Chapter 9
Bond Prices and Yield

Debt Classes: Payment Type

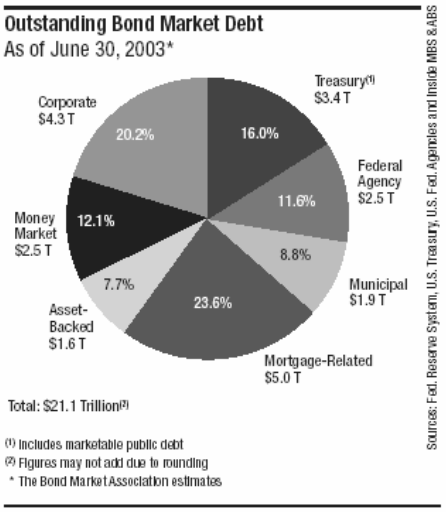
- A security obligating issuer to pay interests and principal to the holder on specified dates,
  - Coupon rate or interest rate, e.g. 4%, 5 3/4%, etc.
  - Face, par value or principal payment, e.g. $1000
  - Maturity, e.g. 3 month, 1 year, 30 year, etc.
- Bond can be classified according to its attributes
  - Payment type, e.g. semi-annual coupon
  - Issuer, e.g. government, agency, corporate, etc.
  - Maturity, e.g. short, medium, long, etc.
  - Security, e.g. secured, unsecured, etc.

Debt Classes: Payment Type

- Pure discount bond or zero-coupon bond
  - No coupon payments prior to maturity
  - Bond's face value paid at maturity
- Coupon bond
  - A stated coupon paid periodically prior to maturity.
  - Bond's face value paid at maturity
- Perpetual (Consol) bond
  - A stated coupon paid at periodic intervals forever
- Self-amortizing bond
  - Certain amount of principal paid at each period
  - No balloon payment at maturity

Debt Classes: Issuers

- End of Q2:2003



Debt Classes: Corporate Bonds

- Credit Rating

Moody	S&P	Quality of Issue
Aaa	AAA	Highest quality. Very small risk of default.
Aa	AA	High quality. Small risk of default.
A	A	High-Medium quality. Strong attributes, but potentially vulnerable.
Baa	BBB	Medium quality. Currently adequate, but potentially unreliable.
Ba	BB	Some speculative element. Long-run prospects questionable.
B	B	Able to pay currently, but at risk of default in the future.
Caa	CCC	Poor quality. Clear danger of default .
Ca	CC	High specullative quality. May be in default.
C	C	Lowest rated. Poor prospects of repayment.
D	-	In default.

Source of Risks for Bond Holders

- Interest rate risk (Market risk)
  - The major factor affecting bond prices
  - The price of bond changes in the opposite direction of interest rate change
  - All bonds are exposed to interest rate risk
- Inflation risk
  - Inflation reduces purchasing power
  - Partially captured by market interest rate
  - All bonds are exposed to inflation risk, though floating-rate and inflation-indexed ones are to a lesser degree

Source of Risks

- Credit risk
  - Inability of issuer to pay coupon and/or principal
  - Corporate
  - Emerging market
  - High-yield bonds
- Liquidity risk
  - Inability to unload position without substantial costs
  - Municipal, corporate, and emerging market bond

Bond Pricing

- Discounted cash flow approach
  - Identify cash flows in coupon and principal payment
  - Apply *one* discount rate (market interest rate / yield-to-maturity) to discount all future cash flows
- Quoting conventions for bond coupon rates
  - *APR* (annual percentage rates)
    - Also called *BEY* (bond equivalent yields)
    - *APR* / # of periods per year = rate per-period
- Convert *APR* to *EAY* (effective annual yield)
  - *EAY* accounts for compounded interest
  - $1+EAY=(1+\text{rate per period})^n = (1+APR/n)^n$

Bond Pricing

- Bond Value, *P*

$$P = \frac{C}{(1+r)} + \frac{C}{(1+r)^2} + \cdots + \frac{C}{(1+r)^T} + \frac{F}{(1+r)^T}$$
$$= \sum_{t=1}^{T} \frac{C}{(1+r)^t} + \frac{F}{(1+r)^T} = \frac{C}{r} \times [1 - \frac{1}{(1+r)^T}] + \frac{F}{(1+r)^T}$$

  - *C*: Coupon *per period* in dollars
  - *r* : Interest rate (discount rate) *per period*
  - Price of a 8% semi-annual coupon 30 year T-bond?
    - *F* = $1,000, *C* = $40, *T* = 60
    - When market interest rate is 8%, *r* = 4%, then *P* =?
    - When market interest rate is 10%, *r* = 5%, then *P* =?

Bond Pricing

- Bond price higher if
  - Market interest rate is lower
- Price converges to par as a bond approaches maturity if market interest rate stays constant

Coupon Rate = 8%		F = $1,000			C = $40		
Maturity		Market Interest Rate (APR)					
Year	T	4%	6%	8%	10%	12%	14%
1	2	1038.83	1019.13	1000.00	981.41	963.33	945.76
2	4	1076.15	1037.17	1000.00	964.54	930.70	898.38
5	10	1179.65	1085.30	1000.00	922.78	852.80	789.29
10	20	1327.03	1148.77	1000.00	875.38	770.60	682.18
30	60	1695.22	1276.76	1000.00	810.71	676.77	578.82

Premium Bond *P > par value* | Par Bond *P=par value* | Discount Bond *P < par value*

Bond Yield-to-Maturity

- Yield to Maturity (*YTM*)
  - The interest rate (or discount rate) that makes the *PV* of bond cash flow equal to its price
  - *YTM* is the "average" return of holding a bond to maturity
    - total return from holding the bond for one period if the market interest rate stays constant
- *YTM* is different from *current yield*

$$Current\,Yield = \frac{Annual\,coupon}{Bond\,market\,price}$$

  - Current yield ignores the capital gain (loss) component of total holding period return (*HPR*)

Bond Yield-to-Maturity

- Q: what is the relationship between coupon rate, current yield and ytm?
- A: It depends on the type of bond
  - 1. premium bond

    Coupon rate > current yield > ytm
  - 2. par bond

    Coupon rate = current yield = ytm
  - 3. discount bond

    Coupon rate < current yield < ytm

YTM vs. Current Yield – An Example

- Example: What's *YTM* of a bond with F = \$1,000, C = \$40, T = 60, P = \$1,276.76 ?

$$P = \sum_{t=1}^{T} \frac{C}{(1+r)^t} + \frac{F}{(1+r)^T} \Rightarrow 1{,}276.76 = \sum_{t=1}^{60} \frac{40}{(1+r)^t} + \frac{1{,}000}{(1+r)^{60}}$$

$$r = 3\%, \quad r_{BEY} = 2 \times r = 6\%, \quad r_{EAY} = (1+r)^2 - 1 = 6.09\%$$

  - We refer r_{BEY} as commonly used *YTM*
  - Notice the differences/similarities among coupon rate, market interest rate (*YTM/APR/*r_{BEY}), per-period discount rate r,r_{EAY}, and current yield

Bond Yield-to-Call

- A callable bond gives the issuer the right to buy back a bond from the investor at a specified price after the protection period
  - Q: When will a firm call its bond?
  - Putable bond; convertible bond
- Yield-to-Call
  - The discount rate which makes the *PV* of cash flow *up to call date* equal to the current price
    - Cash flow includes coupon payment and call price
  - Often used for premium bond

An Example of Yield-to-Call

- Example: Yield-to-call for a bond with
  - 20 year maturity, 5 year call at $1,050, 9% coupon, priced at P = $1,098.96

$$P = \sum_{t=1}^{40} \frac{45}{(1+0.04)^t} + \frac{1{,}000}{(1+0.04)^{40}}$$

  - Implied *YTM* = 8%
  - Yield to call: r = 3.72%, r_{BEY} = 7.44%

$$1{,}098.96 = \sum_{t=1}^{10} \frac{45}{(1+r)^t} + \frac{1{,}050}{(1+r)^{10}}$$

  - Q: Which yield measure is more relevant to the bond investor?

Bond Default Risk

- Corporate bond may default
  - Lower expected cash flow / yield than promised
  - Stated *YTM* = maximum possible yield
- Stated *YTM* vs expected *YTM*
  - 10yr, 9% coupon, $750 price, and 70% par recovery
  - Stated YTM: r = 6.825%, r_{BEY} = 13.65%

$$750 = \sum_{t=1}^{20} \frac{45}{(1+r)^t} + \frac{1{,}000}{(1+r)^{20}}$$

  - Expected YTM: r = 5.815%, r_{BEY} = 11.63%

$$750 = \sum_{t=1}^{20} \frac{45}{(1+r)^t} + \frac{700}{(1+r)^{20}}$$

Municipal Bond

- Issued by state or local government
- Exempt from federal (and local) income tax

$$r_m = (1-\tau)r \text{ or } r = \frac{r_m}{1-\tau}$$

  - r_m: yield on tax-free municipal
  - r: equivalent taxable yield
  - τ: tax-rate
- Example:
  - your *marginal* tax rate is 30%, T-bond offers 10% yield, what yield does a muni bond need to offer to get you interested?

Yield Curve

- Definition
  - A graph of YTM as a function of maturity
  - Also called "term structure of interest rates"
  - Bloomberg: http://www.bloomberg.com/markets/rates/
- *Expectation theory*:
  - YTM determined by expectation of future rate
- *Liquidity preference theory*:
  - Investor demands a risk premium for long-term bond
  - Explains upward-trending yield curve on average
- *Market segmentation theory*:
  - Separation of long-maturity and short-maturity bond markets, with each at its own equilibrium
  - Explains all forms of yield curve

Recap

- How to value a bond based on DCF approach?
- What's the meaning of yield?
- What are the differences between current yield, YTM and yield-to-call?
- How does call and default options affect bond yield?
- How to find the equivalent taxable yield of a municipal bond?
- What are the three theories of yield