# How Likely is Contagion in Financial Networks?

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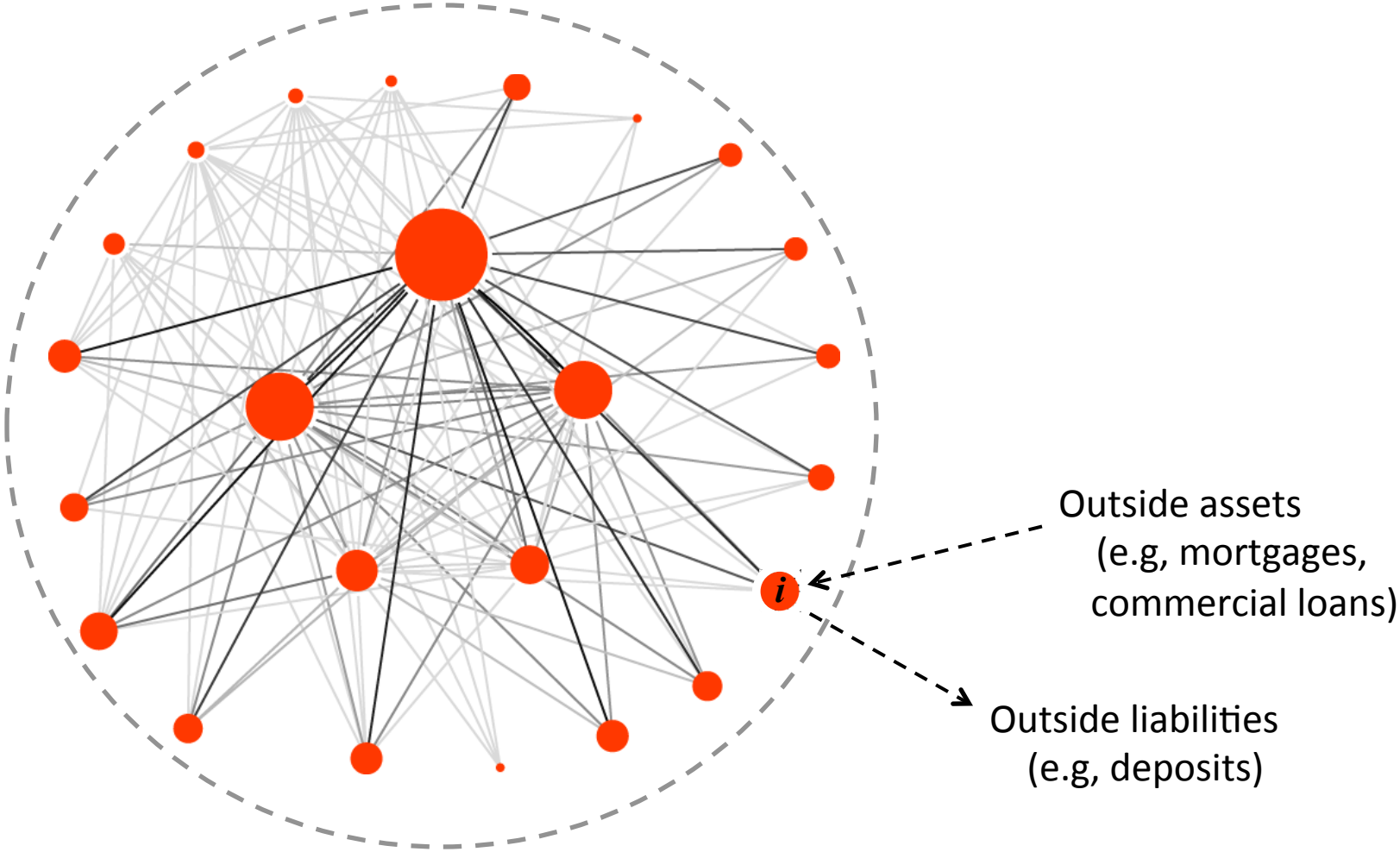
# Overview of What We Do

- We look at “interbank” networks in which
  - Nodes are financial institutions
  - Edges are defined by payment obligations
  - Assets are subject to exogenous stochastic shocks

- Networks are opaque – nobody has a comprehensive view
  - What can we say using just node-level data?
  - What node-level metrics should be monitored?

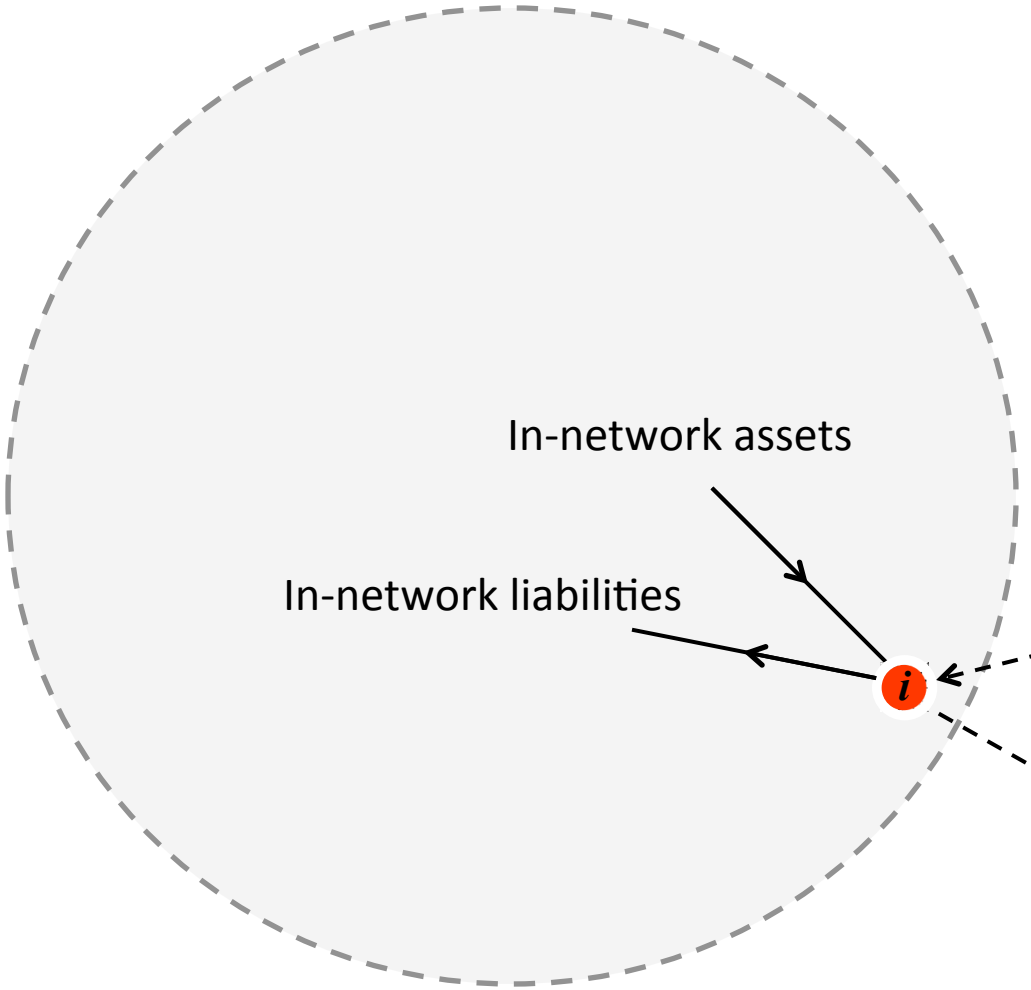
- How much do network effects add to system-wide losses?
  - We bound contagion probabilities and loss amplification

# The Financial Network And The Outside World




Network figure from Bank of England

# What We See




At each node, we see

- Total outside assets
- Total outside liabilities
- Total in-network assets
- Total in-network liabilities

We don't see interconnections

Outside assets

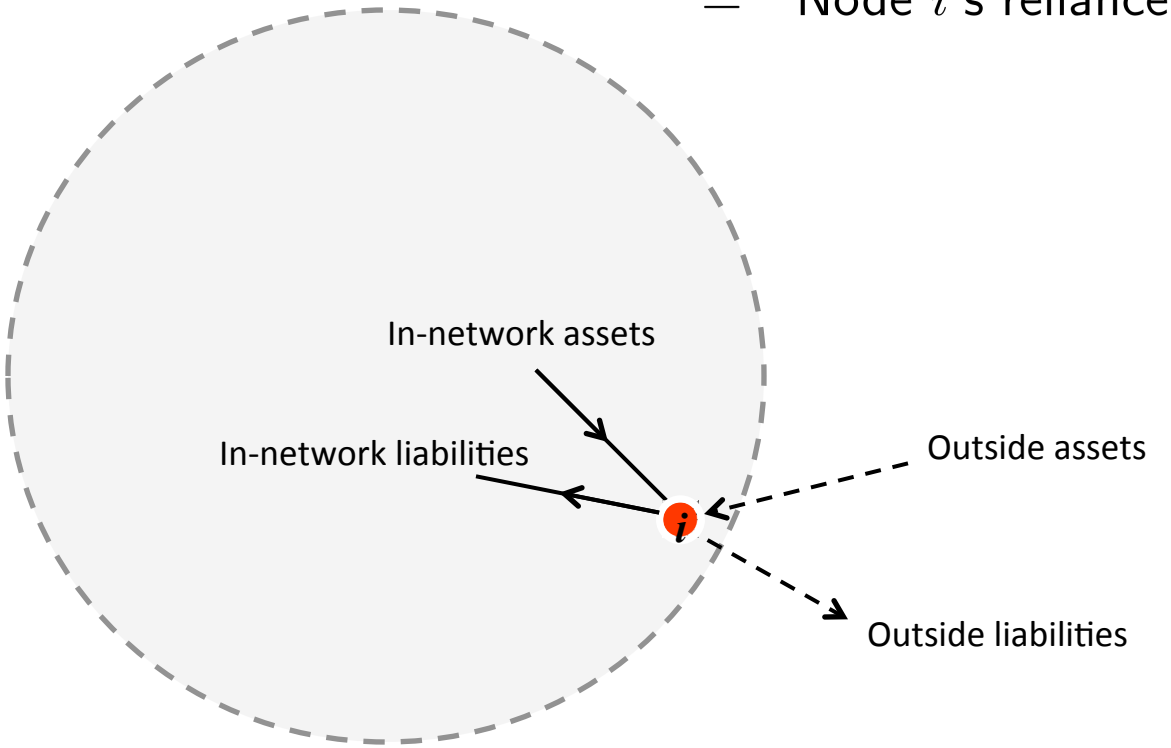
Outside liabilities

# Financial Connectivity

A key quantity:

$$\beta_i = \frac{\text{Node } i\text{'s in-network liabilities}}{\text{Node } i\text{'s total liabilities}}$$

$$= \text{Node } i\text{'s reliance on in-network funding}$$



# Comparison of Expected Losses with a Network and in a System of Isolated Nodes

$c_i =$ value of node $i$'s outside assets

$\delta_i =$ probability that $i$ defaults from a direct shock to its assets

For a broad class of shock distributions

$$\frac{E[\text{losses with network}]}{E[\text{losses w/o network}]} \leq 1 + \frac{\sum_i \delta_i c_i}{(1 - \beta_{\max}) \sum_i c_i}$$

where $\beta_{\max} = \max_i \beta_i$.

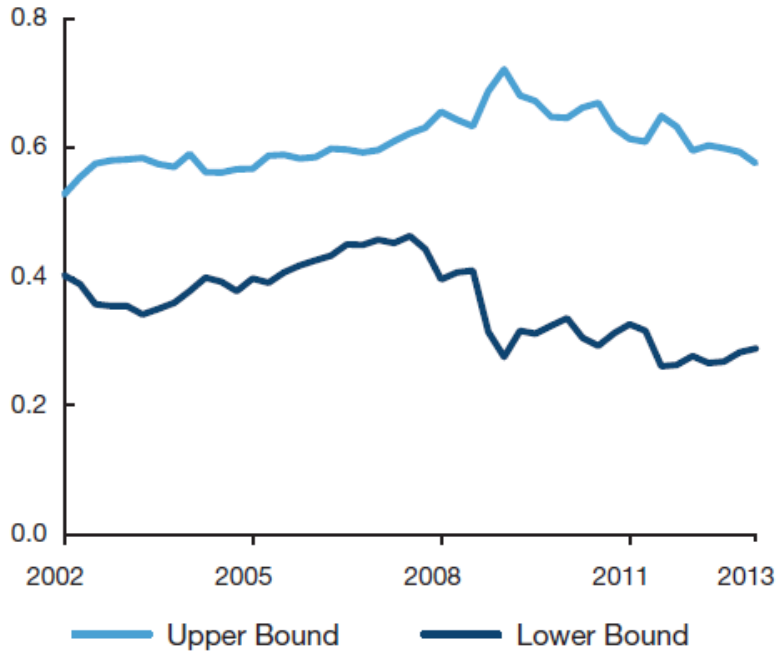
If $\delta_i \leq 1\%$ and $\beta_{\max} \leq 0.50$, then the network multiplier is at most 1.02.

If the risk at each node is managed and the nodes are not overly connected, the network can't do a lot of damage

# Rough Estimates of Financial Connectivity

From OFR's 2013 Annual Report

Figure 44. Trends in Financial Connectivity of 50 Largest U.S. Bank Holding Companies (ratio)




Note: Top 50 U.S. bank holding companies by assets as of March 2013. Upper bound calculated as (Noncore Funding + Off-Balance-Sheet Derivative Liabilities)/(Total Liabilities + Off-Balance-Sheet Derivative Liabilities). Lower bound calculated as (Noncore Funding)/(Total Liabilities + Off-Balance-Sheet Derivative Liabilities).

Sources: FR Y-9C data from Federal Reserve System (2013).

# Network Effects on Contagion

- We say that contagion from node $i$ to a set of nodes $D$ is *weak* if the nodes in $D$ are more likely to default from direct shocks than through contagion from node $i$

- Define the node-level measure

  Contagion Index$_i$ = $\beta_i$ x (Net Worth$_i$) x (Leverage of Outside Assets$_i$ – 1)

- We show that contagion is weak if the Contagion Index is small, relative to the average net worth and leverage of the nodes in $D$.

- In other words, we bound network contagion effects using node-level information: connectivity, net worth, and leverage
- At reasonable parameter values, contagion is typically weak

# Summary

- We can bound network effects using node-level balance sheet data
- The bounds point to quantities to monitor at each node:
  - Financial connectivity
  - Contagion index
- But network effects from spillovers or domino effects are not very large at realistic parameter values
- Need other mechanisms (e.g., funding runs, fire sales) to get crisis dynamics in network models