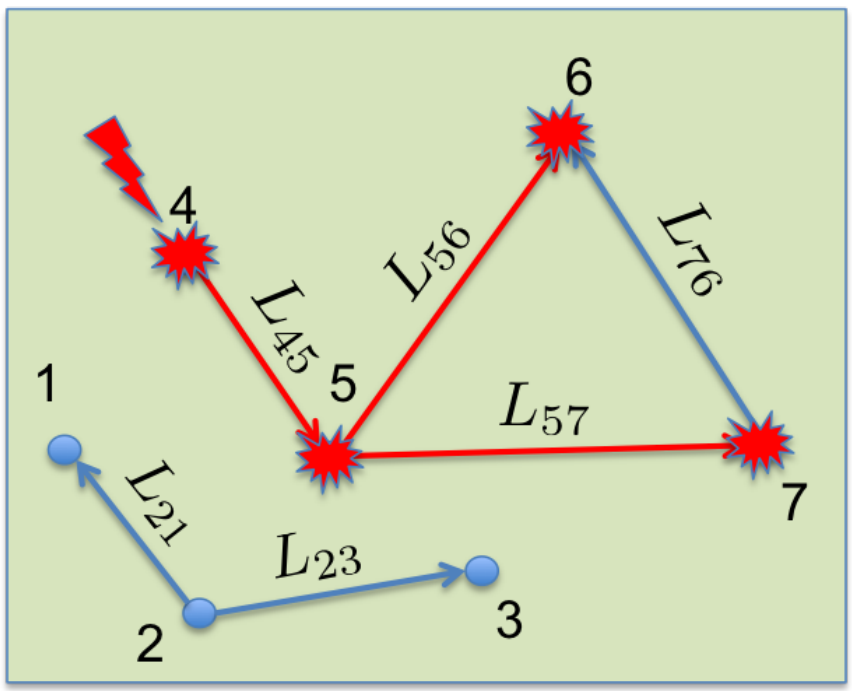
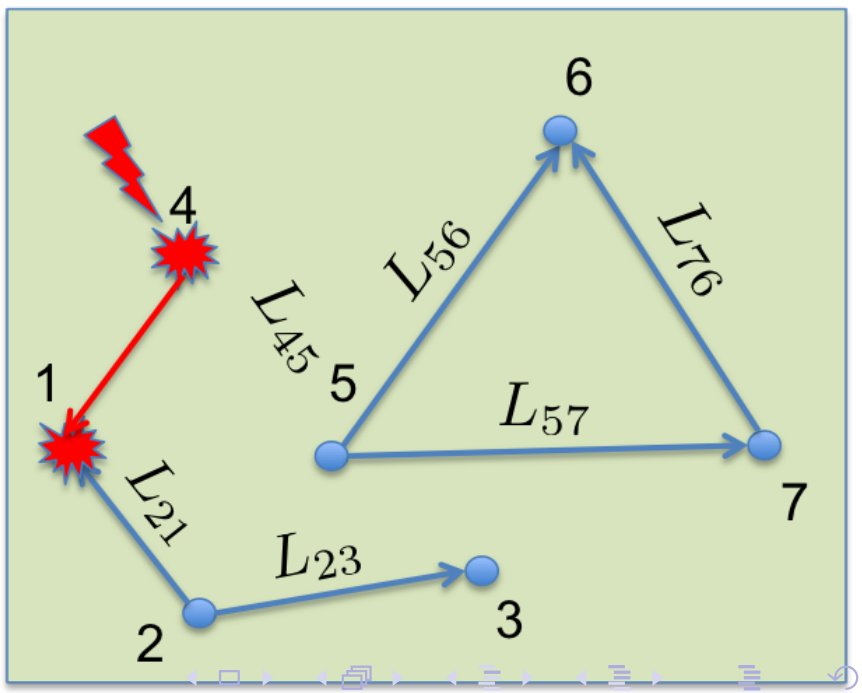


EL^{syst}

Effect of a Particular Loan Exposure

- **Observation**: different loans have different effects on systemic risk
- **Question**: how can we reorganize the network of exposures?
- **Answer**: We can transfer an exposure from one bank to another using a Credit Default Swap (CDS)





Controlling the Formation of Financial Networks: CDS's

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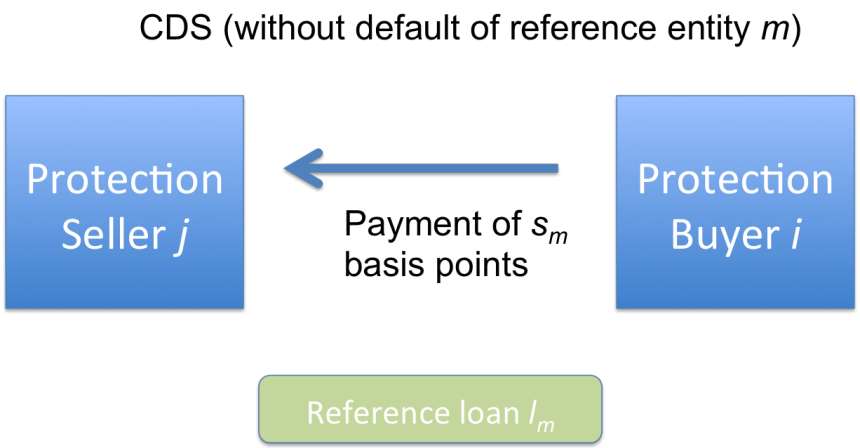

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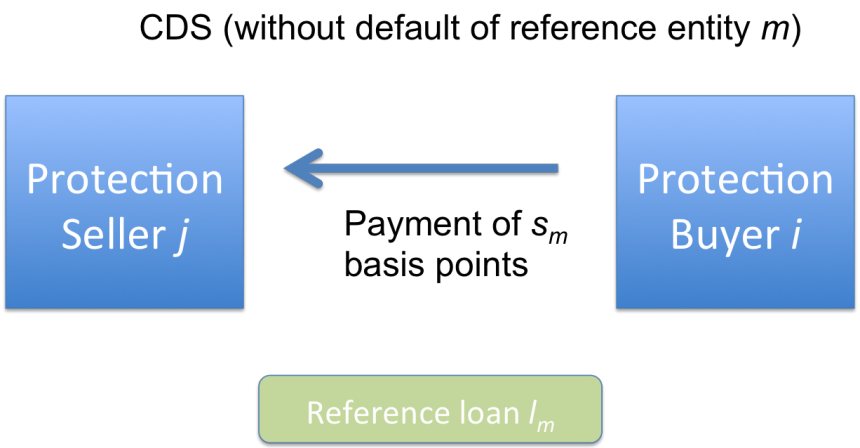

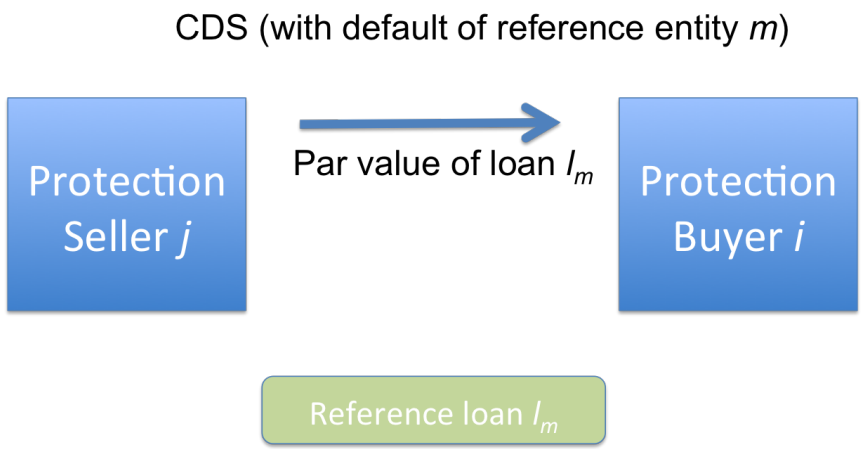

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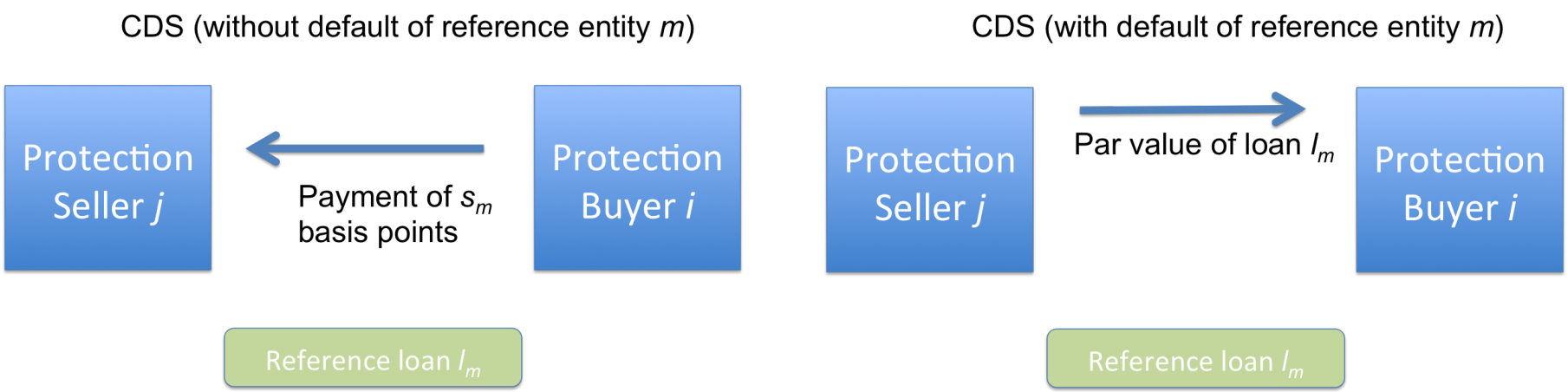
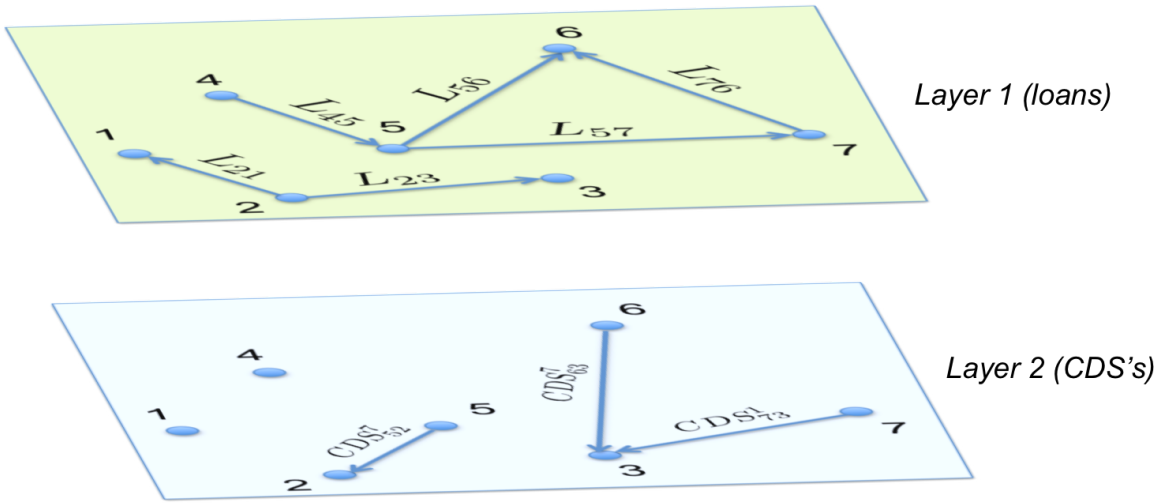


- A CDS transfers an exposure from one bank to another
  $\Rightarrow$ *it effectively rewires the network*

Multi-Layer Representation of Inter-Bank System

We need a multi-layer representation of interbank system

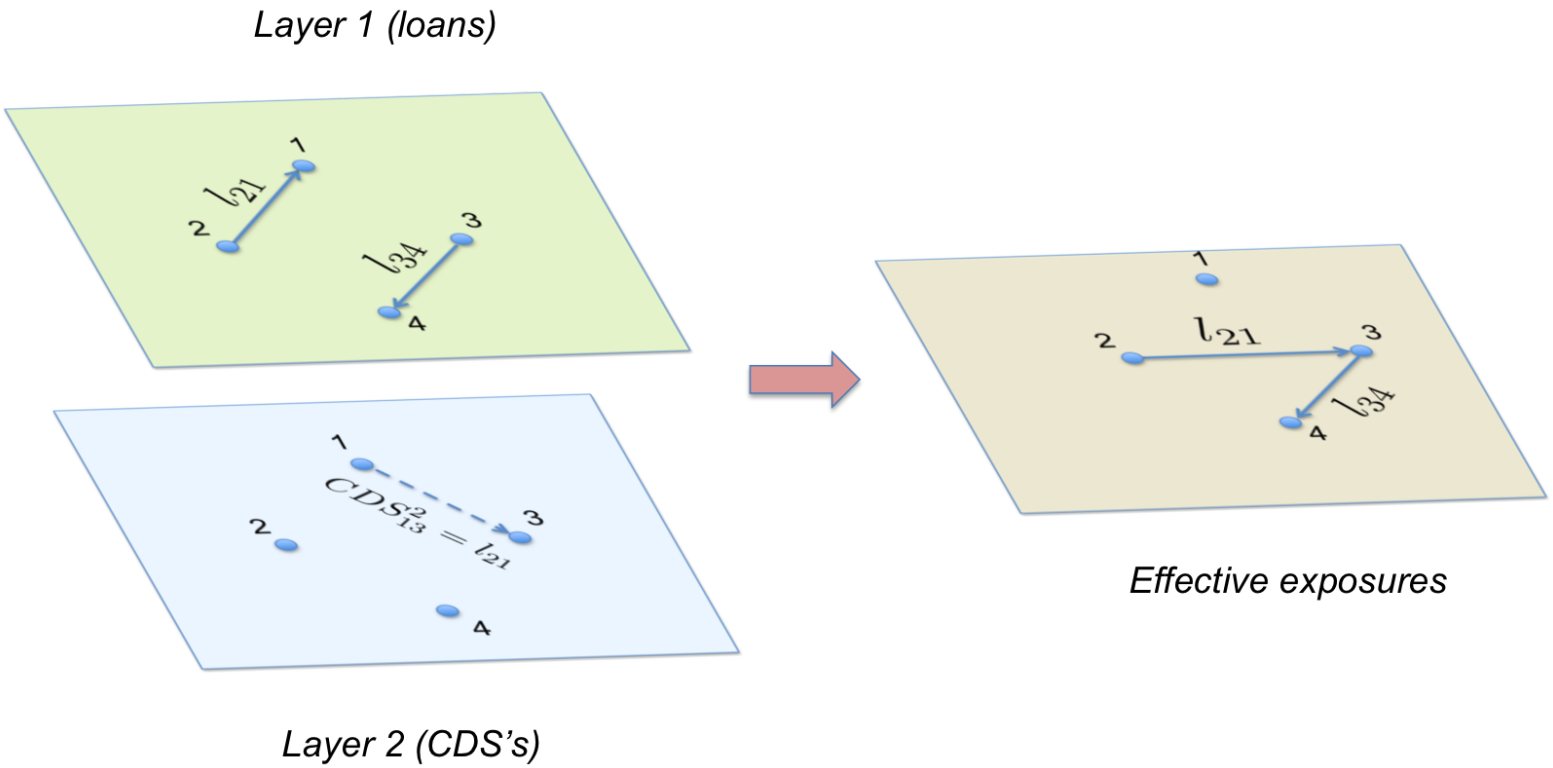


- First layer represent net loan exposures
- Second layer represent net CDS contracts between buyers and sellers

$\Rightarrow$ interplay between different layers non-trivial.

Multilayer Network Mapped into a Single Layer

We can map the two layers into a single layer of *effective* exposures



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- A bank normally pays an insurance premium (a 'spread') s_m to buy protection against default of bank m
- Now it pays $s_{ij} = s_m + \tau_{ij}$

τ_{ij} is a systemic surcharge (i.e. a tax):

$$\tau_{ij} = \zeta \cdot \max \left[0, \Delta EL^{\text{syst}} \right]$$

Simulation with an ABM

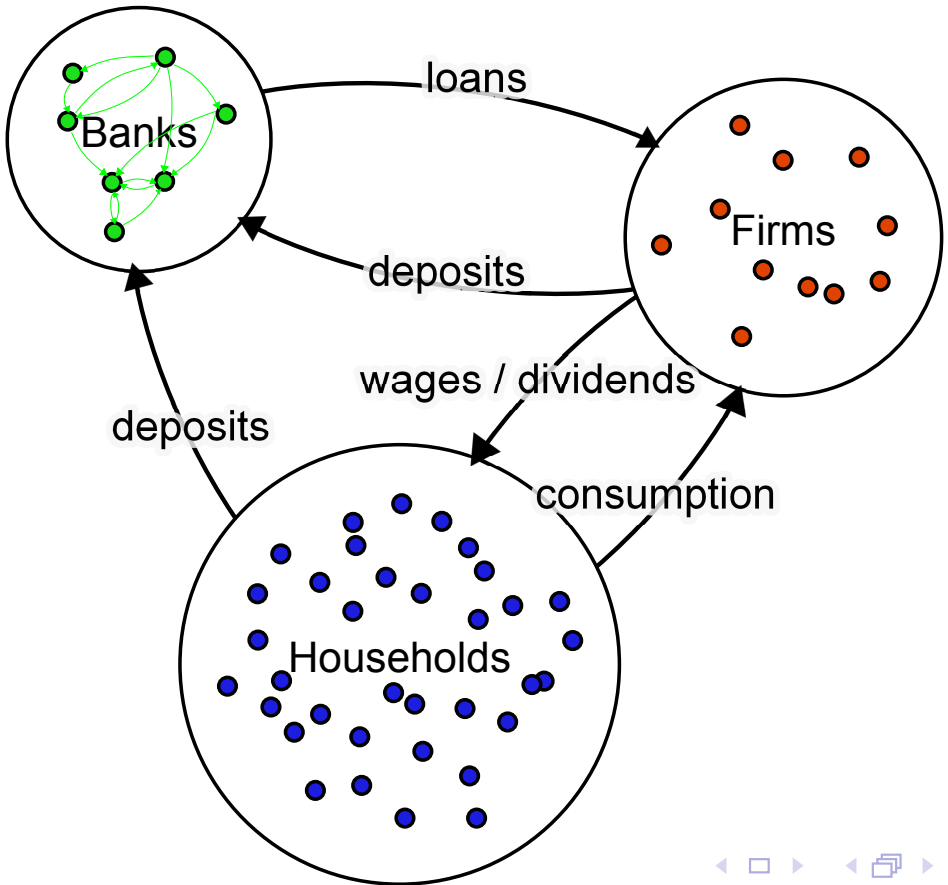
We study a simple model:

- Banks extend interbank loans to each other
- They insure these loans with CDSs sold by other banks
- Regulator imposes a surcharge τ_{ij} on CDSs

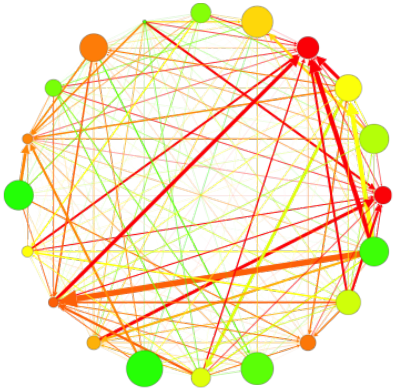
Simulation with ABM

CRISIS agent-based model.

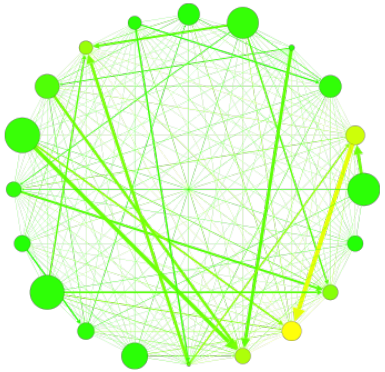
Modified with an interbank system for loans and derivatives



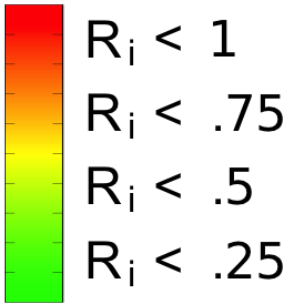
Results



without a CDS market



with a regulated CDS market



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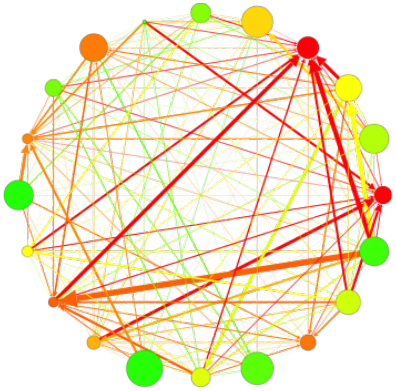

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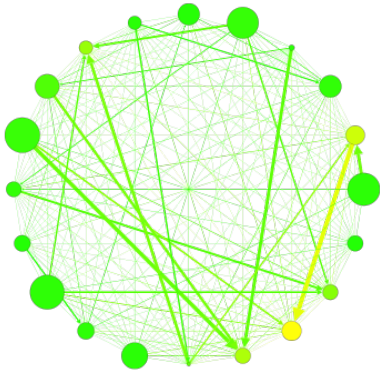

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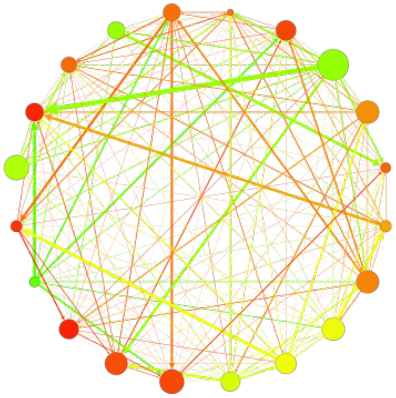
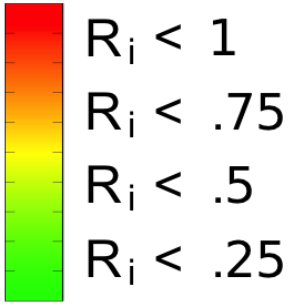


with a Tobin tax



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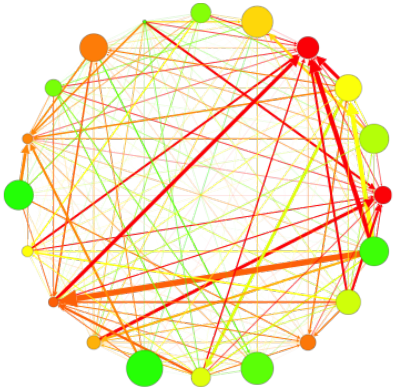

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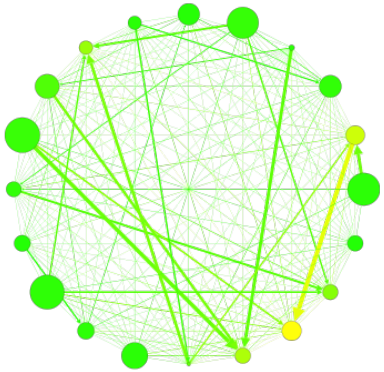

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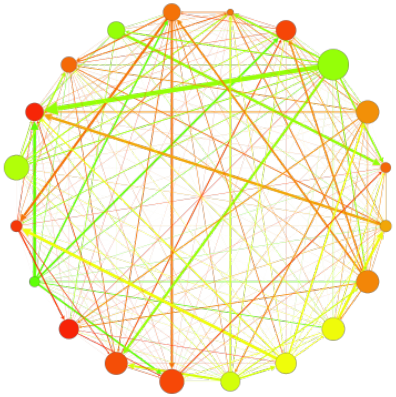

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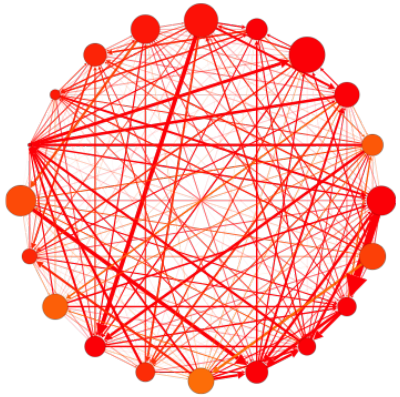
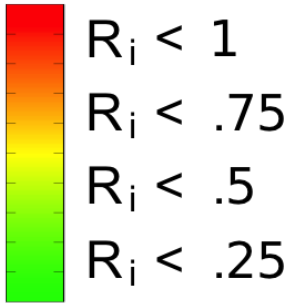


with an unregulated CDS market



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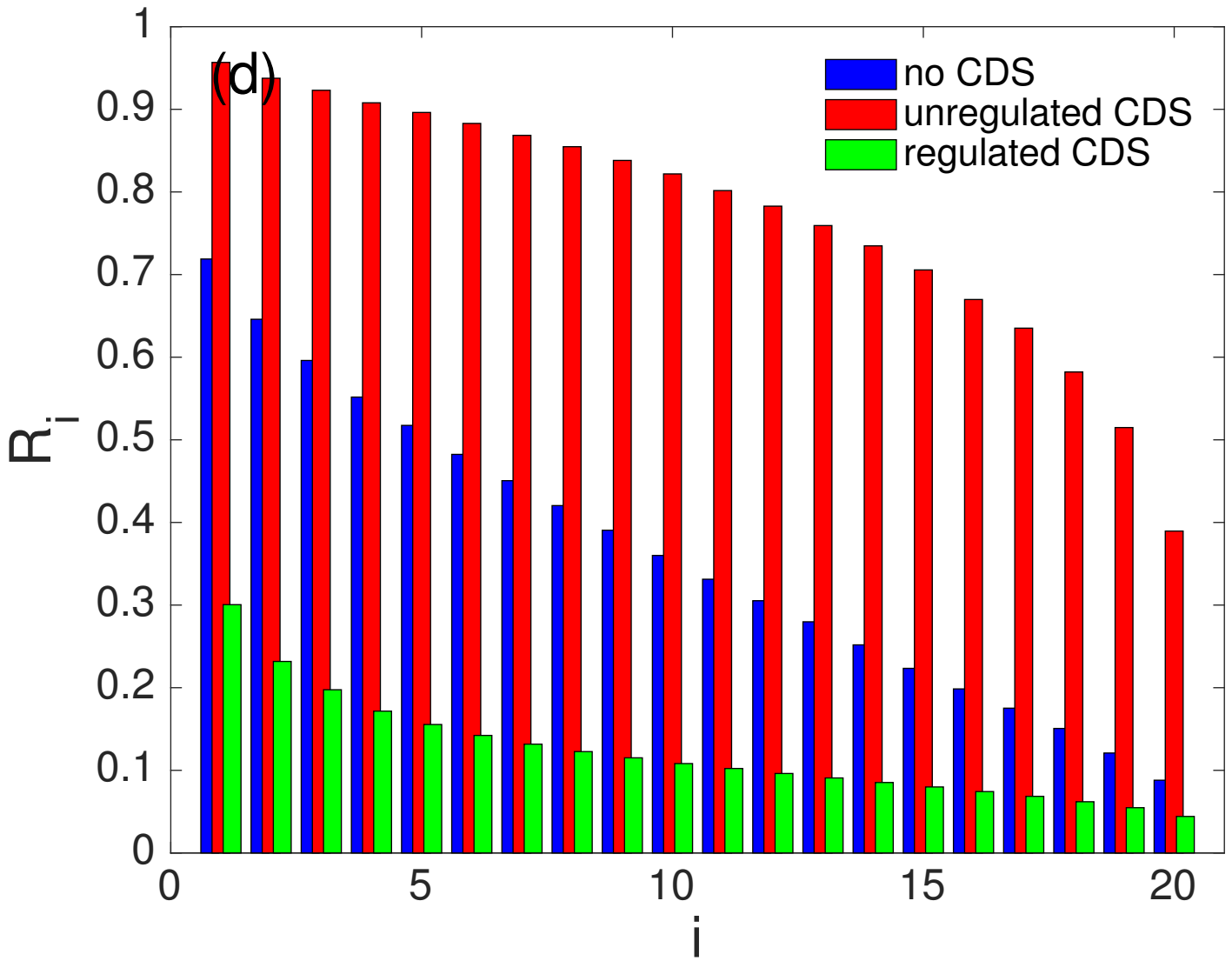
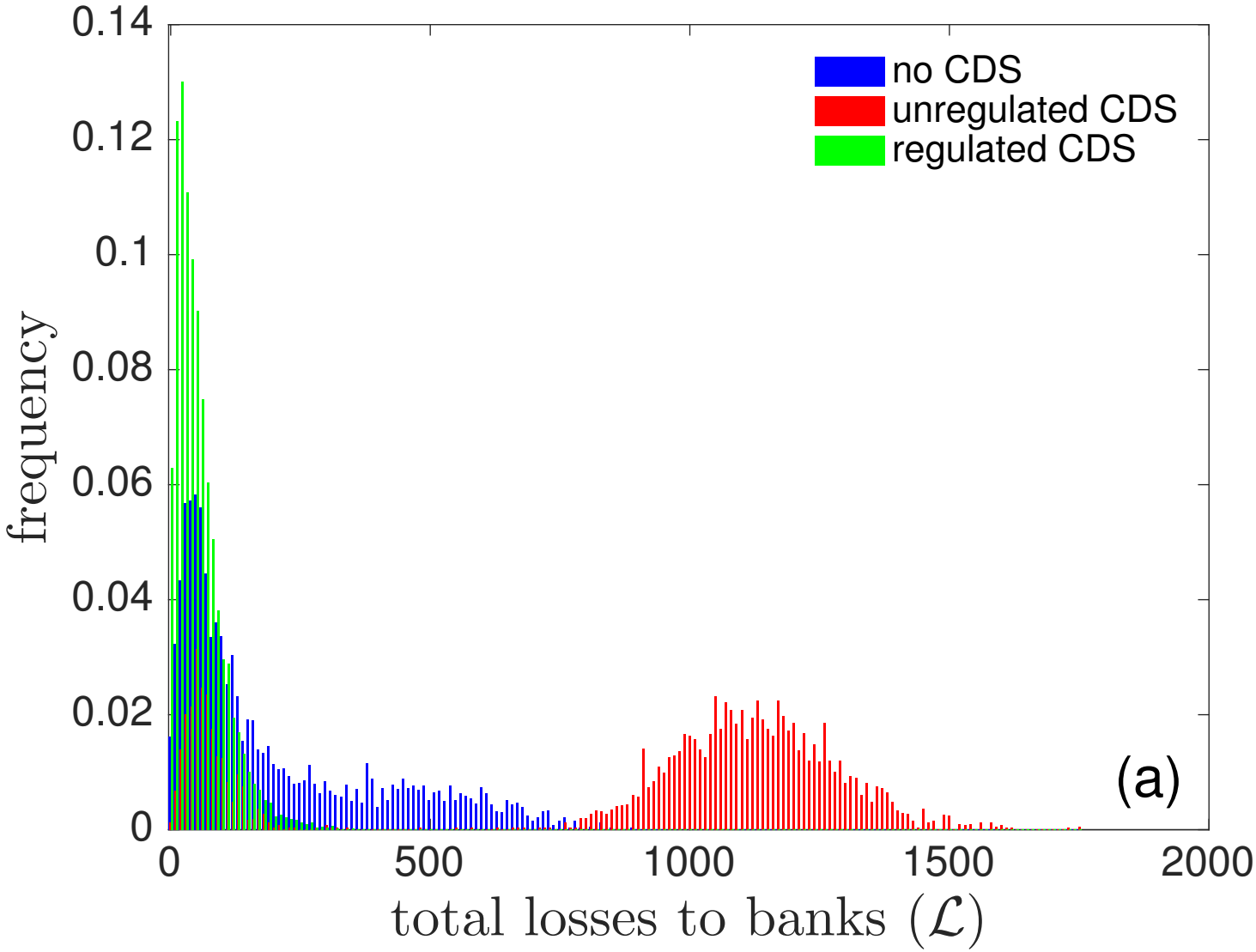

(d)
no CDS
unregulated CDS
regulated CDS
R_i
i
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
5
10
15
20

Results


0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
frequency
0
500
1000
1500
2000
total losses to banks ($\mathcal{L}$)
no CDS
unregulated CDS
regulated CDS
(a)

Paper:

Systemic Risk Management in Financial Networks with Credit Default Swaps. Leduc, M.V., S. Poledna and S. Thurner. (2016)

Available online on SSRN and ArXiV.

Thank you