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

![Outstanding Bond Market Debt](chart.png)

- Corporate: $4.5 T
- Treasury: $3.4 T
- Agency: $2.9 T
- Money Market: $2.5 T
- Asset-backed: $1.6 T
- Municipal: $1.0 T
- Mortgage-Related: $0.7 T

Total: $21.1 Trillion

*As of June 30, 2003

**Source: Federal Reserve Board
***Figures may include bond in market

2/1/2006  FIN 3710 - Investments - Professor Rui Yao
Debt Classes: Corporate Bonds

- **Credit Rating**

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

- **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
  - $1+EAY=(1+\text{rate per period})^n = (1+\text{APR}/n)^n$
Bond Pricing

- **Bond Value, \( P \)**
  
  \[
  P = \frac{C}{(1+r)} + \frac{C}{(1+r)^2} + \cdots + \frac{C}{(1+r)^T} + \frac{F}{(1+r)^T}
  \]
  
  \[
  = \sum_{t=1}^{T} \frac{C}{(1+r)^t} + \frac{F}{(1+r)^T} = \frac{C}{r} \left[ 1 - \frac{1}{(1+r)^T} \right] + \frac{F}{(1+r)^T}
  \]

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

---

2/1/2006    FIN 3710 - Investments - Professor Rui Yao

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**

<table>
<thead>
<tr>
<th>Coupon Rate = 8%</th>
<th>( F = $1,000 )</th>
<th>( C = $40 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maturity</strong></td>
<td><strong>Market Interest Rate (APR)</strong></td>
<td><strong>Year</strong></td>
</tr>
<tr>
<td>1</td>
<td>1038.83</td>
<td>1019.13</td>
</tr>
<tr>
<td>2</td>
<td>1076.15</td>
<td>1037.17</td>
</tr>
<tr>
<td>5</td>
<td>1179.65</td>
<td>1085.30</td>
</tr>
<tr>
<td>10</td>
<td>1327.03</td>
<td>1148.77</td>
</tr>
<tr>
<td>30</td>
<td>1695.22</td>
<td>1276.76</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Premium Bond</th>
<th>Par Bond</th>
<th>Discount Bond</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P &gt; \text{par value} )</td>
<td>( P = \text{par value} )</td>
<td>( P &lt; \text{par value} )</td>
</tr>
</tbody>
</table>

---

2/1/2006    FIN 3710 - Investments - Professor Rui Yao
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**
  
  \[
  \text{Current Yield} = \frac{\text{Annual coupon}}{\text{Bond market price}}
  \]
  - Current yield ignores the capital gain (loss) component of total holding period return (HPR)

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
\[ F = 1,000, \ C = 40, \ T = 60, \ P = 1,276.76 \]?

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

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

- 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: \( r = 3.72\% \), \( r_{BEY} = 7.44\% \)

- 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

\[ r_m = (1 - \tau)r \quad \text{or} \quad r = \frac{r_m}{1 - \tau} \]

- \( r_m \): yield on tax-free municipal
- \( r \): equivalent taxable yield
- \( \tau \): 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”
- 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?