Financial Institutions and System

Week 4: The Meaning and Behavior of Interest Rates

Iegor Vyshnevskyi, Ph.D.

Sogang University

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Agenda

1. What is an Interest Rate?
2. The Behavior of Interest Rates
3. Class Activity: Understanding Interest Rates in Action

1. What is an Interest Rate?

Interest Rates: The Cost of Money

Definition: The **interest rate** is the **price of borrowing money** or the **return earned from lending or saving money**.

Why it matters: It affects everything—from mortgages and student loans to investment decisions and inflation.

Interest rate = **Risk-free rate** + **Risk premium**

where, **Risk-free rate** = **Real rate** + **Expected inflation**

Note:

- **Real rate** is the rate of return on an investment after adjusting for inflation.
- Expected inflation is the rate at which prices are expected to rise.
- Risk-free rate is the return on an investment that carries no risk of financial loss.
- Risk premium is the return in excess of the risk-free rate.

Measuring Interest Rates

Present Value (PV): Reflects the idea that **money today is worth more than money in the future**.

- A dollar today earns interest and grows to $1 \times (1 + i)$ tomorrow.
- Ex: Would you prefer \$20M **today**, or \$1M every year for 20 years?

The answer depends on the **discount rate** or interest rate used.

Compound Interest Example

Let `i = 0.10` (10%)

- Year 1:

$$\$100 \times (1 + 0.10) = \$110$$

- Year 2:

$$\$110 \times (1 + 0.10) = \$121 \rightarrow or \$100 \times (1 + 0.10)^2$$

- Year 3:

$$\$121 \times (1 + 0.10) = \$133 \rightarrow or \$100 \times (1 + 0.10)^3$$

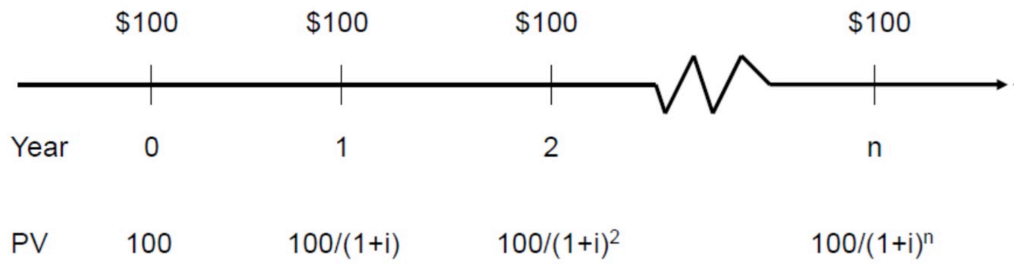
General formula: $FV = PV \times (1 + i)^n$

Simple Present Value

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

Where:

- **PV** = Present Value
- **CF** = Future Cash Flow
- **i** = Interest Rate
- **n** = Time in years



This formula helps us **compare money received at different times**.

How Much Is That Jackpot Worth?

You win \$20M, paid as \$1M per year for 20 years.

- Is it really worth \$20M today?
- Let's assume an interest rate of 10%.

Calculate Present Value:

$$PV = \frac{1M}{(1+0.10)} + \frac{1M}{(1+0.10)^2} + \ldots + \frac{1M}{(1+0.10)^{20}}$$

This will result in a value significantly **less** than \$20M. That's the power of **discounting**.

Four Types of Credit Market Instruments

1. **Simple Loan**: Lump sum borrowed and repaid with interest (e.g., short-term bank loan).

2. **Fixed Payment Loan**: Equal regular payments (e.g., car loans, mortgages).

3. **Coupon Bond**: Pays fixed interest (coupon) annually + face value at maturity.

    - **Coupon rate** = Annual coupon ÷ Face value
    - **Zero-coupon bonds**: No interim payments, only repayment at maturity.

4. **Discount Bond**: Sold below face value, pays no coupon (e.g., Treasury bills).

Yield to Maturity (YTM)

YTM is the interest rate that **equates the bond's current price with the present value of its future payments**.

Why is YTM important?

- It reflects the **true return** on a bond if held to maturity.

Example – Simple Loan:

- PV = $100
- CF = $110 in 1 year

$100 = \frac{110}{1+i} \Rightarrow i = 10$

Fixed Payment Loan Formula

$LV = \sum_{t=1}^{n} \frac{FP}{(1+i)^t}$

Where:

- **LV** = Loan Value
- **FP** = Fixed annual payment
- **n** = Number of years

Used in amortized loans like mortgages.

Coupon Bond Formula

$$P = \sum_{t=1}^{n} \frac{C}{(1+i)^t} + \frac{F}{(1+i)^n}$$

Where:

- **P** = Current bond price
- **C** = Annual coupon payment
- **F** = Face value
- **i** = Interest rate
- **n** = Years to maturity

Bond Pricing Insights

- **YTM = Coupon Rate** → Bond trades at **par** (face value).
- **YTM > Coupon Rate** → Bond trades **below par** (discount).
- **YTM < Coupon Rate** → Bond trades **above par** (premium).

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

Remember: Bond price and Yield to Maturity (YTM) are inversely related — when price increases, yield decreases.

Why? Because paying a higher price for the same fixed future payments results in a lower return.

Consol (Perpetuity)

A **consol bond** or **perpetuity** pays **coupon payments forever** and never matures.

$$P = \frac{C}{i_c}$$

Where:

- **P** = Price
- **C** = Annual coupon
- **i_c** = Current yield

Used as a **simple approximation** of YTM when maturity is distant.

Discount Bond Formula

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

Where:

- **F** = Face value
- **P** = Current price

Like other bonds, **price ↑ → yield ↓**.

Interest Rates vs Returns

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

Where:

- **RET** = Return from holding bond for 1 period
- **C** = Coupon payment
- P_t = Price at time t
- P_{t+1} = Price at time t+1

Two components:

1. **Current yield**
2. **Capital gain/loss**

Return vs Yield

- Return equals YTM **only** if held to maturity.
- Longer maturity → **greater interest-rate risk**.
- If interest rates **rise**, prices fall → **capital loss**.

Table 2 One-Year Returns on Different-Maturity 10%-Coupon-Rate Bonds When Interest Rates Rise from 10% to 20%

(1) Years to Maturity When Bond Is Purchased	(2) Initial Current Yield (%)	(3) Initial Price ($)	(4) Price Next Year* ($)	(5) Rate of Capital Gain (%)	(6) Rate of Return [col (2) + col (5)] (%)
30	10	1,000	503	–49.7	–39.7
20	10	1,000	516	–48.4	–38.4
10	10	1,000	597	–40.3	–30.3
5	10	1,000	741	–25.9	–15.9
2	10	1,000	917	–8.3	+1.7
1	10	1,000	1,000	0.0	+10.0

Interest-Rate Risk

- **Long-term bonds** are more sensitive to interest rate changes.
- If you sell before maturity $\rightarrow$ you face price risk.
- But if you hold to maturity, your return = YTM.

Rule: The longer the maturity, the **higher the volatility** of bond price.

Real vs Nominal Interest Rates

- **Nominal rate (i)**: Not adjusted for inflation
- **Real rate (i_r)**: Adjusted for inflation

Types of real rates:

- **Ex ante**: Based on **expected inflation**
- **Ex post**: Based on **actual inflation**

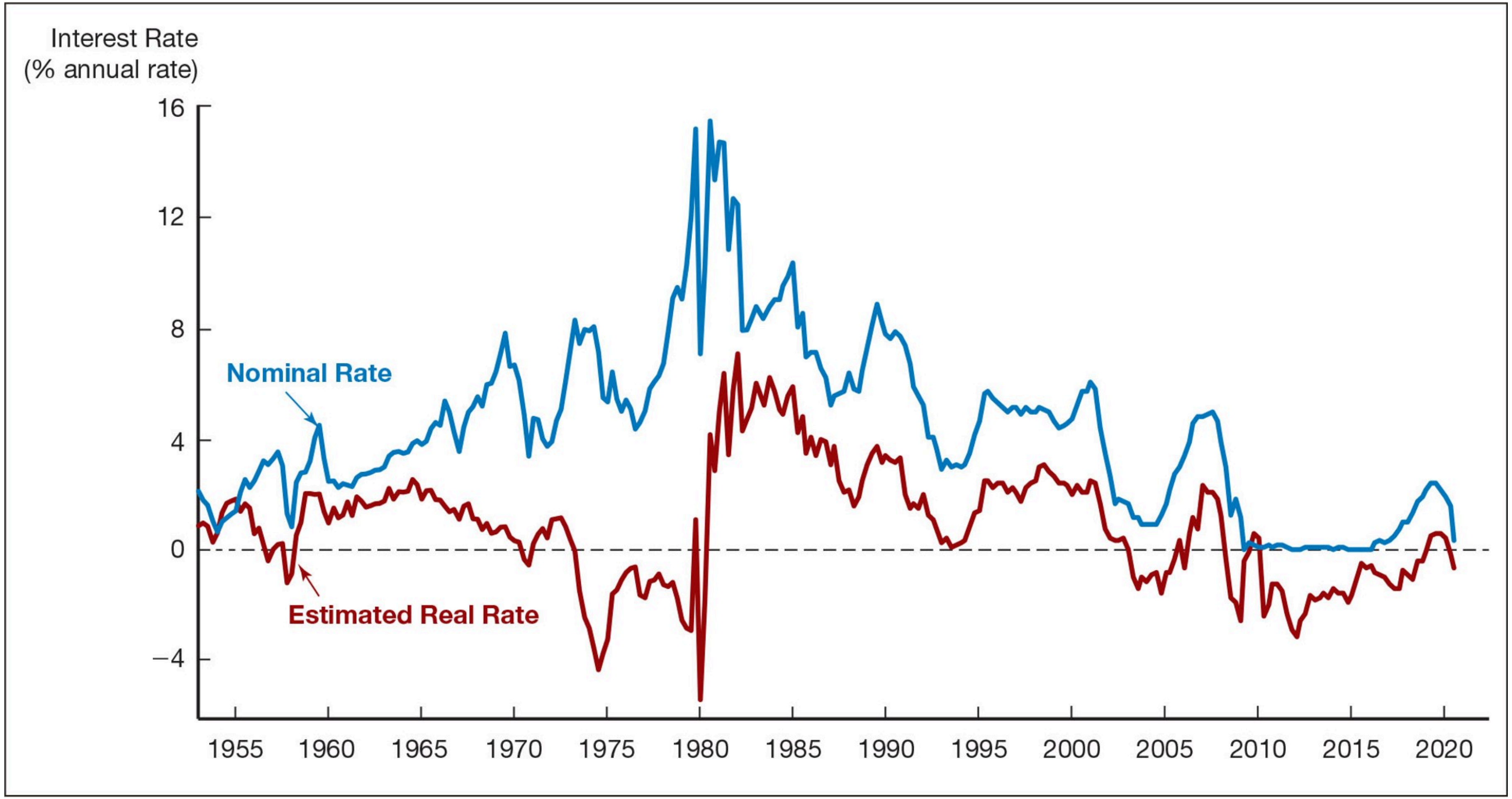
Fisher Equation

$$i = i_r + \pi^e$$

Where:

- **i** = Nominal rate
- **i_r** = Real rate
- π^e = Expected inflation

Low real rates → borrowing is cheap → **more demand for credit**


Interest Rate
(% annual rate)
16
12
8
4
0
−4
Nominal Rate
Estimated Real Rate
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

Real-World Example: Fed Rate Hikes & Bank Failures

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U.S. Markets

Fed's Barr says supervisors more aggressive, honing in on interest rate risk

By Pete Schroeder

February 16, 2024 11:33 PM GMT+9 · Updated 24 days ago

Aa

Federal Reserve Board Vice Chair for Supervision, Michael Barr, testifies before a Senate Banking, Housing, and Urban Affairs Committee hearing in the wake of recent bank failures, on Capitol Hill in Washington, U.S., May 18, 2023. REUTERS/Evelyn Hockstein/File Photo

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Fed Commentary: Financial Stability Risks

- Fed has increased exams after Silicon Valley Bank (SVB) collapse.
- Issue: **Unrealized losses** on long-term assets due to rising rates.
- Banks now face **tighter supervision and capital requirements**.

Shows how **interest rate changes ripple through the financial system**.

2. The Behavior of Interest Rates

Determinants of Asset Demand

An asset is anything that can be owned and has value.

Examples: money, laptops, cellphones, bonds, stocks, art, land, houses, and machinery.

Asset demand is the amount of an asset that people are willing to hold at a given price.

Financial assets are claims on real assets or income.

Factors Affecting Asset Demand

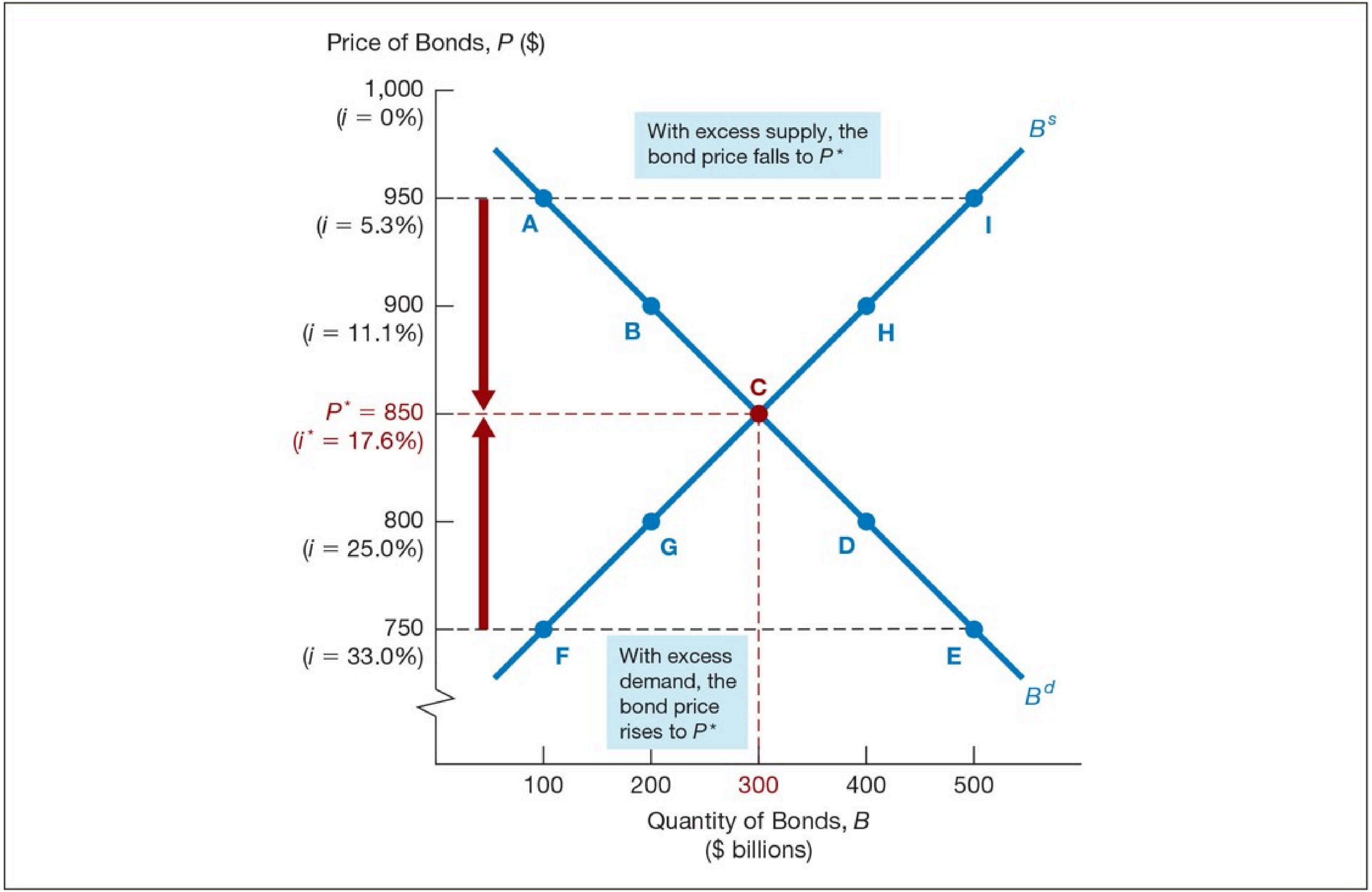
- **Wealth**: Total resources, including all assets
- **Expected Return**: Return relative to other assets
- **Risk**: Uncertainty of returns
- **Liquidity**: Ease of converting to cash

Theory of Portfolio Choice

1. Demand ↑ with **wealth**
2. Demand ↑ with **expected return**
3. Demand ↓ with **risk**
4. Demand ↑ with **liquidity**

Bond Market: Supply & Demand

- Lower price $\rightarrow$ Higher interest rate $\rightarrow$ Higher demand for bonds
- Lower price $\rightarrow$ Higher interest rate $\rightarrow$ Lower supply of bonds



Price of Bonds, P ($)
1,000
(i = 0%)
950
(i = 5.3%)
900
(i = 11.1%)
P* = 850
(i* = 17.6%)
800
(i = 25.0%)
750
(i = 33.0%)
With excess supply, the bond price falls to P*
With excess demand, the bond price rises to P*
A
B
C
D
E
F
G
H
I
B^s
B^d
100
200
300
400
500
Quantity of Bonds, B
($ billions)

Market Equilibrium in Bonds

- Market clears when: $B^d = B^s$
- $B^d > B^s$: Excess demand $\rightarrow$ Price $\uparrow$ $\rightarrow$ Interest rate $\downarrow$
- $B^d < B^s$: Excess supply $\rightarrow$ Price $\downarrow$ $\rightarrow$ Interest rate $\uparrow$

Changes in Equilibrium Interest Rates

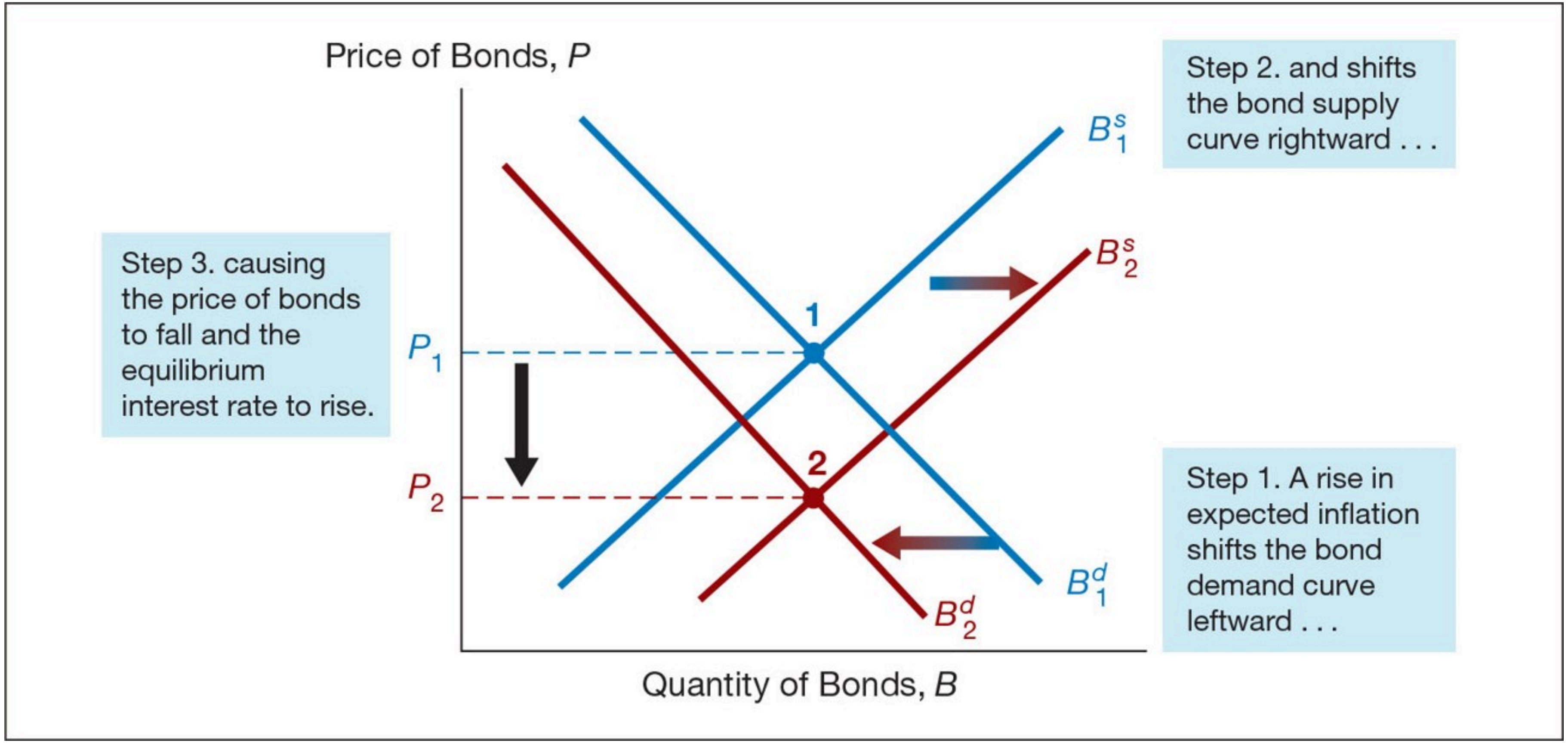
Demand for Bonds Shifts:

- $\uparrow$ Wealth $\rightarrow$ Demand $\uparrow$
- $\uparrow$ Expected interest rate $\rightarrow$ Demand $\downarrow$
- $\uparrow$ Expected inflation $\rightarrow$ Demand $\downarrow$
- $\uparrow$ Risk $\rightarrow$ Demand $\downarrow$
- $\uparrow$ Liquidity $\rightarrow$ Demand $\uparrow$

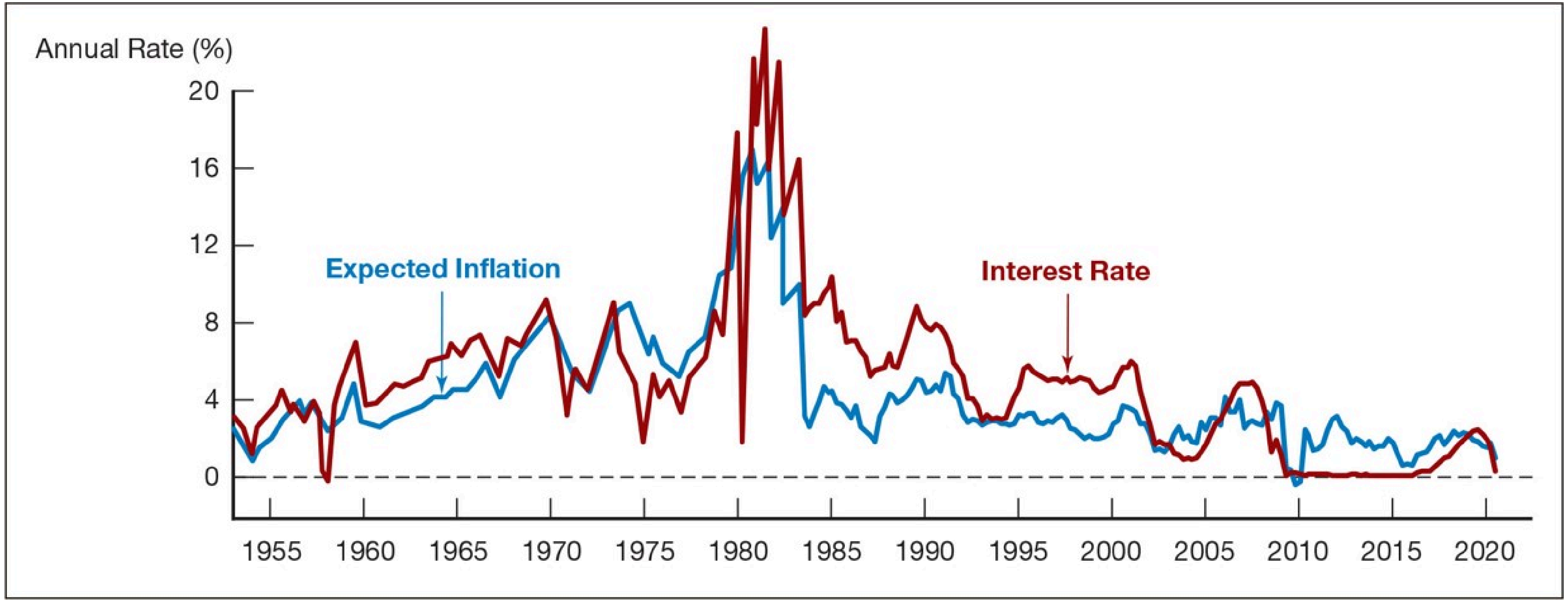
Supply of Bonds Shifts

- $\uparrow$ Profitability $\rightarrow$ Supply $\uparrow$
- $\uparrow$ Expected inflation $\rightarrow$ Supply $\uparrow$
- $\uparrow$ Budget deficit $\rightarrow$ Supply $\uparrow$

Fisher Effect: Response to Expected Inflation



Expected Inflation vs Interest Rates (1953–2020)



Liquidity Preference Framework

- Keynesian model: equilibrium interest rate via money supply & demand
- Wealth held in either **money** or **bonds**

$B^s + M^s = B^d + M^d \rightarrow$ Rearranged: $B^s - B^d = M^s - M^d$

If $M^s = M^d \rightarrow$ then $B^s = B^d$

Demand for Money

As interest rate ↑:

- Opportunity cost of holding money ↑
- Expected return of money ↓ → Demand for money ↓

Assume money supply is **fixed** by central bank.

Meaning:

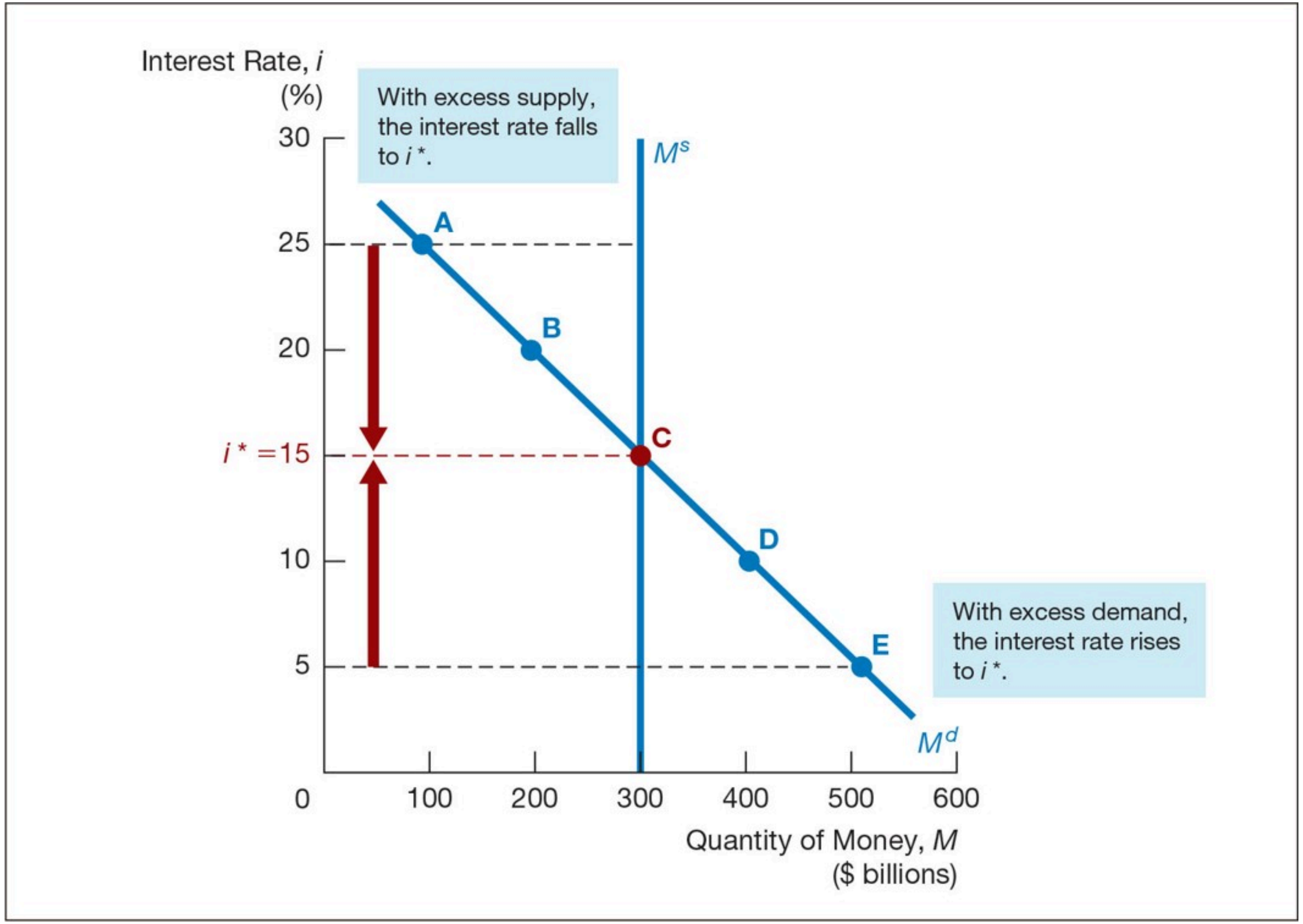
- When interest rates go up:

You're missing out on more potential earnings by just holding onto cash — that's the opportunity cost.

Since cash doesn't earn interest, its return becomes less attractive compared to alternatives like bonds or savings accounts.

- Result: People prefer to hold less money and instead invest it — so the demand for money falls.

Equilibrium in Money Market



Changes in Equilibrium (Liquidity Preference)

Demand for Money Shifts:

- **Income Effect:** $\uparrow$ income $\rightarrow$ $\uparrow$ money demand
- **Price-Level Effect:** $\uparrow$ prices $\rightarrow$ $\uparrow$ money demand

Shifts in Supply of Money

- Central bank controls money supply
- Fed increases $M^s \rightarrow$ Supply curve shifts **right**

Money & Interest Rates

- Liquidity preference says $\uparrow M^s \rightarrow \downarrow$ interest rate
- But...
  - **Price-level effect:** $\uparrow M^s \rightarrow \uparrow$ prices $\rightarrow \uparrow$ interest rate

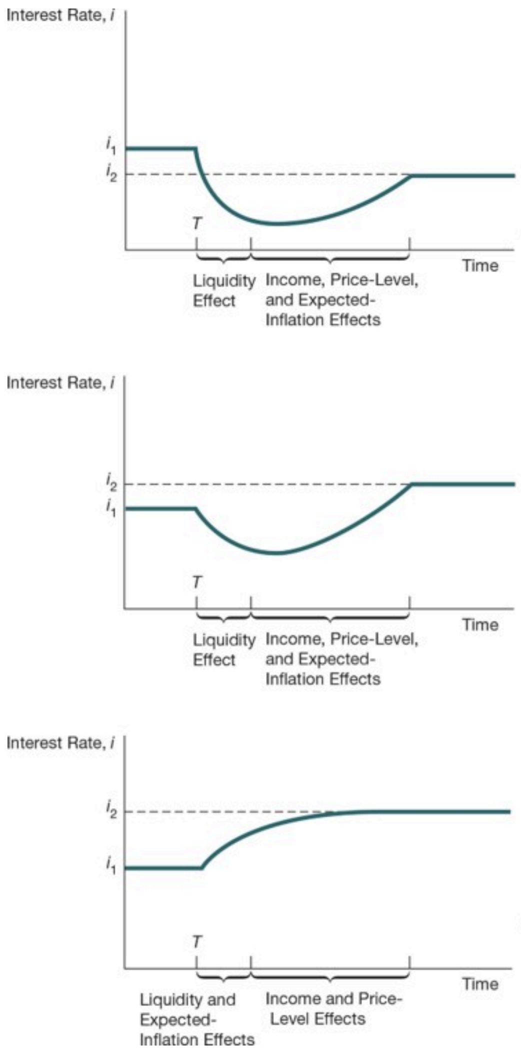
More Effects of Money Growth

- **Expected-inflation effect**: if people expect rising inflation, they demand higher interest
- **Income effect:** $\uparrow M^s \rightarrow \uparrow$ income $\rightarrow \uparrow$ interest

Net Effect? Does ↑ Money Supply ↓ Rates?

- **Liquidity effect:** ↓ rates
- **Income effect:** ↑ rates
- **Price-level effect:** ↑ rates
- **Expected-inflation effect:** ↑ rates

Response Over Time to Money Growth

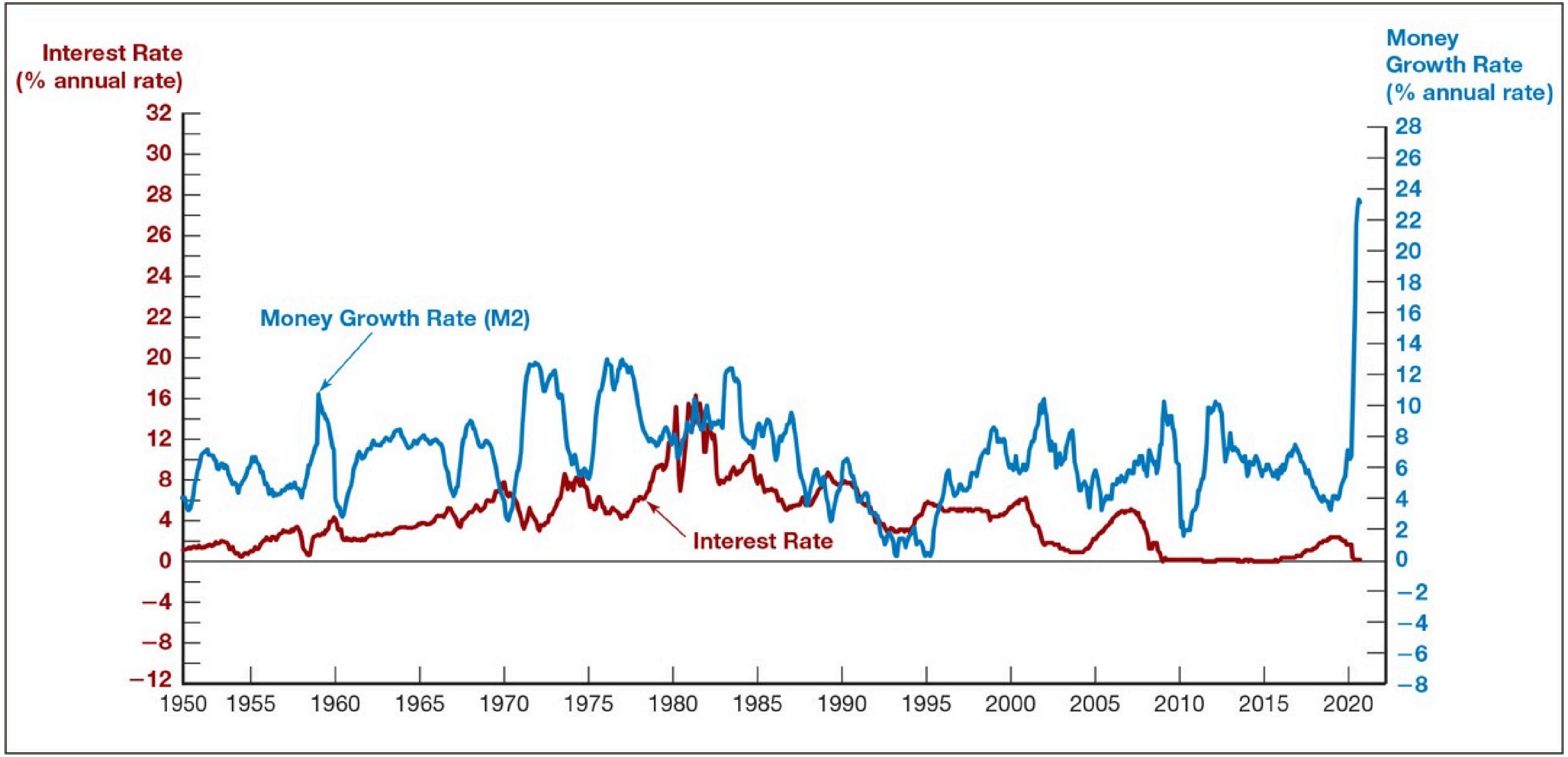


(a) Liquidity effect larger than other effects

(b) Liquidity effect smaller than other effects and slow adjustment of expected inflation

(c) Liquidity effect smaller than other effects and fast adjustment of expected inflation

Money Growth & Interest Rates (1950–2020)



3. Class Activity: Understanding Interest Rates in Action

Any QUESTIONS?

Thank You!

Next Class

- (Apr 4)
  - **Chap 6.** The Risk and Term Structure of Interest Rates;
  - **Chap 7.** The Stock Market, the Theory of Rational Expectations, and the Efficient Market Hypothesis