Corporate Finance

Lecture 5: Bond Valuation

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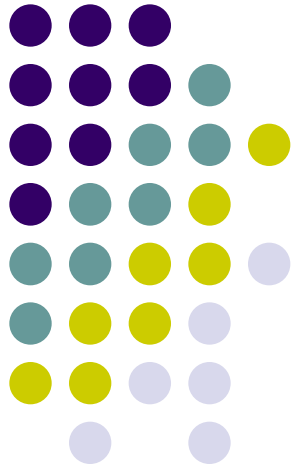

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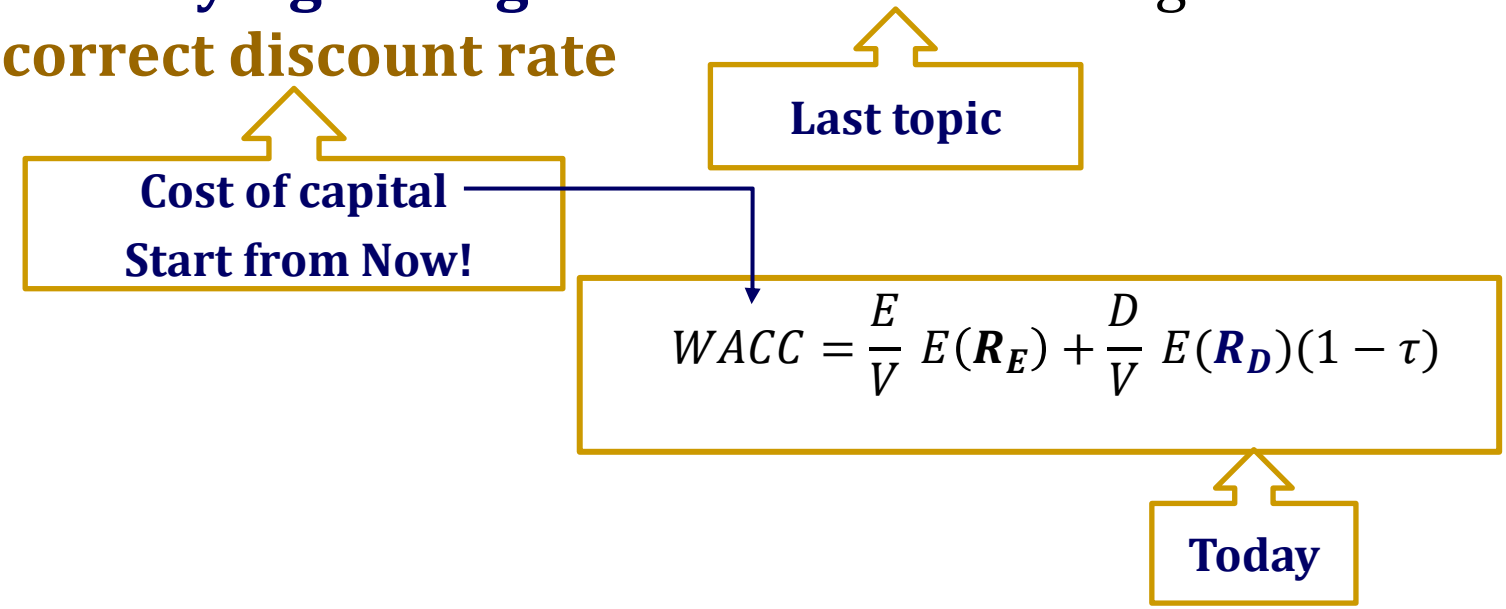
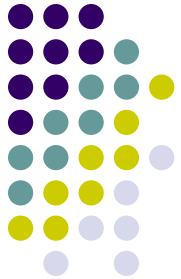
Where we are

NPV is the right **capital budgeting** technique

- Tells us if a particular project is a good investment
- But you must make sure you are using it correctly by **identifying the right cash flows** and using the **correct discount rate**



Review of Key Points

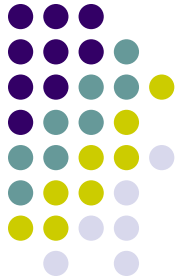


- Security Price = PV of Cash Flows
  - Investing in a financial assets gives zero NPV.
- Return, expected return, and discount rate

Return

- Definition of the return on a financial asset
  - *Actual/Realized* vs. *Expected* Return
- Suppose price of a financial asset today is P_0
- Buying the asset costs P_0.
- At the end of the year, I get a cash amount C_1 and the price of the asset is P_1.
- Return = $\frac{C_1+P_1-P_0}{P_0} = \frac{C_1}{P_0} + \frac{P_1-P_0}{P_0}$
- **Return = Cash Yield + Capital Gain Yield**

Expected Return



- Expectation of future return from the investment, i.e. C_1 and P_1 are in "expected terms"
- Expected return = E $\left(\frac{C_1+P_1-P_0}{P_0}\right) = \frac{E(C_1)}{P_0} + \frac{E(P_1)-P_0}{P_0}$
- **Expected Return = Expected Cash Yield + Expected Capital Gain Yield**

- Expected return is the same as the discount rate for the asset's cash flows!
- Why? By definition

Expected Return = Discount Rate

- $P_0 = \frac{E(C_1)+E(P_1)}{1+r}$, where r is the discount rate
- Rearranging terms, r = $\frac{E(C_1) + E(P_1)-P_0}{P_0}$
- Which is the definition of expected return

- Simple definition and proof, but very useful and important for finance

- Expected return = required discount rate
  = cost of capital

Determination of discount rate

- Time value of money
  - Discount rate compensates for people's preference for money today over money tomorrow
- Inflation
- Risk

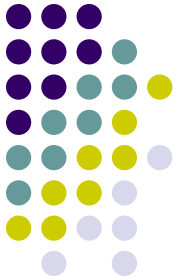
Determination of discount rate

- Time value of money
- Inflation
  - Real interest rate (r) = Nominal interest rate – inflation
    - Derived from Fisher equation:
    - Real Quantity = Nominal Quantity / Price
    - 1 + Nominal Interest Rate = (1 + Real Interest Rate)*(1+Inf)
- Risk-free rate reflects inflation and time value of money
- Risk

Fisher equation:

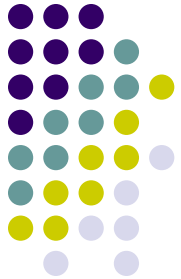
- $1 + i = (1 + r)(1 + \pi)$
- $i \approx r + \pi$

Determination of discount rate



- Time value of money
- Inflation
- Risk
  - Covariance, relative movement as compared with the rest of the economy
  - CAPM, to be discussed

Bonds: outlines



- Basic lingo in the bond market
- Yield to maturity vs. Current yield vs. Coupon rate
- Interest rate quotation
- Interest rate risk & Duration
- Credit risk & credit rating

Bond

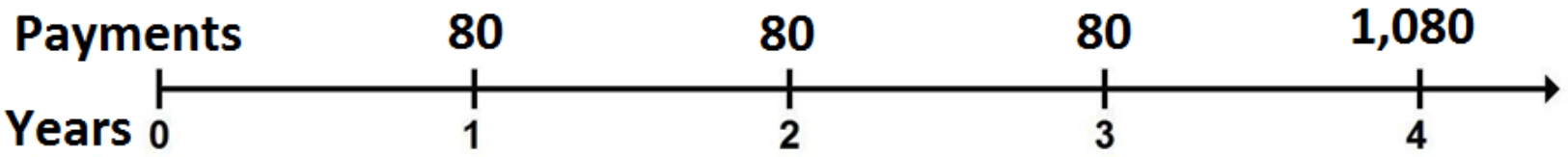
- A bond is a debt instrument requiring the borrower (i.e., **issuer**) to repay to the lender (i.e., **bondholder**) the amount borrowed (**principal**) plus interest over a specific period of time.
- The bondholder generally receives a fixed interest payment, (**coupon**), each period until the bond matures

Lingo

- **Face value/par value/principal (F) is** the amount of a bond that is repaid at the maturity
- **Coupon (C)** is the regular interest payment until maturity
- **Coupon rate** is the annual coupon payment as a percentage of face value **(C/F)**
- **Maturity (T)** is the specified date on which the last payment (face value) on the bond is made
- **Price (P)** is the traded value of the bond

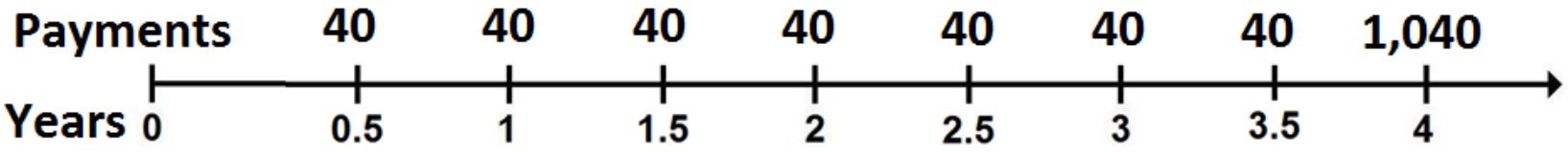
Example

If a bond has four years to maturity, a 8% annual coupon rate, and a $1000 face value, its cash flows would look like this:

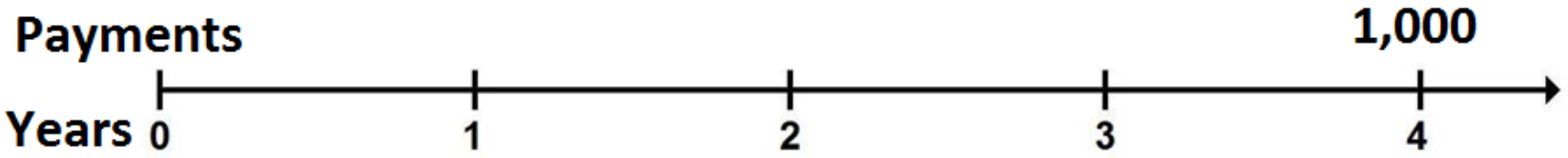


Other Examples

Could be **semi-annual** coupons:



Could be no coupon at all (**zero-coupon bond**):



Bond Price

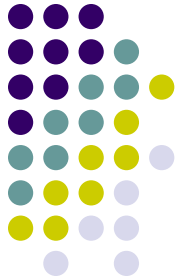
- **Bond price** is the present value of all cash flows discounted at **the required rate of return**

$$P = \frac{C}{(1+r)} + \frac{C}{(1+r)^2} + \ldots + \frac{C+F}{(1+r)^T}$$

$$P = \frac{C}{r}\left(1 - \frac{1}{(1+r)^T}\right) + \frac{F}{(1+r)^T}$$

- How is r determined?
  - Time value of money, Risk & Inflation

Yield to Maturity (YTM)



- YTM is the discount rate used to price the bond.
- YTM is also the expected return of investing in the bond.
- Find the discount rate from the price of bond.
  - Note that P is observed from the market, C is contractually fixed, and the time to maturity "t" is also known.
  - One can then solve for the discount rate → called YTM
  - Excel: IRR(-P,C,C,C…,C+F)

Exercise

Ch8-5 Valuing Bonds A German company issues a bond with a par value of €1,000, 15 years to maturity, and a coupon rate of 5.1 percent paid annually. If the yield to maturity is 4.3 percent, what is the current price of the bond?

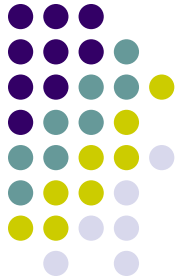
$$P = \frac{(1000 \times 5.1)}{4.3\%} \times \left(1 - \frac{1}{(1+4.3\%)^{15}}\right) + 1000 \times \frac{1}{(1+4.3\%)^{15}}$$

$$P = 1087.11$$

Key Points

- For a company planning to raise capital by issuing bonds, the **YTM** is the relevant **cost of debt**.
  - If the YTM is 8%, bondholders must be *promised an expected return* of 8%.
  - The interest cost of debt (before taxes) is 8%.
- Other interest rates of a bond:
  - Current yield = C/P;
  - Coupon rate = C/F.
- The relationship:
  - If a bond is selling at par (P = F), YTM = Current Yield = Coupon Rate
  - If a bond is selling at a premium (P>F) or discount (P<F), the YTM is different from the current yield and coupon rate.

YTM vs. Current Yield



- **Expected return = Expected Cash Yield + Expected Capital Gains**
- Intuitively, consider a bond with maturity = 1:
  - Expected return = YTM
  - Cash Yield = C/P → *current yield*
  - YTM = current yield, only if the expected capital gain = 0. This is only true if a bond is selling at par (P=F).
- Relation between P and F:
  - Selling at par (P=F), if YTM = current yield;
  - Selling at a premium (P>F), the expected capital gain is negative, and current yield > YTM.
  - Selling at a discount (P<F), the expected capital gain is positive, and current yield < YTM.

YTM vs. Coupon Rate

$$P > F \Leftrightarrow \frac{C}{YTM}\left[1 - \frac{1}{(1+YTM)^T}\right] + \frac{F}{(1+YTM)^T} > F$$

$$\Leftrightarrow \frac{C}{YTM}\left[1 - \frac{1}{(1+YTM)^T}\right] - F \times \left[1 - \frac{1}{(1+YTM)^T}\right] > 0$$

$$\Leftrightarrow \left[\frac{C}{YTM} - F\right]\left[1 - \frac{1}{(1+YTM)^T}\right] > 0$$

$$\Leftrightarrow \frac{C}{YTM} - F > 0 \Leftrightarrow \frac{C}{F} > YTM$$

Example

What is the YTM on the bond with 4 years to maturity, a 8% annual coupon rate, a $1000 face value, that sells at $1050?

$$1050 = \frac{80}{(1+\text{YTM})} + \frac{80}{(1+\text{YTM})^2} + \frac{80}{(1+\text{YTM})^3} + \frac{1080}{(1+\text{YTM})^4}$$

Using IRR function, we find YTM is 6.54%.

Current Yield = 80/1050 = 7.6%.

Selling at premium (P>F):

- Current Yield > YTM
- Coupon rate > YTM

P vs. F

- Most bonds are issued at par:
  - At issuance, YTM=Coupon Rate & P= F
  - After that, C, F, & T are fixed, but r fluctuates. So P moves around.
- Zero coupon bonds always trade below par. (why?)
- "Pull to par" effect:
  - If bond's risk does not change, as maturity date approaches, the price of the bond approaches the face value. (why?)

Interest Rate Quotation

- Interest rates are usually quoted on annual basis
  - If coupons are paid multiple times per year, we usually *annualize* the "per-period" interest rate
  - E.g., a semiannual bond that pays $40 per 6 months with face value of $1000 is called "8% semiannual coupon bond"
- **Annual Percentage Rate (APR)**
  - Rate quoted by banks, credit cards, mortgages, etc.
  - Omits the compounding of interest within a year.
- **Effective Annual Rate (EAR)**
  - The compounded interest rate actually paid per year.
  - Suppose n coupons are paid per year

$$(1 + \text{EAR}) = \left(1 + \frac{\text{APR}}{n}\right)^n$$

Example

- 8% semi-annual bond with 2 years to maturity and face value of $1000.
  - 8% is the coupon rate quoted as APR;
  - The bond pays 1000 x 4% = $40 every half year;
  - Effective Annual Rate $= (1 + 4\%)^2 - 1 = 8.16\%$.
- What is the YTM, if the bond price is $964.54?
  - Note that YTM is quoted also as APR

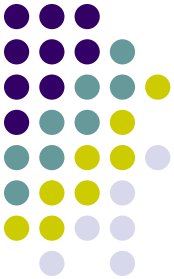
$$\$964.54 = \frac{40}{(1+\text{YTM}/2)} + \frac{40}{(1+\text{YTM}/2)^2} + \frac{40}{(1+\text{YTM}/2)^3} + \frac{1040}{(1+\text{YTM}/2)^4}$$

Exercise

Ch8-25 Using Bond Quotes Suppose the following bond quote for IOU Corporation appears in the financial page of today's newspaper. Assume the bond has a face value of $1,000, it makes semiannual coupon payments, and the current date is April 15, 2019. The coupon rate is APR. What is the yield to maturity of the bond? What is the current yield?

Company (Ticker)	Coupon	Maturity	Last Price	Last Yield	EST Vol (000s)
IOU (IOU)	7.240	Apr 15, 2031	964.12	??	1,827

Exercise

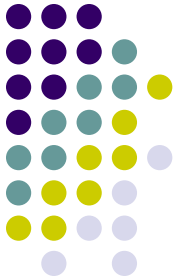


- Time to maturity: T = 12 years
- Coupon Payment (semiannual) C = 1000 x 7.24% x 0.5 = $36.2
- Bond Price P = $964.12
- Cash flows: -964.12, +36.2, +36.2, … +1036.2 (from t=0 to t=24)
- IRR = 3.852% (need to use excel or financial calculator)
- YTM is the annualized semiannual interest rate:

  YTM = 3.852% x 2 = 7.7%
- Current Yield = Annual Coupon Payment/ Bond price

  Current Yield = 72.4 / 964.12 = 7.51%
- Double check:
  - Bond price < Par value ↔ YTM > Coupon Rate
  - Bond price < Par value ↔ YTM > Current Yield

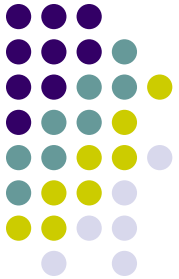
Risks that Affect Bond Yields and Prices



- Credit risk/default risk
- Interest risk

- Prepayment risk
- Rollover risk

Credit Risk



- The **risk** associated with **the issuer failing** to satisfy the terms of the obligation with respect to the timely payment of interest and face value.
- Which $1,000 bond trade at a higher price (lower yield)?
  - US Government bond 5-year, 5% coupon
  - Corporate bond 5-year, 5% coupon
- Both bonds have the same promised payments.
- But the corporate bond has lower expected payments due to the (higher) risk of default.

Credit Risk

- Two determinants
  - Probability that default occurs
  - Recovery rate (salvage value for bondholders)
    - Depends on bond characteristics (seniority, collateral, etc.) and the type of firm's assets
- **YTM = Risk-free Rate + Credit Spread**
  - Credit spread determined in the market
  - In practice, often reference credit spread for similarly risky bonds
  - The higher credit risk, the higher credit spread

Bond ratings

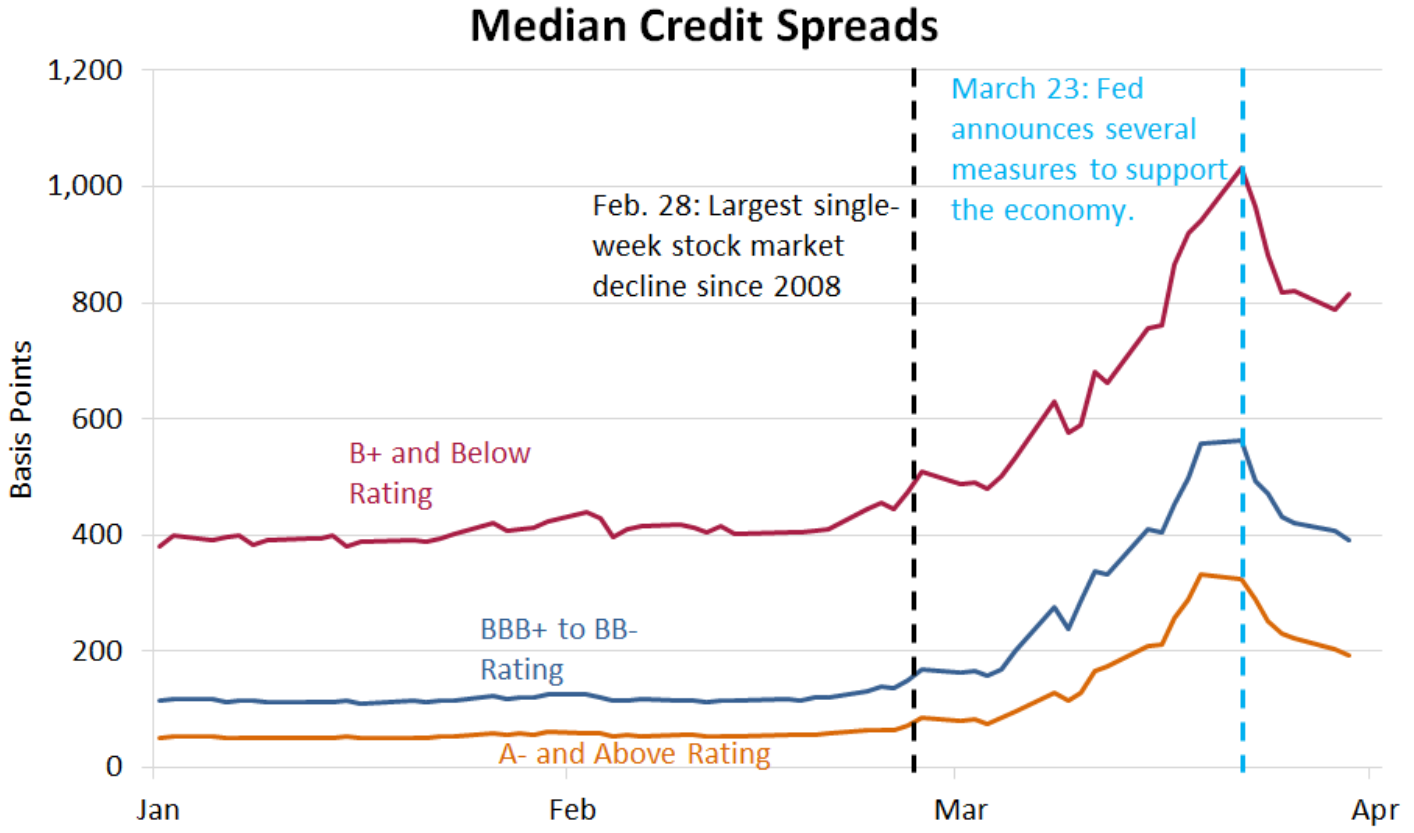
- Letter grade assigned by a rating agency reflecting the credit risk
  - Moody's, Standard & Poor's, and Fitch
  - China: 中诚信, 上海新世纪, 联合资信, 大公资信, 中正鹏元

- Less default risk ⟶ higher ratings ⟶ lower credit spreads

Rating:	AAA	AA	A	BBB	BB	B	CCC	CC-C
Default Rate:								
Average	0.0%	0.0%	0.2%	0.4%	2.1%	5.2%	9.9%	12.9%
In Recessions	0.0%	1.0%	3.0%	3.0%	8.0%	16.0%	43.0%	79.0%

Source: "Corporate Defaults and Recovery Rates, 1920–2008," *Moody's Global Credit Policy*, February 2009.

Credit spread reflects economic risk

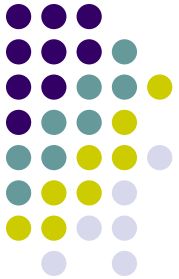


NOTES: For the credit spread, the authors combined bond prices from TRACE (FINRA) with bond-level information from Mergent FISD and applied methodology from the 2012 paper "Credit Spreads and Business Cycle Fluctuations" by economists Simon Gilchrist and Egon Zakrajsek.
SOURCES: TRACE (FINRA), Mergent FISD and authors' calculations.

Ratings

Moody's	S&P	Fitch	Description
Aaa	AAA	AAA	Prime, maximum safety
Aa1 to Aa3	AA+ to AA-	AA+ to AA-	High grade, high quality, superior
A1 to A3	A+ to A-	A+ to A-	Upper medium grade, satisfactory
Baa1 to Baa3	BBB+ to BBB-	BBB+ to BBB-	Lower medium grade, adequate
Ba1	BB+	BB+	Non-investment grade
Ba2 to Ba3	BB to BB-	BB to BB-	Speculative
B1 to B3	B+ to B-	B+ to B-	Highly speculative
Caa1	CCC+	CCC+	Substantial risks, very highly speculative
Caa2 to Caa3	CCC to CCC-	CCC to CCC-	In poor standing, very highly speculative
Ca	-	-	Extremely speculative
C	-	-	May be in default
-	D	DDD to D	In default

Grades



Investment grade

- Aaa to Baa3 (Moody's), AAA to BBB (S&P, Fitch)
- Some institutional investors can only hold these bond

Non-investment grade(junk)

- Ba1 and below (Moody's), BB+ and below (S&P, Fitch)

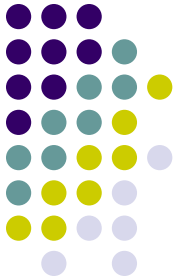
Fallen angels

- Bond downgraded from investment grade to junk

Rising stars

- Bonds upgraded from junk to investment grad

Interest Rate Risk



- The fluctuation in financial asset prices due to changes in interest rates.
- This risk is present even if the bond issuer has no default risk.
  - Risk-free rate (treasury rate) moves around.
- Different bonds are affected differently.
  - Long-term bonds more risky than short-term bonds.
  - Low coupon rate bonds more risky than high coupon rate bonds.
- How to gauge a bond's price sensitivity to interest rate risk?

Duration

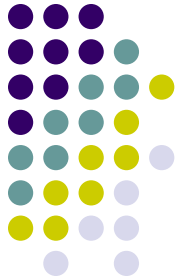
- Duration measures the % change in bond price for a 1% change in the gross yield.

$$D = \frac{-dP/P}{d(1+r)/(1+r)}$$

- Zero coupon bond: $P = \frac{F}{(1+r)^T} \leftrightarrow D = T$
- Coupon bond:
  - Consider it as a package of zero coupon bonds.
  - Duration is the weighted average of T of each zero bond, PV as the weight.

$$D = \frac{1}{P} \times \left[1 \times \frac{C}{1+r} + 2 \times \frac{C}{(1+r)^2} + \ldots + T \times \frac{C+F}{(1+r)^T} \right]$$

Takeaways



- Bond value is equal to the discounted coupon payments and face value (P=PV)
- The discount rate setting P=PV is called Yield-to-Maturity
- Duration measures the price sensitivity to interest rate of bond.
- YTM = Risk-free rate + Credit spread