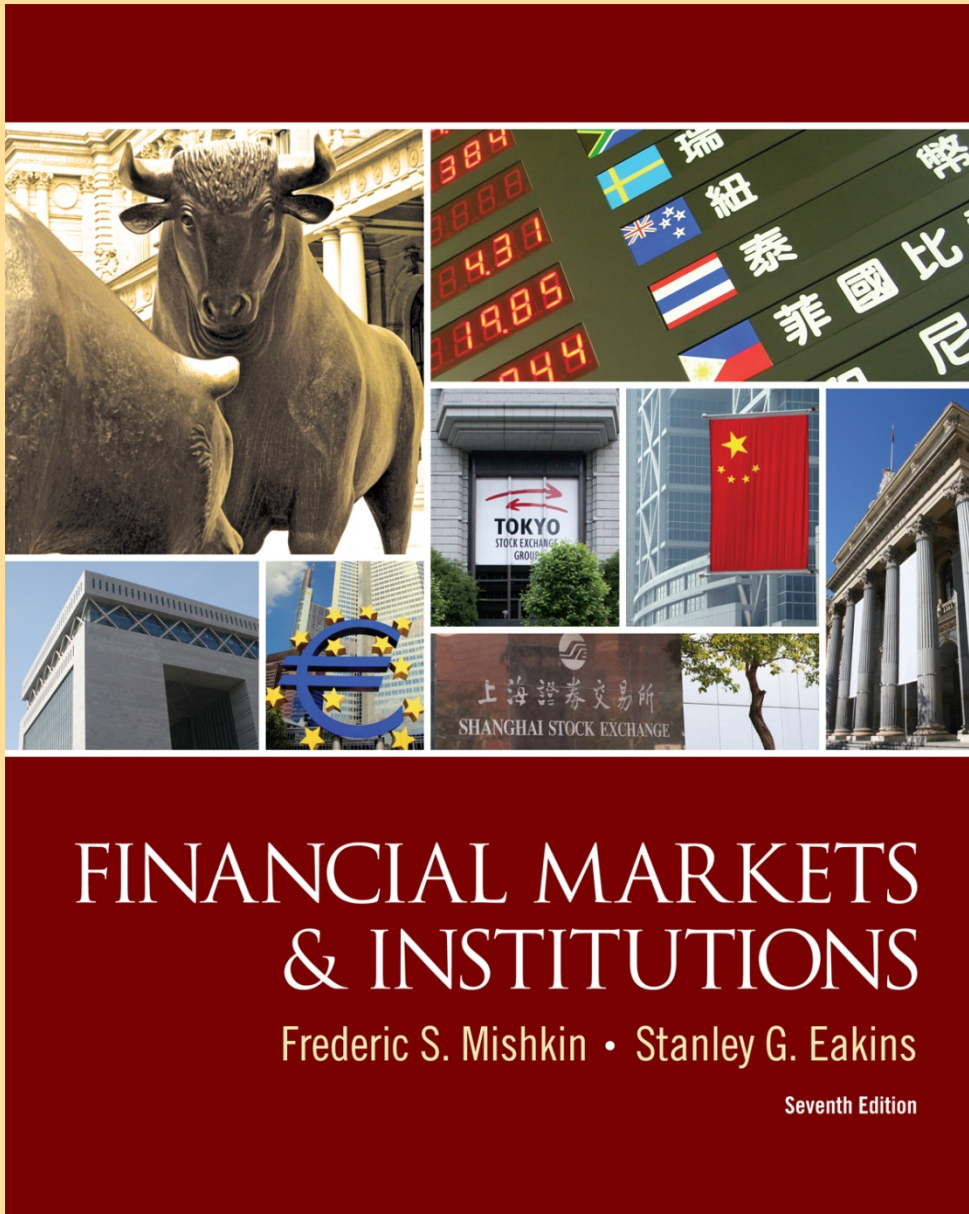


CHAPTER 4

Why Do Interest Rates Change?



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Chapter Preview

In the early 1950s, short-term Treasury bills were yielding about 1%. By 1981, the yields rose to 15% and higher. But then dropped back to 1% by 2003. In 2007, rates jumped up to 5%, only to fall back to near zero in 2008.

What causes these changes?



Chapter Preview

In this chapter, we examine the forces that move interest rates and the theories behind those movements. Topics include:

- Determining Asset Demand
- Supply and Demand in the Bond Market
- Changes in Equilibrium Interest Rates



Determinants of Asset Demand

- An **asset** is a piece of property that is a store of value. Facing the question of whether to buy and hold an asset or whether to buy one asset rather than another, an individual must consider the following factors:
 1. **Wealth**, the total resources owned by the individual, including all assets
 2. **Expected return** (the return expected over the next period) on one asset relative to alternative assets
 3. **Risk** (the degree of uncertainty associated with the return) on one asset relative to alternative assets
 4. **Liquidity** (the ease and speed with which an asset can be turned into cash) relative to alternative assets



EXAMPLE 1: Expected Return

EXAMPLE 4.1 Expected Return

What is the expected return on the Exxon-Mobil bond if the return is 12% two-thirds of the time and 8% one-third of the time?

Solution

The expected return is 10.68%.

$$R^e = p_1R_1 + p_2R_2$$

where

$$p_1 = \text{probability of occurrence of return 1} = \frac{2}{3} = 0.67$$

$$R_1 = \text{return in state 1} = 12\% = 0.12$$

$$p_2 = \text{probability of occurrence return 2} = \frac{1}{3} = 0.33$$

$$R_2 = \text{return in state 2} = 8\% = 0.08$$

Thus,

$$R^e = (.67)(0.12) + (.33)(0.08) = 0.1068 = 10.68\%$$



EXAMPLE 2: Standard Deviation (a)

Consider the following two companies and their forecasted returns for the upcoming year:

		Fly-by-Night	Feet-on-the-Ground
Outcome 1	Probability	50%	100%
	Return	15%	10%
Outcome 2	Probability	50%	
	Return	5%	



EXAMPLE 2: Standard Deviation (b)

What is the standard deviation of the returns on the Fly-by-Night Airlines stock and Feet-on-the-Ground Bus Company, with the return outcomes and probabilities described on the previous slide? Of these two stocks, which is riskier?



EXAMPLE 2:

Standard Deviation (c)

Solution

Fly-by-Night Airlines has a standard deviation of returns of 5%.

$$\sigma = \sqrt{p_1(R_1 - R^e)^2 + p_2(R_2 - R^e)^2}$$
$$R^e = p_1R_1 + p_2R_2$$

where

$$p_1 = \text{probability of occurrence of return 1} = \frac{1}{2} = 0.50$$

$$R_1 = \text{return in state 1} = 15\% = 0.15$$

$$p_2 = \text{probability of occurrence of return 2} = \frac{1}{2} = 0.50$$

$$R_2 = \text{return in state 2} = 5\% = 0.05$$

$$R^e = \text{expected return} = (.50)(0.15) + (.50)(0.05) = 0.10$$

Thus,

$$\sigma = \sqrt{(.50)(0.15 - 0.10)^2 + (.50)(0.05 - 0.10)^2}$$

$$\sigma = \sqrt{(.50)(0.0025) + (.50)0.0025} = \sqrt{0.0025} = 0.05 = 5\%$$



EXAMPLE 2:

Standard Deviation (d)

Feet-on-the-Ground Bus Company has a standard deviation of returns of 0%.

$$\sigma = \sqrt{p_1(R_1 - R^e)^2}$$

$$R^e = p_1 R_1$$

where

$$p_1 = \text{probability of occurrence of return 1} = 1.0$$

$$R_1 = \text{return in state 1} = 10\% = 0.10$$

$$R^e = \text{expected return} = (1.0)(0.10) = 0.10$$

Thus,

$$\begin{aligned}\sigma &= \sqrt{(1.0)(0.10 - 0.10)^2} \\ &= \sqrt{0} = 0 = 0\%\end{aligned}$$



EXAMPLE 2: Standard Deviation (e)

- Fly-by-Night Airlines has a standard deviation of returns of 5%; Feet-on-the-Ground Bus Company has a standard deviation of returns of 0%.
- Clearly, Fly-by-Night Airlines is a riskier stock because its standard deviation of returns of 5% is higher than the zero standard deviation of returns for Feet-on-the-Ground Bus Company, which has a certain return.
- A *risk-averse* person prefers stock in the Feet-on-the-Ground (the sure thing) to Fly-by-Night stock (the riskier asset), even though the stocks have the same expected return, 10%. By contrast, a person who prefers risk is a *risk preferrer* or *risk lover*. We assume people are risk-averse, especially in their financial decisions.



Determinants of Asset Demand (2)

The quantity demanded of an asset differs by factor.

1. **Wealth:** Holding everything else constant, an increase in wealth raises the quantity demanded of an asset
2. **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
3. **Risk:** Holding everything else constant, if an asset's risk rises relative to that of alternative assets, its quantity demanded will fall
4. **Liquidity:** The more liquid an asset is relative to alternative assets, holding everything else unchanged, the more desirable it is, and the greater will be the quantity demanded



Determinants of Asset Demand (3)

TABLE 4.1 Summary Response of the Quantity of an Asset Demanded to Changes in Wealth, Expected Returns, Risk, and Liquidity
SUMMARY

Variable	Change in Variable	Change in Quantity Demanded
Wealth	↑	↑
Expected return relative to other assets	↑	↑
Risk relative to other assets	↑	↓
Liquidity relative to other assets	↑	↑

Note: Only increases in the variables are shown. The effect of decreases in the variables on the change in quantity demanded would be the opposite of those indicated in the far-right column.



Supply & Demand in the Bond Market

We now turn our attention to the mechanics of interest rates. That is, we are going to examine how interest rates are determined—from a demand and supply perspective. Keep in mind that these forces act differently in different bond markets. That is, current supply/demand conditions in the corporate bond market are not necessarily the same as, say, in the mortgage market. However, because rates tend to move together, we will proceed as if there is one interest rate for the entire economy.



The Demand Curve

Let's start with the demand curve.

Let's consider a one-year discount bond with a face value of \$1,000. In this case, the return on this bond is entirely determined by its price. The return is, then, the bond's yield to maturity.



Derivation of Demand Curve

$$i = R^e = \frac{(F - P)}{P}$$

- Point A: if the bond was selling for \$950.

$$P = \$950$$

$$i = \frac{(\$1000 - \$950)}{\$950} = .053 = 5.3\%$$

$$B^d = 100$$



Derivation of Demand Curve (cont.)

- Point B: if the bond was selling for \$900.

$$P = \$900$$

$$i = \frac{(\$1000 - \$900)}{\$900} = .111 = 11.1\%$$

$$B^d = 200$$



Derivation of Demand Curve

How do we know the demand (B^d) at point A is 100 and at point B is 200?

Well, we are just making-up those numbers. But we are applying basic economics—more people will want (demand) the bonds if the expected return is higher.



Derivation of Demand Curve

To continue ...

- Point C: $P = \$850$ $i = 17.6\%$ $B^d = 300$
- Point D: $P = \$800$ $i = 25.0\%$ $B^d = 400$
- Point E: $P = \$750$ $i = 33.0\%$ $B^d = 500$
- Demand Curve is B^d in Figure 4.1 which connects points A, B, C, D, E.
 - Has usual downward slope



Supply and Demand for Bonds

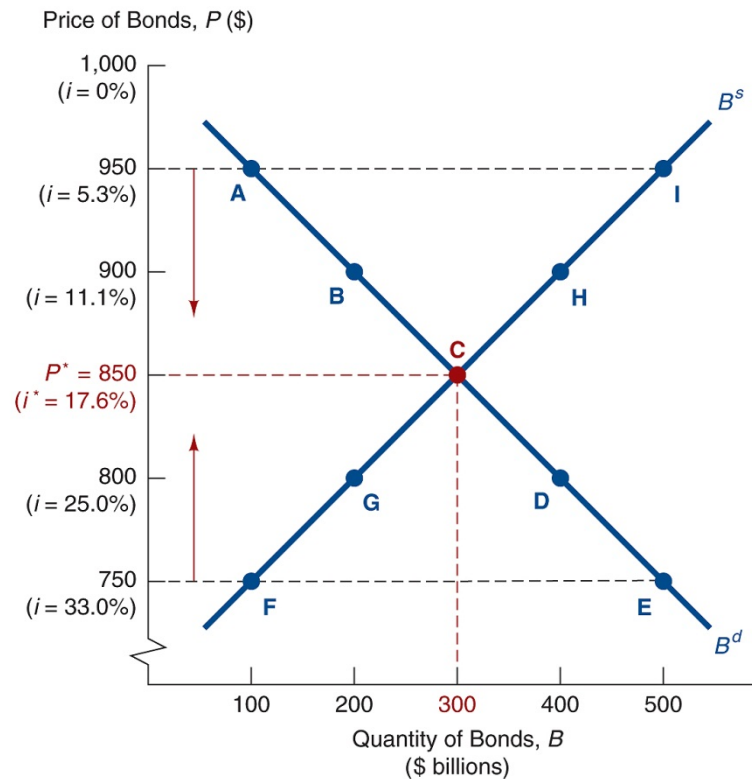


FIGURE 4.1 Supply and Demand for Bonds

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 $i^* = 17.6\%$.



Derivation of Supply Curve

In the last figure, we snuck the supply curve in—the line connecting points F, G, C, H, and I. The derivation follows the same idea as the demand curve.



Derivation of Supply Curve

- Point F: $P = \$750$ $i = 33.0\%$ $B^S = 100$
- Point G: $P = \$800$ $i = 25.0\%$ $B^S = 200$
- Point C: $P = \$850$ $i = 17.6\%$ $B^S = 300$
- Point H: $P = \$900$ $i = 11.1\%$ $B^S = 400$
- Point I: $P = \$950$ $i = 5.3\%$ $B^S = 500$
- Supply Curve is B^S that connects points F, G, C, H, I, and has upward slope



Derivation of Demand Curve

- How do we know the supply (B_s) at point P is 100 and at point G is 200?
- Again, like the demand curve, we are just making-up those numbers. But we are applying basic economics—more people will offer (supply) the bonds if the expected return is lower.



Market Equilibrium

The equilibrium follows what we know from supply-demand analysis:

- Occurs when $B^d = B^s$, at $P^* = 850$, $i^* = 17.6\%$
- When $P = \$950$, $i = 5.3\%$, $B^s > B^d$
(excess supply): $P \downarrow$ to P^* , $i \uparrow$ to i^*
- When $P = \$750$, $i = 33.0$, $B^d > B^s$
(excess demand): $P \uparrow$ to P^* , $i \downarrow$ to i^*



Market Conditions

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

Excess supply occurs when the amount that people are willing to sell (*supply*) is greater than the amount people are willing to buy (*demand*) at a given price

Excess demand occurs when the amount that people are willing to buy (*demand*) is greater than the amount that people are willing to sell (*supply*) at a given price



Supply & Demand Analysis

Notice in Figure 4.1 that we use two different vertical axes—one with price, which is high-to-low starting from the top, and one with interest rates, which is low-to-high starting from the top.

This just illustrates what we already know: bond prices and interest rates are inversely related.

Also note that this analysis is an **asset market approach** based on the stock of bonds. Another way to do this is to examine the *flows*. However, the flows approach is tricky, especially with inflation in the mix. So we will focus on the *stock* approach.



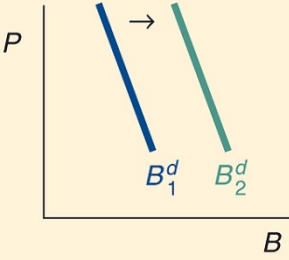
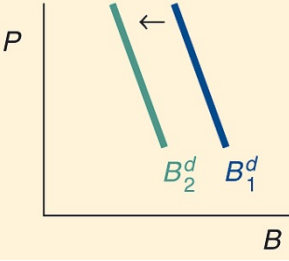
Changes in Equilibrium Interest Rates

We now turn our attention to changes in interest rate. We focus on actual shifts in the curves. Remember: movements along the curve will be due to price changes alone.

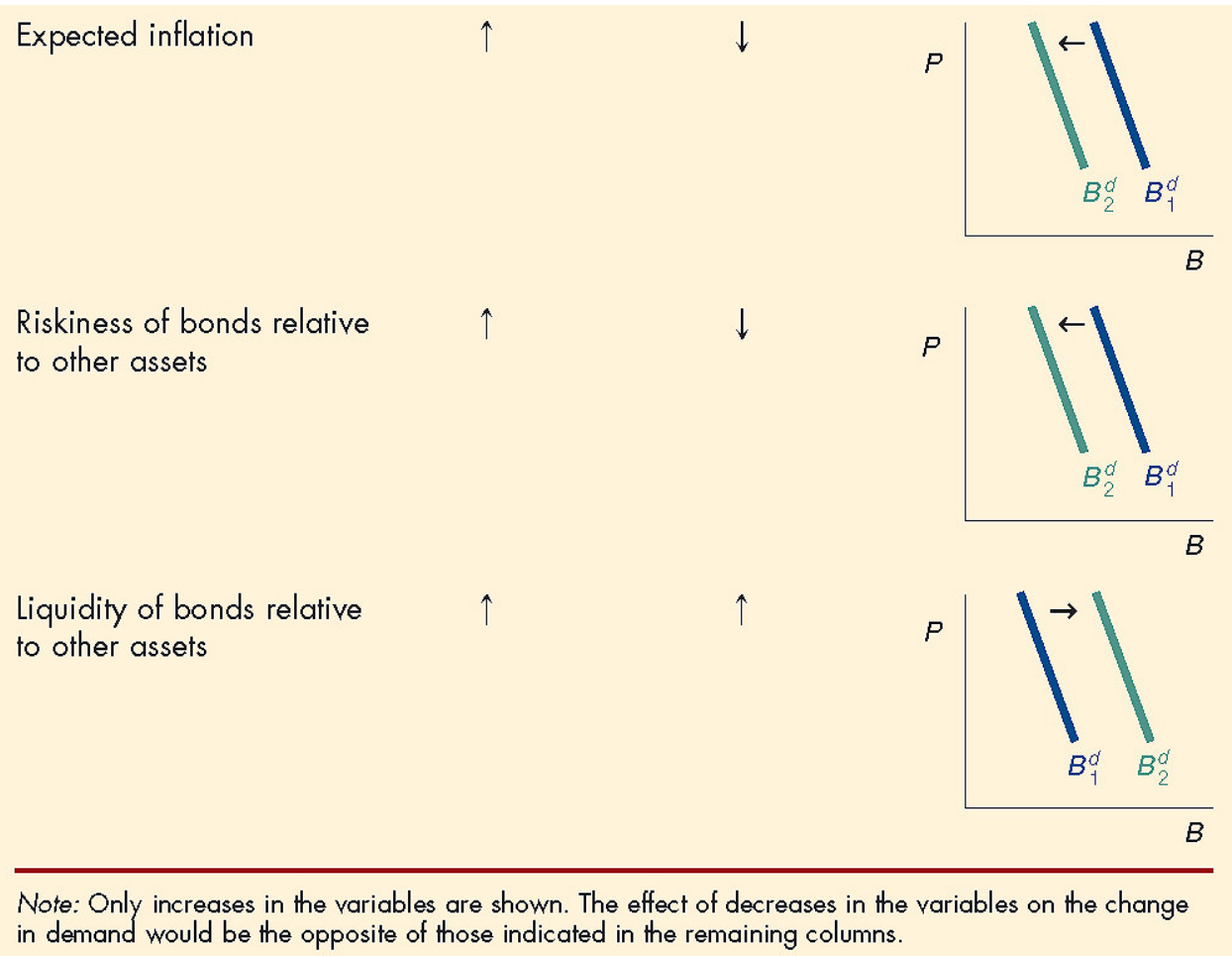
First, we examine shifts in the demand for bonds. Then we will turn to the supply side.

Factors That Shift Demand Curve (a)

TABLE 4.2 Summary Factors That Shift the Demand Curve for Bonds
SUMMARY

Variable	Change in Variable	Change in Quantity Demanded at Each Bond Price	Shift in Demand Curve
Wealth	↑	↑	
Expected interest rate	↑	↓	

Factors That Shift Demand Curve (b)





How Factors Shift the Demand Curve

1. Wealth/saving

- Economy $\uparrow$, wealth $\uparrow$
- $B^d \uparrow$, B^d shifts out to right

OR

- Economy $\downarrow$, wealth $\downarrow$
- $B^d \uparrow$, B^d shifts out to right



How Factors Shift the Demand Curve

2. Expected Returns on bonds

- $i \downarrow$ in future, R^e for long-term bonds $\uparrow$
- B^d shifts out to right

OR

- $\pi^e \downarrow$, relative $R^e \uparrow$
- B^d shifts out to right



How Factors Shift the Demand Curve

...and Expected Returns on other assets

- ER on other asset (stock) $\uparrow$
- R^e for long-term bonds $\downarrow$
- B^d shifts out to left

These are closely tied to *expected interest rate* and *expected inflation* from Table 4.2



How Factors Shift the Demand Curve

3. Risk

- Risk of bonds $\downarrow$, $B^d \uparrow$
- B^d shifts out to right

OR

- Risk of other assets $\uparrow$, $B^d \uparrow$
- B^d shifts out to right



How Factors Shift the Demand Curve

4. Liquidity

- Liquidity of bonds $\uparrow$, $B^d \uparrow$
- B^d shifts out to right

OR

- Liquidity of other assets $\downarrow$, $B^d \uparrow$
- B^d shifts out to right



Shifts in the Demand Curve

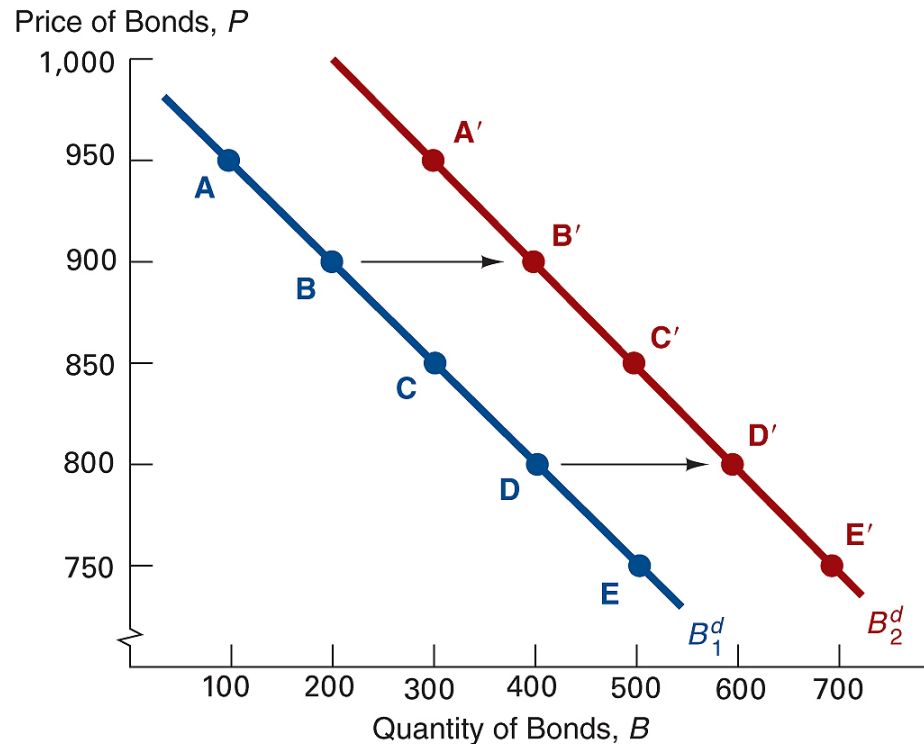


FIGURE 4.2 Shift in the Demand Curve for Bonds

When the demand for bonds increases, the demand curve shifts to the right as shown.



Summary of Shifts in the Demand for Bonds

1. **Wealth:** in a business cycle expansion with growing wealth, the demand for bonds rises, conversely, in a recession, when income and wealth are falling, the demand for bonds falls
2. **Expected returns:** higher expected interest rates in the future decrease the demand for long-term bonds, conversely, lower expected interest rates in the future increase the demand for long-term bonds



Summary of Shifts in the Demand for Bonds (2)

3. **Risk:** an increase in the riskiness of bonds causes the demand for bonds to fall, conversely, an increase in the riskiness of alternative assets (like stocks) causes the demand for bonds to rise
4. **Liquidity:** increased liquidity of the bond market results in an increased demand for bonds, conversely, increased liquidity of alternative asset markets (like the stock market) lowers the demand for bonds



Factors That Shift Supply Curve

We now turn to the supply curve. We summarize the effects in this table:

TABLE 4.3 Summary Factors That Shift the Supply of Bonds
SUMMARY

Variable	Change in Variable	Change in Quantity Supplied at Each Bond Price	Shift in Supply Curve
Profitability of investments	↑	↑	
Expected inflation	↑	↑	
Government deficit	↑	↑	

Note: Only increases in the variables are shown. The effect of decreases in the variables on the change in supply would be the opposite of those indicated in the remaining columns.



Shifts in the Supply Curve

1. Profitability of Investment Opportunities
 - Business cycle expansion,
 - investment opportunities $\uparrow$, $B^s \uparrow$,
 - B^s shifts out to right
2. Expected Inflation
 - $\pi^e \uparrow$, $B^s \uparrow$
 - B^s shifts out to right
3. Government Activities
 - Deficits $\uparrow$, $B^s \uparrow$
 - B^s shifts out to right



Shifts in the Supply Curve

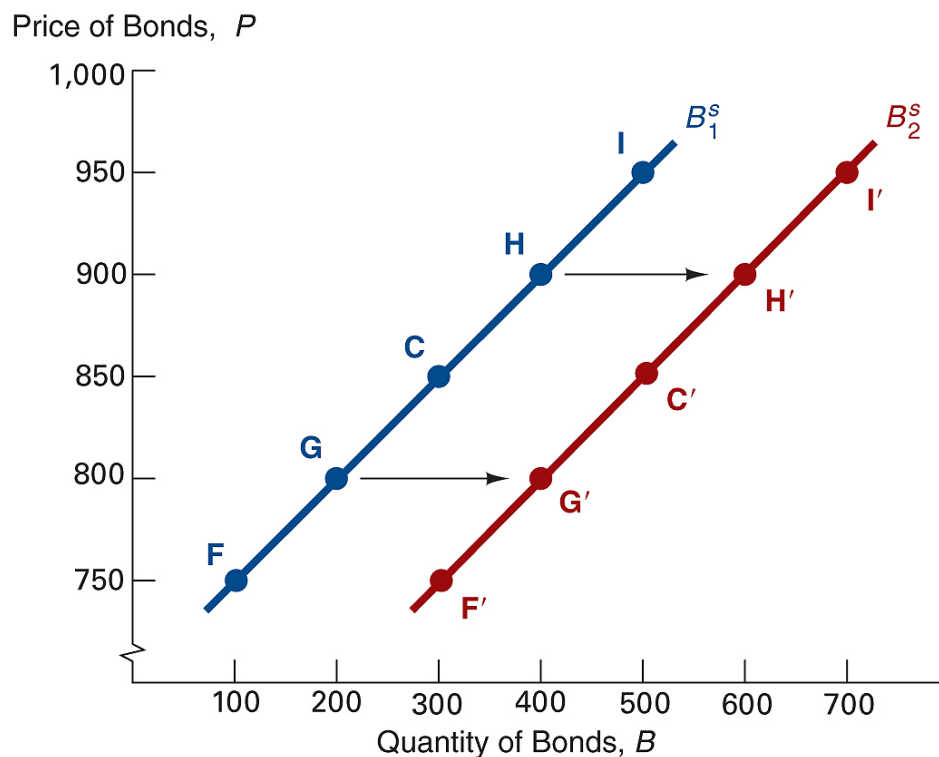


FIGURE 4.3 Shift in the Supply Curve for Bonds

When the supply of bonds increases, the supply curve shifts to the right.



Summary of Shifts in the Supply of Bonds

1. **Expected Profitability of Investment Opportunities:** in a business cycle expansion, the supply of bonds increases, conversely, in a recession, when there are far fewer expected profitable investment opportunities, the supply of bonds falls
2. **Expected Inflation:** an increase in expected inflation causes the supply of bonds to increase
3. **Government Activities:** higher government deficits increase the supply of bonds, conversely, government surpluses decrease the supply of bonds



Case: Fisher Effect

We've done the hard work. Now we turn to some special cases. The first is the Fisher Effect. Recall that rates are composed of several components: a real rate, an inflation premium, and various risk premiums.

What if there is only a change in expected inflation?



Changes in π^e : The Fisher Effect

If $\pi^e \uparrow$

1. Relative $R^e \downarrow$,
 B^d shifts
in to left

2. $B^s \uparrow$, B^s shifts
out to right

3. $P \downarrow$, $i \uparrow$

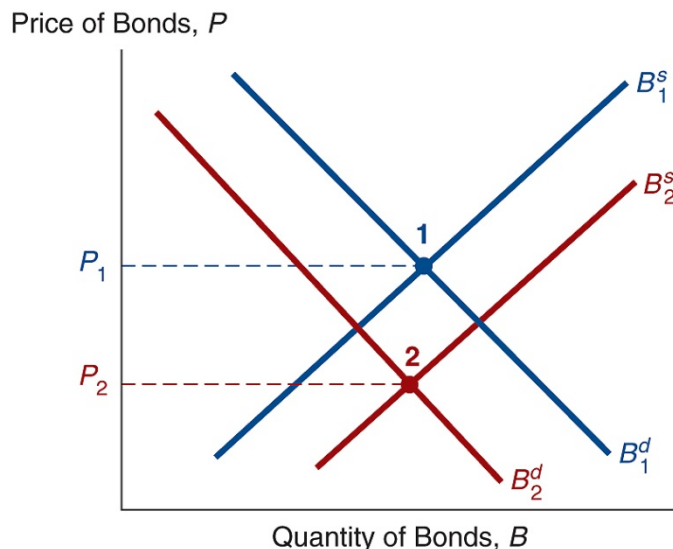


FIGURE 4.4 Response to a Change in Expected Inflation

When expected inflation rises, the supply curve shifts from B_1^s to B_2^s , and the demand curve shifts from B_1^d to B_2^d . The equilibrium moves from point 1 to point 2, with the result that the equilibrium bond price falls from P_1 to P_2 and the equilibrium interest rate rises.



Evidence on the Fisher Effect in the United States

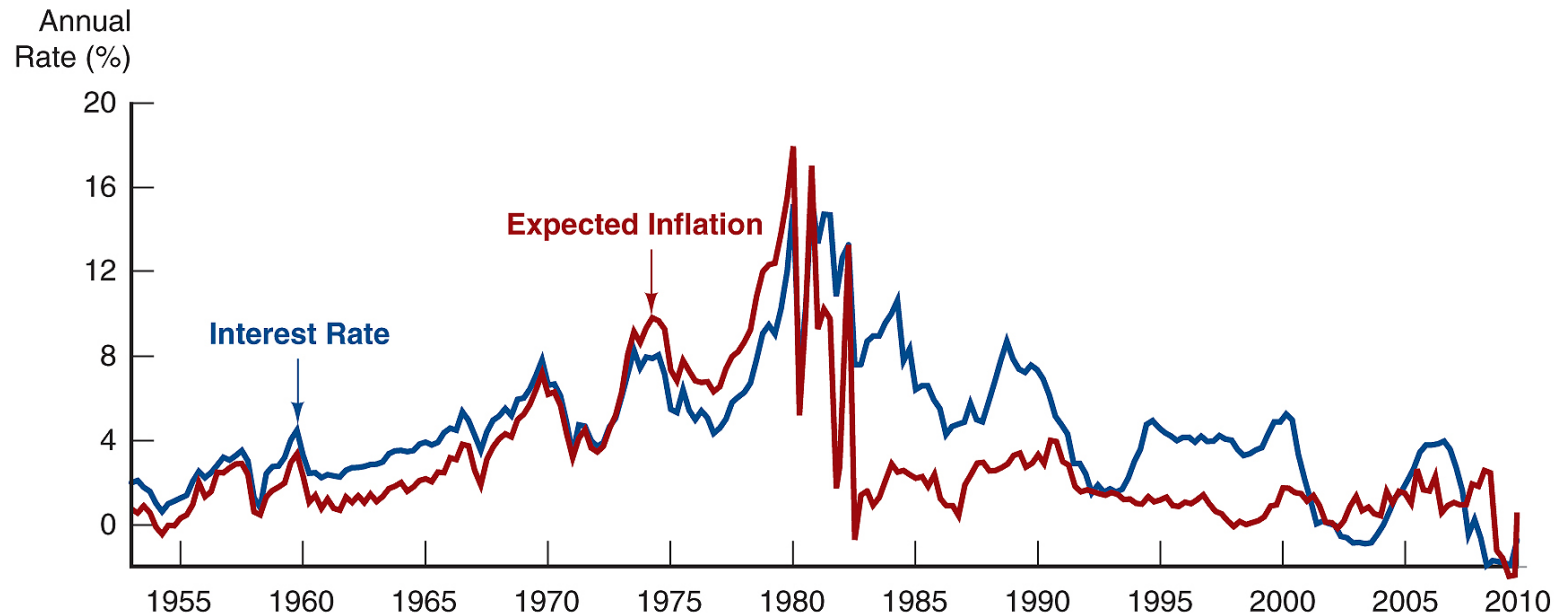


FIGURE 4.5 Expected Inflation and Interest Rates (Three-Month Treasury Bills), 1953–2010

Source: Expected inflation calculated using procedures outlined in Frederic S. Mishkin, "The Real Interest Rate: An Empirical Investigation," *Carnegie-Rochester Conference Series on Public Policy* 15 (1981): 151–200. These procedures involve estimating expected inflation as a function of past interest rates, inflation, and time trends.



Summary of the Fisher Effect

1. If expected inflation rises from 5% to 10%, the expected return on bonds relative to real assets falls and, as a result, the demand for bonds falls
2. The rise in expected inflation also means that the real cost of borrowing has declined, causing the quantity of bonds supplied to increase
3. When the demand for bonds falls and the quantity of bonds supplied increases, the equilibrium bond price falls
4. Since the bond price is negatively related to the interest rate, this means that the interest rate will rise



Case: Business Cycle Expansion

Another good thing to examine is an expansionary business cycle. Here, the amount of goods and services for the country is increasing, so national income is increasing.

What is the expected effect on interest rates?



Business Cycle Expansion

1. Wealth $\uparrow$, $B^d \uparrow$,
 B^d shifts out to right
2. Investment $\uparrow$,
 $B^s \uparrow$, B^s shifts right
3. If B^s shifts more than B^d then $P \downarrow$, $i \uparrow$

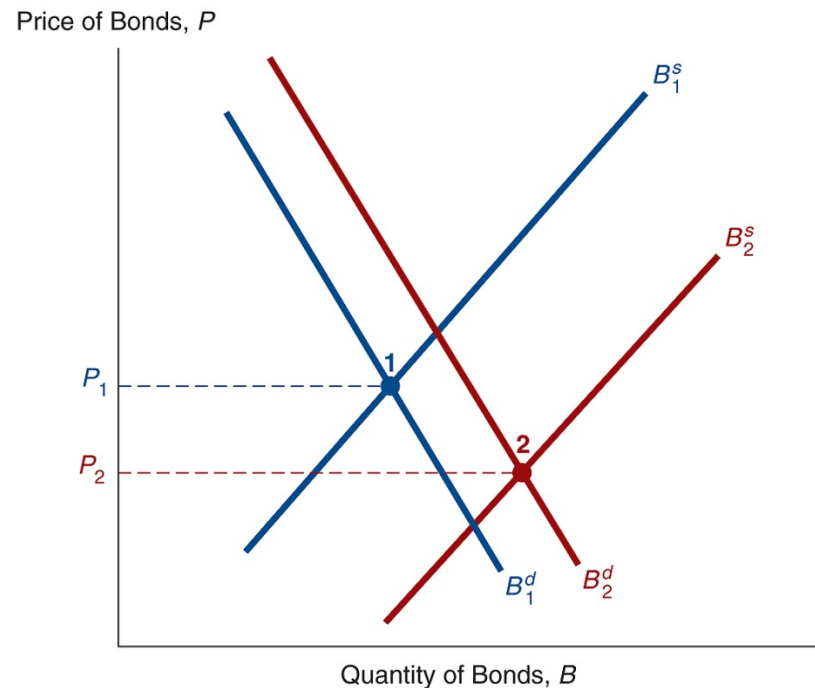


FIGURE 4.6 Response to a Business Cycle Expansion

In a business cycle expansion, when income and wealth are rising, the demand curve shifts rightward from B_1^d to B_2^d and the supply curve shifts rightward from B_1^s to B_2^s . If the supply curve shifts to the right more than the demand curve, as in this figure, the equilibrium bond price moves down from P_1 to P_2 , and the equilibrium interest rate rises.



Evidence on Business Cycles and Interest Rates



FIGURE 4.7 Business Cycle and Interest Rates (Three-Month Treasury Bills), 1951–2010

Shaded areas indicate periods of recession. The figure shows that interest rates rise during business cycle expansions and fall during contractions, which is what Figure 4.6 suggests would happen.

Source: Federal Reserve: www.federalreserve.gov/releases/H15/data.htm.



Case: Low Japanese Interest Rates

In November 1998, Japanese interest rates on six-month Treasury bills turned slightly negative. How can we explain that within the framework discussed so far?

It's a little tricky, but we can do it!



Case: Low Japanese Interest Rates

1. Negative inflation lead to $B^d \uparrow$
— B^d shifts out to right
2. Negative inflation lead to $\downarrow$ in real rates
— B^s shifts out to left

Net effect was an increase in bond prices
(falling interest rates).



Case: Low Japanese Interest Rates

3. Business cycle *contraction* lead to ↓ in interest rates

- B^s shifts out to left
- B^d shifts out to left

But the shift in B^d is less significant than the shift in B^s , so the net effect was also an increase in bond prices.



Case: *WSJ* “Credit Markets”

Everyday, the Wall Street Journal reports on developments in the bond market in its “Credit Markets” column.

Take a look at page 83 in your text. It documents a surge in Treasury prices, noting “Euro Jitters” as the root cause.



Case: *WSJ* “Credit Markets”

What is this article telling us?

- Fear over debt problems in European nations cause demand for Treasury securities to rise. That follows what we learned! Review Table 4.2. The perceived riskiness of Treasury bonds fell relative to Eurobonds.



Case: *WSJ* “Credit Markets”

- Also, investors are finding few reasons to seek riskier assets of emerging nations. Bond prices in Russia and South America fell as well.
- Finally, strong economic growth suggests the Fed will maintain interest rates. Treasury returns, relative to other assets, falls, shifting the demand curve to the left.



The Practicing Manager

We now turn to a more practical side to all this. Many firms have economists or hire consultants to forecast interest rates. Although this can be difficult to get right, it is important to understand what to do with a given interest rate forecast.



Profiting from Interest-Rate Forecasts

- Methods for forecasting
 1. Supply and demand for bonds: use Flow of Funds Accounts and judgment
 2. Econometric Models: large in scale, use interlocking equations that assume past financial relationships will hold in the future



Profiting from Interest-Rate Forecasts (cont.)

- Make decisions about assets to hold
 1. Forecast $i \downarrow$, buy long bonds
 2. Forecast $i \uparrow$, buy short bonds
- Make decisions about how to borrow
 1. Forecast $i \downarrow$, borrow short
 2. Forecast $i \uparrow$, borrow long



Chapter Summary

- Determining Asset Demand: We examined the forces that affect the demand and supply of assets.
- Supply and Demand in the Bond Market: We examine those forces in the context of bonds, and examined the impact on interest rates.



Chapter Summary (cont.)

- Changes in Equilibrium Interest Rates: We further examined the dynamics of changes in supply and demand in the bond market, and the corresponding effect on bond prices and interest rates.