Topic 2 : Debt Market and The Structure of Interest Rate (Part 1)

EE431/438

Federic Mishkin, The Economics of Money, Banking and Financial Markets Chapter 4 - 6
(available at the reserve section of the library, HG173 .M57 2007)

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Outline

1. Measuring Interest Rates (part 1)
2. Nominal Interest Rates (i) and Real Interest Rates (r) (part 2)
3. The Behavior of Interest Rate (part 2)
4. Risk and Term Structure of Interest Rate (part 2)

Introduction

- Structure of financial market classified by the nature of the claims: Equity market and Debt market
- Debt Instruments, Bonds, Debentures : issued to borrow the money
- Fixed income (predetermined)
- “yield” on a bond can be more predictable than an equity instrument
- Bond yields $\Rightarrow$ interest rate$\Rightarrow$ economic and financial decisions
- The objective of this topic: to understand the interest rate

1.1 What defines a bond?

A prototypical bond is a contract that commits the issuers to make a definite sequence of payments until a specified terminal date.
“a contract” between two parties: borrowers(issuers, sellers) and lenders(buyers)

- **Bond market: primary, secondary market**
- **Important Features of the Bond**

(1) Coupons : “a definite sequence of payment”
coupon : the interest rate that the issuer pays to the bond holders. Usually this rate is fixed throughout the life of the bond.
coupon date : the dates on which the issuer pays the coupon to the bond holders.
(2) Par value of face value : the amount on which the issuer pays interest, the principal amount per unit
(3) Maturity (redemption) date : “a specified terminal date” , the date on which the issuer has to repay the principal amount.

Example :
Double A PLC.
Par value: 1000 Baht
Issue date: 11 June 2013
Maturity date: 11 June 2014
Issue term: 1 years
Coupons: Fixed 6%,
Payment Frequency: Yearly
Credit Rating: BBB
Distribution: public offering

- Issued price = 1,000 Baht (nomally, issued price is equal to the par value)
- Bond price is changing over time.
- An investor may purchase this bond at a price $\begin{matrix} < \\ = \\ > \end{matrix}$ par value; depending on the economic condition

- Coupon payment =
- If the price is 900, bond yield 6%
- Interest rate $\Rightarrow$ Bond yield , Interest Rate $\uparrow$ Bond Price $\downarrow$.

1.2. Four types of debt instruments

(1) A simple loans : The loan that must be repaid at the maturity date, along with an additional payment for the interest.

example: a simple loan, par value = 100 Baht, coupon = 5 Baht, ttm = 2 years

(2) Discount bond: repays the par value at its maturity date (zero-coupon bond), has discounted price

example: a discount bond, par = 1000 Baht, sold at 909.1 Baht, ttm = 2 years

(3) Coupon bond: Pays the owner a fixed interest payment every year until the maturity date, when the par value (or face value) is repaid

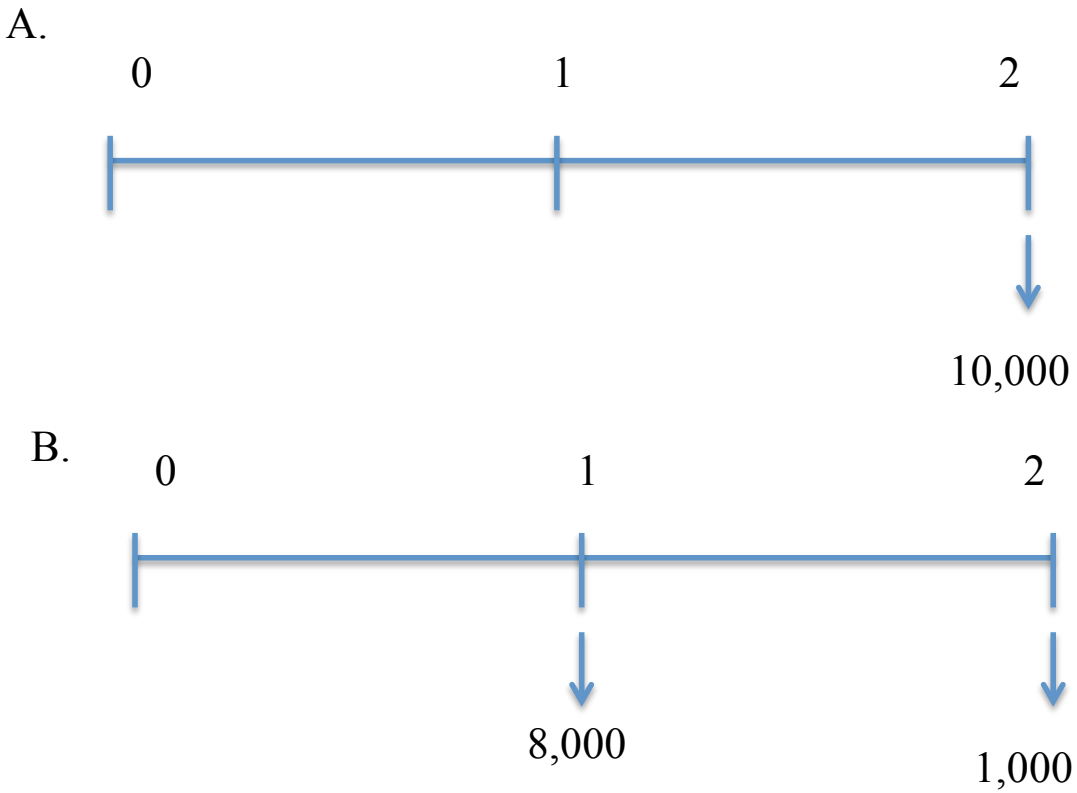
example: Coupon bond, par = 1000 Baht, coupon rate 5%, ttm = 5 years

(4) Fixed payment loans: pays the same amount every period

example : a fixed payment loan, par = 1000 Baht, pay 237.4 Baht yearly for 5 years

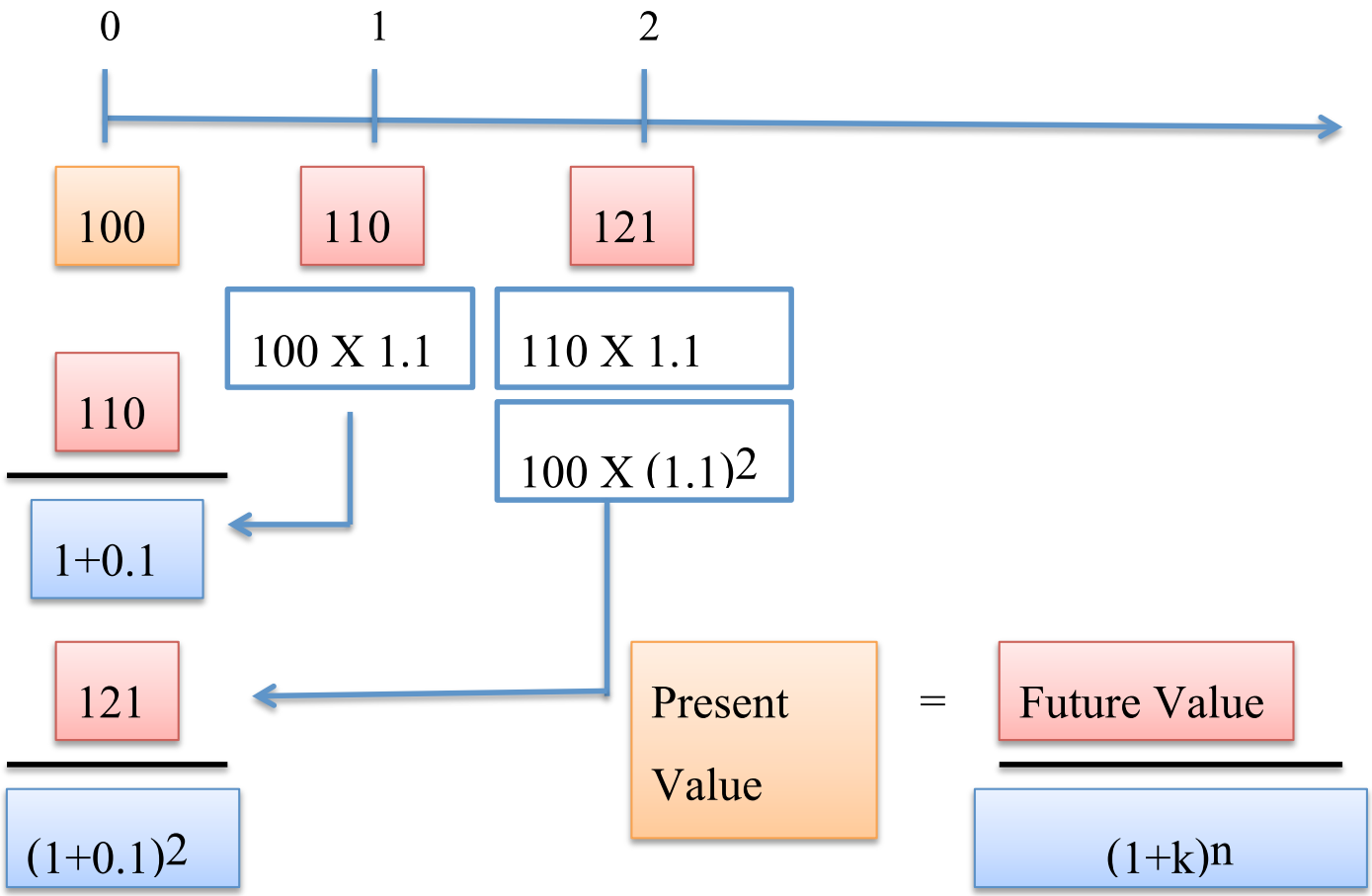
1.3 Bond Price

- Different bonds offer different patterns of payment
- How to compare the returns on each bond?



- Which one is better?

- “Time Value of Money”
- 1 baht at different time has different value
- $1 received today is worth more than $1 received tomorrow : Why?
- “opportunity cost”
- cannot compare $ (amount) received at different time directly
- compare the value at “the same time”


0
1
2
100
110
121
100 X 1.1
110 X 1.1
110
100 X (1.1)2
1+0.1
121
Present Value
=
Future Value
(1+0.1)2
(1+k)n

- The formula is based on the concept of compound interest:

$$\begin{aligned} (1+k)^n PV &= FV, \\ PV &= \frac{FV}{(1+k)^n}, \end{aligned}$$

where k is the discount rate, PV is present value and FV is future value, n is the number of years

- The higher k, the ..... is the PV
- To compare two bonds, compare its PV of cash flow

- Decision to buy or not to buy the bond: compare PV of CF with the price of the bond
- Example: Coupon Bond, Par = 1,000 Baht, Price = 900 Baht, coupon rate 5%, ttm = 5 years, k = 4%. Will you buy in this bond?

- How's about if the bond price is 1,100 Baht?
- How's about if the bond price is 800 Baht?

- Example : Fixed payment loan, Price = 10,000 Baht, ttm = 5 years, payment = 2374 Baht at the end of each year. Will you buy this fixed payment loan? k = 7%

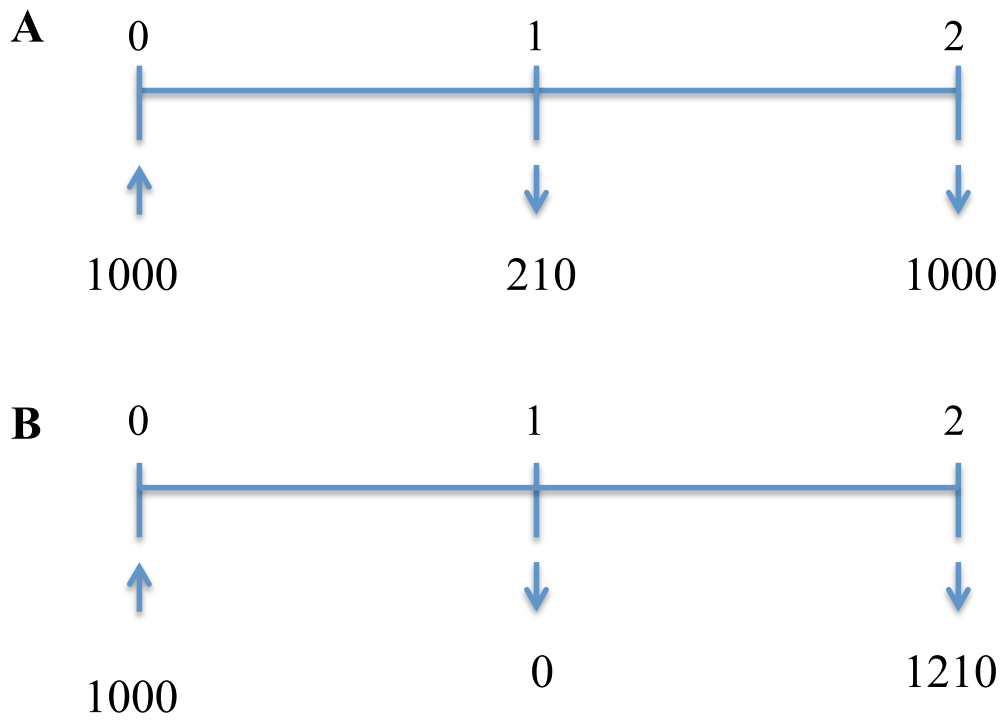
- selling/buying $\Rightarrow$ Bond price
  - PV of CF < Bond price, ... , Bond Price.....
  - PV of CF = Bond price,..... , Bond Price.....
  - PV of CF > Bond price,..... , Bond Price.....
- At equilibrium, price = PV of cash flows payment; k is determined by?
- Valuation Principle : Price = $\sum_{t=1}^{n} \frac{CF_t}{(1+k)^t}$
- Where does “k” (the discount rate) come from?

- Example : Consider a coupon bond, ttm = 6 years, coupon rate 10%, par = 10,000 Baht. What this bond price would be if k= 10%, 12% and 8%?
  - k= 12% PV of CF = ... × ..... + ... ×.....
  - k =10% PV of CF = ... × ..... + ... ×.....
  - k = 8% PV of CF = ... × ..... + ... ×.....

- **For coupon bond**
  - k > Coupon rate Price ..... Par at .....
  - k = Coupon rate Price ..... Par at .....
  - k < Coupon rate Price ..... Par at .....

1.4 Measuring Interest rate

- Bond Market Price = $\sum_{t=1}^{n} \frac{CF_t}{(1+k)^t} \rightarrow k = i$ = interest rate (required rate of return) on the bond (if hold to maturity)
  - Yield to maturity(YTM) : the interest rate that equates the present value of cash flow payments with its value today
  - When the interest rate ↑, the bond price .....
- Why do we have to measure interest rate this way?



- Simple Interest Rate : Both A and B, simple interest rate = ...

- YTM : For B, i = ... For A, i ..... 10%.
- YTM takes into account the time value of money.

Example: A simple loan, ttm = 2 years, price = face value = 1000 Baht, sold at par, coupon = 210 Baht. Find YTM
We want to find the interest rate that solves,

$$PV = \text{price} = \frac{C + F}{(1 + i)^n}$$

Example: A fixed payment loan, ttm = 2 years, price = 917.455 Baht, pay 550 Baht each year, Find YTM.
We want to find the interest rate that solves,

$$PV = \text{price} = \frac{FP}{(1+i)} + \frac{FP}{(1+i)^2} + \frac{FP}{(1+i)^3} + \ldots + \frac{FP}{(1+i)^n}$$

Example: A coupon bond, ttm = 6 years, coupon rate 5%, par = 1000 Baht, Price = 950.826 Baht, Find YTM. (Guess, YTM .... 5%)
We want to find the interest rate that solves,

$$PV = \text{price} = \frac{C}{(1+i)} + \frac{C}{(1+i)^2} + \frac{C}{(1+i)^3} + ... + \frac{C+F}{(1+i)^n}$$

Why it is important to know how to calculate YTM?

Example: Consider a 14% coupon bond with the par value of 4,000 Baht, selling for 5,006.572 Baht. The bond will mature in 7 years. The coupon payment is made annually. Calculate the yield to maturity. Explain.

- Is it possible that cash inflow from bonds is less than cash outflow? Notice that k, i is always positive.
- If we hold the bonds until its maturity date?
- If we do not hold the bonds until its maturity date (we sell it out before its maturity date)?
- Yield VS. Return
- Yield = rate of return on bonds, if we hold the bond to its maturity date
- Return = actual rate of return on bonds that we actually get from investing in a bond
- Bond Price Sensitivity: Longer is maturity, ... is % price change associated with interest rate change

- Actual Rate of Return may not be equal to the bond yield.

$$\text{Actual Rate of Return} = \frac{\text{Cash Inflow-Cash Outflow}}{\text{Cash Outflow}}$$

$$= \frac{(\text{interest} + \text{sell price}) - \text{purchase price}}{\text{purchase price}}$$

$$=$$

Example: Consider a 5% coupon bond with the par value of 1,000 Baht. The bond will mature in 5 years. You bought the bond at par value. You hold it for a year and then you sell it at 1200 Baht. Calculate the rate of return you get from investing in the bond.

One-year Returns on Different-Maturity 10%-Coupon-Rate Bonds When Interest Rates Rises from 10% to 15%, Initial Price = purchase price =1,000

years to maturity	Price next year	Initial Current Yield	Rate of Capital Gain	Rate of Return
30				
20				
10				
5				
1				

- Price next year for the bond with 30 years to maturity

- Price next year for the bond with 20 years to maturity
- Price next year for the bond with 10 years to maturity
- Price next year for the bond with 5 years to maturity

- Bond whose return = yield is bond that maturity ..... holding period
- For bonds with maturity > holding period, i ↑ P ....., implying capital .....
- Bond with high initial interest rate can still have negative return if
  - holding period .... time to maturity
  - at the time the bond is sold, the market interest rate is ..... than the market interest rate at the time when the bond is purchased. This makes the sell price ... than the purchase price, implying capital loss.
  - when the capital loss is ..... initial current yield, the rate of return is .....
- **Prices and returns ..... volatile for long-term bonds because have ..... interest-rate risk**

- Bond Price Sensitivity
  - Δi $\rightarrow$ ΔP
  - “bond price volatility” affects an investor’s decision to invest in bonds
  - Longer is maturity, ... is % price change associated with interest rate change
  - However, “time to maturity” is not enough to capture “bond price sensitivity”.
  - Other charateristics of a bond affect its price sensitivity. For example, “coupon rate” and “yield to maturity”
  - Macualay (1938) Duration, bond price sensitivity
  - Duration $= \left| \frac{\Delta\%P}{\Delta\%(1+i)} \right| = \sum_{t=1}^{n} \frac{PV(CF_t)}{\text{market price}} \times t$
  - The larger is duration, the bond price is ..... sensitive to interest rate

- Duration is the percentage change in price for the “percentage change” in bond yield
- Duration is weighted average the times until those fixed cash flows are received. Thus, duration is measured in “years”
- Duration is ..... the maturity of the bonds.
- Modified Duration : Modified duration $= \left| \frac{\Delta \% P}{\Delta i} \right| = \frac{\text{Duration}}{1 + YTM}$
- Modified Duration is the percentage change in price for a “change” in bond yield.

Example: Consider a coupon bond, par value 1,000 Baht, coupon rate 8%, maturity 3 years, sold at 1026.2456 Baht, find modified duration and interpret its meaning.

Summary

- Bond Price VS. Par Value
- Interest Rate VS. Coupon Rate
- Bond Price = $\sum_t \frac{CF_t}{(1+k)^t}$
- discount rate VS. interest rate
- The discount rate is the rate applied in calculating present value, to convert future value into present value. It is called discount rate because present value is lower than its future value. The discount rate is the rate that discounts(reduces) the future value into present value.

- People may apply different discount rates to evaluate a price of a bond, which they are willing to pay.
- Each person's reservation price reflects each own opinion on the quality of the bond.
- A bond's market price reflects the market opinion on the quality of the bond.
- YTM is the discount rate that equates present value of future cashflows from bonds with its market price.
- If we apply a discount rate which is different from YTM, the present value of cashflows from a bond is not equal to its market price. In other words, we think that the value of the bond is different from its market value.

- If we apply a high discount rate on a particular bond, this means that we are willing to pay a low price. In other words, we require a high rate of return from investment in that bond.
- If we apply a low discount rate on a particular bond, this means that we are willing to pay a high price. In other words, we require a low rate of return from investment in that bond.
- A discount rate is the required rate of return an investor demands for investing in a particular investment.
- YTM is the discount rate that equates present value of future cashflows from bonds with its market price.
- YTM is the market required rate of return from bonds (if hold to maturity).
- YTM is the economic measurement of interest rate.
- When YTM (interest rate) $\uparrow$, bond price $\downarrow$.
- Different bonds have different degrees of price-sensitivity.

- The valuation of ther assets can be done in the same way : Price $= \sum_{t=1}^{n} \frac{CF_t}{(1+k)^t}$, where k is the market's required rate of return of the asset being considered
- Required rate of return is high, the price of the asset is .....
- Bond price sensitivity can be measured by Duration (years), Modified Duration (%)
- $D = \left| \frac{\Delta\%P}{\Delta\%(1+i)} \right|$, $D^* = \left| \frac{\Delta\%P}{\Delta i} \right|$
- a little increase in interest rate $\rightarrow$ a big decrease in bond price $\Rightarrow$ the bond is very price sensitive.
- a big increase in interest rate $\rightarrow$ a little decrease in bond price $\Rightarrow$ the bond is not very price sensitive.
- Consider 2 coupon bonds, same coupon rate, same YTM, different maturities
  1. A coupon bond, ttm = 10 years, coupon rate 5%, par = 1000 Baht, YTM = 5%
  2. A coupon bond, ttm = 2 years, coupon rate 5%, par = 1000 Baht, YTM = 5%

- Able to calculate a bond price, given interest rate.
- Able to calculate the interest rate, given a bond price.
- There is one-to-one mapping from bond price to interest rate.
- One interest rate results in one bond price.
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