Investments

Topic 4: Fixed Income

UCLA | Fall 2024

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Overview of Topic 4

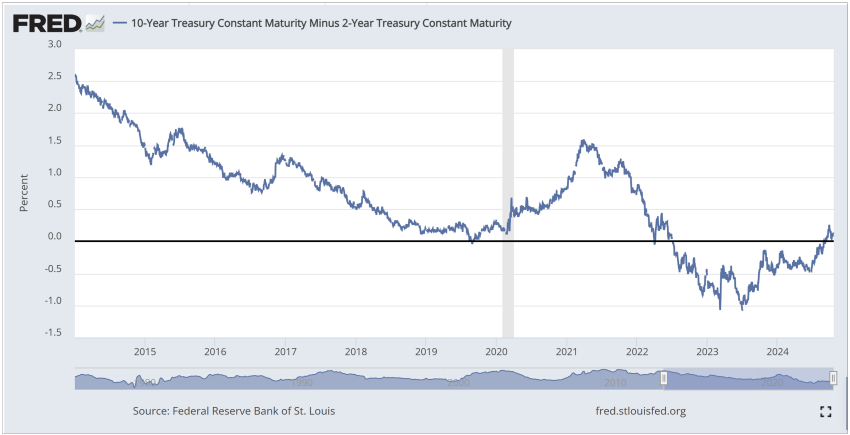
1. Trading fixed income
2. The Eurodollar market
3. Credit risk and instruments
4. Mortgage-backed securities
5. Default risk

1. Trading Fixed Income

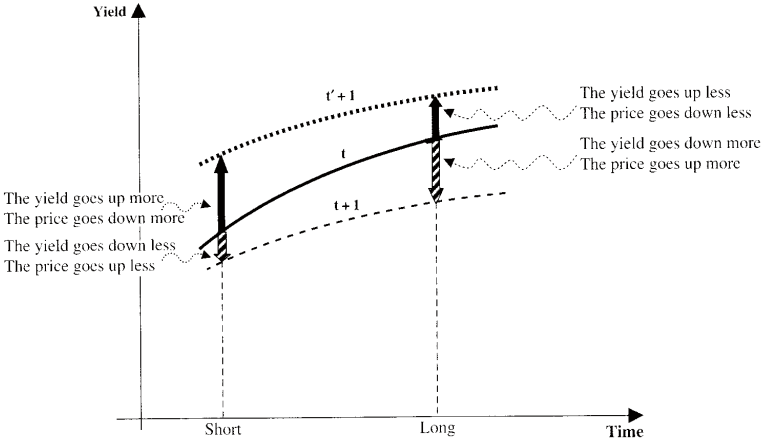
Trading on the slope: Yield curve flattener / steepener

- In 2004 the Fed started raising the target interest rate
  - the economy is growing
  - concerns over inflation
- Anticipate a period of increase in short interest rates, that is, flattening of the curve
- How to exploit this view?
  - Short-sell short-term Treasuries
  - What if there is a curve-wide shift down?
  - Hedge by buying long-term Treasuries
- What about the QE1 announcement in Nov. 2008? discontinuation of QE in 2014?
- **Carry** is similar to flattener
  - Borrow short-term at low rates (like selling a short term debt)
  - Lend for long term at higher rates (like buying long term debt)
  - Banks are in the best position to do carry

The History of Steepeners



Flattener


Yield
t' + 1
t
t + 1
The yield goes up less
The price goes down less
The yield goes down more
The price goes up more
The yield goes up more
The price goes down more
The yield goes down less
The price goes up less
Short
Long
Time

Details

- Suppose you are trading 2- and 10-years zero bonds
- Curve flattener: buy x of the 10-yr per 1 short position in the 2-yr:

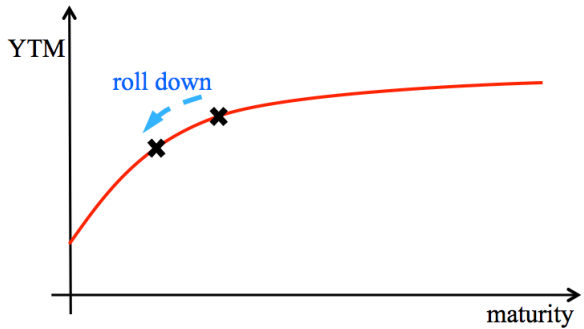
$$P\&L \approx DV01_2 \Delta y_2 - x \cdot DV01_{10} \Delta y_{10}$$

- How do you choose x?
- No change in the portfolio if there is a parallel shift in the curve
- Historical performance can give additional technical information on when to trade

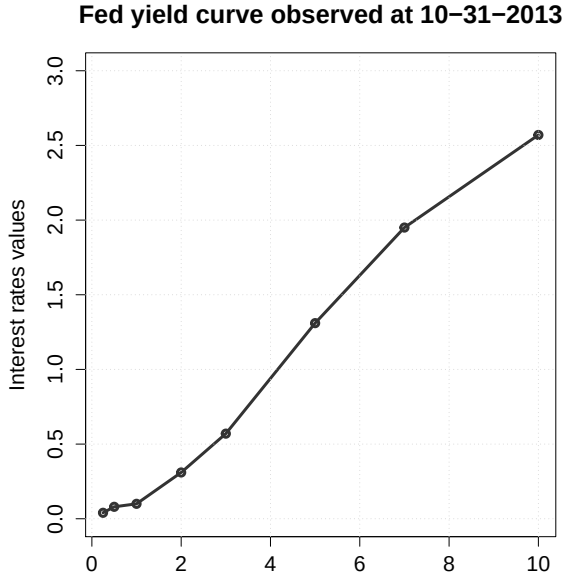
Time Effect: Pull to Par and Roll Down

Flatterner / Carry returns consist of two components

1. Non-parallel shifts in the curve within the same period
2. Changing maturity = passage of time
   - Pull to par: a bond's price approaches face value as time to maturity gets smaller
   - Roll down: more generally, decline in maturity changes the bond price (increases if the curve is normal)



Yield curve in the Fall of 2013



Convexity

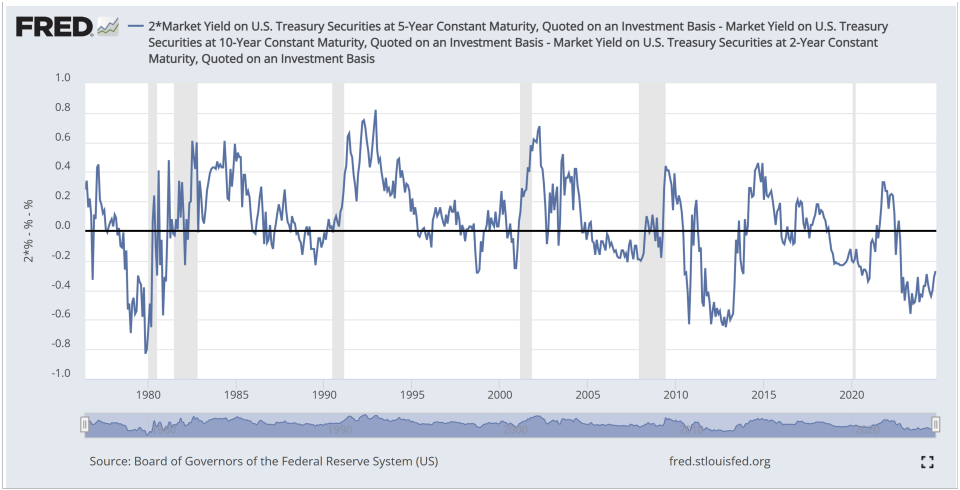
- The flattener benefits from convexity of the curve:
  - Duration increases linearly with maturity
  - Convexity increases with the square of maturity

$$\begin{aligned} C_T &= \frac{1}{P} \cdot \frac{\partial^2 P_T}{\partial y_T^2} \\ &= \frac{T(T+1)}{(1+y_T)^2} \end{aligned} \qquad \text{(zero bond)}$$

  - When duration is *immunized*, long-term convexity will dominate short-term convexity
  - So the flattener is long convexity, and steepener is short convexity

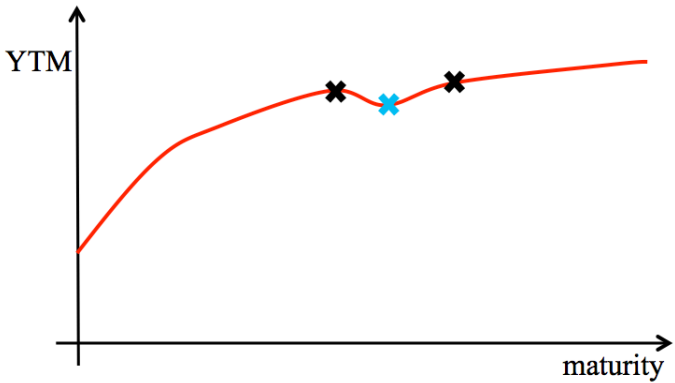
- Intuitively, convexity reflects volatility of interest rates
  - If interest rates do not move much, the difference in convexity won't matter

Curvature: 10-year and 2-year vs 5-year



Butterfly

- This strategy takes advantage of the yield curve's curvature and consists of two legs
  - Barbell: portfolio containing short and long maturity bonds, e.g., 2-year and 10-year
  - Bullet: an intermediate maturity bond, e.g., 5-year
  - Buy a butterfly: buy a barbell (wings) and sell a bullet (body)



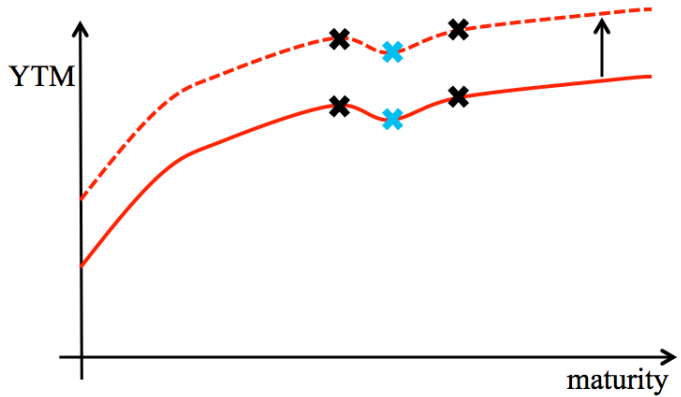
Parallel shift in the yield curve

- Change in value

$$P\&L \approx DV01_5 \Delta y_5 - x_2 \cdot DV01_2 \Delta y_2 - x_{10} \cdot DV01_{10} \Delta y_{10}$$

- To immunize:

$$DV01_5 = x_2 \cdot DV01_2 + x_{10} \cdot DV01_{10}$$



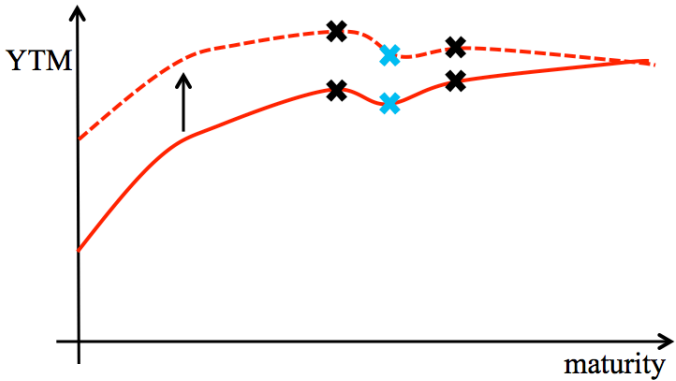
Change in slope

- Suppose

$$\Delta y_2 = \beta \Delta y_5, \Delta y_{10} = \gamma \Delta y_5$$

- To hedge against the changing slope:

$$DV01_5 = \beta x_2 \cdot DV01_2 + \gamma x_{10} \cdot DV01_{10}$$



Trading on the curvature

- Solving the two equations:

$$x_2 = \frac{\gamma - 1}{\gamma - \beta} \cdot \frac{DV01_5}{DV01_2}, x_{10} = \frac{1 - \beta}{\gamma - \beta} \cdot \frac{DV01_5}{DV01_{10}}$$

- Suppose $\beta = 0.9$ and $\gamma = 1.1$ then

$$x_2 = 0.5 \cdot DV01_5/DV01_2,$$

and

$$x_{10} = 0.5 \cdot DV01_5/DV01_{10}$$

- Dollar durations of each of elements of the barbell are half of that of the bullet

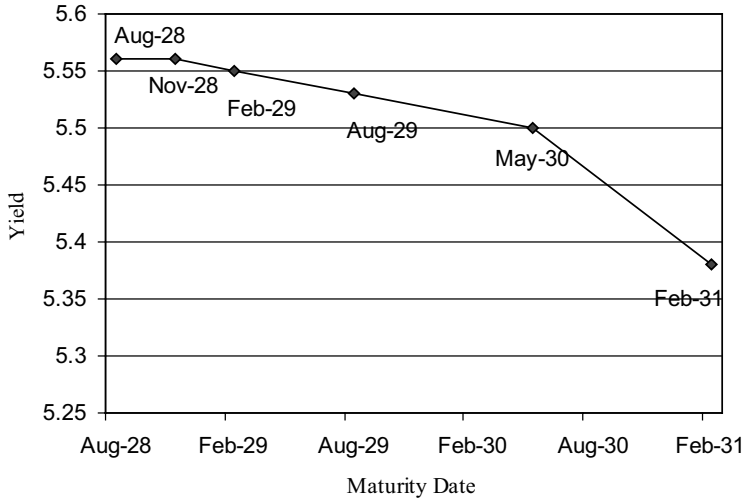
- Profit if the kink converges to zero:

$$P\&L \approx DV01_5 \Delta y_5$$

Snap Trade

- Long-Term Capital Management was famous for such trades with Treasury bonds of similar maturities
- Bonds vary in liquidity due to the auction cycle
- Consider the 30-year note which is auctioned 1-2 times year
  - Newly issued bond is on-the-run
  - 2nd most recently issued bond is off-the-run
- "Liquidity": more new issuances in the market than old ones
  - Insurances and pensions buy old issuances and lock them up
- This creates liquidity driven price and yield differences

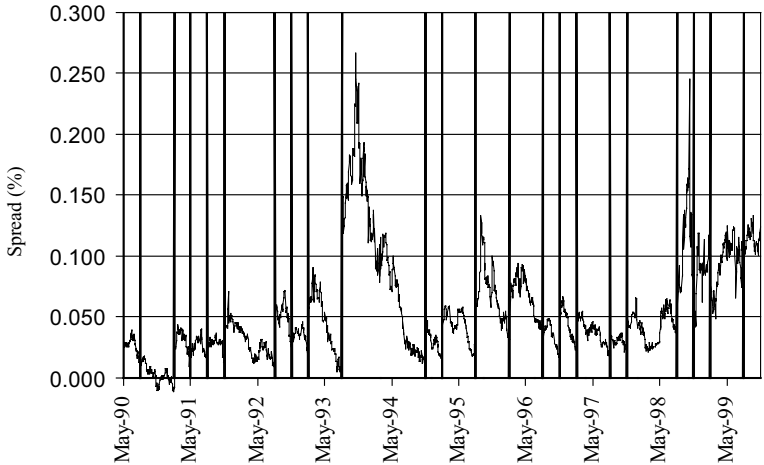
Example: Feb. 9, 2001



LTCM and Treasuries

- Early 1994:
  - Interest rates were rising, bonds prices fell
  - Hedge funds lost lots of money in a couple of days: Soros lost $650mm, Steinhardt $800mm
- Panic selling of bonds: especially off-the-runs.
- On-the-run, off-the-run spreads had widened.

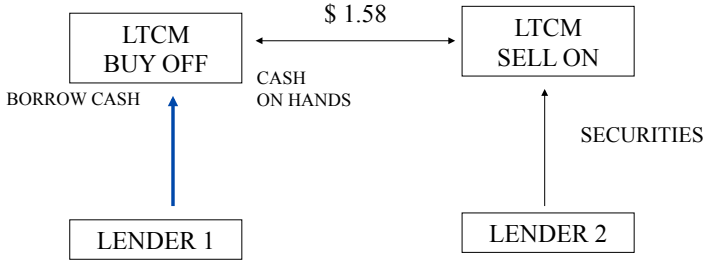
On/Off Spread



Leverage

- Borrow to multiply the spread:
  - Bought $1bn of “cheap” off-the-runs
  - Short $1bn of “expensive” on-the-runs
- Favorable financing: Use off-the-runs as collateral for on-the-runs
- $2bn position with (little or) no money up-front
- Made $15mm when rates converged


LTCM
BUY OFF
$ 1.58
LTCM
SELL ON
CASH
ON HANDS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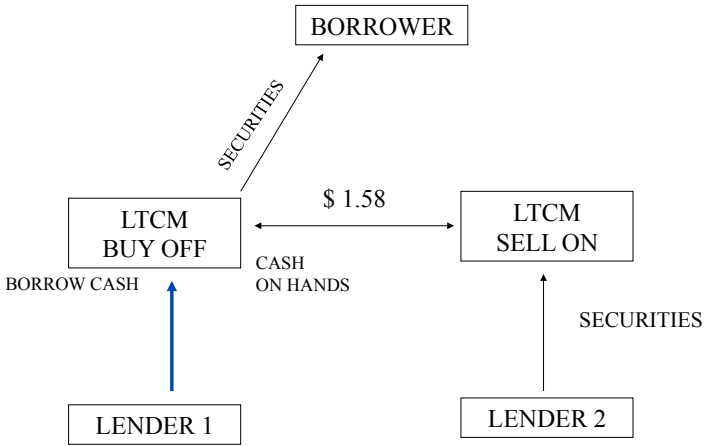
SECURITIES
LENDER 1
LENDER 2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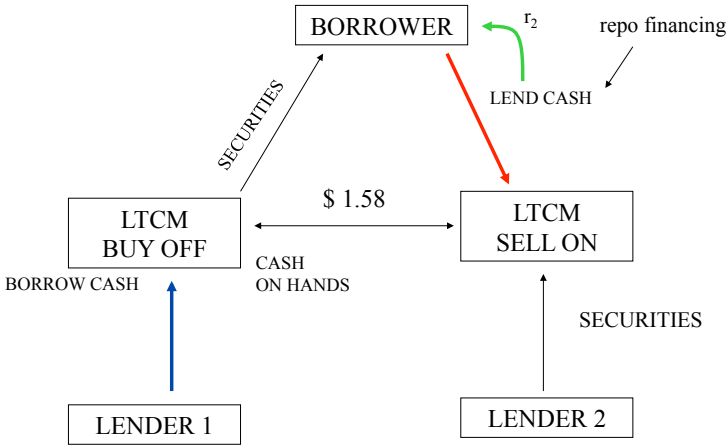
BORROWER
r_2
repo financing
LEND CASH
SECURITIES
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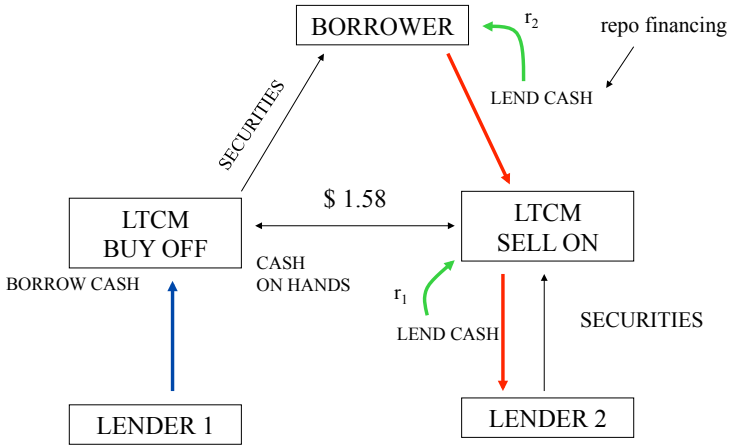
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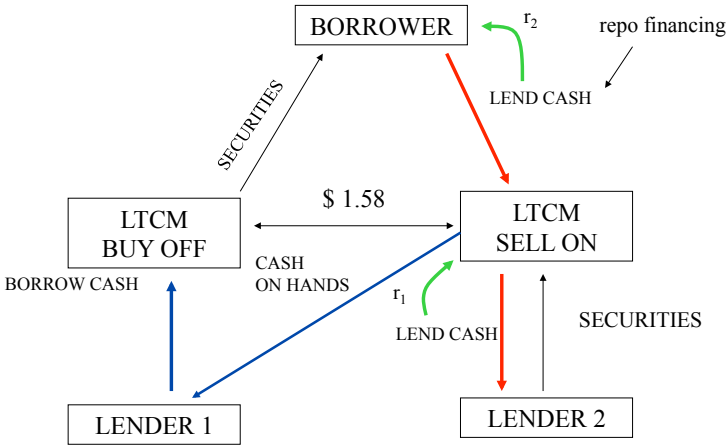
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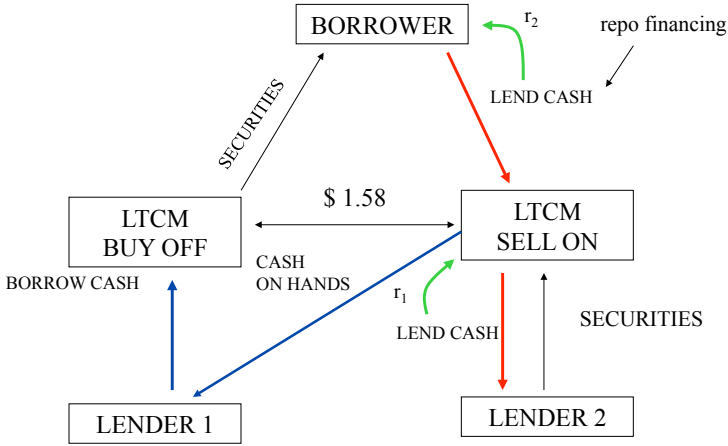
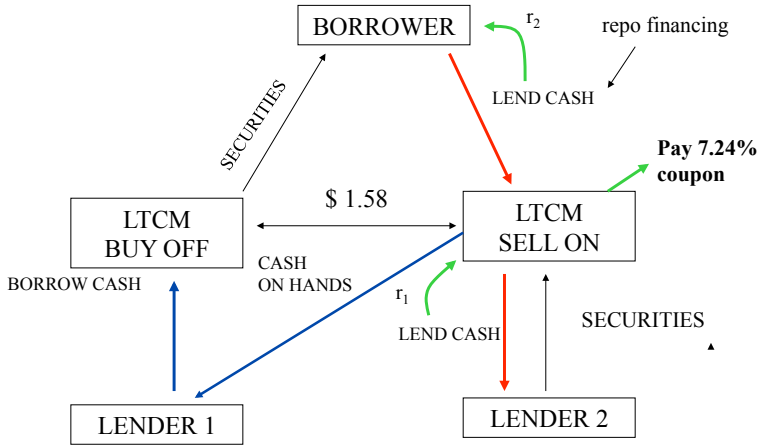


$r_2 > r_1$(“special”)
(interest on cash loan)



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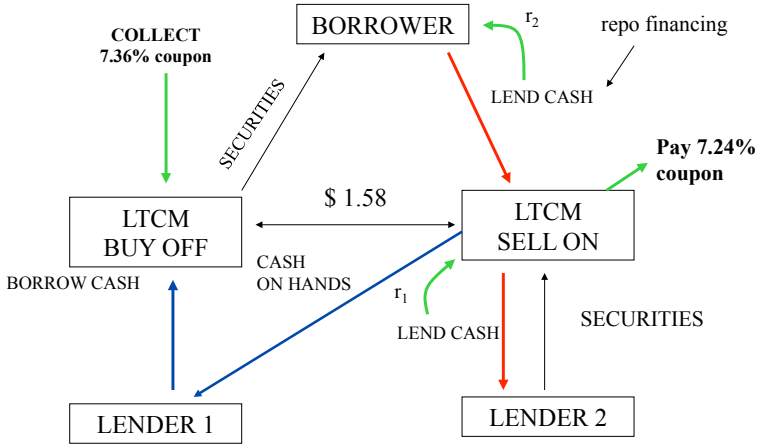

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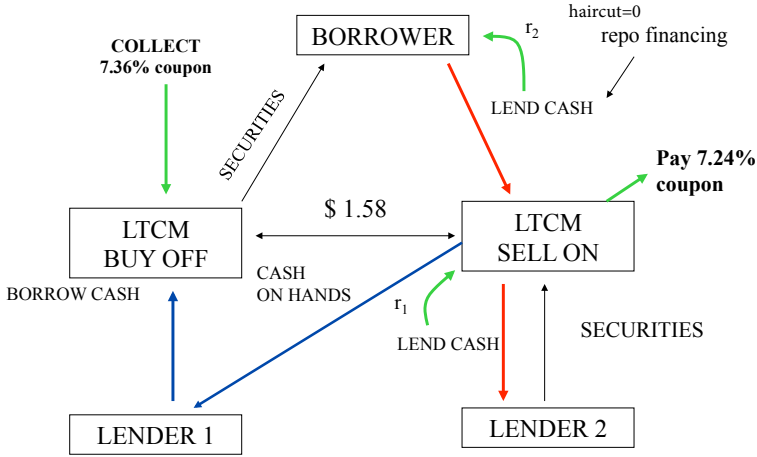
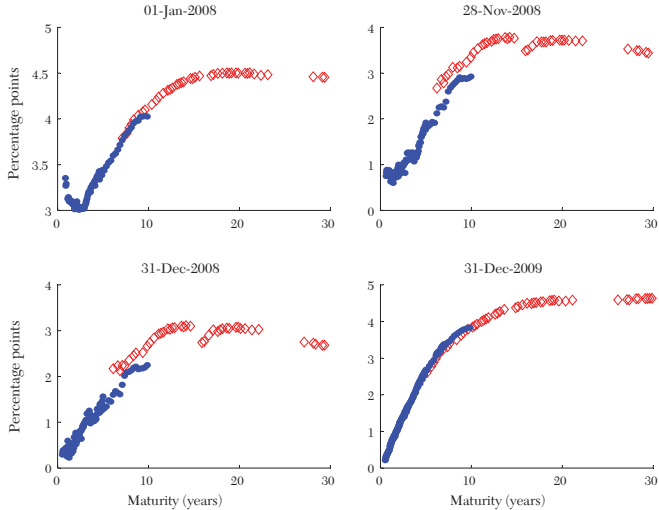


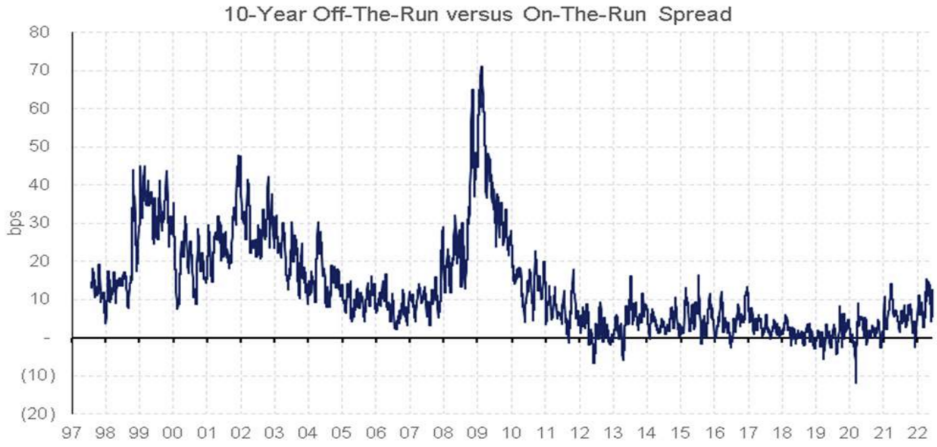
$r_2 > r_1$ ("special")
(interest on cash loan)

On/Off Spread 2



Diamonds: Securities originally issued as thirty-year bonds. Circles: all other bonds.

On/Off Spread 3



Note: The spread is calculated as the difference between the on-the-run yield and the Fed's off-the-run yield curve. A more positive spread indicates higher off-the-run versus on-the-run yields

Sources: Federal Reserve, Haver Analytics, JPMorgan

2. The Eurodollar Market

The Eurodollar Market

- The biggest interest rate market is the Eurodollar market, not the Treasury.
  - What is this market and what is a Eurodollar?
  - Why does it exist?
  - What are the instruments and conventions?

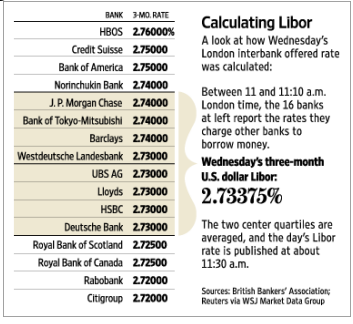
- A Eurodollar is a US$ - denominated deposit outside of the U.S. The primary market for these deposits is in London.

- The market developed in 1960s and 1970s to skirt U.S. banking regulations
  - Europe typically has less regulation
  - Often beneficial tax advantages to doing $ denominated business abroad (Cayman Islands)

- The instruments are fixed and floating rate deposits over various maturities
  - CDs, time deposits, etc.

LIBOR

- Market is benchmarked by the LIBOR rate
  - London Interbank Offered Rate: rate at which major banks are willing to offer $ deposits to each other
  - London Interbank Bid Rate (LIBID): the rate at which major banks will take $ deposits from each other.
- BBA (British Bankers Association) polled panel banks and asked them at what rate would they loan money to other panel banks; since Jan. 2014 it is Intercontinental Exchange



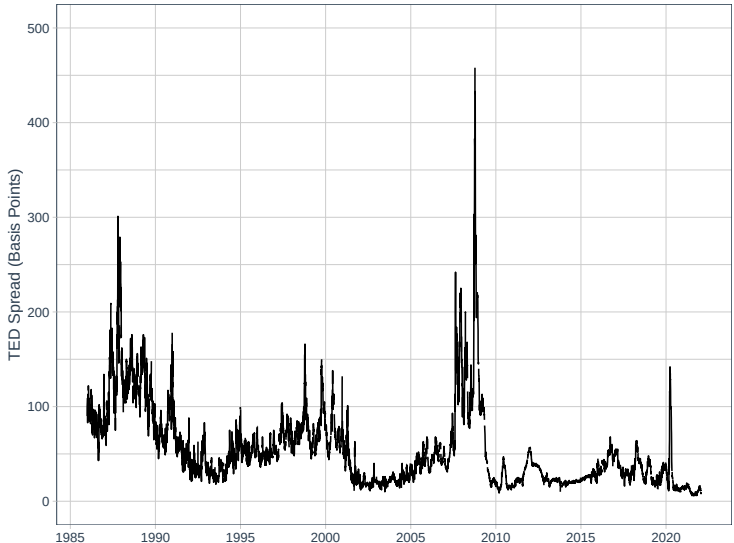
BANK	3-MO. RATE
HBOS	2.76000%
Credit Suisse	2.75000
Bank of America	2.75000
Norinchukin Bank	2.74000
J. P. Morgan Chase	2.74000
Bank of Tokyo-Mitsubishi	2.74000
Barclays	2.74000
Westdeutsche Landesbank	2.73000
UBS AG	2.73000
Lloyds	2.73000
HSBC	2.73000
Deutsche Bank	2.73000
Royal Bank of Scotland	2.72500
Royal Bank of Canada	2.72500
Rabobank	2.72000
Citigroup	2.72000

Why is LIBOR important?

- (Before the crisis) Viewed as the true risk-free rate
  - the rate at which highly rated commercial banks can borrow and lend
  - no liquidity premium as in the U.S. Treasuries
- Short-term interest rate benchmarks
  - Overnight, 1 Week, 2-12 Months
  - Why is it the benchmark? (Before the crisis) Difficult to manipulate
- Vast majority of interest rate derivatives and many bond issuances are linked to LIBOR
  - Floating rates on bonds, forwards and swaps
  - Even U.S. residential mortgages!
- But Eurodollar deposits are not FDIC insured, so LIBOR reflects default risk

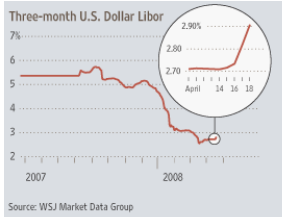
The TED spread

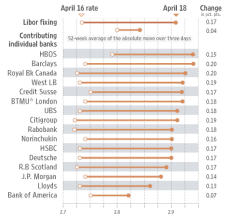
The TED spread



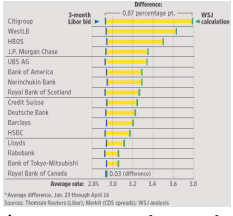
LIBOR default risk and manipulation

- In April 2008, the BBA started investigating LIBOR reporting





- On May 29, 2008 the WSJ proposed an alternative measure of LIBOR on the basis of CDS premiums of banks on the panel

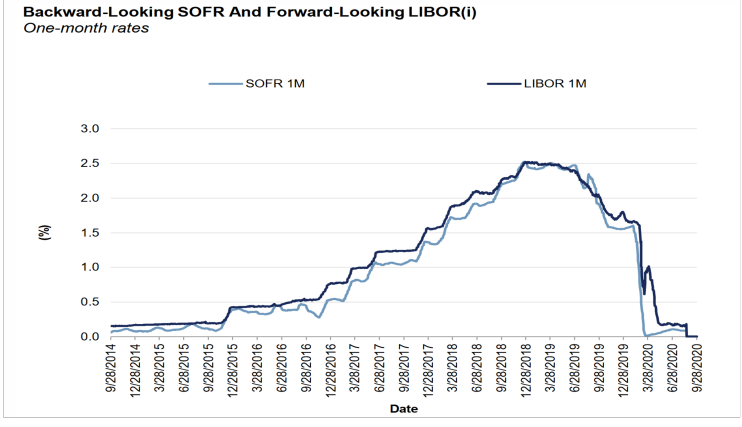


- In June 2012, the scandal broke out starting with Barclays

Abandoning LIBOR

- As of Jan. 1, 2022, the GBP, JPY, CHF, and EUR LIBOR benchmark rates along with the one-week and two-month USD LIBOR, are no longer published

- Substitutes: SONIA, TONA, SARON, EONIA, and SOFR, respectively



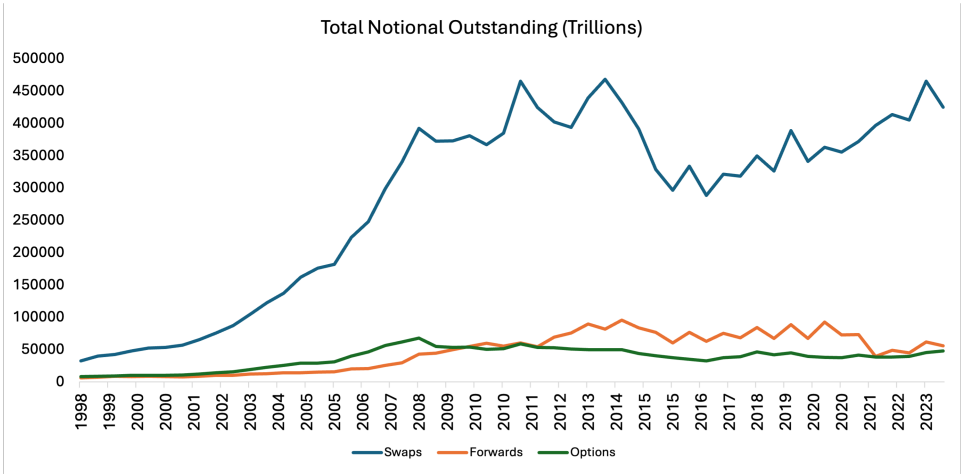
Interest rate swaps

- Forward rates allow us to remove interest rate risk over a given period in the future: t periods ahead for T periods
  - What if we want to be able to remove such risks on a regular basis?
  - Solution: swaps

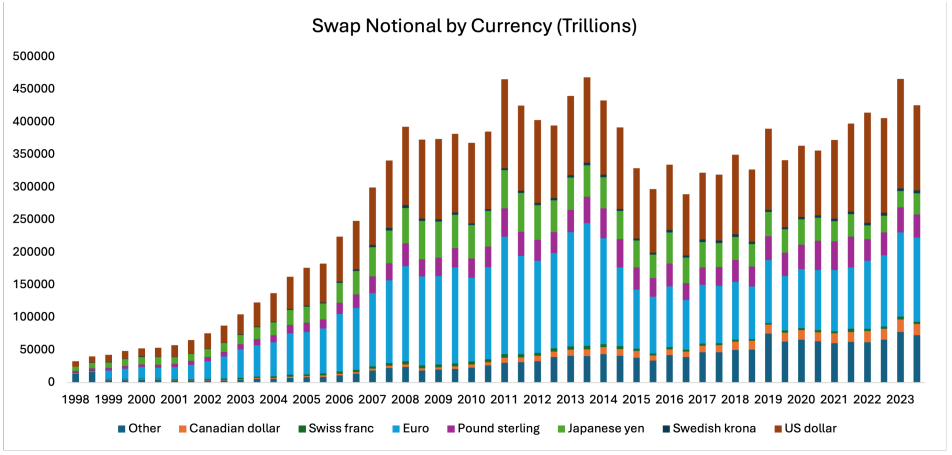
- An interest rate swap is an agreement between two parties to exchange period cash flows
  - One party pays a fixed rate and receives a floating rate
  - The other party pays floating and receives fixed.

- Uses
  - Gives indirect access to fixed or floating capital markets
  - Allows companies to manage their asset/liability structure.
  - A tool for hedging risk and speculation

Interest rate swaps



Interest rate swaps



Contractual features of swaps

- What is swapped? Fixed and Floating Rate payments on a given principal
  - Floating rate: corporate rates, mortgage rates, LIBOR rates
  - Fixed rate: Typically a Treasury rate (on contracting day) plus some basis points
- How often? Reset/settlement period: usually 3 or 6 months.
- For how long? 1 year, 5 years, 10 years, ...
- Fixed payer: fixed rate, aka the swap rate
  - often quoted as a spread off Treasury
- Floating payer: floating rate can be any variable rate
  - Typically LIBOR (now OIS, SOFR)
  - Exchange net on a given principal ($1mil)

Swap valuation

- Valuation means establishing the fixed rate s_T
- If the notional amount of the contract is \$1, then
  - the fixed leg pays s_T every period
  - the floating leg pays ℓ_1 at the end of period 1, $\ell_1(1)$ at the end of period 2, ..., $\ell_1(T-1)$ at the end of period T
- s_T has to be selected in such a way that PVs of the two legs are the same
- Consider a strategy that starts with \$1
  - invest \$1 for 1 period at ℓ_1, at the end of the period pay out ℓ_1, left with \$1
  - invest \$1 for 1 period at $\ell_1(1)$, at the end of the period pay out $\ell_1(1)$, left with \$1
  - ...
  - invest \$1 for 1 period at $\ell_1(T-1)$, at the end of the period pay out $\ell_1(T-1)$, left with \$1 at time T

Swap valuation, cont'd

- Thus, PV(floating cash flows + \$1 at maturity)=\$1
- Must be the case, then, PV(fixed cash flows +\$1 at maturity)=\$1
- It follows that s_T is a par rate of a hypothetical bond:

$$\frac{s_T}{1+\ell_1} + \frac{s_T}{(1+\ell_2)^2} + \ldots + \frac{s_T+1}{(1+\ell_T)^T} = 1, \text{or } s_T = \frac{1-d_T}{\sum_{j=1}^{T} d_j}$$

- Example: $\ell_1 = 5\%$, $\ell_2 = 4.5\%$, $\ell_3 = 4\%$; let's find s_1, s_2, s_3
  - $d_1 = (1+\ell_1)^{-1} = 0.952$; $d_2 = (1+\ell_2)^{-2} = 0.957$; $d_3 = (1+\ell_3)^{-3} = 0.962$
  - $T = 1 : s_1 = (1-d_1)/d_1 \Rightarrow s_1 = \ell_1 = 5\%$
  - $T = 2 : s_2 = (1-d_2)/(d_1+d_2) = 4.51\%$
  - $T = 3 : s_3 = (1-d_3)/(d_1+d_2+d_3) = 4.03\%$

Unwinding

- Buy-back
  - Payment is made based on mark-to-market value of swap, swap is then terminated
- Assignment
  - Find a new counterparty who is willing to assume swap position
  - Requires acquiescence of other counterparty
  - Payment is made to/from new counterparty representing the NPV of the swap
- Swap Reversal
  - Enter into new swap with same (offsetting) terms as original swap

Collateralization

- Full Collateral Agreement:
  - Currently most widely used; mark-to-market exposure collateralized $-for-$
- Threshold Collateral Agreement
  - For (highly) rated counterparties, MTM must exceed threshold amount before collateralized
  - Above threshold MTM is collateralized $-for-$
- "Sliding Scale Agreements": Sets threshold amount, typically by credit rating of counterparty
- Minimum Collateral:
  - % of transaction notional; common for smaller, unrated funds
- Eligible Collateral
  - Cash
  - Treasuries, Agencies, (some) Agency MBS
  - Coupon is passed on to counterparty

Overnight Indexed Swap

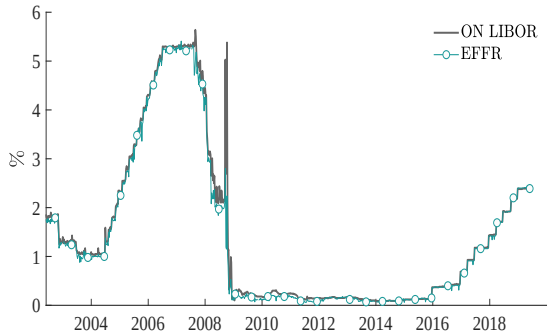
- Overnight indexed swaps are interest rate swaps in which a fixed rate of interest is exchanged for a floating rate that is the geometric mean of a daily overnight rate
  - Fed Funds in the USA
  - EONIA in Europe
  - SONIA in the UK

- Designed to replicate the aggregate interest that would be earned from rolling over a sequence daily loans at the overnight rate.

- The idea is that this is close to the cost of funding for collateralized transaction in the interdealer markets.

Differences between OIS and IRS

- The IRS-OIS spread is determined by the relative riskiness implicit in the benchmarks



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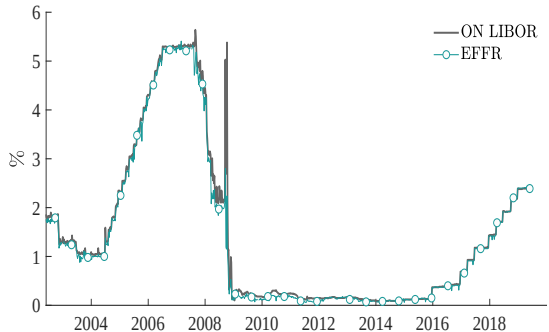
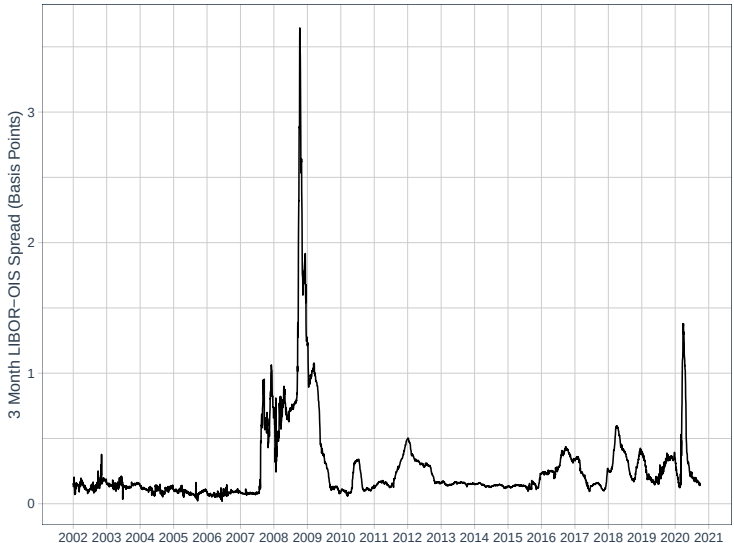


- The reference LIBOR corresponds to a 3-month borrowing horizon
- The reference EFFR corresponds to overnight rolling for 3 months
- So IRS rates should be larger than those of OIS

LIBOR-OIS spread



No-Arbitrage relation to Treasuries

Notation

- CMT - a yield on a par Treasury bond
- CMS - a rate on a fixed leg of an interest swap (IRS or OIS)
- $SS = CMS - CMT$ - a swap spread
- $S_t = f_t - r_t$ - the floating spread between the benchmark uncollateralized index and collateralized repo

		Cash flows at time	
Strategy	0	t	T
Long Treasury bond	-1	CMT	$CMT + 1$
Repo financing cash flows	1	$-r_{t-1}$	$-r_{T-1} - 1$
Pay fixed on swap	–	$-CMS$	$-CMS$
Receive floating on swap	–	f_{t-1}	f_{T-1}
Total	0	$S_{t-1} - SS$	$S_{T-1} - SS$

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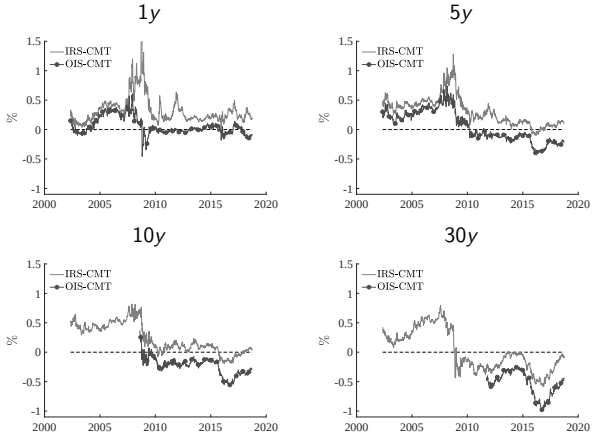
Total	0	$S_{t-1} - SS$	$S_{T-1} - SS$

- $PV(SS) = PV(S_t) \geq 0$
- Crucially depends on absence of US credit risk

Negative Swap Spreads



Extant explanations suggest limits to arbitrage:

- declining demand for Treasuries
- excess demand for swaps of pension funds
- limits to arbitrage due to regulatory capital

3. Credit risk and instruments

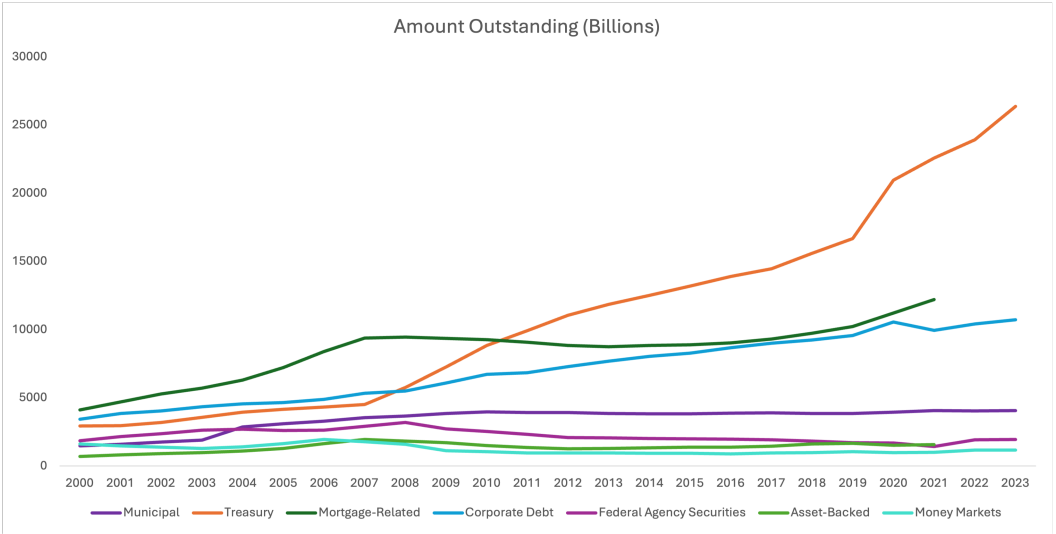
Capital structure and default

- MM: capital structure irrelevance
- Trade-off: tax advantages of debt vs expected *bankruptcy and financial distress* costs
- Financial distress: meeting debt obligations with difficulty
  - difficulty with issuing new debt
  - omitted coupon payments
  - debt restructuring
- Bankruptcy: a legal status of an entity that cannot repay its obligations
  - Liquidation (Chapter 7 in the US, receivership in the UK)
  - Reorganization (Chapter 11)

Credit securities

- Credit trading is making bets about the likelihood and severity of default
- Available securities reflect all stages of distress
- Bonds (often referred to as cash) are claims on coupons, and recovery upon emergence from bankruptcy, or liquidation
- Credit default swaps (CDS) are claims on loss (=1-recovery) in bonds value right after announcement of bankruptcy
- Collateralized debt obligations (CDO, or "tranches") give exposure to correlation between defaults of different companies
- Special case: agency MBS

Reminder ...

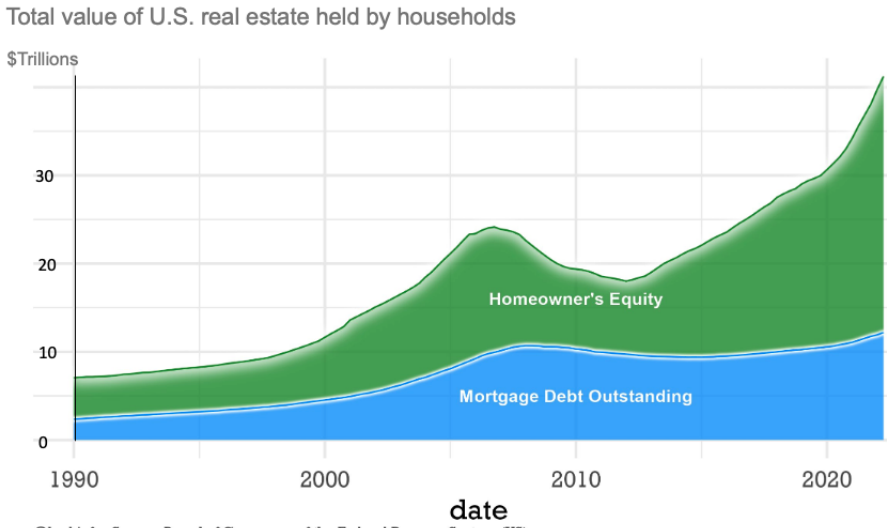

Amount Outstanding (Billions)
30000
25000
20000
15000
10000
5000
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Municipal
Treasury
Mortgage-Related
Corporate Debt
Federal Agency Securities
Asset-Backed
Money Markets

4. Mortgage-Backed Securities

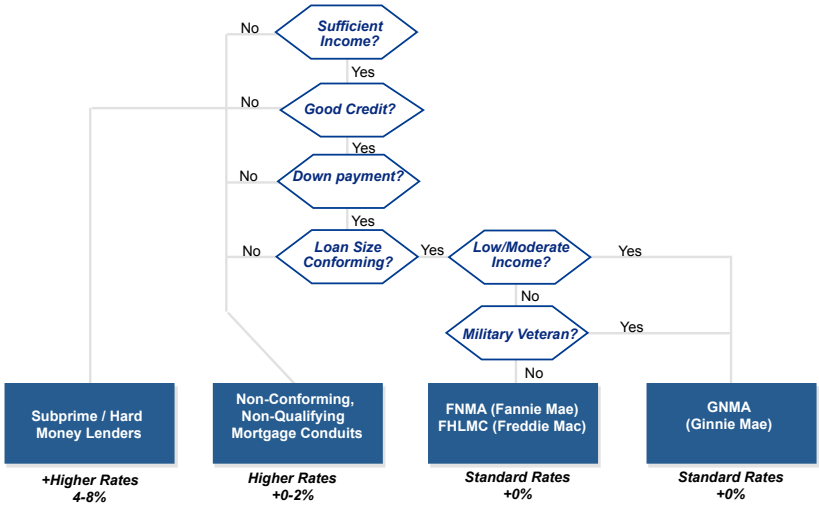
Structured products

- A collection of loans backed by collateral
- Corporate: CDOs or CLOs
- Asset-backed: cars, students loans, credit cards
- Mortgage-backed: residential (RMBS) or commercial (CMBS)

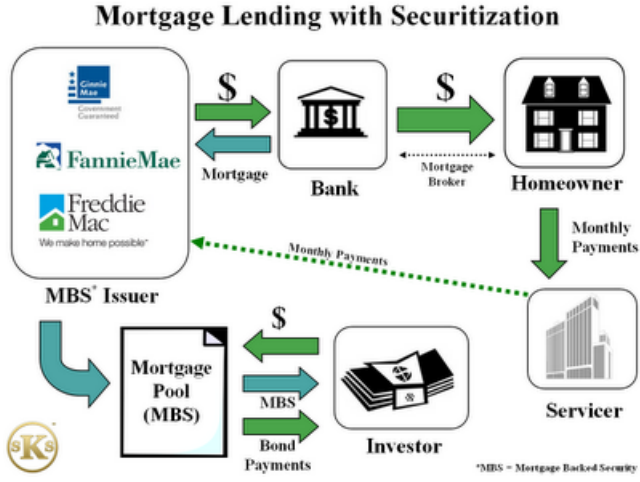
US Housing Stock: Debt and Equity, $ trillion



What determines the features of a mortgage loan?



How does a mortgage loan get securitized?



TBA

- 90% of MBS trade on a to-be-announced (TBA) basis, about $10 trillion
- A buyer does not know the exact pool to be delivered
- Agree on: price, par amount, settlement date, agency program, mortgage type, and coupon
- This structure allows for efficient borrowing with MBS as collateral via the dollar roll
- The "roll seller"
  - sells an MBS in the front-month TBA contract
  - buys an MBS in the future-month TBA contract

Risks of structured products: Timing

- Borrowers prepay the loans
- Factors affecting prepayment
  - Decline in interest rates
  - Housing turnover
  - Aggressive underwriting leads to cash outs
  - Economic cycles
- Risk for an MBS: lose interest payments
- Example based on a 30-year 4.5% MBS

Annual prepayment rate	0%	7%	50%
Pool's duration (in years)	18.4	9.4	1.5

Risks of structured products: Credit

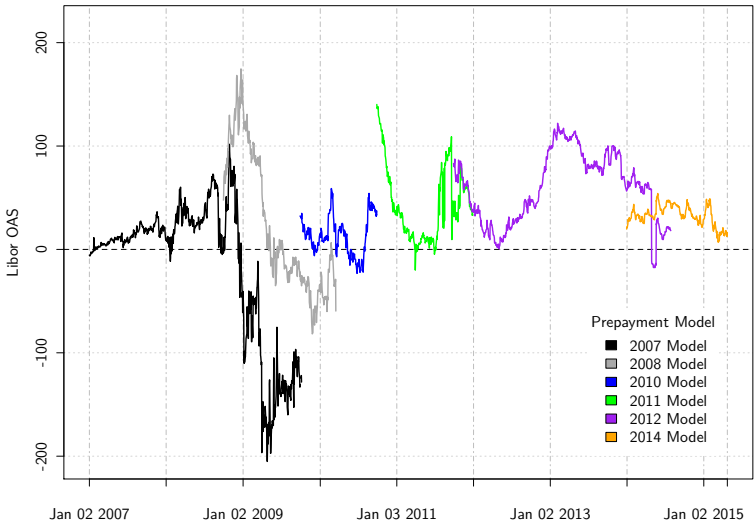
- If there is a default on a mortgage, the pool loses a fraction of the respective principal and the remaining interest payments
- This is where agency backing comes in: they have to purchase the defaulted mortgage from the pool at par
- From the perspective of an MBS investor this looks like prepayment
- The credit risk is shifted to agencies. Do agencies have credit risk?
  - Ginnie Mae has full faith and credit of the US government
  - Fannie and Freddie have an implicit guarantee

MBS valuation

- Very hard ....
- The idea is that an MBS should be cheaper than the otherwise equivalent UST because of prepayments
- Prepayments manifest themselves as uncertain cash flows and higher discount rate
- The relevant concept is Option-Adjusted Spread (OAS)

$$P = \sum_{j=1}^{T} \frac{E_t C(r_j)}{(1 + r_j + OAS)^j}$$

OAS by the same dealer



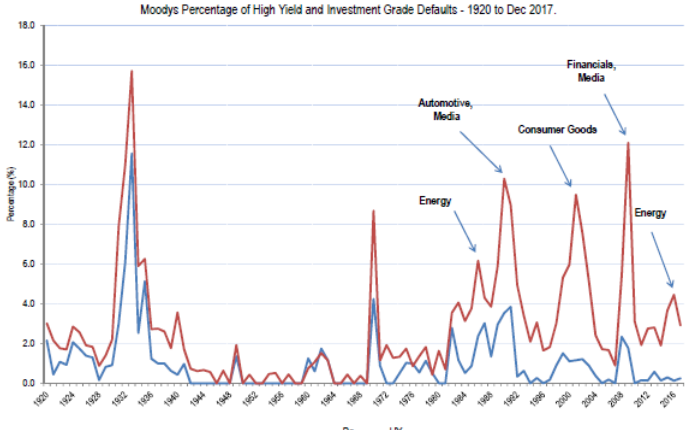
5. Default risk

Defaultable Debt

- Corporate bonds promises the same payments as UST: coupons and par
- The company may not be able to pay obligations at the required time
  - Restructure debt
  - Pay a fraction of the coupon value
  - Omit the coupon payment
  - Liquidate with a partial recovery of par
  - Liquidate with zero recovery of par
- Uncertainty associated with corporate bond payments is known as credit risk
- Corporate debt securities are rated by Moody's, S&P, and Fitch:
  - Investment grade bonds (AAA to BBB-)
  - High yield (junk) bonds (BB+ to B-)
- A common critique of ratings is that, in practice, they reflect changes in the bond prices

The ratings game

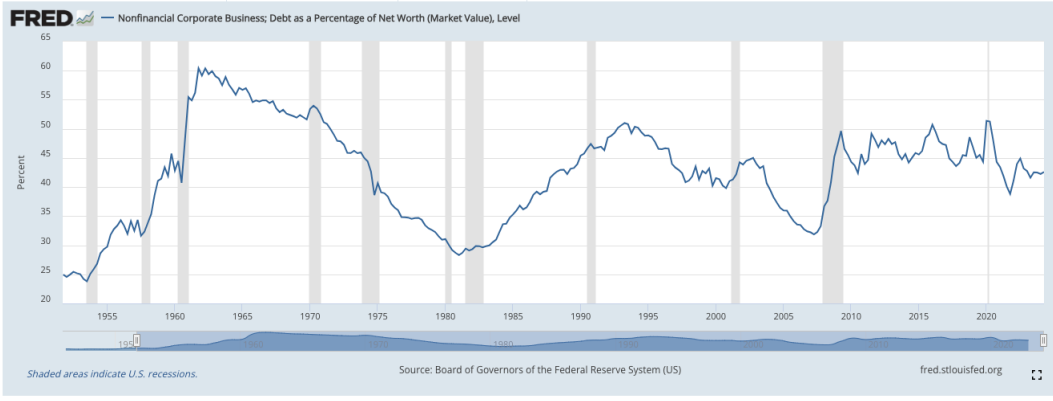
- The ratings aim to reflect how likely a default would take place and what would the loss be
- Credit ratings companies often justify the quality of their rating by historical performance



Fun facts about ratings

- What's the rating of the USA?
- There are only two AAA rated companies in the US now
- How many AAA rated companies in 2006?
- How many MBS rated AAA?

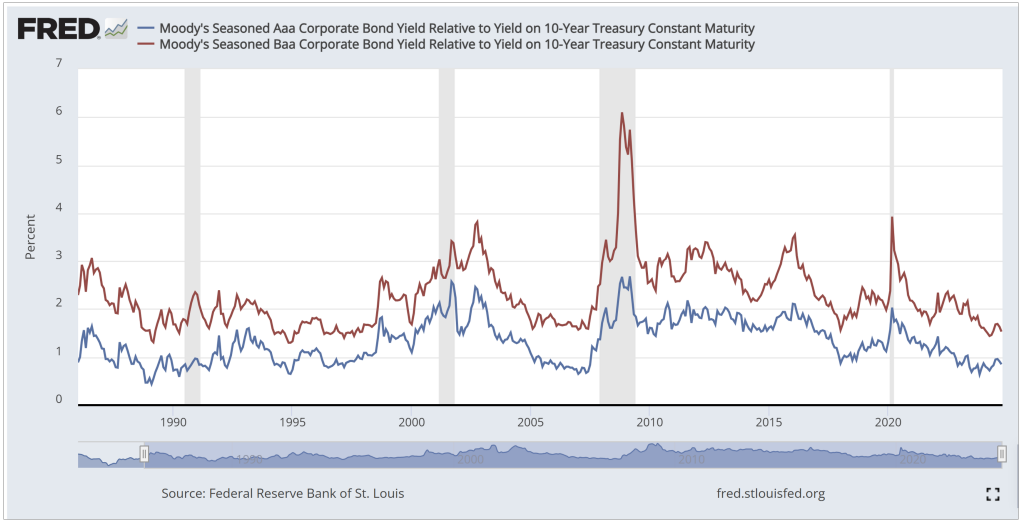
Credit Market Debt as % of Market Value



Corporate Bond Pricing

- Cash flows are uncertain because of default and recovery risk
- Discount rate must be higher than the risk-free rate
  - Recall the TED spread that reflects credit risk in the banking sector
  - The same way corporate bond feature a spread over Treasuries
- In practice, people still compute YTM
- The difference between corporate YTM and Treasury YTM is known as *credit spread*
  - Reflects liquidity risk as well
- Corporate price is driven by both interest rate risk and credit risk
  - Can compute spread duration
  - Note there is no interest rate risk for floating coupon bonds
- After we cover Options, we will be able to think about a more comprehensive approach

Historical Credit Spreads



Issues with corporate bonds

- A bond is a funded instrument – pay close to face value upfront
- When you buy a corporate bond you are betting that the company will do well
- It is hard to short when you want to express an opposite view
  - There are not as many corporate issues as those of the US Treasury
  - Seniority of bonds varies
  - Bonds have embedded options
  - Fixed coupon payments – interest rate risk is lumped together with credit risk
  - Limited choice of maturities; maturities differ across issues

Credit Default Swap

- CDS is a derivative contract linked to the credit quality of the firm rather than to a specific bond
- It is easy to take long and short positions with a standardized horizon
- Originally, the contract was very simple:
  - Pay fixed premium every quarter
  - In case of a "credit event" deliver a bond of the company, receive face value in exchange
- Over time, the notional amount of CDS became so large that settlement started taking place in cash
  - A bond auction takes place within a month of a credit event to determine the settlement value

CDS premium

- The CDS premium should be equal to credit spread
- Buy a par corporate bond and sell a par Treasury bond of matching maturities
- Cashflows: $s = y - r$ every period + nothing at maturity (face values cancel each other)
- If there is a default: buy back the Treasury at par, and receive recovery on the corporate
- Economically, these cashflows are the same as on CDS contract [selling protection]

Paying the premium

- Historically, literally no upfront payment, just quarterly premiums
- A highly risky name may default before protection seller collects any premiums (over 1000 bps)
  - Require "points upfront" – quotes as [100 - PV of expected cash flows]
- MtM: (Premium − Current Premium) $\times DV01$
- Big Bang protocol of 2009 (Small Bang in Europe):
  - Points upfront and fixed premiums
  - 100 bps for IG
  - 500 bps for SG

Basis trade

- Takes advantage of a disparity between the CDS and credit spreads
- Typically, the basis, $CDS - s > 0$
  - The above replication involves borrowing corporate, which is expensive
  - CDS is higher than it should be when ignoring T-costs
  - A mild positive basis is non-arbitrageable
- Negative basis is attractive because it involves buying the corporates and shorting Treasuries (and buying protection)

Ford CDS Basis

There is life after "credit event"

- Vast majority of bankruptcy cases in the US are reorganization (Ch. 11)
- So, while derivatives go away, "base" securities stay
  - Shares trade OTC or on Pink Sheets
  - Debt, loans
- These securities share common traits:
  - Not traded on exchanges
  - No analyst coverage
  - Many institutions are prohibited from holding them
  - Difficult to value

Distressed trading

- Why buy distressed securities?
  - In general, they are undervalued
- "Automatic" behavior of certain investors depresses the value below intrinsic
  - Institutional investors cannot buy and have to sell them
  - Banks have to hold a lot of regulatory capital against them
- Opaque: analyst coverage declines or vanishes
- Illiquid:
  - before credit event may have huge transaction costs
  - after credit event could be delisted
  - hard to sell and easy to buy on the cheap

Risks

- Long positions that are difficult to hedge
  - Diversification
  - Short a CDS index
- Control rights are important, so need a good team of lawyers to understand what can be done and how it affects valuations
- Timing is important: long resolution may erode annualized returns
- Liquidation risk: reorganization may fail