A Network Model Approach to Systemic Risk in the Financial System

Han Chen, FSA & Shaun Wang, FCAS

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Definition of Systemic Risk

1. Systemic risk is the risk that the failure of one financial institution can cause or contribute to the failure of other financial institutions as a result of their linkages to each other.

2. Systemic risk can also be defined as one exogenous shock which causes the failure of multiple financial institutions simultaneously.

Sources of Systemic Failure

Some identified sources of systemic failure:

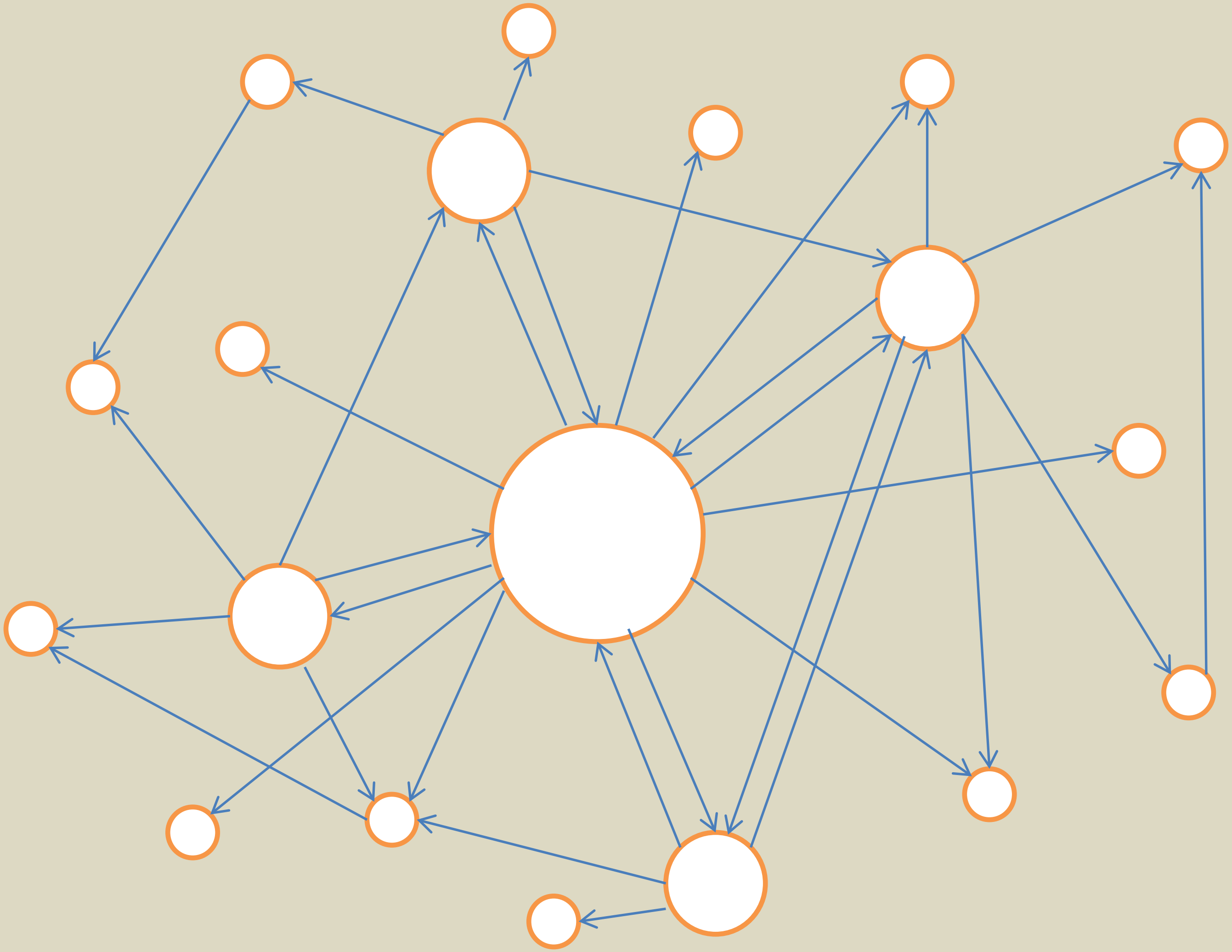
1) direct bilateral interbank exposures
2) common asset exposure among banks
3) net settlement systems for large payments
4) imitative runs fueled by information contagion.

A System of Credit Default Swaps

Systemic failure can also occur from the counterparty exposure risk in derivative transactions.

In this paper, we study systemic risk which arises from CDS when one institution fails to settle its derivative position with another institution – the loss spreads through the network.

How Loss Spreads in a CDS Network



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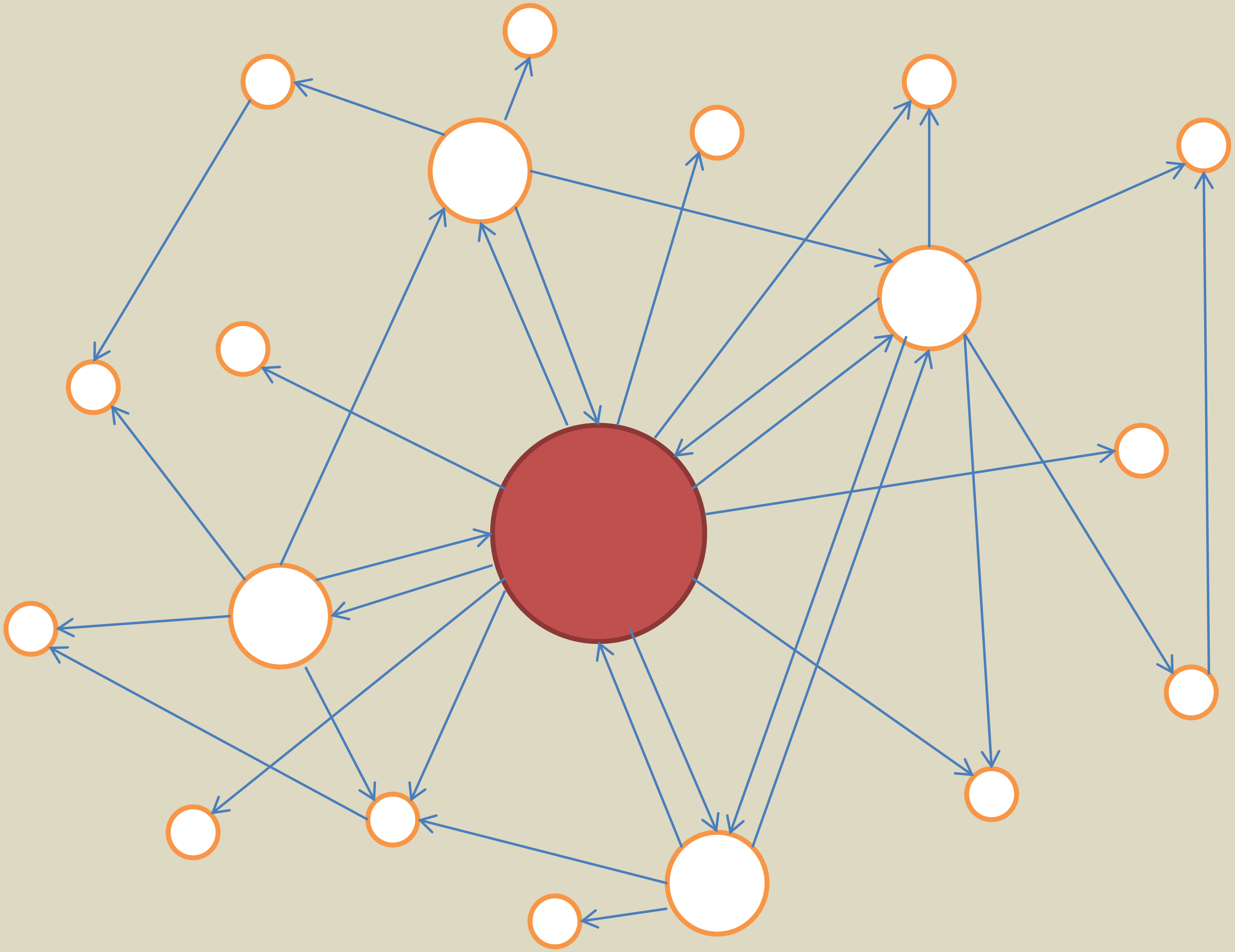

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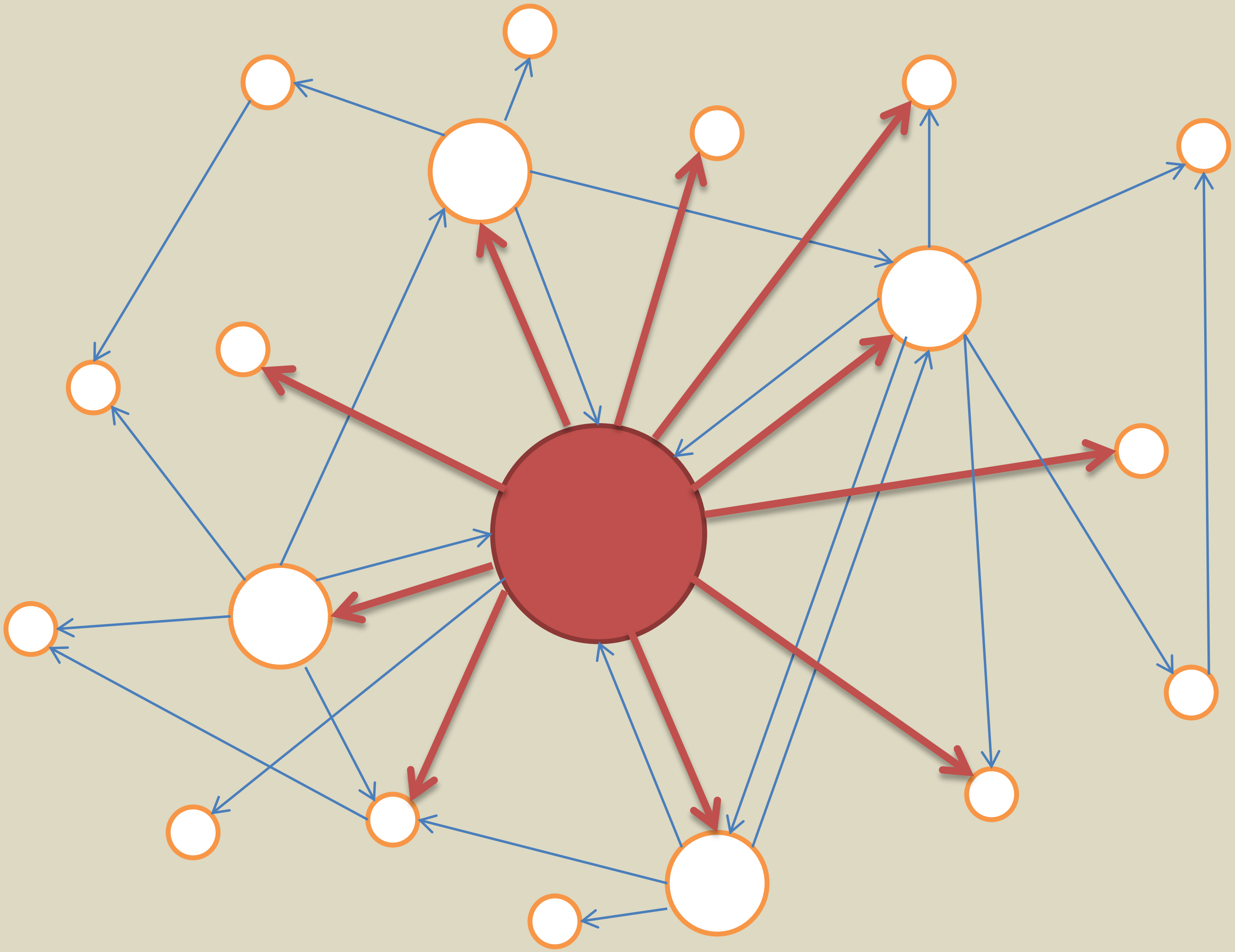

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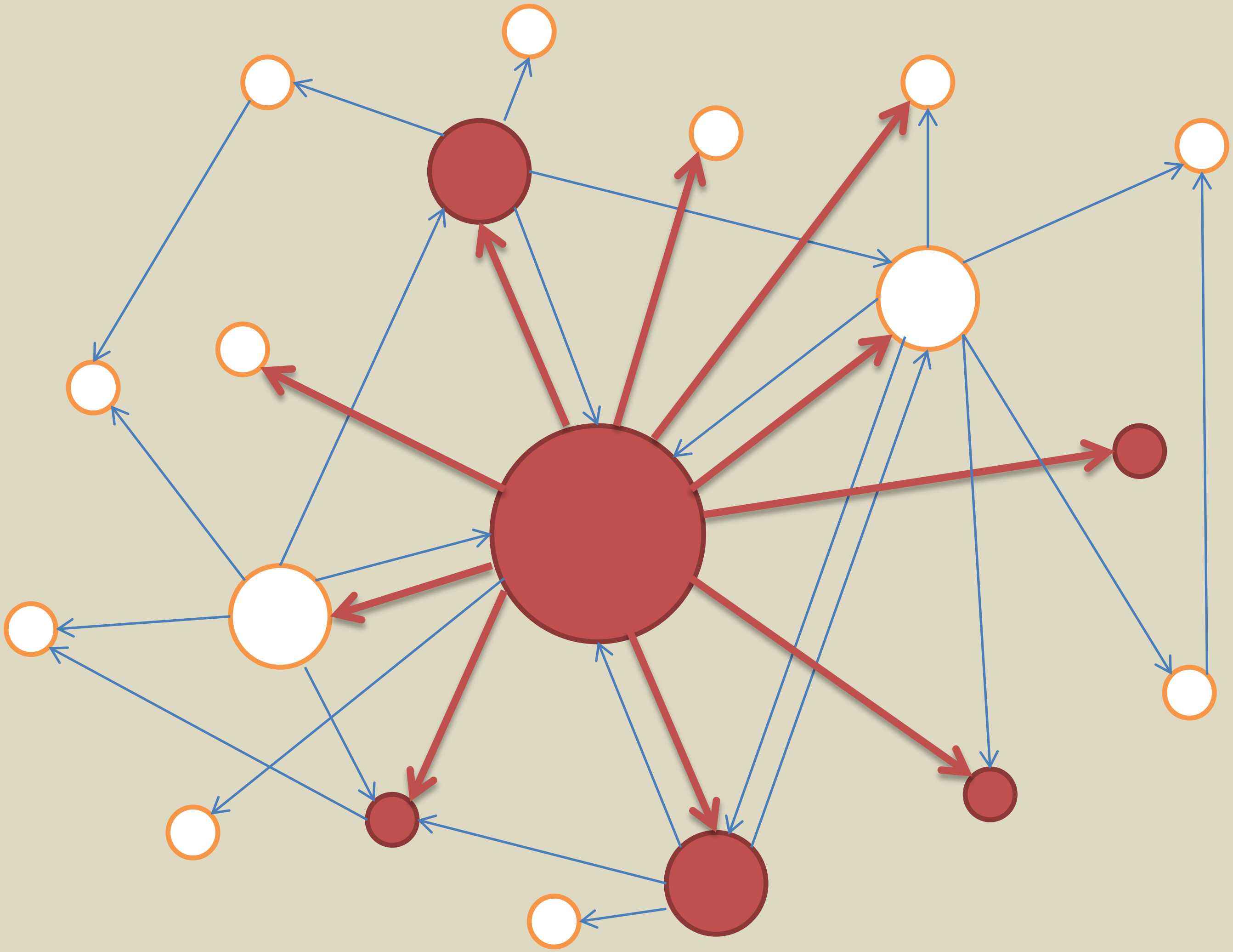

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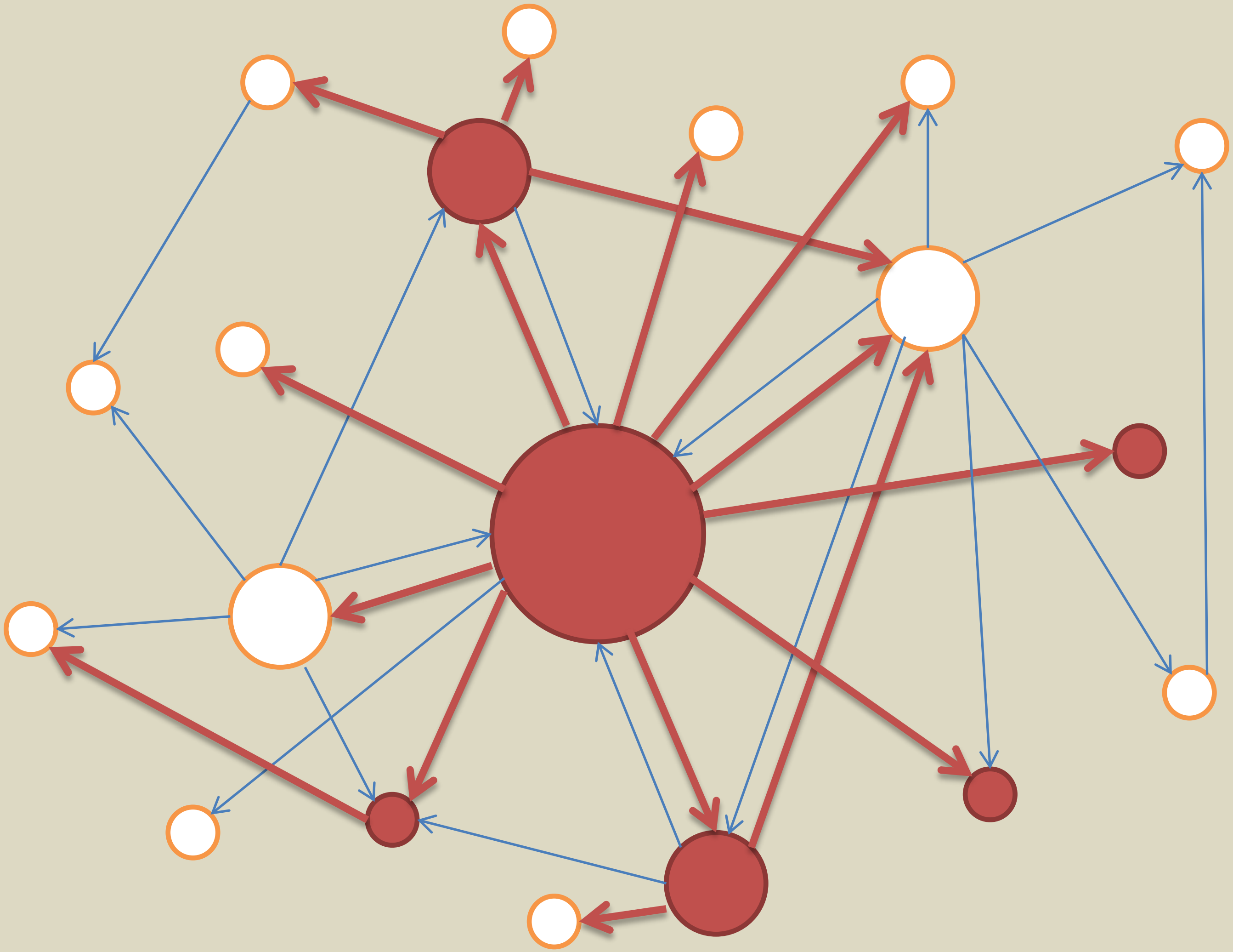

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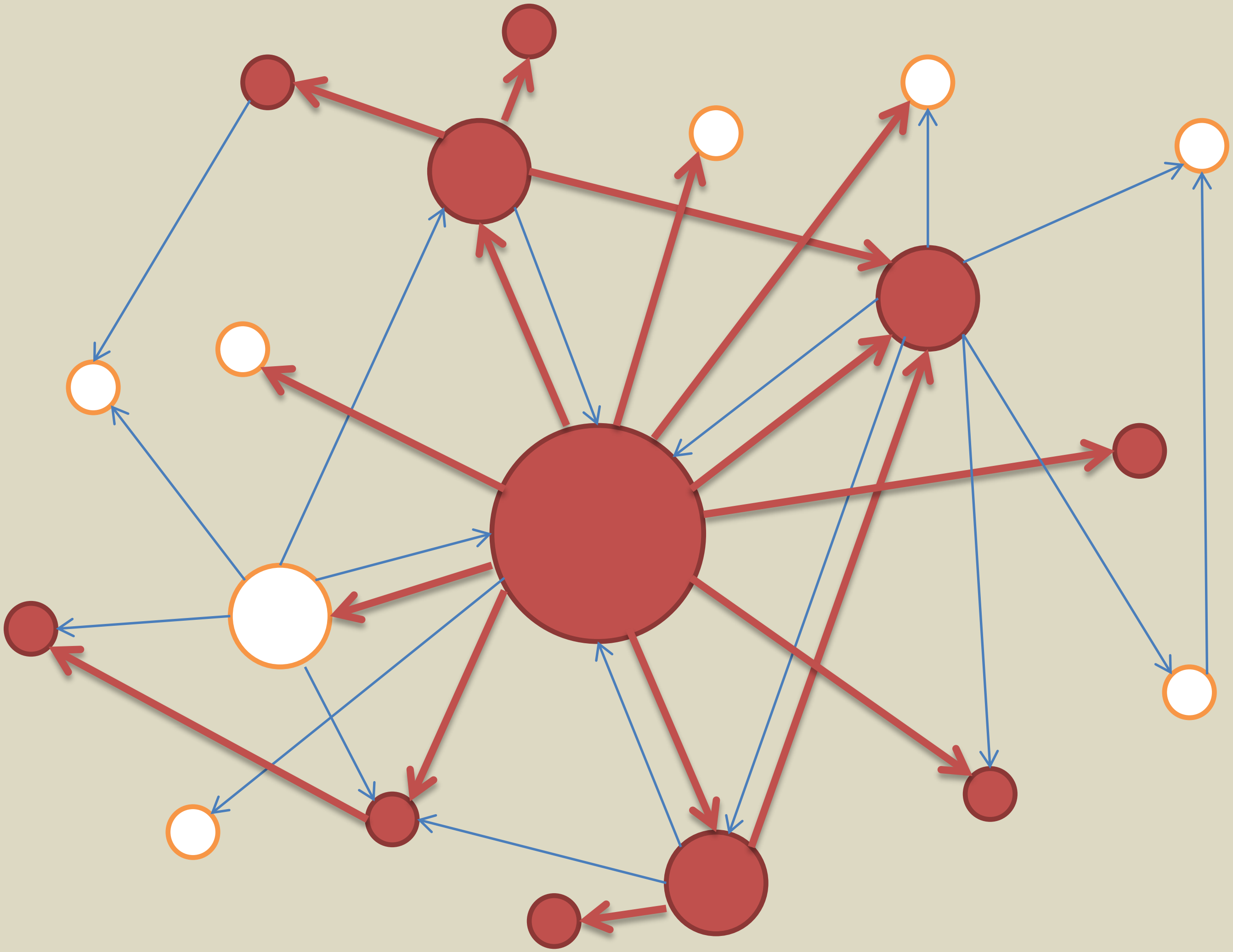

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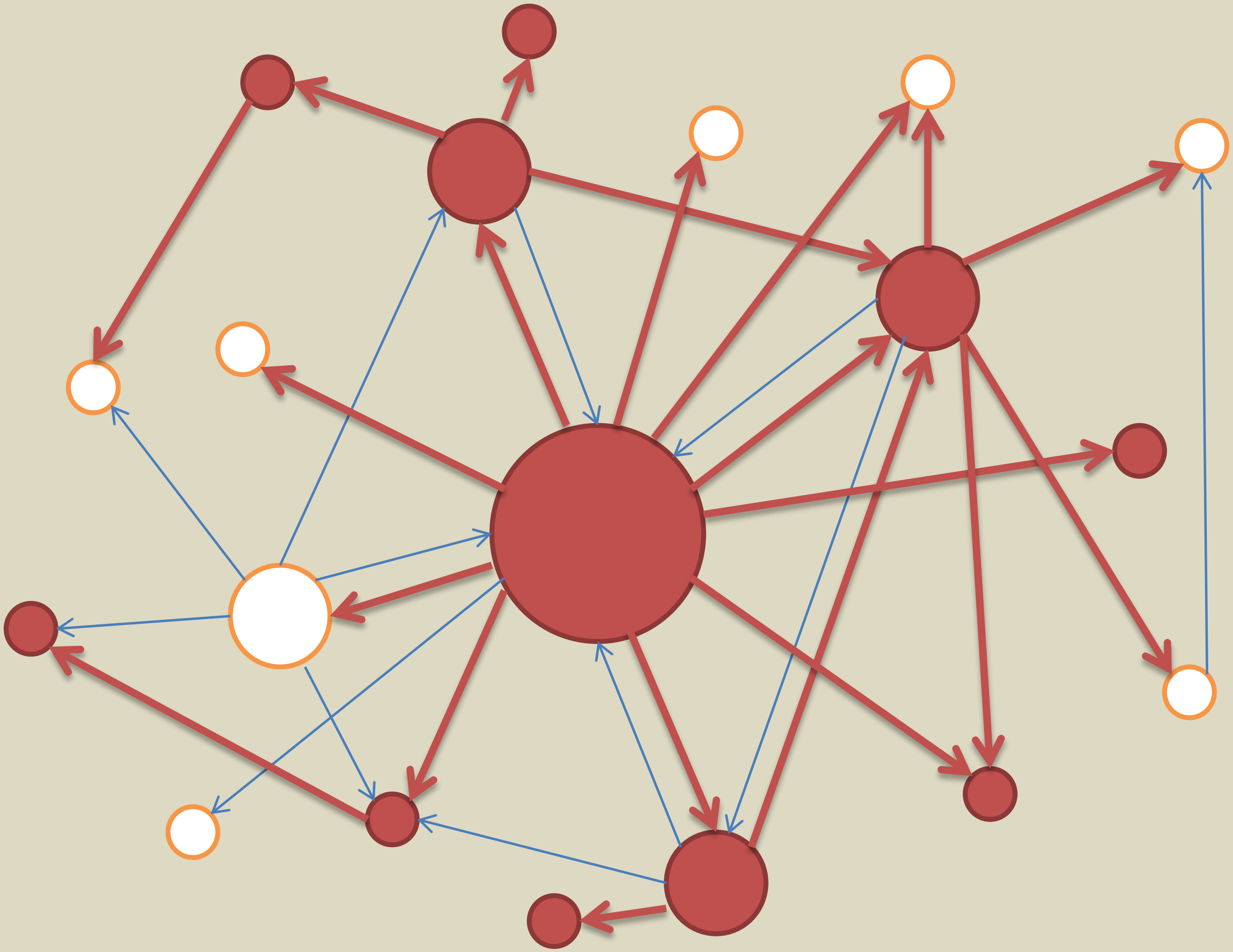

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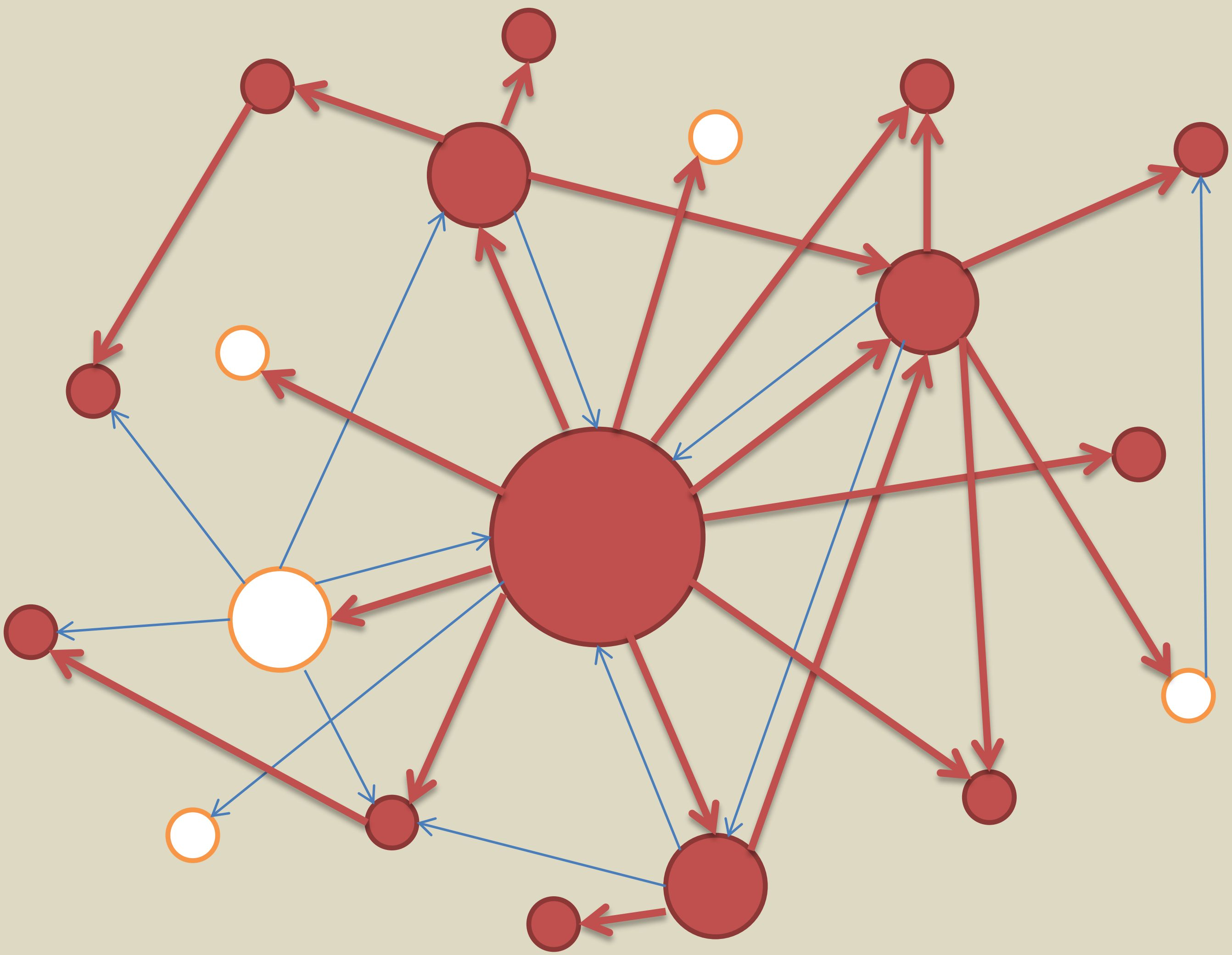

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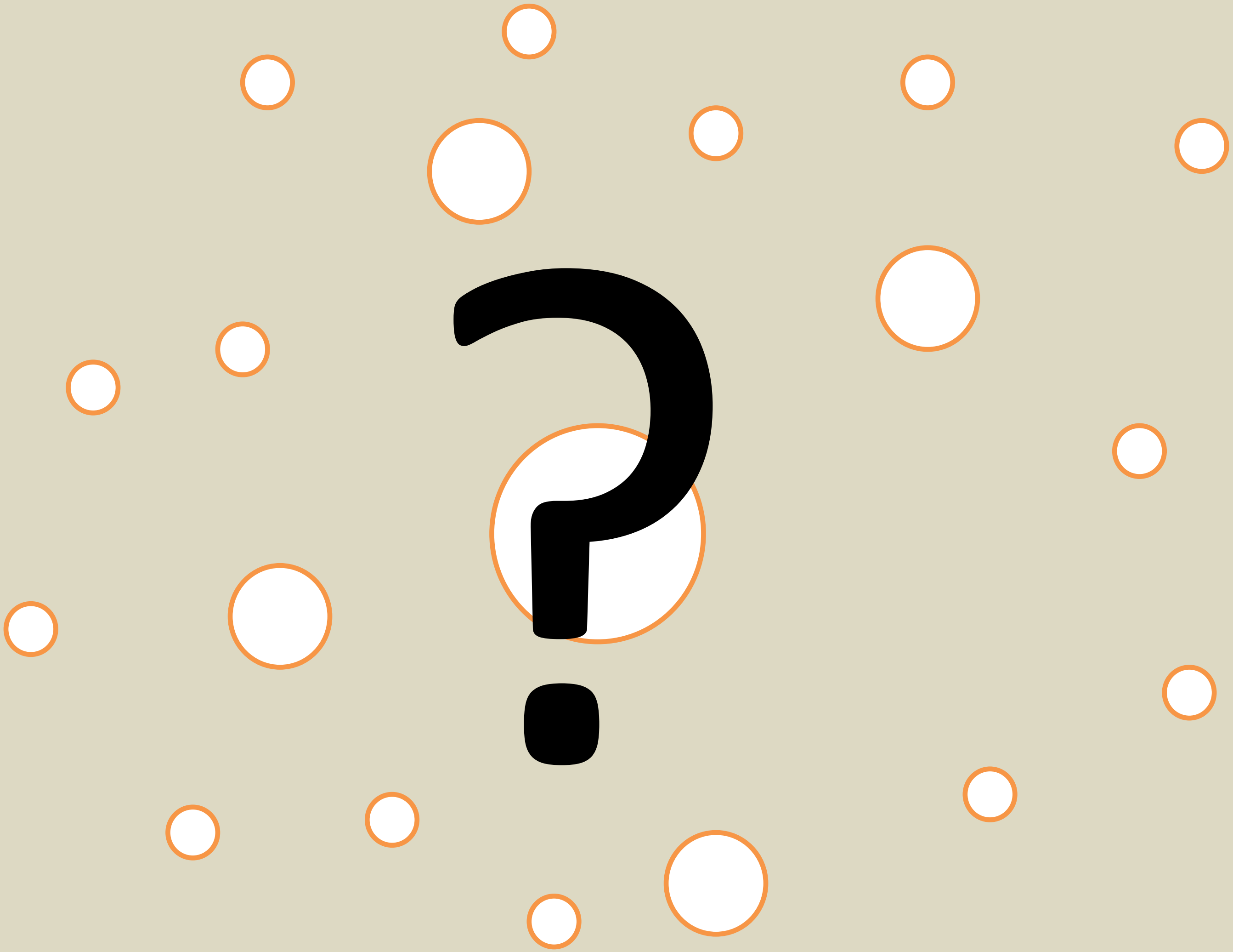


CDS Network Model Data & Assumptions

CDS contracts are off-balance-sheet items. Neither the SEC nor any regulator has authority over the CDS market, even to require minimal disclosure to the market.

However, for each FDIC registered bank, the gross CDS purchase or sale data can be acquired from the FDIC database.

CDS Network Model Data & Assumptions

As of 12/31/2008	CDS Buy ($ in thousand)	CDS Sell ($ in thousand)
JPMorgan Chase Bank	4,284,364,000	4,107,265,000
Citibank	1,429,121,000	1,301,313,000
Bank of America	1,036,642,383	1,013,961,250
Goldman Sachs	874,128,000	655,240,000
HSBC Bank	472,528,036	486,911,678
Wachovia Bank	155,316,000	145,957,000

*Data Source: FDIC

CDS Network Model Data & Assumptions

Based on the total CDS trading volume, a bilateral connection matrix is generated stochastically in order to simulate a plausible CDS network reflecting the real market.

Buy&Sell Amount Matrix	JPMorgan Chase Bank ($4,284,364,000)	Citibank ($1,429,121,000)	Bank of America ($1,036,642,383)
JPMorgan Chase Bank ($4,107,265,000)			
Citibank ($1,301,313,000)			
Bank of America ($1,013,961,250)			

CDS Network Model Data & Assumptions

The fundamental assumption to simulate the one-to-one bilateral connection is that the probability of Company A to buy from Company B is proportional to Company B's market share.

Based on the gross CDS buy (sell) data, the market share for each bank can be obtained:

$$S_i^B = \frac{B_i}{B}: \ Bank_i \ market \ share \ on \ the \ buy \ side \ of \ CDS$$

$$S_i^s = \frac{S_i}{S}: \ Bank_i \ market \ share \ on \ the \ sell \ side \ of \ CDS$$

CDS Network Model Data & Assumptions

A bilateral trading probability matrix *X* is derived from CDS market share data of *N* banks:

$$X = \begin{bmatrix} 0 & x_{1,2} & \cdots & x_{1,N} \\ x_{2,1} & 0 & & . \\ . & & 0 & x_{N-1,N} \\ x_{N,1} & \cdots & x_{N,N-1} & 0 \end{bmatrix}$$

Where $x_{i,j}$ represents the likelihood that $Bank_j$ buys CDS from $Bank_i$, proportional to $S_i^s/(1-S_j^s)$

Systemic Risk Ratio

We define the systemic risk ratio as:

$$Systemic\ Risk\ Ratio = E(Final\ Total\ System\ Loss)/E(Initial\ Loss)$$

Final Total System Loss is the overall loss in a financial system after the initial loss is spread through financial institutions' failures.

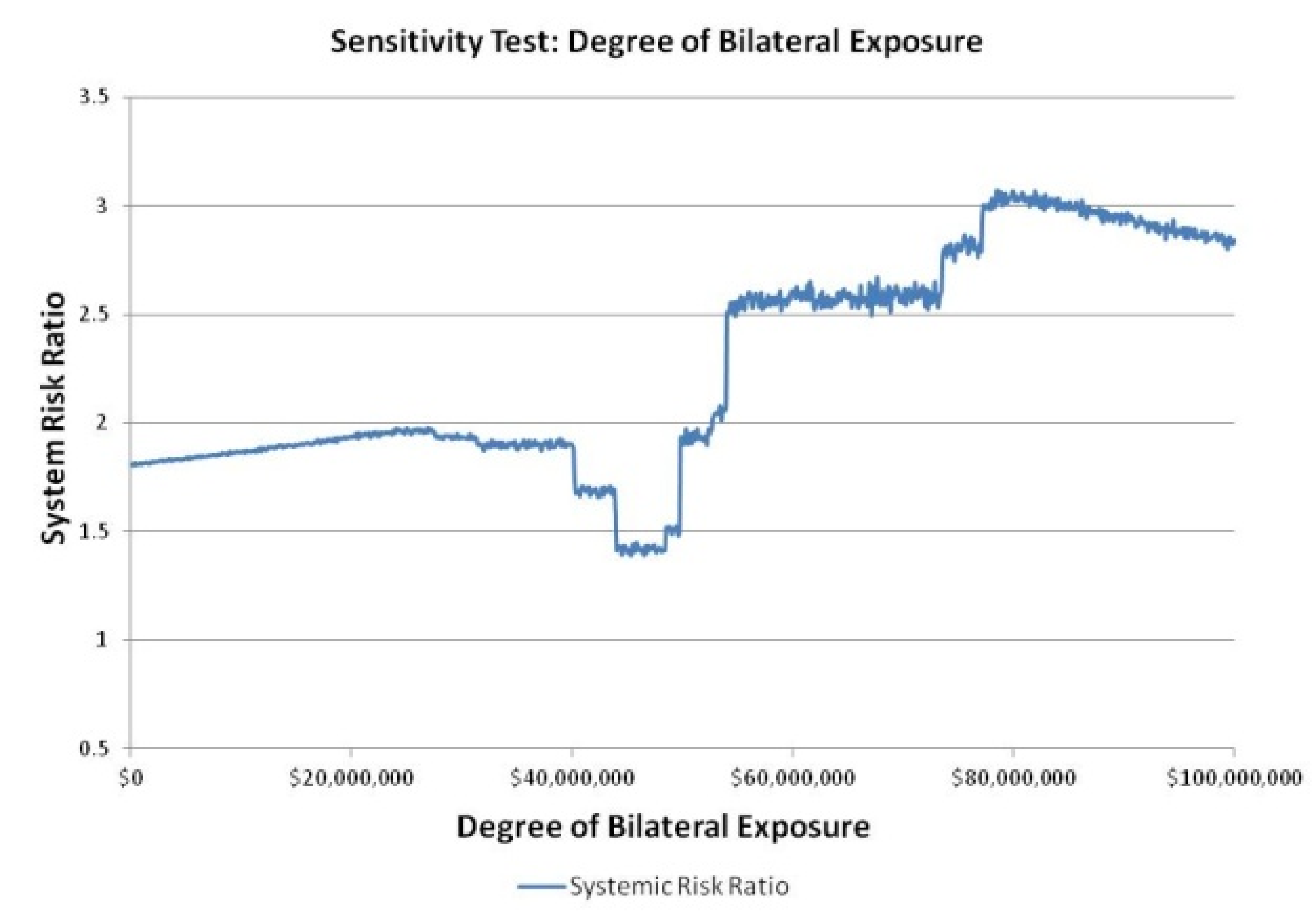
In this paper, we analyze the systemic risk ratio from both sector failure and institution failure.

Clearing House Effect

A clearing house guarantees that CDS are still valid even though the original writer defaults.

In this paper, by comparing the expected final loss of the system with the expected first round loss, the effect of a clearing house's contribution to the system robustness is demonstrated.

Sensitivity Test of Network Structure



Conclusion

This study points out that counterparty information is critical in determining a financial system's stability. A different network structure would result in completely different dynamics of the system.

Our illustrative model can be expanded to analyze other over-the-counter derivatives, such as interest rate swaps and currency swaps.

Questions and Answers

Author Contact Information:

Han Chen, FSA
han.chen@risklighthouse.com

Dr. Shaun Wang, FCAS, MAAA
shaunwang@gsu.edu