

# The New Architecture of Our Financial System

## A Work in Progress

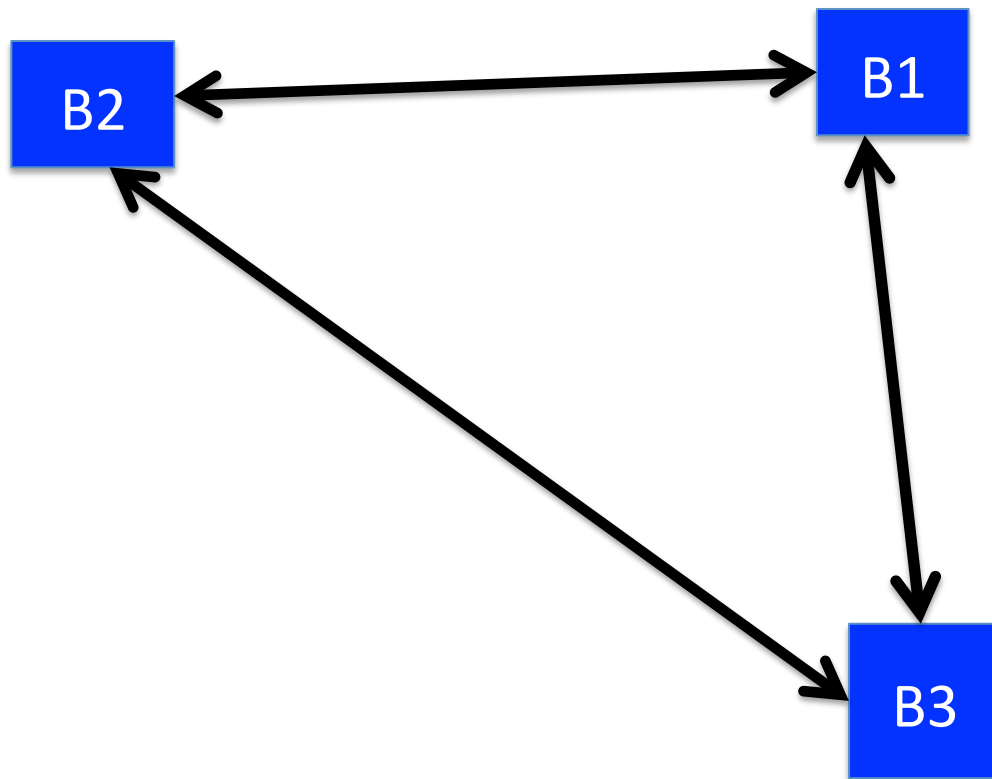
Darrell Duffie  
Stanford University

Mathematics of the Planet Earth  
Fields Institute, Toronto  
April 11, 2013

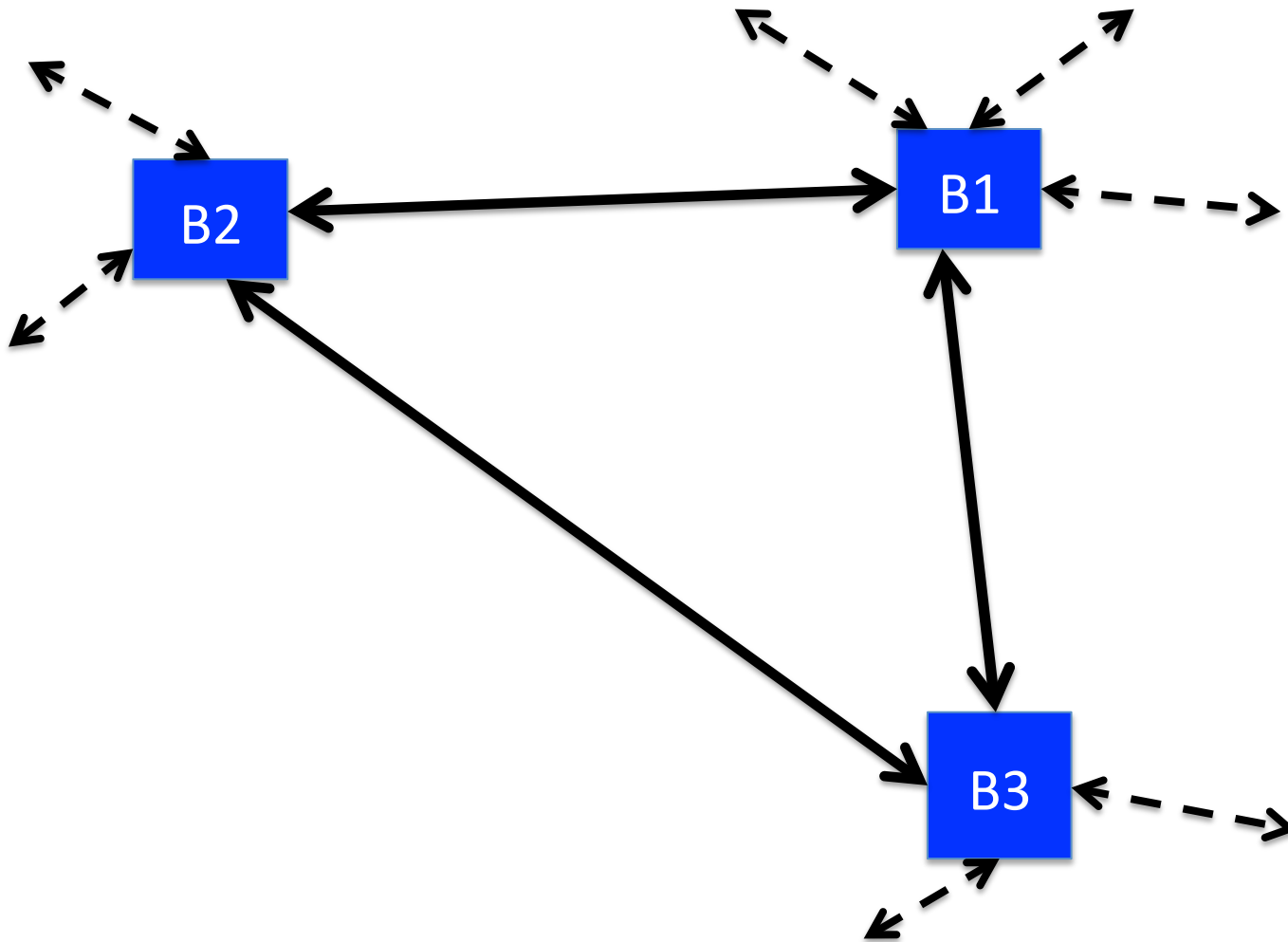
# Outline

- ▶ Why does the financial system matter?
- ▶ How is the structure of the financial system changing?
- ▶ What are the weakest links in the system?
- ▶ How should one model inter-bank risk?
- ▶ Should we be concerned about the central clearing of derivatives?

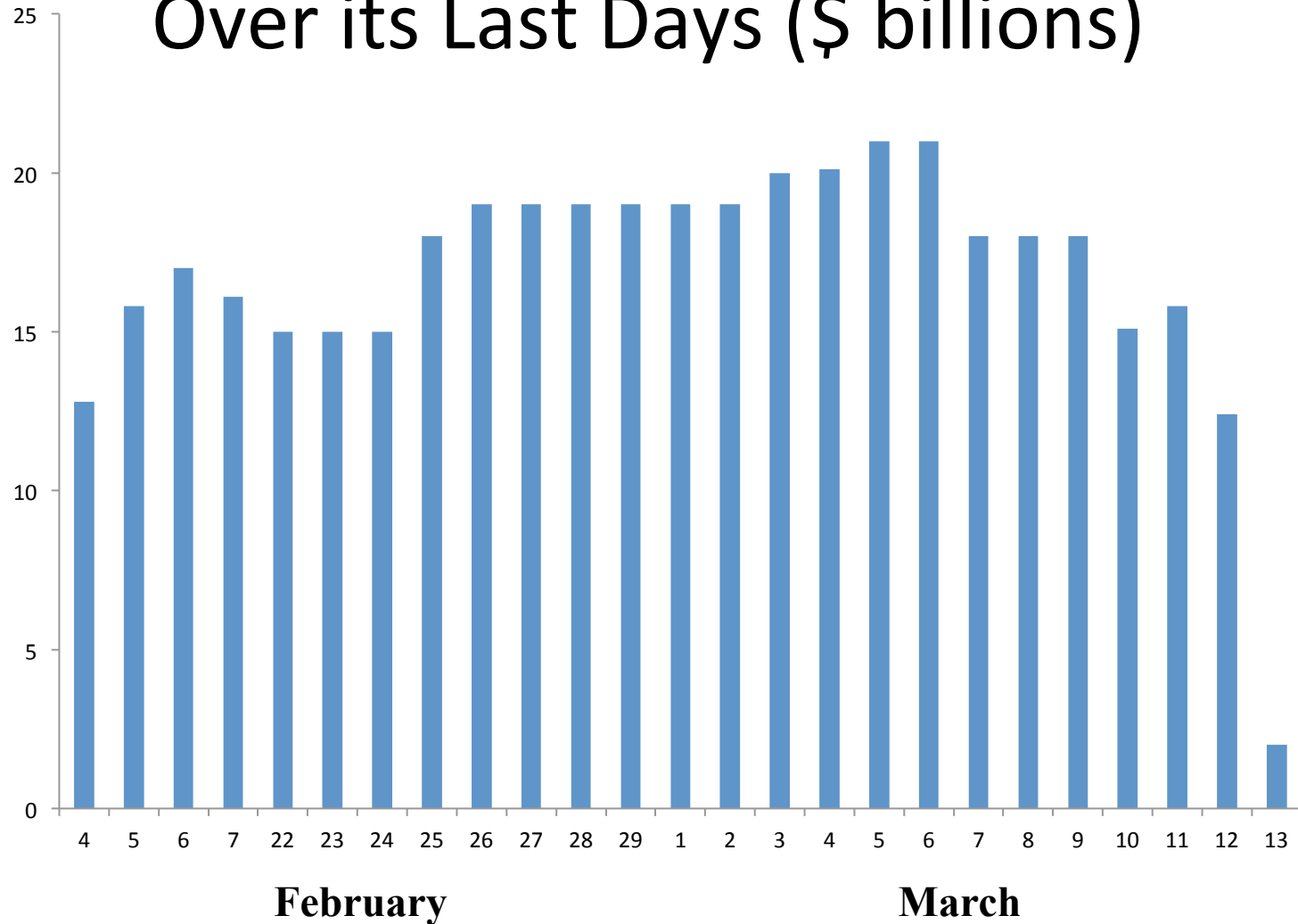
# Core Interbank Network



# Transmission of Risk and Liquidity To Ultimate Investors

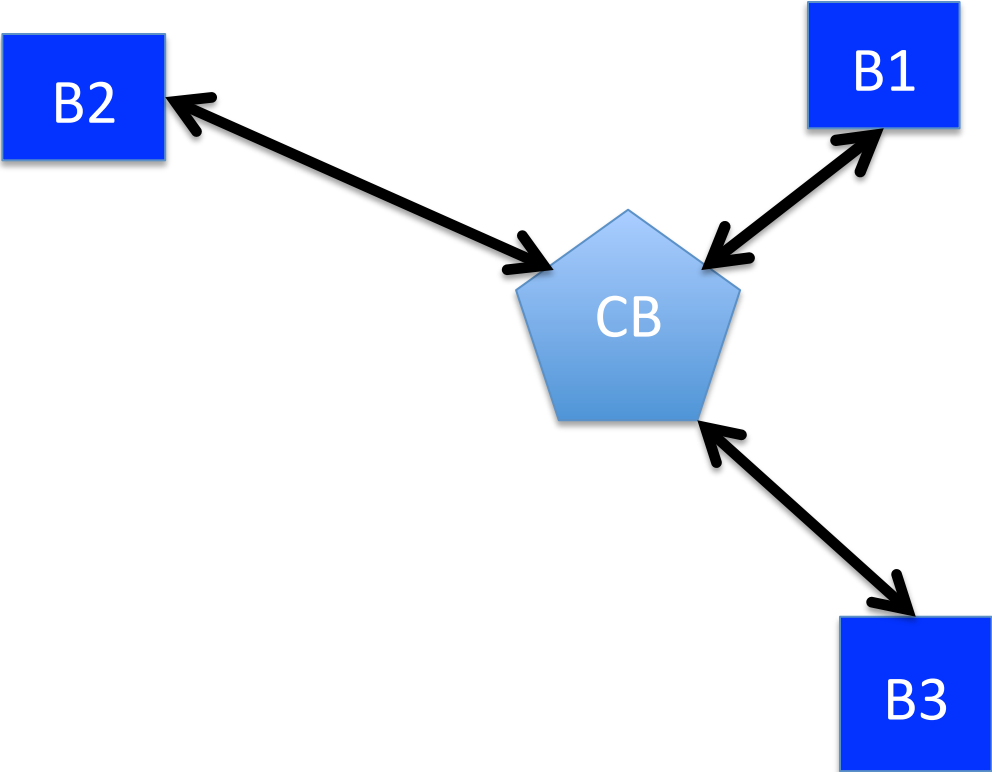


# Bear Stearns' Liquidity Pool Over its Last Days (\$ billions)

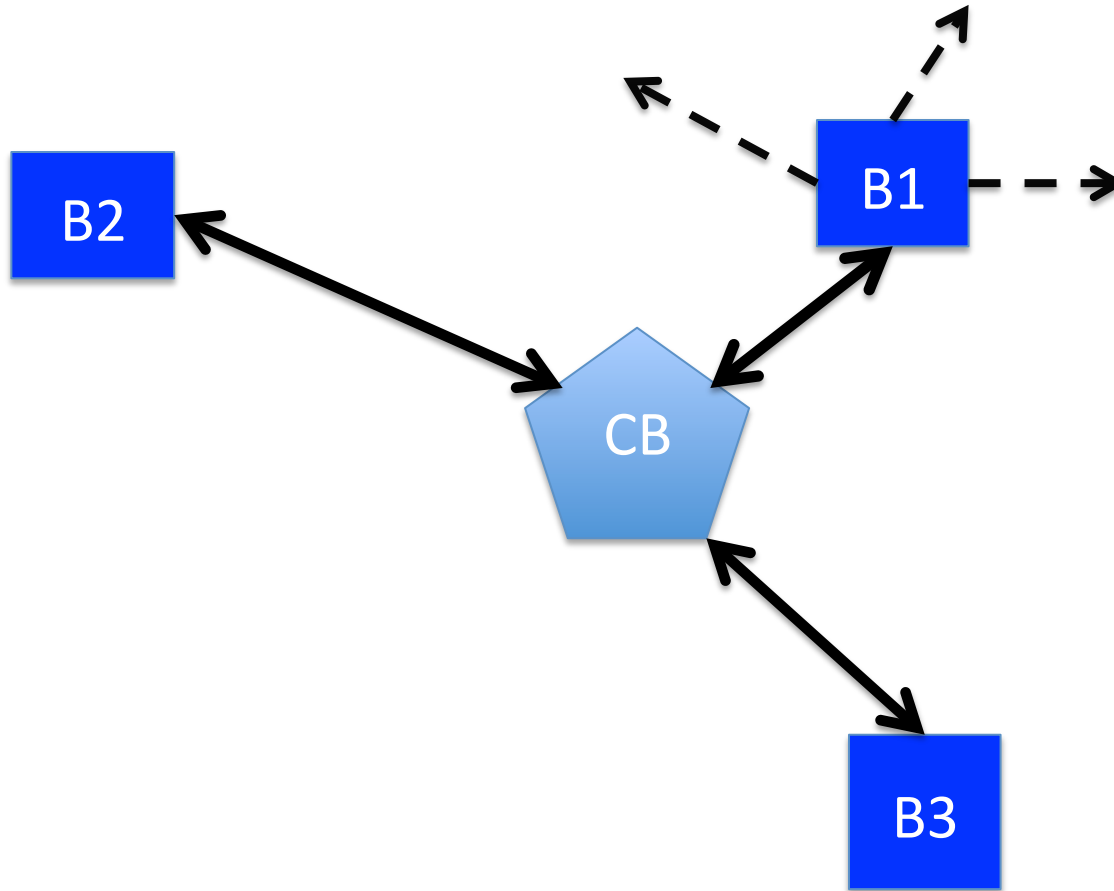


Data Source: Cox (2008)

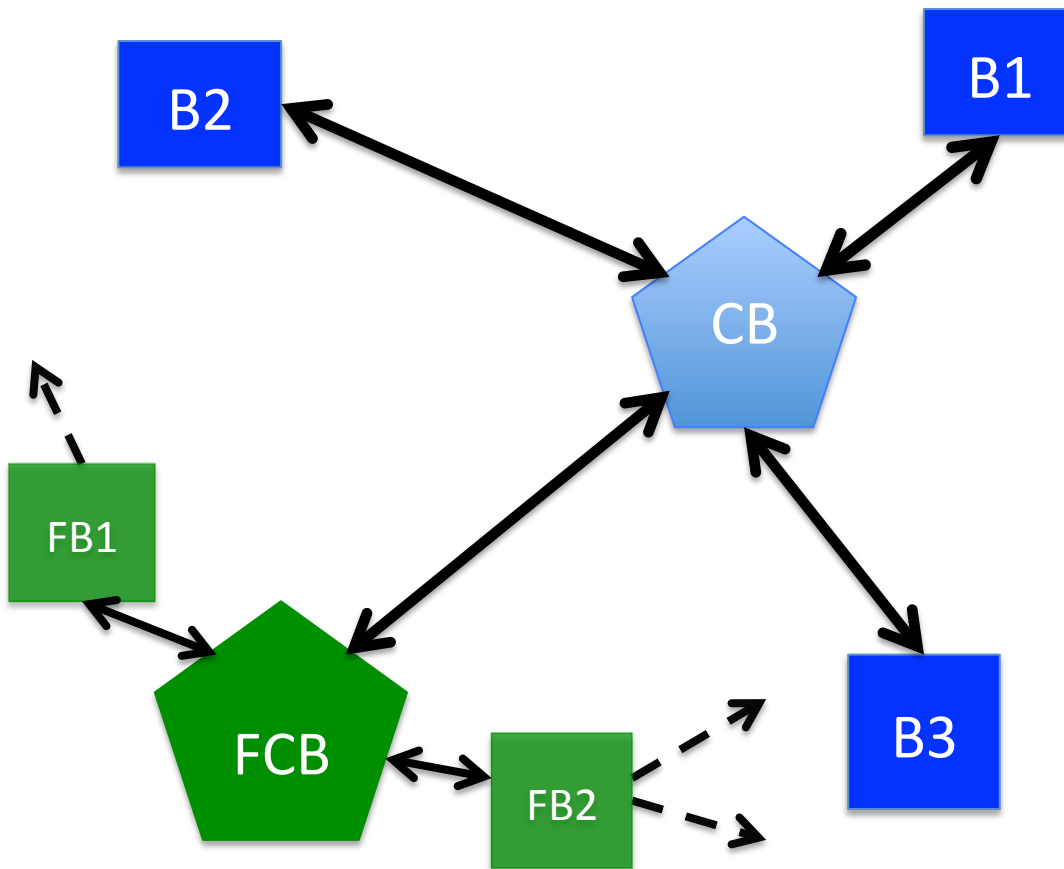
# Central Bank Emergency Liquidity



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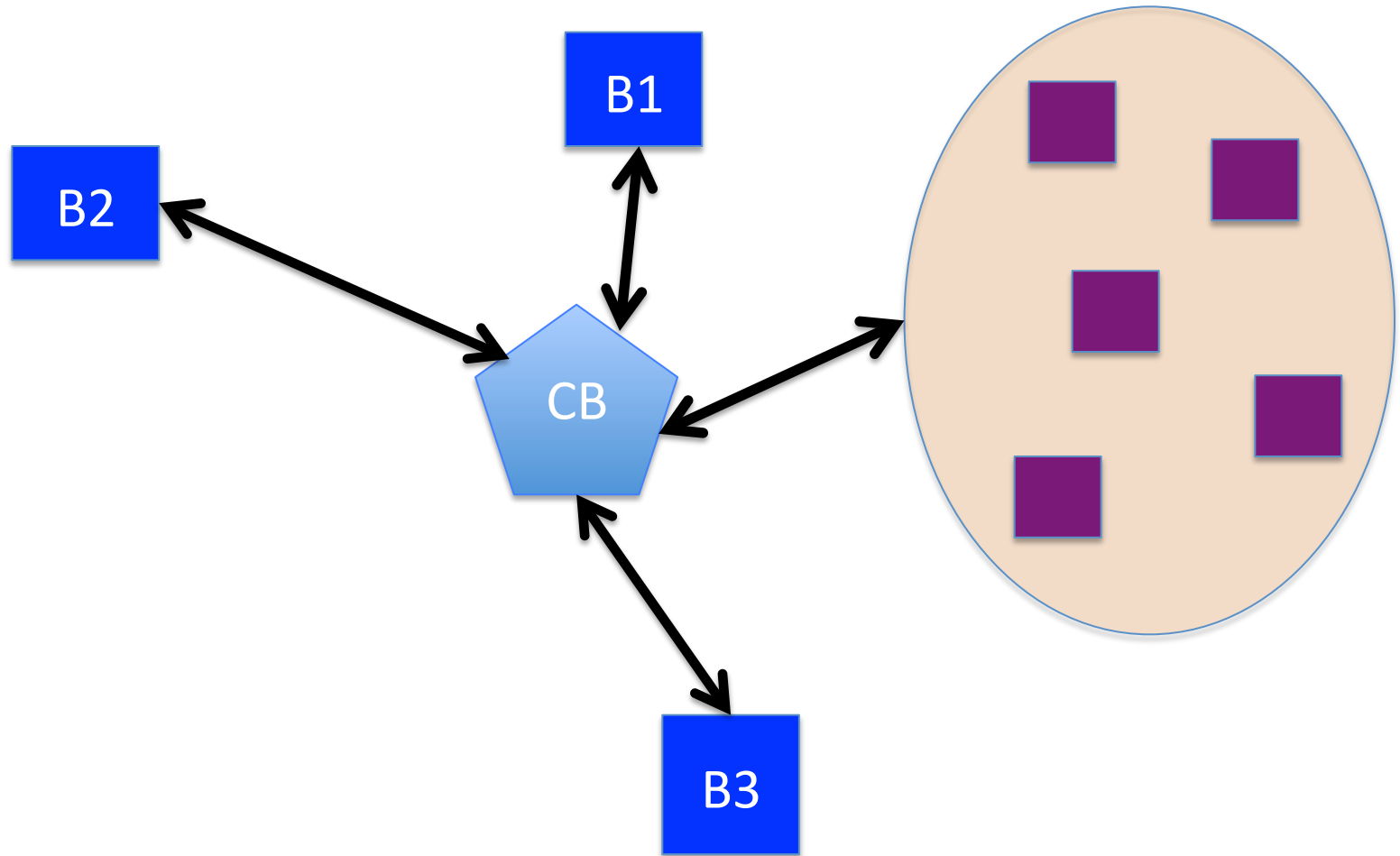


# Central Bank Currency Swap Lines

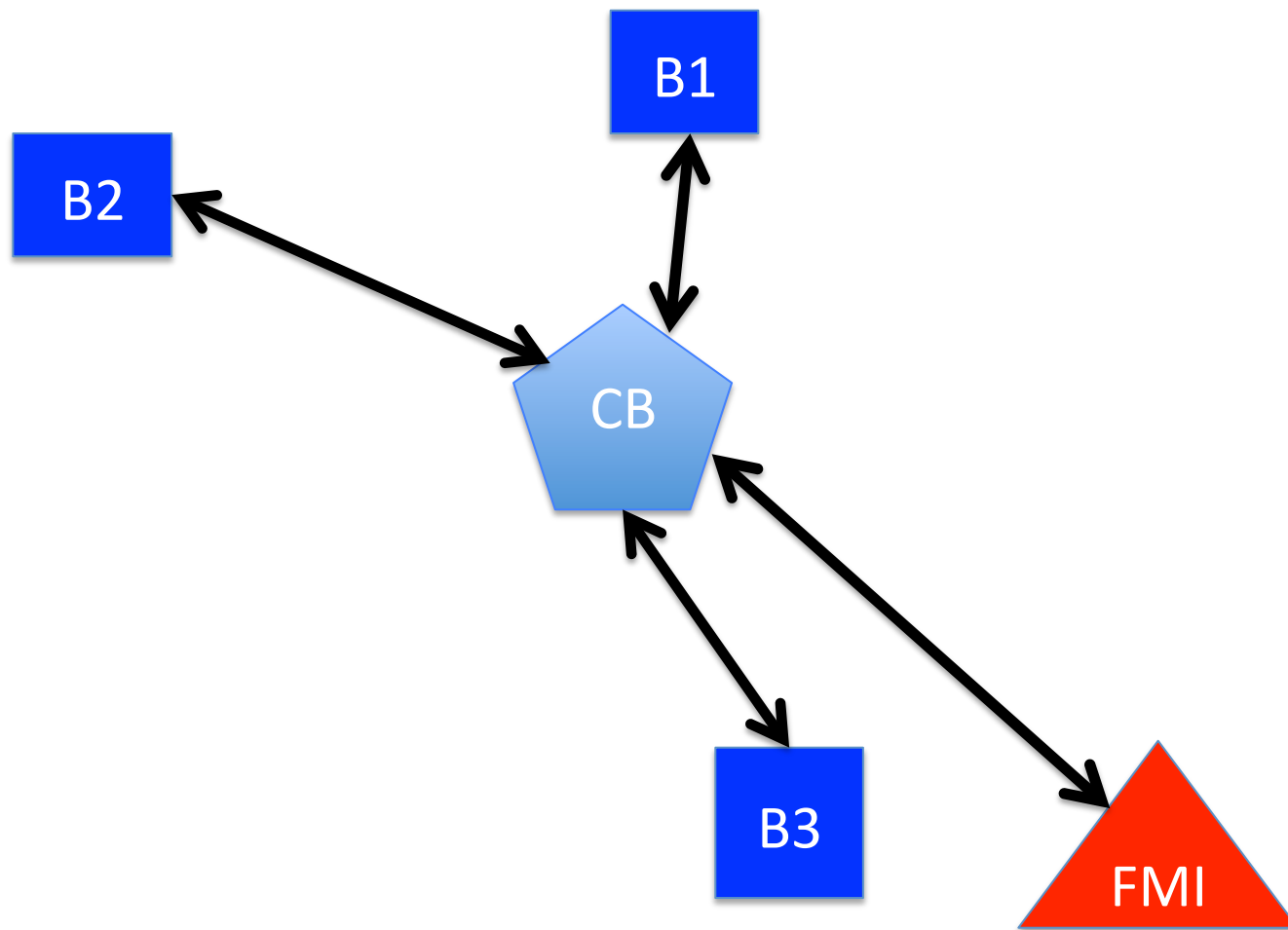




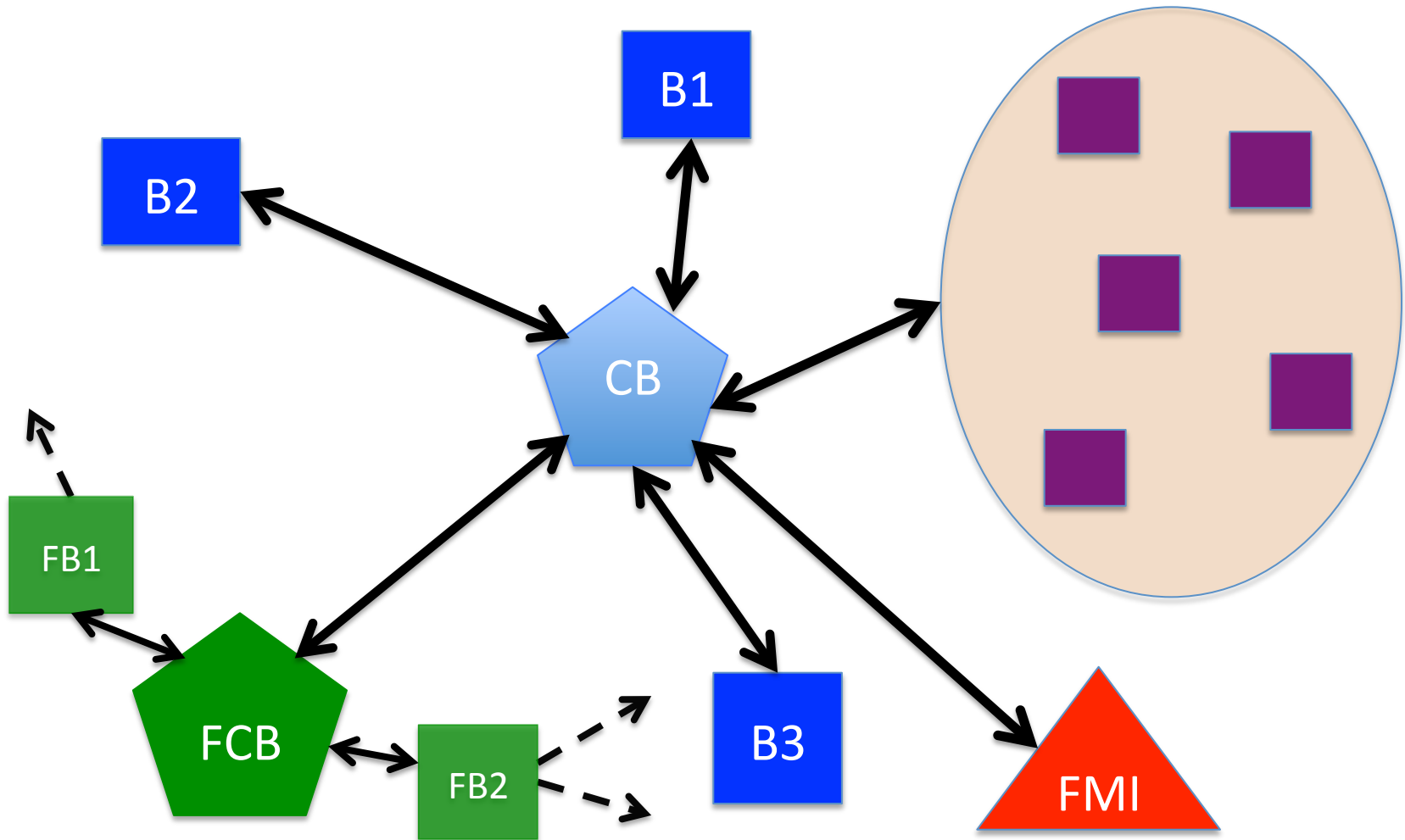
# Broad Programmatic Credit Facilities



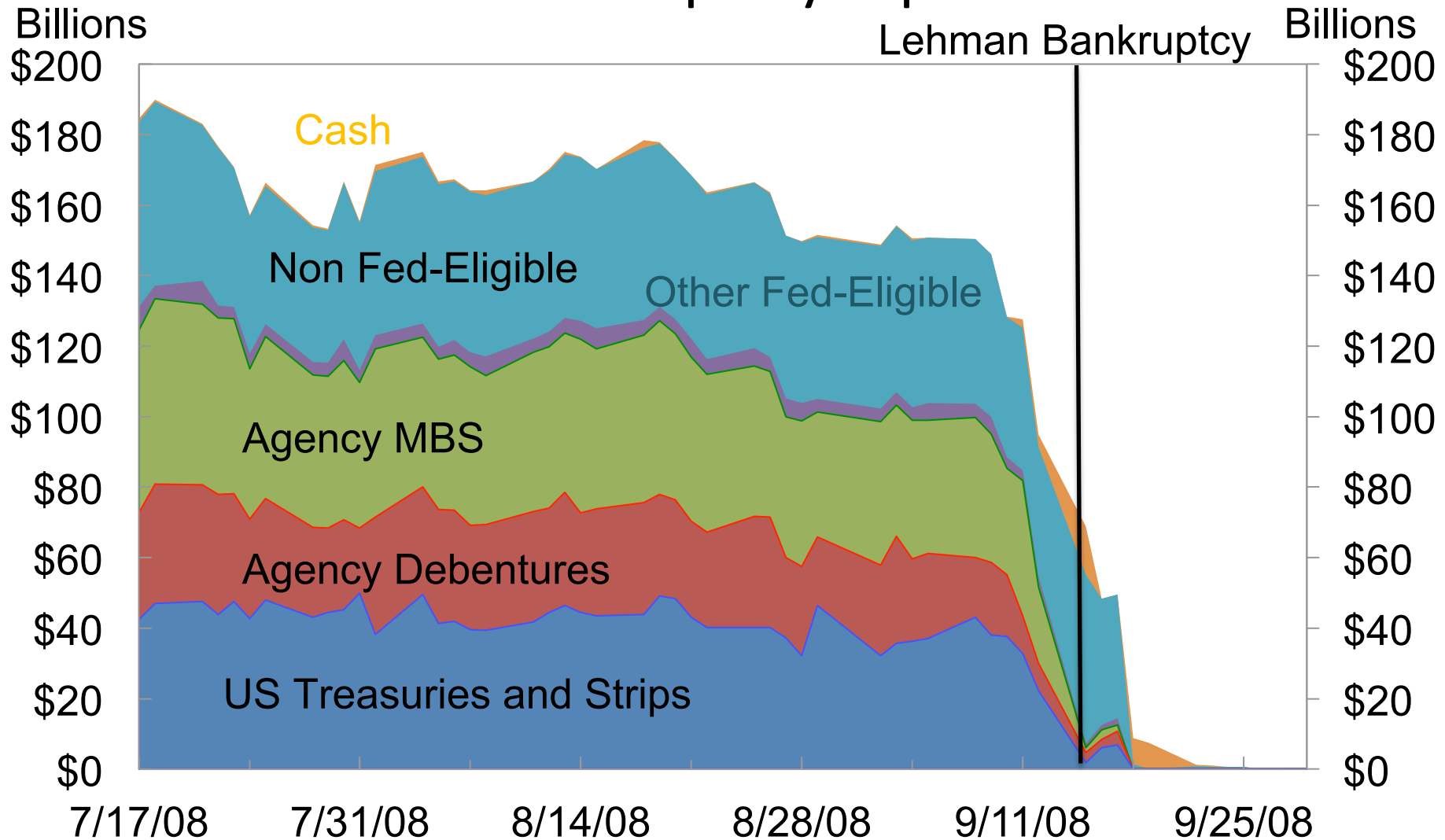
# Liquidity to Financial Market Infrastructure



# Lending of Last Resort

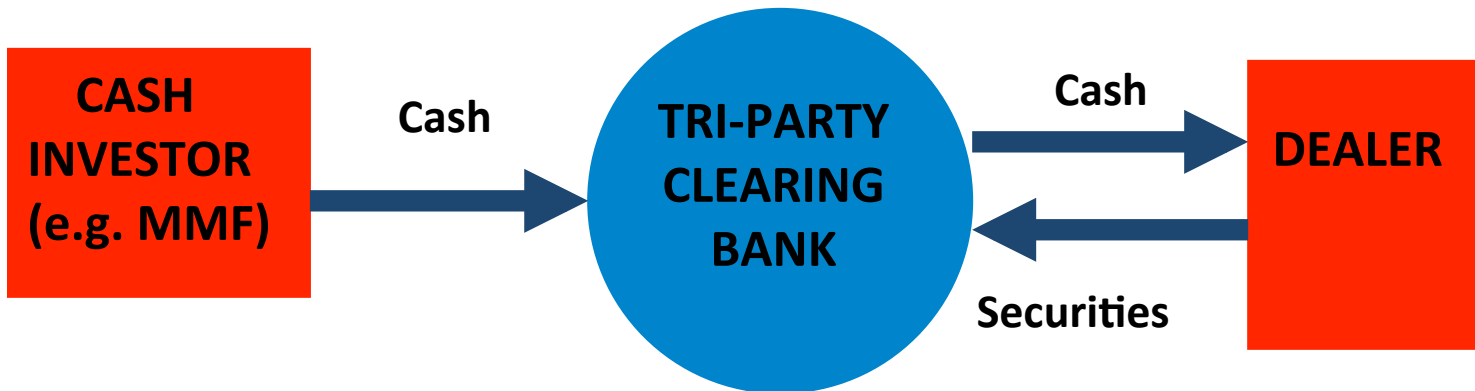


# Lehman's tri-party repo book



Source: Copeland, Martin, Walker (2011) FRBNY

# Tri-Party Repo



# Current Reform of Tri-Party Repo Infrastructure

Pre reform



FICC GCF repos  
settle

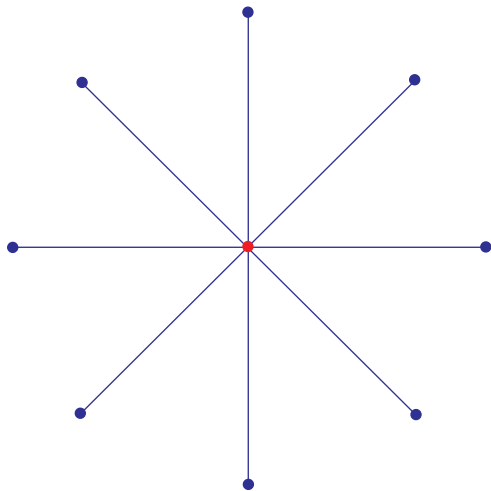
DTCC equities  
available

Fedwire Securities  
interbank open

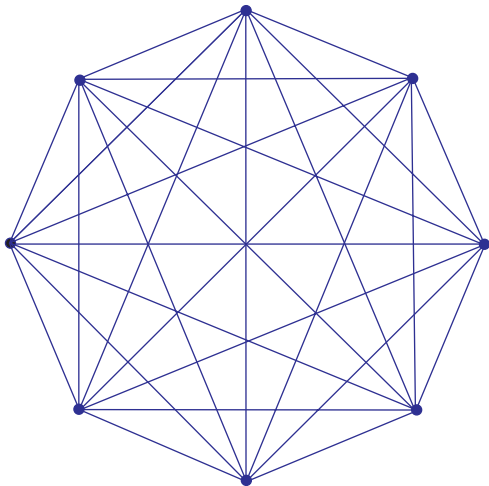
3:30PM

Post reform



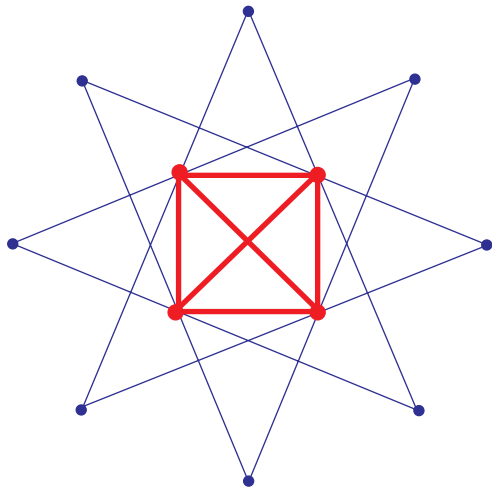


**Figure :** Neoclassical centralized financial market.

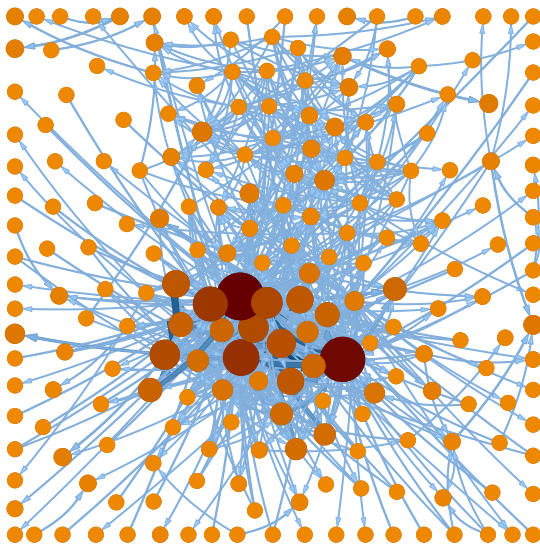


**Figure :** Completely connected over-the-counter market.

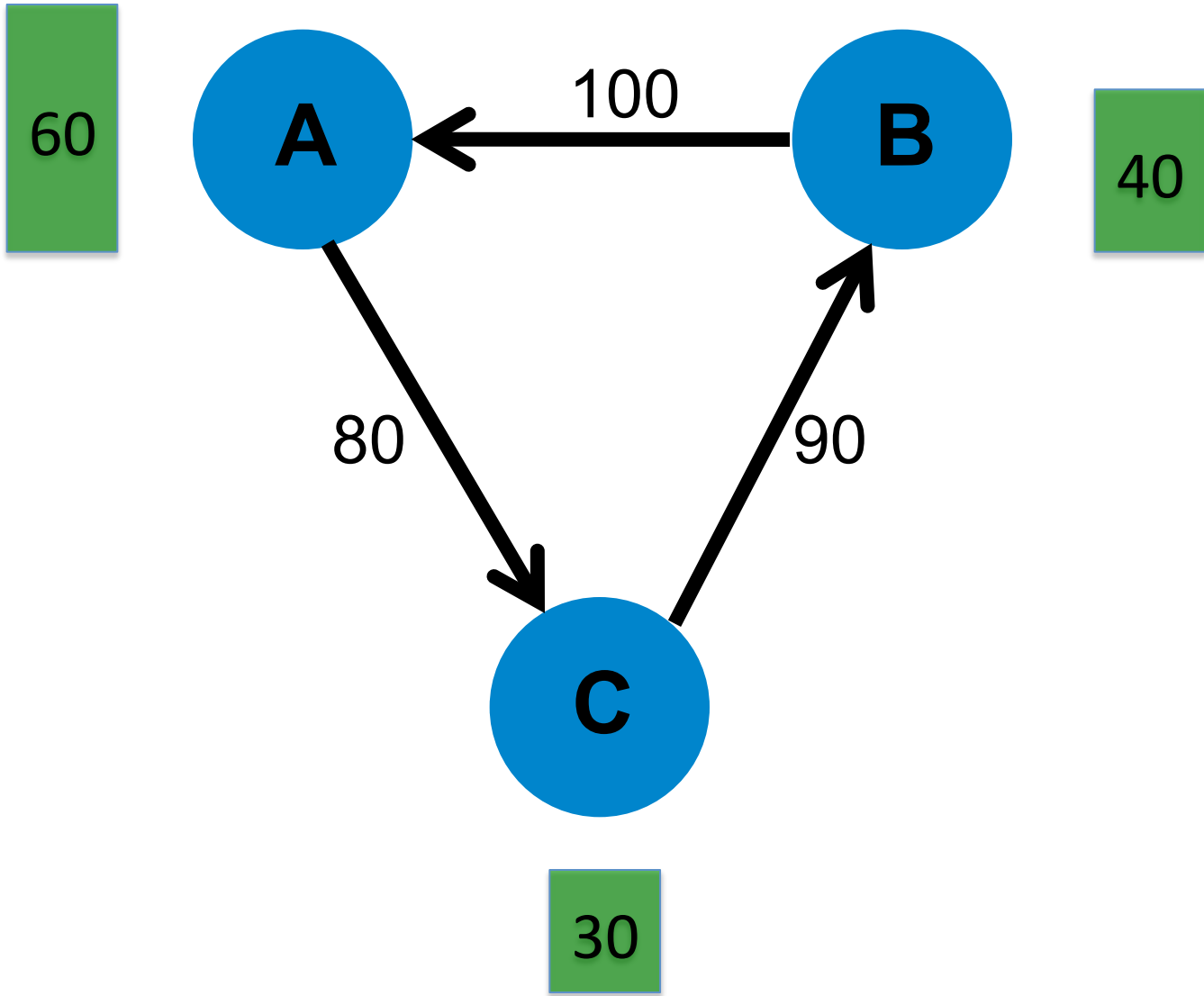


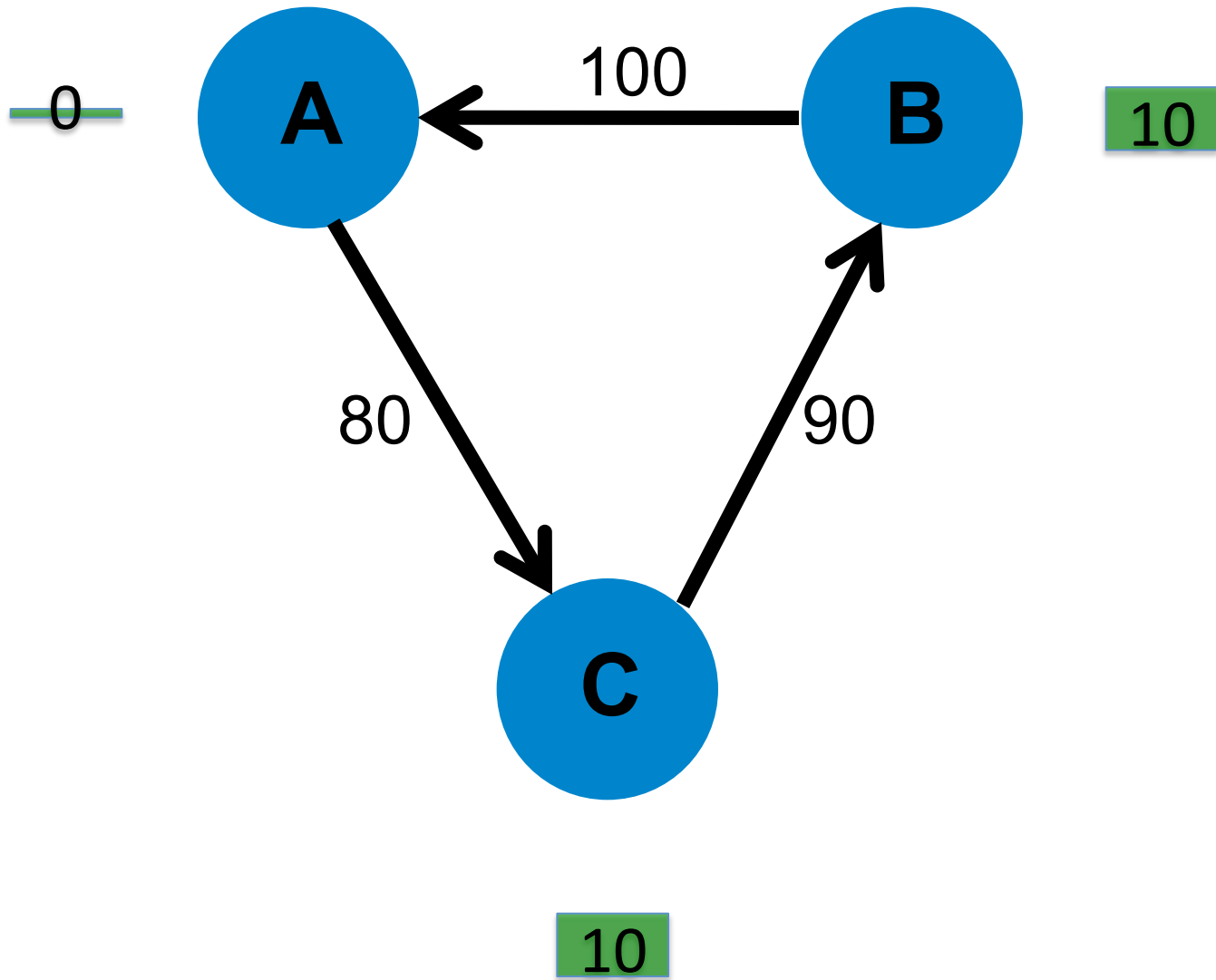


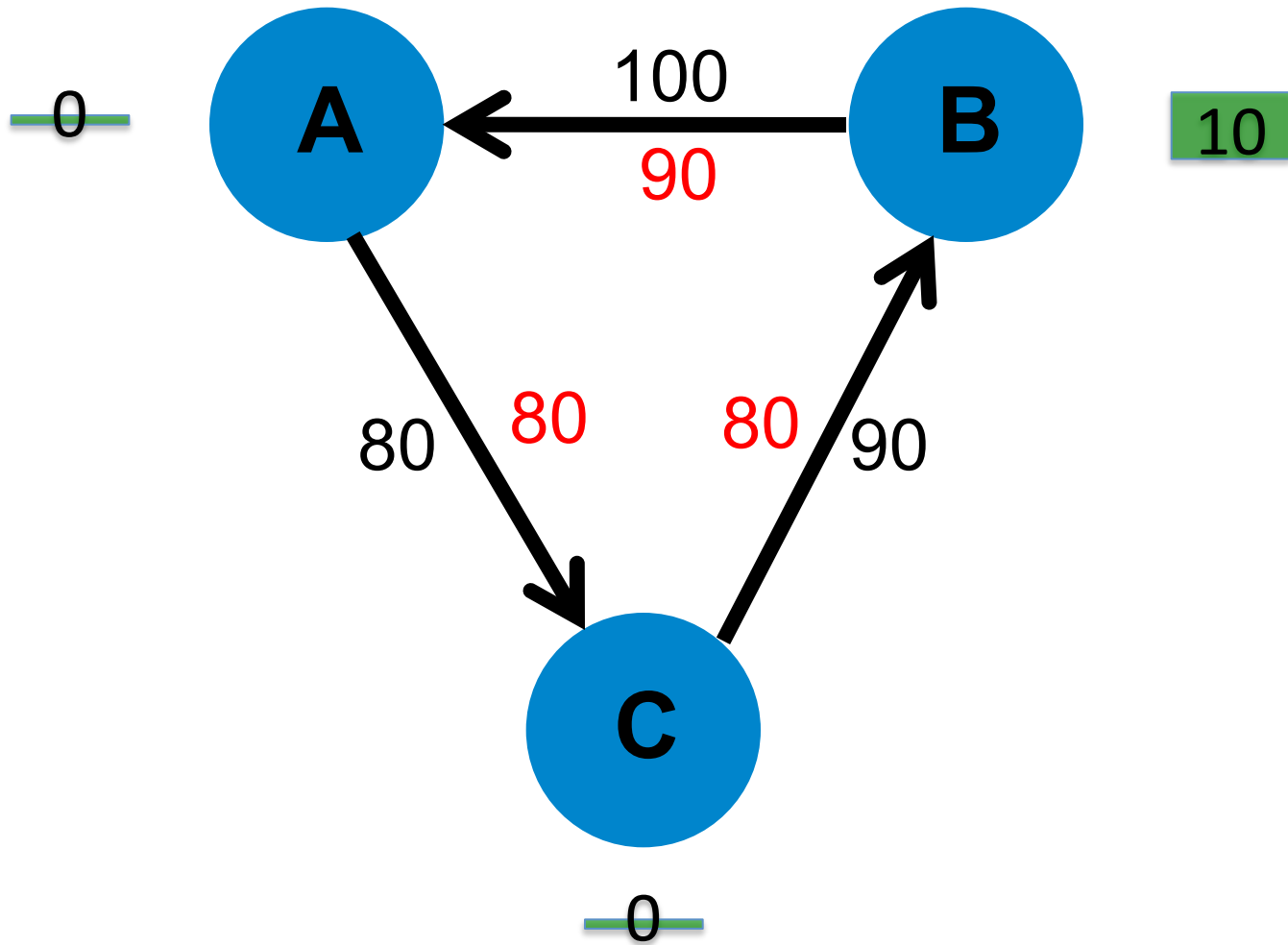
**Figure :** Core-periphery financial network.



**Figure:** Daily trade in the federal funds Market. Source: Bech and Atalay (2012).







# Static Network Payment Equilibrium

## Eisenberg-Noe (2001)

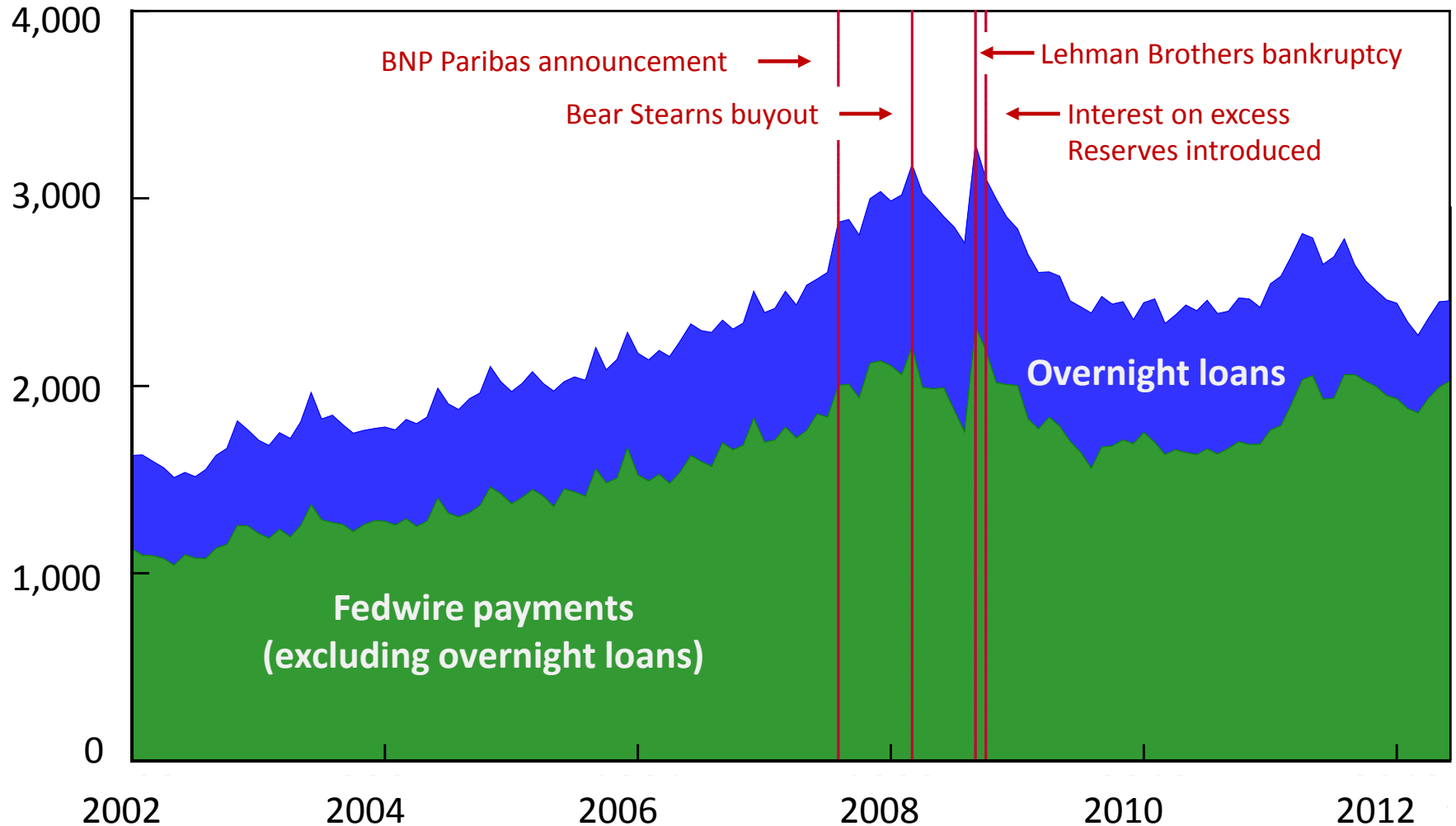
- ▶ Node  $i$  has net cash  $c_i \in \mathbb{R}$  and a debt to node  $j$  of  $y_{ij} \in \mathbb{R}_+$ , so a total debt of  $Y_i = y_{i1} + \dots + y_{in}$ .
- ▶ The actual payment of  $x_{ij}$  of  $i$  to  $j$  solves the equilibrium equations:

$$x_{ij} = \frac{y_{ij}}{Y_j} [\min(Y_j, c_i + x_{1i} + \dots + x_{ni})]^+, \quad i \in \{1, \dots, n\}.$$

- ▶ Existence follows from Tarski's Fixed Point Theorem.
- ▶ Uniqueness applies under mild conditions.
- ▶ Eisenberg and Noe (2001), Acemoglu, Ozdaglar, and Tahbaz-Salehi (2013).

# Components of Payments Values over Time

Billions of U.S. Dollars

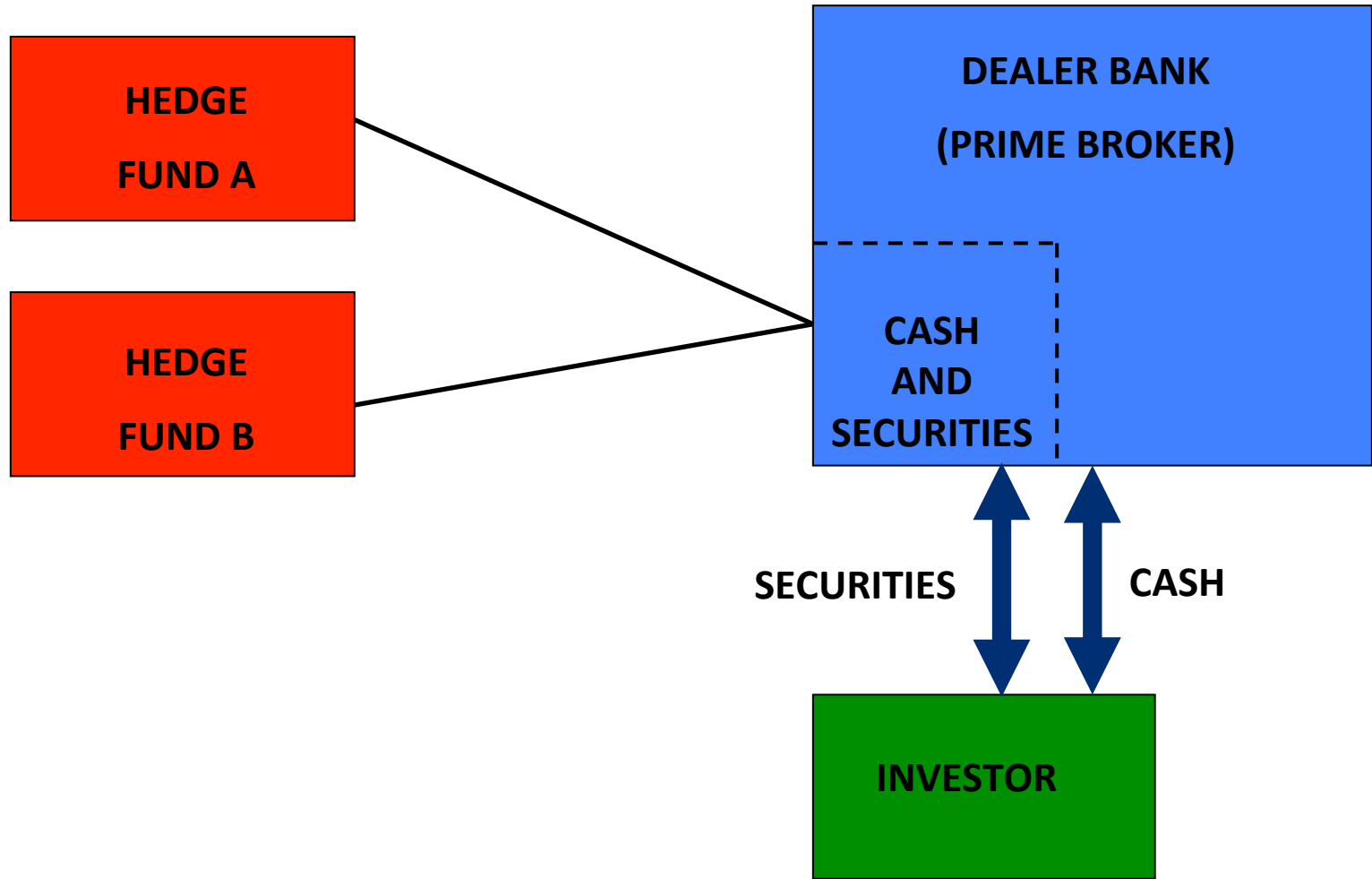


Source: Authors' calculations, based on data from the Federal Reserve Bank of New York.

Note: Data are monthly averages.

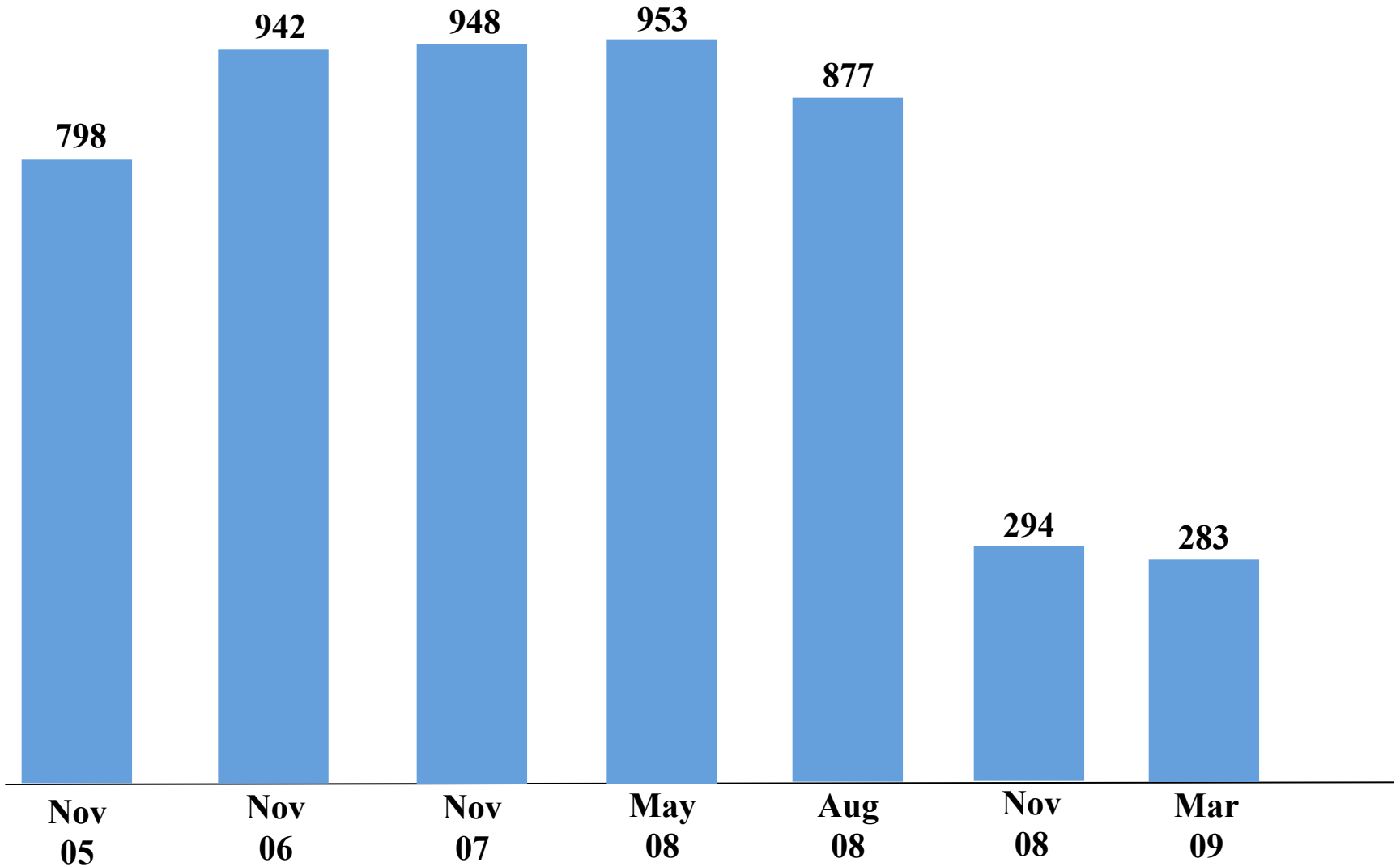
Source: Sastry and Skeie (2013)

# Prime-Brokerage



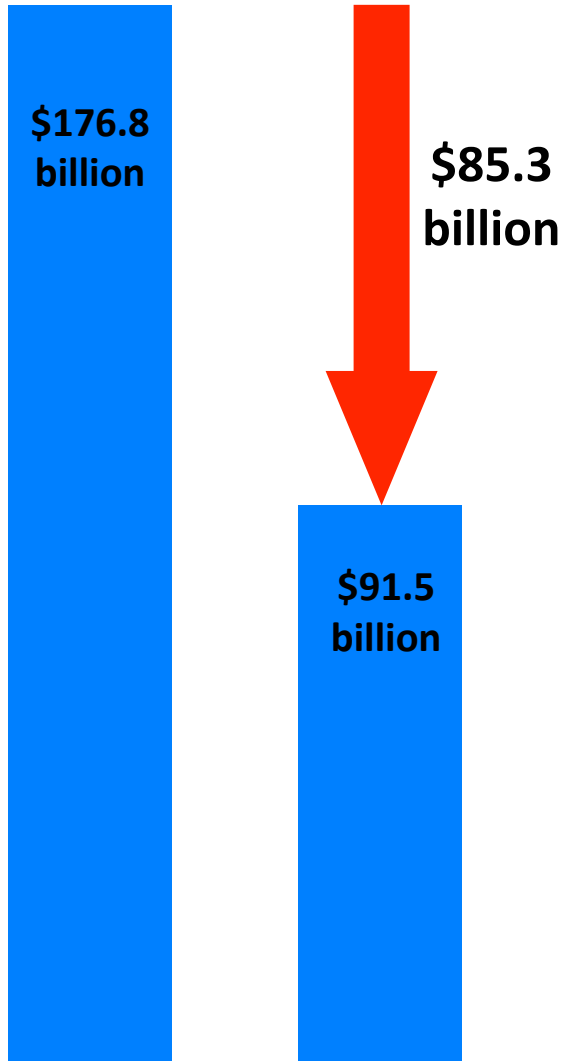


# Morgan Stanley collateral received that can be pledged (\$ billions)

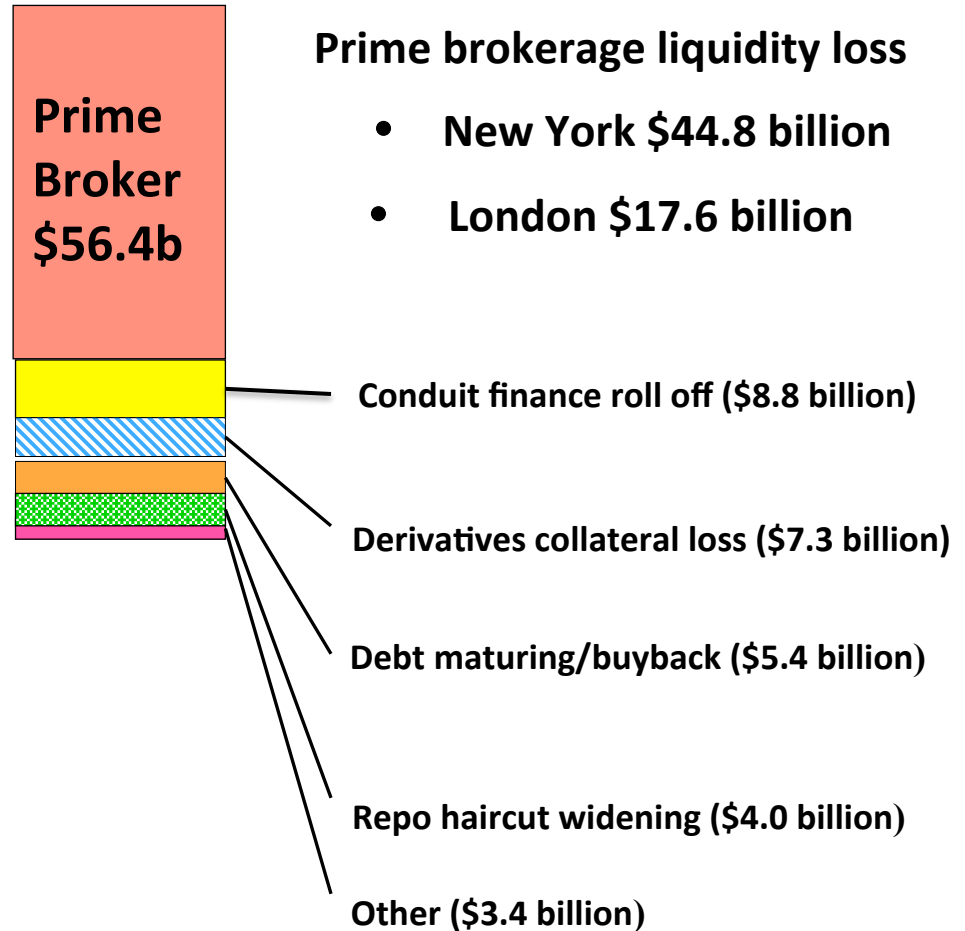


Data Source: Singh (2009)

# Morgan Stanley's Liquidity Loss Sept. 12-22, 2008

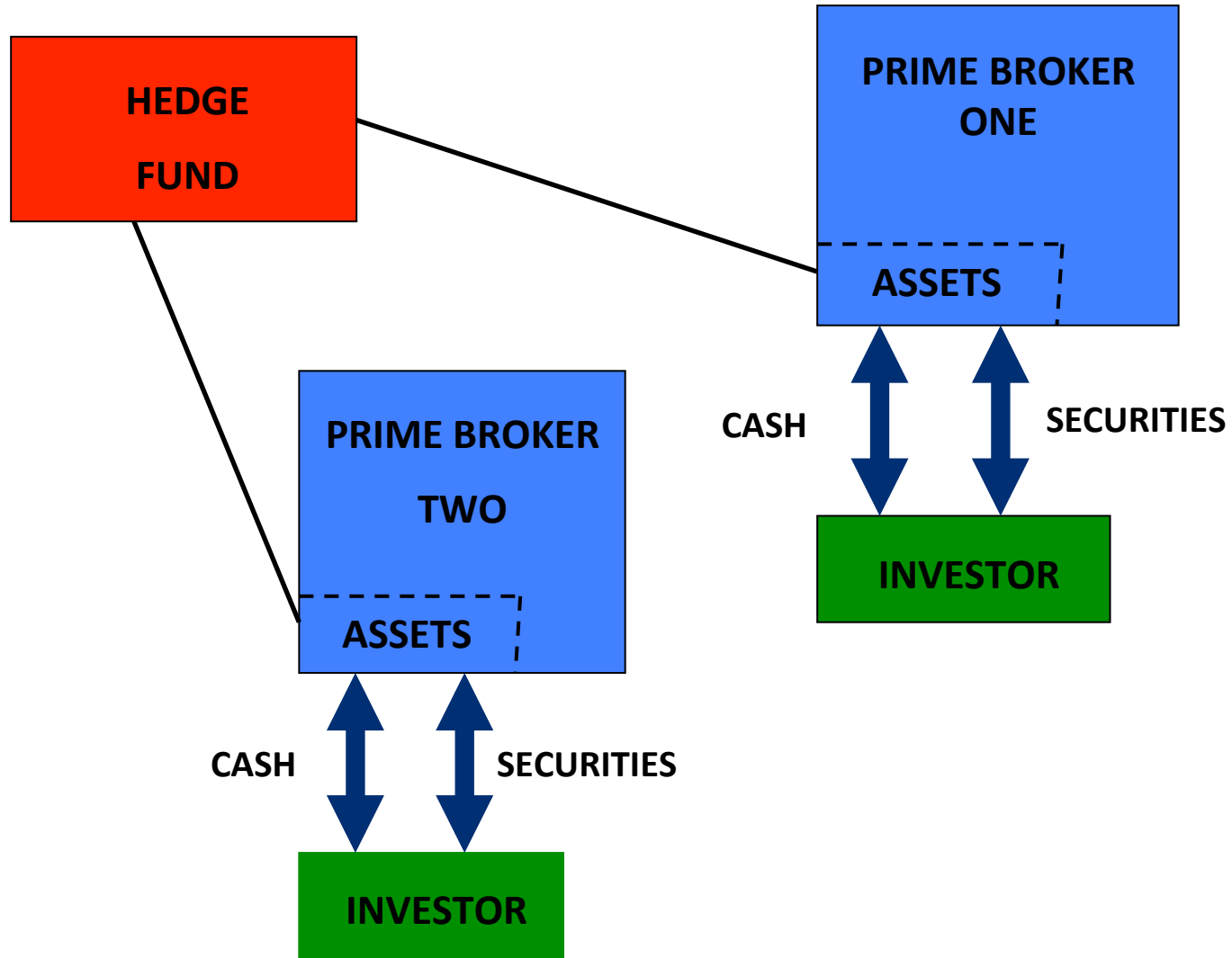


Duffie (2011)

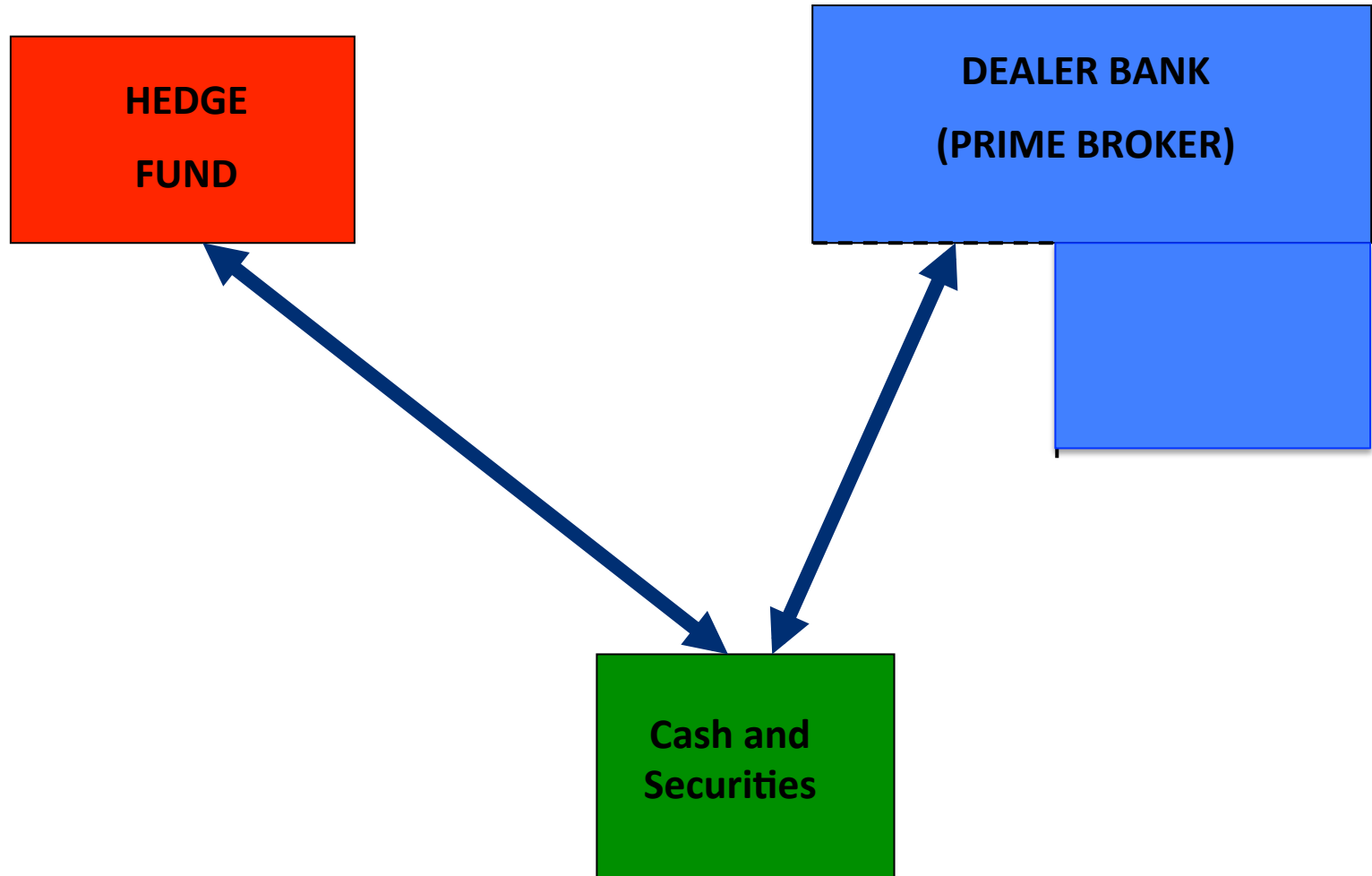


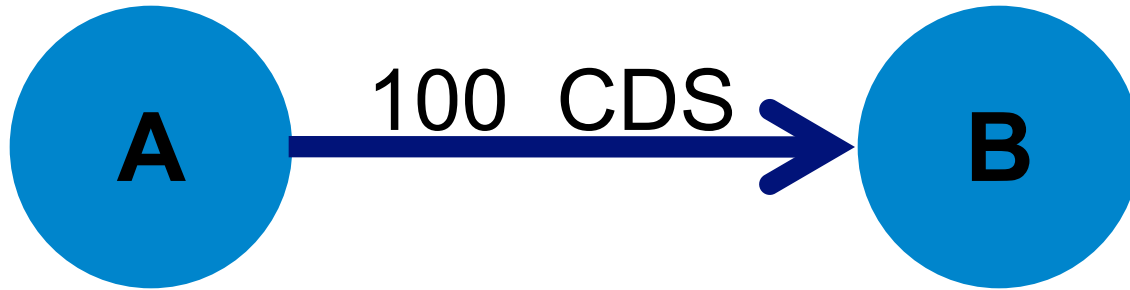
Data source: Morgan Stanley-FRBNY FCIC disclosure

# Multiple Prime Brokers

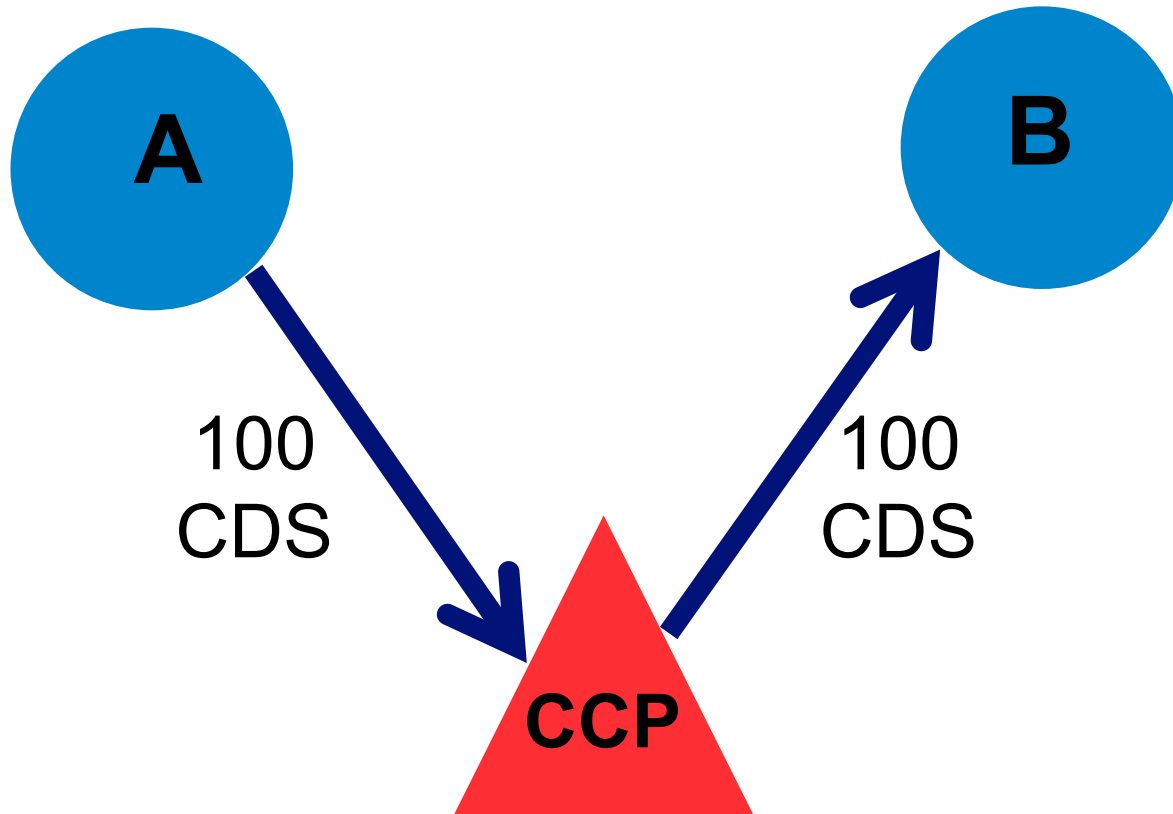


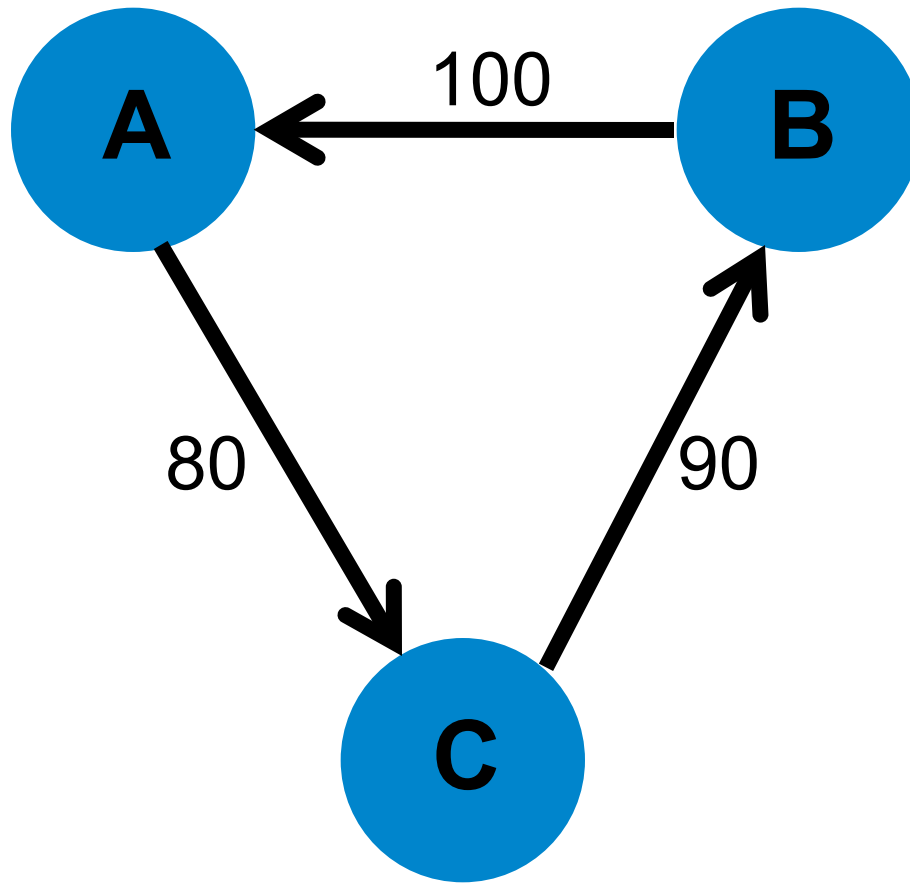
# Prime-Brokerage Custodian



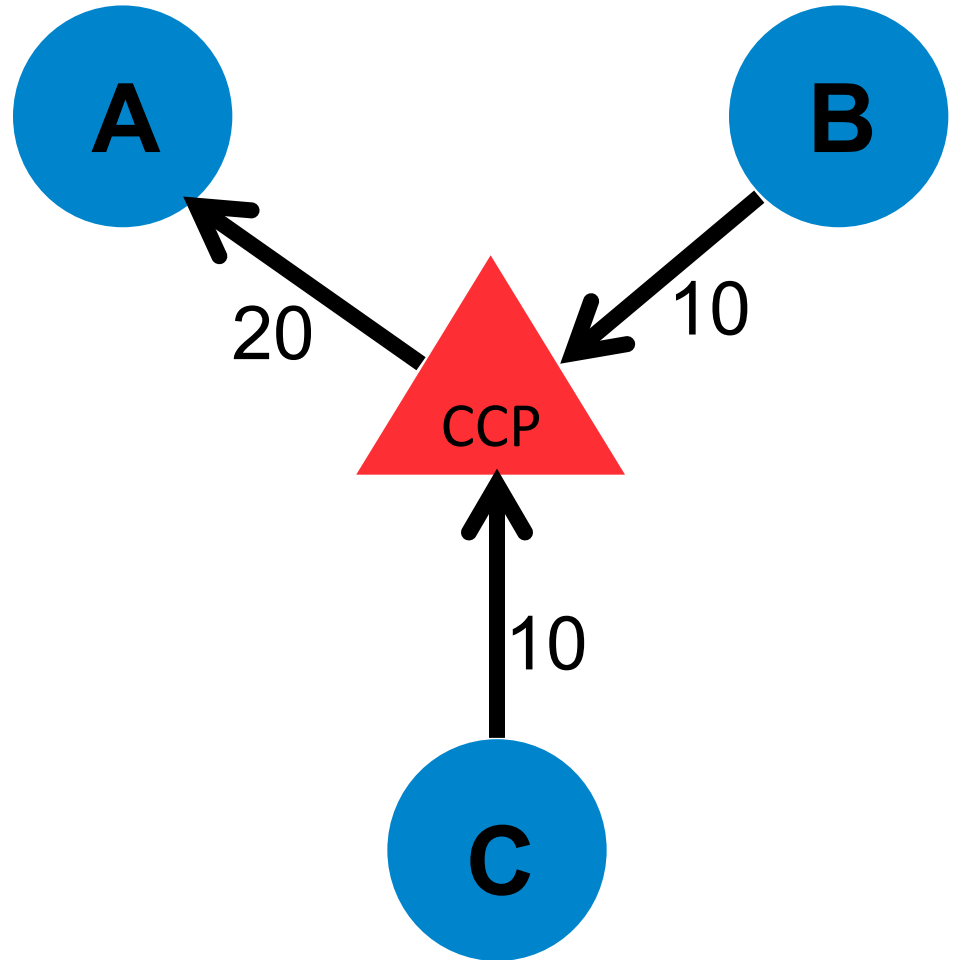
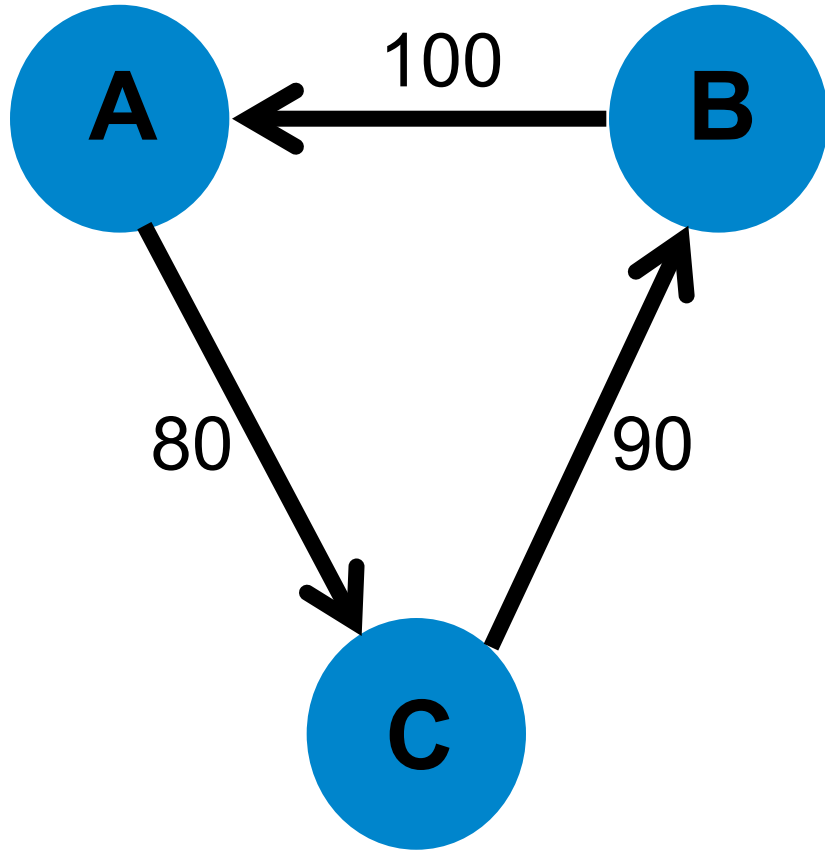


# Central Clearing

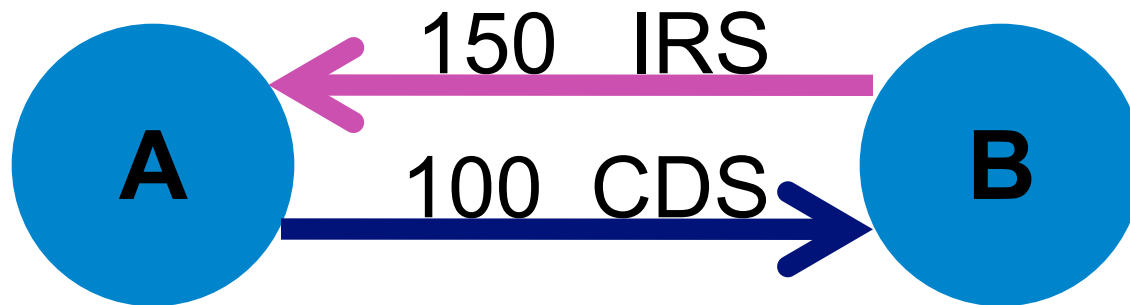




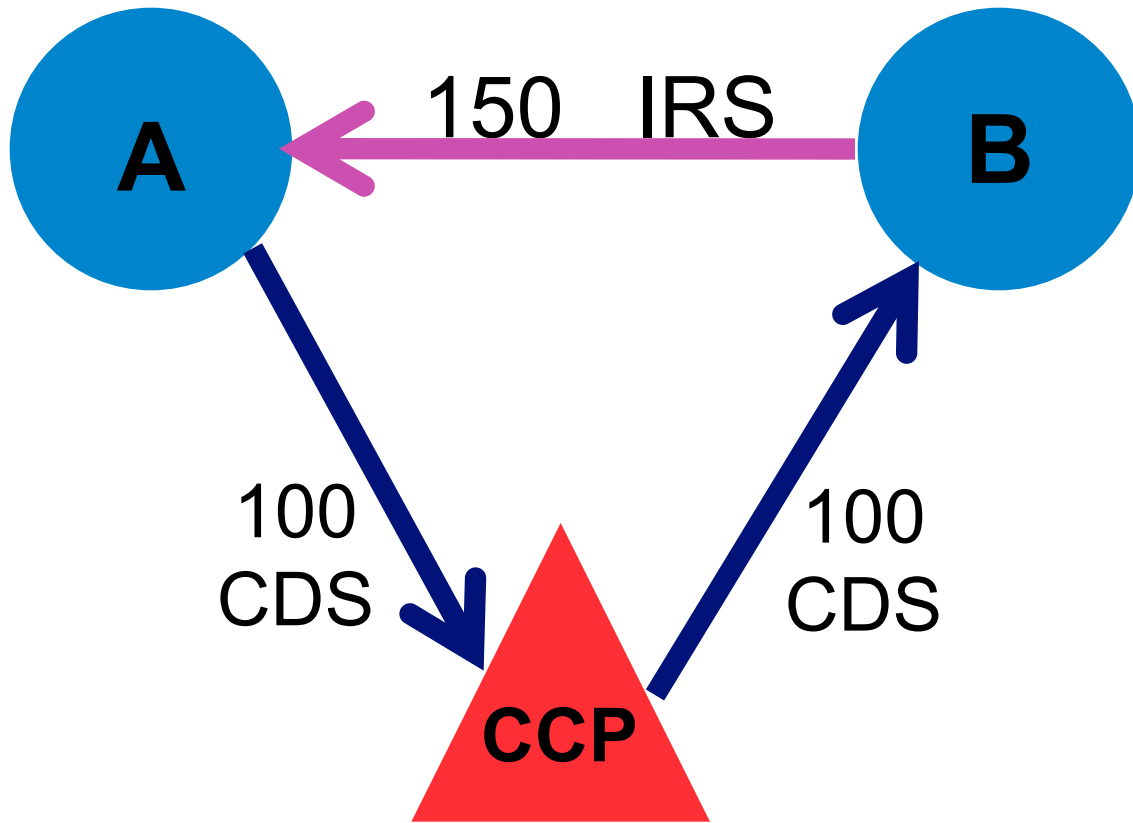
# Central Clearing

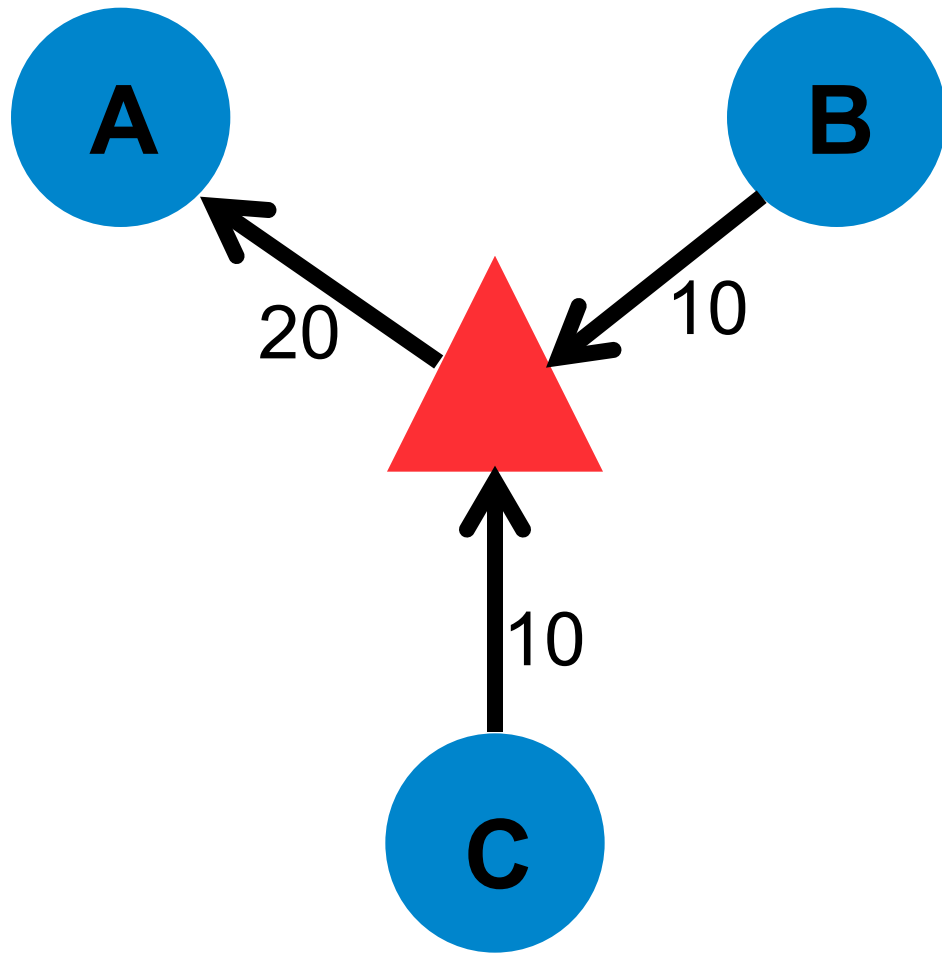
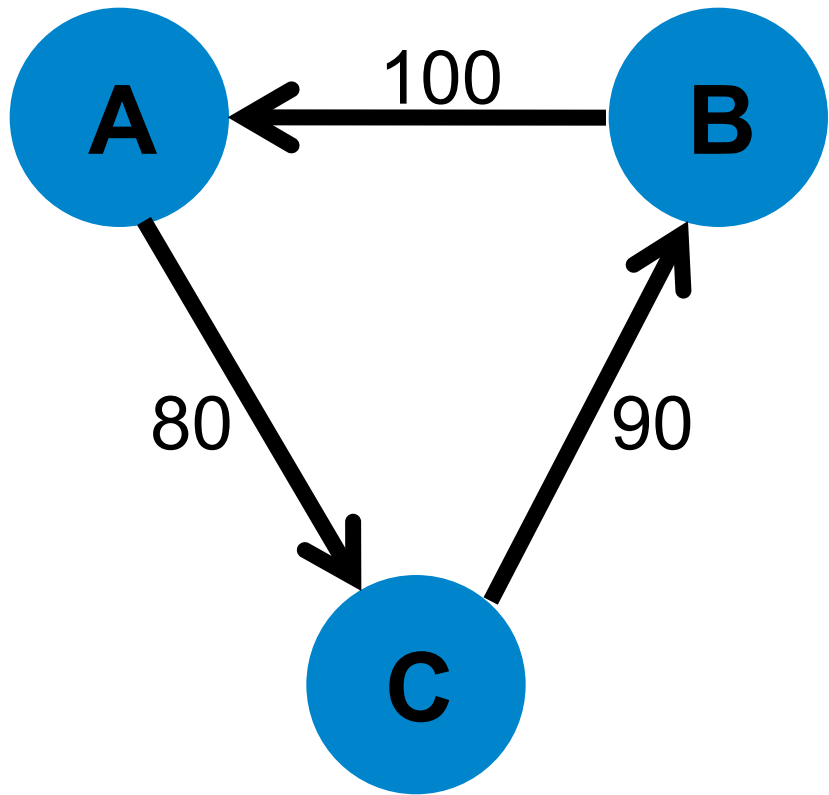


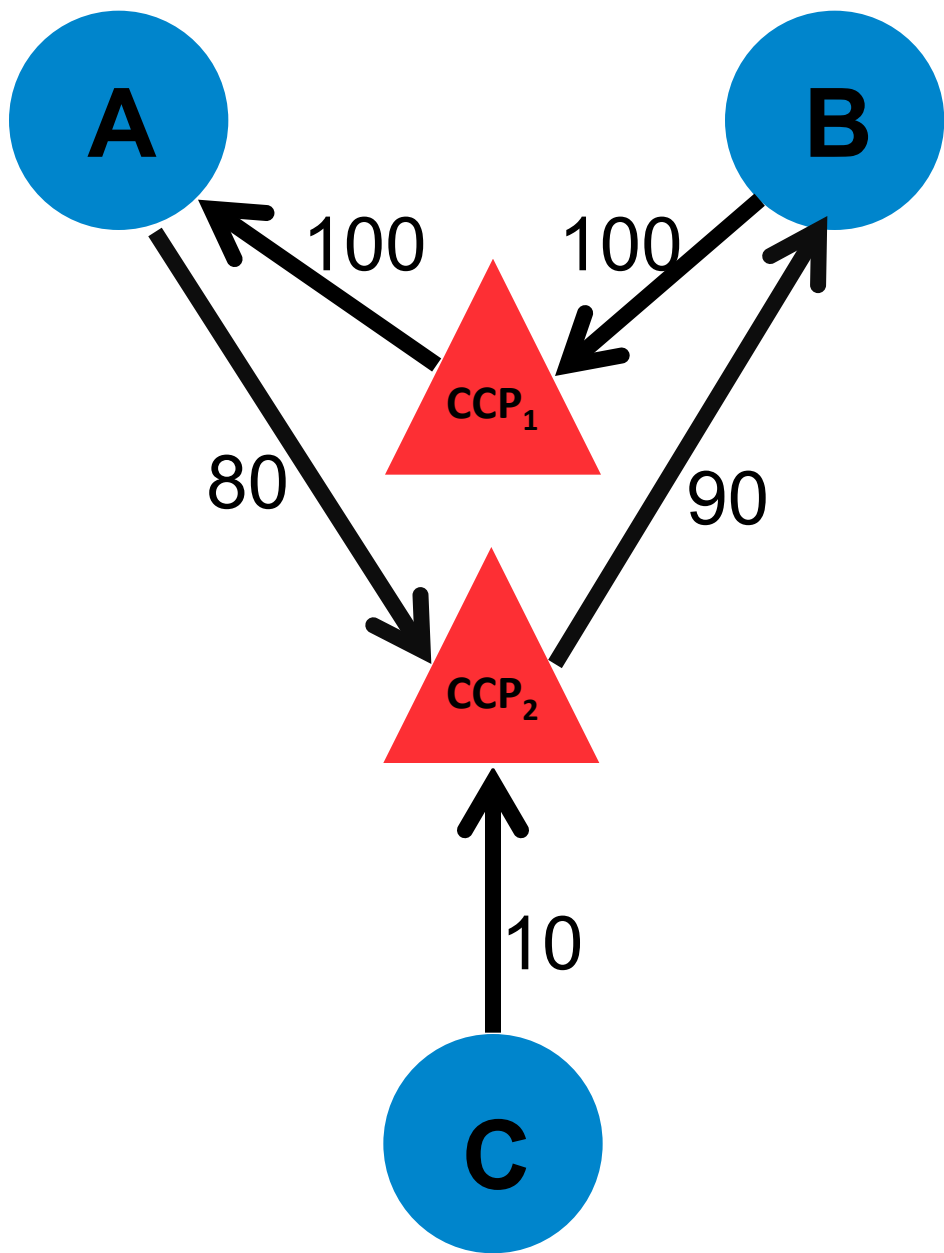
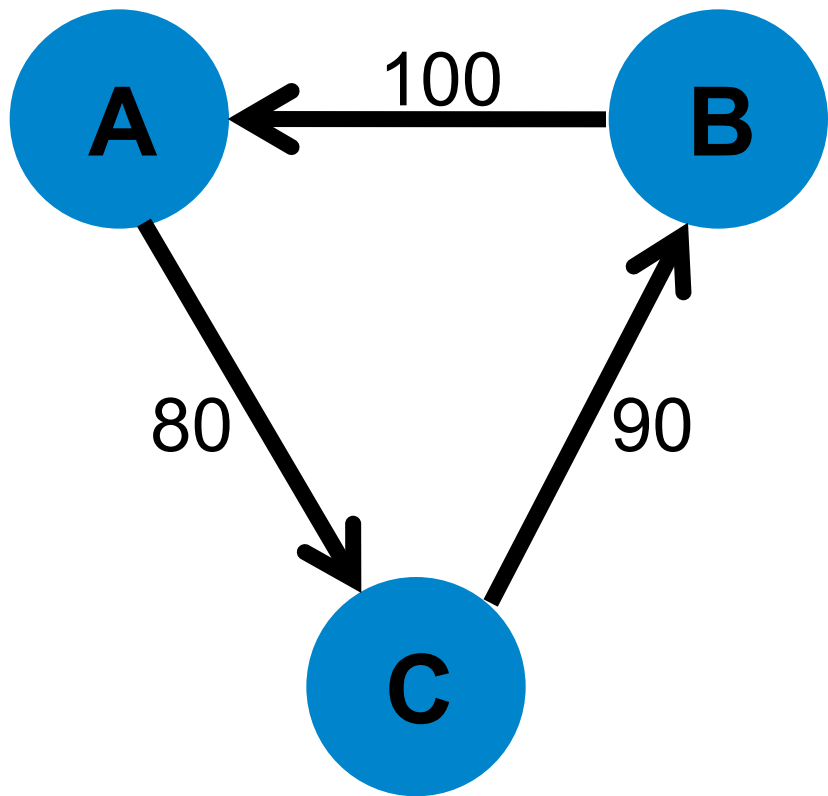


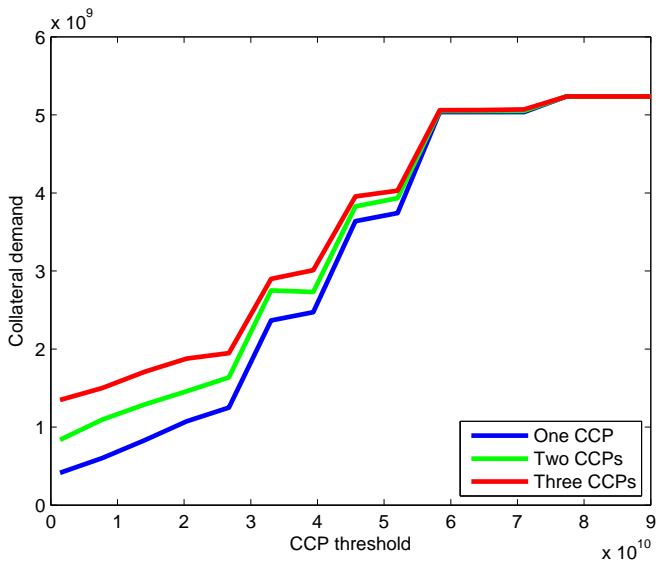


Net Default Exposure: 50



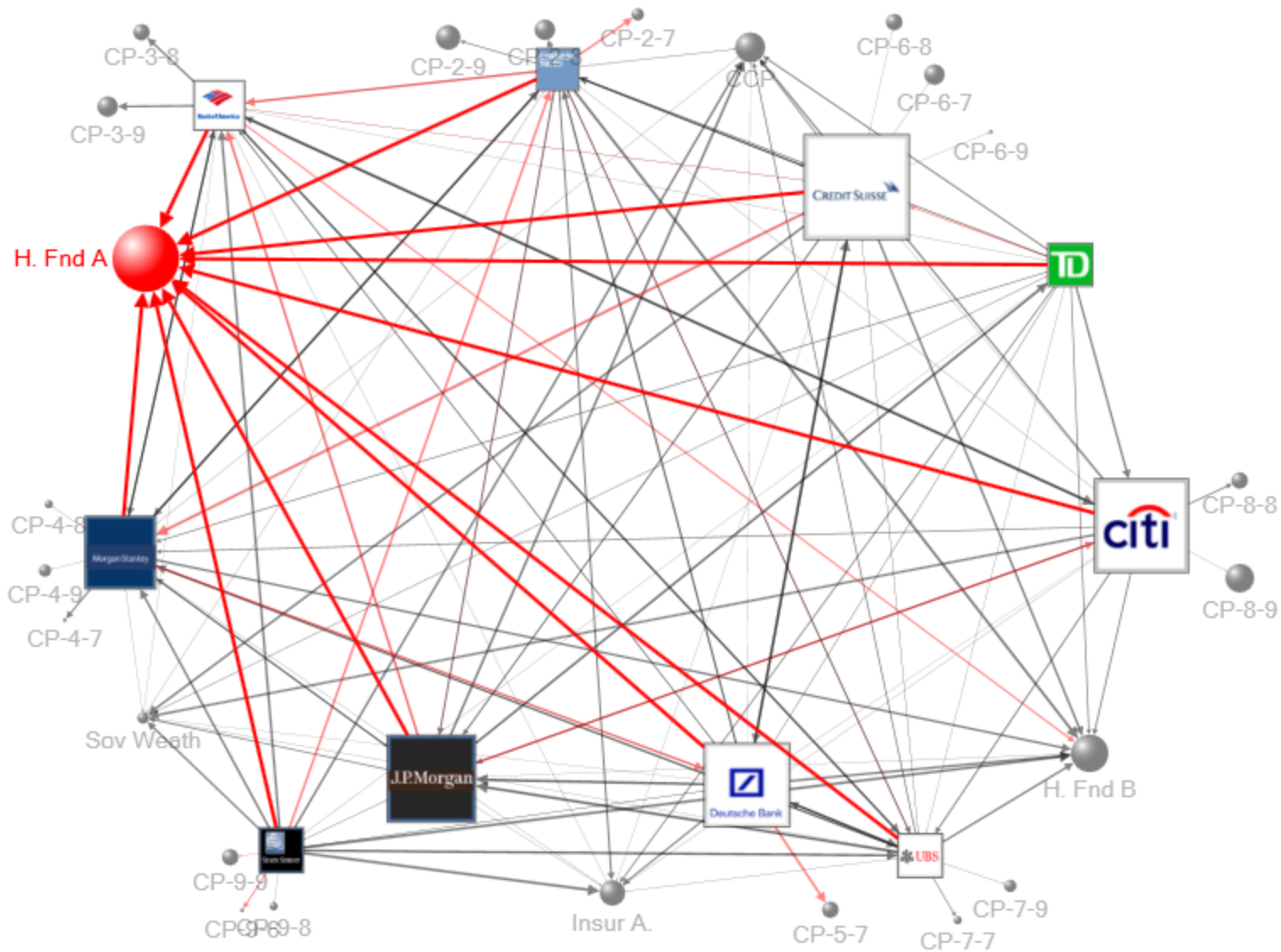






**Figure :** Source: Duffie, Scheicher, Vuillerney (2013).

# 10-by-10-by-10 Systemic Risk Monitoring



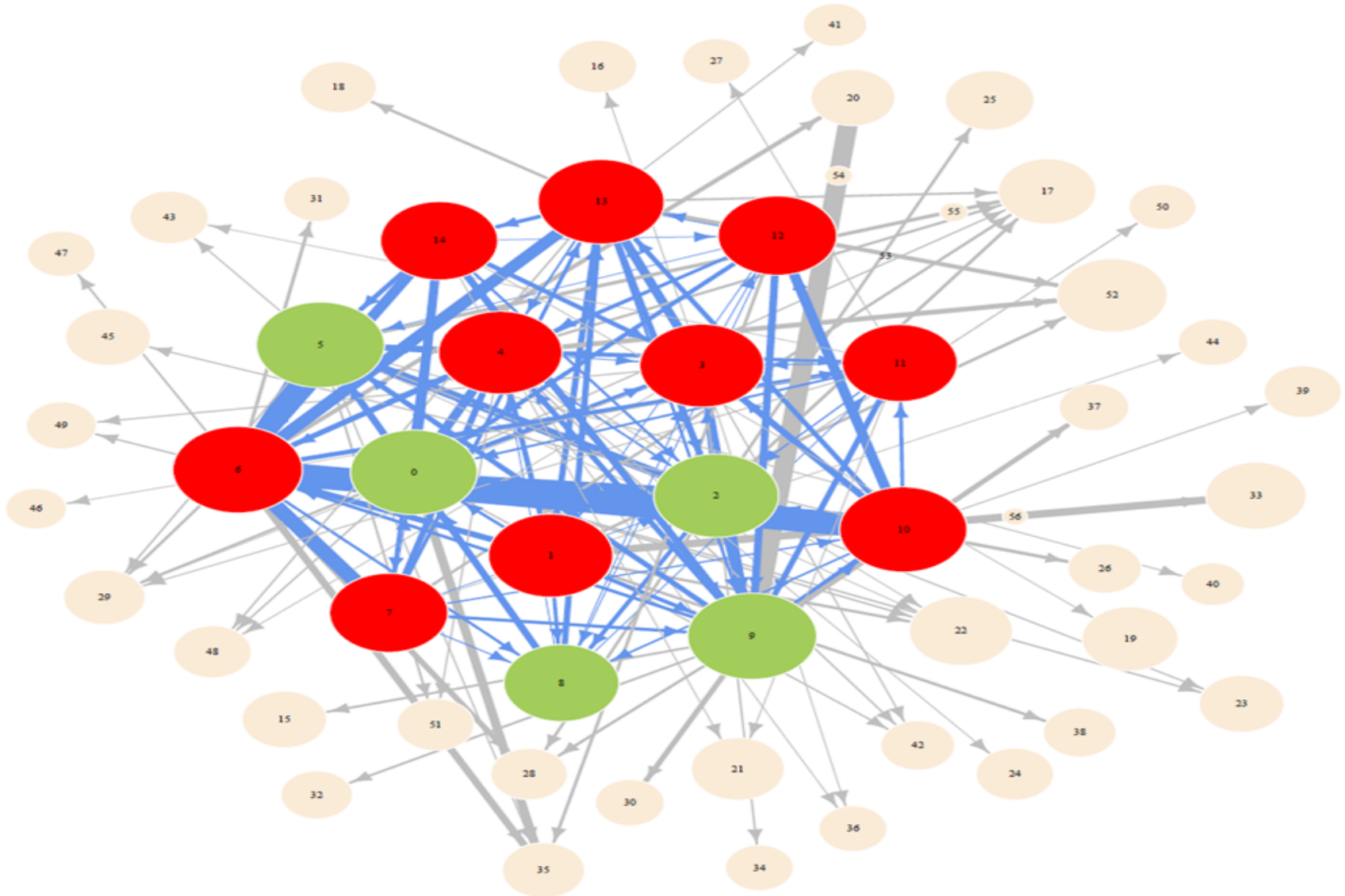
Source: Duffie (2011)

# A Bank's 10-by-10-by-10 Submission

	Stress 1	...	Stress j	...	Stress 10
Self					
Counterparty 1					
⋮					
Counterparty i					
⋮					
Counterparty 10					
⋮					
Counterparty 10					
⋮					
Counterparty 10					

The table illustrates a 10-by-10-by-10 submission structure. The columns represent different stress scenarios (Stress 1, Stress j, Stress 10), and the rows represent different counterparties (Self, Counterparty 1, Counterparty i, Counterparty 10). A blue dashed box highlights the intersection of Counterparty i and Stress j, labeled "Ctpy ID & Exposure".

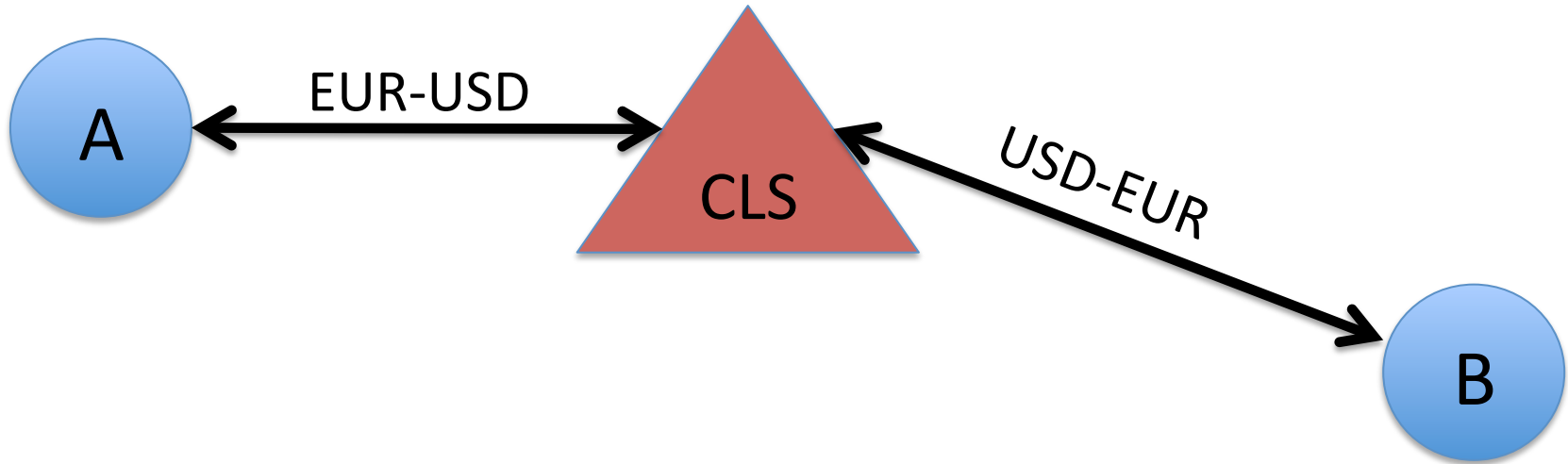
# Network CDS systemic exposures



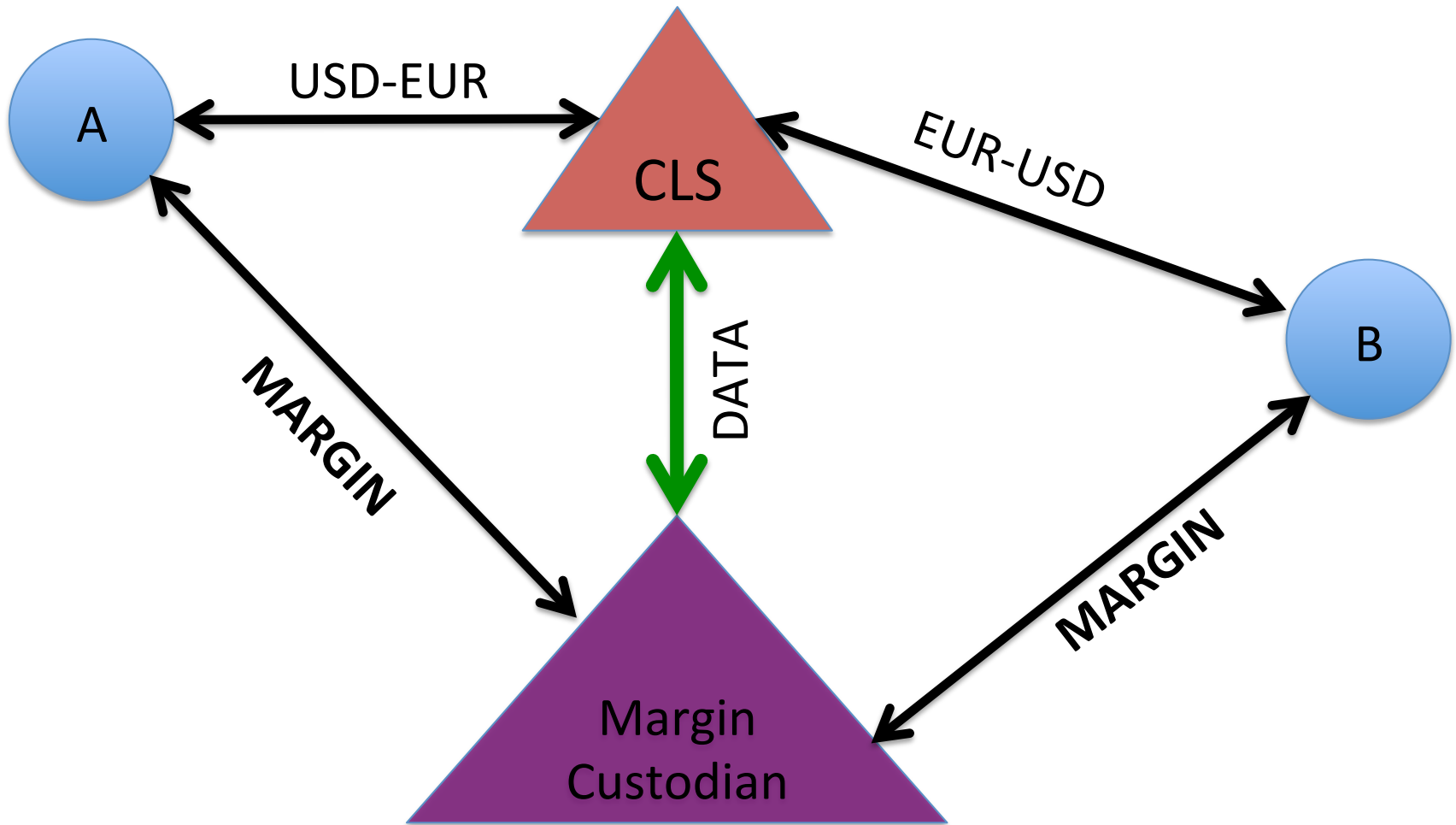
Source: Brunnermeier, Clerc, Scheicher (2013). Data: DTCC.

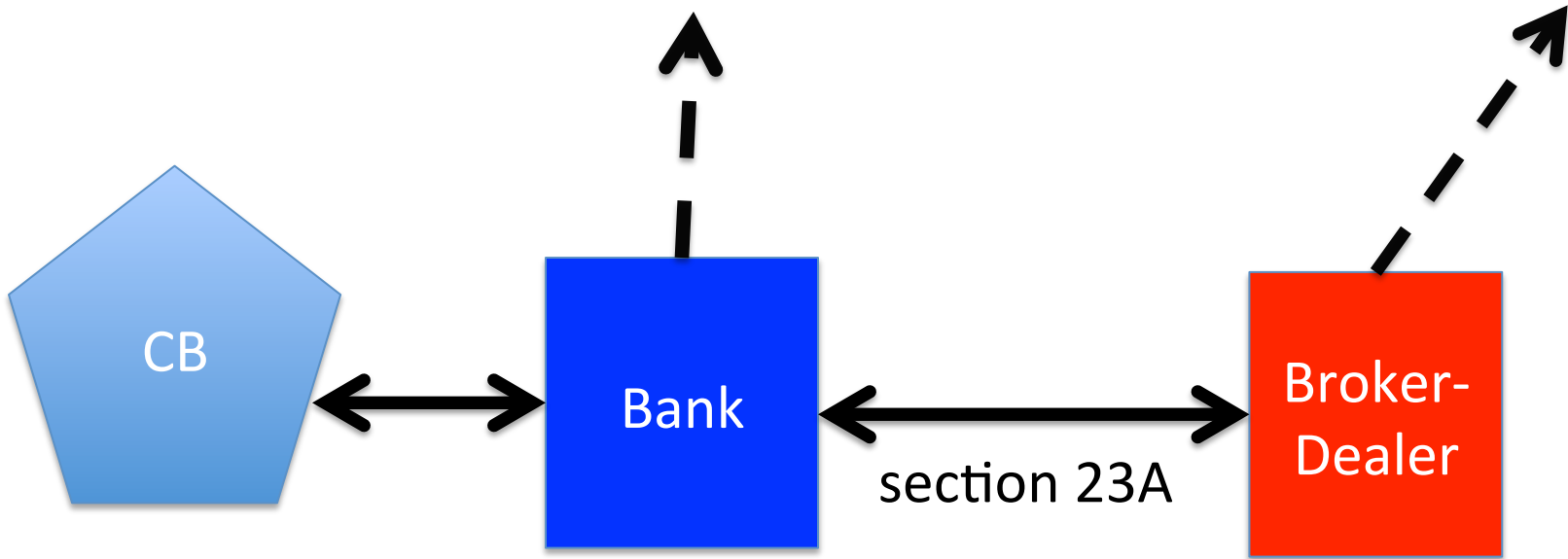


# Uncleared Foreign Exchange Derivatives

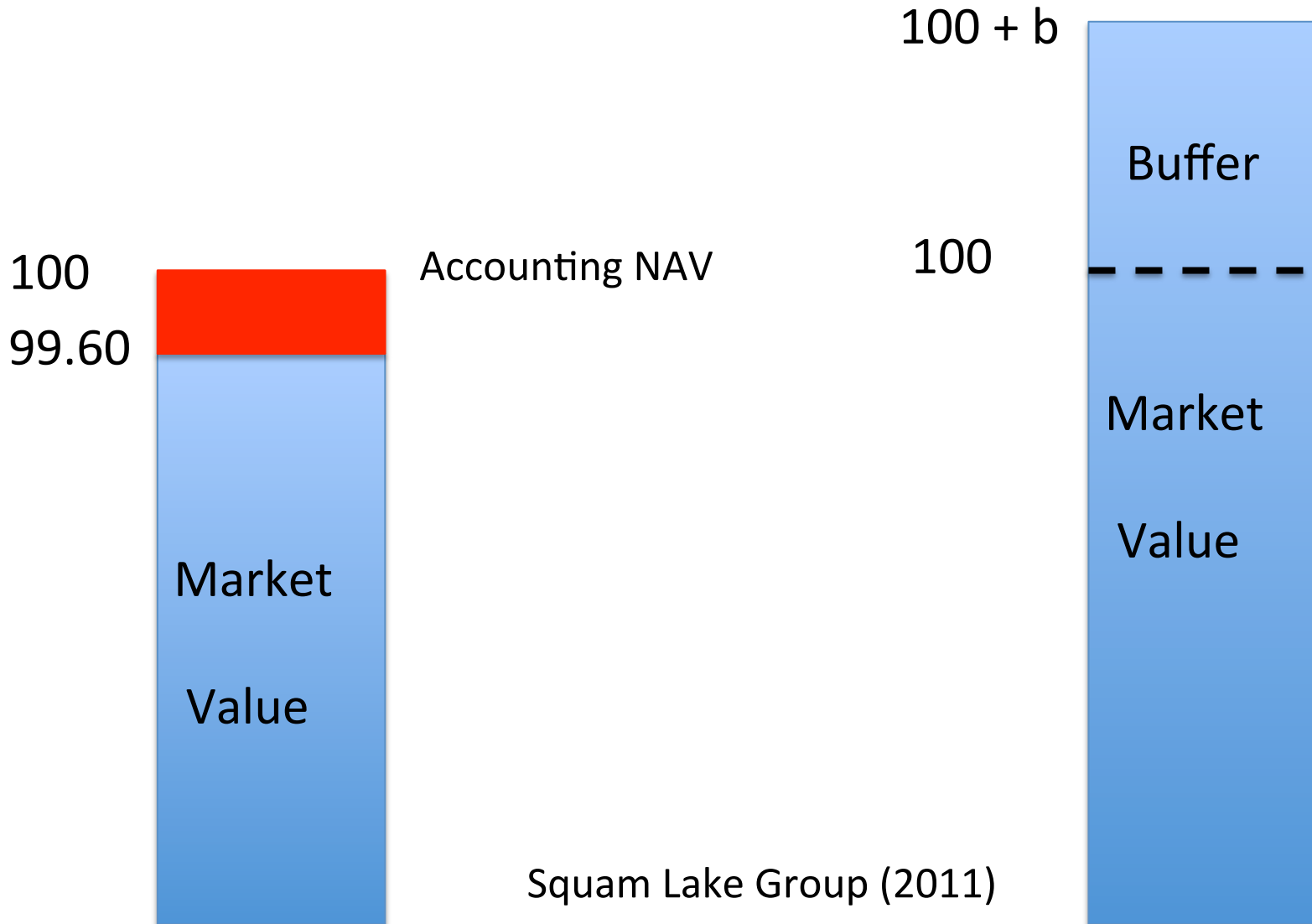


# Margining of FX Derivatives





# Money Market Fund Capital Buffers



# Money Market Funds

“Stable” NAV



Floating NAV

