

Lecture notes on risk management, public policy, and the financial system

# Leverage and leverage risk

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**Analysis of leverage**

**Putting on leverage through carry trades**

**Credit markets in the U.S.**

**Collateralized security loans and leverage**

**Incentive alignment and capital structure**

## Analysis of leverage

Defining and measuring leverage

Leverage and risk

Putting on leverage through carry trades

Credit markets in the U.S.

Collateralized security loans and leverage

Incentive alignment and capital structure

# Economic balance sheet

- **Leverage:** funding of assets by issuing of debt in addition to equity (owner resources)
- Defined in terms of firm's or investor's *economic* balance sheet
- Accounting standards may not fully reflect economic reality; may, for example
  - Keep some exposures and obligations off-balance sheet
  - Display some assets and liabilities at inaccurate historical values
  - Permit use of possibly inaccurate valuation models

## Definition of leverage

Assets	Liabilities
Value of the assets or exposure ( $A$ )	Equity ( $E$ )
	Debt ( $D$ )

- Leverage  $L$  (in “turns”): ratio of assets to equity

$$L = \frac{A}{E} = \frac{E + D}{E} = 1 + \frac{D}{E}$$

- But several common alternative definitions, e.g.  $\frac{D}{A}$
- Regulatory ( $\rightarrow$ ) **leverage ratio** defined as  $\frac{\text{regulatory capital}}{\text{adjusted assets}}$ 
  - With detailed definitions of numerator and denominator
- Distinct from **operating leverage**  $\frac{\% \Delta \text{operating income}}{\% \Delta \text{sales}}$ 
  - High when income/net revenue increases rapidly with output and sales due to low variable and high fixed costs

## Modigliani-Miller irrelevancy

- **Corporate financial policy:** decisions about capital structure
- Includes decisions about
  - Capital distributions—dividends, share repurchases
  - Forms of debt and equity issuance
- **Modigliani-Miller theorem** (Proposition I): equivalently,
  - Firm market value—sum of the values of equity and debt—is independent of capital structure
  - Only firm asset choices—investments in productive capital—matter for firm value
  - Firm market value equals market's assessment of asset value
  - **Weighted average cost of capital** (WACC)=expected asset return
- Requires strong assumption of perfect capital markets, including
  - Complete arbitrage
  - No taxes
  - No bankruptcy costs apart from LGD
  - But debt may be risky
- Core argument: investors can borrow or lend at prevailing rates to undo corporate financial decisions
  - And achieve degree of leverage they desire

## Why is leverage attractive?

- WACC can be expressed as

$$r^a = \frac{1}{L}r^e + \left(1 - \frac{1}{L}\right)r$$

$r^e$  rate of return on equity

$r^a$  WACC/rate of return on assets

$r$  blended cost of debt financing

- $\Rightarrow$  Leverage amplifies return on equity

$$r^e = Lr^a - (L - 1)r = L(r^a - r) + r$$

$$\frac{\partial r^e}{\partial L} = r^a - r$$

- $r^a > r$ : no limit on  $r^e$  as leverage rises
- $r^a < r$ : but loss amplification as leverage rises
- “Degenerate cases”
  - $r^a = r \Rightarrow r^e = r^a$ : no effect of leverage
  - $L = 1 \Rightarrow r^e = r^a$ : no debt financing, earn exactly return on assets

## Sources of the impact of leverage on returns

- Decompose  $r^a$  into asset appreciation  $\frac{\Delta S}{S}$  and cash flow  $q$

$$r^e = L \left( \frac{\Delta S}{S} + q \right) - (L - 1)r = L \left( \frac{\Delta S}{S} + q - r \right) + r$$

- $q$  may represent bond coupon, foreign interest, dividend
- For commodities, real estate,  $q < 0$ : storage/maintenance
- $\frac{\Delta S}{S}$ ,  $q$ ,  $r$  defined as annual percent change or rate, for consistency with typical quoted rates
- The standalone  $r$  arises from equity funding
- $q - r$  called the **carry**
- $r$  can also be seen as risk-free rate  $\rightarrow$  leverage amplifies excess return
- $\frac{\Delta S}{S}$  can be decomposed into expected  $\mathbf{E} \left[ \frac{\Delta S}{S} \right]$  asset appreciation and surprise  $\frac{\Delta S}{S} - \mathbf{E} \left[ \frac{\Delta S}{S} \right]$
- Taxes may create additional complications

# Leverage increases risk

- Both sides of balance sheet, not just assets, important to risk
  - VaR applied to assets only → does not reveal capital structure risk
  - VaR must be compared to equity to capture effect on firm viability
- Market risk:  $\frac{\Delta S}{S} - \mathbf{E} \left[ \frac{\Delta S}{S} \right]$  sufficiently adverse to exceed carry
  - Greater vulnerability to price decline
    - If capital thinner or carry lower
    - If occurs over shorter time horizon
- (→) Funding liquidity risks
  - $r$  rises
  - Margin call
  - Rollover risk, forced unwind

## Leverage and systematic risk

- Modigliani-Miller Proposition II: higher leverage increases required equity return
- Proposition I: independence of WACC and leverage
- $\Rightarrow$  Assets a portfolio of equity and debt
  - With leveraged-based weights of the WACC definition
- Assume debt has no systematic risk (but possibly plenty of idiosyncratic risk)

$$\beta^a = \frac{1}{L}\beta^e \Leftrightarrow \beta^e = L\beta^a$$

## Analysis of leverage

### **Putting on leverage through carry trades**

- Defining carry trades

- Leveraged fixed-income trades

- Leveraged foreign exchange trades

### Credit markets in the U.S.

### Collateralized security loans and leverage

### Incentive alignment and capital structure

## Carry trades and search for yield

- **Carry trades:** earn positive carry, avoid  $\frac{\Delta S}{S}$  surprises
  - Leveraged trades generally expected to have positive carry
  - Many market participants will not/cannot bear negative carry
- **Hurdle** or **target rate of return:** often set by firms, pension funds, portfolio managers
  - $L$  set so as to achieve return target ( $\rightarrow$  **reaching for yield**)

$$\text{required leverage} = \frac{\text{target } r^e - r}{r^a - r} = \frac{\text{target } r^e - r}{\frac{\Delta S}{S} + q - r}$$

- **Example:** bank's target return  $\bar{r}^e = 25$  percent,  $r^a = 4$  percent,  $r = 2$  percent, sets  $L = 11.5$
- **Financing:** hedge fund leverage often provided by broker-dealer
- Structurally identical to commercial bank NIM
  - Silicon Valley Bank (SVB) an extreme case
  - Monetary policy since global financial crisis characterized as a carry trade

## Scenario analysis

- Establish a set of baseline assumptions
- Scenarios: determine impact on equity return if outcome differs from baseline
- Decline in asset price sufficient to drive  $r^e \rightarrow 0$ : find  $\frac{\Delta S}{S}$  such that

$$r^e = 0 \Leftrightarrow \frac{\Delta S}{S} = - \left( q - r + \frac{r}{L} \right)$$

- Decline in asset price sufficient to wipe out equity:  $r^e \rightarrow -1$  (-100 percent):  $\frac{\Delta S}{S}$  such that

$$r^e = -1 \Leftrightarrow \frac{\Delta S}{S} = - \left[ (q - r) + \frac{1}{L}(1 + r) \right]$$

- Further asset price decline equal to haircut  $\frac{1}{L}$  compared to  $r^e = 0$  scenario

## Fixed-income carry trade

- Trade thesis:
  - Buy higher-yielding (longer-term and/or credit-risky) bond
  - Financed by short-term ( $\rightarrow$ )repo financing
  - Earn difference between yield and financing cost
  - General level of interest rates and term spread not expected to change dramatically
  - Hence bond price unlikely to change materially
- Key risks: bond price decline ( $\frac{\Delta S}{S} < 0$ ), loss of funding or rise in funding cost
- Audience: hedge funds, prop desks, dealers
- **Roll-down:** maturity of bond shorter at unwinding of trade
  - Unless yield curve flat, value of shorter-term bond different—generally higher
  - Can be approximated using duration and term spread
  - Present to a small extent in floating-rate securities
  - Should also be taken into account in measuring carry trade gains, but can ignored for short-term trades

## Example: fixed-income carry trade

- Parameters: long floating-rate AAA ABS

Expected change in bond price	$E \left[ \frac{\Delta S}{S} \right]$	0
Leverage	$L$	25
Repo rate	$r$	0.025
Coupon rate	$q$	0.035

- Risk scenarios (at annual rate, but monitored daily)

Scenario	$\frac{\Delta S}{S} (\%)$	$q - r (\%)$	$r^e (\%)$
Baseline: zero bond price change	0.00	1.00	27.50
Break-even bond price change	-1.10	1.00	0.00
Bond price change → 100% loss	-5.10	1.00	-100.00
Funding rate ↑100 bps	0.00	0.00	3.50

## Back-of-envelope risk calculations

- How large a spread widening  $\rightarrow$  100% loss?
  - Suppose spread<sub>01</sub> = 400
  - +1 bp  $\rightarrow \frac{\Delta S}{S} = -0.04$  percent, +127.5 bp  $\rightarrow \frac{\Delta S}{S} = -5.1$  percent
- $\Rightarrow$  Spread widening of  $\frac{5.1}{0.04} = 127.5$  bps  $\rightarrow$  wipe-out

## Foreign exchange carry

- Trade thesis: earn difference between money market rates in target and funding currencies
  - Invest in high-yield **target currency** (e.g. AUD, emerging markets)
  - Financed by borrowing in low-yield **funding currency** (e.g. CHF, ¥)
- Key risk: funding currency appreciation  $\frac{\Delta S}{S} < 0$
- Initiating and unwinding currency carry trade:
  - Buy  $S_t^{-1}$  units of target currency, with  $S_t$  exchange rate in funding currency units, invest at rate  $q$
  - Sell proceeds at rate  $S_{t+1}$  to attain excess return

$$(1 + q) \left( 1 + \frac{\Delta S}{S} \right) - (1 + r) = (1 + q) \frac{\Delta S}{S} + q - r$$

- If leverage is applied, the return is

$$r^e = L \left[ (1 + q) \frac{\Delta S}{S} + q - r \right] + r$$

- For foreign exchange trades,  $S$  is the exchange rate in funding currency units

## Example: foreign exchange carry trade

- Parameters: long AUD against ¥ (funding currency)

Expected exchange rate appreciation	$E \left[ \frac{\Delta S}{S} \right]$	0
Leverage	$L$	25
¥ money-market rate	$r$	0.005
AUD money-market rate	$q$	0.025

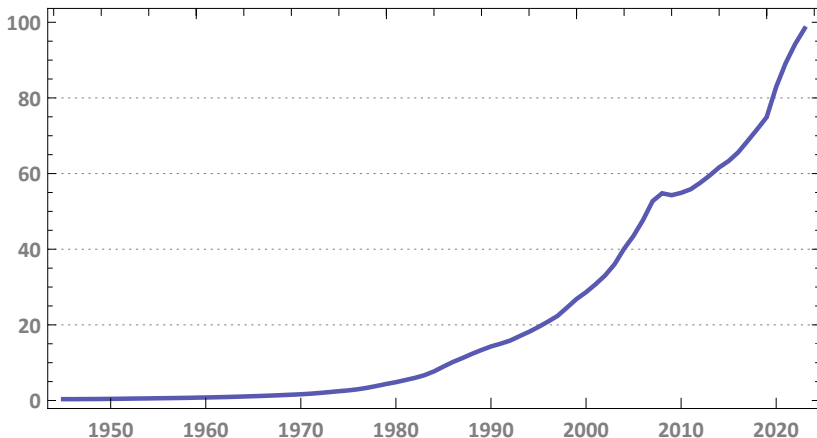
- Risk scenarios (at annual rate, but monitored daily)

Scenario	$\frac{\Delta S}{S} (\%)$	$r^e (\%)$
Baseline: zero ¥ appreciation	0.000	50.500
Break-even ¥ appreciation	-1.971	0.000
¥ appreciation → 100% loss	-5.873	-100.000

## Risks of foreign exchange carry trade

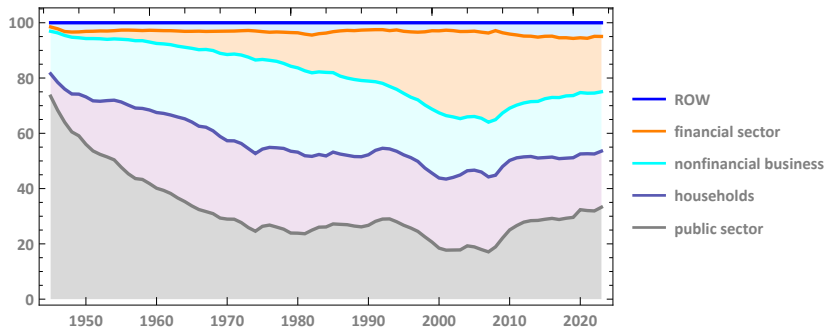
- Back-of-envelope risk calculations: informal assessments of risk based on rough approximations, unrealistic assumptions
- Probability of wipe-out over 1 year: suppose
  - Implied or historical vol of AUD-JPY exchange rate  $\approx 6$  percent p.a.
  - Long AUD-JPY position held unchanged for 1 year
  - AUD-JPY exchange rate approximately normally distributed
- ¥ appreciation  $\geq 6$  percent  $\Leftrightarrow \approx 1$  s.d. or greater decline in  $S_t$ 
  - $\Rightarrow$  Probability 16 percent of 100 percent loss

## Growth of credit markets in the U.S. 1945–2023



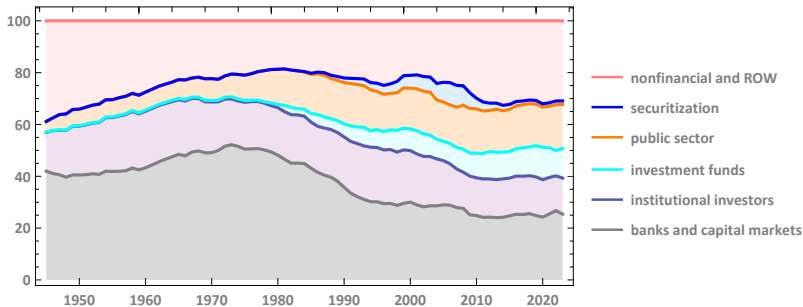
Outstanding volume of borrowing in U.S. markets via loans and debt securities, annual, \$ trillions. *Data:* Federal Reserve Board, Financial Accounts of the United States (Z.1), Table D.3.

## Who's borrowing in the U.S. 1945–2023



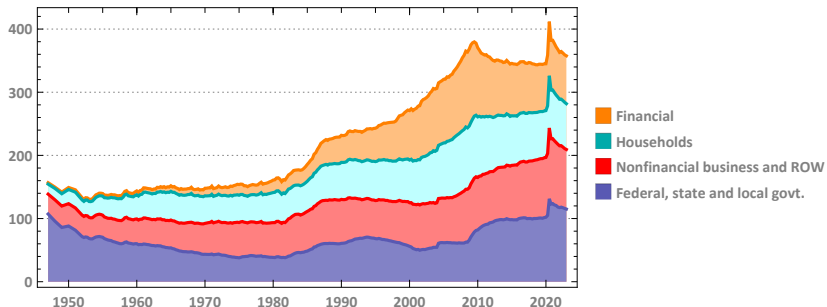
Share of each sector in total borrowing in U.S. markets via loans and debt securities, annual, percent. *Data source:* Federal Reserve Board, Financial Accounts of the United States (Z.1), Table D.3.

## Who's lending in the U.S., 1945–2023



Share of each sector in total lending via loans and debt securities in US markets, annual, percent. Banks and capital markets includes finance companies, brokers, and dealers. Institutional investors include insurance companies and private and public pension funds. Public sector includes assets held by the Federal Reserve and are held or guaranteed by government-sponsored enterprises (GSEs). Securitization includes nongovernment-guaranteed asset-backed securities (ABS). *Data source:* Federal Reserve Board, Financial Accounts of the United States (Z.1), Tables L.208 and L.214.

## U.S. debt-to-GDP ratio by sector 1946–2022



Ratio of total debt outstanding (debt securities and loans) to GDP, current dollars, percent, quarterly, Q4 1946 to Q4 2022. *Source:* Federal Reserve Board, Financial Accounts of the United States (Z.1), Tables D.3 and F.2.

## Leverage since crisis

- Rapid increase in debt levels from 1980s
- Since crisis
  - Financial sector: sharply reduced debt
  - Households: less sharply reduced debt
  - Nonfinancial business: modestly increased debt
  - Public sector: sharply increased debt
- Overall picture not much changes since pre-crisis period

	Debt-to-GDP ratios (%)		
	Q4 1980	Q2 2020	Q4 2022
Total	162	412	358
Financial	21	86	76
Households	48	83	73
Nonfinancial business and ROW	55	112	94
Federal, state and local govt.	39	131	115

# Key postwar developments in U.S. credit markets

**Reduced role of commercial banks** as alternative forms of short-term investment and long-term borrowing grow

- **Disintermediation**: funding via capital markets, not banks
- Closely related to non-bank intermediation, “**shadow banking**”
- Has advanced further in U.S. than rest of world

**Rise of capital markets** and trading volumes

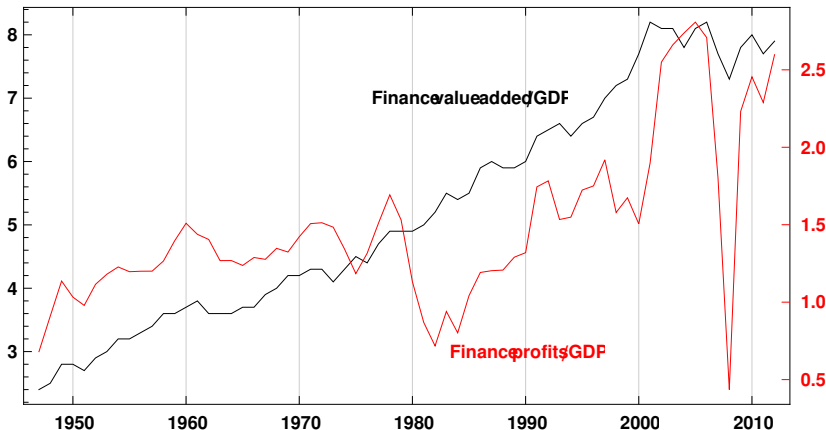
- Increase in borrowing through markets rather than banks via issuance of corporate bonds, commercial paper
- Rise of **wholesale funding** via money markets
- Large capital pools: hedge funds, private equity, reserves

**Securitization**: pooling assets and creating securities through which their cash flows are distributed, esp. loans, mortgages

**Increased leverage** by all sectors, but esp. households, financial firms

**Increased foreign direct investment** in U.S. and by U.S. abroad

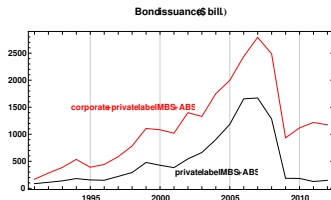
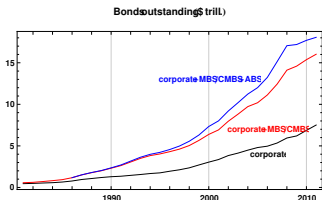
## Growth of U.S. finance 1947–2012



Black plot: Finance and insurance value added as a percentage of gross domestic product, annual.  
 Red plot: financial corporate profits as a percentage of gross domestic product, annual. *Source:*  
 Bureau of Economic Analysis, GDP-by-industry accounts, value added by industry as a percentage  
 of GDP, line 51; National Income and Product Accounts, Table 1.1.5, line 1, Table 6.16A-D, line 3.

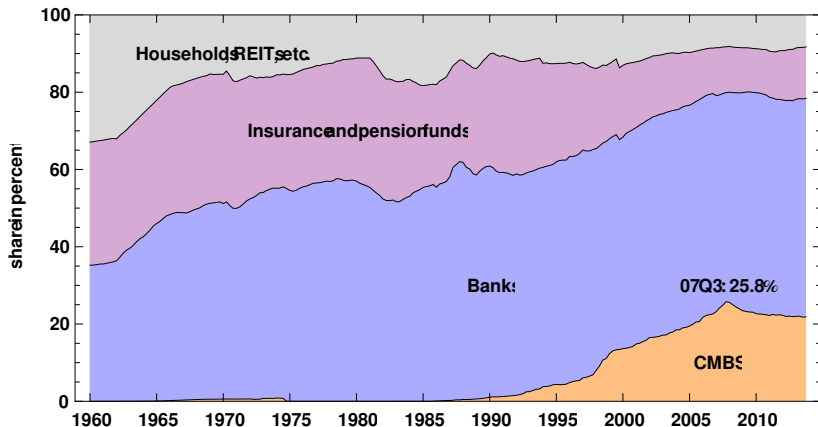
## Growth of private-sector bond markets 1980–2011

- Growth driven in recent years by mortgage- and asset-backed securities
- Collapse of subprime MBS and ABS issuance in crisis, but revival of corporate bond issuance



Par values. Source: SIFMA (<http://www.sifma.org/research/statistics.aspx>).

## Commercial real estate debt finance 1960–2013



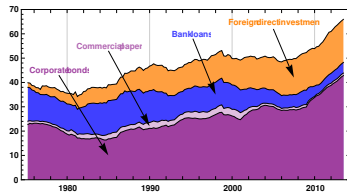
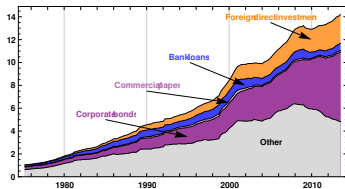
Shares of total commercial real estate lending loans held by each sector, quarterly, percent. Banks include U.S.-domiciled commercial banks and savings institutions. Institutional investors include insurance companies and pension funds. Other includes finance companies. Source: Federal Reserve Board, Financial Accounts of the United States (Z.1), Table L.220.

# “Shadow banking”

- **Nonbank financial intermediaries (NBFIs)**
  - Key aspect of financial innovation
  - Off-balance sheet treatment: difficult to obtain and aggregate data
  - Large capital pools: hedge funds, private equity, reserves
  - Falls outside pre-existing regulatory framework
- Institutional elements
  - MMMFs
  - Structured credit products
  - Structured investment vehicles (SIVs) and conduits

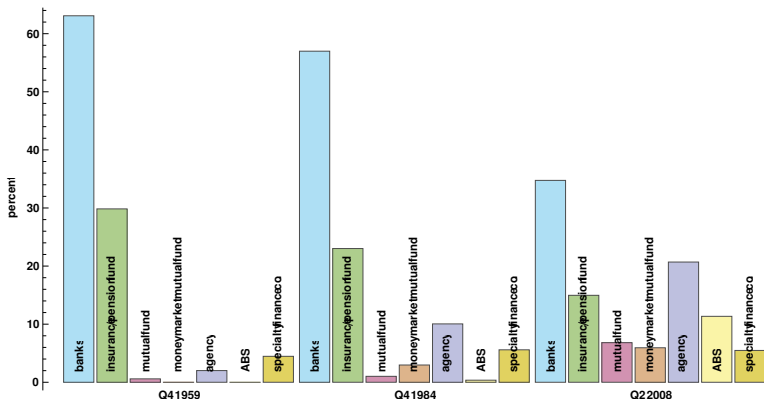
## Disintermediation in U.S. finance 1980–2013

By liability type:



Total liabilities of U.S. nonfarm nonfinancial corporations by type. Bank lending is comprised mostly of commercial and industrial loans (C&I loans). “Other” consists primarily of trade payables and mortgages. Left: \$US trillions; right: shares, in percent. Quarterly, 1975 to Q2 2013. *Source:* Federal Reserve Board, Financial Accounts of the United States (Z.1), Table L.102.

# Intermediation by sector 1985–2008



Share of each sector in total credit market assets held by financial sectors, percent. *Source:* Federal Reserve Board, Financial Accounts of the United States (Z.1), Table L.1 (line nos. in parentheses):

banks

Monetary authority (34)

money market mutual fund

MMMFs (47)

insurance/pension fund  
mutual fund

Banks (35, 40-41)  
Brokers and dealers (56)  
Insurance, pensions (42-47)  
Incl. ETFs (48-50)

agency

GSEs (51)  
Agencies, GSE MBS (52)  
ABS issuers (53)  
Incl. REITs (54-55, 57)

ABS  
specialty finance co.

## Continuing dependence on bank leverage

- BHCs face higher capital charges
- But indirectly provide leverage to successor intermediaries
- Basis trading shifting toward hedge funds
- Prime brokerage
- Credit extension shifting toward private credit

## Analysis of leverage

## Putting on leverage through carry trades

## Credit markets in the U.S.

## **Collateralized security loans and leverage**

- Structure of collateralized security loan markets

- Repo markets

- Treasury markets and the basis

## Incentive alignment and capital structure

# Collateralized security loans

- (Generally) short-term loans in which financial assets serve as collateral:
  - Securities themselves serve as collateral for long positions in the securities
  - Cash serves as collateral for short positions in the securities
- Predominantly bonds and equity
- Key mechanism by which financial system
  - Establishes and finances leveraged positions
  - Supplies (→)liquidity to markets and large intermediaries
- Economic functions:
  - Borrowers use collateral markets to finance long positions in securities
  - Lenders of securities or excess cash use collateralized security loans to earn additional interest
  - Short sellers borrow securities in collateral markets to establish positions

## Participants in collateralized security loan markets

- Predominantly conducted by intermediaries on both sides of transactions: **market-based** or **short-term wholesale funding (STWF)**
- Generally involving broker-dealer (“sell side”) on at least on side
- Often referred to as **securities financing transactions (SFTs)** by regulators

# Legal mechanics of collateralized security loans

- Securities are **pledged**—used as collateral—to obtain secured loans of cash or other securities
  - Pledged assets said to be **encumbered**
- Loans collateralized by securities may look like sales but are economically loans
  - Holder of pledged securities must remit dividend and coupon payments
  - Voting rights a tricky issue
- Collateral may be **rehypothecated** or repledged by lender
  - Adds to liquidity of collateral markets in normal times, can cause freezes in stress
  - **Rehypothecation risk**: collateral seized by downstream lender
- Arrangements for netting

# Legal arrangements for holding collateral

- Two types of arrangement, legally distinct but economically similar
  - **Security interest** in collateral transferred to lender
  - **Title transfer** to lender, obligation to return **equivalent collateral**
- Both enjoy wide exemption from **automatic stay** in bankruptcy
  - → *Seize and sell*: cash lender can sell collateral without delay

## Major types of collateralized security loan

**Margin loans:** loans financing security transactions in which the loan is collateralized by the security

- Key participants: short sellers, e.g. long-short equity HF, institutional investors

**Repurchase agreements** or **repo:** matched spot sale and forward repurchase of security, at prices implying a lending rate

- Economically equivalent to margin loan

**Securities lending** is the loan of a security in exchange for a fee

- Administered on large scale by major **custodian banks** (e.g. Bank of New York Mellon (BONY), State Street, JPMorgan)
- Key participants: institutional investors with high-quality collateral

## U.S. stock market margin debt 1997–2023



Debit balances in customers' securities margin accounts at Financial Industry Regulatory Authority (FINRA) member firms, month-end, Jan. 1997 to Feb. 2023, \$ bill. *Source:* FINRA.

## Repo market mechanics

- Cash borrower said to have entered a repo transaction, cash lender a **reverse repo** transaction
- What makes it a secured loan, rather than a purchase and sale?
  - Seller (cash borrower) has obligation to repurchase
  - Seller bears market risk, since sale and repurchase prices determined at start
- Most repo overnight, but rolled over for longer periods
  - **Term repo** has longer maturities than o/n
- Most repo **general collateral** transactions, collateralized by any securities within a class, e.g. Treasuries or agencies
  - Substitution of securities: repo purchaser (cash lender) may return “equivalent” securities
  - Other repo collateralized by specific securities identified by CUSIP
- Most repo is **Treasury repo** collateralized by Treasuries
- Generally governed by standardized documentation: **Master Repurchase Agreement**
  - Provides for netting of some transactions

## Participants in the repo market

- Very large market, near \$2 trillion
- Key participants:
  - “Outer market”: cash lenders include MMMFs, corporate treasuries; cash borrowers include hedge funds, institutional investors
  - Larger banks and broker-dealers intermediate between cash lenders and borrowers
  - “Inner market”: trades between dealers to manage and fund inventories, support market-making
- **Dealer matched-book repo:** simultaneously enter repo and reverse-repo with different counterparties, earn spread
  - Dealer raises cash from reverse-repo counterparty and lends to repo counterparty
  - At same time, dealer rehypothecates repo counterparty’s collateral to reverse-repo counterparty

# Types of repo

**Tri-party repo:** third-party custodian values securities, settles trades via transfers of cash and securities between participants' accounts

- Used by larger participants in repo markets, primary trading venue for cash lenders and borrowers
- Accounts for about  $\frac{2}{3}$  of U.S. transaction volume
- In U.S., BONY sole tri-party custodian

**Delivery-versus-payment (DVP) or bilateral repo:** direct transactions in specific collateral

- Generally between dealers, and in U.S., cleared through **Depository Trust and Clearing Corporation (DTCC)**

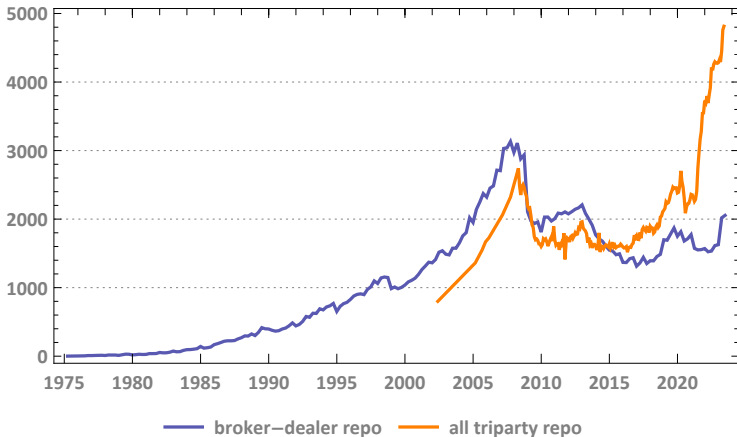
**GCF Repo:** similar to tri-party repo, but open to smaller dealers

- Executed via a DTCC subsidiary and cleared through BONY tri-party platform

## Tri-party repo and systemic risk

- Day-long, complex settlement process: daily “unwind”
- Custodian bank BONY provides intraday financing of dealers’ securities, large intraday counterparty exposure during settlement
- Custodian may trigger default of weak dealer by declining to clear its trades
- Custodian may itself be weakened by default of major participant

## U.S. broker-dealer and tri-party repo 1975–2023



Net liabilities (borrowed cash) under security repurchase agreements of US broker-dealers, \$ billions, quarterly, Q1 1975 to Q2 2023; total volume of tri-party repo (market value of the collateral), all collateral classes, \$ billions, monthly, 31May2002 to 31Oct2023. *Sources:* Federal Reserve Board, Financial Accounts of the United States (Z.1), Table L.130, Federal Reserve Bank of New York.

# U.S. Treasury debt management

- **Debt management:** financing of deficit and maturing debt
  - Schedule, volume and maturities of new issuance
  - Securities initially sold via auctions to **primary dealers**
  - Highly liquid secondary market trading, wide set of dealers, market makers
- Nominal debt maturities at issuance
  - Bills:** 4–52 weeks
  - Notes:** 2–10 years
  - Bonds:** 20 and 30 years
- **“regular and predictable”** issuance
  - Regular schedule, no surprises in volume and maturities of new issuance
  - **When-issued** securities: coupon, maturity and auction date announced but not yet delivered
  - **On-the-run**—most recently auctioned—securities most liquid
- Methodological difficulties introduced by trading costs, changes in risk and risk appetite over time

# Basis trades

- Important example of near-arbitrage
- **Basis spread:** small price or yield differentials between near-identical exposures
- **Basis trading:** form of near-arbitrage
  - Long position in relatively dear exposure, short in relatively cheap one
  - Small unit profit, so acceptable return requires high leverage
  - Long position financed in repo market
- Tail risk of basis widening rather than convergence
  - Collateral calls accelerate unwinding

## Treasury basis trades

- **Treasury basis:** yield difference between cash Treasuries and generally slightly lower yield (higher price) of nearby futures contracts
  - Transactions cost
  - Liquidity risk
  - Risk of change in **cheapest-to-deliver** security
- Trade construction:
  - Long position in cash Treasuries
  - Financed in repo market, typically with high leverage ratio, rolled over daily
  - Short position in Treasury futures
- Profitable if bond yield and convergence of cash and futures price exceeds repo financing cost
- Largest participants formerly dealers, currently hedge funds

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**Incentive alignment and capital structure**

Leverage and moral hazard

Debt overhang

## Risk-sharing impact of leverage

- For any firm, leverage a mechanism for distributing risk between equity owners and lenders to firm
- Merton model: debt and equity as options on firm assets
- Moral hazard in presence of limited liability generates inefficiencies
- Takes two forms that are inverse to one another
  - **Risk-shifting** or **asset substitution**: equity owners choose riskier projects/loans
  - **Debt overhang**: equity owners avoid riskier projects/loans
- Distribution as well as mean of outcomes of additional projects/loans important
- Capital regulation and presence of government guarantees can generate or exacerbate either one

## Risk-shifting

- Limited liability generates incentive for equity owners to take on greater risk at expense of debtholders
  - Higher leverage shifts risk from equity owners to creditors
- Equity owners may have incentive to accept negative NPV to obtain positive upside debtholders
- Effect of guarantees (→ deposit insurance, TBTF): equity owners incentivized to increase risk
  - Equivalent to “taxpayer put” provided to intermediaries
- Exacerbated by decline in firm asset value leading to **gambling for redemption**: incentive to make more/riskier loans

## Definition of debt overhang

- High leverage and/or high default probability may have negative impact on firm's willingness to invest
- Positive NPV has much larger impact on recovery and current market value of existing senior debt than on equity
  - Impact on equity may even be negative due to dilution or funding via new junior debt
  - Seniority of high existing debt would force new equity to share returns with debtholders
- Owners may avoid equity-financed positive NPV projects if it raises value of debt and reduces value of equity→
  - New investment projects with positive net present value cannot be financed via equity
  - No incentive of current owners to finance projects via junior debt

## Example of debt overhang: assumptions

- Existing debt: senior debt, par value 100
  - With covenants preventing increased issuance or subordination to new debt
  - Yield/interest rate  $r = 0$
- Default event: default if asset value = 80, nondefault value 110
  - $\Rightarrow$  Debt LGD 20, recovery 80
- Firm/asset value: default probability-weighted average of asset value

$$\text{firm value} = \pi \times 80 + (1 - \pi) \times 110$$

- Debt value: default probability-weighted average of par (100) and recovery (80)

$$\text{debt value} = \pi \times 80 + (1 - \pi) \times 100$$

- New investment opportunity: invest 5, certain future value of 15
  - Financing through issuance of new shares or junior debt

## Example of debt overhang: results

Default probability	1.000	0.500	0.005
Before new investment			
Firm value	80.000	95.000	109.850
Debt value	80.000	90.000	99.900
Equity value	0.000	5.000	9.950
After new investment			
Firm value	95.000	110.000	124.850
Debt value	95.000	97.500	99.975
Equity and junior debt value	0.000	12.500	24.875
Equity gain net of funding cost	-5.000	2.500	9.925

## Interpreting the example

- Default certain or near-certain:
  - All the future value of new investment goes to senior debt holders
  - Current or new equity and junior debt investors lose entire cost of investment
- Default probability high:
  - Much of the future value of new investment goes to senior debt holders
  - Little left over after cost of investment to incentivize firm owners
- Default probability low:
  - Senior debt recovery little changed
  - Owners have ample incentive to invest in a “sure thing”