Lecture 11:
Money and Banking

Macroeconomics (Quantitative)
Econ 101B

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Credit as Money

- Early monetary systems used coins, cattle, cowrie shells, etc. as money
- Past millenium saw a shift to the use of credit as money
- Today, most forms of money are a credit instrument –
  i.e., someone's liability
  (usually a bank's liability)

- Card payments:
  - You are paying with bank deposits
  - Funds transferred from your bank account to merchant's bank account
- Bank notes are a bank liability
- Even coins are a bank liability today

Banks and the Modern Payment System

- Banks are a crucial part of modern monetary system
- Virtually all money is a bank liability today
- When we pay for things, we do this with bank liabilities
  - Card systems (retail/internet)
  - Automated Clearinghouse (ACH) (Payroll/utility bills/mortgage payments)
  - Checks
  - Apple Pay, Google Pay, Venmo, PayPal, etc. (Pix in Brazil, UPI in India)
  - Large-value payment systems: Fedwire (“wire transfers”), CHIPS
- Let’s look at how a typical payment works

How Modern Payments Work

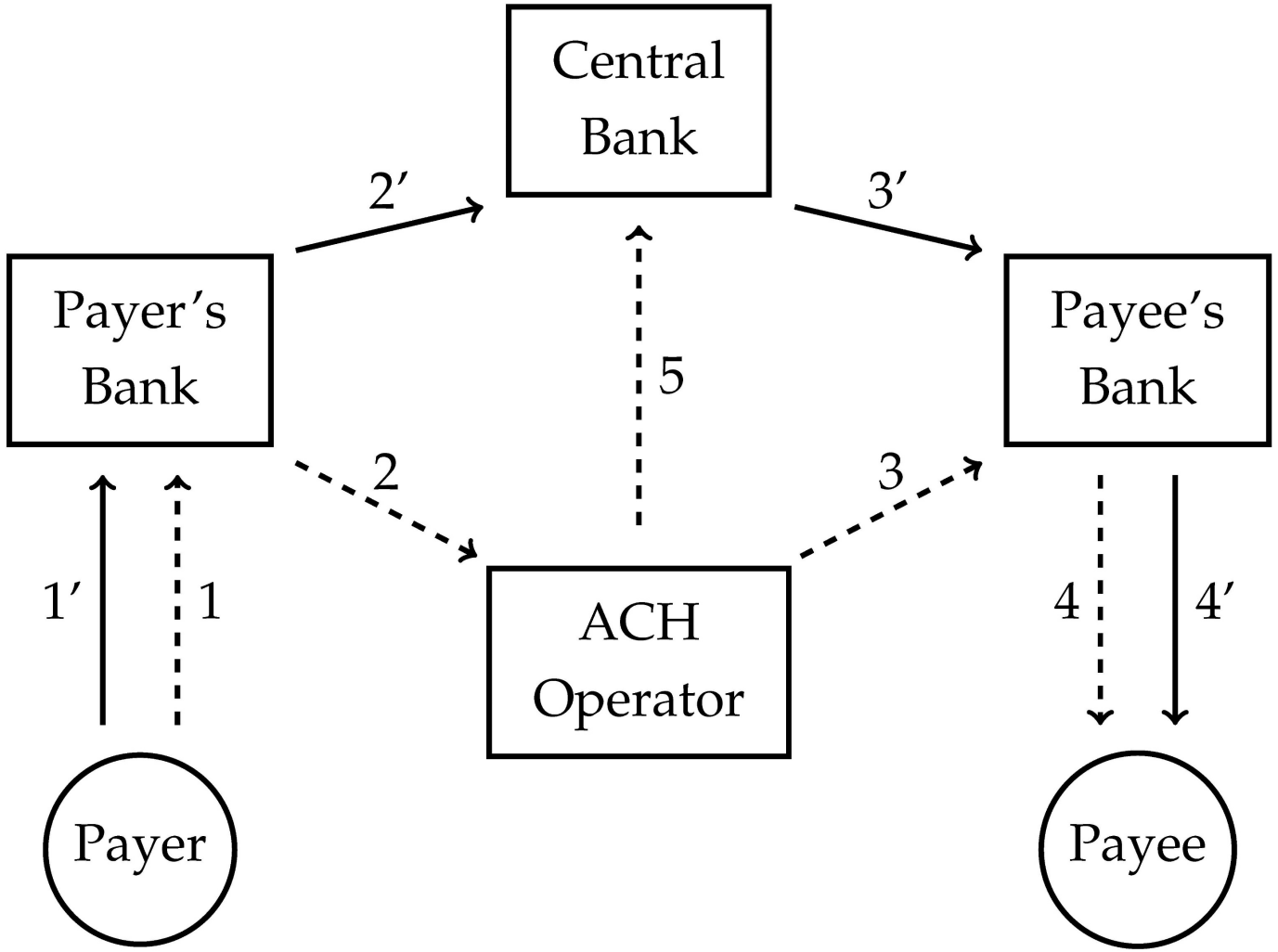

Figure 1: Clearing and Settlement of ACH Credit Payment

Evolution of Payments

- How did our modern payment system come to be?
- Took hundreds of years of innovation
  - Bills of exchange used by merchants to avoid shipping coins between cities
  - Bank of Amsterdam was first “modern” high value payment system
  - Paper money developed in China and Europe
- These are discussed in sections 3-5 of textbook chapter (we skip)

Defining the Money Supply

- In an economy with only coins: Sum of the value of coins
- In an modern economy: Less is obvious
- Conceptually we want money supply to be:
  - Value of assets that are used as a medium of exchange
- Checking accounts primary medium of exchange today
- But what about savings accounts and money market accounts?
- Not directly used, but easy to transfer. Should they count?

Defining the Money Supply

- **Money supply**: Sum of bank notes and deposits *in the hands of the public*
  - Ignore distinction between checking and savings accounts
  - Roughly current definition of M1
- "In the hands of the public":
  - Bank notes in bank vaults don't count
  - Suppose you deposit $100 in bank (money supply doesn't change)
  - Deposits of banks at other banks don't count

Monetary Base

- Deposits are promises to pay something
- That something is the monetary base
- Completely different concept than money supply
- Monetary base today: Currency and bank reserves
  - Held by public and by banks
- Monetary base in 17th-19th century: gold and silver specie
  - Held by public and by banks
- Sometimes also called “high-powered” money or “outside” money

Banks and the Money Supply

- Banks create money when they make loans
- Money supply increases one-for-one when a bank makes a loan

Borrower's Bank

Assets		Liabilities	
Loan to Borrower	$1,000	Borrower's deposits	$1,000

Borrower

Assets		Liabilities	
Deposits at Borrower's Bank	$1,000	Loan from Borrower's Bank	$1,000

(a) Loan Amount Deposited in Borrower's Account

Borrower's Bank

Assets		Liabilities	
Loan to Borrower	$1,000		
Currency	-$1,000		

Borrower

Assets		Liabilities	
Currency	$1,000	Loan from Borrower's Bank	$1,000

(b) Loan Paid Out to Borrower in Central Bank Notes

Figure 8: A Bank Makes a Loan

Banks Create Money with Loans

- Many find this fact shocking
- Confers dangerous powers on banks?
- How can we control money supply and keep price level stable if money can “flow from the fountain pens” of commercial bankers?
- Read chapter for fuller discussion of this

- Most other transactions don’t affect money supply

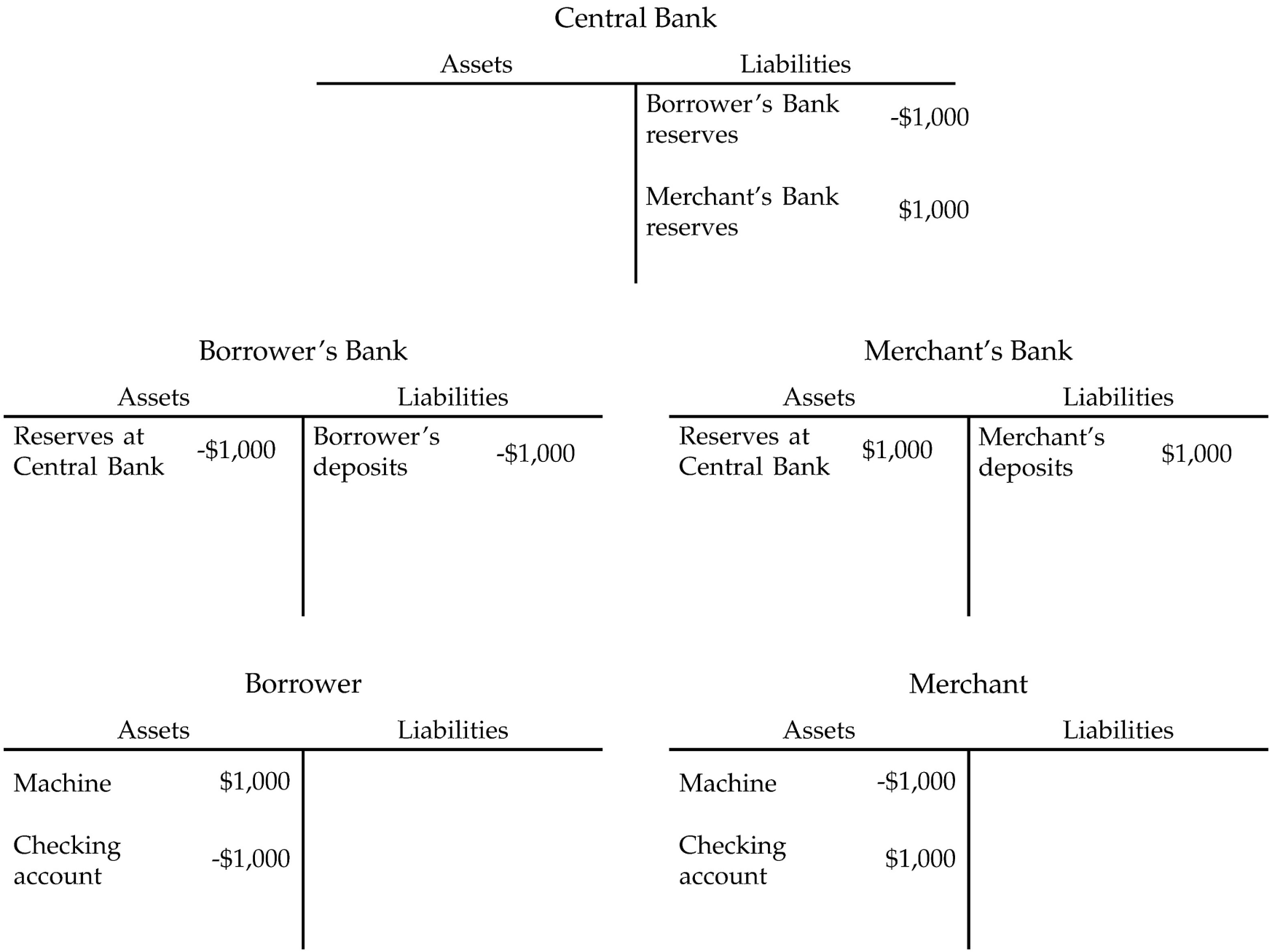

Figure 9: How a Typical Transaction Moves Through the Banking System

Fractional Reserve Banking

- Most banks have more deposits than they have cash reserves
- They practice fractional reserve banking

Bank (before loan)

Assets		Liabilities	
Treasury bills	$1,000	Deposits	$1,000
Currency	$1,000	Net worth	$1,000

Bank (after loan)

Assets		Liabilities	
Treasury bills	$1,000	Deposits	$2,000
Currency	$1,000	Net worth	$1,000
Loan	$1,000		

Figure 10: Balance Sheet Consequences of a Bank Making a Loan

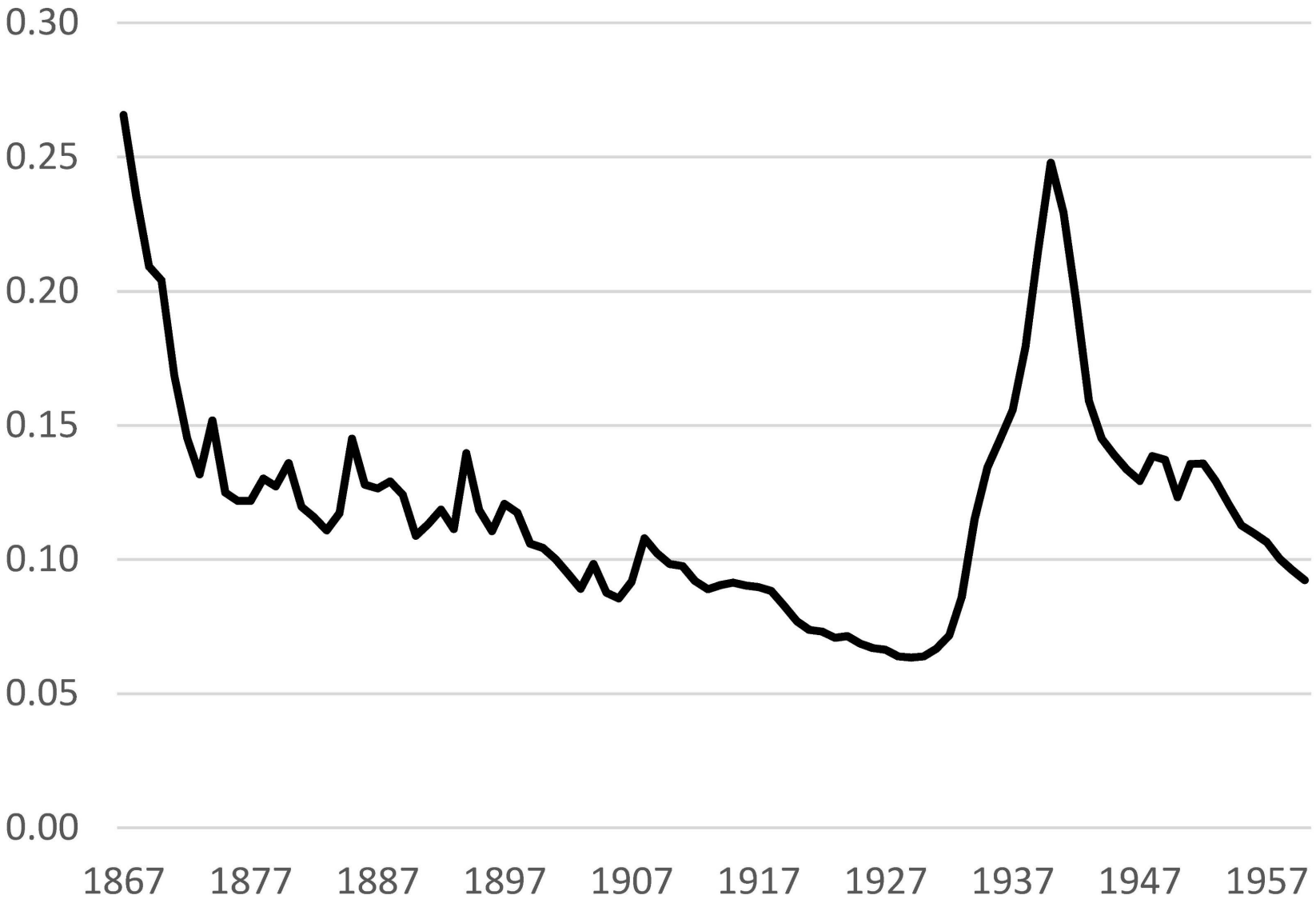

Figure 11: Reserve Ratio of Banks in the United States

Fractional Reserve Banking

- Typical bank around 1900 had a reserve ratio of about 10%
- Banks create a lot of money!!
- This means that they multiply the monetary base

Assets		Liabilities	
Treasury bills	$1,000	Deposits	$10,000
Currency	$1,000	Net worth	$1,000
Loan	$9,000		

Figure 12: Balance Sheet of a Typical Bank

Money Multiplier

- Money supply:

$$M = C + D$$

  - M: Money supply
  - C: Currency
  - D: Deposits

- Monetary base:

$$M_b = C + R$$

  - M_b: Monetary base
  - C: Currency
  - R: Reserves

$$\frac{M}{M_b} = \frac{C + D}{C + R}$$

$$\frac{M}{M_b} = \frac{C/D + 1}{C/D + R/D}$$

$$M = \frac{C/D + 1}{C/D + R/D} M_b = B_m M_b$$

Money Multiplier

$$M = \frac{C/D + 1}{C/D + R/D} M_b = B_m M_b$$

- B_m is the money multiplier
- Starting with M_b, banking system multiplies money supply by B_m through fractional reserve lending
- B_m is a function of two ratios:
  - C/D: Currency-to-Deposit ratio
  - R/D: Reserve-to-Deposit ratio

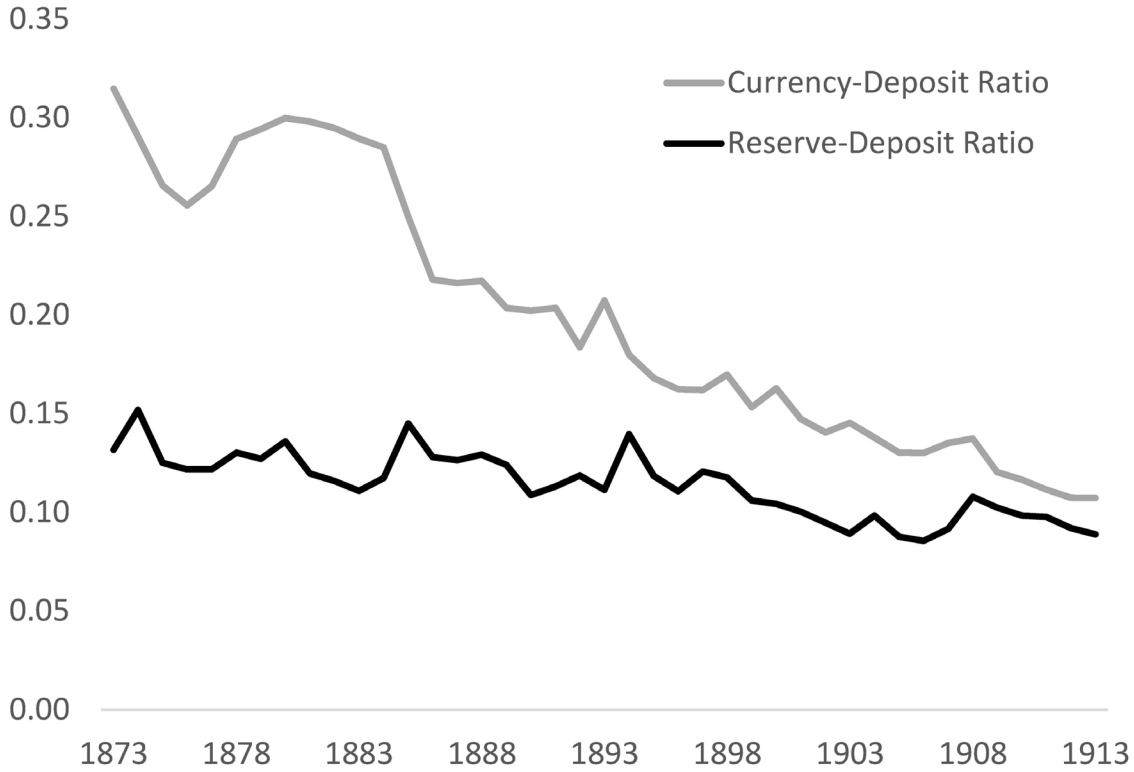

Figure 14: Currency and Reserve to Deposit Ratios in the United States, 1873-1913

Fractional Reserves and Bank Leverage

Assets		Liabilities	
Treasury bills	$1,000	Deposits	$10,000
Currency	$1,000	Net worth	$1,000
Loan	$9,000		

Figure 12: Balance Sheet of a Typical Bank

- Typical bank around 1900 had a reserve ratio of about 10%
- This bank is leveraged 11 to 1
- Leverage: Assets over net worth

- Suppose the assets of this bank fell in value by 1%. How much would its net worth fall?

Bank Leverage and Risk

- Leverage is intimately connected to risk
- Suppose value of bank assets falls by 1%
- Net worth falls by 11%

- The more leveraged, the more sensitive net worth is to percent losses on assets

Assets		Liabilities	
Treasury bills	$1,000	Deposits	$10,000
Currency	$1,000	Net worth	$890
Loan	$8,890		

Figure 13: Balance Sheet After a Loss of 1% of Assets

- Leverage ratio of Goldman Sachs in 2008 was about 26

Bank Maturity Mismatch

- All banks – even the best capitalized – are fragile
- Basic reason:
  - Short-term liabilities (deposits)
  - Long-term assets (loans)
- Why this maturity mismatch?
- Banks' most important roles:
  1. Assist costumers in making payments (calls for demand deposits)
  2. Finance investments (issue long-term loans)
- Banks create vast amounts of liquidity
  - Transform illiquid loans into liquid deposits

Bank Fragility

- Bank maturity transformation very valuable
- But it also makes banks fragile
- If depositors lose confidence in bank and want money back, bank can get in trouble fast (assets illiquid)
- Depositors know this and may be scared it could happen
- Loss of confidence can be **self-fulfilling prophesy**

- To understand this better, we need a little bit of game theory

Prisoner’s Dilemma

- Police have arrested two people, but have insufficient evidence unless at least one confesses
- Prisoners held in separate cells and cannot communicate
- Police explain to each one:
  - If you confess, they don’t: You go free, they get 10 years
  - If they confess, you don’t: You get 10 years, they go free
  - If both confess: Both get 5 years
  - If neither confess: Both get 1 year
- Prisoners know that they face the same choice

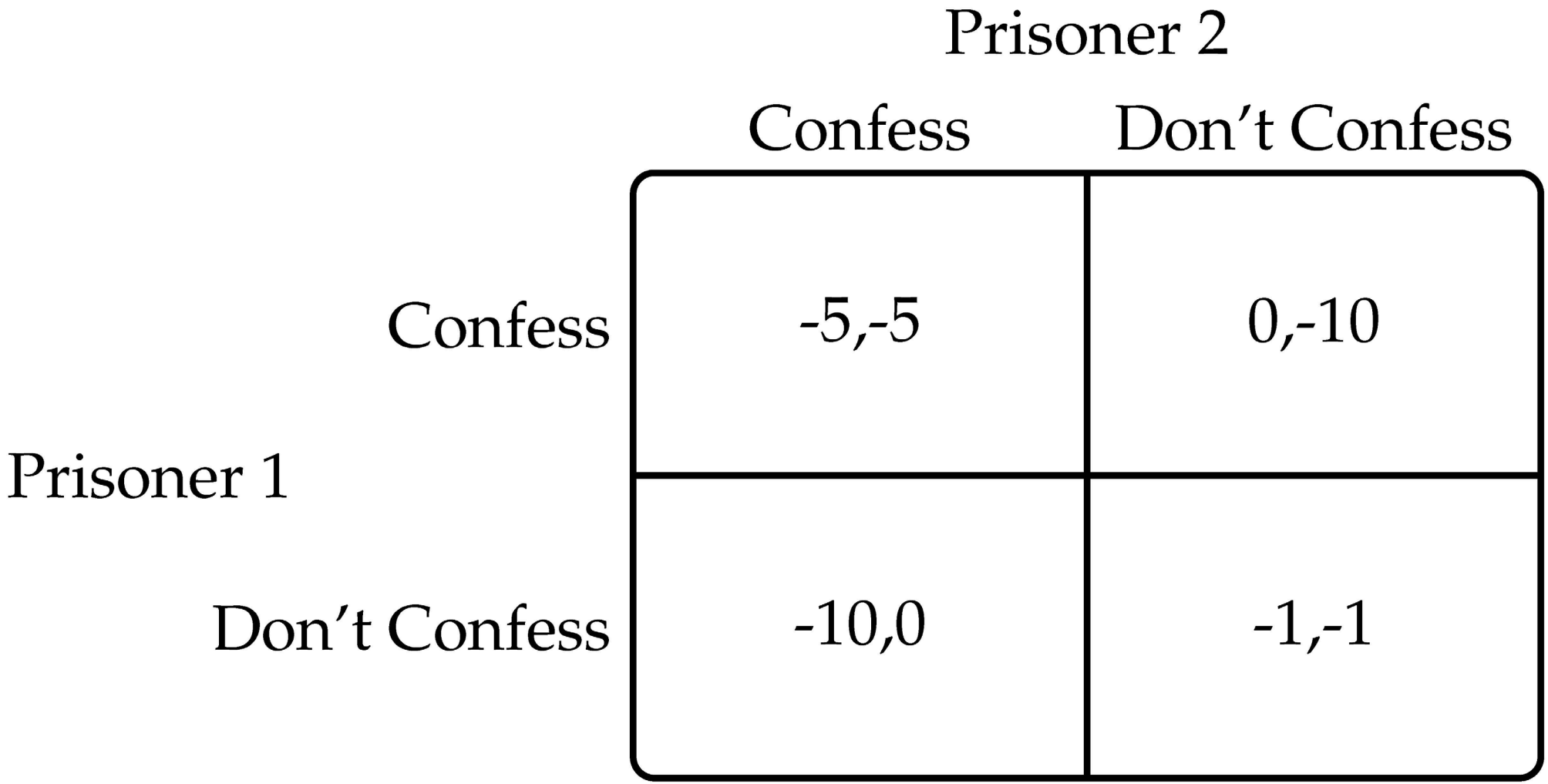

Figure 15: The Prisoner's Dilemma Game

Prisoner's Dilemma Game

- **Nash Equilibrium:** Each player plays a "best response" given what other players play
- Prisoner's dilemma game has a single **Nash Equilibrium**
  - Confess, Confess
- But (Confess, Confess) is much worse outcome than (Don't confers, Don't confess)
- Mutual cooperation would benefit both, but is not in their individual self interest

Diamond Dybvig Model of Bank Runs

- Bank takes deposits from many depositors
- Uses funds to finance projects that take two periods to complete
  - Projects earn a return of R_l on average
- Depositors need to be able to make payments every period
  - Deposits are completely liquid. Can be withdrawn after one period
- Banks compete for depositors by offering return of R_d over two periods
  - R_l a little larger than R_d so bank can cover other costs

Diamond Dybvig Model of Bank Runs

- Heart of the model: What happens in period one
  - Bulk of bank assets illiquid (lent for two periods)
  - Depositors must decide whether to withdraw or not
- Suppose a single depositor gets cold feet and withdraws
  - Bank survives (has enough reserves)
  - Depositor encores some cost from finding new bank (or mattress)
  - Denote this cost by ϵ. So, depositor return is $R_d - \epsilon$
- Suppose most depositors get cold feet and withdraw
  - Bank fails (not enough reserves)
  - Some depositors who run get money back, others don't. On average r
  - Depositors who don't run get nothing

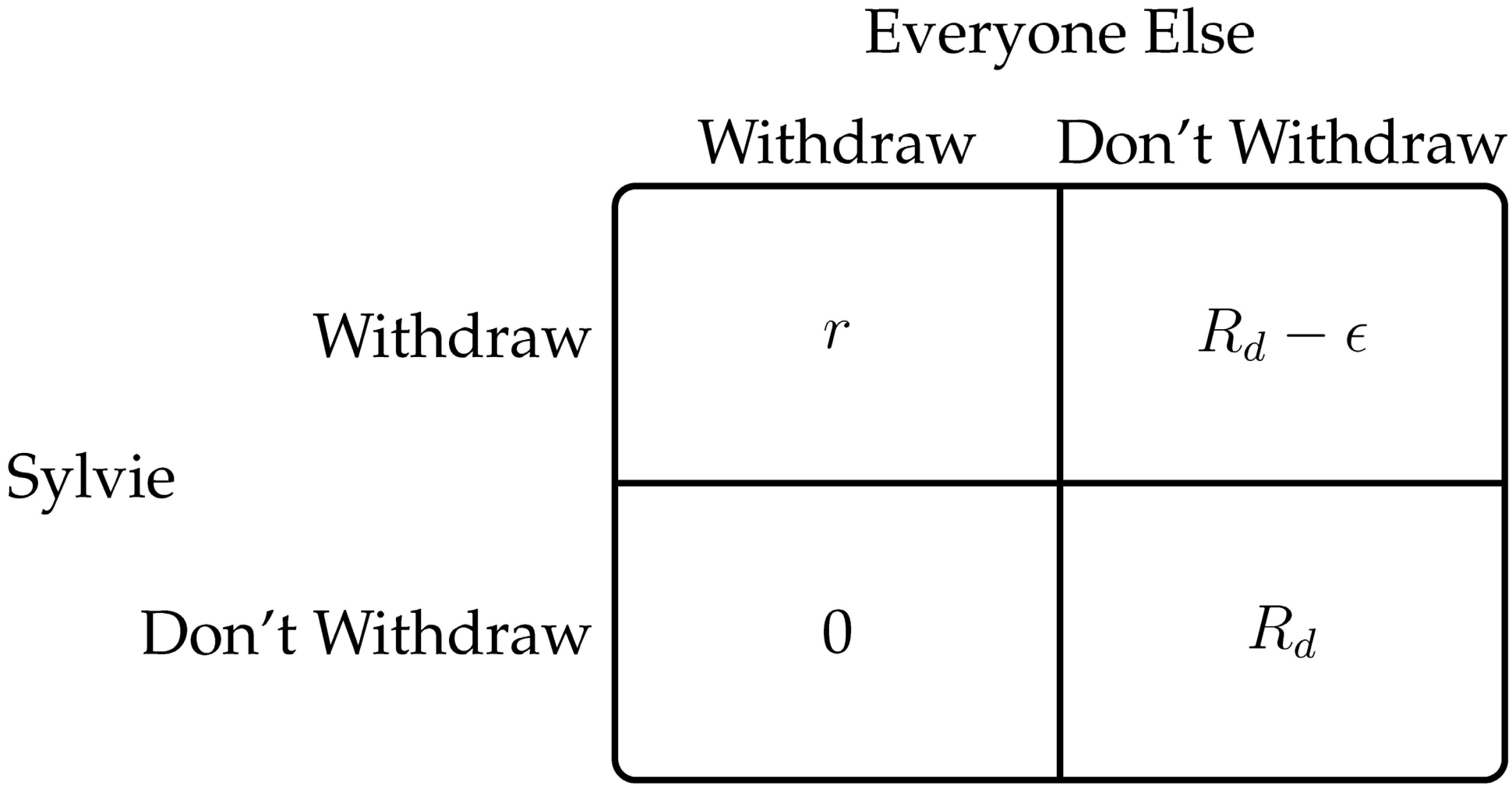

Figure 16: The Diamond Dybvig Game

Diamond Dybvig Model of Bank Runs

- Two (symmetric) Nash equilibria:
  - If everyone else runs, Sylvia should run
  - If no one else runs, Sylvia should not run

- Fear of run can become self-fulfilling
  - If you believe everyone else will run, your best response is to run
  - It is only because you think others are going to run that you decide to run

Banking Panics

- Bank runs can trigger generalized panics
- Panics in history:
  - England: 1672, 1763, 1772, 1793, 1796, 1811, 1825, 1847, 1857, 1866
  - U.S.: 1814, 1833, 1837, 1857, 1873, 1893, 1907, 1930-33
- Panics contribute to deep recessions
- Among most severe economic calamities in capitalist economies
- Preventing panics one of most important public policy problems

Suspension of Convertibility

- Bank can close its doors to depositors seeking withdrawal
  - Milder versions: count slowly, restrict amount
- Widespread suspensions in U.S. in 1893, 1907, 1933
- Buys time to:
  - Raise funds
  - Convince the public bank is sound
  - Allow panic to subside
- Creates a dual monetary system: currency vs. deposits
  - Deposits trade at a time varying discount
- Payment difficulties (e.g., firms making payroll)

Lender of Last Resort

- A central bank with unlimited resources can stop a banking panic by acting as a lender of last resort
- Suppose central bank commits to lend enough to bank that it can withstand any amount of depositor withdrawals
- This eliminates the run equilibrium
  - No longer optimal for Sylvie to run even if others run
  - Bank will not fail even if others run
- Mere announcement (if credible) can prevent runs from happening
- Bagehot's principles (1873): In a crisis …
  1. Lend freely, 2. At a penalty rate, 3. Against good collateral

Moral Hazard and Last Resort Lending

- Banks will act less prudently if they know central bank will help them out in a crisis
- This is called **moral hazard**
- Moral hazard is a side effect of insurance
- Central bank is providing banks with insurance against runs
- Some argue:
  - Last resort lending is bad policy because it makes for more crises
  - If government commits not to bail out banks, they will not get in trouble
- But is such a commitment credible?

Penalty Rate and Good Collateral

- Bagehot's principles (1873): In a crisis …
  1. Lend freely, 2. At a penalty rate, 3. Against good collateral
- Penalty rate:
  - Compensation for providing "insurance" to banks
  - Last resort lending is risky, compensation for taking risks
- Good collateral:
  - Central bank should limit lending to deserving banks. But how?
  - Define deserving as banks that have good collateral.
  - Banks in liquidity crisis vs. solvency crisis

Liquidity Crisis vs. Solvency Crisis

- Liquidity problem:
  - Bank fundamentally solvent
  - Faces a run and needs liquidity (assets illiquid)
  - Has good collateral for central bank to lend against
  - Central bank will make money on emergency loans
- Solvency problem:
  - Bank fundamentally insolvent
  - Assets worth less than liabilities
  - Doesn’t have enough good collateral
  - Central bank would lose money if they bailed bank out
  - Fiscally costly bailouts should be decided on by elected officials

Liquidity Crisis vs. Solvency Crisis

- But how should bank assets be valued?
- Crisis leads to **fire sale** of assets
  - Value of assets falls below “fundamental” value
  - Fundamental value: value when crisis subsides
- Should central bank value assets at fundamental value or market value?
- Hard to figure out fundamental value
- “Fog of war” makes these decisions hard in a crisis

Persistence of Banking Panics in U.S.

- No more panics in England after 1866
- Regular panics in U.S. for another 70 years
- Why?

Table 1: U.S. Banking Panics, 1866-1929

Major Banking Panic	Non-Major Banking Panic
Sept. 1873	
	May 1884 (New York City, Pennsylvania, New Jersey)
	Nov. 1890 (New York City)
May-Aug. 1893	
	Dec. 1896 (Illinois, Minnesota, Wisconsin)
	Dec. 1899 (Boston, New York City)
	June-July 1901 (Buffalo, New York City)
	Oct. 1903 (Pennsylvania, Maryland)
	Dec. 1905 (Chicago)
Oct.- Nov. 1907	
	Jan. 1908 (New York City)
	Aug.-Sept. 1920 (Boston)
	Nov. 1920 - Feb. 1921 (North Dakota)
	July 1926 (Florida, Georgia)
	March 1927 (Florida)
	Jul.-Aug. 1929 (Florida)

Note: Replicates a portion of Table 2 in Jalil (2015).

Persistence of Banking Panics in U.S.

1. Absence of a central bank
   - U.S had no central bank from 1836 (Jackson's veto) to 1913 (Fed established)
   - No lender of last resort

2. Unit banking
   - No interstate banking until 1970s / No branching in many states
   - Banks small and undiversified. Especially fragile.
   - Canada had national branch banks and no banking crises

Deposit Insurance

- U.S. had a lender of last resort after 1913, but experiences massive banking crisis during Great Depression
- Fed failed to act
- U.S. instituted federal deposit insurance in 1933
- Deposit insurance eliminates the run equilibrium in Diamond-Dybvig model
  - Sylvia doesn’t want to run (even if others do) because her deposits are insured
- Ushered in “quiet period” of financial stability

Bank Regulation

- Core problem: Bank runs
- Direct policy response: Last resort lending and despot insurance
- Knock on problem: Moral hazard
- Policy response to moral hazard: capital and liquidity regulation

- Also: Deposit financing too cheap due to tax incentives (profits net of interest payment on debt are taxed).

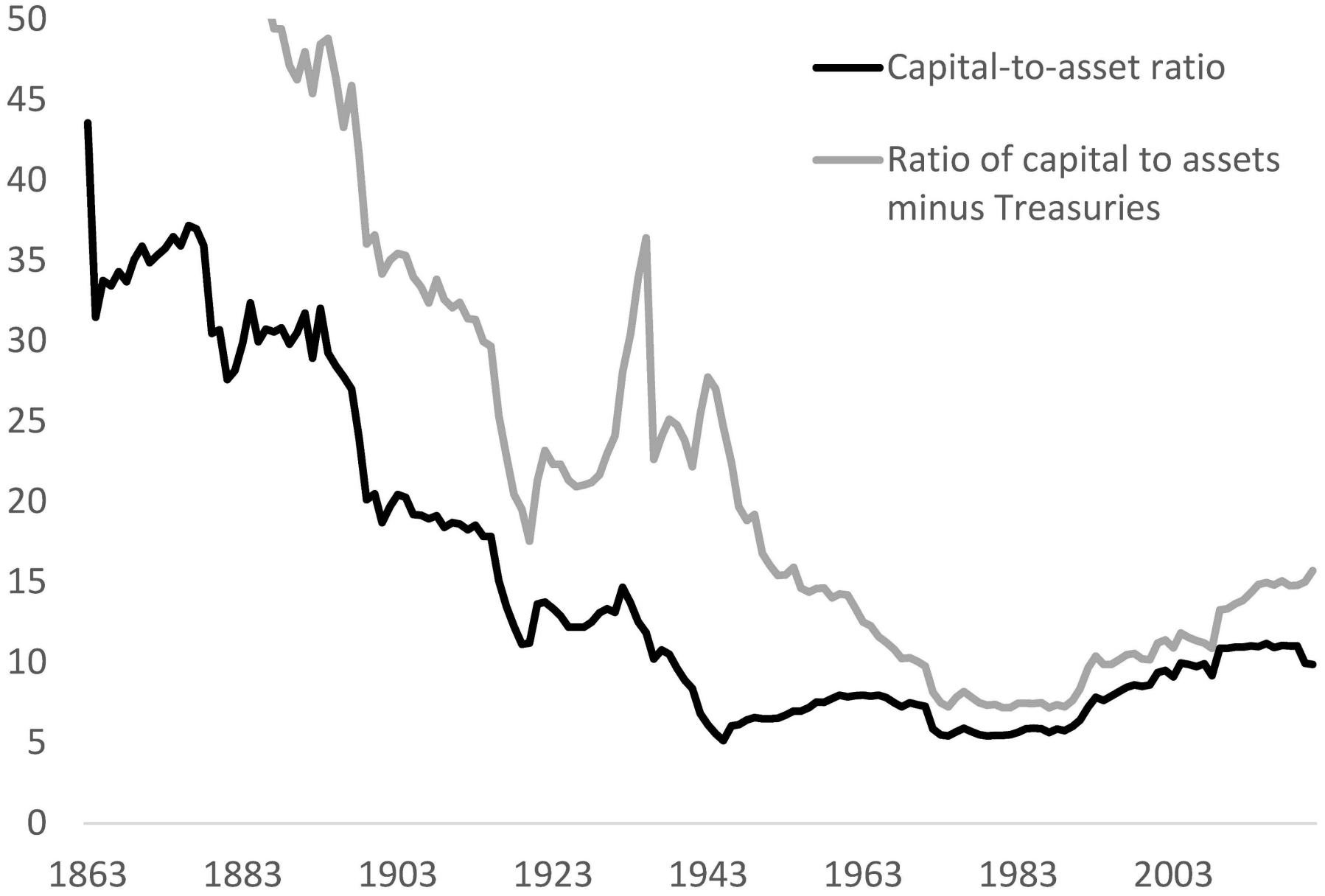

Figure 19: Capital of National Banks in the United States

Basel I

- 1988 G-10 agreement on capital regulation
- Minimum capital ratios:
  - 4% Tier 1 capital ratio
  - 8% Total capital ratio
- Capital relative to risk-weighted assets
- Risk weights:
  - 0%: Cash, central government debt
  - 10%: Public sector debt
  - 20%: Claims on other banks
  - 50%: Residential mortgages
  - 100% Commercial and industrial loans

Basel II

- Focus on improving risk weights
- Large banks could use internal models to assess risk
- Trading accounts involve a lot of hedging
- Use of internal models allowed banks to take account of hedging
- Better risk weights supposed to reduce regulatory arbitrage
  - E.g., Package mortgages into securities, sell off high trances, hold lowest trances (which have most of the risk), lower capital requirement
- Downside: Internal risk models biased

Financial Crisis – Basel III

- Financial crisis of 2007-09 led to calls for more stringent capital requirements
- Response: Basel III and Dodd-Frank in U.S.
  - Higher capital ratios
  - More detailed risk weights (some higher than 100%)
  - Leverage ratios (un-risk-weighted capital ratios)
  - G-SIBs (Globally systemically important banks due to “too big to fail”)
  - Stress tests (forward looking, central bank model)

Table 2: Regulatory Minima for Capital and Leverage Ratios

	Basel I and II	Basel III
Capital Ratios:		
Common Equity Tier 1 Capital Ratio	–	4.5%
Tier 1 Capital Ratio	4.0%	6.0%
Total Capital Ratio	8.0%	8.0%
Capital Conservation Buffer	–	+2.5%
G-SIB Surcharge	–	+1.0-4.5%
Counter Cyclical Capital Buffer	–	+0.0-2.5%
Leverage Ratios:		
Leverage Ratio	4.0%*	4.0%
Supplemental Leverage Ratio	–	3.0%*
Enhanced Supplemental Leverage Ratio	–	6.0%*