中南财经政法大学
ZHONGNAN UNIVERSITY OF ECONOMIC AND LAW

Financial Markets

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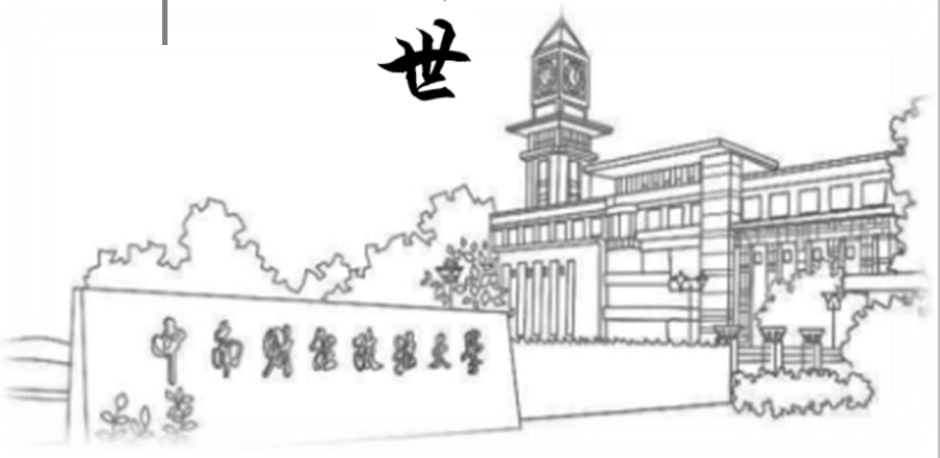


Chapter 5: The Behavior of Interest Rates

Motivation

In the early 1950s, nominal interest rates on three-month T-bill were about 1%; by 1981, they had reached over 15%. Then they fell below 1% in 2003, adn rose to 5% in 2007, then dropped to near 0% in 2008. What explains these substantial fluctuations in interest rates?

In this chapter, we examine how the overall level of nominal interest rates is determined and which factors influence their behavior. Topics include:

- Portfolio theory
- Supply and demand in the bond market and market equilibrium
- The liquidity preference framework

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:

- **Wealth**: the total resources owned by the individual, including all assets
- **Expected Return**: the return expected over the next period on one asset relative to alternative assets
- **Risk**: the degree of uncertainty associated with the return on one asset relative to alternative assets
- **Liquidity**: the ease and speed with which an asset can be turned into cash relative to alternative assets

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

$$\begin{aligned}
p_1 &= \text{probability of occurrence of return 1} &&= \tfrac{2}{3} = 0.67 \\
R_1 &= \text{return in state 1} &&= 12\% = 0.12 \\
p_2 &= \text{probability of occurrence return 2} &&= \tfrac{1}{3} = 0.33 \\
R_2 &= \text{return in state 2} &&= 8\% = 0.08
\end{aligned}$$

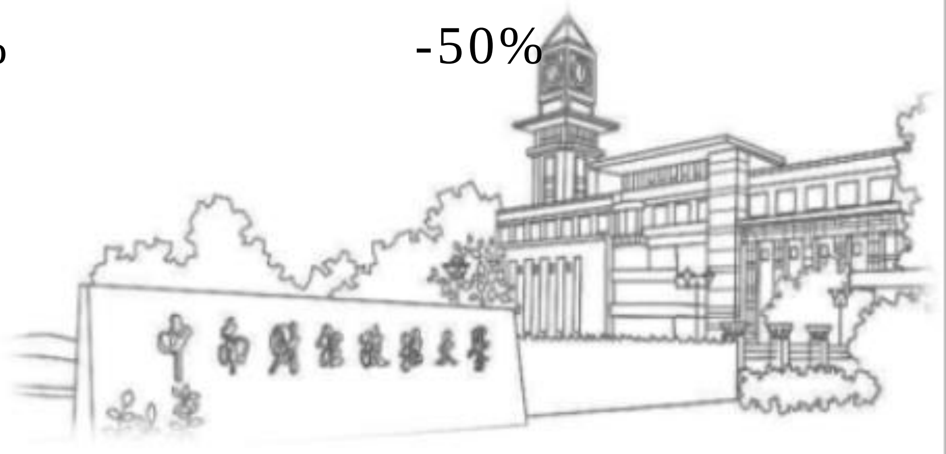
Thus,

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

EXAMPLE: Expected Return

Suppose you are trying to decide whether to purchase Apple Stock and you expect the following one year returns depending on the effectiveness of competition and the state of the economy:

Event (state of nature)	Probability (P_i)	Return (R_i)
iOS 18 head to head w Android, Normal Growth	50%	10%
iOS 18 kills Android, Strong Growth	25%	25%
iOS 18 is less appealing than Android, Recession	20%	0%
iOS 18 causes cancer, Disaster	5%	-50%



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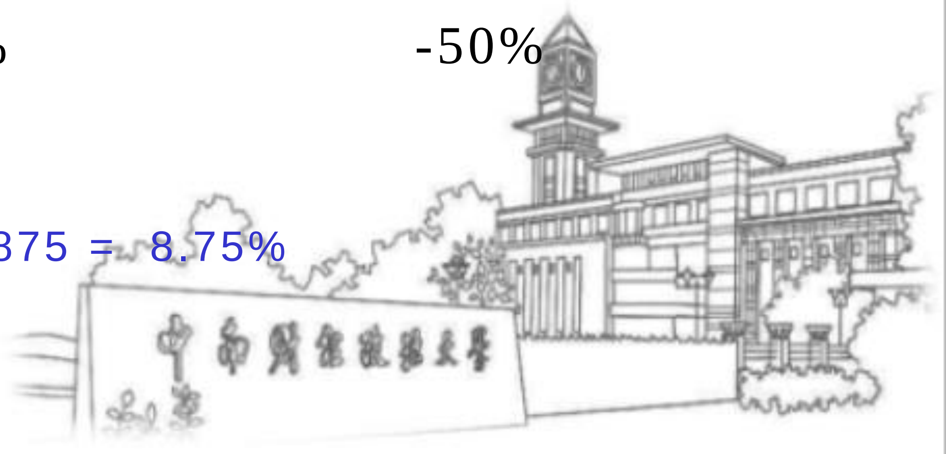
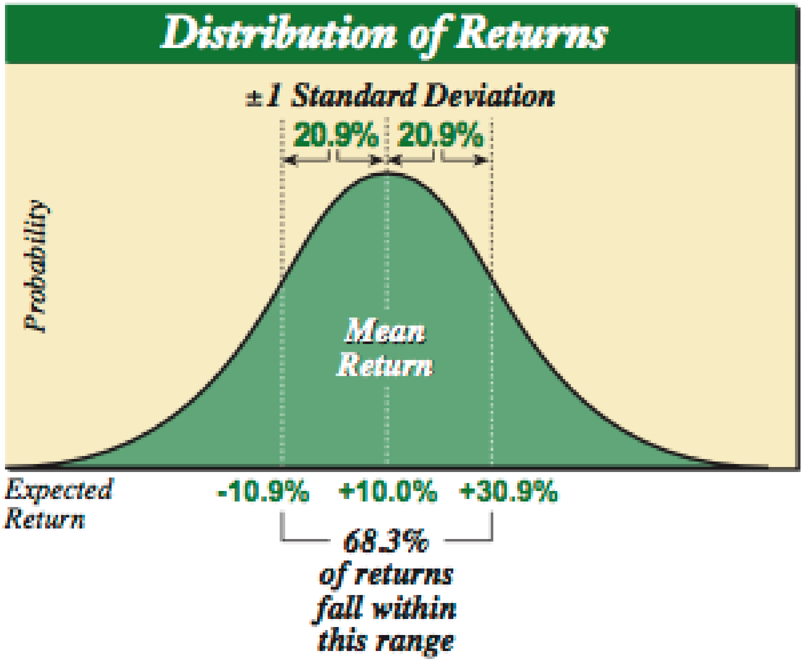
iOS 18 causes cancer, Disaster	5%	-50%

$R^e = p_1 R_1 + \ldots + p_4 R_4$

Thus $R^e = (.5)(0.10) + (.25)(0.25) + (.20)(0.0) + (.05)(-.5) = .0875 = 8.75\%$



Definition of Risk



The degree of risk usually means the uncertainty of an asset’s return. We can use a measure of risk called the **Standard Deviation**.

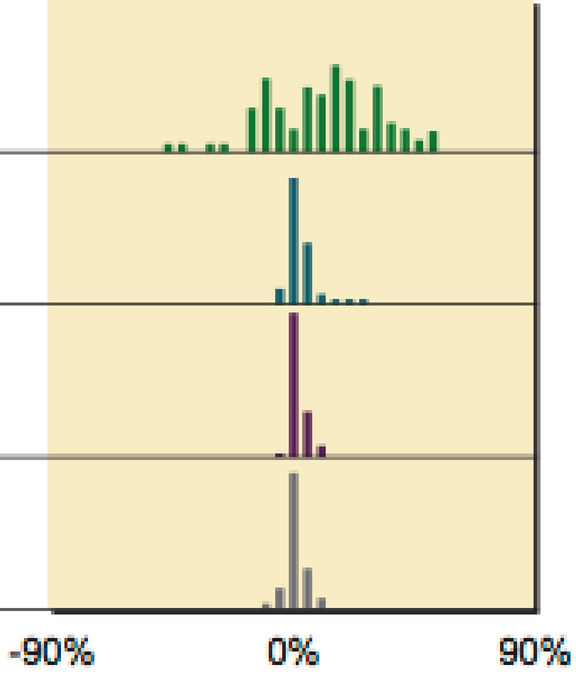
For Symmetric Distributions

- 2/3 of all values lie within 1 standard deviation of the mean (expected return)
- 95% of all values lie within 2 standard deviations of the mean
- A standard deviation is the square root of the variance.

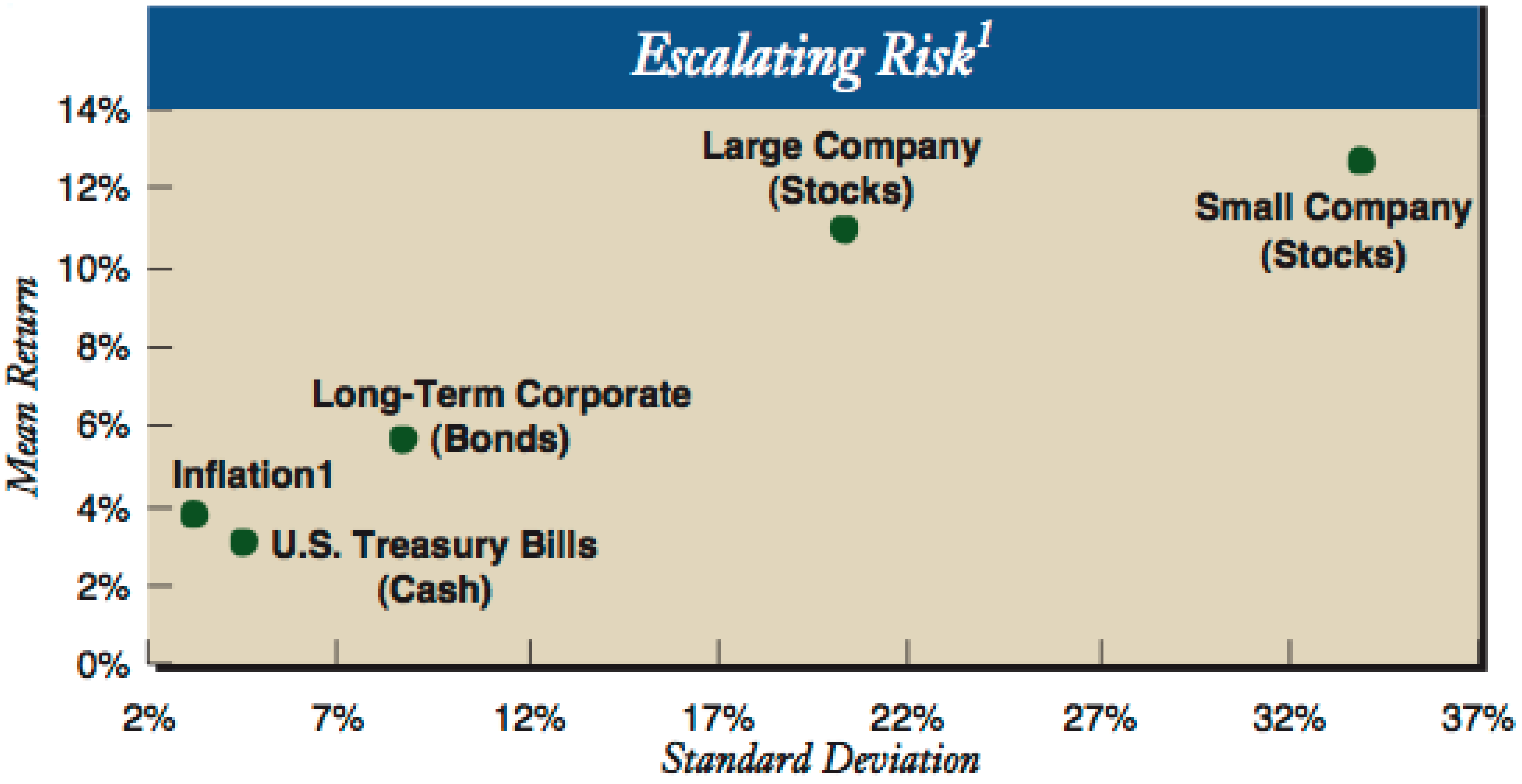
Relative Risk

Summary Statistics of Annual Return Distributions[2]

Series	Geometric Mean	Standard Deviation	Distribution
Common Stocks	10.0%	20.9%	
Intermediate-Term Govt. Bonds	4.8%	5.5%	
U.S. T-Bills	3.5%	3.3%	
Inflation Rates	3.1%	4.8%	



Relative Risk



EXAMPLE: Standard Deviation

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%	

How risky is the FBN or FOTG?

- A common measure of risk for an individual asset is the **variance** (or more typically the **standard deviation**) of its return.
- Lets calculate the standard deviation of the returns of two hypothetical companies with stupid names: the Fly-by-Night Airlines stock and Feet-on-the Ground Bus Company.
- The question is, of these two stocks, which is riskier?

EXAMPLE: Standard Deviation

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

R_1 = return in state 1 $= 15\% = 0.15$

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

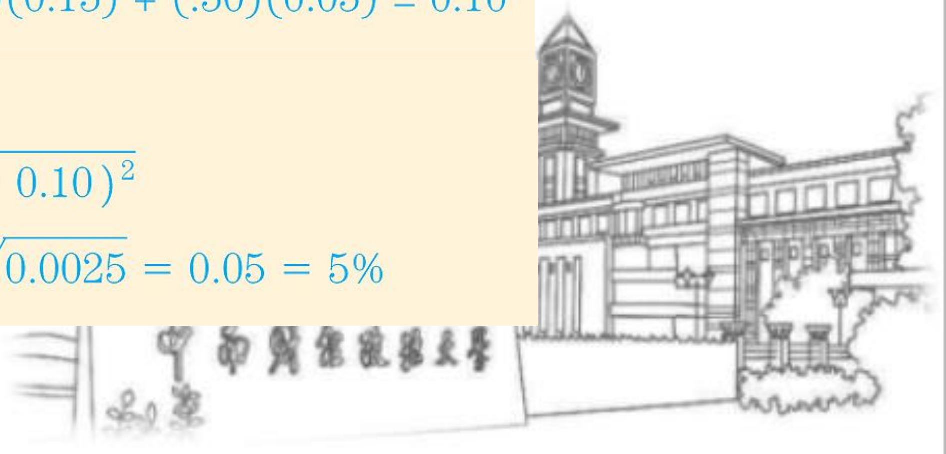
R_2 = return in state 2 $= 5\% = 0.05$

R^e = 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: Standard Deviation

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 = probability of occurrence of return 1 = 1.0

R_1 = return in state 1 = 10% = 0.10

R^e = expected return = (1.0)(0.10) = 0.10

Thus,

$$\sigma = \sqrt{(1.0)(0.10 - 0.10)^2}$$

$$= \sqrt{0} = 0 = 0\%$$

EXAMPLE: Standard Deviation

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 seeker** or risk lover.

We assume people are **risk-averse**, especially in their financial decisions.

Theory of Portfolio Choice

All the determining factors can be assembled into the **theory of portfolio choice**:

Wealth: Holding everything else constant, an increase in wealth raises the quantity demanded of an asset

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

Risk: Holding everything else constant, if an asset's risk rises relative to that of alternative assets, its quantity demanded
will fall

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

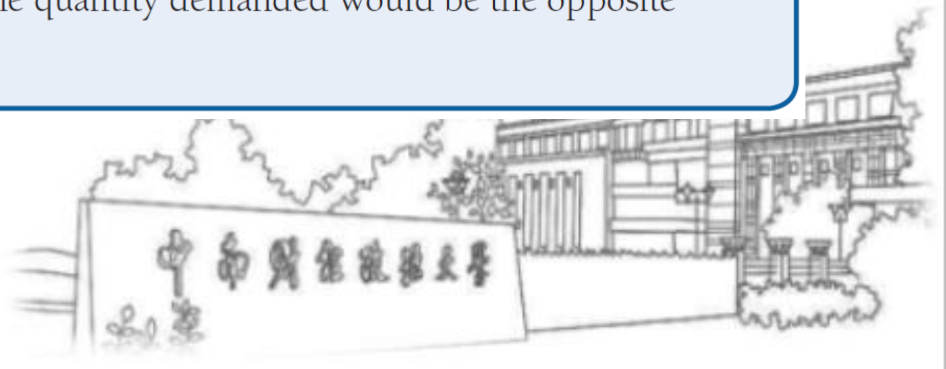
Theory of Portfolio Choice

SUMMARY TABLE 1

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

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 effects of decreases in the variables on the quantity demanded would be the opposite of those indicated in the rightmost column.



Supply and Demand in the Bond Market

Our first approach to the analysis of interest-rate determination looks at supply and demand in the bond market so that we can better understand how the prices of bonds are determined.

In the previous slides, we have studied the determinants of asset demand. Now we will apply the theory of portfolio choice on our analysis of bond demand. The first step in our analysis is to obtain a bond **demand curve**.

The Demand Curve

Let’s start with the demand curve.

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. Based on equation 6 in chapter 4:

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

i= interest rate = yield to maturity

R^e=expected return

F=face value of the discount bond

P=initial purchase price of the discount bond

Derivation of Demand Curve

If the bond sells for $950, the interest rate and expected return are:

$$\frac{\$1000-\$950}{\$950}=0.053=5.3\%$$

If the bond sells for $900, the interest rate and expected return are:

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

If the bond sells for $850, the interest rate and expected return are...

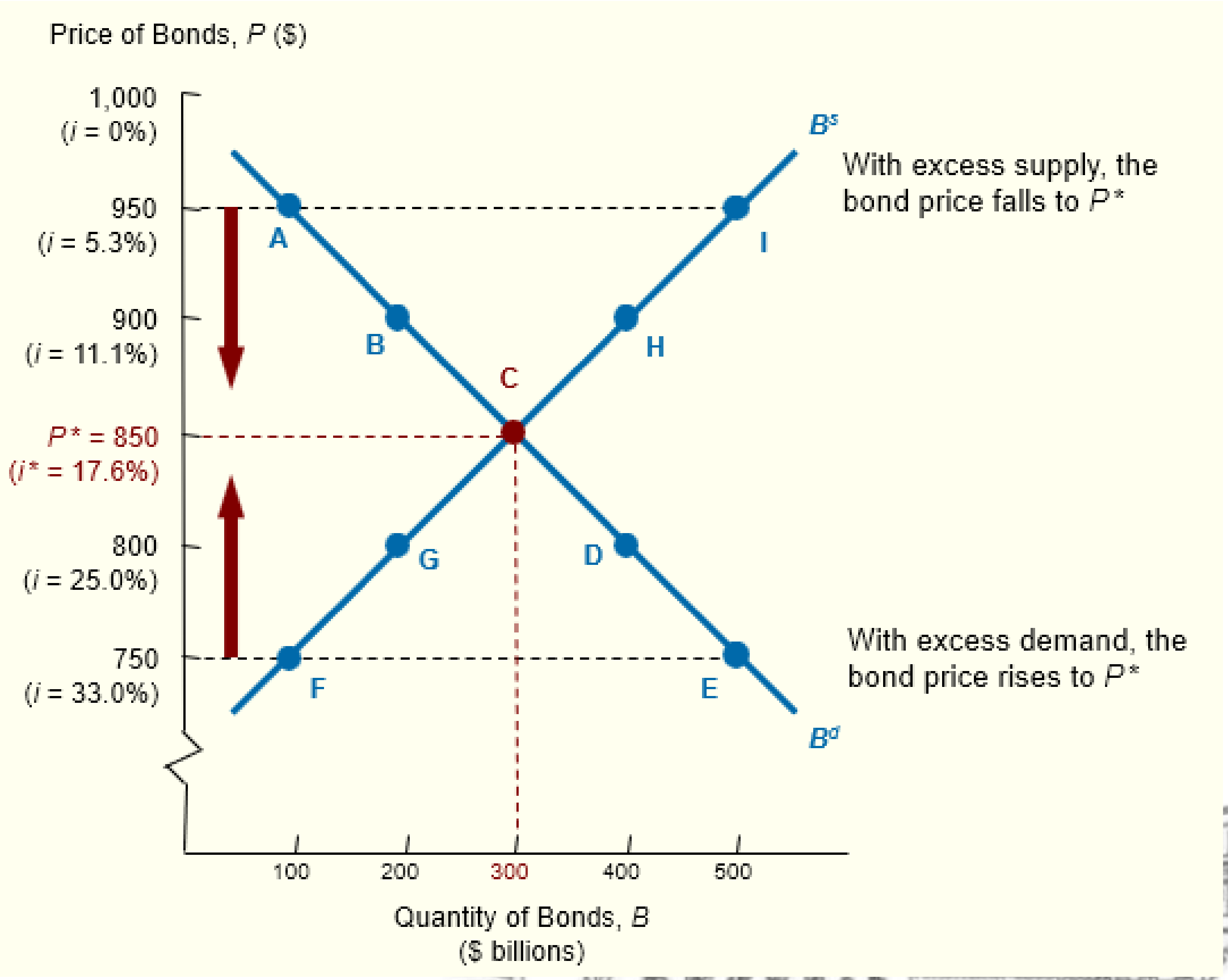
....

Based on the portfolio theory, with all other economic variables hold constant, the quantity demanded of these bonds will be higher when the expected return is higher, so we can draw the demand curve.

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 Supply Curve

The supply curve shows the relationship between the quantity of bonds supplied and the price when all other economic variables are held constant (**ceteris paribus**).

Intuitively speaking, when the interest rate is low, it is less costly to borrow by issuing bonds. Firms will be willing to borrow more through bond issues, and the quantity of bonds supplied is higher.

Hence, the supply curve for bonds has the usual upward slope found in supply curve, indicating that as the price increases (everything else being equal), the quantity supplied increases.

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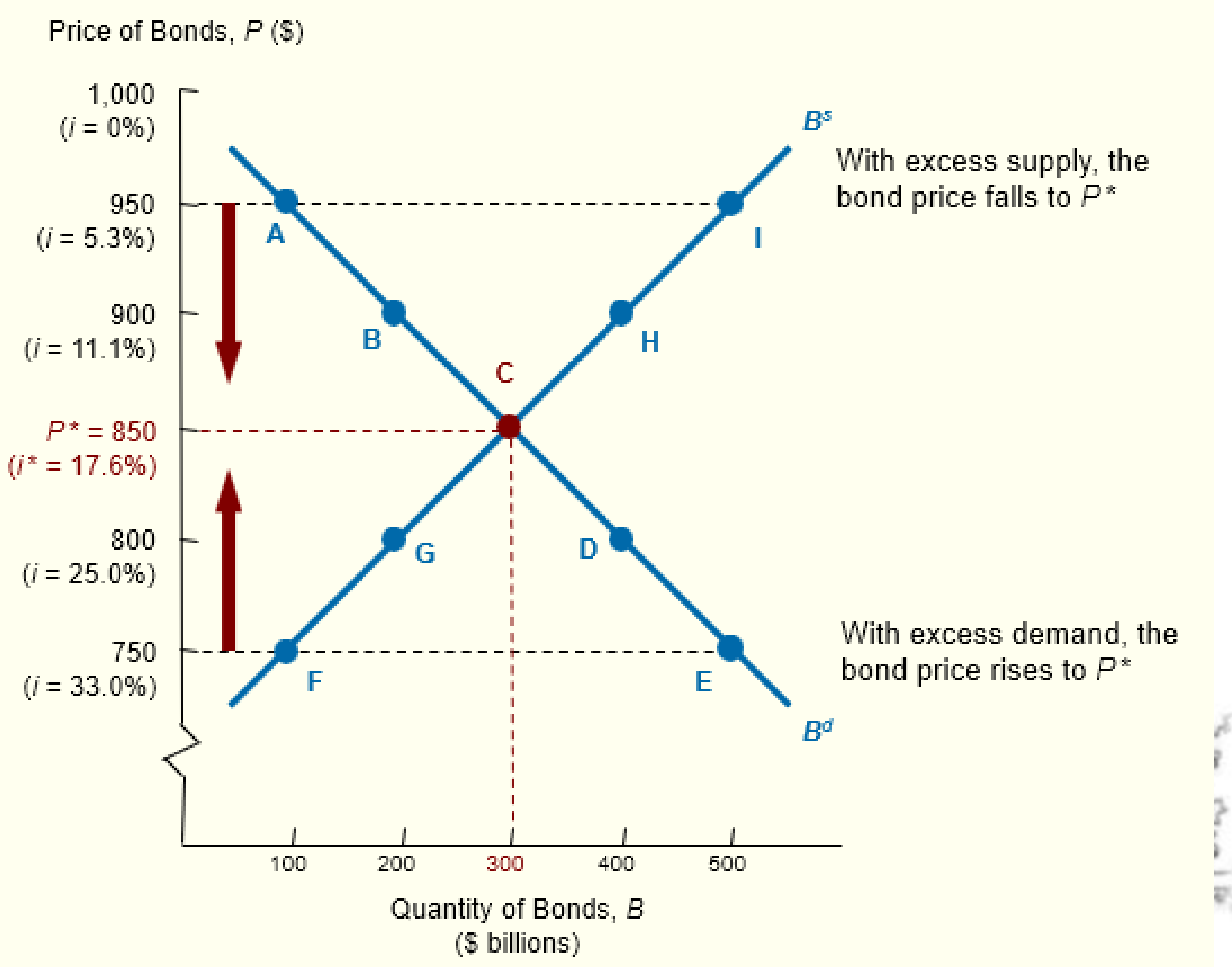
Supply and Demand in the Bond Market

At lower prices (higher interest rates), ceteris paribus, the quantity demanded of bonds is higher: an inverse relationship

At lower prices (higher interest rates), ceteris paribus, the quantity supplied of bonds is lower: a positive relationship



Supply and Demand for Bonds

Quiz

Write down an equation for both B^d and B^s.

Hint:

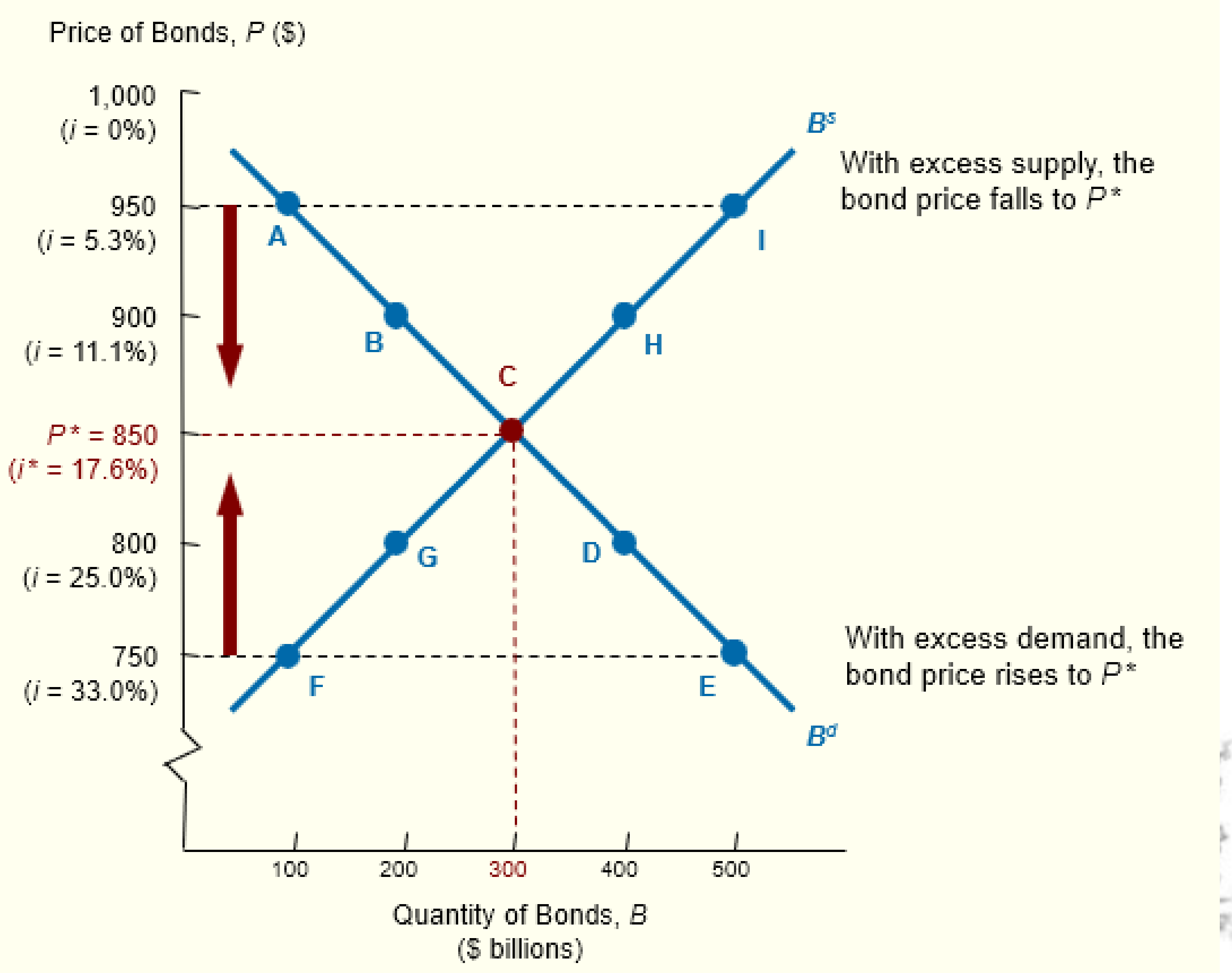
B^d intercept is

P= 1000 (see vertical axis).

B^s intercept is

P = 700 (see vertical axis).

Solve for equilibrium P*



Supply and Demand for Bonds

Slope of B^d = ΔP/ΔQ = +50/-100 = - ½.

Slope of B^s = ΔP/ΔQ = +50/+100 = ½.

P^d = 1000 - 0.5Q

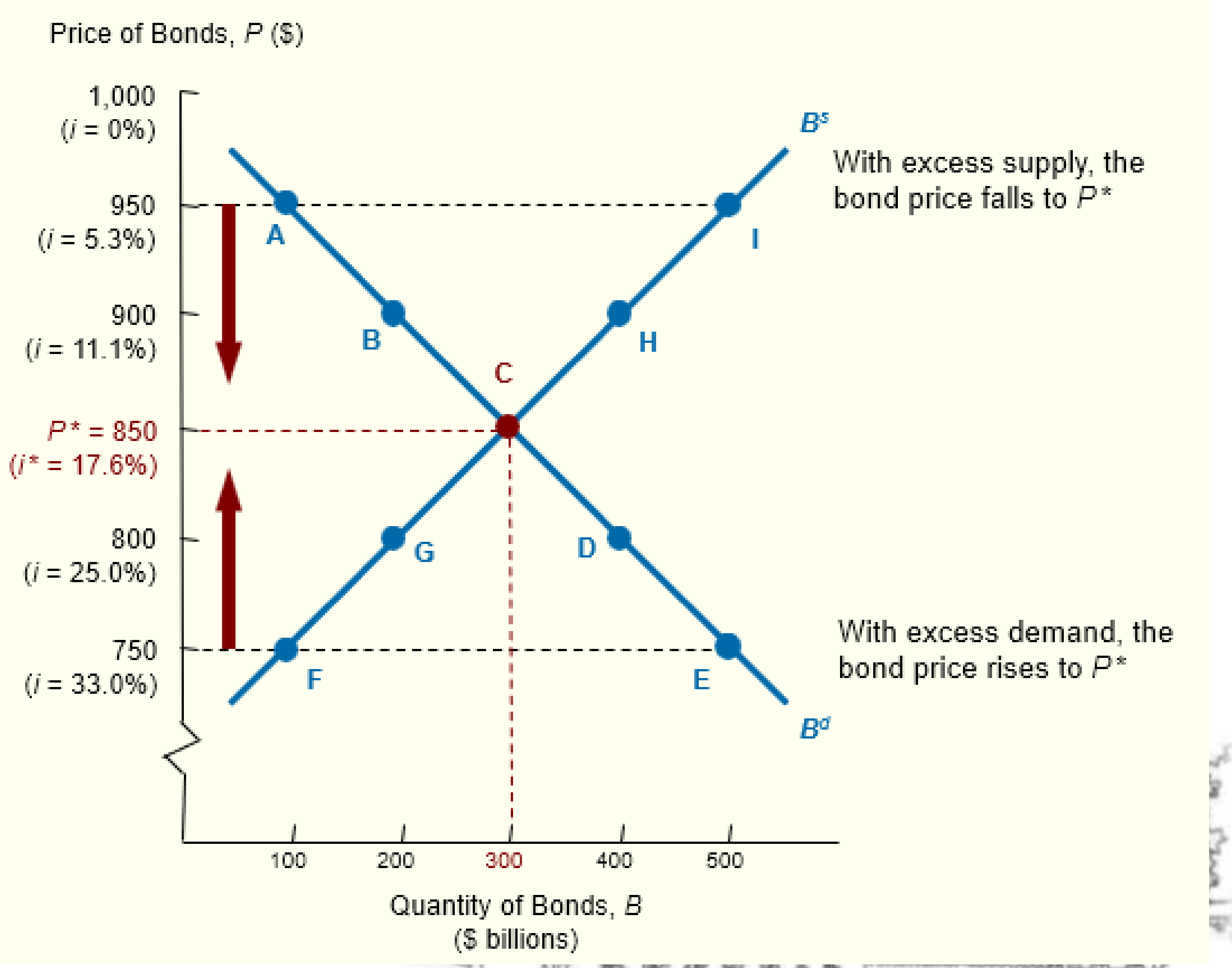
P^s = 700 + 0.5Q

Equilibrium: set P^d = P^s

1000 - 0.5Q = 700 + 0.5Q

Q = 1000-700 = 300

P = 1000 – 0.5*300 = 850



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

$B^d = B^s$ defines the equilibrium (or market clearing) price and interest rate.

When Bd > Bs , there is excess demand, price will rise and interest rate will fall

When Bd < Bs , there is excess supply, price will fall and interest rate will rise

- 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^*

Changes in Equilibrium Interest Rates

Shifts in the demand for bonds:

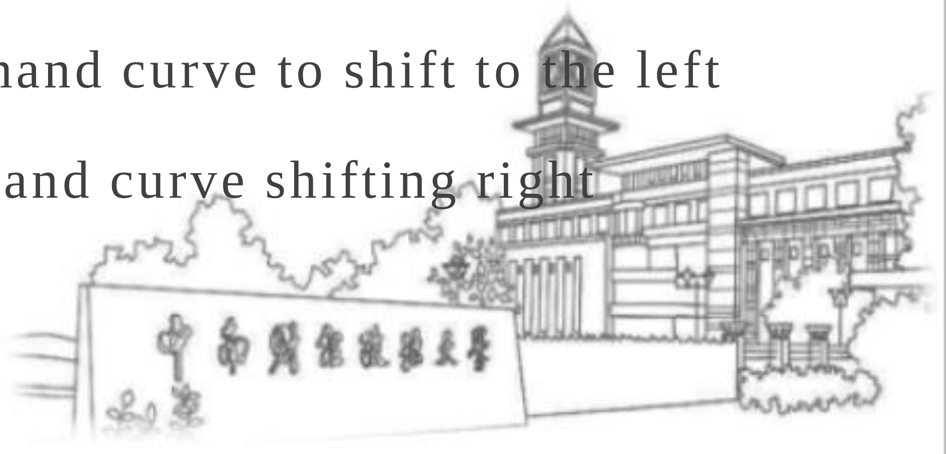
Wealth: in an expansion with growing wealth, the demand curve for bonds shifts to the right

Expected Returns: higher expected interest rates in the future lower the expected return for long-term bonds, shifting the demand curve to the left

Expected Inflation: an increase in the expected rate of inflations lowers the expected return for bonds, causing the demand curve to shift to the left

Risk: an increase in the riskiness of bonds causes the demand curve to shift to the left

Liquidity: increased liquidity of bonds results in the demand curve shifting right



How Factors Shift the Demand Curve

Wealth

- Economy ↑, wealth ↑, B^d ↑, B^d shifts out to right

<u>Expected</u> Return

- i ↓ **<u>in future</u>**, R^e for long-term bonds ↑, B^d shifts out to right
- π^e ↓, expected real yield↑, B^d shifts out to right

Risk

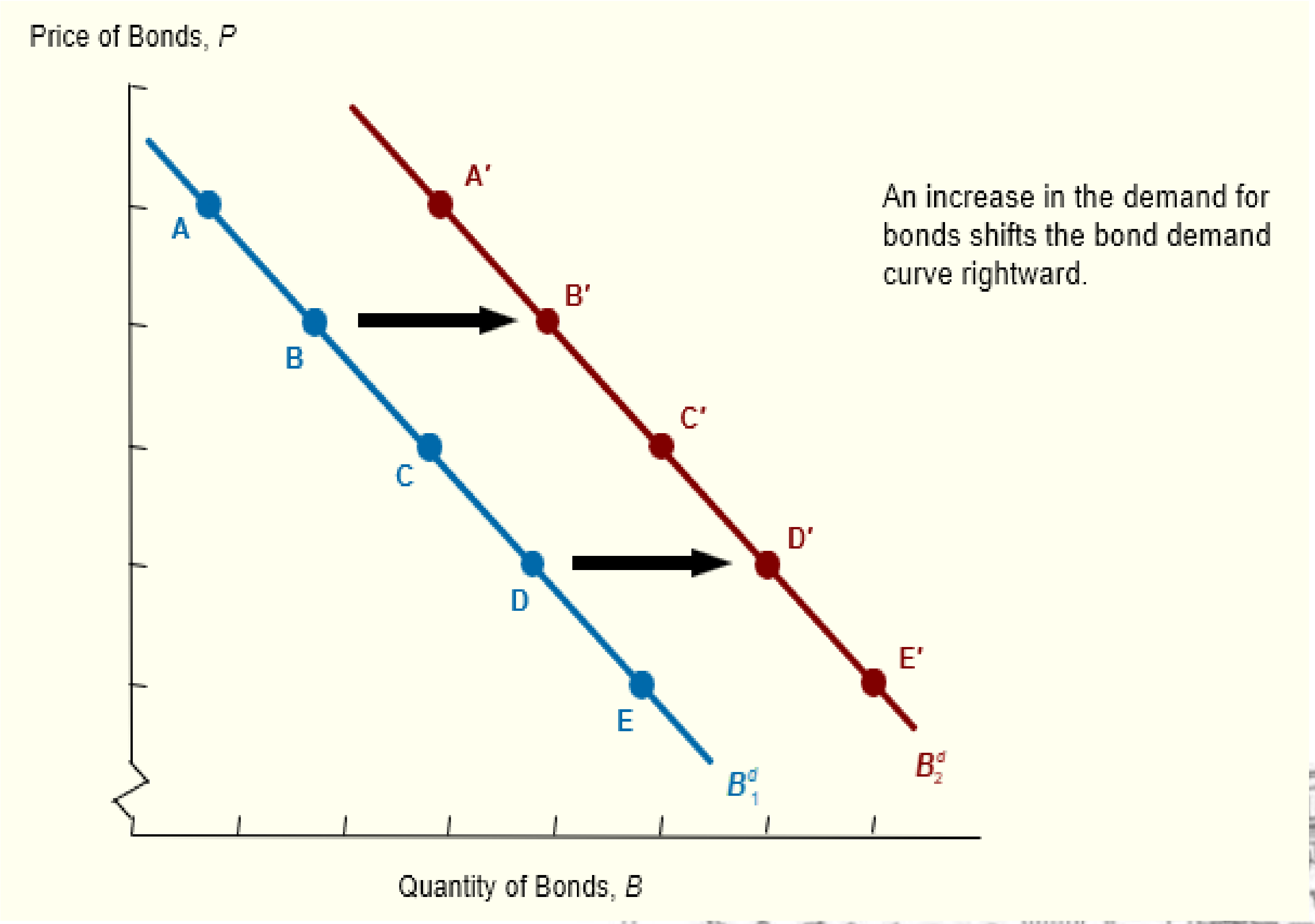
- Risk of bonds ↓, B^d ↑, B^d shifts out to right
- Risk of other assets ↑, B^d ↑, B^d shifts out to right

Liquidity

- Liquidity of bonds ↑, B^d ↑, B^d shifts out to right
- Liquidity of other assets ↓, B^d ↑,B^d shifts out to right

Shift in the Demand Curve for Bonds

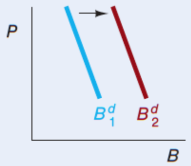
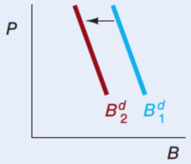
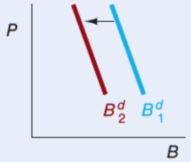
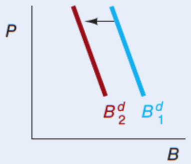
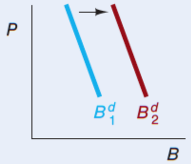
Remember the difference:
- ➢ movements along a demand curve
- ➢ shifts in a demand curve



Shifts in the Demand for Bonds

SUMMARY TABLE 2

Factors That Shift the Demand Curve for Bonds

Variable	Change in Variable	Change in Quantity Demanded at Each Bond Price	Shift in Demand Curve
Wealth	↑	↑	
Expected interest rate	↑	↓	
Expected inflation	↑	↓	
Riskiness of bonds relative to other assets	↑	↓	
Liquidity of bonds relative to other assets	↑	↑	

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

Shifts in the Supply of Bonds

Shifts in the supply for bonds:

Profitability of Investment Opportunities

- Business cycle expansion,
- investment opportunities ↑, B^s ↑,
- B^s shifts out to right

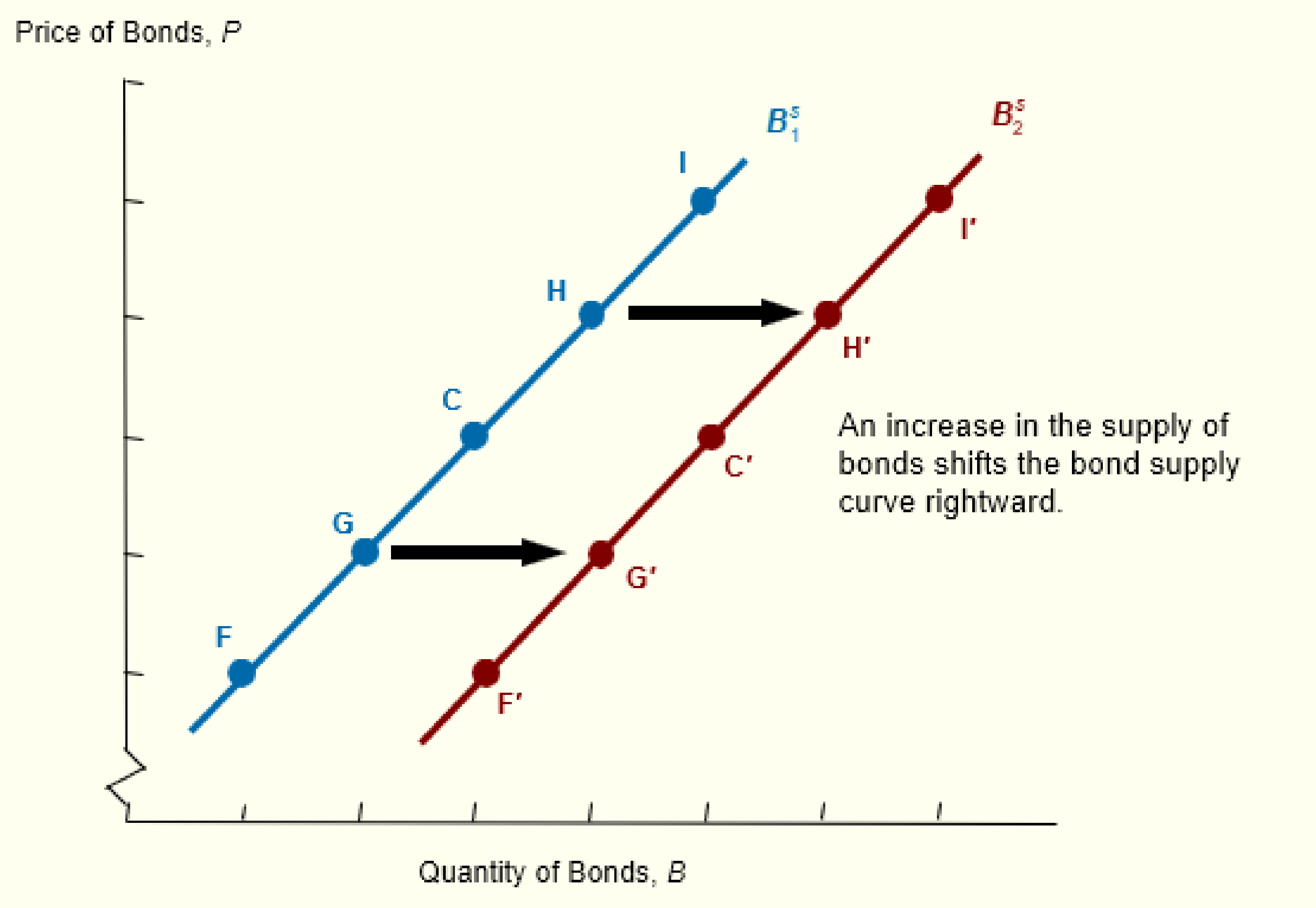
Expected Inflation

- p^e ↑, B^s ↑
- B^s shifts out to right

Government Activities

- Deficits ↑, B^s ↑
- B^s shifts out to right

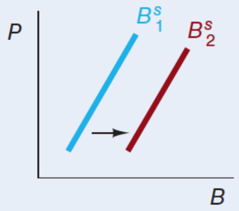
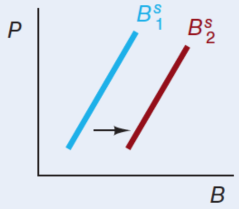
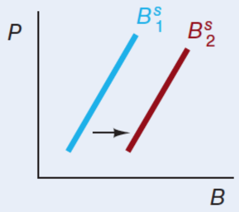
Shift in the Supply Curve for Bonds



Shifts in the Supply of Bonds

SUMMARY TABLE 3

Factors That Shift the Supply of Bonds

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 effects of decreases in the variables on the supply would be the opposite of those indicated in the remaining columns.

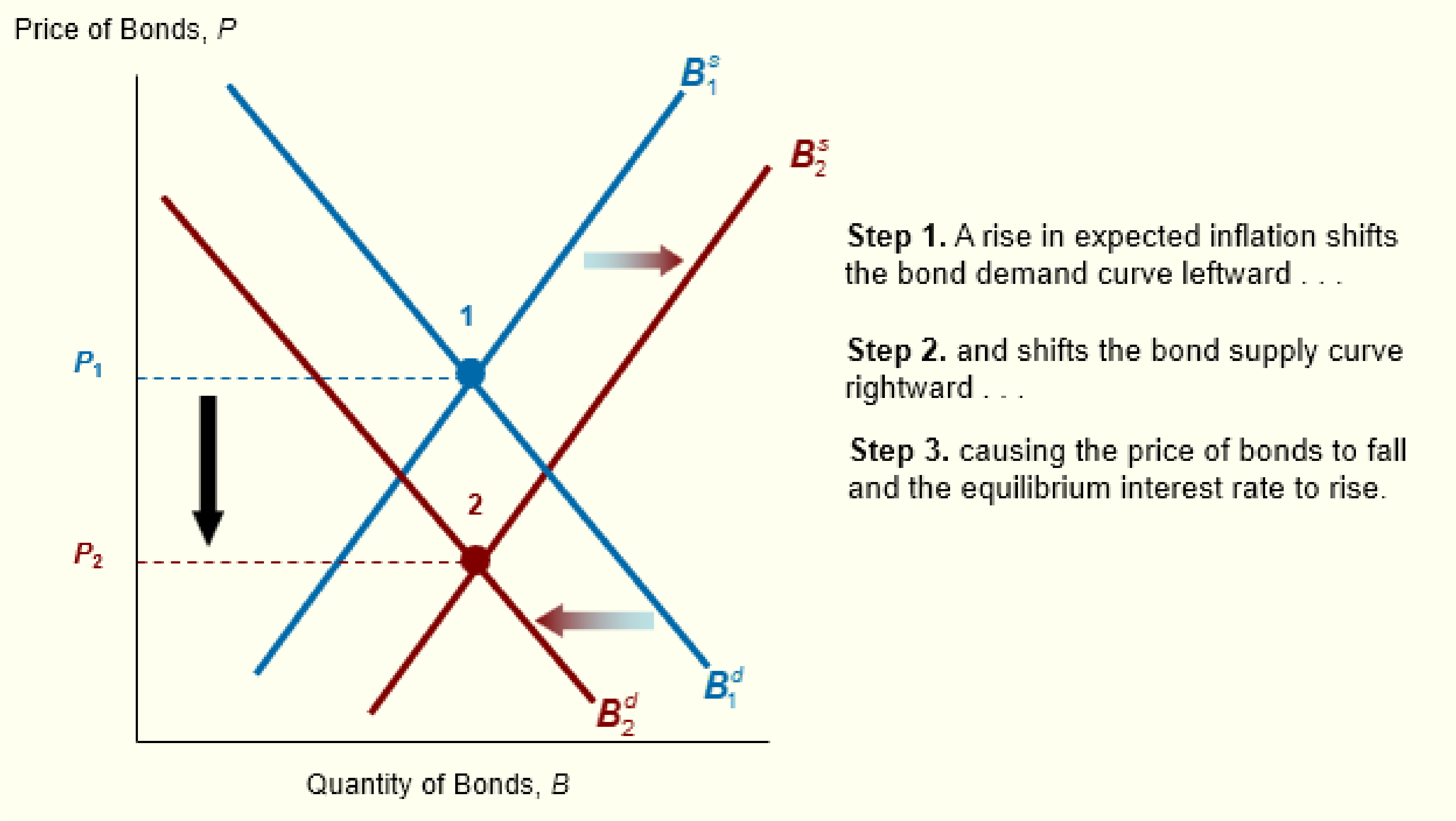
Remember

When we examine the effect of a variable change, remember we assuming that all other variables are unchanged, that is, we are making use of the *ceteris paribus* assumption.

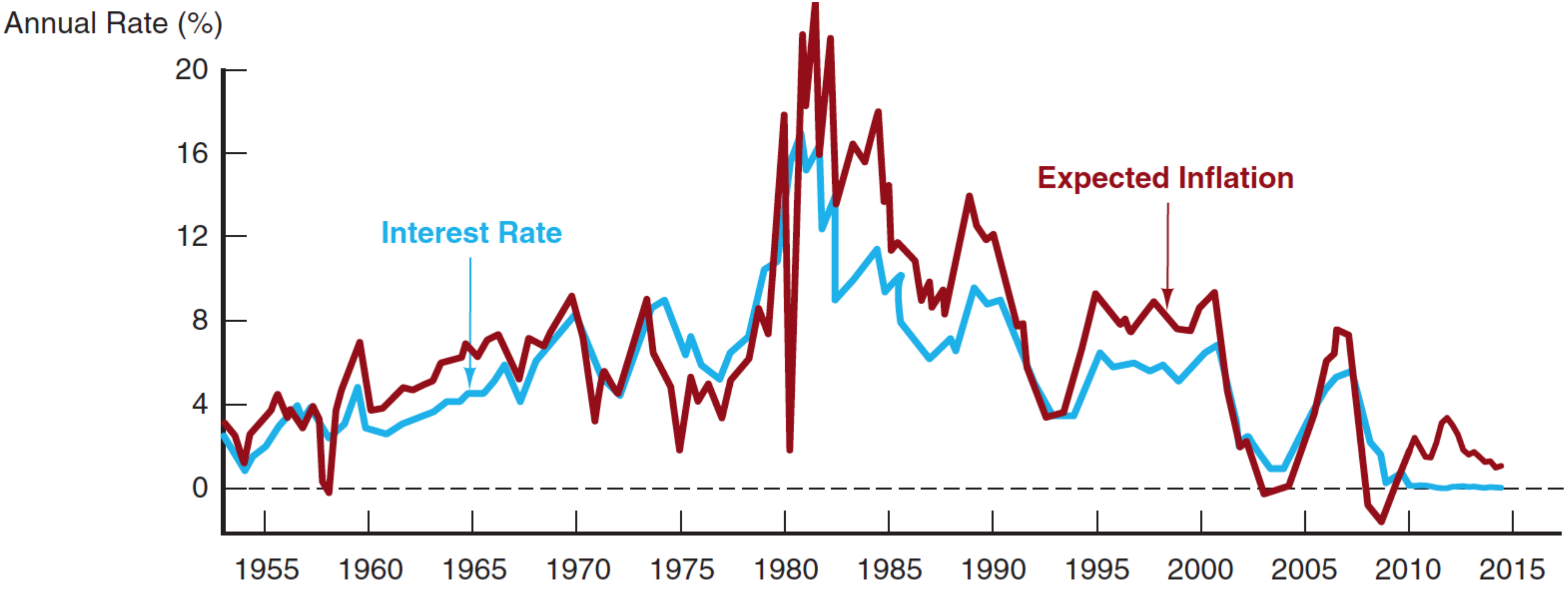
Remember that the interest rate is negatively related to the bond price, so when the equilibrium bond price rises, the equilibrium interest rate falls.

Response to a Change in Expected Inflation

When expected inflation rises, interest rate will rise. This result has been named the **Fisher effect**.



Expected Inflation and Interest Rates (Three-Month Treasury Bills), 1953–2014



Summary of the Fisher Effect

- 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
- The rise in expected inflation also means that the real cost of borrowing has declined, causing the quantity of bonds supplied to increase
- When the demand for bonds falls and the quantity of bonds supplied increases, the equilibrium bond price falls
- Since the bond price is negatively related to the interest rate, this means that the interest rate will rise

Business Cycle Expansion

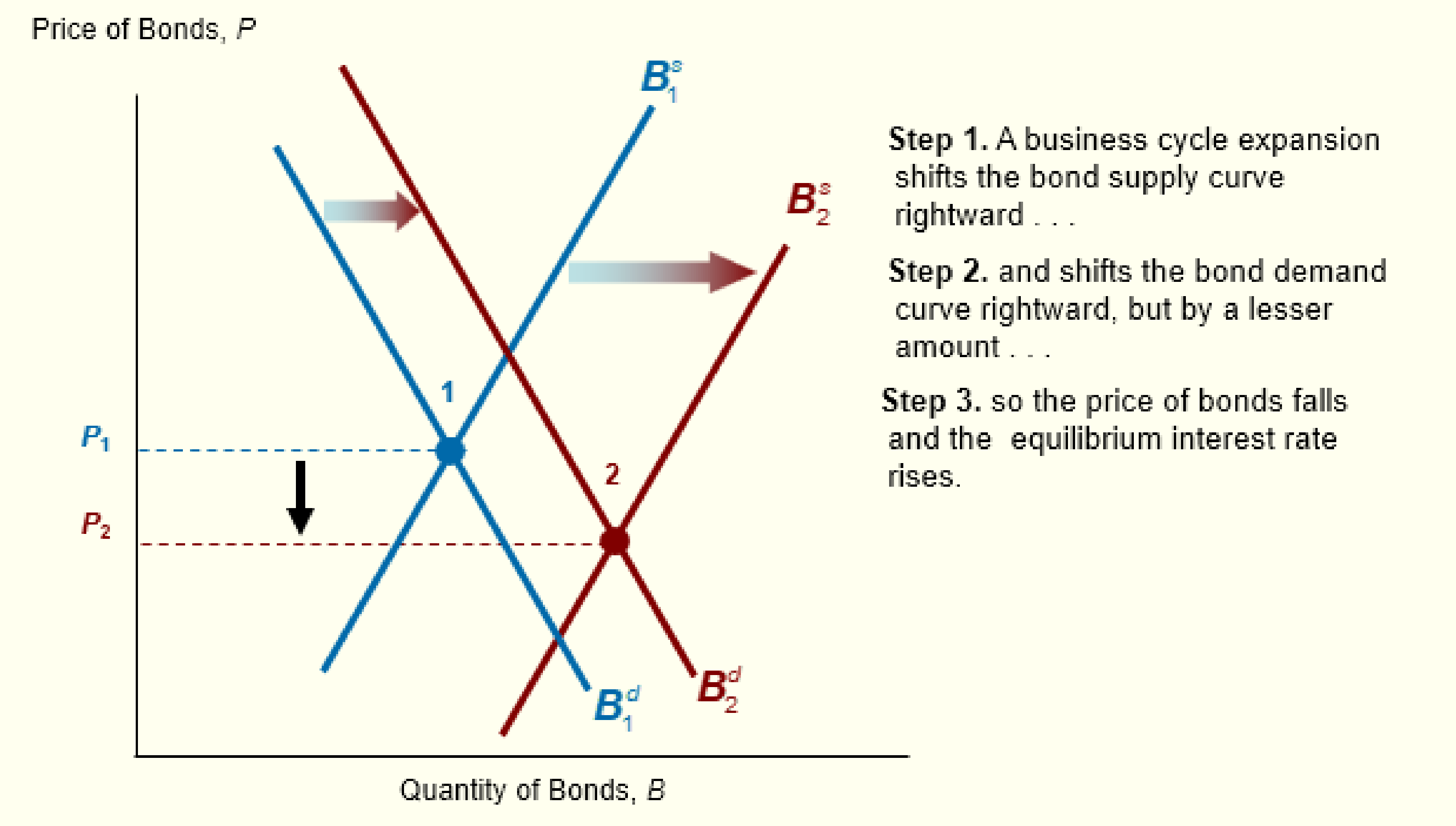
Another good thing to examine is an expansionary business cycle. Here, the amount of goods and services for the country is increasing, so national income is increasing.

What is the expected effect on interest rates?

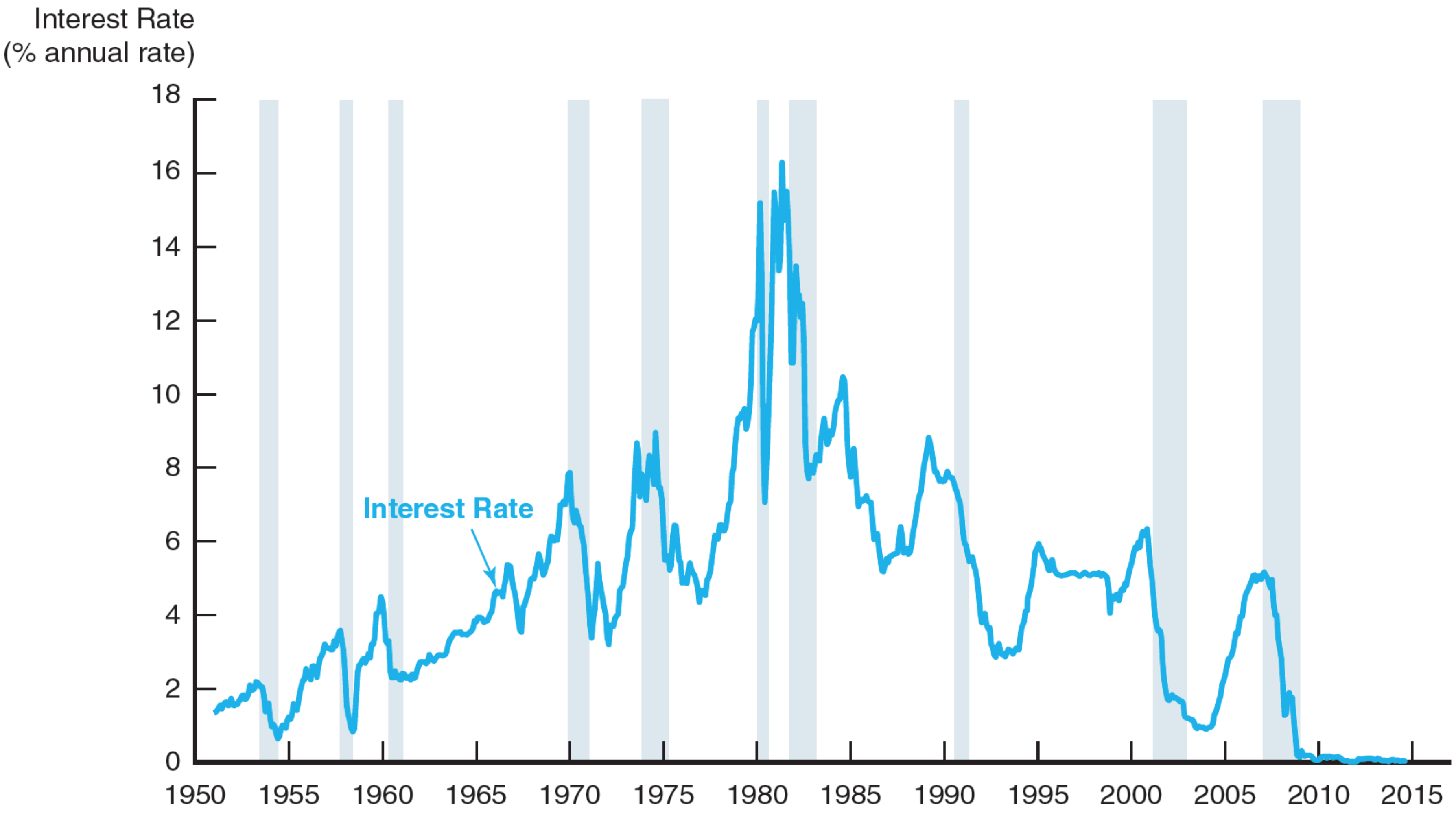
- In a business cycle expansion, businesses are more willing to borrow because they are likely to have many profitable investment opportunities for which they need financing.
- Expansion in the economy also affects the demand for bonds. As the economy expands, wealth is likely to increase.

Response to a Business Cycle Expansion

Depending on whether the supply curve shifts more than the demand curve or vice versa, the new equilibrium interest rate can either rise or fall.



Business Cycle and Interest Rates (Three-Month Treasury Bills), 1951–2014



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 $\uparrow$ in real interest rates
   - B^s shifts out to left

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

3. Business cycle contraction lead to $\downarrow$ in investment opportunity and wealth
   - 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.

Profiting from Interest-Rate Forecasts

- Methods for forecasting
  - ➢ Supply and demand for bonds: use Flow of Funds Accounts and judgment
  - ➢ Econometric Models: large in scale, use interlocking equations that assume past financial relationships will hold in the future
- Make decisions about assets to hold
  1. Forecast $i \downarrow$, hold long-term bonds
  2. Forecast $i \uparrow$, hold short-term bonds
- Make decisions about how to borrow
  1. Forecast $i \downarrow$, borrow short-term bonds
  2. Forecast $i \uparrow$, borrow long-term bonds

Supply and Demand in the Market for Money: The Liquidity Preference Framework

The Liquidity Preference Framework is developed by John Keynes.

This framework determines the equilibrium interest rate in terms of the supply and demand for money rather than the supply of and demand for bonds.

Keynes assumes that people use two main categories of assets to store their wealth: money and bonds.

Total wealth in the economy = $B^s + M^s$ = $B^d + M^d$

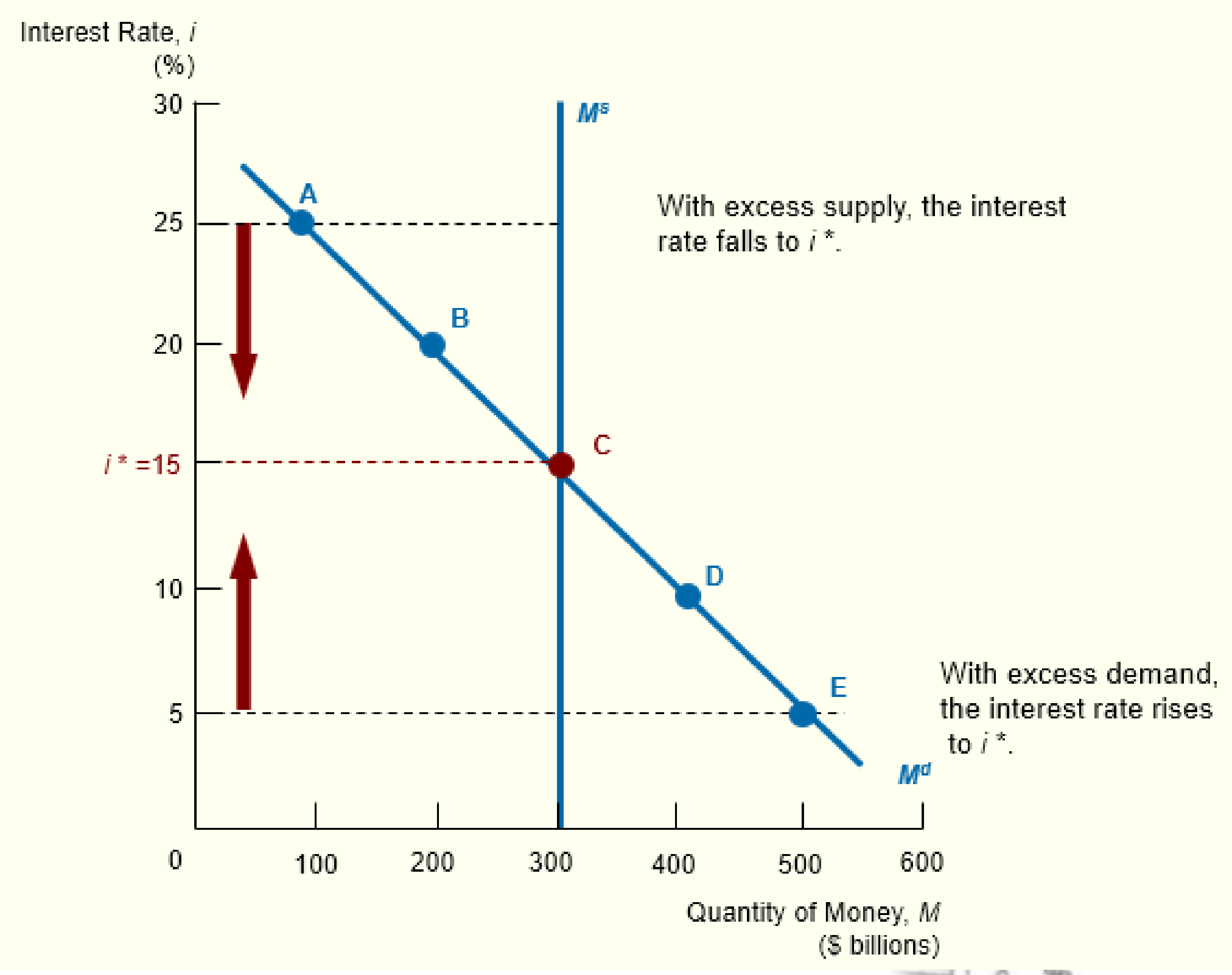
The above equation can be rewritten as: $B^s - B^d$ = $M^s - M^d$

Hence, if the market for money is in equilibrium ($M^s = M^d$), then the bond market should also be in equilibrium ($B^s = B^d$).

The Liquidity Preference Framework

- The bond supply and demand framework is easier to use when analyzing the effects caused by changes in expected inflation.
- The Liquidity preference framework is easier to use when analyzing the effects caused by changes in income, the price level, and the supply of money.
- The quantity of money demanded and the interest rate should be negatively related.
  - When the interest rate increases, the opportunity cost of holding money increases, therefore the quantity demanded of money decreases.
- At this point, we assume the central bank has the total control on money supply.

Equilibrium in the Market for Money



Changes in Equilibrium Interest Rates in the Liquidity Preference Framework

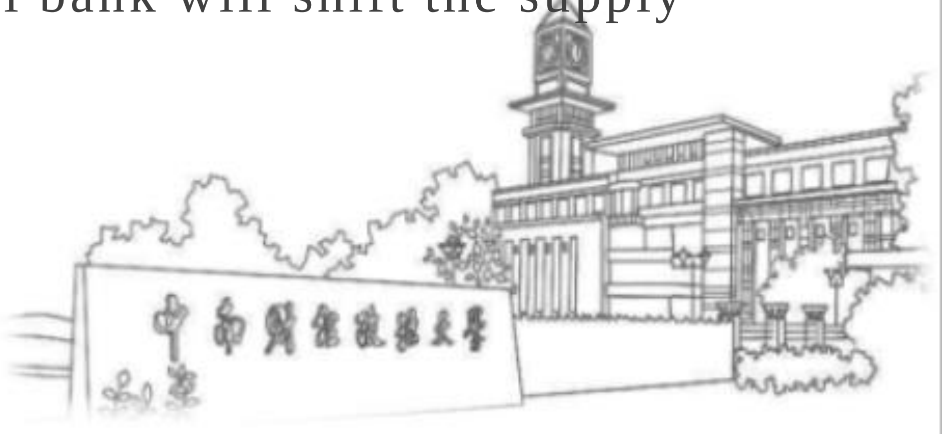
- Shifts in the demand for money:

Income Effect: a higher level of income causes the demand for money at each interest rate to increase and the demand curve to shift to the right

Price-Level Effect: a rise in the price level causes the demand for money at each interest rate to increase and the demand curve to shift to the right

- Shifts in the supply of money:

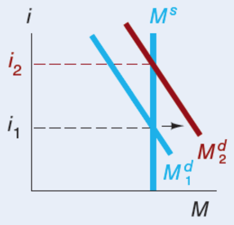
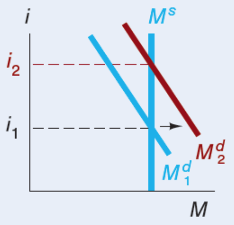
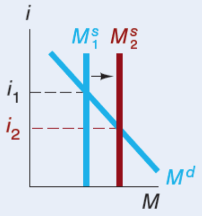
An increase in the money supply engineered by the central bank will shift the supply curve for money to the right.



Changes in Equilibrium Interest Rates in the Liquidity Preference Framework

SUMMARY TABLE 4

Factors That Shift the Demand for and Supply of Money

Variable	Change in Variable	Change in Money Demand (M^d) or Supply (M^s) at Each Interest Rate	Change in Interest Rate	
Income	↑	M^d↑	↑	
Price level	↑	M^d↑	↑	
Money supply	↑	M^s↑	↓	

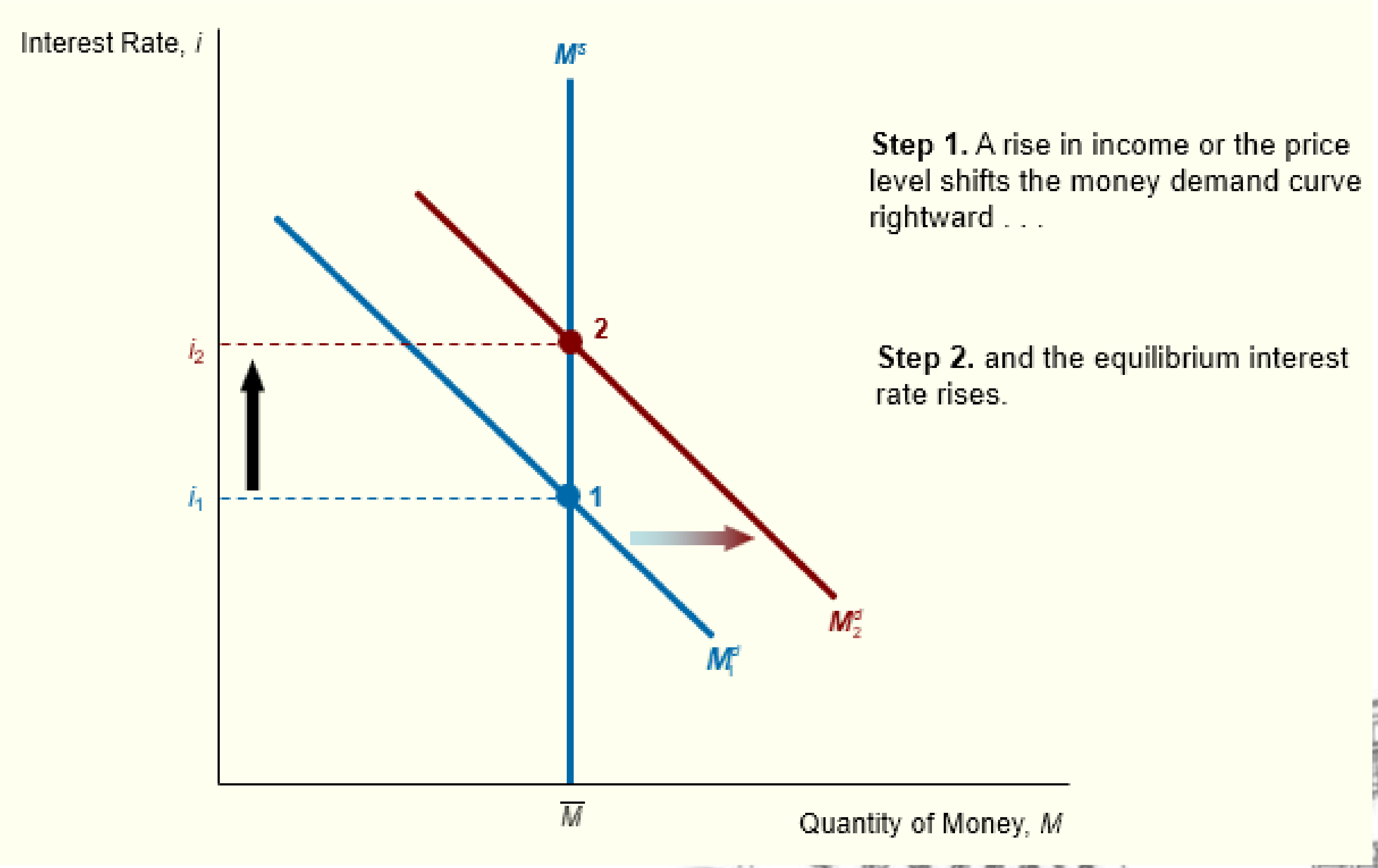
Note: Only increases in the variables are shown. The effects of decreases in the variables on demand and supply would be the opposite of those indicated in the remaining columns.

Response to a Change in Income or the Price Level

Holding other economic variables constant:

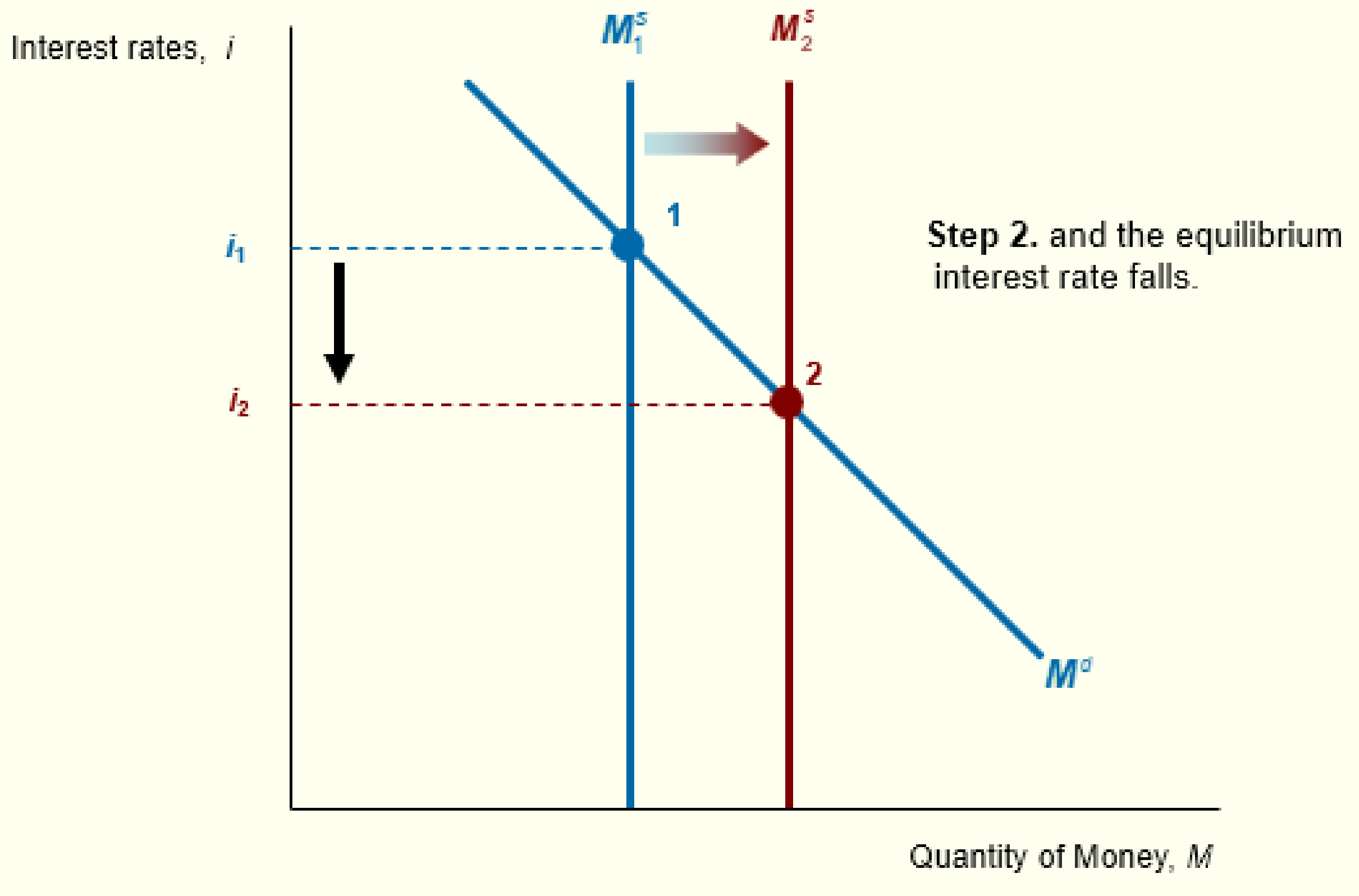
- When income is rising during a business cycle expansion, interest rates will rise. This conclusion is different from the one using the bond demand and supply analysis.

- When the price level increases, interest rates will rise.



Response to a Change in the Money Supply

When the money supply increases (everything else remaining equal), interest rates will decline.



Money and Interest Rates

How does money supply affect interest rates?

- **Liquidity Effect:** as we shown in the previous slide, an increase in the money supply (everything else remaining equal) lowers interest rate.

However, Milton Friedman raised some criticism on this conclusion:

- **Income Effect:** an increasing money supply can cause national income and wealth to rise, which will cause interest rates to rise.
- **Price-level Effect:** an increase in the money supply can cause the overall price level in the economy to rise, which will lead to a rise in interest rates.
- **Expected-inflation Effect:** an increase in the money supply may lead people to expect a higher price level in the future (higher expected inflation), which will lead to a higher level of interest rates.

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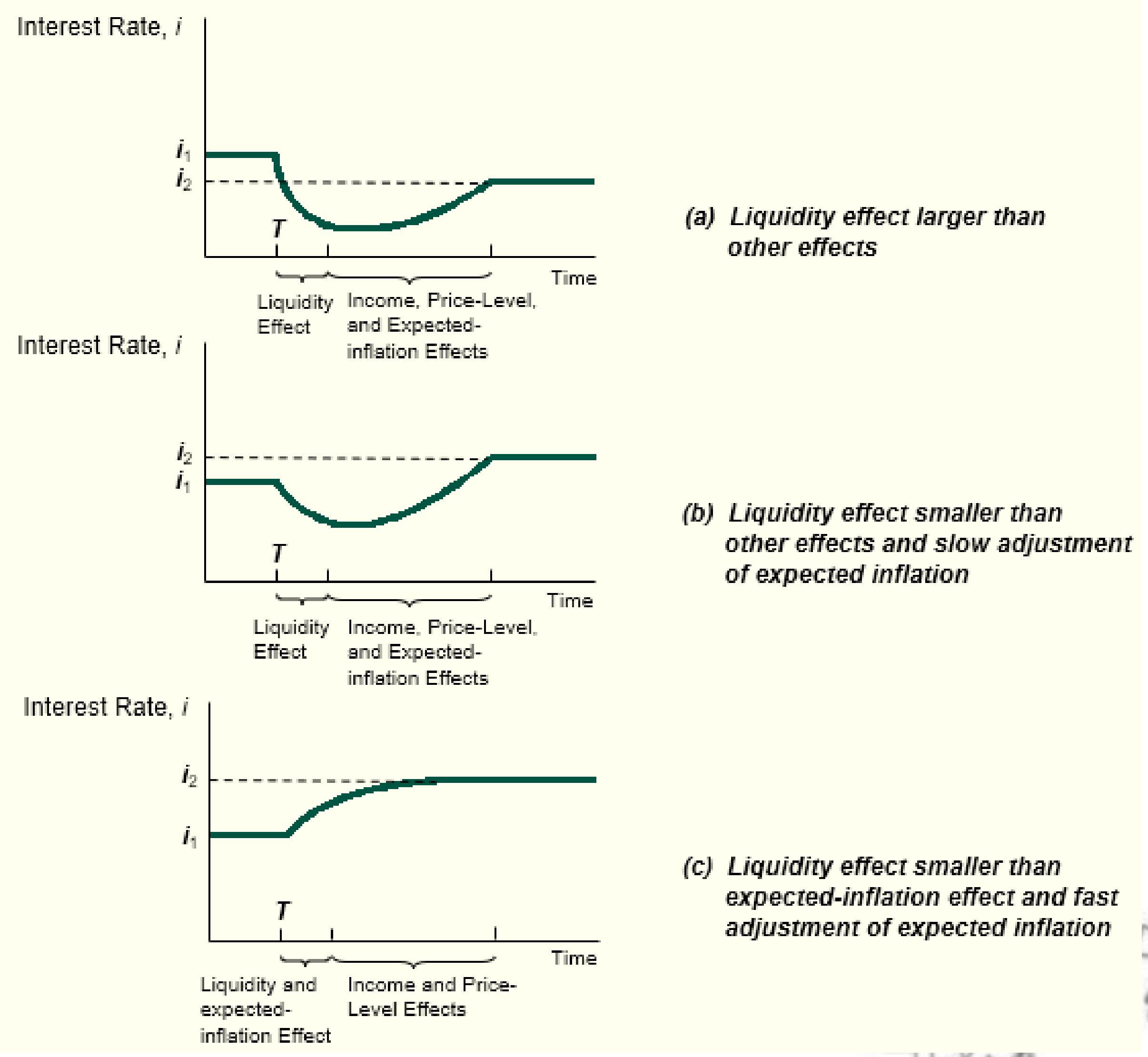
Response over Time to an Increase in Money Supply Growth



Price-level effect VS. Expected-inflation effect

- Price-level effect

A one time increase in the money supply will cause prices to rise to a permanently higher level by the end of the year. The interest rate will rise via the increased prices.

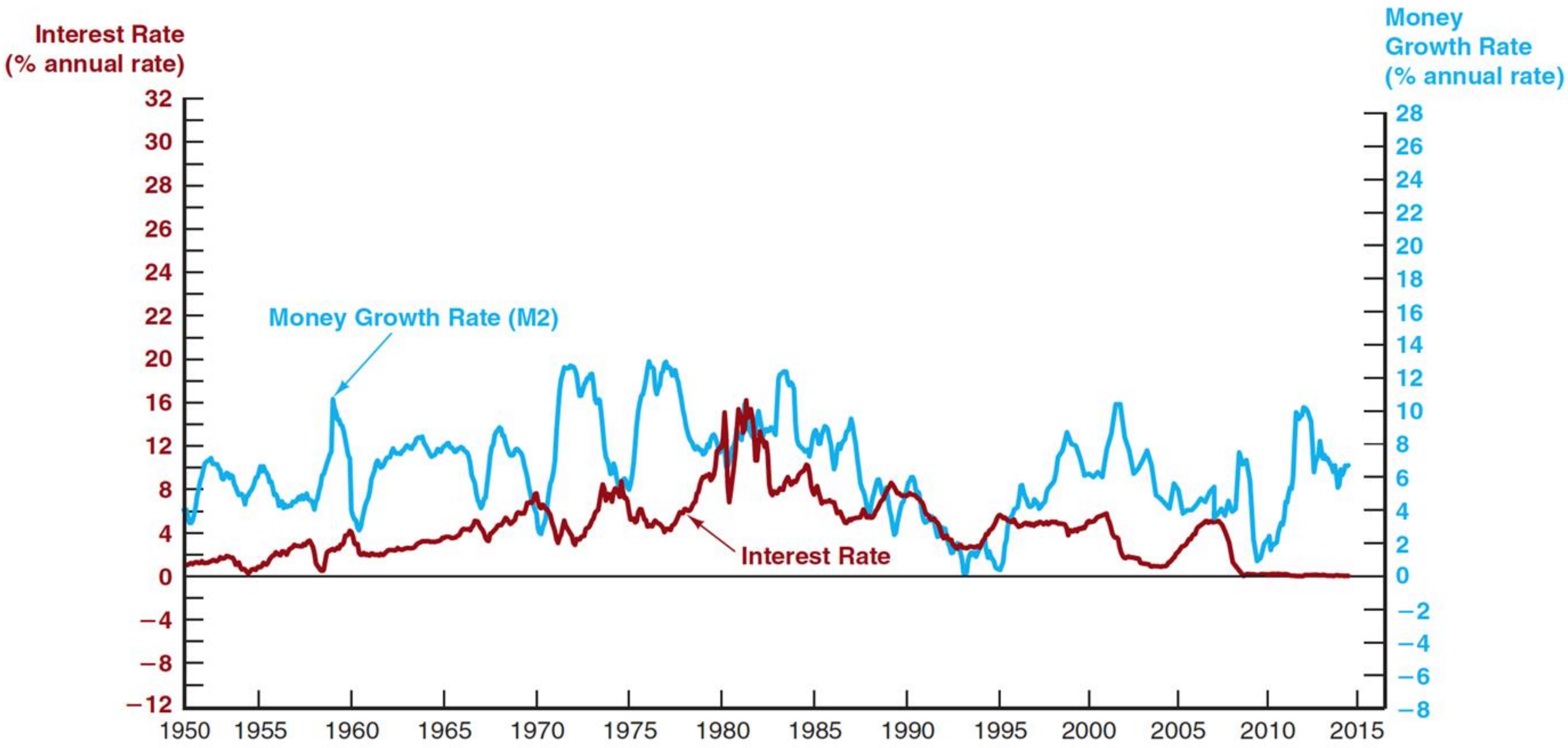
Price-level effect remains even after prices have stopped rising.

- Expected-inflation effect

A rising price level will raise interest rates because people will expect inflation to be higher over the course of the year. When the price level stops rising, expectations of inflation will return to zero.

Expected-inflation effect persists only as long as the price level continues to rise.

Money Growth (M2, Annual Rate) and Interest Rates (Three-Month Treasury Bills), 1950–2014



Acknowledgment

Slides here are adopted from the official slides published by Pearson Education Ltd.