# Topic 6 : Debt Market and The Structure of Interest Rate (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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**Financial market: flow of funds, borrowing/lending**

**Intertemporal Consumption:**
How agents allocate their resources across the time

**Decision Under Uncertainty:**
Rational agents are risk averse, they need "compensation" to accept the risk

**Mean Variance Analysis, CAPM, APT :**
How rational agents make their financial investment decision. the equilibrium price, "market required rate of return"

**Debt Market and Interest Rates**

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**Asymmetric Information and Financial Intermediation**

# Outline

- Measuring Interest Rates
- Nominal Interest Rates ($i$ ) and Real Interest Rates ($r$)
- The Behavior of Interest Rate
- Risk and Term Structure of Interest Rate

# 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 payment 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 2011
Maturity date: 11 June 2012
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 $\lessgtr$ par value; depending on the economic condition

- Coupon payment =
- If the price is 900, bond yield =
- Interest rate $\Rightarrow$ Bond yield

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
- To compare or to calculate the interest rate on each bonds: use the concept of "present value"
- 1 baht at different time has different value; opportunity cost
- The formular is based on the concept of compound interest:

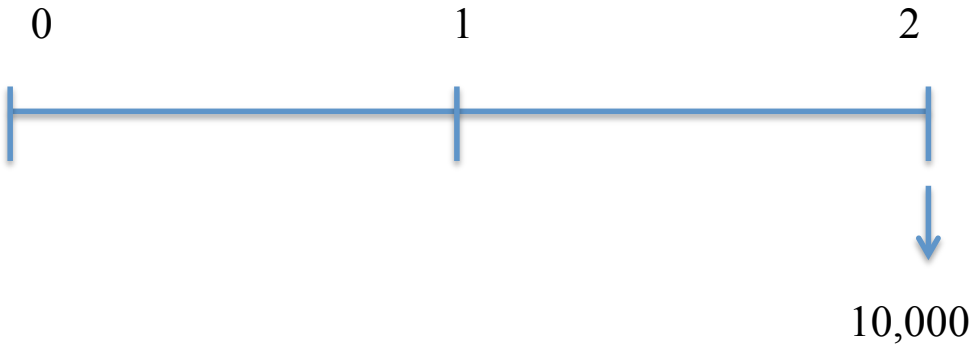
$$\begin{aligned} (1+k)^n PV &= FV, \\ PV &= \frac{FV}{(1+k)^n}, \end{aligned}$$



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

A.

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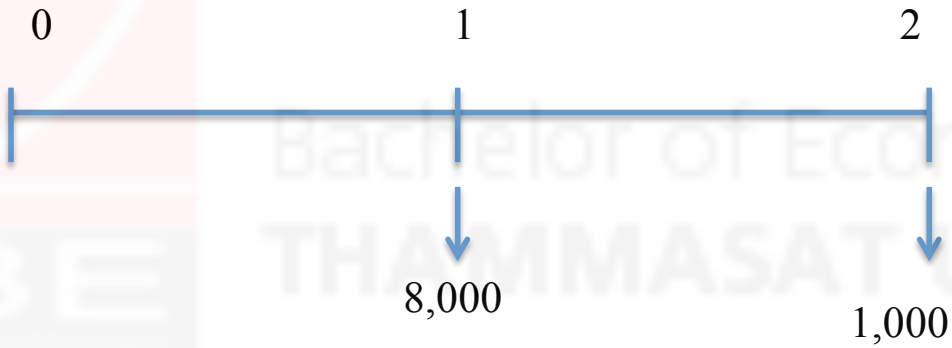





- Which one is better?
- Suppose k = 10%
- Suppose k = 15%

- 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 about if the bond price is 1,100 Baht?

- 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 = $\sum_{t=1}^{n} \frac{CF_t}{(1+k)^t}$

## 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 $\uparrow$, the bond price .....

Example: A coupon bond, ttm = 6 years, coupon rate 10%, par = 10,000 Baht. What should be the price of this bond if $i$ = 10%, 12% and 8%

i = 12%  PV of CF = ..... $\times$ ..... + ..... $\times$..... =9,117.71

i =10%  PV of CF = ..... $\times$ 4.35526 + ..... $\times$0.56447 =10,000.23

i = 8%  PV of CF = 1,000 $\times$ 4.6228 + 10,000 $\times$ 0.63017 = .....

**Interesting fact for coupon bonds**

i > Coupon rate  Price ..... Par  at .....

i = Coupon rate  Price ..... Par  at .....

i < Coupon rate  Price ..... Par  at .....

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 = 951 Baht, Find YTM. (Guess, YTM .... 5%)
We want to find the interest rate that solves,

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



Why it is important to know how to calculate YTM? $\Rightarrow$ In practice, the interest rate varies over the time and what we can directly observe is the price of the bonds.

Is it possible to make a (nominal) loss on a coupon bond investment if we buy the bond at par? 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) $\rightarrow$

Yield = rate of return on bonds, if we hold the bond to its maturity date
Actual Rate of Return may not be equal to the bond yield.

$$\begin{aligned} \text{Actual Rate of Return} &= \frac{\text{Cash Inflow-Cash Outflow}}{\text{Cash Outflow}} \\ &= \frac{(\text{interest} + \text{sell price}) - \text{purchase price}}{\text{purchase price}} \\ &= \end{aligned}$$

One-year Returns on Different-Maturity 10%-Coupon-Rate Bonds When Interest Rates Rises from 10% to 20%, Initial Price = purchase price =1,000

| years to maturity | Price next year | Initial Current Yield | Rate of Capital Gain | Rate of Return |
|---|---|---|---|---|
| 30 | 503 | | -49.7 | |
| 20 | 516 | | -48.4 | -38.4 |
| 10 | 597 | | -40.3 | -30.3 |
| 5 | 741 | | -25.9 | -15.9 |
| 1 | 1,000 | | 0.0 | 10 |

- Bond whose return = yield is bond that maturity ... holding period
- For bonds with maturity > holding period, i ↑ P ...., implying capital .....
- Longer is maturity, ..... is % price change associated with interest rate change
- 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 purcahsed. 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 higher interest-rate risk**
- **No interest-rate risk for any bond whose maturity ..... holding period**

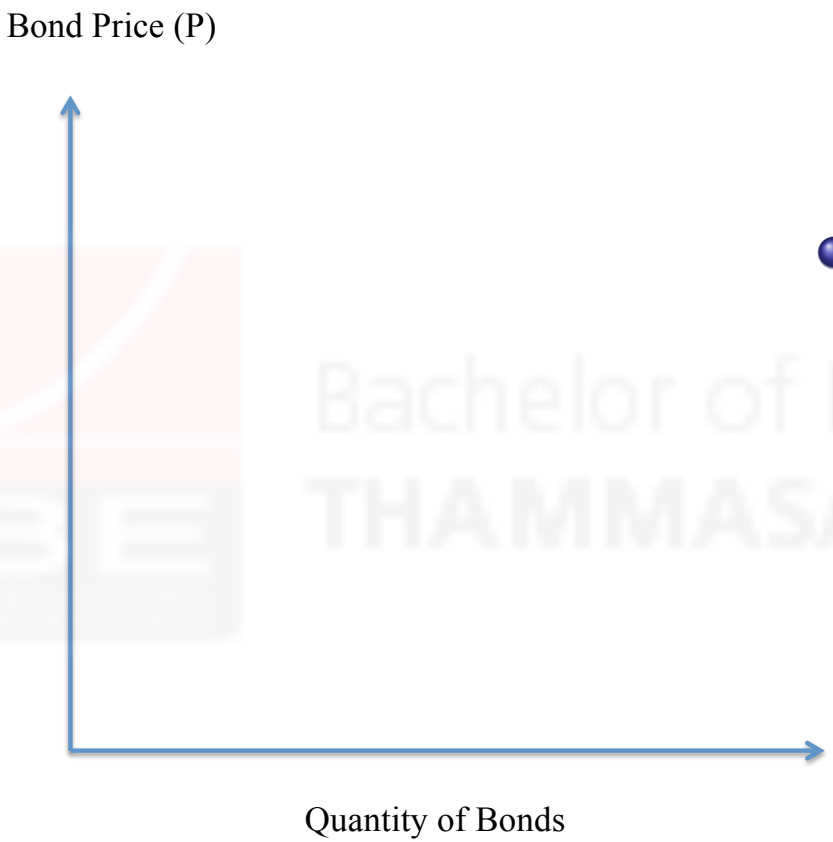
# 2. Real VS. Nominal Interest Rate

- Real VS Nominal?
- General price level $\uparrow \Rightarrow$ Purchasing Power of Money ....
- Borrow 1000 Baht, 1 year, 10% interest rate,
- Price level at the begining of the year $=PI_0 = 100$. At the end of the year $=PI_1 = 125$
- " Money Illusion "
- Fisher Equation : Nominal Interest Rate ($i$ ) = Real Interest Rate(r) + Expected Inflation Rate($\pi^e$)

3.1 Loanable Fund Theory : Interest Rate $\Leftarrow$ Bond Demand (loanable fund supply) and Bond Supply (loanable fund demand)

| Determinants of Bond Demand ($B^d$) |
| --- |
| 1. Wealth $\uparrow$ , $B^d$..... |
| 2. Expected return on bonds relative to other assets $\uparrow$, $B^d$..... |
| $r \uparrow$ , $B^d$..... |
| *** $\pi^e$ **constant,** $i \uparrow$ **Bond Price ....,** $r$ **.....** $B^d$**.....,** *** |
| |
| $i$ constant , $\pi^e \uparrow$**,** $r$ ....., $B^d$..... |
| 3. Liquidity relative to other asset s$\uparrow$ , $B^d$..... |
| 4. Riskiness relative to other assets $\uparrow$ , $B^d$..... |

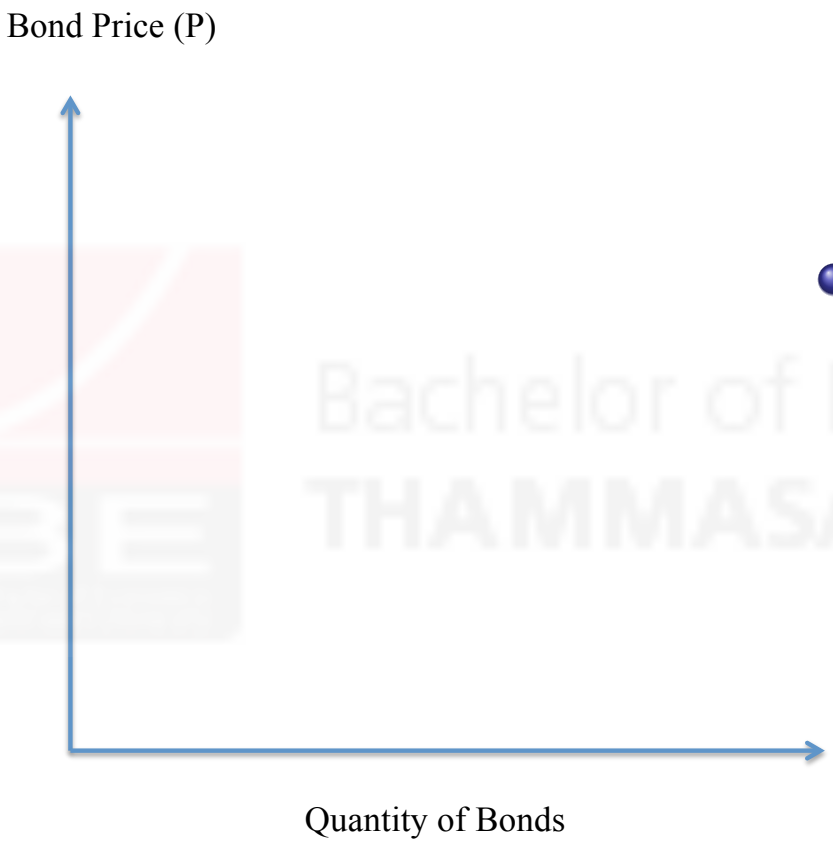
- Shift in Bond Demand : example




- Suppose Bond demand shift to the right,
  - total wealth.....
  - liquidity of bonds relative to the other assets .....
  - risk relative to other assets .....

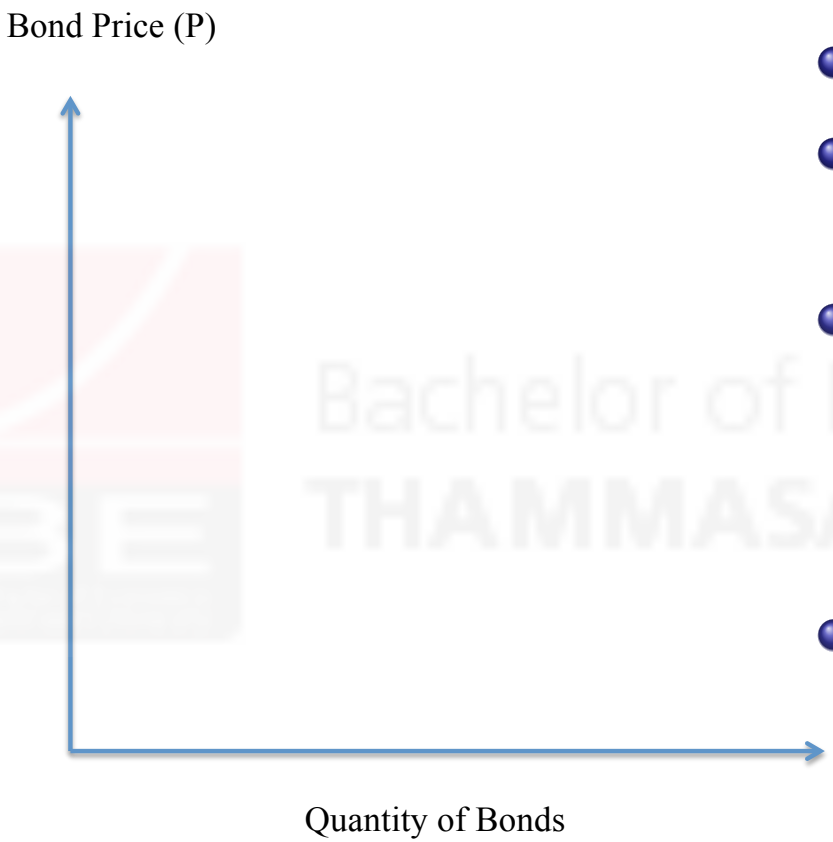
| Determinants of Bond Supply ($B^s$) |
| --- |
| 1. Expected Profitability $\uparrow$ , $B^s$..... |
| Corporate Taxation $\uparrow$, $B^s$..... |
| Subsidy $\uparrow$ , $B^s$..... |
| 2. Expected Inflation |
| $\pi^e \uparrow$, $r$ ....., all i, $B^s$..... |
| *** $\pi^e$ **constant,** $i \uparrow$ **Bond Price ... ,** $r$ **....,**$i \uparrow$ , $r$ ...., $B^s$...., *** |
| 3. Government Borrowing |
| Government Borrowing $\uparrow$, $B^s$..... |

- Shift in Bond Supply



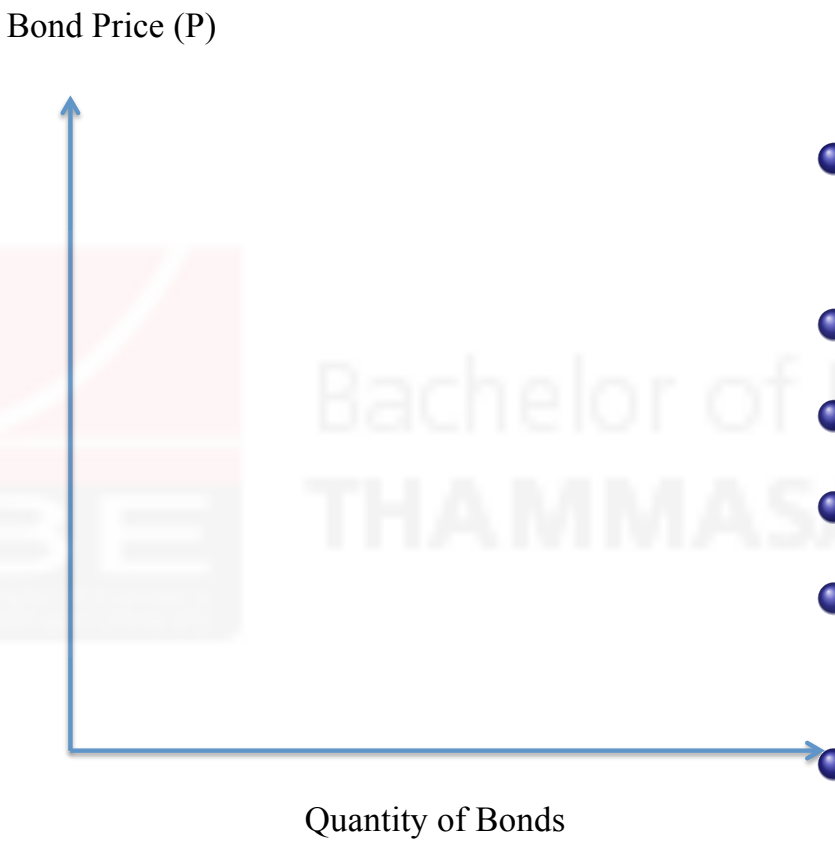

- Suppose Bond Supply shift to the right,
  - profitability of investments .....
  - expected inflation ......
  - government deficit .....

- A change in $\pi^e$




- Suppose $\pi^e \uparrow$
- Bond Demand shift to ..... and Bond Supply shift to .....
- Equilibrium Bond Price ..... , Equilibrium nominal interest rate ..... Equilibrium quantity .....
- Recall : Fisher equation $\Rightarrow i = r +$ ..... , implying $\pi^e \uparrow$, $i$ .....
- "Fisher effect"

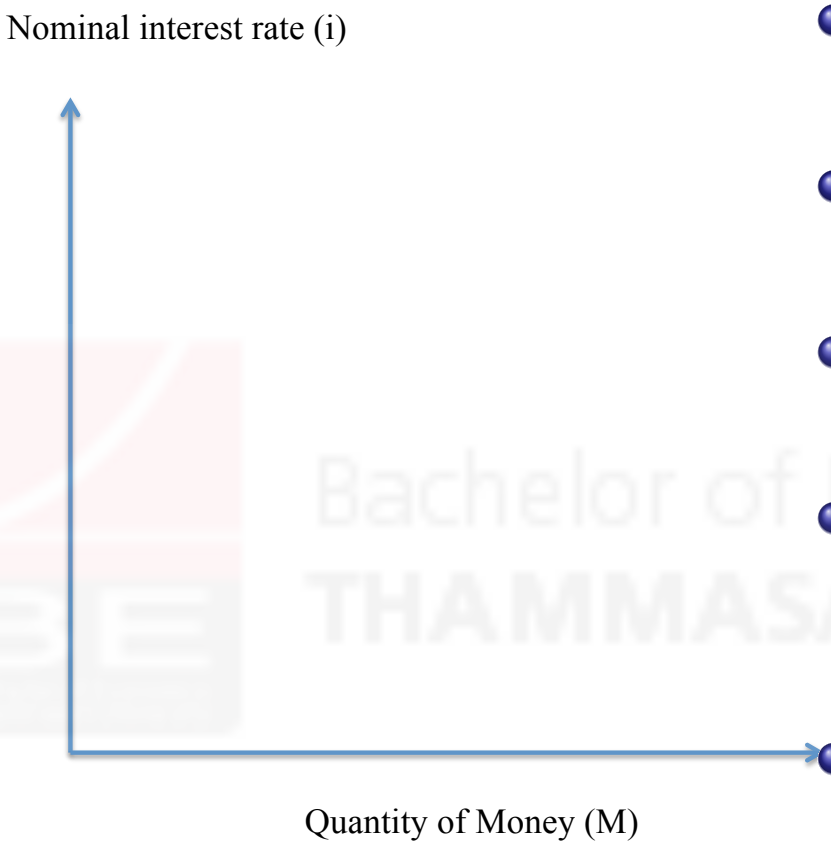
- Reponse to a business cycle expansion




- In a business cycle expansion, income and wealth are rising.
- Bond Demand shift to .....
- and Bond Supply shift to .....
- Equilibrium Bond Price ..... ,
- Equilibrium nominal interest rate .....
- Equilibrium quantity .....

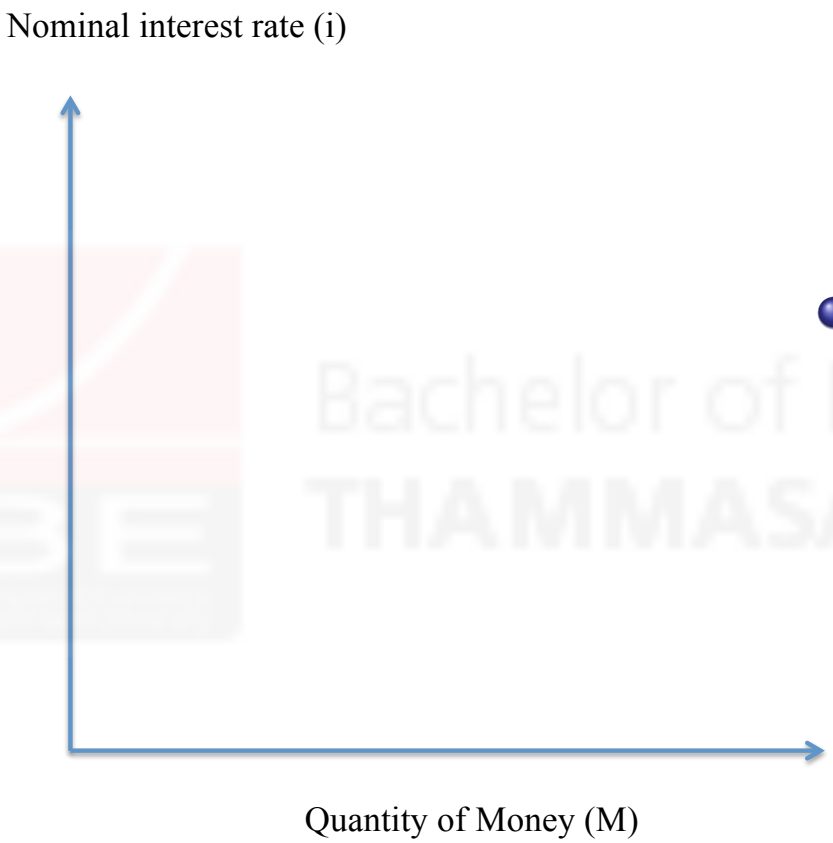
## 3.2 Liquidity Preference Framework (Keynesian)

- two main assets people use to store their wealth : Money and Bonds
- $M^d + B^d = M^s + B^s =$ total wealth
- $M^d = M^s \rightarrow B^d = B^s$. Whenever money market is in equilibrium, bond market must be in equilibrium.
- Analysing money market is equivalent to analysing bond market
- Liquidity preference framework $\rightarrow$ analyse the money market
- Money Demand
  - Transation demand
  - Precautionary demand
  - Speculative demand
- Money Supply
  - controlled by the central bank



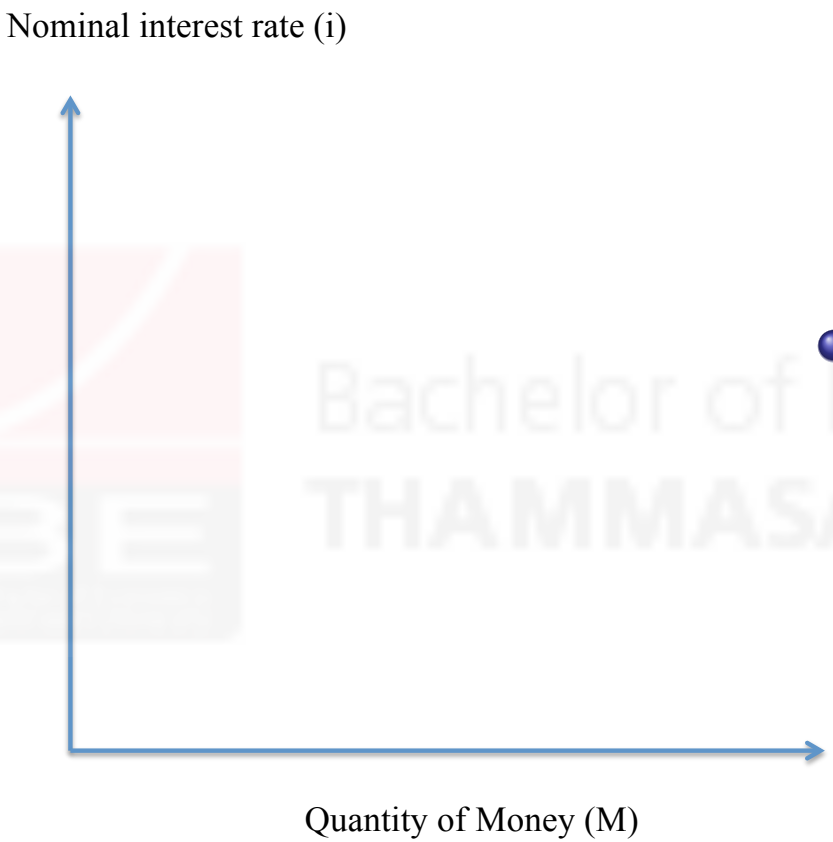

- If interest rate is lower than the equilibrium interest rate,
- there will be excess money .....
- agents will ..... (buy/sell) more bonds,
- then bond ..... (demand/supply) ..... (increases/decreases),
- therefore the interest rate ..... (increases/decreases)

- Shift in money supply




- Suppose money supply shift to the right, caused by
  - the central bank ..... money supply due to ..... monetary policy

- Shift in money demand




- Suppose money demand shift to the right, caused by
  - income .....
  - price level .....