Lecture 3 Chapter 7: Interest Rates and Bond Valuation

- Why study bonds ?
  - clean application of the Time Value of Money
  - central to corporate finance
  - central to monetary policy
  - central to financial speculation

- But first … Unfinished Business!
  - Section 6.4: Loan Types and Amortization

Loan types and Loan Amortization

- **Pure discount loan**
  - *Borrower receives money today and repays a single lump sum at some time in the future.*

  - Example:

    The XYZ firm wishes to finance its investment project by issuing a pure discount bond. They expect to be able to repay a sum of $35,000 in 7 years. How much will they receive today if investors want a return of 12% ?

Loan types and Loan Amortization

- **Amortized loan**
  - *Borrower receives money today and repays both interest and portions of the principal in each period.*
  - Example:

    You want to put $3000 into your RRSP before the February 28th deadline, but you don't have the cash. Your bank offers to lend you the $3000 at a monthly interest rate of 0.5%, provided you pay it back in 12 monthly payments. You need to find the size of the payments to see whether you can afford it.

  - One way of looking at the amortization of a loan is to say that the payments give a PV equal to the amount borrowed.

    ➢ Taking out an amortized loan is like selling an annuity to the bank

Loan types and Loan Amortization

Amortization of RRSP loan

Month	Outstanding Balance	Interest due	Payment	Reduction of o/s bal.	New balance
1	$3,000.00	$15.00	$258.20	$243.20	$2,756.80
2	$2,756.80	$13.78	$258.20	$244.42	$2,512.38
3	$2,512.38	$12.56	$258.20	$245.64	$2,266.75
4	$2,266.75	$11.33	$258.20	$246.87	$2,019.88
5	$2,019.88	$10.10	$258.20	$248.10	$1,771.78
6	$1,771.78	$8.86	$258.20	$249.34	$1,522.44
7	$1,522.44	$7.61	$258.20	$250.59	$1,271,85
8	$1,271,85	$6.36	$258.20	$251.84	$1,020.01
9	$1,020.01	$5.10	$258.20	$253.10	$766.91
10	$766.91	$3.83	$258.20	$254.37	$512.54
11	$512.54	$2.56	$258.20	$255.64	$256.91
12	$256.91	$1.28	$258.20	$256.92	$-0.01

Loan types and Loan Amortization

- **Interest-only loans**
  - *Borrower receives loan today and pay interest each period and repays the entire principal at some point in the future.*
  - Example

    XYZ decides to finance its project by issuing an interest only loan that will pay investors $35,000 in 7 years and interest payments of 12% compounded annually over a period of 7 years.
    - How much can the company expect to receive from this financing?
    - How does the answer compare to the pure discount loan ?

      Any ideas why ?

Bonds (chapter 7)

- **Definition:** Long-term debt of a corporation or government
- Usually in the form of an interest-only loan
- Important components:
  - **Face value**: Amount to be repaid at maturity
  - **Coupon**: Regular (interest) payments made to the bond holder; expressed in the **coupon-rate** as a percentage of the face value
  - **Maturity**: The date when the face value is repayed and the coupon payments end

Bond Basics

- The coupon, the face value and the maturity date are all determined by the bond issuer; these are written into the bond.
- The amount borrowed is determined by the bond's price in the primary market; this is market-determined.
- Standard corporate bonds have a face value of $1000.
- Coupons are typically paid semi-annually.
- Coupon rate is an APR:
  - 10% rate means $50 every 6 months (i.e. 1/2 of 10% of $1000)
- Question: Is the coupon rate a simple interest rate or a compound interest rate?

Bond Valuation

A corporate treasurer has to finance $2 million of new spending by issuing bonds with a coupon rate of 6.5% and a maturity of 4 years. If the bonds have a face value of $1000 each, how many bonds must be issued?

No, not 2,000 bonds. It depends on the (primary) market price of the bonds. What would you be willing to pay for a bond? => PV

To calculate the PV, we look at its cash flows:

- **coupon payments:** look just like an annuity!
- **face value:** looks just like a future value!

Bond Valuation (cont.)

- *So what is the bond's market price?*
- The PV of the bond must be PV of its cash flows
- The PV of its cash flows must be the sum of the PV of the different parts of its cash flows

- In general Bond Value = PV(coupon payments) + PV(face value) =

$$\frac{C}{r} * \left[1 - \frac{1}{(1+r)^t} \right] + \frac{F}{(1+r)^t}$$

- where
  - *C* is the coupon payment per period = F * coupon rate per period
  - *r* is the periodic interest rate
  - *t* is the number of periods until maturity
  - *F* is the face value

Bond Valuation (cont.)

- If we assume yearly coupon payments, and a market interest rate of 9%, what would be the price of the bonds issued by the company?

- How many bonds would the treasurer need to issue to raise the $2million?

Yields

- **3 Bond-related rates to keep straight:**
  - **Coupon rate:** annual coupon payments as a fraction of face value ? fixed by the company at C/F
  - **Current yield:** annual coupon payments as a fraction of market price: C/P
  - **Yield to maturity:** discount rate that makes the bond's PV equal its market price (also called **internal rate of return)** ? set by the market at r

- **Let's look again at the 4-year bond example.**
  - Coupon rate = 6.5% or $65 / $1000
  - Current yield= 7.07% or $65 / $919.01
  - Yield to Maturity = 9%

Semi-Annual Valuation

- We assumed that coupons were paid annually, but semi-annual is the norm.
- **How much difference does it make to bond prices?**
- Let's use the same formula, but with semi-annual coupon, interest rate and number of periods.
  - *C* =
  - *n* =
  - *r* =
  - *Bond value* =

Yields

- Corporations generally try to set the coupon rate equal to the yield-to-maturity at the time of issue.
- If they do this, then what is the price of the bond?

- When coupon rate > yield-to-maturity, the price of the bond is _____ the face value.
- When coupon rate < yield-to-maturity, the price of the bond is _____ the face value.

Example:

A 4-year bond with a 14% annual coupon sells for $1200. What is the yield to maturity?

The equation to solve is

$$\textit{Bond value} = 140 * \frac{1 - 1/(1+r)^4}{r} + 1000 * \frac{1}{(1+r)^4} = 1200$$

Solving for *r* is tough. Two approaches:

1. Iterate until you're "close enough"
2. let your financial calculator or computer do it

Solving for *r*

- How to solve for r in a PV equation:
  - Guess. Try *r = 0.1* or some other value.
  - Calculate the PV for that value of *r* .
  - Is the PV too high? Then your *r* needs to be higher.
  - Is the PV too low? Then your *r* needs to be lower.
  - Return to step 1 with a better-informed guess.
- As you repeat this, you "bracket" the correct value and gradually approach the answer.
- This is not just true for bonds. In general:
  - solving PV equations for *r* is hard
  - this iterative approach takes you to the right answer
  - this approach is used by most calculators and computers

Interest rate risk

- The value of a bond depends on the interest rate .
  - higher *r* means the PV of payments in the future will be less (higher opportunity cost) ? Lower bond prices
- Suppose you bought our treasurer's bonds when the interest rate was 9%, but then they fell to 6.5%. How are you affected?
  - Your cash flow does not change.
  - The PV of this cash flow is now higher
  - Therefore, the market price of this bond is now higher.
- Congratulations! You just made a capital gain! How much?
- We know that at 9%, the bond price was $919.01 and at 6.5% it is $1000 (why?).

You made $80.99, or 8.8% profit overnight*!*

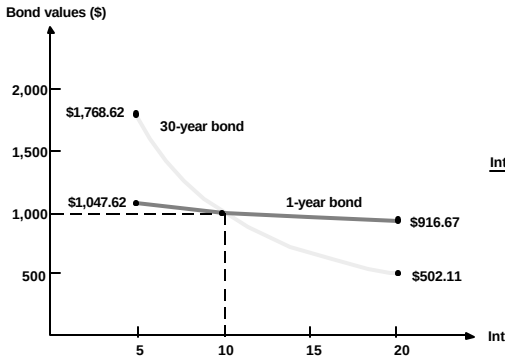
Interest Rate Risk (cont.)

- Suppose instead of a 4-year bond, you had a 1-year bond.
  - Its price at 9% interest would be 1065 / 1.09 = 977.06
  - Its price at 6.5% would be $1000.
  - capital gain = $22.94/$977.06 = 2.35%
- Suppose we had a perpetuity?
  - price goes from $65/0.09 = 722.22 to $65/0.065 = $1000
  - capital gain = 277.78 / 722.22 = 38.5%
- **The longer the maturity, the more sensitive the price is to interest rate changes**

➢ **Interest rate risk increases with maturity**

Interest Rate Risk and Time to Maturity

- Figure 7.2 (page 198)



	Time to Maturity	
Interest rate	1 year	30 years
5%	$1,047.62	$1,768.62
10	1,000.00	1,000.00
15	956.52	671.70
20	916.67	502.11

Value of a Bond with a 10% Coupon Rate for Different Interest Rates and Maturities

Rate of Return on Bonds

- Rate of Return: *Earnings per period per dollar invested.*
- Returns on bonds have two components:
  - coupon payments
  - capital gains & losses due to changes in interest rates

Never confuse YTM with RoR!

- YTM is the special case of RoR where you hold the bond until maturity.
- RoR applies regardless of whether you hold until maturity or for a shorter period.

Example: *Suppose you buy a 4-year bond with a 6.5% coupon when interest rates are 9%. Interest rates remain at 9% over the next year and you sell the bond after one year.*

- What is the price of the bond when you sell it?
- What RoR have you earned on your investment?

Why does the bond's price change if the interest rate doesn't?

- repayment of face value is closer
- coupon rate < interest rate, so coupons do not fully compensate for having to wait for repayment. Therefore, we have to get a capital gain in order to get our "fair" 9% *RoR.*

Lesson 1 Constant interest rates need not imply constant bond prices

Lesson 2 If interest rates are unchanged, $r = RoR$

Bond features

Indenture: written agreement between the borrower and the creditor

- Terms of the bond
  - *Registered: corporation keeps track of owners*
  - *Bearer: certificate is the only evidence of ownership*
- Security
  - *Collateral, mortgage, unsecured*
- Seniority: in case of trouble, who gets paid first?
  - *junior vs senior*
- Repayment
  - *sinking fund managed by a trustee*
- Call provisions
- Protective covenants
  - *negative vs positive*

Bond Features (cont)

- Debt versus Equity
  - **Ownership:** Debt holders have no control over the management of the firm, except through bond covenants
  - **Bankruptcy:** Debt holders must be paid all they are owed before equity holders get anything
  - **Taxation:** Interest payments are tax-deductible to the corporation, but taxable to the investor; dividend payments are the reverse.
- The *art* of finance: creative bonds
  - Stripped, floating, retractable, convertible, income
- Question: Is a perpetual income bond really debt or equity, and why does it matter?

Another risk: Bond Defaults

- **Default:** When the issuer of the bond stops making the agreed payments.

- Bondholders can sue to obtain payments or the assets of the firm unless:
  - Firm has bankruptcy protection
  - The lender is a sovereign nation

- National government bonds payable in domestic currency are typically considered "risk-free"
  - government can always print money to pay off these bonds.

- For a firm that has a chance of defaulting in the future, we can no longer count on receiving all the promised payments.
- Instead, we demand an extra yield to compensate for the possibility of default. This extra yield versus an equal-maturity government bond is sometimes called the **default premium**

Bond Rating

- There are companies that specialize in judging the probability of bond defaults. They publish **bond ratings**.
- The Canadian bond raters are the *Canada Bond Rating Service* (CBRS) and the *Dominion Bond Rating Service* (DBRS)
- In the US, the business is dominated by *Moody's* and *Standard and Poor's*.
  - Since capital markets are international, the US bond raters often rate non-US borrowers.
- Rating systems vary by company, class of issuer, type of instrument, etc.
- Generally, they are like school grades; A is better than B, + is better than -
  - the better the rating, the lower the probability of default
  - in bond rating, anything lower than a B is usually a failing grade
- Bonds with low ratings are politely called *non-investment grade*, and are less politely called **junk bonds**.

Bond Markets

- Over the counter markets
  - Trade takes place on a dealer-to-dealer basis; no central exchange to coordinate
  - Huge volume and huge variety of bonds
  - Lack of transparency
  - Consequently, it is often difficult to find a market price

- To price a bond that has no recent transactions:
  - Find a bond of similar maturity and risk (bond rating)
  - Use the yield-to-maturity of that bond to discount the cash flows of the bond that you want to price and obtain a present value

The Yield Curve

- YTM varies with maturity. This is called the **term structure of interest rates**
- A graph of YTM versus maturity is called the **yield curve**.
- Typically, short-term yields < long-term yields
  - if not, we say the yield curve is "inverted"
  - inverted yield curves have been linked to oncoming recessions, but that's another story
- If long-term YTMs are higher, why would anyone buy short-term bonds?
  - **Risk:** We saw rates of return on long-term bonds are more sensitive to changes in interest rates than those of short-term bonds. If you dislike risk, you'll demand a reward for facing risk.
  - **Expectations:** You might be expecting short-term interest rates to rise.

Inflation and Interest Rates

- Nominal rates: *Interest rates or rates of return that have not been adjusted for inflation*
- Real Rates: *Interest rates or rates of return that have adjusted for inflation*
  - We are concerned not with the number of dollars we will have, but with how much those dollars will buy

The Fisher effect:

$$1 + r_{nominal} = (1 + r_{real}) * (1 + \text{inflation rate})$$

$$\Rightarrow \quad r_{nominal} = r_{real} + \text{inflation rate} + r_{real} * \text{inflation rate}$$

$$\tilde{} \; r_{real} + \text{inflation rate}$$

Inflation (cont)

- The important thing to remember is to **match** *real cash flows* with *real rates* and *nominal cash flows* with *nominal ones.*
- Example:

You want to plan for 20 years of retirement.
You think you can live on $24,000/yr. (in current purchasing power).
You think the Bank of Canada will keep inflation at 2%.
Long-term interest rates are 5.5%.

a) How much do you need upon retirement to finance this? (i.e. to buy a 20-year annuity for this amount?)

b) You want to retire 40 years from now. How much do you have to save every year to have enough saved when you retire?

- For a real world example check out : ***http://www.tdcanadatrust.com/planning/rrsp_planning_calc.jsp***

What we know now

- Loan types
  - Discount
  - Amortized
  - Interest-only
- Bond characteristics
  - Face value / coupon / maturity
- How to value bonds
  - Discounted cashflow
  - Difference between coupon rate, current yield and yield to maturity
- Bond features
  - Terms / security / seniority / protective covenants
  - Debt versus equity / financial engineering
  - Bond markets: over-the-counter
- Bond Risk
  - Interest rate risk
    - Term structure of interest rates / the yield curve
    - Inflation
  - Default Risk
    - Credit ratings

A few translations

See also: http://www.granddictionnaire.com/

Maturity	*l'échéance*
Face value	*la valeur nominale*
Coupon	*le coupon*
Coupon rate	*le taux de coupon*
Yield	*le rendement*
Coupon yield	*le rendement coupon*
Current yield	*le taux actuariel*
Dividend yield	*le rendement des actions*
Effective yield	*le rendement effectif ou réel*
Yield to maturity	*le taux actuariel ou le rendement actualisé*
To yield (financial)	*rapporter*