Money and Banking

Interest Rates 2/2
Mishkin (12th) Chapter 4,5,6

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Don't Fear higher Interest Rates

Roadmap - The Behavior of Interest Rates

- Determinants of Asset Demand
- S&D in the Bond Market
- Changes in Equilibrium Interest Rates
- Moving along vs Shifting S&D
- Liquidity preference framework
- Change in equilibrium interest rate
- Money and Interest Rate

Determinants of Asset Demand

- **Wealth**. Suppose after consuming some of your income you realize that you have some left. So you think about ways to store that additional purchasing power.

$$\text{Wealth } \uparrow \Rightarrow \text{Asset Demand} \uparrow \tag{1}$$

- **Expected Return**. An increase in an asset's expected return relative to that of an alternative asset, holding everything else unchanged, raises the quantity demanded of the asset.

$$\text{Expected Return } \uparrow \Rightarrow \text{Asset Demand} \uparrow \tag{2}$$

Determinants of Asset Demand

- **Risk**. Holding everything else constant, if an asset's risk rises relative to that of alternative assets, its quantity demanded will fail.

$$\text{Risk} \uparrow \Rightarrow \text{Asset Demand} \downarrow \tag{3}$$

- **Liquidity**. The more liquidity an asset is relative to alternative assets, holding everything else unchanged, the more desirable it is and the greater the quantity demanded will be.

$$\text{Liquidity} \uparrow \Rightarrow \text{Asset Demand} \uparrow \tag{4}$$

Determinants of Asset Demand Summary

- A compact way to summarize what determines interest rates is to express them as a function of the aforementioned variables:

$$\begin{aligned} A^d &= f(\underset{+}{w}, \underset{+}{R^e}, \underset{-}{\sigma}, \underset{+}{l}) \qquad (5) \\ A^d &: \text{Asset Demand} \\ w &: \text{Wealth} \\ R^e &: \text{Expected Return} \\ \sigma &: \text{Risk} \\ l &: \text{Liquidity} \end{aligned}$$

- Where in () we have the signs of partial derivatives or the direction of the relationship, e.g.

$$\frac{\partial A^d}{\partial w} > 0 \qquad (6)$$

S&D in the Bond Market

- First, think about this: "interest rates of different assets tend to move together".
- Thus, as a first approximation we can focus on one type of asset: bonds.
- From previous micro course we know that any S&D analysis we need to know the relevant prices and quantities.

Example

Suppose that you can buy a bond with face value of $1,000, the holding period is a year and no coupon payments (i.e. interest rate=YTM=rate of return) for $950. Now suppose that under such conditions you would be happy to hold $500k worth of that bond. If the price of such bond falls to $900, would you demand more or less of it? Why?

Solution

$$i = R^e = YTM = \frac{F - P}{P} \tag{7}$$

$$i = \frac{1000 - 950}{950} = 5.3\%; \quad i = \frac{1000 - 900}{900} = 11.1\% \tag{8}$$

$$P \downarrow \Rightarrow i \uparrow \tag{9}$$

- Because the price fell, we know that the interest rate must have risen.
- Since in this case interest rate=return, the theory of asset demand tells us that the quantity demanded will rise.
- Draw demand curve.

Example

Suppose that you are the CFO of a firm and are considering issuing $1,000 face value, no coupon bonds (i.d. a debt contract). This week you survey the market and you realize that, at prevailing interest rates, it is willing to buy your bonds at $750 each. You issue $100k. If the price at which you can sell them rises, would you issue more or less of them?.

- Draw supply curve.

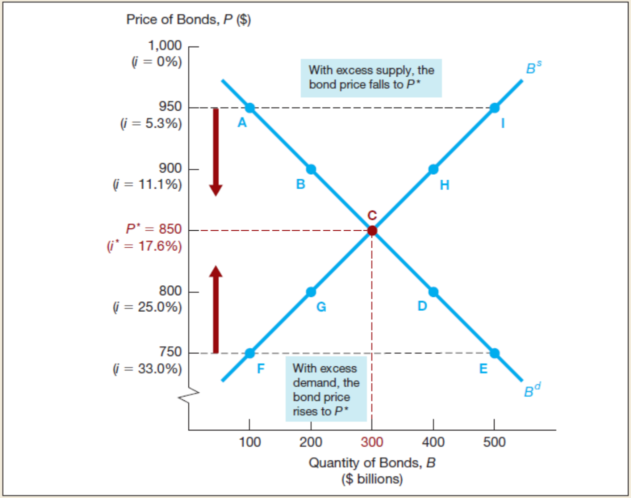
S&D in the Bond Market

Demand & Supply Curve

FIGURE 1

Supply and Demand for Bonds

Equilibrium in the bond market occurs at point C, the intersection of the demand curve B^d and the bond supply curve B^s. The equilibrium price is $P^* = \$850$, and the equilibrium interest rate is $i^* = 17.6\%$.



Definition

In economics, market equilibrium occurs when the amount that people are willing to buy (demand) equals the amount that people are willing to sell (supply) at a given price. In a bond market, this is achieved when the quantity of bonds demanded equals the quantity of bonds supplied:

$$B^d = B^s \tag{10}$$

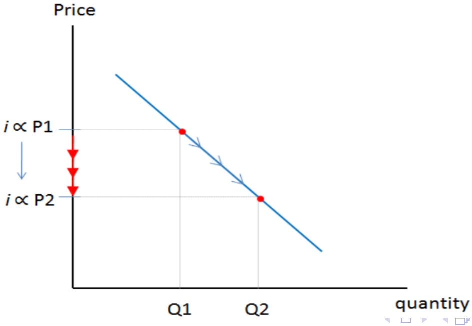
Moving Along vs Shifting S&D

Problem

When are we moving along the S/D curves?

Solution

When the quantity demanded/supplied changes as a result of a price change



Moving Along vs Shifting S&D

Problem

When are we shifting S/D curves?

Solution

When quantities demanded/supplied for any given price

Shifting Demand

Problem

What shifts the demand for bond curves to the **RIGHT**, *at each bond price?*

1. Wealth $\uparrow$
2. Risk $\downarrow$
3. Liquidity $\uparrow$
4. Expected inflation $\downarrow$
5. **Expected Interest Rate** $\downarrow$

Shifting Demand
Expected Interest Rate

- If $R^e = in\ i$, then $\Delta R^e \rightarrow \Delta in\ i \rightarrow \Delta P \rightarrow$moving along the demand curve
- therefore only when $R^e \neq in\ i \rightarrow$shifting the demand curve
- Note the subtlety: suppose that you expect interest rates to rise in the future compared to their current level.
- Then because of the inverse relationship between P and i, for a long term bond, expected future $i \uparrow \Rightarrow$ bond future $P \downarrow \Rightarrow$expected bond return$\downarrow \Rightarrow$bond demand$\downarrow \Rightarrow$bond demand curve to the left.
- Why for a long-term bond? This is because longer-term bonds have a greater duration than short-term bonds that are closer to maturity and have fewer coupon payments remaining.

Shifting Supply

Problem

Now, that shifts the supply curve to the **RIGHT***?*

1. Expected profitability of investment $\uparrow$ .Consider the case of economic expansions: profitable investment opportunities abound.
2. Government budget deficits $\uparrow$ .Whenever the Government increases its budget deficit it needs to issue more bonds
3. Expected inflation $\uparrow$ .At a given nominal interest rate higher expected inflation reduces the cost of borrowing.

Case Study 1: Expected Inflation

- From our last lecture, we know, in the monetary theory of inflation, money growth is the cause of inflation. One expects inflation because one expects money growth.
- Higher expected inflation reduces the cost of borrowing $\Rightarrow B_1^s \rightsquigarrow B_2^s$ (right)
- Higher expected inflation lowers the expected return on bond$\Rightarrow B_1^d \rightsquigarrow B_2^d$ (left)

Case Study 1: Expected Inflation

Example

Suppose you take out a \$50,000 loan from the bank to pay for college, and they give you five years to pay back the loan. If inflation unexpectedly increases over the next five year, who is helped by the inflation, you or the bank?

Solution

The unexpected inflation benefits you and hurts the bank. The value of the dollars you pay back to the bank is less than the value of the dollars the bank thought they would be getting because you are paying back the loan using dollars that are worth less.

Fact

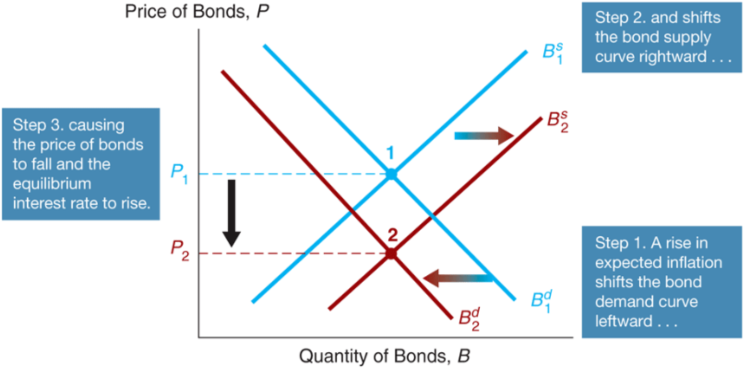
There are both winners and losers from inflation.

Case Study 1: Expected Inflation

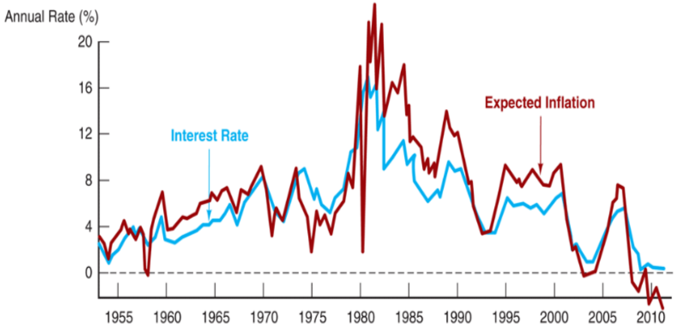
Fact

Some people think inlfation makes everyone worse off (X)

Case Study 1: Expected Inflation

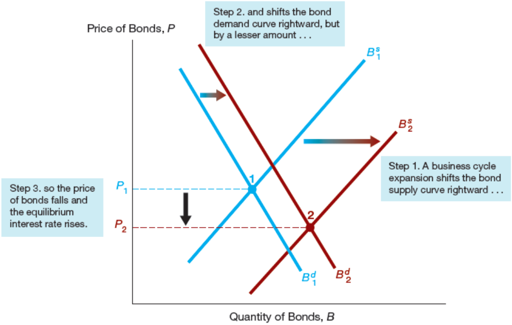


Case Study 2: Expected Inflation vs Interest Rate



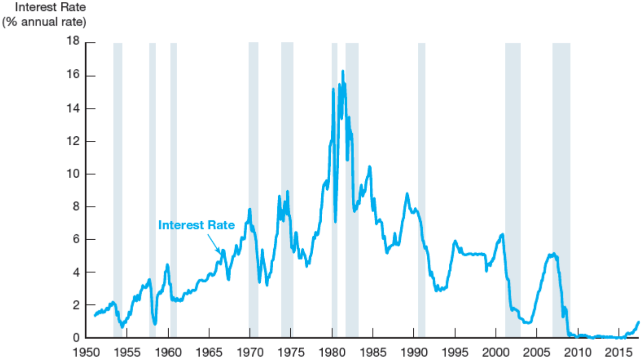
- Fisher Effect: the interest rate on three-month Treasury bills and the expected inflation rate generally move together.

Case Study 3: Business Cycle Expansion



- Demand effect: Wealth
- Supply effect: Profitability

Case Study 4: Business Cycle and Interest Rates



- Shaded areas indicate periods of recession. The interest rate tends to rise during business cycle expansion and fall during recession.

Liquidity Preference Framework (Keynes)

- This framework determines the equilibrium interest rate in terms of the supply of and demand for **money** rather than they supply of and demand for bonds.
- Suppose people only hold bonds and money:

$$\underbrace{B^d + M^d}_{\text{total wealth}} = \underbrace{B^s + M^s}_{\text{supply of assets}} \tag{11}$$

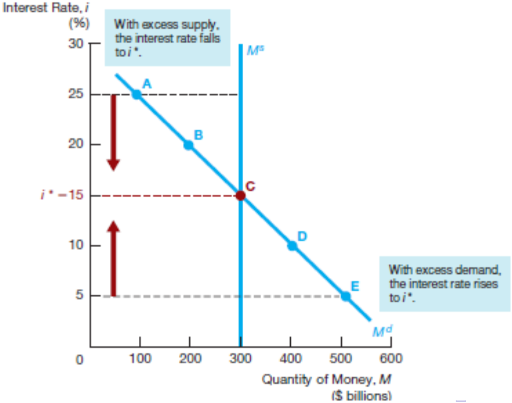
- or

$$B^s - B^d = M^d - M^s \tag{12}$$

- That is, the bonds market is in equilibrium $\iff$ the money market is in equilibrium
- Opportunity cost of holding money. Because $R_M^e = 0$, and $R_B^e > 0$

Liquidity Preference Framework (Keynes)

- Suppose the central bank controls the amount of money supplied at a fixed quantity of $300 billion
- As the interest rate on bonds rises, the opportunity cost of holding money rises. Thus money is less desirable and quantity of money demanded fall.



Changes in Equilibrium Interest Rate

What shifts the demand curve in the market for money?

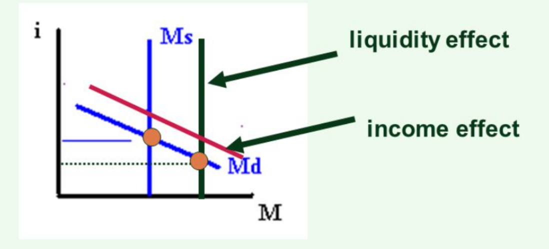
- Income. Higher income results in higher wealth $\Rightarrow$ need to store value rises.
- Price level. When $P \uparrow \Rightarrow$ need more money to prevent purchasing power from falling.

$$\frac{M}{P} = \text{purchasing power} \tag{13}$$

Changes in Equilibrium Interest Rate

What shifts the supply curve in the market for money?

- ...the Fed does. An increase in the money supply engineered by the Federal Reserve will shift the supply curve for money to the right.
- Liquidity effect: an increase in the money supply (everything else remaining equal) lowers interest rates.

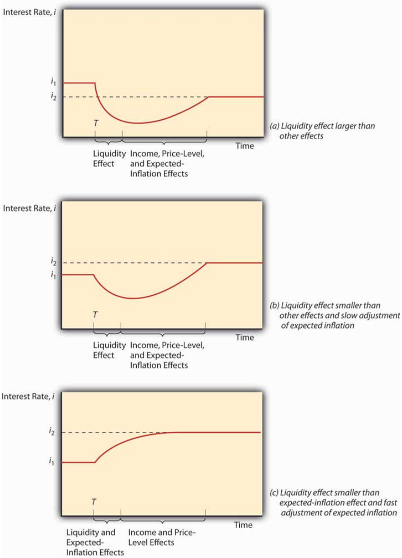


Money and Interest Rate

The "all else equal" in this case is unattainable. Consider Milton Friedman's criticism:

- There is also **income effect**: at first, lower interest rates tend to boost economic activity but as this happens, agents will demand more bonds and more money and interest rates will go up again though we cannot tell how much.
- Note also the **price level effect**: The income effect may partially offset the reduction in interest rates, which in turn means that the monetary expansion outweights the real expansion driving up prices; thus demand for money will rise further.
- **Inflation effect**: while prices are adjusting, agents will expect prices to rise in the future, that is, they will predict inflation which in turn drives up interest rates.

Money and Interest Rate



Money and Interest Rate

Problem

How to understand that liquidity effect is larger than the other effects?

- Because the liquidity effect is larger than the other three effects, the interest rate never rises back to its initial level.

A Lower Interest Rate Doesn't Make A Debt Go Away

Roadmap - The Risk and Term Structure of Interest Rates

- Risk structure of interest rates
- Term structure of interest rates

Beyond the Role of Interest Rates

- So far we have studied the role of interest rates in financial markets; we know they help us in the task of valuing money over time.
- Recall YTM: used to discount future flows and express them in terms of present purchasing power:

$$PV = \frac{CF}{(1+i)^n} \tag{14}$$

- But what is "i" made of and why it may differ from one asset to other?
- Moreover, what causes "i" to fluctuate over time?

Risk Structure of Interest Rates

Bonds with the same maturity have different interest rate due to:

- default risk
- liquidity
- tax considerations

Definition (Default Risk)

Probability that the issuer of the bond is unable or unwilling to make interest payments or pay off the face value.

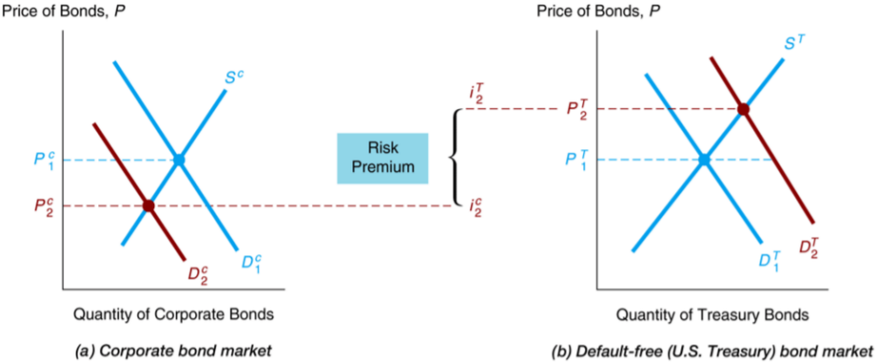
- U.S. Treasury bonds are considered default free (government can raise taxes).

Definition (Risk Premium)

the spread between the interest rates on bonds with default risk and the interest rates on (same maturity) Treasury bonds

Risk Structure of Interest Rates

Default Risk and Risk Premium



- A bond with default risk will always have a positive risk premium and the latter increases whenever the former increases.

Capital Asset Pricing Model (CAPM), which is a model for pricing an individual security or portfolio. The formula for calculating the expected return of an asset given its risk is as follows:

$$\begin{aligned} ER_i &= R_f + \beta_i(ER_m - R_f) \qquad (15) \\ ER_i &= \text{Expected return on the capital asset} \\ R_f &= \text{risk free rate of interest} \\ \beta_i &= \text{sensitivity} \\ ER_m &= \text{Expected return of the market} \\ ER_m - R_f &= \textbf{risk premium} \end{aligned}$$

$$\underbrace{ER_i - R_f}_{\text{individual risk premium}} = \beta_i * \underbrace{(ER_m - R_f)}_{\text{market risk premium}} \tag{16}$$

which states that the individual risk premium equals the market premium times β.

Private Solution to Information Asymmetries: rating scales used by moody's, S&P, and Fitch

Rating			
Moody's	S&P	Fitch	Definitions
Aaa	AAA	AAA	Prime Maximum Safety
Aa1	AA-	AA-	High Grade High Quality
Aa2	AA	AA	
Aa3	AA-	AA-	
A1	A+	A+	Upper Medium Grade
A2	A	A	
A3	A-	A-	
Baa1	BBB+	BBB+	Lower Medium Grade
Baa2	BBB	BBB	
Baa3	BBB-	BBB-	
Ba1	BB+	BB+	Non Investment Grade
Ba2	BB	BB	Speculative
Ba3	BB-	BB-	
B1	B-	B-	Highly Speculative
B2	B	B	
B3	B-	B-	
Caa1	CCC+	CCC	Substantial Risk
Caa2	CCC	—	In Poor Standing
Caa3	CCC-	—	
Ca	—	—	Extremely Speculative

Private Solution to Information Asymmetries: rating scales used by moody's, S&P, and Fitch

- Highly rated investment-grade bonds are those with the lowest risk of default.
- **Junk Bonds** have the highest risk premium and are at the highest risk of default.
- Investment grade: 1) strongest Aaa~Baa3; 2) noninvestment Ba1~Ca (junk bonds); 3) weakest C (junk bonds)
- Moody's, Standard & Poor's, and Fitch append their ratings with an indicator to show a bond's ranking within a category. Moody's uses a numerical indicator. For example, A1 is better than A2 (but still not as good as Aa3). Standard & Poor's and Fitch use a plus or minus indicator. For example, A+ is better than A, and A is better than A-.
- Remember that ratings aren't perfect and can't tell you whether or not your investment will go up or down in value. Before using ratings as one factor in your investment selection process, learn about the methodologies and criteria each ratings agency employs.

- The relative ease with which an asset can be converted into cash.
- Cost of selling a bond
- Number of buyers/sellers in a bond market

Risk Structure of Interest Rates

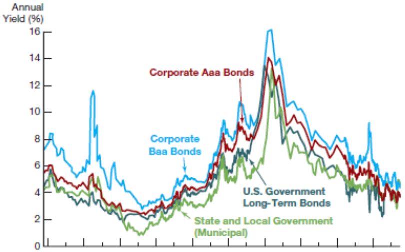
Tax Considerations

Municipal bonds vs Treasury bonds

- Municipal bonds are certainly not default-free: State and local governments have defaulted on municipal bonds in the past, particularly during recession.

Problem

Why is it, then, that these bonds have had lower interest rates than U.S. Treasury bonds for most of the past 100 years?



Solution

The explanation lies in the fact that interest payments on municipal bonds are exempt from federal income taxes.

Example

Let's imagine that your income is high enough to put you in the 40% income tax bracket. You have two options: 1)own a $1000-face value U.S. Treasury bond that sells for $1000 and has a coupon payment of $100. 2) own a $1000 face value municipal bond that sells for $1000 and pays only $80 in coupon payments. Which one would you choose?

$$\text{Option 1}: \; 100(1-40\%) = \$60 \tag{17}$$

$$\text{Option 2}: 80 \tag{18}$$

Term Structure of Interest Rates: bond spread

- Bonds with identical risk, liquidity, and tax characteristics may have different interest rates because the time remaining to maturity is different. This difference is called a **bond spread**.
- Mathematically, a bond spread is the simple subtraction of one bond yield from another.

Term Structure of Interest Rates: interpreting the yield curve

- Yield curve: a plot of the yield on bonds with differing terms to maturity but the same risk, liquidity and tax considerations. It is plotted with bond yield on the vertical axis and the years to maturity on the horizontal axis.
- A yield curve tells us about the relative cost of short-term and long-term debt and allows companies to not only decide about the structure and timing of their capital structure changes, but it also carries important information about the economic outlook and financial market conditions.

Term Structure of Interest Rates: interpreting the yield curve

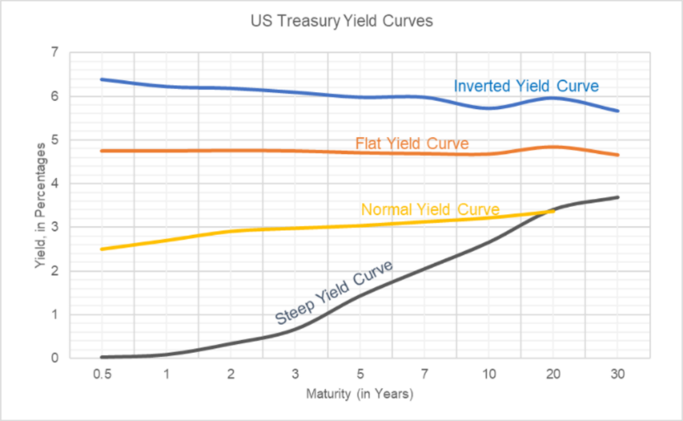
Example

let us consider the following data obtained from US Department of Treasury website regarding yield on US treasuries.

Date ↓/ Maturity→	**Shape of Yield Curve**	**0.5**	**1**	**2**	**3**	**5**	**7**	**10**	**20**	**30**
31-Aug-00	Inverted	6.38	6.22	6.18	6.09	5.98	5.98	5.73	5.96	5.67
03-Mar-06	Flat	4.75	4.75	4.76	4.75	4.71	4.69	4.68	4.84	4.66
26-Sep-13	Steep	0.03	0.09	0.34	0.67	1.43	2.05	2.66	3.41	3.69
11-Feb-18	Normal	2.5	2.7	2.91	2.98	3.04	3.13	3.22	3.37	3.46

Term Structure of Interest Rates: four types of yield curve

- If we plot these on a graph, we get the following diagram. This is called the yield curve.



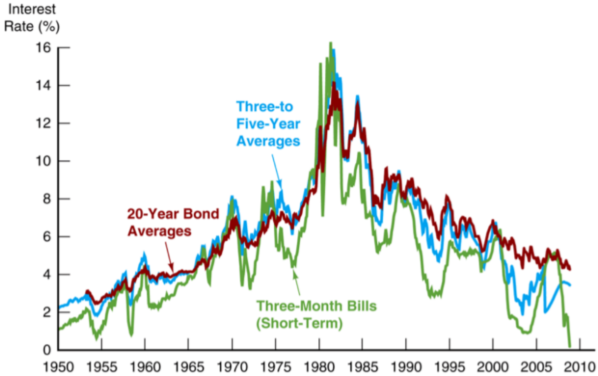
Term Structure of Interest Rates: four types of yield curve

- In general, long-term yields are typically higher than short-term yield due to the higher risk involved in long-term investment. Since this is the most common shape of the yield curve, it is called the **normal yield curve**.
- A **steep yield curve** is the one in which the short-term yields are at normal level, but the long-term yields are higher. A steep yield curve signals that the interest rates are expected to be increase in future.
- A **flat yield curve** is one in which there is no significant difference between yields on short-term and long-term debt. Since the long-term yield is lower than normal, a flat yield curve signals a slow-down in the economy and a decrease in interest rates. When the yield curve is flat, no one would want to obtain long-term debt because they expect interest rates to fall. It is a precursor of *recession*.
- An **inverted yield curve** is just opposite of the normal yield curve (therefore, it is also called abnormal yield curve). When the yield for shorter maturities is higher than the yield for longer maturities, the yield curve slopes downward and the graph looks inverted.

Term Structure of Interest Rates: Yield Curve Summary

- Upward-sloping: long-term rates are above short-term rates
- Flat: short- and long-term rates are the same
- Inverted: long-term rates are below short-term rates
- Steep: short-term rates are normal, the long-term rates are higher

Term Structure of Interest Rates: stylized facts



Term Structure of Interest Rates: stylized facts

Fact (1)

Interest rates on bonds of different maturities move together over time

Fact (2)

When short-term interest rates are low, yield curves are more likely to have an upward slope; when short-term rates are high, yield curves are more likely to slope downward and be inverted

Fact (3)

Yield curves almost always slope upward

Term Structure of Interest Rates: what may explain this?

- Assume bond holders consider bonds with different maturities to be perfect substitutes
- Buyers of bonds do not prefer bonds of one maturity over another; they will not hold any quantity of a bond if its expected return is less than that of another bond with a different maturity
- **Expectation Theory**: The interest rate on a long-term bond will equal an average of the short-term interest rates that people expect to occur over the life of the long-term bond

Example

Let the current rate on one-year bond be 6%. You expect the interest rate on a one-year bond to be 8% next year. Then the expected return for buying two one-year bonds averages $(6\% + 8\%)/2 = 7\%$. The interest rate on a two-year bond must be 7% for you to be willing to purchase it.

Term Structure of Interest Rates: ET

Example

Let us be more general. Suppose that we compare two strategies invest a \$1 as follows: #1) Buy a one period bond, hold it and when it matures, buy another one (roll-over strategy); #2) Buy a two period bond and hold it until maturity.(buy and hold).

- So we have:

i_t = today's interest rate on one period bonds
i^E_{t+1} = next period expected interest rate on one period bonds
i_{2t} = today's interest rate on two period bonds

Term Structure of Interest Rates: ET

- Expected return from the "buy and hold" strategy": the expected return from investing $1 in the two-period bond and holding it for the two periods can be calculated as:

$$\begin{aligned} (1+i_{2t})(1+i_{2t})-1 &= 2i_{2t}+(i_{2t})^2 \qquad (19)\\ &\approx 2i_{2t} \qquad (20) \end{aligned}$$

- Expected return from the "roll over" strategy: the expected return on the $1 investment over the two periods is:

$$\begin{aligned} (1+i_t)(1+i^E_{t+1})-1 &= 1+i_t+i^E_{t+1}+i^E_{t+1}*i_t-1 \qquad (21)\\ &\approx i_t+i^E_{t+1} \qquad (22) \end{aligned}$$

Term Structure of Interest Rates: ET

- The ET of the term structure tells us that both bonds will be held only if their returns are equal we equate these two results:

$$i_t + i^E_{t+1} = 2i_{2t} \Longrightarrow i_{2t} = \frac{i_t + i^E_{t+1}}{2} \tag{23}$$

- or more generally:

$$i_{nt} = \frac{i_t + i^E_{t+1} + i^E_{t+1} + i^E_{t+1} + ... + i^E_{t+n-1}}{2} \tag{24}$$

Term Structure of Interest Rates: ET

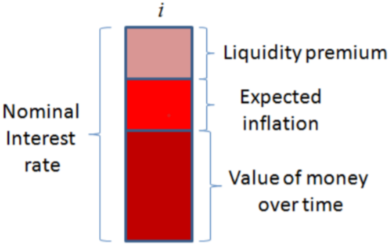
- So the ET explains Fact (1), namely that interest rates of different maturities move together.
- It also explains the Fact(2), if the short term interest rate i_t is low, then people expect it to go back to a normal level in the future; that is, they expect i^E_{t+1} is higher than i_t .
- Therefore, the average of $i_t + i^E_{t+1}$ would be higher than i_t and the two period bond will have a higher interest rate.
- However, the ET fails to explain Fact(3)

Term Structure of Interest Rates: Segmented markets theory

- Radical departure: markets for different maturity bonds are completely separate and segmented.
- Interest rates for each maturity are determined by D&S in each market.
- Investors have preferences for bonds of one maturity over another.
- If investors generally prefer bonds with shorter maturities that have less interest-rate risk, then this explains why yield curves usually slope upward (Fact 3).

Term Structure of Interest Rates: Liquidity premium theory

- The interest rate on a long-term bond will equal an average of short-term interest rates expected to occur over the life of the long-term bond plus a liquidity premium that responds to supply and demand conditions for that bond.
- So we can add to our break-down of interest rates. If we are comparing two bonds with the same risk structure:



- Note: if we are comparing bonds with different default risk, we would add a risk premium.

Term Structure of Interest Rates: Liquidity premium theory

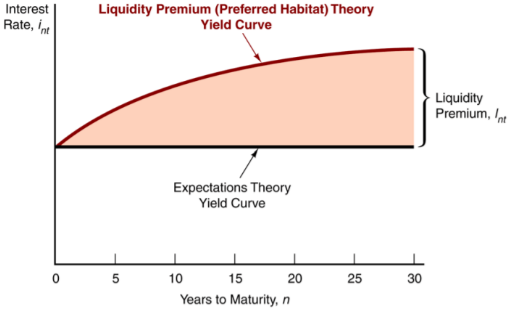
- Thus, we can adjust the resutl from the ET framework to account for the **liquidity premium theory**:

$$i_{nt} = \underbrace{\frac{i_t + i^E_{t+1} + i^E_{t+1} + i^E_{t+1} + \dots + i^E_{t+n-1}}{2}}_{\text{Pure expectations thoery}} + \underbrace{l_{nt}}_{\text{Liquidity premium theory}} \quad (25)$$

- Note the subindex in l_{nt} ; it has two components, n and t.
- Usually the longer the maturity, the higher the liquidity premium.
- Also, the liquidity premium may change over time; in good times it may be lower and in uncertain times it may be much higher.
- A similar approach is that of the **preferred habitat theory**: Investors have a preference for bonds of one maturity over another.
- They will be willing to buy bonds of different maturities only if they earn a somewhat higher expected return.

Term Structure of Interest Rates: Liquidity premium theory

- Usually investors preferred habitat would be that of short term bonds in which case the analysis would be the same as the liquidity premium theory:



- (The expectations yield curve is drawn flat because it is as likely to be upward sloping as it is to be downward sloping).
- However, the preferred habitat theory may allow for different investors to prefer different "habitats".

Term Structure of Interest Rates: testing the yield curve

- Modern evidence suggests that yield curve data contain good information about the liquidity premium between short and long term bonds but not so good information about intermediate term bonds.
- Yield curve data are also helpful in forecasting future inflation.
- Since rising interest rates are associated with economic booms and falling interest rates are associated with recessions, the yield curve may have predictive power over the business cycle.