Essex EC248-2-SP
Lecture 2

Financial Markets:
Determinants and Role
of Interest Rates

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Plan of Talk

- **Introduction**

1. Interest rates: definition and behaviour
2. The risk and term structure of interest rates
3. Interest rates and the stock market
4. Interest rates and the exchange rate: UIP

- **Wrap-up**

Aims and learning outcomes

- **Aims**
  - Understand what determines interest rates and their behaviour
  - Discuss how interest rates affect, in turn, other variables
- **Learning outcomes**
  - Compute interest rates for the basic types of credit instruments
  - Characterise the risk and term structure of interest rates
  - Discuss their relationship with the stock market and the exchange rate

Present Value

Four Types of Credit Instruments

1. Simple loan
2. Fixed-payment loan
3. Coupon bond
4. Discount (zero coupon) bond

Concept of Present Value

Simple loan of $1 at 10% (constant) interest p.a.

Year	1	2	3	n
	\$1.10	\$1.21	\$1.33	$\$1 \text{x} (1 + i)^n$

$$\text{PV of future } \$1 = \frac{\$1}{(1+i)^n}$$

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%)**

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

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

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

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

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

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

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 in 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

Distinction Between Interest Rates and Returns

Rate of Return

$$R = \frac{C + P_{t+1} - P_t}{P_t} = i_c + g$$

where: $$i_c = \frac{C}{P_t} = \text{current yield}$$

$$g = \frac{P_{t+1} - P_t}{P_t} = \text{capital gain/loss}$$

Distinction Between Real and Nominal Interest Rates

Real Interest Rate

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

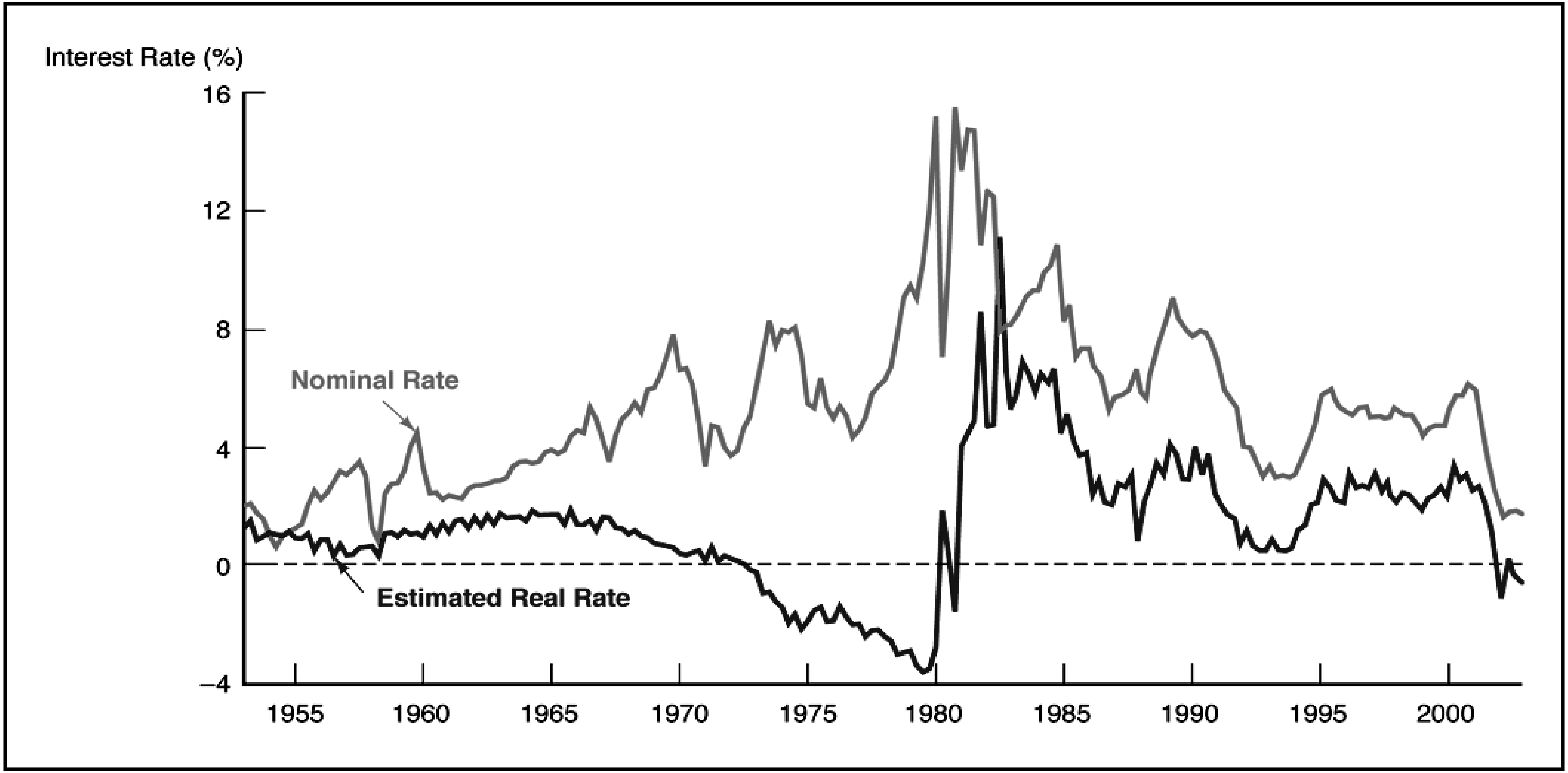
if i = 5% and π^e = 3% then:

$$i_r = 5\% - 3\% = 2\%$$

if i = 8% and π^e = 10% then

$$i_r = 8\% - 10\% = -2\%$$

U.S. Real and Nominal Interest Rates



Asset Market Approach to Interest Rates: Derivation of Bond *Demand* Curve

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

Point A:

$P = \$950$

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

$B^d = \$100$ billion

Derivation of Bond *Demand* Curve (cont.)

Point B:

$P = \$900$

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

$B^d = \$200$ billion

Point C: $P = \$850$, $i = 17.6\%$ $B^d = \$300$ billion

Point D: $P = \$800$, $i = 25.0\%$ $B^d = \$400$ billion

Point E: $P = \$750$, $i = 33.0\%$ $B^d = \$500$ billion

Demand Curve is B^d (in the figure next) which connects points A, B, C, D, E, has usual downward slope

Derivation of Bond *Supply* Curve

Point F: P = \$750, i = 33.0%, B^s = \$100 billion

Point G: P = \$800, i = 25.0%, B^s = \$200 billion

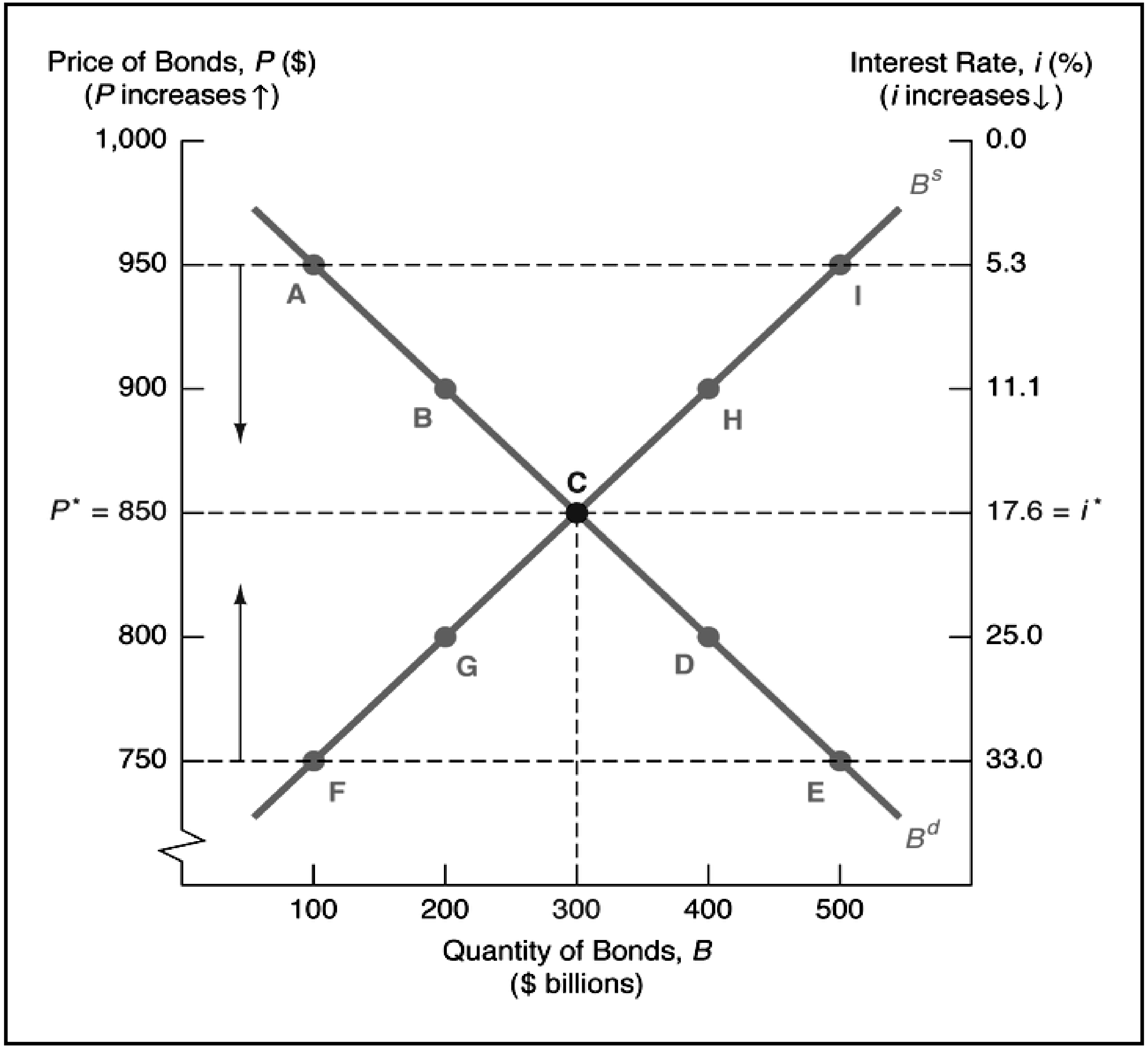
Point C: P = \$850, i = 17.6%, B^s = \$300 billion

Point H: P = \$900, i = 11.1%, B^s = \$400 billion

Point I: P = \$950, i = 5.3%, B^s = \$500 billion

Supply Curve is B^s that connects points F, G, C, H, I, and has upward slope

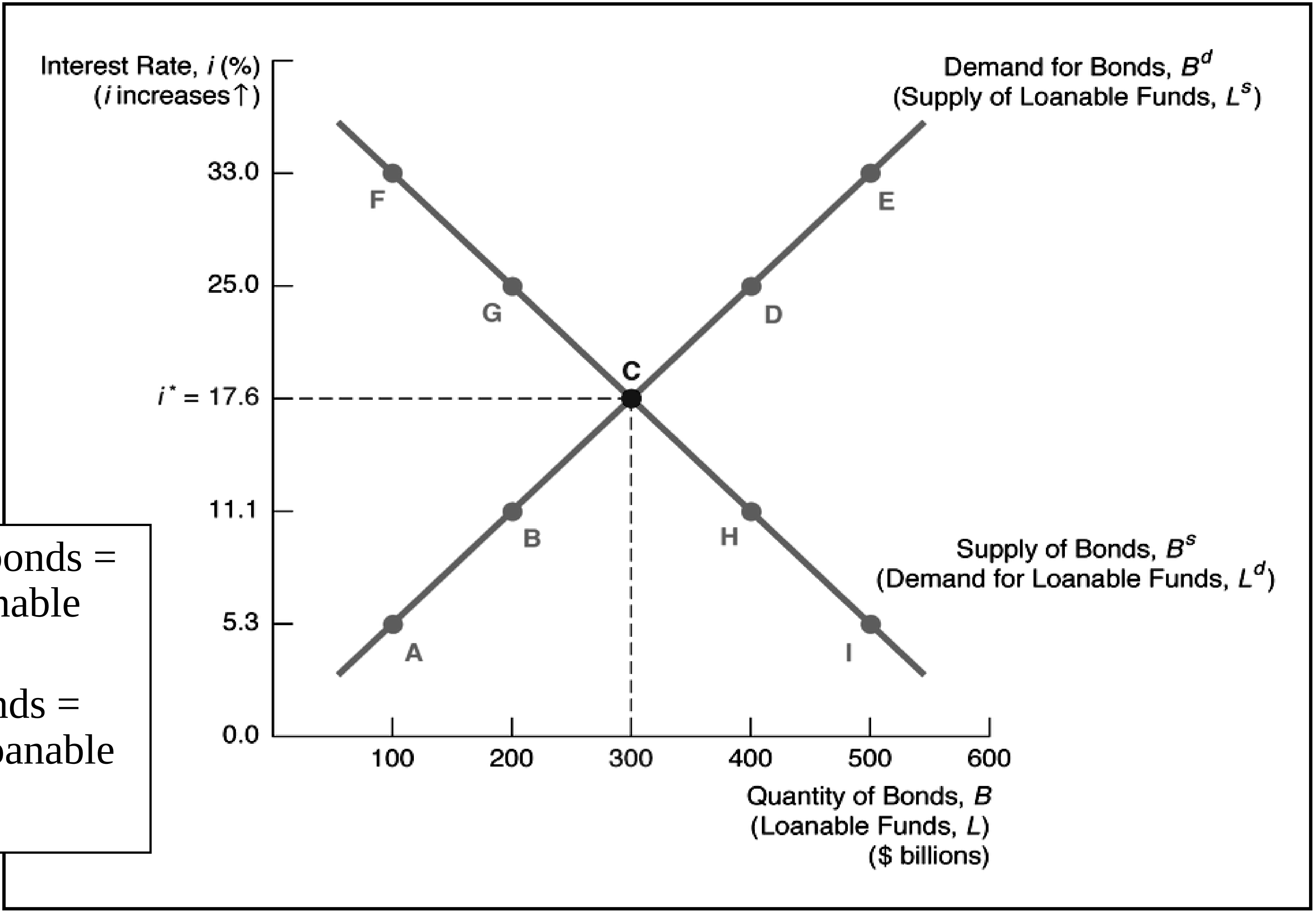
Supply and Demand Analysis of the Bond Market



Market Equilibrium

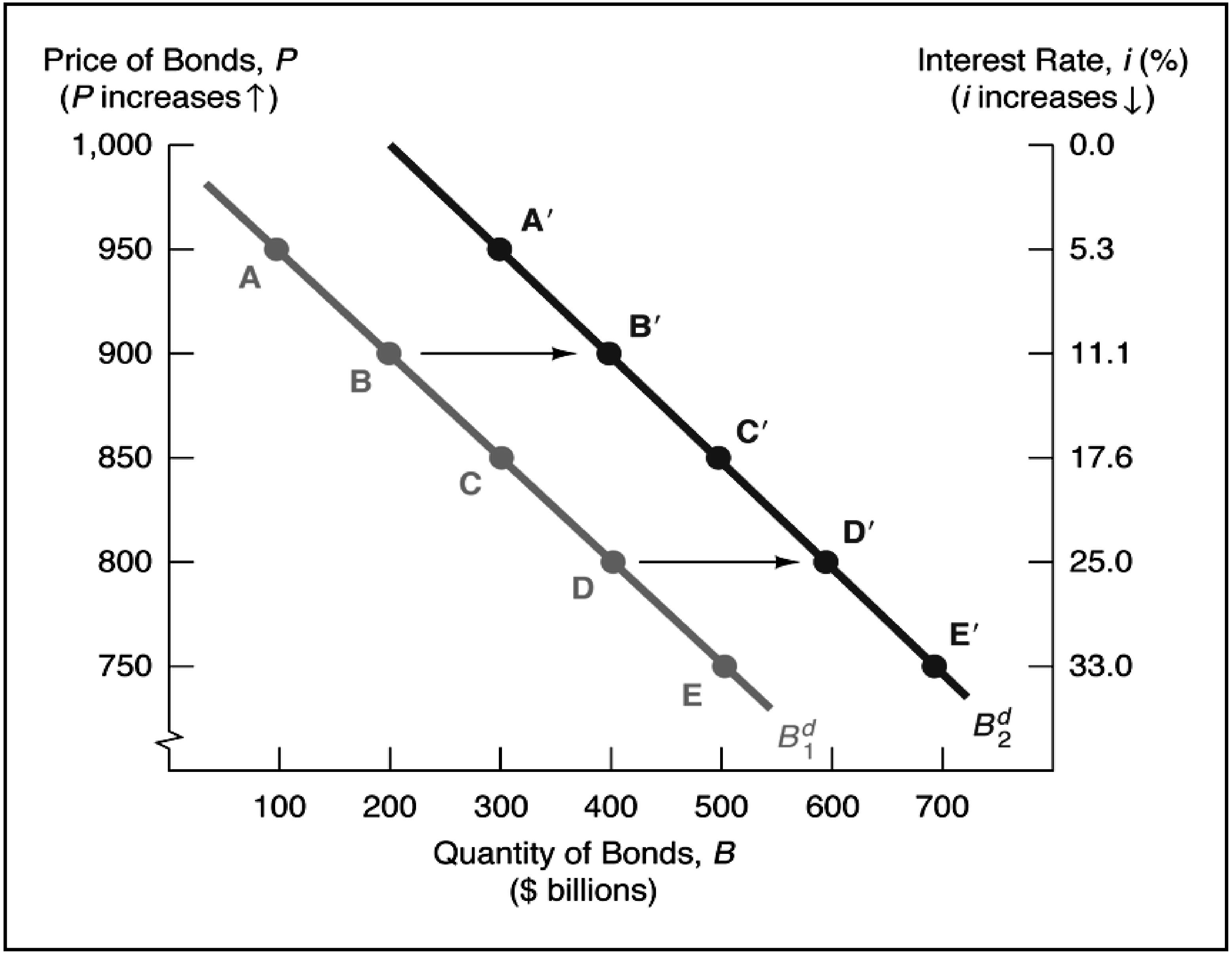
1. Occurs when $B^d = B^s$, at $P^* =$ \$850, $i^* = 17.6\%$
2. When $P = \$950$, $i = 5.3\%$, $B^s > B^d$ (excess supply): $P \downarrow$ to P^*, $i \uparrow$ to i^*
3. When $P = \$750$, $i = 33.0$, $B^d > B^s$ (excess demand): $P \uparrow$ to P^*, $i \downarrow$ to i^*

Loanable Funds Terminology



1. Demand for bonds = supply of loanable funds
2. Supply of bonds = demand for loanable funds

Shifts in the Bond Demand Curve



Factors that *Shift* the Bond *Demand* Curve

1. Wealth

A. Economy grows, wealth ↑, B^d ↑, B^d shifts out to right

2. Expected Return (identical to the **interest rate** *only for* a 1-yr discount bond and a 1-yr holding period *but not for* longer-term bonds!)

A. i ↓ in future, P^e => R^e for long-term bonds ↑, B^d shifts out to right

B. π^e ↓, *relative* R^e (to that of *real* assets) ↑, B^d shifts out to right

C. Expected return of *other* assests ↓, B^d ↑, B^d shifts out to right

3. Risk

A. Risk of bonds ↓, B^d ↑, B^d shifts out to right

B. Risk of *other* assets ↑, B^d ↑, B^d shifts out to right

4. Liquidity

A. Liquidity of bonds ↑, B^d ↑, B^d shifts out to right

B. Liquidity of *other* assets ↓, B^d ↑, B^d shifts out to right

Factors that *Shift* the Bond *Supply* Curve

1. **Profitability of Investment Opportunities**

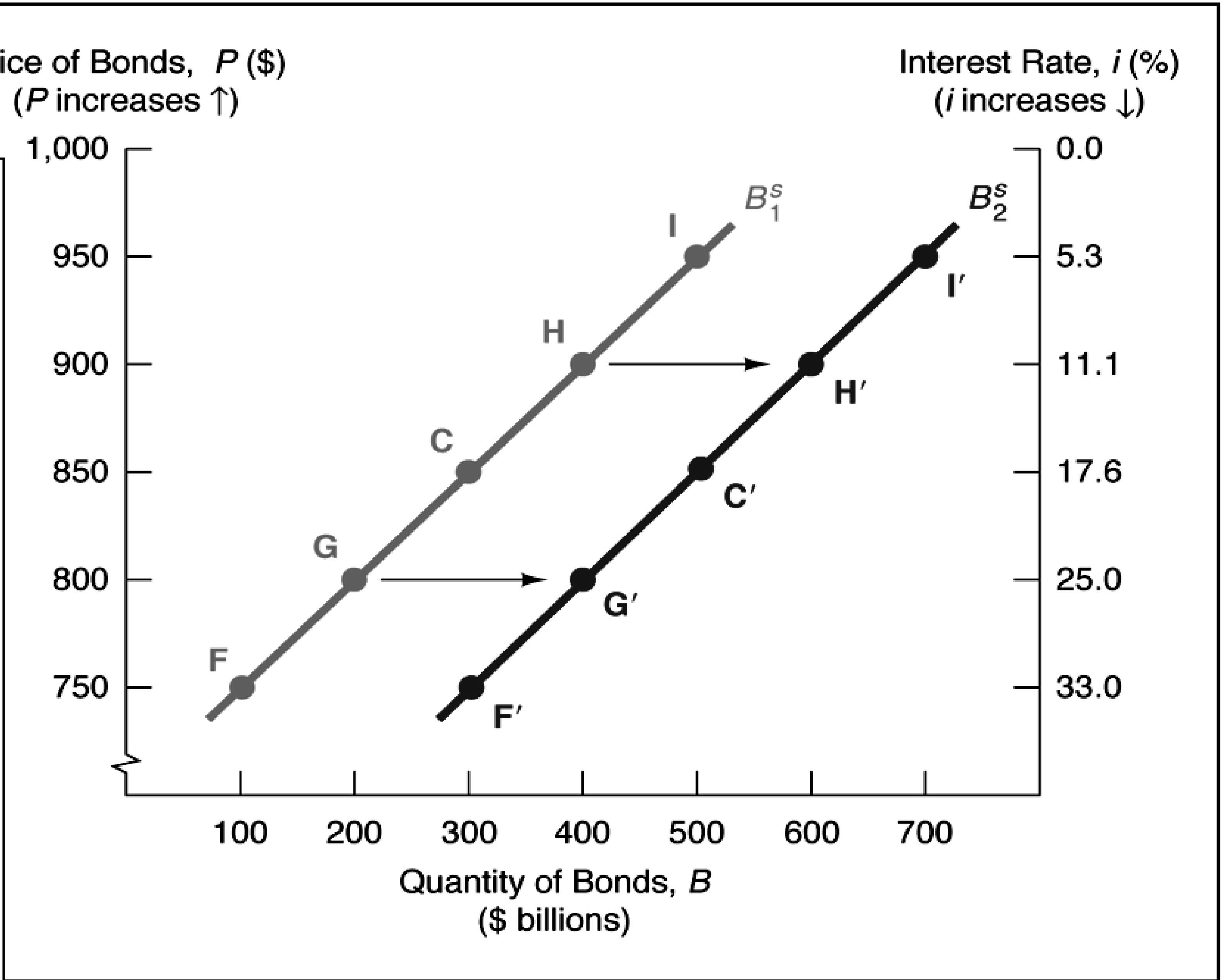
   Business cycle expansion, investment opportunities ↑, B^s ↑, B^s shifts out to right

2. **Expected Inflation**

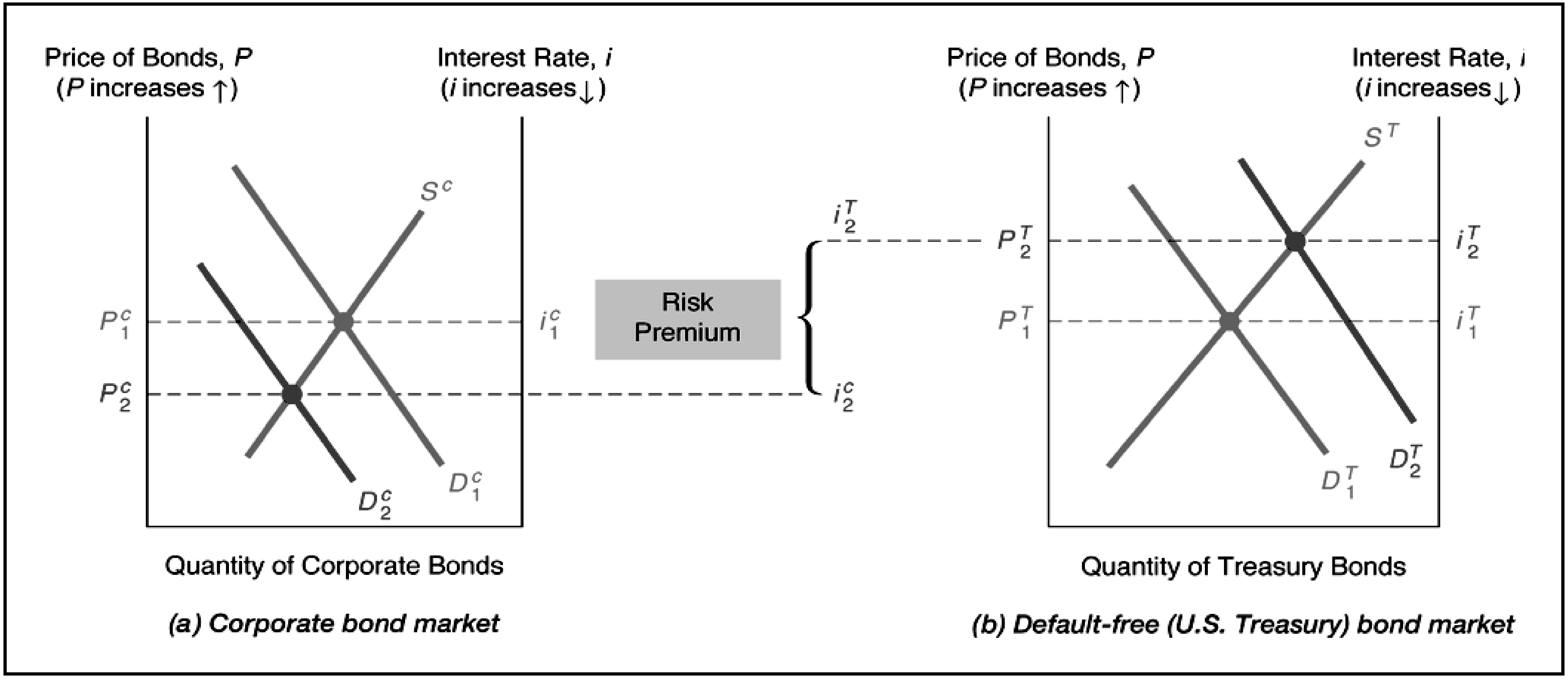
   π^e ↑, RIR ↓, B^s ↑, B^s shifts out to right

3. **Government Activities**

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



Increase in Default Risk on Corporate Bonds => Risk Premium

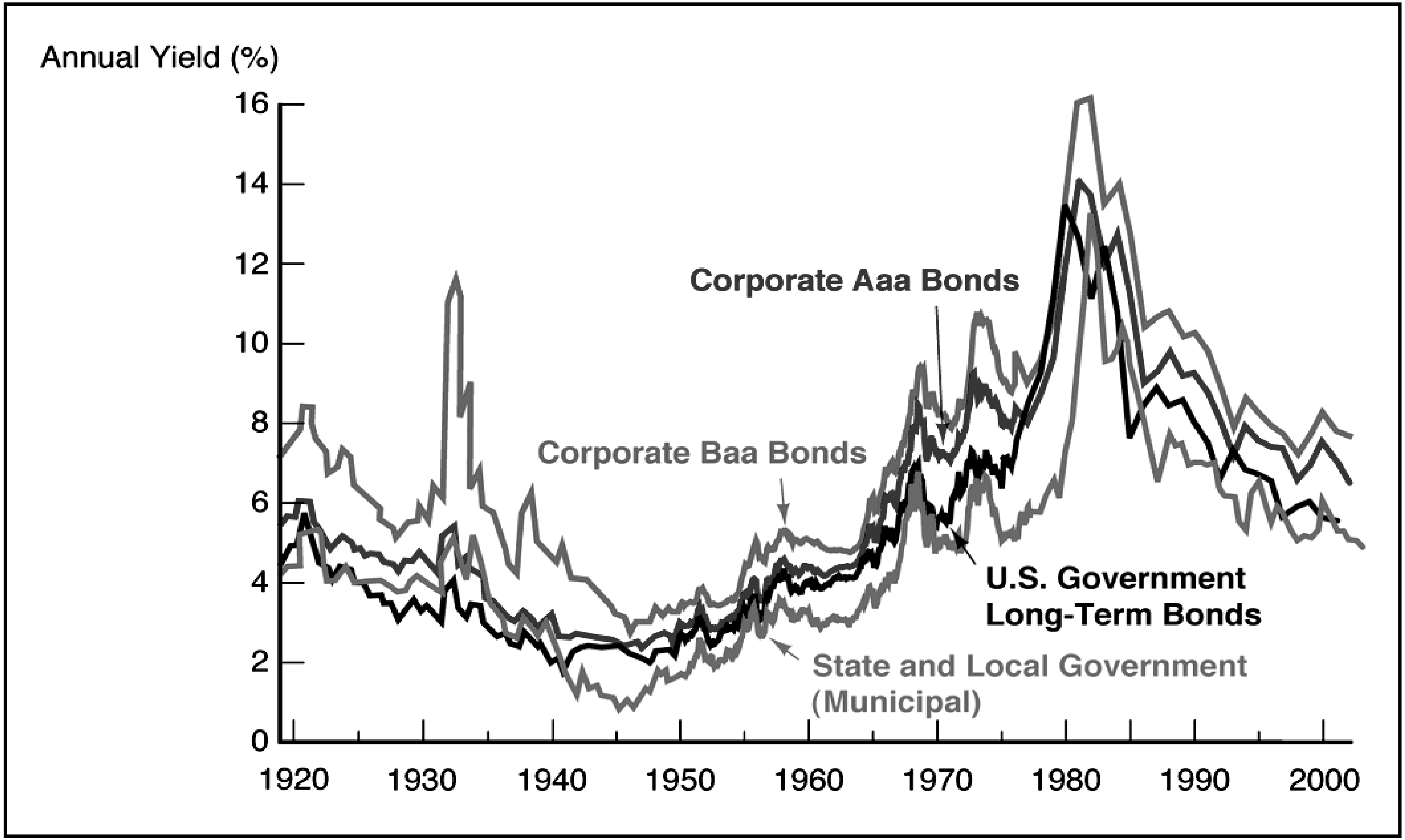


Bond Ratings

Table 1 Bond Ratings by Moody's and Standard and Poor's

Rating: Moody's	Standard and Poor's	Descriptions	Examples of Corporations with Bonds Outstanding in 2003
Aaa	AAA	Highest quality (lowest default risk)	General Electric, Pfizer Inc., North Carolina State, Mobil Oil
Aa	AA	High quality	Wal-Mart, McDonald's, Credit Suisse First Boston
A	A	Upper medium grade	Hewlett-Packard, Anheuser-Busch, Ford, Household Finance
Baa	BBB	Medium grade	Motorola, Albertson's, Pennzoil, Weyerhaeuser Co., Tommy Hilfiger
Ba	BB	Lower medium grade	Royal Caribbean, Levi Strauss
B	B	Speculative	Rite Aid, Northwest Airlines Inc., Six Flags
Caa	CCC, CC	Poor (high default risk)	Revlon, United Airlines
Ca	C	Highly speculative	US Airways, Polaroid
C	D	Lowest grade	Enron, Oakwood Homes

Risk Structure of Long-Term Bonds in the United States



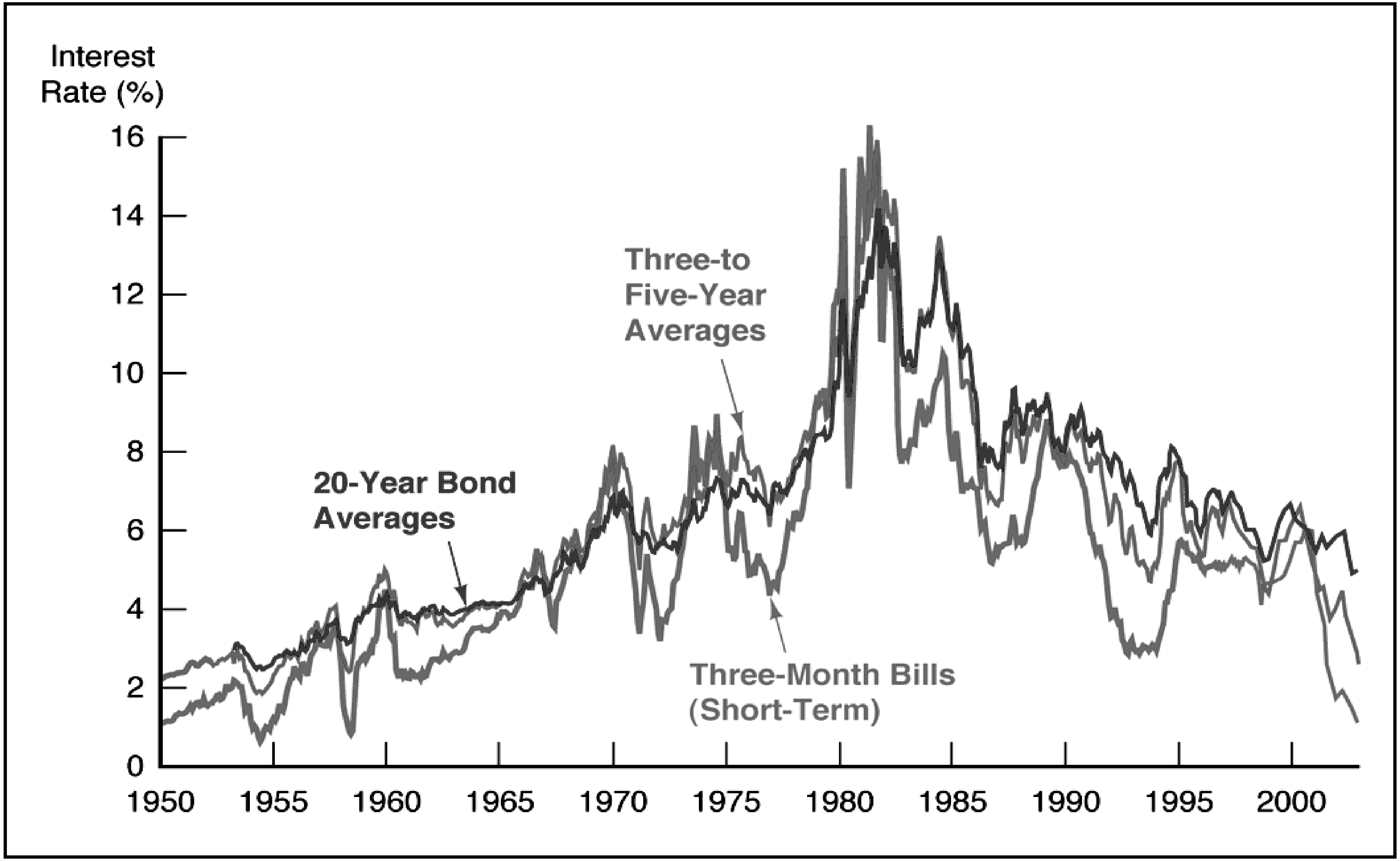
Term Structure Facts to be Explained

1. Interest rates for different maturities move together over time
2. Yield curves tend to have steep upward slope when short rates are low and downward slope when short rates are high
3. Yield curve is typically upward sloping

Three Theories of Term Structure

1. Expectations Theory
2. Segmented Markets Theory
3. Liquidity Premium (Preferred Habitat) Theory
    - A. Expectations Theory explains 1 and 2, but not 3
    - B. Segmented Markets explains 3, but not 1 and 2
    - C. Solution: Combine features of both Expectations Theory and Segmented Markets Theory to get Liquidity Premium (Preferred Habitat) Theory and explain all facts

Interest Rates on Different Maturity Bonds Move Together



Yield Curves

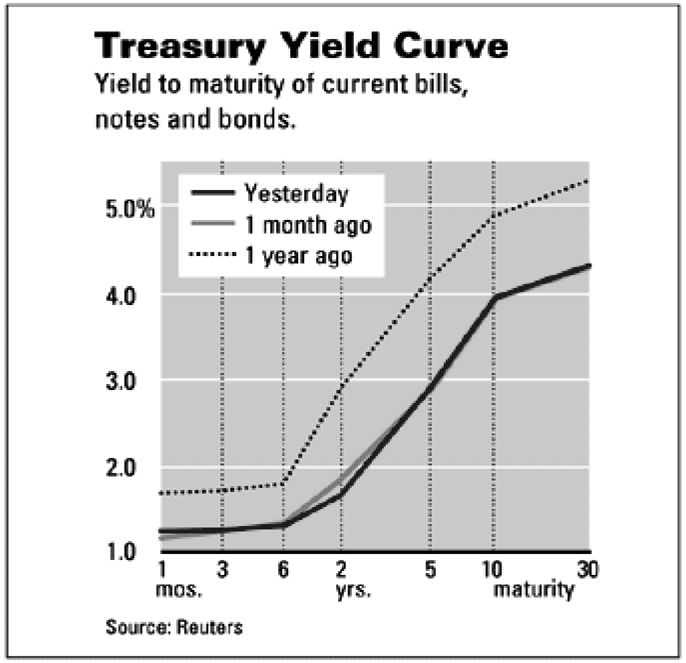
Following the Financial News

Yield Curves

The *Wall Street Journal* publishes a daily plot of the yield curves for Treasury securities, an example of which is presented here. It is typically found on page 2 of the "Money and Investing" section.

The numbers on the vertical axis indicate the interest rate for the Treasury security, with the maturity given by the numbers on the horizontal axis. For example, the yield curve marked "Yesterday" indicates that the interest rate on the three-month Treasury bill yesterday was 1.25%, while the one-year bill had an interest rate of 1.35% and the ten-year bond had an interest rate of 4.0%. As you can see, the yield curves in the plot have the typical upward slope.

Source: Wall Street Journal, Wednesday, January 22, 2003, p. C2.



Expectations Hypothesis

Key Assumption: Bonds of different maturities are perfect substitutes

Implication: R^e on bonds of different maturities are equal

For an *n*-period bond:

$$i_{nt} = \frac{i_t + i^e_{t+1} + i^e_{t+2} + \cdots + i^e_{t+(n-1)}}{n}$$

In words: interest rate on long bond = average short rates expected to occur over life of long bond

Numerical example:

One-year interest rate over the next five years 5%, 6%, 7%, 8% and 9%

Interest rate for one to five year bonds:

5%, 5.5%, 6%, 6.5% and 7%

Segmented Markets Theory

Key Assumption: Bonds of different maturities are not substitutes at all

Implication: Markets are completely segmented: interest rate at each maturity determined separately

Explains Fact 3 that yield curve is usually upward sloping

People typically prefer short holding periods and thus have higher demand for short-term bonds, which have higher price and lower interest rates than long bonds

Does not explain Fact 1 or Fact 2 because assumes long and short rates determined independently

Liquidity Premium (Preferred Habitat) Theories => Term (Liquidity) Premium

Key Assumption: Bonds of different maturities are substitutes, but are not perfect substitutes

Implication: Modifies Expectations Theory with features of Segmented Markets Theory

Investors prefer short rather than long bonds ⇒ must be paid positive liquidity (term) premium, l_{nt}, to hold long-term bonds

Results in following modification of Expectations Theory

$$i_{nt} = \frac{i_t + i^e_{t+1} + i^e_{t+2} + \ldots + i^e_{t+(n-1)}}{n} + l_{nt}$$

Computing the Price of Common Stock

- Basic Principle of Finance

  Value of Investment = Present Value of Future Cash Flows

- One-Period Valuation Model

$$P_0 = \frac{D_1}{1+k_e} + \frac{P_1}{1+k_e}$$

- Generalised Dividend Valuation Model

$$P_0 = \frac{D_1}{(1+k_e)^1} + \frac{D_2}{(1+k_e)^2} + \ldots + \frac{D_n}{(1+k_e)^n} + \frac{P_n}{(1+k_e)^n}$$

- Since last term of the above equation is small, it can be written as

$$P_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+k_e)^t}$$

Theory of Rational Expectations

Rational expectation (RE) = expectation that is optimal forecast (best prediction of future) using all available information: i.e., RE ⇒

$$X^e = X^{of}$$

2 reasons expectation may not be rational

1. Not best prediction
2. Not using available information

Rational expectation, although optimal prediction, may not be accurate

Rational expectations makes sense because is costly not to have optimal forecast

Implications:

1. Change in way variable moves, way expectations are formed changes
2. Forecast errors on average = 0 and are not predictable

Efficient Markets Hypothesis

$$R = \frac{P_{t+1} - P_t + C}{P_t}$$

$$R^e = \frac{P^e_{t+1} - P_t + C}{P_t}$$

Rational Expectations implies:

$$P^e_{t+1} = P^{of}_{t+1} \Rightarrow R^e = R^{of} \qquad (1)$$

Market equilibrium

$$R^e = R^* \qquad (2)$$

Put (1) and (2) together: Efficient Markets Hypothesis

$$R^{of} = R^*$$

Why the Efficient Markets Hypothesis makes sense

If $R^{of} > R^* \Rightarrow P_t \uparrow, R^{of} \downarrow$

If $R^{of} < R^* \Rightarrow P_t \downarrow, R^{of} \uparrow$

until $R^{of} = R^*$

1. All unexploited profit opportunities eliminated
2. Efficient Market holds even if are uninformed, irrational participants in market

Evidence on Efficient Markets Hypothesis

Favorable Evidence

1. Investment analysts and mutual funds don't beat the market
2. Stock prices reflect publicly available information: anticipated announcements don't affect stock price
3. Stock prices and exchange rates close to random walk
   If predictions of ΔP big, $R^{of} > R^* \Rightarrow$ predictions of ΔP small
4. Technical analysis does not outperform market

Unfavorable Evidence

1. Small-firm effect: small firms have abnormally high returns
2. January effect: high returns in January
3. Market overreaction
4. Excessive volatility
5. Mean reversion
6. New information is not always immediately incorporated into stock prices

Overview

Reasonable starting point but not whole story

Law of One Price

Example: American steel $100 per ton, Japanese steel 10,000 yen per ton

If *E* = 50 yen/$ then prices are:

	American Steel	Japanese Steel
In U.S.	**$100**	**$200**
In Japan	**5000 yen**	**10,000 yen**

If *E* = 100 yen/$ then prices are:

	American Steel	Japanese Steel
In U.S.	**$100**	**$100**
In Japan	**10,000 yen**	**10,000 yen**

Law of one price $\Rightarrow$ *E* = 100 yen/$

Purchasing Power Parity (PPP)

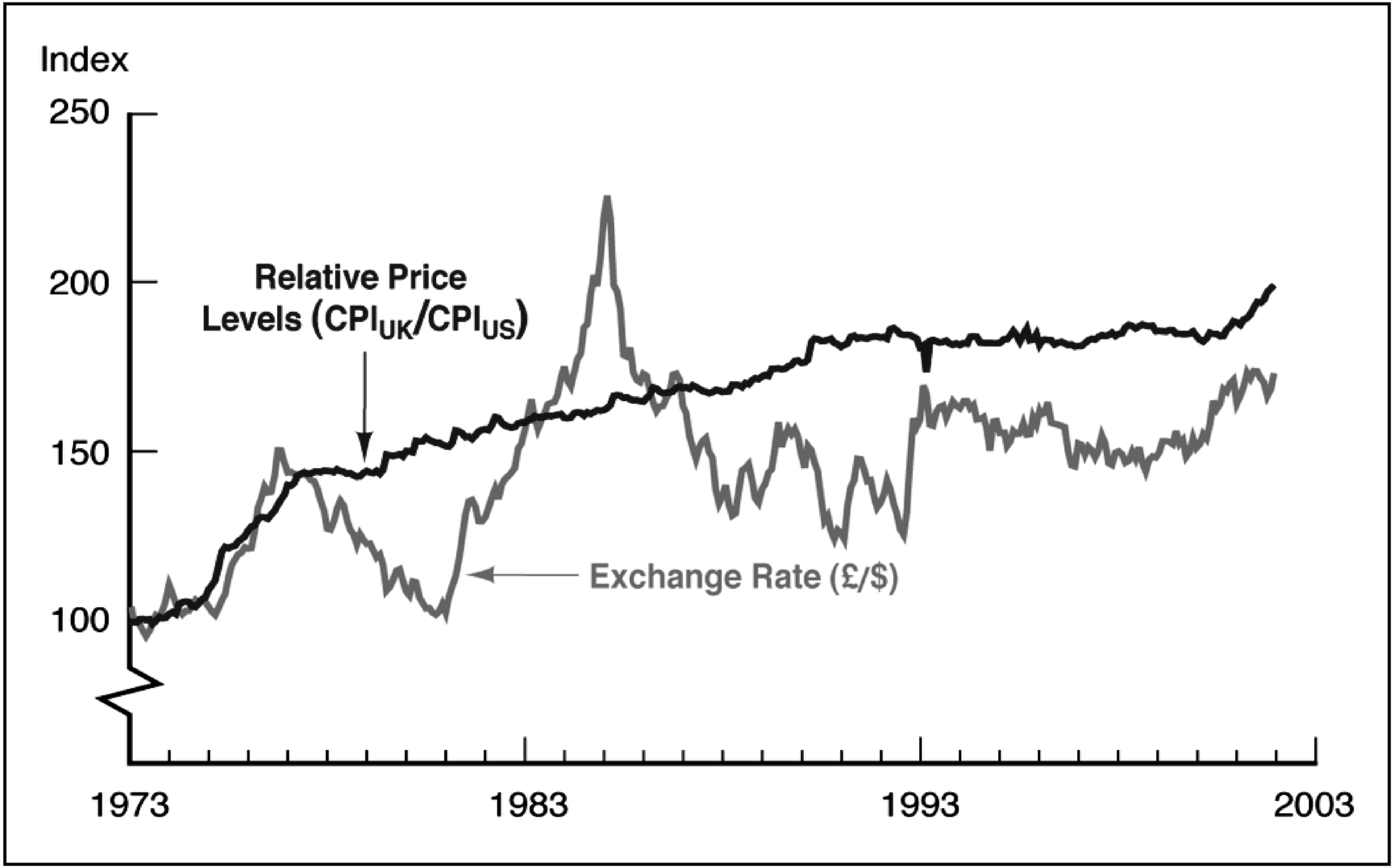
PPP $\Rightarrow$ Domestic price level $\uparrow$ 10%, domestic currency $\downarrow$ 10%

1. Application of law of one price to price levels
2. Works in long run, not short run

Problems with PPP

1. All goods not identical in both countries: Toyota vs Chevy
2. Many goods and services are not traded: e.g. haircuts

PPP: U.S. and U.K



Index
250
200
150
100
Relative Price Levels (CPI_UK/CPI_US)
Exchange Rate (£/$)
1973
1983
1993
2003

Expected Returns and Interest Parity

	R^e for	
	Francois	**Al**
$ Deposits	$i^D + (E^e_{t+1} - E_t)/E_t$	i^D
Euro Deposits	i^F	$i^F - (E^e_{t+1} - E_t)/E_t$
Relative R^e	$i^D - i^F + (E^e_{t+1} - E_t)/E_t$	$i^D - i^F + (E^e_{t+1} - E_t)/E_t$

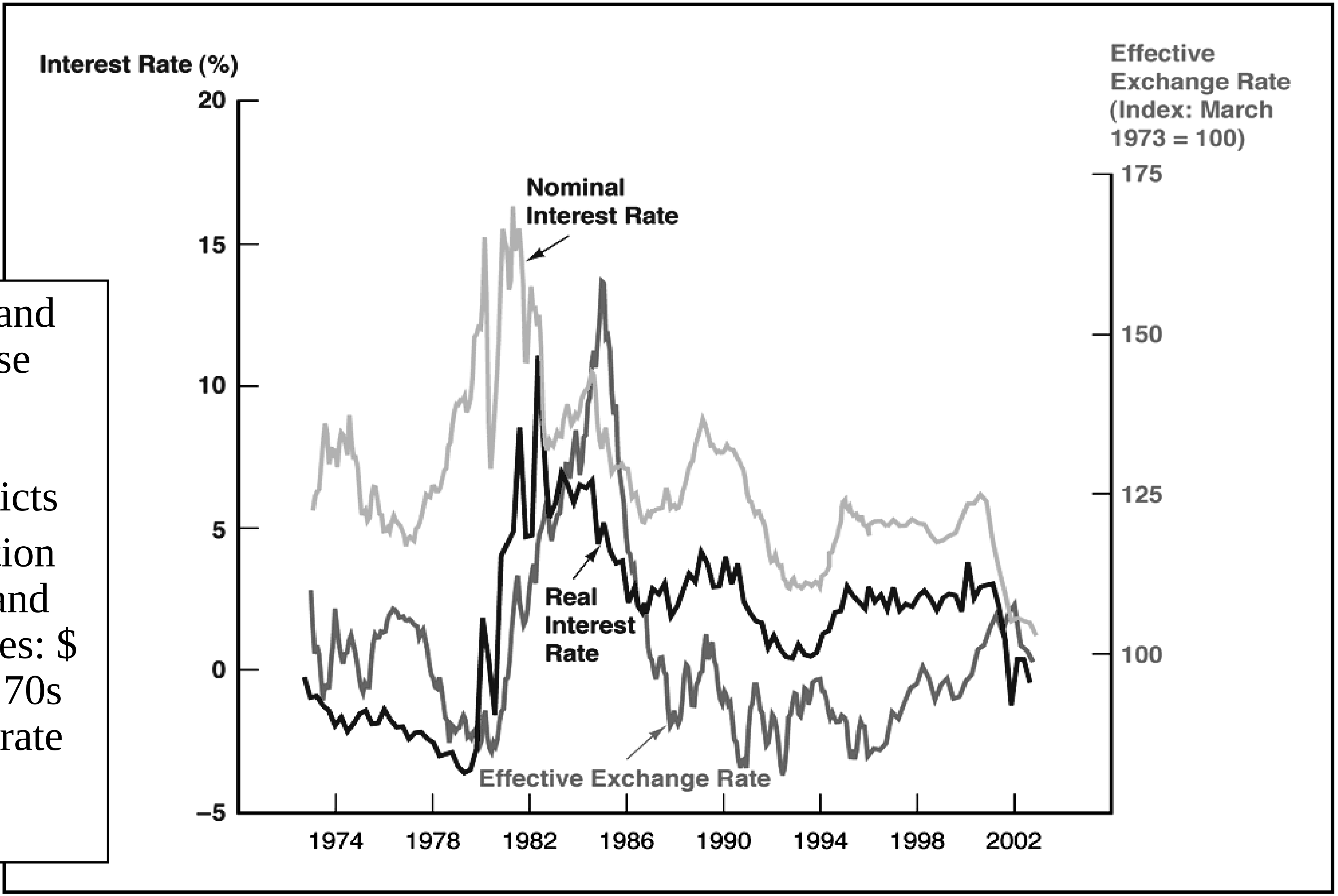
Interest Parity Condition:

$ and Euro deposits perfect substitutes

$i^D = i^F - (E^e_{t+1} - E_t)/E_t$

Example: if $i^D = 10\%$ and expected appreciation of $,
$(E^e_{t+1} - E_t)/E_t$, $= 5\% \Rightarrow i^F = 15\%$

The Dollar and Interest Rates



1. Value of $ and real rates rise and fall together, as theory predicts
2. No association between $ and nominal rates: $ falls in late 70s as nominal rate rises

Concluding Wrap-Up

- **What have we learnt?**
  - Why interest rates are so important in the economy
  - What are their types and how they are related
  - How interest rates interact with other key financial market variables
- **Where we go next:** to a closer look at financial intermediaries, with a focus on banking and regulation