ECN 135 Lecture 5
Money, Banks & Financial Institutions

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Understanding Interest Rates

- Present Value
- Credit Instruments
- Interest Rates: Real and Nominal

Present Value

- **Concept of Present Value or Present discounted value**
- Simple loan of $1 at 10% interest
- Year 1 2 3 n
- $1.10 $1.21 $1.33 $1x(1 + *i*)^n
- $1 PV of future $1 = (1 + *i*)^n
- Why Present discounted Value is important?
  - $ in a year from now is less than $ today
  - We need to compare dollars across time [dollar today with dollar at other dates]

Types of Credit Instruments

- **Four Types of Credit Instruments**
- 1. Simple loan (borrower repays the principal + interest)
- 2. Fixed-payment loan (auto, mortgage) [called also fully amortized loan]
- 3. Coupon bond pays
  - C – yearly coupon (or half a year coupon), n=years to maturity
  - F – face value
  - P - price of coupon bond $P=C/(1+i)+\ldots C/(1+i)^n + F/(1+i)^n$, where i is yield to maturity
  - If Coupon rate is 10%, C=100 for F=1000
- 4. Discount (zero coupon) bond (same as for a simple loan)
  From $F=P(1+i)$ we have $i=(F-P)/P$
- 5. Console or Perpetuity $P=C/i$
- Yield to maturity=**interest rate that equates today's value with present value of all future payments**
- Yield to maturity reflects TODAY value of interest rate most accurately

Yield to maturity = interest rate that equates today's value with present value of all future payments

[M] p.66 – 6, see Table 1

When coupon rate and yield to maturity are equal, P=F

If yield to maturity rises, price of bond falls. Intuition: when interest rates increase, bonds with the same face value should cost less ➔ fall in price ←➔ If yield rises, price falls

←➔P<F ←➔yield rate i >coupon rate

Yield to Maturity: Loans

Yield to maturity = interest rate that equates today's value with present value of all future payments

1. Simple Loan (i = 10%)

$\$100 = \$110/(1+i) \Rightarrow$

$$i = \frac{\$110 - \$100}{\$100} = \frac{\$10}{\$100} = 0.10 = 10\%$$

2. Fixed Payment Loan (i = 12%)

$$\$1000 = \frac{\$126}{(1+i)} + \frac{\$126}{(1+i)^2} + \frac{\$126}{(1+i)^3} + \ldots + \frac{\$126}{(1+i)^{25}}$$

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

Yield to Maturity: Bonds

3. Coupon Bond (Coupon rate = 10% = C/F)

$$P = \frac{\$100}{(1+i)} + \frac{\$100}{(1+i)^2} + \frac{\$100}{(1+i)^3} + \ldots + \frac{\$100}{(1+i)^{10}} + \frac{\$1000}{(1+i)^{10}}$$

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

Consol: Fixed coupon payments of $$C$ forever

$$P = \frac{C}{i} \qquad i = \frac{C}{P}$$

4. Discount Bond ($P = \$900$, $F = \$1000$), one year

$$\$900 = \frac{\$1000}{(1+i)} \Rightarrow$$

$$i = \frac{\$1000 - \$900}{\$900} = 0.111 = 11.1\%$$

$$i = \frac{F - P}{P}$$

Relationship Between Price and Yield to Maturity

Table 1 Yields to Maturity on a 10%-Coupon-Rate Bond Maturing in Ten Years (Face Value = $1,000)

Price of Bond ($)	Yield to Maturity (%)
1,200	7.13
1,100	8.48
1,000	10.00
900	11.75
800	13.81

Three Interesting Facts from Table 1

1. When bond is at par, yield equals coupon rate
2. Price and yield are negatively related
3. Yield greater than coupon rate when bond price is below par value

Current Yield

$$i_c = \frac{C}{P}$$

Two Characteristics

1. Is better approximation to yield to maturity, nearer price is to par and longer is maturity of bond
2. Change in current yield *always* signals change in same direction as yield to maturity

Yield on a Discount Basis

$$i_{db} = \frac{(F - P)}{F} \times \frac{360}{\text{(number of days to maturity)}}$$

One year bill, P = \$900, F = \$1000

$$i_{db} = \frac{\$1000 - \$900}{\$1000} \times \frac{360}{365} = 0.099 = 9.9\%$$

Two Characteristics

1. Understates yield to maturity; longer the maturity, greater is understatement
2. Change in discount yield *always* signals change in same direction as yield to maturity

Rate of Return & Interest Rate

- **Rate of Return NOT equal to the interest rate of the bond**
- **Rate of Return for a security**

$$RET=(C + P_{t+1} - P_t)/ P_t = i_c + g,$$

- where:
  - $i_c = C/ P_t$ = current yield
  - $g = (C + P_{t+1} - P_t)/ P_t$ = rate of capital gain
  - P_t is price of the bond at time t
  - P_{t+1} is price of the bond at time t+1
- Long term bonds are considered not safe because their prices fluctuate substantially with interest rate changes
- Do you Remember that bond prices fall when interest rates increase and vice versa?
- Short term bonds prices and returns are less volatile than long term [M], p. 78
- Short term bonds are less risky relative to long term bonds when holding period and the maturity are not identical.

Key Facts about Relationship Between Interest Rates and Returns

Table 2 One-Year Returns on Different-Maturity 10%-Coupon-Rate Bonds When Interest Rates Rise from 10% to 20%

(1) Years to Maturity When Bond Is Purchased	(2) Initial Current Yield (%)	(3) Initial Price ($)	(4) Price Next Year* ($)	(5) Rate of Capital Gain (%)	(6) Rate of Return (2 + 5) (%)
30	10	1,000	503	−49.7	−39.7
20	10	1,000	516	−48.4	−38.4
10	10	1,000	597	−40.3	−30.3
5	10	1,000	741	−25.9	−15.9
2	10	1,000	917	−8.3	+1.7
1	10	1,000	1,000	0.0	+10.0

*Calculated using Equation 3.

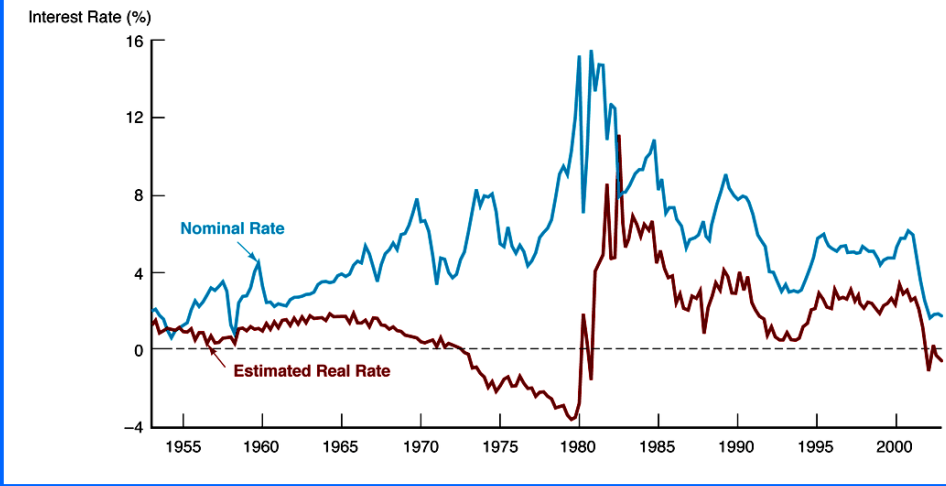
Maturity & Volatility of Bond Returns

- **Key Findings from Table 2**
  - 1. Only bond whose return = yield is one with maturity = holding period
  - 2. For bonds with maturity > holding period, $i\uparrow$ $P\downarrow$ implying capital loss
  - 3. Longer is maturity, greater is % price change associated with interest rate change
  - 4. Longer is maturity, more return changes with change in interest rate
  - 5. Bond with high initial interest rate can still have negative return if $i\uparrow$
- **Conclusion from Table 2 Analysis**
  - 1. Prices and returns more volatile for long-term bonds because have higher interest-rate risk
  - 2. No interest-rate risk for any bond whose maturity equals holding period

Real and Nominal Interest Rates

- **Fisher's equation $(1+i)=(1+i_r)(1+\pi^e)$ & for small π^e and i_r →**
  $$i=i_r+\pi^e$$
- **Real Interest Rate is Interest rate that is adjusted for expected changes in the price level**
  $$i_r = i - \pi^e$$
- 1. Real interest rate more accurately reflects true cost of borrowing
- 2. When real rate is low, greater incentives to borrow and less to lend
  - **if i = 5% and π^e = 3% then:**
  - **i_r = 5% – 3% = 2%**
  - **if i = 8% and π^e = 10% then**
  - **i_r = 8% – 10% = –2%**

U.S. Real and Nominal Interest Rates



1. If real interest rate us low ➔ incentives to borrow increase, and to lend decrease (because costs of borrowing are low in this case/ borrowing is cheap)
2. In real terms, costs of borrowing in 1980 was low.

Interest Rates and Taxes

- Need to adjust Fisher equation to taxes because after tax interest rate matters, i.e. after taxes are subtracted

  $i_r = i(1-\tau) - \pi^e$,

  - Where τ is a tax rate
- If tax rate is τ=30%, and π^e=5%, after tax rate for i=10% bond is 7%, and

  i_r=2%
- After-tax real rate is the effective cost of borrowing. After-tax rate is below real rate

TIPS=Treasury Inflation Protected Securities

- New instrument in US in 1997 (introduced by US Treasury (Summers))
- TIPS are Indexed Bonds or inflation protected bonds
- What TIPS do?
  - Provide a measure of real interest rate, i.e. TIPS make i_r observable
  - Serve to estimate expected inflation (or market expectations about future inflation)
- Why TIPS are useful? TIPS generate information
  - ➔ can be used to hedge against changes in inflation
  - ➔ estimate credit tightness (show real interest rate)
- US was following example of other countries (UK, Canada, Australia & Sweden)
- If for 10 year TIPS interest rate is 2.19%, and for 10 year T-bill 3.84 ➔ π^e = **1.65%**
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Next Lecture

- Your preparation: read [M] Ch. 4, 5, 6
- More on interest rates & bonds

Summary of Today

- Present Value
- Types of Debt Instruments
- Have a Nice Night