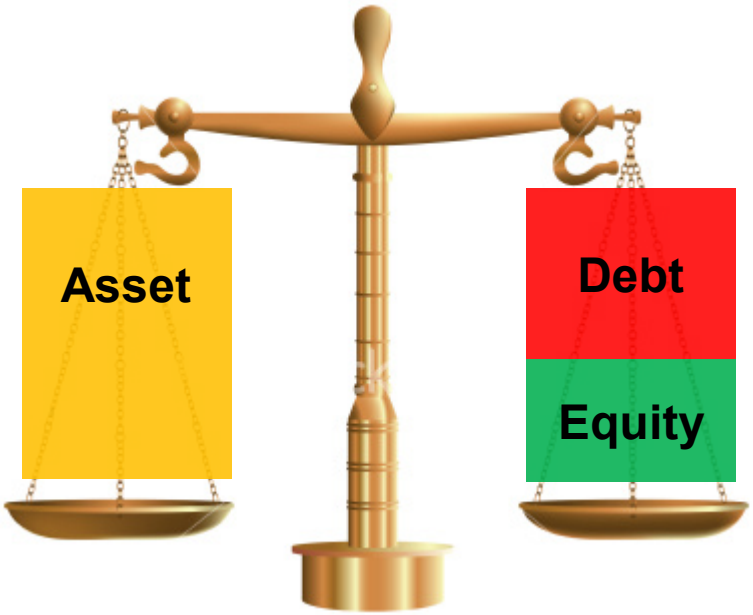
FIN2010 Financial Management
Lecture 6: Bond Pricing

Review—Capital Markets



- Equity Financing:
  - Venture capital
  - Private equity
  - IPO
    - Costs: gross spread, underpricing
  - SEO
- Debt Financing:
  - Private debt
  - Public debt (bond)
    - Credit rating

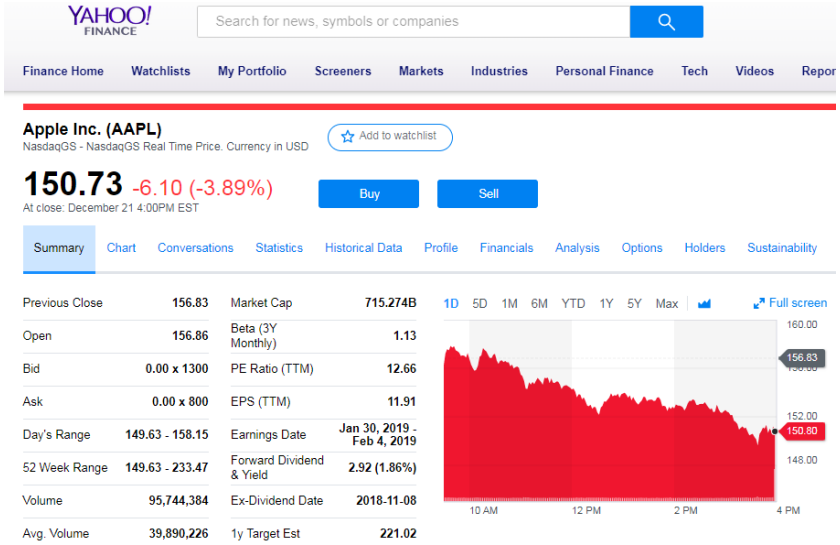
Agenda

- What is asset valuation
- Bond terminologies
- Bond value
- Bond yield
- Determinants of value and yield

Agenda

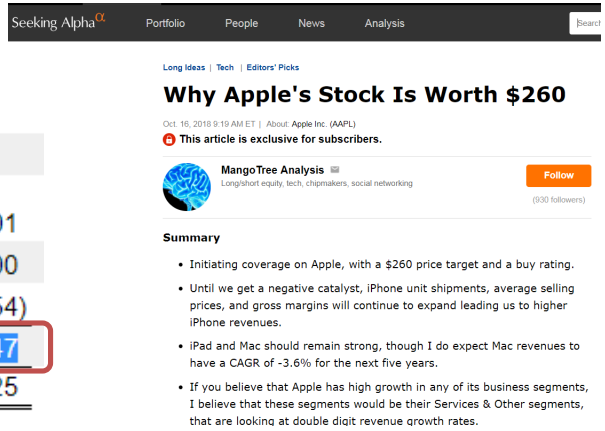
- What is asset valuation
- Bond terminologies
- Bond value
- Bond yield
- Determinants of value and yield

Asset Valuation- What is Value?



Market value = $150.73 per share on 12/21/2018

An analyst on Seeking Alpha believe that fair value should be $260.
There are a thousand Hamlets in a thousand people's eyes.



CONSOLIDATED BALANCE SHEETS
(In millions, except number of shares which are reflected in thousands and par value)

Shareholders' equity:	
Common stock and additional paid-in capital, $0.00001 par value: 12,600,000 shares authorized; 4,754,986 and 5,126,201 shares issued and outstanding, respectively	40,201
Retained earnings	70,400
Accumulated other comprehensive income/(loss)	(3,454)
Total shareholders' equity	107,147
Total liabilities and shareholders' equity	$ 365,725

Book value = 107,147,000,000 / 4,754,986,000 = $22.53 per share

Note: shareholders' equity is in $millions, and number of shares are in thousands according to the balance sheet
Source: https://s22.q4cdn.com/396847794/files/doc_financials/quarterly/2018/Q4/10-K-2018-(As-Filed).pdf

Asset Valuation – Why?

- Asset valuation: the process of determining fair price/value
  - Alternative terms for fair value: fair price/value, fundamental price/value, intrinsic price/value…
- Important decision rules
  - Buyers:
    - Market price <= fair value: buy
    - Market price > fair value: not buy
  - Seller:
    - Market price >= fair value: sell
    - Market price < fair value: not sell

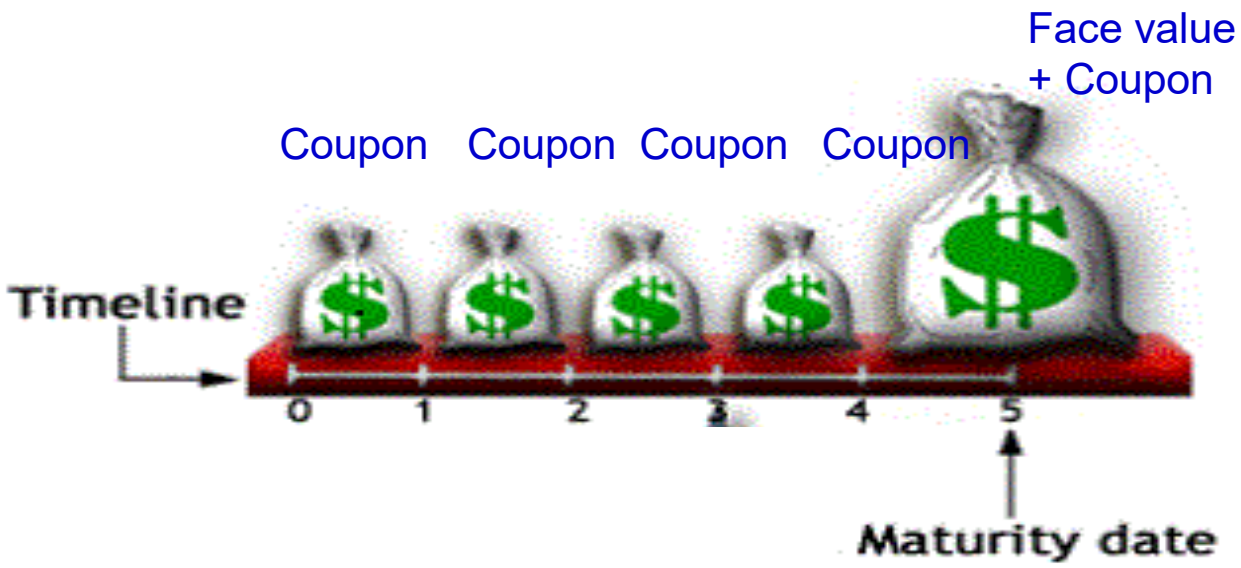
Fair Value and Market Value

- Economics 101:
  - Fair valuation → supply and demand → market price
- How do supply and demand determine prices in an exchange where there is no face-to-face interaction among buyers and sellers?
  - Watch the video of Lecture 13 – Microstructure of the Financial Market

Agenda

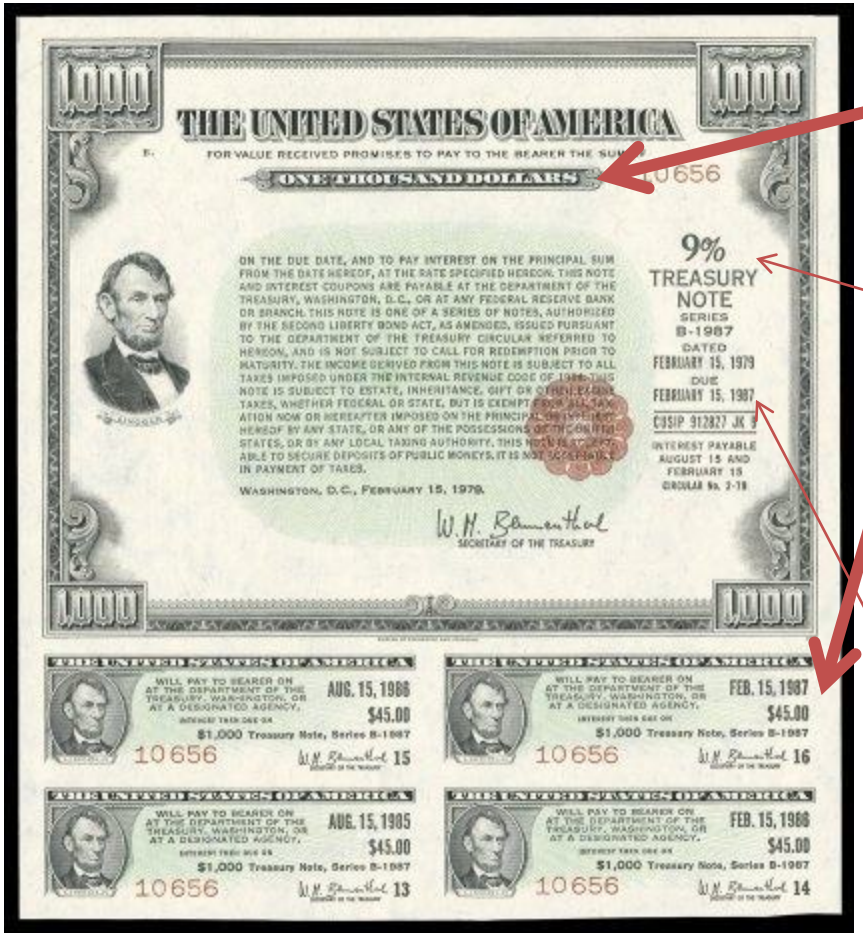
- What is asset valuation
- Bond terminologies
- Bond value
- Bond yield
- Determinants of value and yield

What is Bond?



- Publicly traded debt is also called **bond**
- Depending on who the issuer is, bond can be classified as corporate bond (firms), treasury bond (central government), municipal bond (local government)

Bond Features



Face Value/Par Amount: amount to be repaid as principle

- Note: usually face value ≠ amount the borrower raised, or amount the investor paid

Coupon: interim interest payments, stated in APR

- Coupon rate= Coupon/Par value
- For instance, if a bond with par value of $1,000 pays $90 in interest each year, we say that $90 is the coupon and 9%($80/$1000) is the coupon rate. If the bond makes semiannual payments, there would be a $45 interest payment every 6 months.

Coupon Frequency: how often coupons are paid (semiannual 99% of the times)

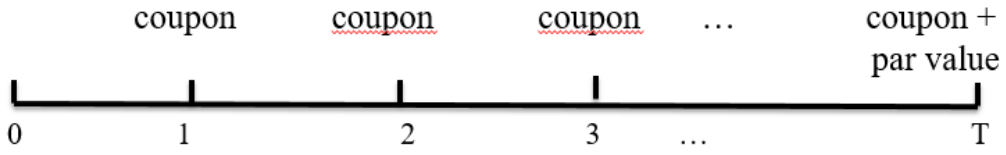
Maturity: date that principle is paid back

Bond Features

- **Rating**: an AAA to D grade indicating credit worthiness of issuer
- **Call provision**: whether the issuer has the option to retire the bond before maturity
  - Treasury debts are not callable. 70% of recent corporate bonds are callable
- **Conversion feature**: whether the lender has the option to convert bond into equity
  - Treasury debts are not convertible. It is very common for small firms/entrepreneurs to use convertible debt
- **Put feature**: the lender has the option to demand early prepayment of principle
  - Treasury debts are not puttable. Less than 1% of corporate bonds are puttable
- **Secured vs Unsecured debt**
  - Whether the bond issue is secured by collateral or not. A secured bond has specific assets pledged to support repayment of the bond.
- …

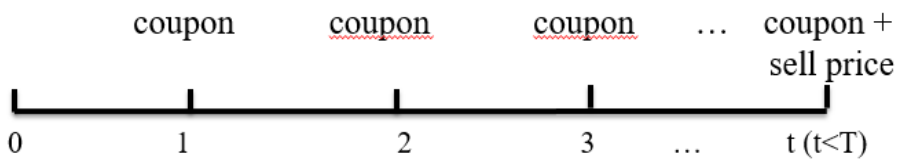
Bond Investment Profits (Losses)

- Source of income: coupon + capital gain/loss
  - Capital gain/loss: price changes
- Investment strategies. Denote maturity as T.
  - Hold until maturity. Denote maturity as T.



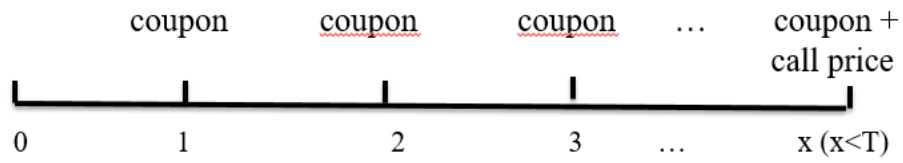
Cash flow : T coupons + part value
Capital gain = par value – purchase price

  - Sell before maturity



Cash flow: t coupons + sell price
Capital gain = sell price – purchase price

  - Hold until call date



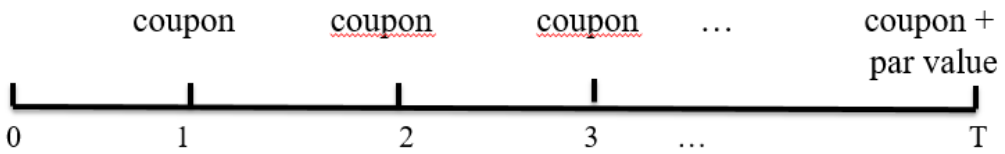
Cash flow: x coupons + call price
Capital gain = call price – purchase price

Agenda

- What is asset valuation
- Bond terminologies
- Bond value
- Bond yield
- Determinants of value and yield

Bond Valuation- 3 Steps

- Determine the future **cash flows**
  - Oftentimes, we assume that we will hold the bond until maturity.



- Determine the appropriate **discount rate** (r)
  - To determine how much we are willing to pay, we need to know how much return we require or the required return.
- Find the present value of future cash flows

What is the Appropriate Discount Rate?

- **What:** required return
- **How:** *often* use similar bonds' return, termed as the market prevailing yield
- **Why:** the law of one price
  - Assumption: arbitrageurs exist in competitive market and they take advantage of the price differences so that these differences disappear quickly
  - If *equivalent* investment opportunities trade simultaneously in competitive markets, then they must offer the same return for investors
  - What determines equivalency:
    - Product market: function and quality etc.
    - Securities market: risk level
  - In summary: securities with similar risk should offer similar returns

Examples- Bond Value

On Jan.1st,2013, AT&T issued a bond with a maturity date of Dec. 31,2032 and a coupon rate of 8.5%. AT&T pays interest every year. Par value is $1,000. The market's yield for a similar debt is 7.5% per year. What is the value of the bond?

Answer:

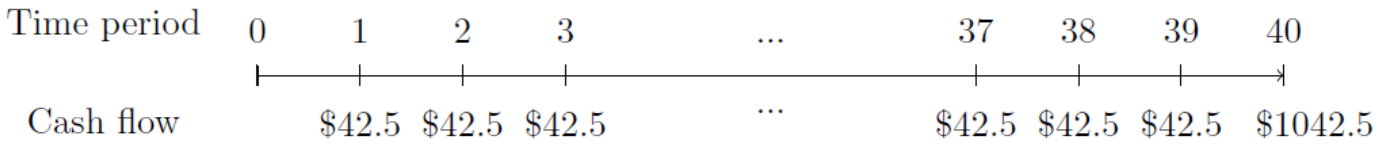
$$\text{Bond value} = \frac{85}{(1+7.5\%)^1} + \frac{85}{(1+7.5\%)^2} + \ldots + \frac{85}{(1+7.5\%)^{20}} + \frac{1000}{(1+7.5\%)^{20}}$$

$$= 85 * \frac{1 - \frac{1}{(1+7.5\%)^{20}}}{7.5\%} + \frac{1000}{(1+7.5\%)^{20}}$$

$$= 1101.94$$

Examples- Bond Value

- In the AT&T example, what if the coupon is paid semi-annually?
- Answer:



$$\text{Bond value} = \frac{42.5}{(1+3.75\%)^1} + \frac{42.5}{(1+3.75\%)^2} + \ldots + \frac{42.5}{(1+3.75\%)^{40}} + \frac{1000}{(1+3.75\%)^{40}}$$

$$= 42.5 * \frac{1 - \frac{1}{(1+3.75\%)^{40}}}{3.75\%} + \frac{1000}{(1+3.75\%)^{40}}$$

$$= 1102.75$$

Examples-Pricing of Zero-Coupon Bond

- **Zero-coupon bonds** have no coupons.
- Suppose you purchased a 15-year zero coupon bond today. The par value is $1,000 and the market prevailing yield for similar bonds is 8%. What is the value of this zero-coupon bond?

$$\text{Value of the bond} = \frac{1000}{(1+8\%)^{15}} = 315$$

- Rather, these securities are sold at a discount from their face values.
- Investors' profit purely come from the capital gain.

Key Relationships in Bond Valuation

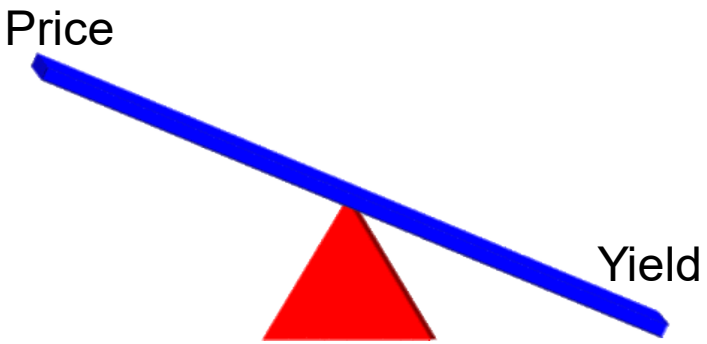
- Example: there are three similar bonds with maturity of 5 years, 3 years, and 1 year. Their coupon rates are all 12%. Please calculate these bonds' prices when the market prevailing yields are 15%,12%, and 9% respectively. The par value is $100, and coupons are paid annually.

Market prevailing yield	year to maturity			
	5	3	1	0
15%				
12%				
9%				
Change in bond's value when yield change from 9% to 15%				

Key Relationships in Bond Valuation

Market prevailing yield	year to maturity			
	5	3	1	0
15%	89.94	93.15	97.39	100.00
12%	100.00	100.00	100.00	100.00
9%	111.67	107.59	102.75	100.00
Change in bond's value when yield change from 9% to 15%	-19%	-13%	-5%	0

- When yield goes up, price goes down.
  - When yield=coupon, price=100
    - The bond is traded at par
  - When yield>coupon, price<100
    - The bond is traded at a discount
  - When yield<coupon, price>100
    - The bond is traded at a premium
  - For a zero coupon bond, price<100



- **Long term bonds** have **greater** interest-rate risk than short-term bonds.

Agenda

- What is asset valuation
- Bond terminologies
- Bond value
- Bond yield
- Determinants of value and yield

Bond Yield

- Definition: the return investors can expect from bond investment should they purchase the bond at the market price
  - It is the discount rate that sets the present value of the promised bond payments equal to the current market price of the bond.
  - Same as the IRR concept in lecture 3.
  - Note: bond yields are **quoted as APRs**

- Different types of yield
  - Yield to maturity(YTM): measures investors' annual expected return when the bond is ***held until maturity date*** and the firm makes all the promised payments. Our focus!

$$Market\ price = PV = Coupon * \frac{1 - \frac{1}{(1+r)^t}}{r} + \frac{par\ value}{(1+r)^t}$$

$$so \quad r = ?, APR = ?$$

  - Yield to call (YTC): investors' annual expected return when they expect to ***hold the bond until the first call date***
  - Investors' annual expected return when they expect to ***sell the bond before the maturity date.***

Format of Bond's Market Prices

- Market price → yield
- Par value: usually in denomination (smallest unit one can buy) of $1000 (US) or ￥100 (China)
- Quoted price (报价): percentage points of the par value

证券代码	证券简称	最新	涨跌幅	涨跌	成交量(手)
122015	09长电债	101.11	0.00%	0.00	0
122017	09大唐债	100.87	0.00%	0.00	0
122019	09中交G2	101.09	0.00%	0.00	0
122046	10中铁G2	101.57	0.24%	0.24	70
122052	10石化02	100.90	0.00%	0.00	0
122054	10中铁G3	100.70	0.00%	0.00	0
122055	10中铁G4	101.00	0.00%	0.00	0
122057	10龙源02	100.00	0.00%	0.00	0
122062	11西矿02	99.00	0.00%	0.00	0
122064	11龙源02	108.35	0.00%	0.00	0
122066	11大唐01	103.17	0.00%	0.00	0
122071	11海航02	94.19	0.31%	0.29	202

Market price = 101.57%*￥100 = ￥101.57

Treasury Notes and Bonds				
Maturity	Coupon	Bid	Asked	Chg
2015 May 15	4.125	110:06	110:07	−6
2016 Feb 15	4.500	111:29	111:30	−10
2016 May 15	5.125	115:02	115:04	−12
2016 Nov 30	2.750	102:00	102:02	−14
2017 Feb 28	3.000	103:00	103:01	−15
2017 May 15	8.750	136:24	136:27	−20
2017 Jul 31	2.375	98:17	98:18	−16
2017 Aug 15	4.750	113:02	113:03	−19
2018 Aug 15	4.000	107:25	107:27	−22
2018 Nov 15	3.750	105:26	105:27	−21
2018 Nov 15	9.000	143:09	143:12	−28
2019 Feb 15	2.750	98:05	98:06	−22
2019 May 15	3.125	100:15	100:15	−22
2019 Aug 15	3.625	103:25	103:26	−24
2019 Aug 15	8.125	138:12	138:15	−30
2019 Nov 15	3.375	101:14	101:15	−24
2020 Feb 15	3.625	103:01	103:01	−26
2020 May 15	3.500	101:17	101:18	−26
2020 Aug 15	2.625	93:28	93:29	−26
2020 Aug 15	8.750	145:01	145:04	−33

Example- YTM with Annual Coupons

- Consider a bond with a 10% annual coupon rate and 15 years to maturity. The current price is 92.81.

- Will the yield be more or less than 10%?
- Solution:

$$92.81 = 10 * \left[\frac{1 - \frac{1}{(1+r)^{15}}}{\mathrm{r}} \right] + \frac{100}{(1+\mathrm{r})^{15}}$$

$$\mathrm{r} = 11\%$$

Example-YTM with Semiannual Coupons

- Suppose a bond with a 10% coupon rate and semiannual coupons, 20 years to maturity and is selling for $119.79.
- Is the YTM more or less than 10%?

- Solution:

$$119.79 = 5 * \left[\frac{1 - \frac{1}{(1+r)^{40}}}{\mathrm{r}} \right] + \frac{100}{(1+\mathrm{r})^{40}} \Rightarrow \mathrm{r} = 4\%$$

YTM = 4%*2 = 8%

YTM and the Realized Return

- Assumptions in YTM:
  - 1. Investors hold the bond till maturity
  - 2. Firms make all promised payments
  - 3. All coupon payments are reinvested at the same rate as the bond's current yield (YTM)
- *In reality, these assumptions could be violated. Thus, your actual return may differ from YTM*
- Returns from investing in bonds are often uncertain even though bonds are "fixed-income" assets!

YTM and the Realized Return

- In the example on page 25, what if the firm go bankrupt in the 15th year (after the 30th coupon payment) and default on the remaining coupons and par value? **Assumption 2 violated.**
  - $119.79 = 5 * \left[\frac{1-\frac{1}{(1+r)30}}{r}\right] + \frac{0}{(1+r)40} \Rightarrow r = 1.52\%$
  - Actual yield = 3.04%
- Using the same example, suppose the firm makes all the promised payment. However, when you receive the coupons, you cannot find a good place to invest, so you put them in the bank which generates 5% per year. How much do you have after 20 years? What is your investment return (actual yield) per year? **Assumption 3 violated.**
  - $FV = 5\frac{1.025^{40}-1}{2.5\%} + 100 = 437.01$
  - Return per half year $= \left(\frac{437.01}{119.79}\right)^{1/40} - 1 = 3.29\%$, actual yield = 6.58%
- Note yields in both scenarios are not equal to the yield, which is 8%.

Agenda

- What is asset valuation
- Bond terminologies
- Bond value
- Bond yield
- Determinants of value and yield

Prices (Yield) Vary across Time and Bond

证券代码	证券简称	最新	涨跌幅	涨跌	成交量(手)
122015	09长电债	101.11	0.00%	0.00	0
122017	09大唐债	100.87	0.00%	0.00	0
122019	09中交G2	101.09	0.00%	0.00	0
122046	10中铁G2	101.57	0.24%	0.24	70
122052	10石化02	100.90	0.00%	0.00	0
122054	10中铁G3	100.70	0.00%	0.00	0
122055	10中铁G4	101.00	0.00%	0.00	0
122057	10龙源02	100.00	0.00%	0.00	0
122062	11西矿02	99.00	0.00%	0.00	0
122064	11龙源02	108.35	0.00%	0.00	0
122066	11大唐01	103.17	0.00%	0.00	0
122071	11海航02	94.19	0.31%	0.29	202

- Example: Microsoft Corp. US dollar bond, issued on Sep 22, 2010, maturity date April 2040, coupon rate 4.5%, price at offering was 98.91.
- The prices vary for the same bond over time

- The prices vary across bonds at the same time.
- Why?

Data source: FINRA

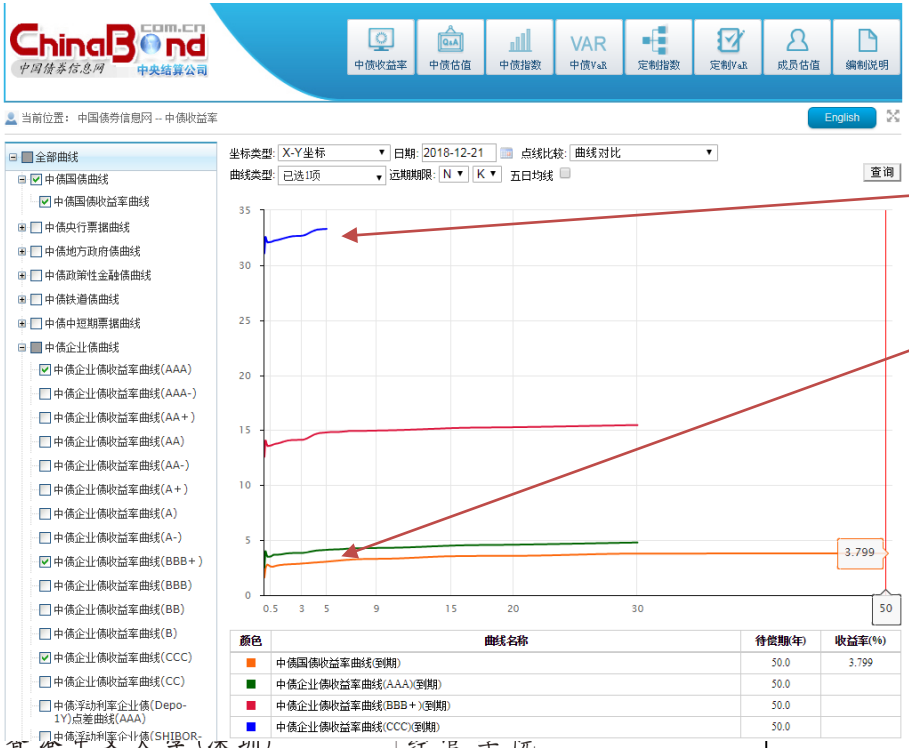
Determinants of Bond Prices and Yield

- Bond prices vary over time and across industries although bonds are called “fixed-income” assets

- Fair valuations, market prices, and yield vary with:
  - Promised cash flow streams
  - Required return. Generally, higher risk → higher return. Risk can come from
    - Interest rate risk
    - Default risk
    - Liquidity risk (may not be able to sell the bond at a reasonable price when needed.)
    - Call feature
    - Reinvestment risk (coupon reinvested as unknown interest rate)
    - Maturity
    - Will have an in-depth discussion of risk and return relationship in lecture 8-10.

Default Risk and Bond Prices

- Definition: the chance that the issuer will default on interest or principal payments
- Holding all else equal, higher default risk → lower price and higher yield
  - By saying holding all else equal, we pull out the effect of all other factors
- The difference between the yields of the corporate bonds and the treasury (safest bond) yields is the **default spread** or **credit spread**



Credit spread is high for bonds with low ratings.

e.g., yield spread between treasury bond and CCC corporate bond

Example – Bond Issuance

- A firm would like to issue a 5-year 4.5% coupon (annual payments) bonds with par value equal to $10 million. Currently the 5-year 3% coupon government bond is traded at par. The following table summarizes the credit spreads for bonds of various ratings:

Rating	AAA	AA	A	BBB	BB
Credit Spread	0.70%	0.90%	1.10%	1.50%	2.00%

- Assuming the bonds will be rated AA, how much money can they raise?

- **Solution:**
  - Yield for 5-year government bond is 3%
  - Yield for this bond should be 3%+0.9%=3.9%
  - $Price = 4.5\frac{1-1.039^{-5}}{3.9\%} + 100(1.039)^{-5} = 102.6786$
    That is, they can raise (investors are willing to pay) $10.27 million

Call Provisions and Bond Prices

- Some bonds have call provisions, which grant the borrowers the options to pay back the debt earlier than the maturity date
  - Option: the borrower can choose to call or not to call
  - Timing: either any time or on specific dates
  - Call price: often higher than par value

- When would the borrower want to exercise the call?
  - When
    - Market prevailing yield declines
    - Credit quality of the borrower improves
  - Reason: borrower can now issue a new debt paying a lower interest rate. Why keep paying the higher interest rate for the previous debt?
- Who benefits? How does call provisions affect asset prices?
  - Borrowers benefit. Investors suffer. Therefore, investors willing to pay less for callable bonds than non-callable bonds, everything else equal.

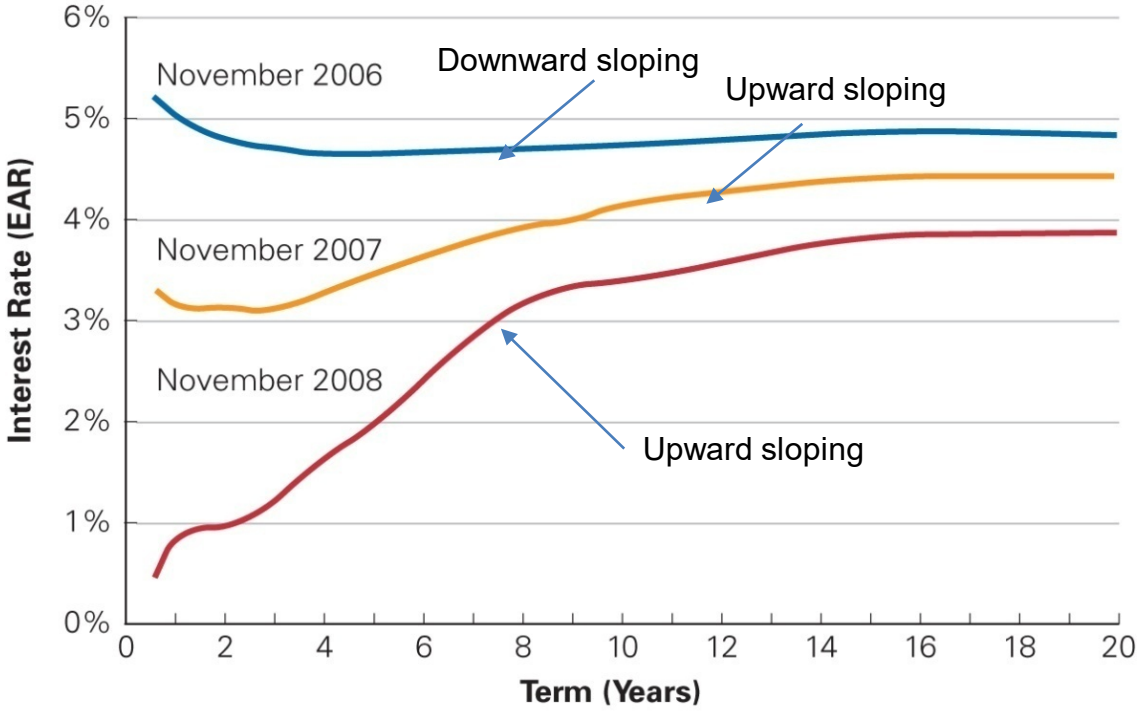
Time to Maturity and Yield

- Holding all else equal, the relationship between time to maturity and yields is called term structure.
- Time-to-maturity has a huge impact on yield through affecting interest rate risk, inflation risk, liquidity risk…
- Yield curve – graphical representation of the term structure
  - The yield curve is usually upward-sloping, meaning long-term yields are higher than short-term yields
  - Sometimes, it can also be downward-sloping, long-term yields are lower than short-term yields
  - Exactly why the curve display a certain shape is beyond the scope of this lecture. If you are interested, please take Fixed Income

Yield Curve in Reality

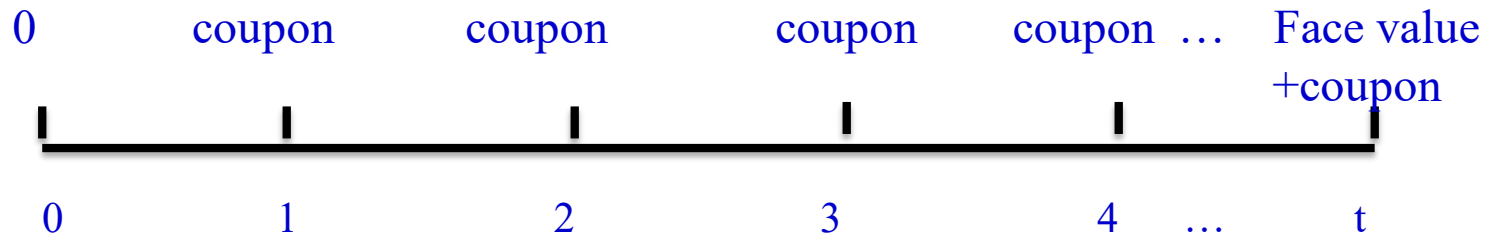
Figure: Term Structure of Risk-Free U.S. Interest Rates, November 2006, 2007, and 2008

Term (years)	Date Nov-06	Nov-07	Nov-08
0.5	5.23%	3.32%	0.47%
1	4.99%	3.16%	0.91%
2	4.80%	3.16%	0.98%
3	4.72%	3.12%	1.26%
4	4.63%	3.34%	1.69%
5	4.64%	3.48%	2.01%
6	4.65%	3.63%	2.49%
7	4.66%	3.79%	2.90%
8	4.69%	3.96%	3.21%
9	4.70%	4.00%	3.38%
10	4.73%	4.18%	3.41%
15	4.89%	4.44%	3.86%
20	4.87%	4.45%	3.87%



Summary

- Bond:



- Price = PV (coupons + principal)
- Yield: discount rate that equates the PV (CF) and the price
  - Expressed in APR
  - Yield ↑⇒ price ↓
  - Yield-to-maturity is often not the same as the investment return
- Determinants of prices and yield