FN312 Investment
Lecture 9 The Term Structure of Interest Rates

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Reading:
Chapter 15

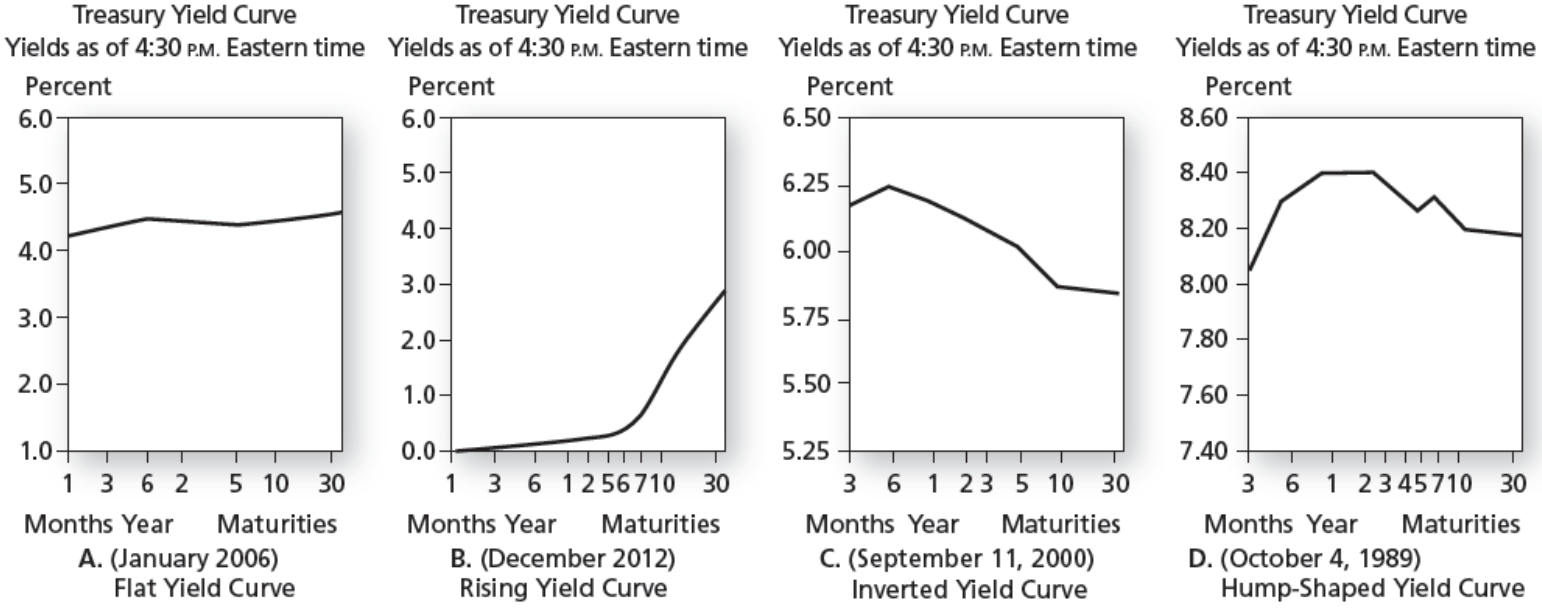
Outline

- The Yield Curve
- **The Yield Curve and Future Interest Rates**
  (Yield Curve Under Certainty)
- **Interest Rate Uncertainty and Forward Rates**
- **Theories of Term Structure**

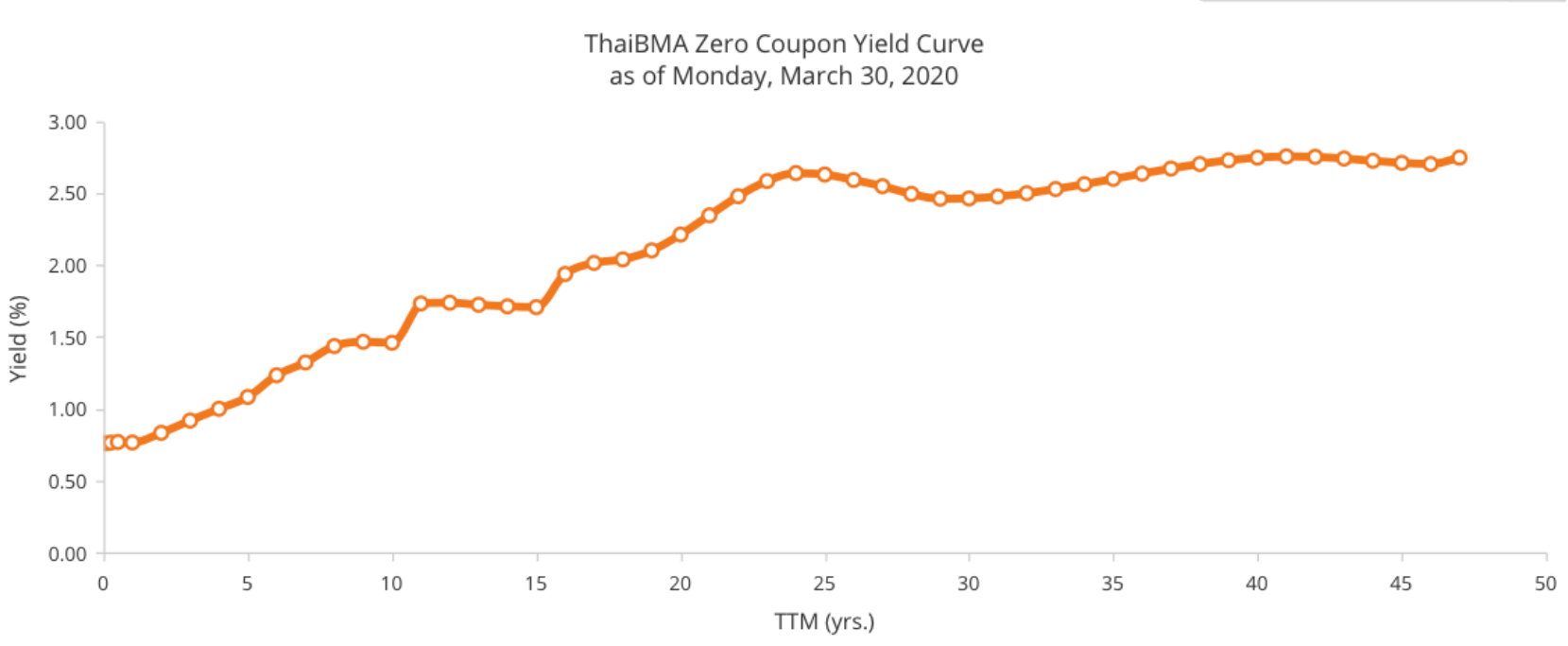
The Yield Curve

The Yield Curve

- The yield curve displays the relationship between YTM and time to maturity
- Information on expected future short-term rates can be implied from the yield curve



ThaiBMA Zero Coupon Yield Curve



ThaiBMA Corporate Bond Yield Curve

30/03/2020

Export to Excel

Corporate Bond Yield Curve (Based on TTM) as of 30 March 2020

Group	Averaged Spread (bp)			Standard Deviation (bp)			Averaged Maturity		
	<= 3 Yrs.	3 - 5 Yrs.	> 5 Yrs.	<= 3 Yrs.	3 - 5 Yrs.	> 5 Yrs.	<= 3 Yrs.	3 - 5 Yrs.	> 5 Yrs.
AAA	51.534149	95.364281	90.901228	20.422105	43.719392	12.264387	1.416327	4.160730	6.224200
AA	64.218871	88.352238	127.187882	40.870169	27.971279	27.500264	1.552054	3.915525	7.947677
A	79.779096	110.984949	143.938694	39.991232	39.547453	38.864430	1.392266	3.855825	8.105622
BBB	196.977724	275.639880	333.470930	47.877255	38.387682	50.847349	1.439524	3.868914	5.305479

Export to Excel

Corporate Bond Yield Curve (Based on Duration) as of 30 March 2020

Group	Averaged Spread (bp)			Standard Deviation (bp)			Averaged Maturity		
	<= 3 Yrs.	3 - 5 Yrs.	> 5 Yrs.	<= 3 Yrs.	3 - 5 Yrs.	> 5 Yrs.	<= 3 Yrs.	3 - 5 Yrs.	> 5 Yrs.
AAA	51.801641	100.392322	91.877112	20.438278	27.801772	17.438578	1.438904	5.249771	7.609589
AA	64.995067	93.871648	133.630535	40.834550	26.592841	25.870294	1.633294	4.306544	8.402896
A	80.925123	114.354598	152.205665	40.402980	39.637731	37.120021	1.452697	4.228980	8.565720
BBB	199.159881	288.250804		48.873841	46.010477		1.486692	4.209694	

Remark :

1. Each rating group includes all signs. For example, AA group consists of rating AA+, AA and AA-.
2. Averaged Spread is simple average of spreads.
3. Blank means there is no bonds in the criteria.
4. Averaged averaged maturity means the average of average maturities of all bonds in the criteria.
5. Avaraged maturity of each bond is calculated from: sum(principal * time) / sum(principals)

Interpreting the Term Structure

- The yield curve reflects expectations of future interest rates
- The forecasts are clouded by liquidity premiums
- An upward sloping curve could indicate:
  - Rates are expected to rise

and/or

  - Investors require large liquidity premiums to hold long term bonds

Interpreting the Term Structure

- The yield curve is a good predictor of the business cycle
  - Long term rates tend to rise in anticipation of economic expansion
  - Inverted yield curve may indicate that interest rates are expected to fall and signal a recession

Yield Curve: Bond Pricing

- Yields on different maturity bonds are not all equal
- Consider each bond cash flow as a stand-alone zero-coupon bond
- **Bond stripping and bond reconstitution offer opportunities for arbitrage**
- The value of the bond should be the sum of the values of its parts

Prices and Yields to Maturities on Zero-Coupon Bonds ($1,000 Face Value)

Maturity (years)	Yield to Maturity (%)	Price
1	5%	$952.38 = $1,000/1.05
2	6	$890.00 = $1,000/$1.06^2$
3	7	$816.30 = $1,000/$1.07^3$
4	8	$735.03 = $1,000/$1.08^4$

Example 1: Zero Price or Face Value > Coupon Bond

Face (Zero)	**1000**	**Sold at (CB)**	**800**
C Rate	5%	$50	
N =	5		

Step1: Buy

GAIN (Loss)=

Step2: Sell

NET

Total

Example 2: Zero Price or Face Value < Coupon Bond

Face (Zero)	**1000**	**Sold at (CB)**	**1200**
C Rate	5%	$50	
N =	5		

Step1: Buy

GAIN (Loss)=

Step2: Sell Strip

NET

Total

Valuing Coupon Bonds

- Value a 3-year, 10% coupon bond using discount rates from the TABLE:

(1) Solving price from the YTM given:

$$\text{Price} = \frac{\$100}{1.05} + \frac{\$100}{1.06^2} + \frac{\$1100}{1.07^3} \quad = \$1082.17$$

(2) Solving YTM of the coupon bonds:

YTM = 6.88%

>> which is less than the 3-year rate of 7% ***... So ?***

Bond Pricing: Two Types of Yield Curves

Pure Yield Curve	On-the-Run Yield Curve
• Uses stripped or zero-coupon Treasuries	• Uses recently-issued coupon bonds selling at or near par
• May differ significantly from the on-the-run yield curve	• The one typically published by the financial press

The Yield Curve and Future Interest Rates

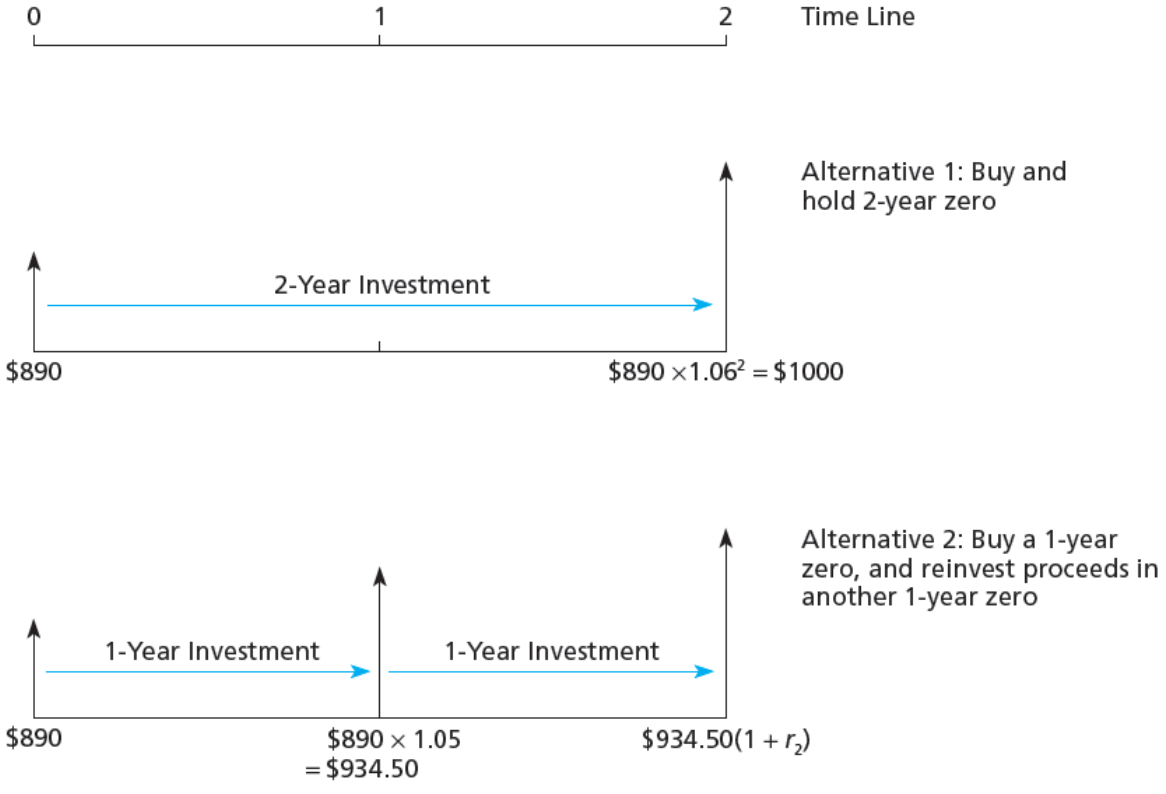
(Yield Curve Under Certainty)

The Yield Curve and Future Interest Rates (1)

- Yield Curve Under Certainty
  - Suppose you want to invest for 2 years
    - Buy and hold a 2-year zero

    OR

    - Rollover a series of 1-year bonds
  - Equilibrium requires that both strategies provide the same return



The Yield Curve and Future Interest Rates (2)

- Yield Curve Under Certainty
  - Buy and hold vs. rollover:

$$(1+y_2)^2 = (1+r_1)\times(1+r_2)$$
$$1+y_2 = \left[(1+r_1)(1+r_2)\right]^{.5}$$

  - (r_2) is just enough to make rolling over a series of 1-year bonds equal to investing in the 2-year bond

From previous example:

The Yield Curve and Future Interest Rates (3)

- Yield Curve Under Certainty
  - **Short rate**
    - The rate for a given maturity (e.g. one year) at different points in time
  - **Spot rate**

    = the geometric average of its component short rates
    - The rate that prevails today for a given maturity

Example (2)

13. Prices of zero-coupon bonds reveal the following pattern of forward rates:

Year	Forward Rate
1	5%
2	7
3	8

In addition to the zero-coupon bond, investors also may purchase a 3-year bond making annual payments of $60 with par value $1,000.

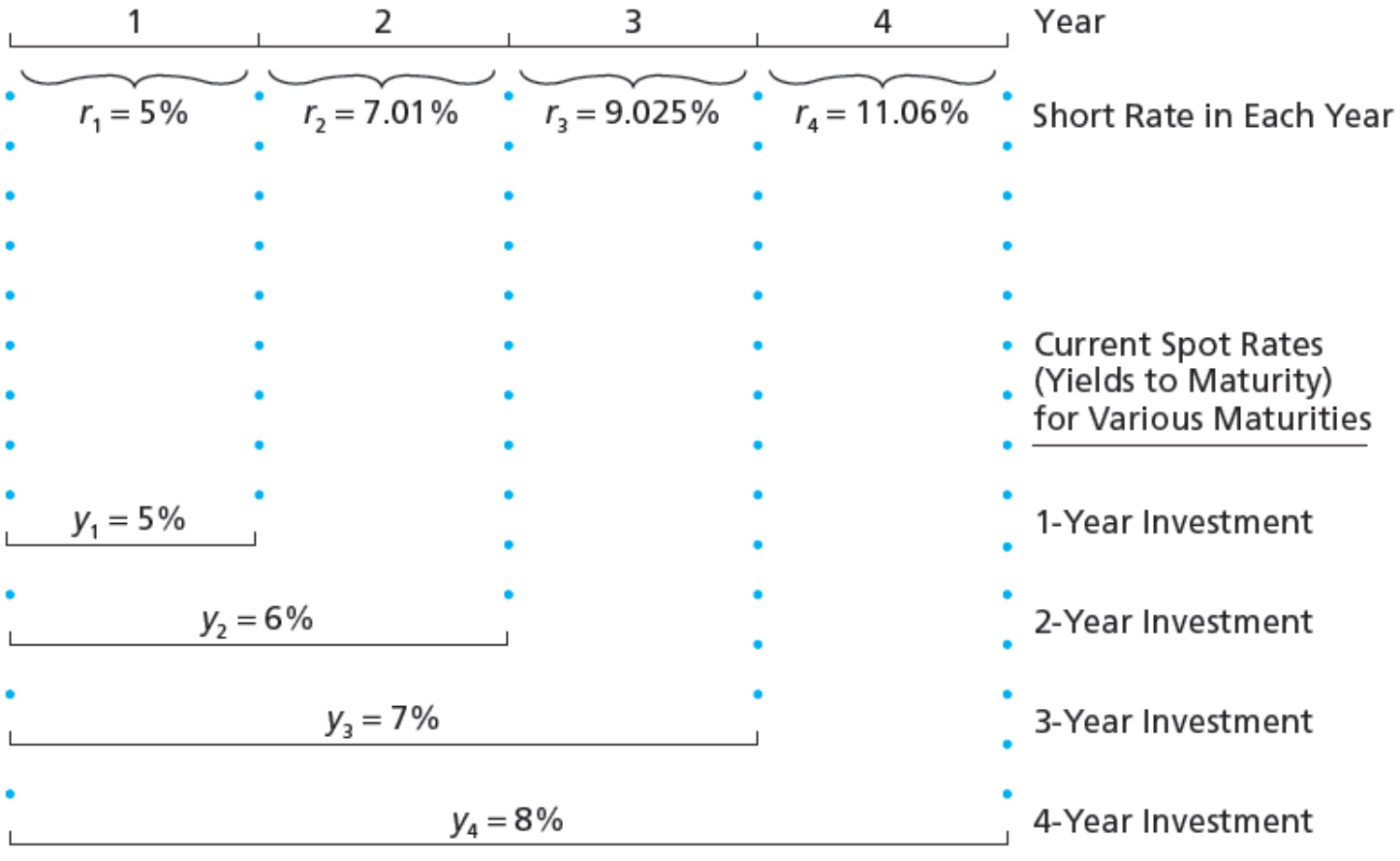
a. What is the price of the coupon bond?
b. What is the yield to maturity of the coupon bond?
c. Under the expectations hypothesis, what is the expected realized compound yield of the coupon bond?
d. If you forecast that the yield curve in one year will be flat at 7%, what is your forecast for the expected rate of return on the coupon bond for the 1-year holding period?

The Yield Curve and Future Interest Rates (4)

Short Rates and Yield Curve Slope

- When next year's short rate, **r2 > r1**, the yield curve slopes up
- May indicate rates are expected to rise
- When next year's short rate, **r2 <r1**, the yield curve slopes down
- May indicate rates are expected to fall

Short Rates versus Spot Rates



The Yield Curve and Future Interest Rates (5)

- Forward rates

$$(1+y_n)^n = (1+y_{n-1})^{n-1} \times (1+f_n)$$

$$(1+f_n) = \frac{(1+y_n)^n}{(1+y_{n-1})^{n-1}}$$

  - f_n = One-year forward rate for period n
  - y_n = Yield for a security with a maturity of n

Forward Rates: Example

- The forward interest rate is a forecast of a future short rate
- Rate for 4-year maturity = 8%
- Rate for 3-year maturity = 7%

Forward Rates: Example (2)

7. The following is a list of prices for zero-coupon bonds of various maturities.
   a. Calculate the yield to maturity for a bond with a maturity of (i) one year; (ii) two years; (iii) three years; (iv) four years.
   b. Calculate the forward rate for (i) the second year; (ii) the third year; (iii) the fourth year.

Maturity (years)	Price of Bond
1	$943.40
2	898.47
3	847.62
4	792.16

Interest Rate Uncertainty and Forward Rates

Interest Rate Uncertainty and Forward Rates (1)

- Suppose that today's rate is 5% and the *expected* short rate for the following year is $E(r_2) = 6\%$. The value of a 2-year zero is:

- The value of a 1-year zero is:

Interest Rate Uncertainty and Forward Rates (2)

- **The investor wants to invest for 1 year**

  Option1: Buy the 2-year bond today and plan to sell it at the end of the first year for $1000/1.06 = $943.40

  OR

  Option2: Buy the 1-year bond today and hold to maturity

  … So?

- What if next year's interest rate differs from 6%?
  - The actual return on the 2-year bond is **UNCERTAIN**!

Interest Rate Uncertainty and Forward Rates (3)

- Investors require a risk premium to hold a longer-term bond
- This **LIQUIDITY PREMIUM** compensates short-term investors for the uncertainty about future prices

Theories of Term Structure

Theories of Term Structure

(1) The Expectations Hypothesis Theory

- Observed long-term rate is a function of today's short-term rate and expected future short-term rates
- The forward rate equals the market consensus expectation of the future short interest rate
  - $f_n = E(r_n)$ and **LIQUIDITY PREMIUMS ARE ZERO!**

Recall that: $(1+y_2)^2 = (1+r_1)\times(1+r_2)$

The Expectations Hypothesis Theory: Example

9. Consider the following $1,000 par value zero-coupon bonds:

Bond	Years to Maturity	YTM(%)
A	1	5%
B	2	6
C	3	6.5
D	4	7

According to the expectations hypothesis, what is the market's expectation of the yield curve one year from now? Specifically, what are the expected values of next year's yields on bonds with maturities of (*a*) one year? (*b*) two years? (*c*) three years?

Theories of Term Structure

(2) Liquidity Preference Theory

- Long-term bonds are riskier => $f_n > E(r_n)$

- The excess of f_n over $E(r_n)$ is the **LIQUIDITY PREMIUM!**

- The yield curve has an upward bias built into the long-term rates because of the liquidity premium

Yield Curve Examples

Panel A:

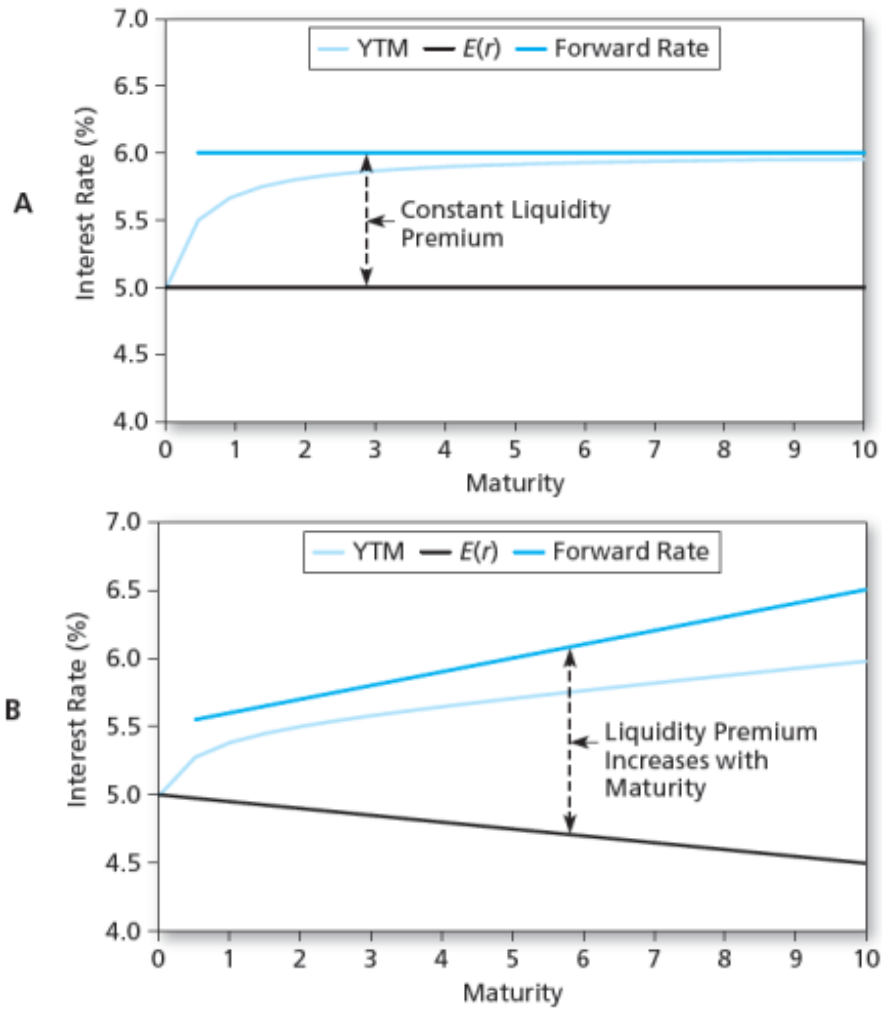
Constant Expected Short Rate

Constant Liquidity Premium

Panel B:

Declining Expected Short Rate

Increasing Liquidity Premiums

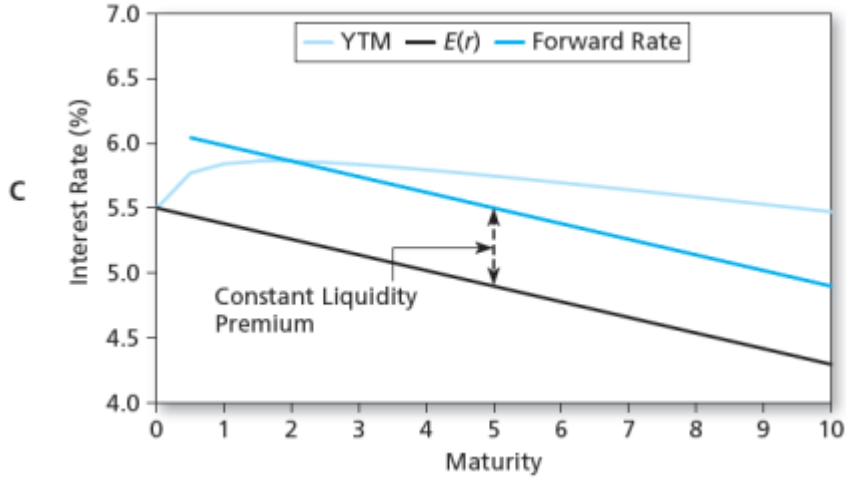


Yield Curve Examples

Panel C:

Declining Expected Short Rate

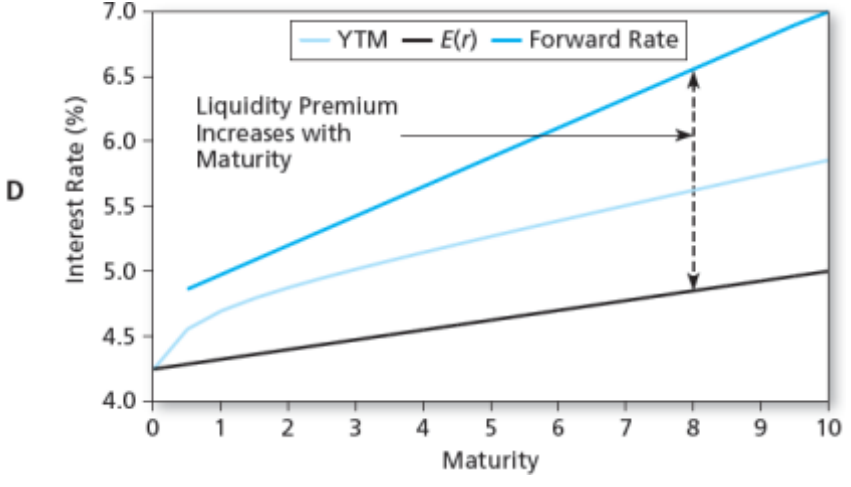
Constant Liquidity Premiums



Panel D:

Increasing Expected Short Rates

Increasing Liquidity Premiums



Question?