Systemic Risk Management in Financial Networks with Credit Default Swaps

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January 13, 2015
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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)
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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))

Systemic risk can be quantified by DebtRank (Battiston et al. (2012))
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Systemic risk can be quantified by DebtRank (Battiston et al. (2012))

Similar to PageRank:

⇒ A page is important if many important pages point to it
DebtRank: An institution is *Systemically Risky* if many *Systemically Risky* institutions are exposed to it.
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DebtRank $R_i$ of bank $i$: fraction of economic value in the financial network that is lost following $i$’s default.

**DebtRank Austria Sept 2009**
Systemic Risk: DebtRank

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

\[ EL^{syst} = \sum_{i} p_{default}(i) \cdot R_i \]
Effect of a Particular Loan Exposure

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- **Observation**: different loans (directed edges) have different incremental effects on systemic risk
- **Question**: how can we reorganize the network of exposures?
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)
A Credit Default Swap (CDS) is a form of insurance against default risk.
Controlling the Formation of Financial Networks: CDS’s

- A Credit Default Swap (CDS) is a form of insurance against default risk

CDS (without default of reference entity \( m \))

- Protection Seller \( j \)
- Protection Buyer \( i \)
- Payment of \( s_m \) basis points
- Reference loan \( l_m \)
A Credit Default Swap (CDS) is a form of insurance against default risk.

- Protection Seller $j$ receives a payment of $s_m$ basis points.
- Protection Buyer $i$ is paid the par value of loan $l_m$. 

CDS (without default of reference entity $m$):
- Protection Seller $j$ to Protection Buyer $i$.

CDS (with default of reference entity $m$):
- Protection Seller $j$ to Protection Buyer $i$. 

Reference loan $l_m$. 

A Credit Default Swap (CDS) is a form of insurance against default risk.

- A CDS transfers an exposure from one bank to another ⇒ it effectively rewire the network.
We need a multi-layer representation of interbank system

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

⇒ 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.

*Layer 1 (loans)*

*Layer 2 (CDS’s)*

*Effective exposures*
Question: Can a regulator use CDS market to rewire the financial network and reduce systemic risk?

Answer: Yes, by penalizing CDS transactions that increase SR and encouraging those that decrease it.
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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 $s_{ij} = s_m + \tau_{ij}$, where $\tau_{ij}$ is a systemic surcharge (i.e. a tax): $\tau_{ij} = \zeta \cdot \max\left[0, \Delta \text{EL}_{syst}\right]$. "$ \Delta \text{EL}_{syst} = \max\left[0, \Delta \text{EL}_{syst}\right] $
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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 $\tau_{ij}$ on CDSs
Simulation with ABM

CRISIS agent-based model.

Modified with an interbank system for loans and derivatives

[Diagram showing interactions between Banks, Firms, and Households]
Results

without a CDS market

with a regulated CDS market

R_i < 1
R_i < 0.75
R_i < 0.5
R_i < 0.25
Results

without a CDS market    with a regulated CDS market

with a Tobin tax

Legend:
$R_i < 1$
$R_i < 0.75$
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Results

- Without a CDS market
- With a regulated CDS market
- With a Tobin tax
- With an unregulated CDS market

Legend:
- $R_i < 1$
- $R_i < 0.75$
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(d) Results showing the distribution of regulatory elements in three categories: no CDS, unregulated CDS, and regulated CDS. The x-axis represents the index 'i', and the y-axis represents the normalized ratio $R_i$. The graph visually compares the distribution patterns across these categories.
Results

(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