4. Money and Inflation

Based on Mankiw, Chapters 5 & 6: *A First Look at the Monetary System* & *Inflation: Its Causes, Effects, and Social Costs*

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Money: Definition and functions

Money is the stock of assets that can be readily used to make transactions.

Functions:

1. *Medium of exchange*
   we use it to buy stuff
2. *Store of value*
   transfers purchasing power from the present to the future
3. *Unit of account*
   the common unit by which everyone measures prices and values

Inflation: Definition

Inflation is an increase in the average price of goods and services.

Inflation is measured as the change in some general price index. *What price indices have we seen earlier?*

Linking money with inflation

Basic concept: more money in circulation decreases its value

Example: a village with 15 cows and 30 pebbles

- 2 pebbles per cow, so the price of cows is 2
- What if the village chief adds another 30 pebbles?

Linking money with inflation

Basic concept: more money in circulation decreases its value

Example: a village with 15 cows and 30 pebbles

- 2 pebbles per cow, so the price of cows is 2
- What if the village chief adds another 30 pebbles?
- Now there are 60 pebbles for 15 cows ⇒ new price is 4
- 100% inflation!

We will now formalize this link using the **quantity theory of money (QTM)**

QTM begins with the concept of **velocity**

Velocity, part 1

- Basic concept: the rate at which money circulates.
- Definition: the number of times the average currency changes hands in a given time period.
- Example 1: in our village with 15 cows and 60 pebbles
  - Suppose 3 cows exchanged owners last year
  - In total 3×4=12 pebbles were involved in those transactions
  - The average pebble was used in 12/60=0.2 transactions
  - So, velocity = 0.2
- Example 2: in the United States in 2025 Q2
  - $30,353 billion in transactions (nominal GDP)
  - money supply was $21,584 billion
  - So, velocity = 30,353B/21,584B = 1.406

Velocity, part 2

This suggests the following definition:

$$V = \frac{T}{M} = \frac{P \times Y}{M}$$

where

V = velocity

T = value of all transactions

M = money supply

P = price of output (GDP deflator)

Y = quantity of output (real GDP)

$P \times Y$ = value of output (nominal GDP)

The quantity equation

The **quantity equation**

$$M \times V = P \times Y$$

follows from the definition of velocity.

It is an *identity:* It holds by definition of the variables.

In growth rates:

$$\frac{\Delta M}{M} + \frac{\Delta V}{V} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}$$

(The growth rate of a product equals the sum of growth rates)

From the quantity equation to the quantity theory of money

Assumptions:

1. Velocity is exogenous and constant over time: $V = \bar{V}$

2. Real output is determined by the economy's supplies of capital, labor, and the production function: $Y = F(K, L)$

Why are there no bars?

3. The supply of money is exogenous and can be controlled by the monetary authority

The quantity theory of money, part 1

Under assumption 1, the growth rate of velocity is 0.

The quantity equation in growth rates becomes:

$$\frac{\Delta M}{M} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}$$

Let π (Greek letter pi) denote the inflation rate: $\pi = \frac{\Delta P}{P}$

Therefore: $$\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}$$

The quantity theory of money, part 2

$$\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}$$

- Normal economic growth requires a certain amount of money supply growth to facilitate the growth in transactions.
- Money growth in excess of this amount leads to inflation.
- Lower money growth than economic growth leads to…?

The quantity theory of money, part 3

$$\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}$$

- Assumption 2: $\Delta Y/Y$ depends on growth in the factors of production and on technological progress, all of which we take as given (for now).
- Assumption 3: the monetary authority can control $\Delta M/M$

Hence, QTM predicts that the monetary authority can control the inflation rate through money supply.

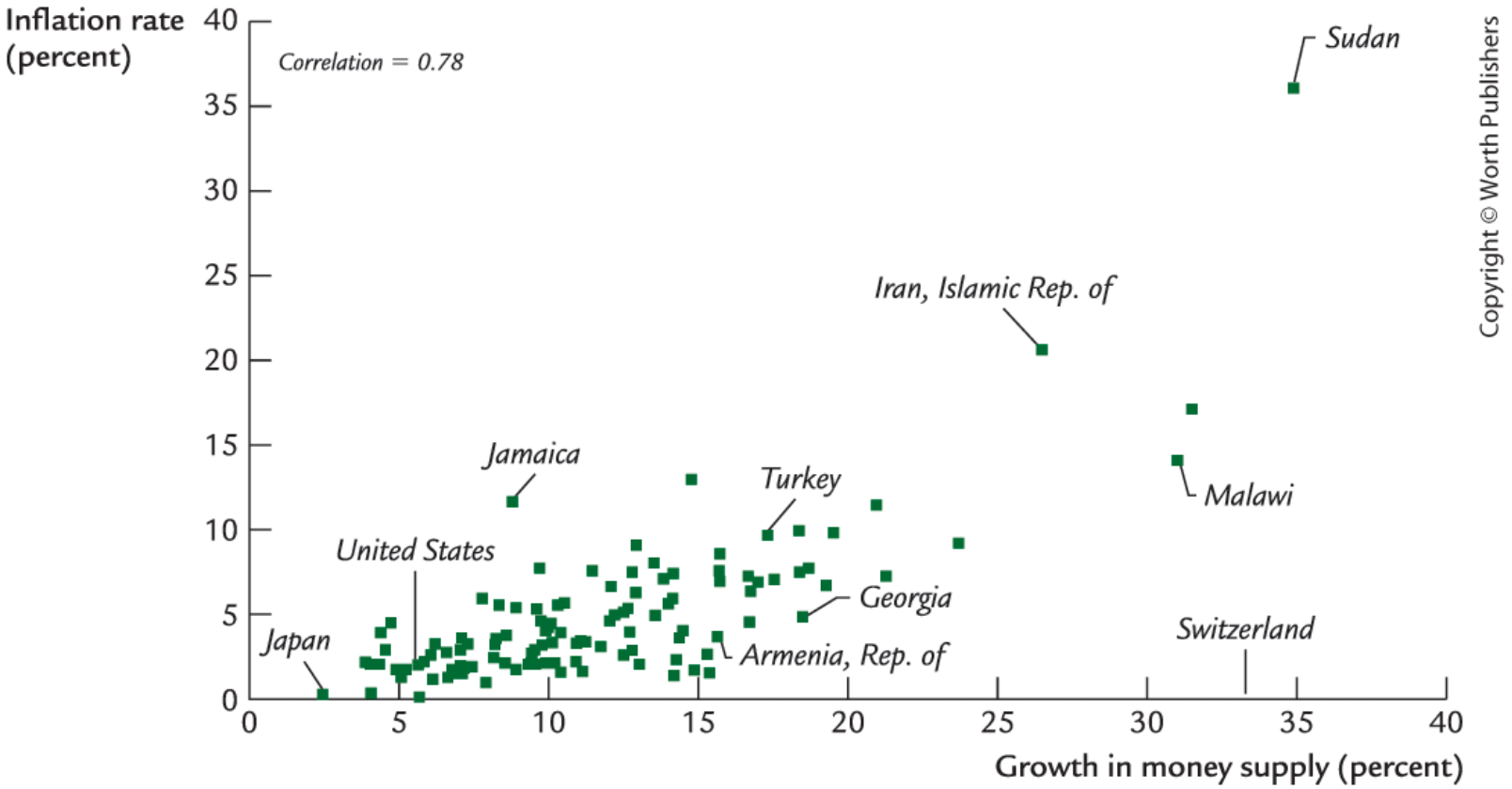
Confronting the quantity theory with data

The quantity theory of money implies:

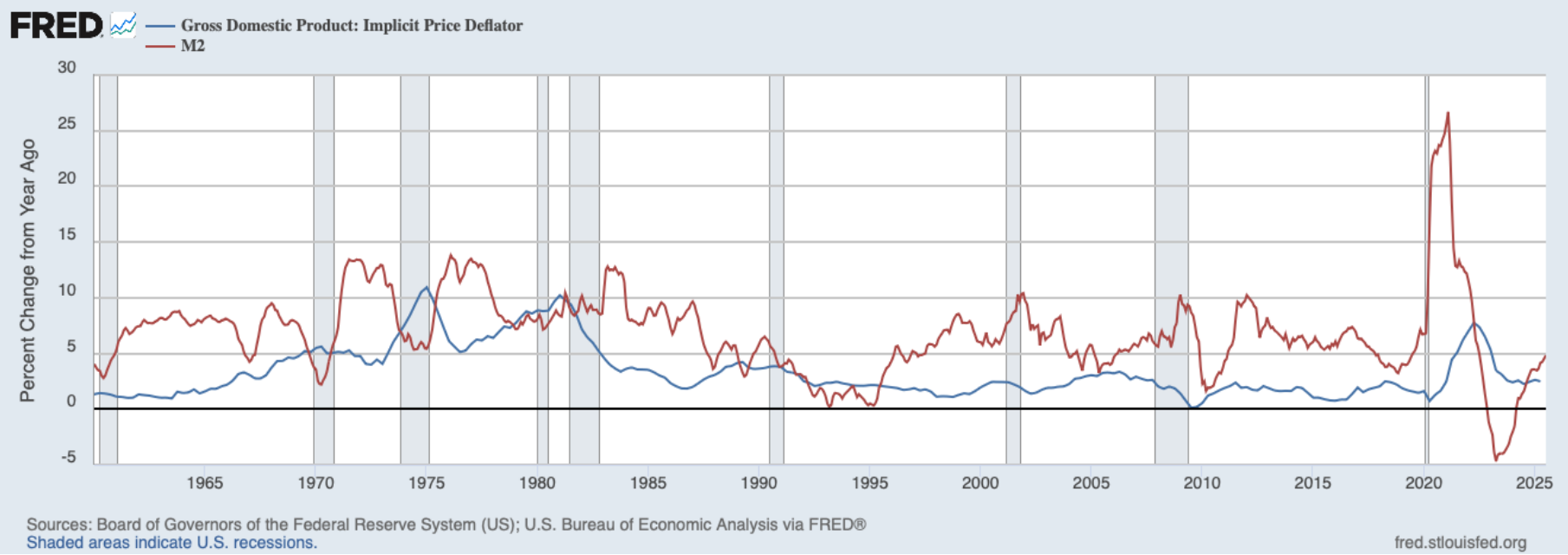
1. Countries with higher money growth rates should have higher inflation rates.
2. The long-run trend in a country's inflation rate should be similar to the long-run trend in the country's money growth rate.

Are the data consistent with these implications?

International data on inflation and money growth



U.S. inflation and money growth, 1960–2025



Why can't the government just print money without consequences?

- To spend more without raising taxes or selling bonds, the government can create money.
- The "revenue" raised from money creation is called **seigniorage** (pronounced SEEN-your-idge).
- The **inflation tax**:
  Money creation to raise revenue causes inflation, paid by holders of money and other nominal assets.

Inflation and interest rates

- Let ***i*** denote the nominal interest rate, (not adjusted for inflation)
- Let ***r*** denote the real interest rate(adjusted for inflation):

  $$r = i - \pi$$

- Therefore:

  $$i = r + \pi$$

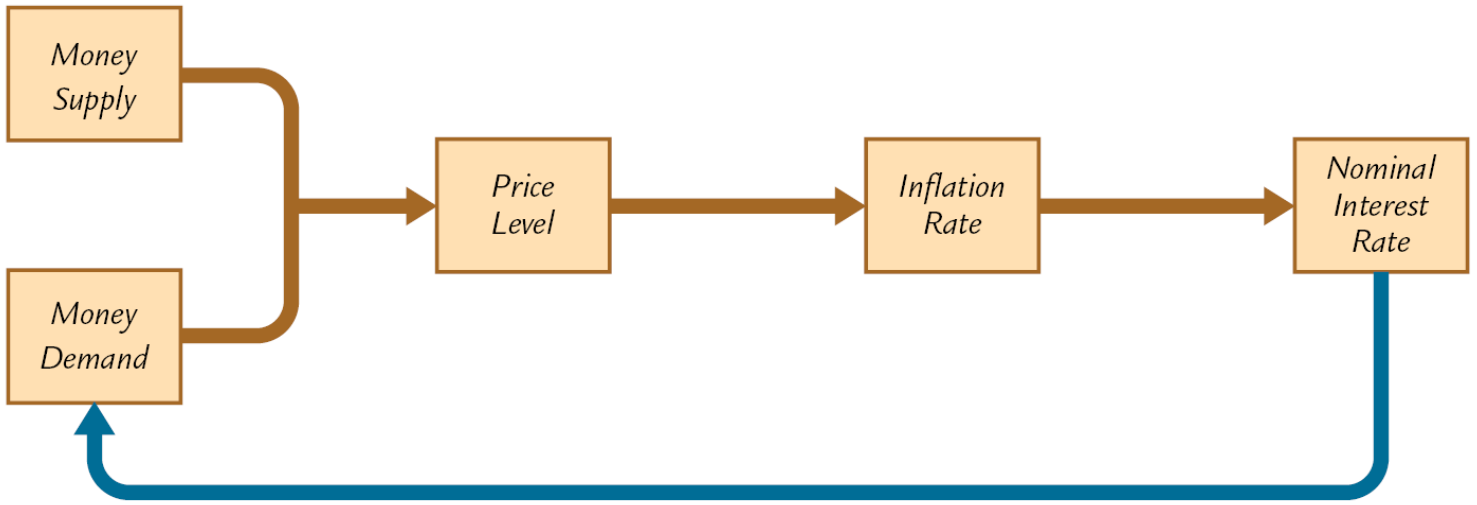
The Fisher effect

The Fisher equation: $i = r + \pi$

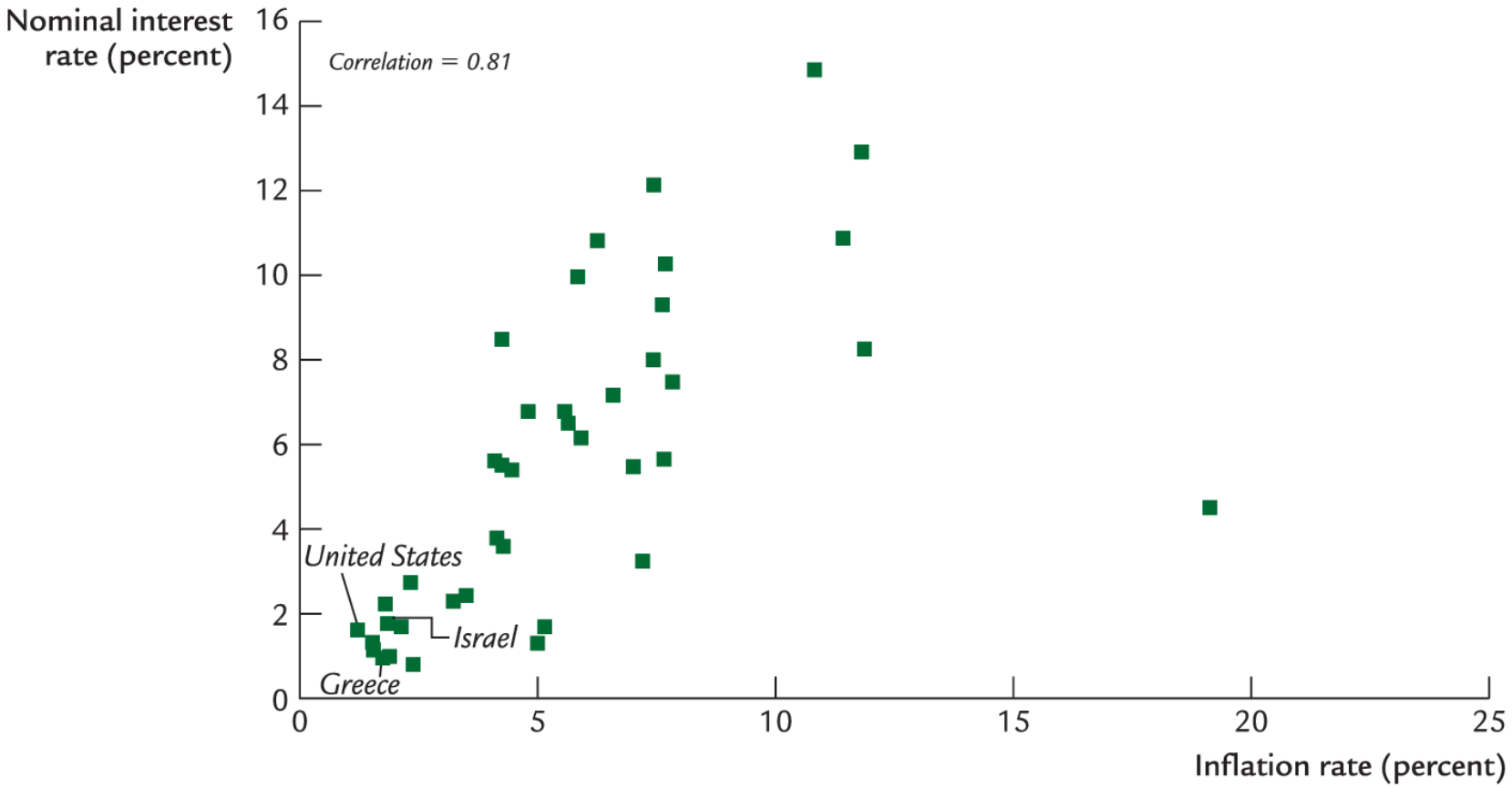
From the loanable funds model: $S = I$ determines r.

Hence, an increase in π causes an equal increase in i.

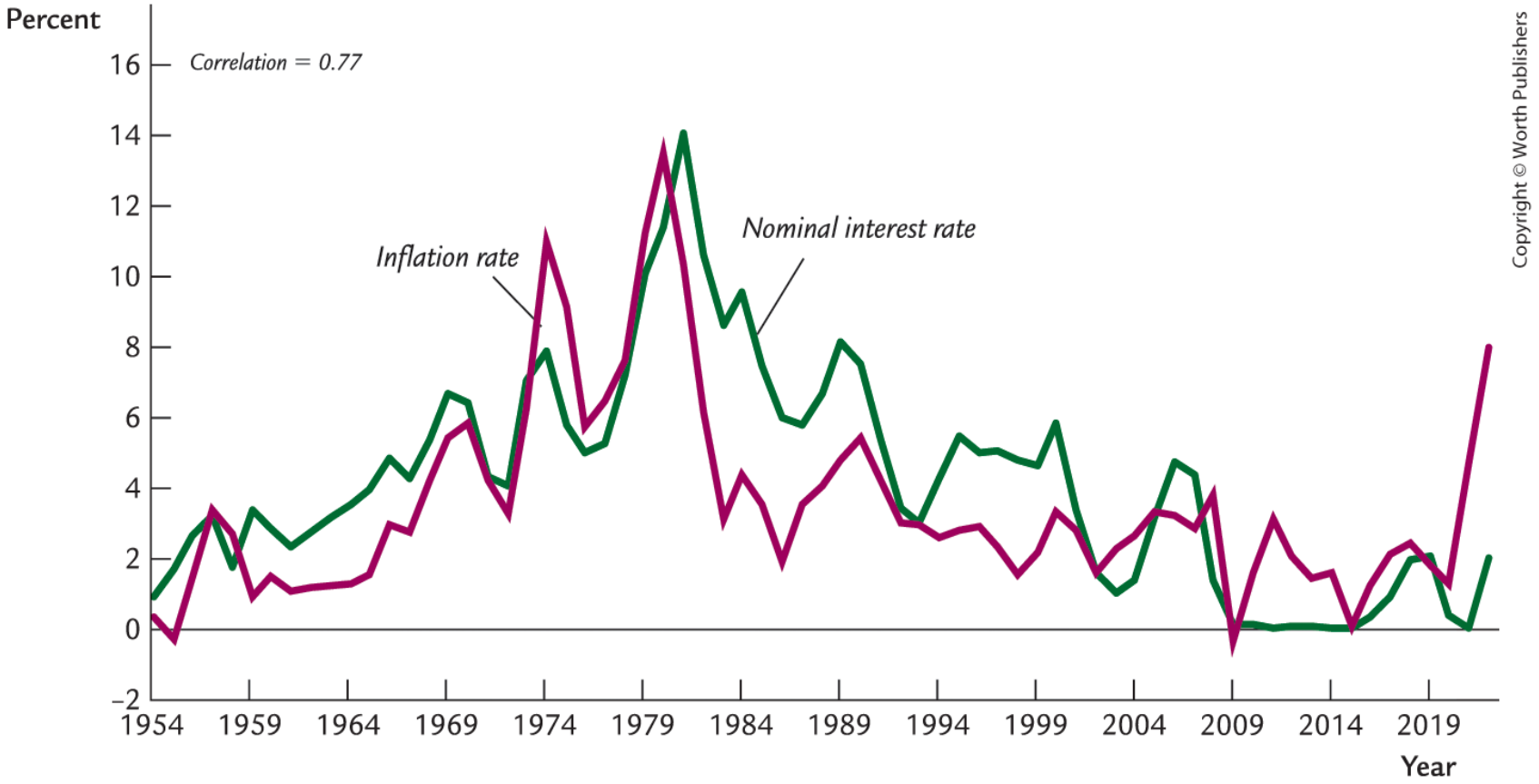
This one-for-one relationship is called the **Fisher effect**.



Inflation and nominal interest rates in 40 countries



U.S. inflation and nominal interest rates, 1955–2022



NOW YOU TRY
Applying the theory

Suppose V is constant, M is growing 5 percent per year, Y is growing 2 percent per year, and $r = 4$.

a. Solve for i.

b. If the Fed increases the money growth rate by 2 percentage points per year, find Δi.

c. Suppose the growth rate of Y falls to 1% per year.
   - What will happen to π?
   - What must the Fed do if it wishes to keep π constant?

NOW YOU TRY

Applying the theory, answers

V is constant, ***M*** grows 5 percent per year, ***Y*** grows 2 percent per year, ***r*** = 4.

a. First, find $\pi = 5 - 2 = 3$.

   Then, find $i = r + \pi = 4 + 3 = 7$.

b. $\Delta i = 2$, the same as the increase in the money growth rate.

c. If the Fed does nothing, $\Delta\pi = 1$.

   To prevent inflation from rising, the Fed must reduce the money growth rate by 1 percentage point per year.

Money demand and the nominal interest rate

- In the quantity theory of money, the demand for real money balances depends only on real income ***Y***.
- In reality, there is another determinant of money demand:
  - the nominal interest rate ***i***.
  - the opportunity cost of holding money (instead of bonds or other interest-earning assets).
- So, money demand depends negatively on ***i***.

The money demand function, part 1

$$\left(\frac{M}{P}\right)^{d} = L(i, Y)$$

(M/P)^d = real money demand, depends

- negatively on ***i***

  i is the opportunity cost of holding money.

- positively on ***Y***

  higher ***Y*** increases spending on goods & services

  so increases the need for money.

(***L*** is used for the money demand function because money is the most liquid asset.)

The money demand function, part 2

$$\left(\frac{M}{P}\right)^d = L(i, Y)$$

$$= L(r + E\pi, Y)$$

Eπ: expected inflation rate

*Why **Eπ**?* When people are deciding whether to hold money or bonds, they don't know what inflation will turn out to be.

Hence, the nominal interest rate relevant for money demand is ***r*** + ***Eπ***.

- ***i*** – ***Eπ*** = ***ex ante*** real interest rate:
  the real interest rate people expect at the time they buy a bond or take out a loan
- ***i*** – ***π*** = ***ex post*** real interest rate:
  the real interest rate actually realized

Equilibrium

$$\frac{M}{P} = L(r + E\pi, Y)$$

The supply of real money balances

Real money demand

How *P* responds to Δ*M*

$$\frac{M}{P} = L\left(r + E\pi, Y\right)$$

- For given values of ***r***, ***Y***, and ***Eπ***, a change in ***M*** causes ***P*** to change by the same percentage—just like in the quantity theory of money.
- Yet in real life, changes in ***M*** can change ***Eπ***. Therefore, the effect of money on prices is more complicated than the quantity theory of money suggests.

What about expected inflation?

- Over the long run, people don't consistently over- or under-forecast inflation,
  so $E\pi = \pi$ on average.
- In the short run, $E\pi$ may change when people get new information.
- *Example*: The monetary authority announces it will increase ***M*** next year. People will expect next year's ***P*** to be higher, so $E\pi$ rises.
- This affects ***P*** now, even though ***M*** hasn't changed yet . . .

How *P* responds to Δ*Eπ*

$$\frac{M}{P} = L\left(r + E\pi,\ Y\right)$$

For given values of ***r***, ***Y***, and ***M***,

$\uparrow E\pi \Rightarrow \uparrow i$ (the Fisher effect)

$\Rightarrow \downarrow \left(M/P\right)^{d}$

$\Rightarrow \uparrow P$ to make $\left(M/P\right)$ fall

to reestablish eq'm

The classical view of inflation

- *The classical view:*
  A change in the price level is merely a change in the units of measurement.

Then, why is inflation a problem?

The costs of inflation fall into two categories:

1. costs when inflation is expected.
2. costs when inflation is different from what people had expected.

The costs of expected inflation: 1. Shoe-leather costs

- Definition: the costs and inconveniences of reducing money balances to avoid the inflation tax.
- If π increases, ***i*** increases (why?), so people reduce their real money balances.
- The same monthly spending but lower average money holdings means more frequent trips to the bank to withdraw smaller amounts of cash.
- *Why shoe-leather?* More frequent trips to the bank wear out people's shoes faster, so they have to spend more on leather soles for their shoes

The costs of expected inflation: 2. Menu costs

- Definition: the costs of changing prices
- Examples:
  - cost of printing new menus and mailing out catalogs
  - time spent trying to decide on what the new prices should be
- The higher is inflation, the more frequently firms must change their prices and incur these costs.

The costs of expected inflation: 3. Relative price distortions

- Firms facing menu costs change prices infrequently.
- Different firms change their prices at different times, leading to relative price distortions . . .

  . . . causing microeconomic inefficiencies in the allocation of resources.

The costs of expected inflation: 4. Tax treatment

Some taxes, such as the capital gains tax, are not adjusted to account for inflation.

Example:

- Jan 1: You buy $10,000 worth of Apple stock.
- Dec 31: You sell the stock for $11,000, so your nominal capital gain is $1,000 (10%).
- Suppose $\pi = 10\%$ during the year.
  Your real capital gain is $0.
- Yet, you must pay taxes on your $1,000 nominal gain!

The costs of *unexpected* inflation: Arbitrary redistribution of purchasing power

- Many long-term contracts are not indexed but are based on $E\pi$.
- If π turns out to be different from $E\pi$, then some gain at others' expense.

  Example: borrowers and lenders

  - If $\pi > E\pi$, then $(i - \pi) < (i - E\pi)$
    and purchasing power is transferred from lenders to borrowers.
  - If $\pi < E\pi$, then purchasing power is transferred from borrowers to lenders.

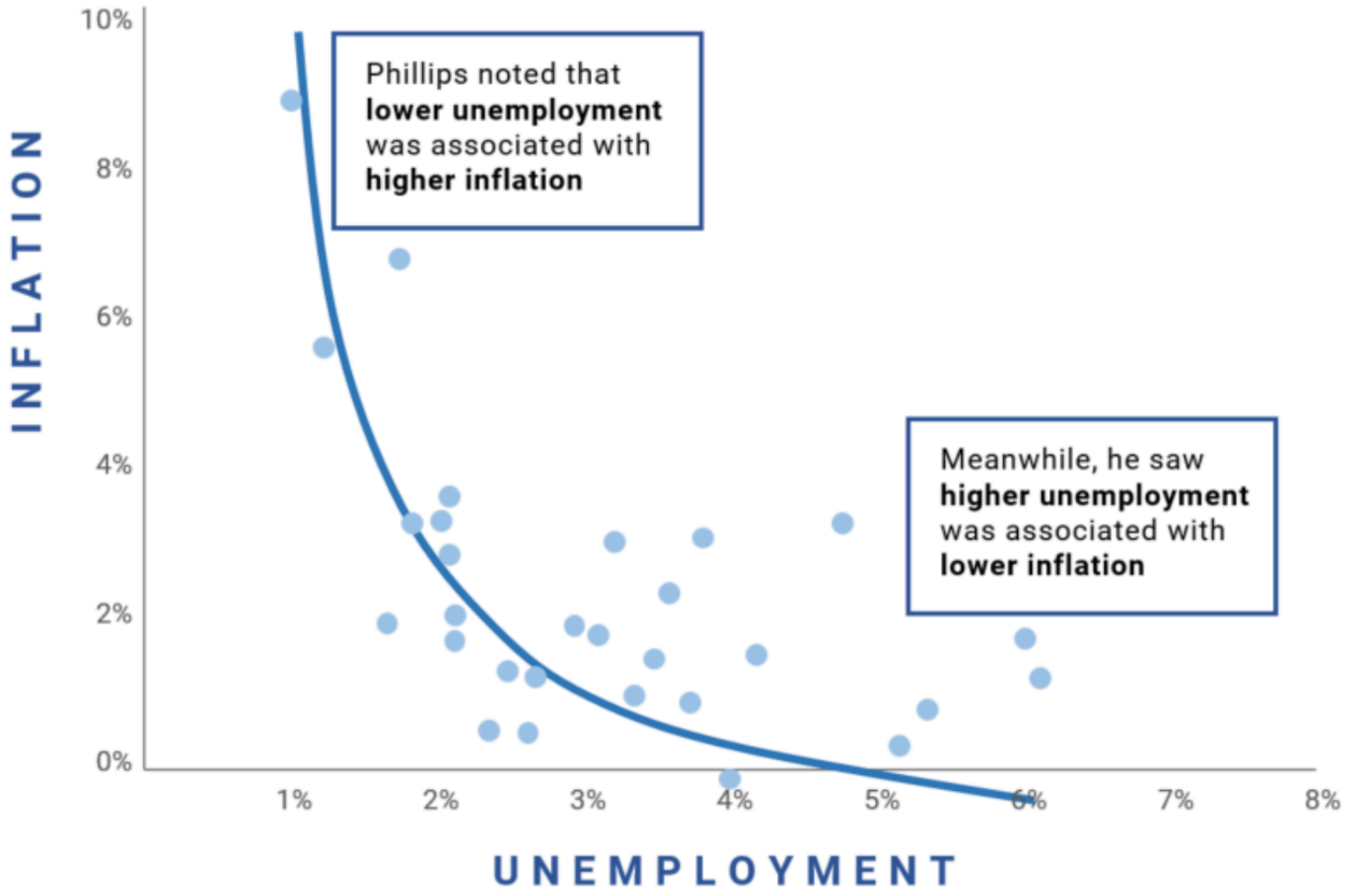
Additional cost of high inflation: Increased uncertainty

- When inflation is high, it's more variable and unpredictable: π turns out different from $E\pi$ more often, and the differences tend to be larger, *though not systematically positive or negative.*
- So, arbitrary redistributions of wealth are more likely.
- This increases uncertainty, making risk-averse people worse off.

One *benefit* of inflation

- Nominal wages are sticky ⇒ real wages fall with inflation
  - Some workers renegotiate their contracts, some switch jobs ⇒ higher turnover
  - Demand for labor goes up ⇒ increased hiring
- Inflation allows real wages to reach equilibrium levels without nominal wage cuts.
- Therefore, moderate inflation improves the functioning of labor markets.

Phillips curve: the link between inflation and unemployment



Source: Federal Bank of St. Louis

Hyperinflation

- Common definition: $\pi \geq 50\%$ per month
- All the costs of moderate inflation described above become ***HUGE*** under hyperinflation.
- Money ceases to function as a store of value, and it may not serve its other functions (unit of account, medium of exchange).
- People may conduct transactions with barter or a stable foreign currency.

Examples of hyperinflation

Germany, 1923

π: 29,500% per month

Hungary, 1946

π: 207% per day

Image sources: alphahistory.com, Getty Images, Hungarian National Museum

What causes hyperinflation?

- Hyperinflation is caused by excessive money supply growth.
- When the monetary authority creates money, the price level rises.
- If it creates money rapidly enough, the result is hyperinflation.

Why governments create hyperinflation

- When a government cannot raise taxes or sell bonds, it must finance spending increases via money creation.
- In theory, the solution to hyperinflation is simple: Stop money creation.
- In the real world, this requires drastic and painful fiscal restraint.

The classical dichotomy, part 1

Real variables: measured in physical units—quantities and relative prices, *for example:*

- quantity of output produced
- real wage: output earned per hour of work
- real interest rate: output earned in the future by lending one unit of output today

The classical dichotomy, part 2

***Nominal variables**:* measured in money units—*for example:*

- nominal wage: dollars per hour of work
- nominal interest rate: dollars earned in the future by lending one dollar today
- price level: number of dollars needed to buy a representative basket of goods

The classical dichotomy, part 3

- ***Classical dichotomy***: the theoretical separation of real and nominal variables, which implies nominal variables do not affect real variables.
- ***Neutrality of money***: idea that changes in the money supply do not affect real variables.
- In reality, money is approximately neutral in the long run.

The fiscal theory of the price level (FTPL)

- Alternative(ish) to QTM, currently under academic debate
- QTM is material for the exam, FTPL is not… but it is material for your future!
- The premise of FTPL is that fiscal policy (not monetary policy) determines the price level, thus inflation
- Basic logic of FTPL:
  - The central bank creates money out of government debt (e.g., OMOs)
  - People are happy to hold gov't debt as long as they expect it to be repaid… but if not, the price of debt (***r***) goes up, thus inflation goes up too
  - Hard to test FTPL empirically

The fallacy of modern monetary "theory" (MMT)

- Decades of low interest rates, low inflation, and unorthodox monetary policy tools (e.g., quantitative easing)
- The core tenet of MMT is that gov't can print money indefinitely since it is the sole issuer of currency
- Hence, deficits don't matter as the gov't can just print money to fulfill debt obligations
- *Why is this wrong?*

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- The core tenet of MMT is that gov't can print money indefinitely since it is the sole issuer of currency
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- *Why is this wrong?* Inflation tax!
- Besides, MMT does not offer testable (falsifiable) hypotheses, so it isn't a theory

Money

Money: Definition and functions

Money is the stock of assets that can be readily used to make transactions.

Three functions:

Money: Definition and functions

Money is the stock of assets that can be readily used to make transactions.

Three functions:

1. *Medium of exchange*
   we use it to buy stuff
2. *Store of value*
   transfers purchasing power from the present to the future
3. *Unit of account*
   the common unit by which everyone measures prices and values

Money and Barter (1 of 4)

1. To better understand the role and functions of money, compare two types economies:
   - A barter economy—goods are exchanged for goods.
   - A monetary economy—money is used to buy goods and services

Money and Barter (2 of 4)

1. For barter to operate, the **double coincidence of wants** must be satisfied:
   - If I have a pen and I **want** an eraser, I need to find someone who has an eraser but also **wants** a pen in exchange.
   - Likelihood of an exchange or trade is low in a barter economy.

Money and Barter (3 of 4)

1. In a monetary economy, money is used as a medium of exchange and medium of account to buy goods and services:
   - If I want an eraser, I need to find someone who has an eraser and I **know** the person wants my money in exchange.
   - Likelihood of an exchange or trade is higher in a monetary economy than in a barter economy.

Money and Barter (4 of 4)

1. In a barter economy, only simple transactions are possible and searching for a trade partner can be time consuming and costly.

2. In a monetary economy, more complex transactions are possible and the cost of transacting is likely to be low.

Money: Types

1. Fiat money
   - has no intrinsic value
   - example: the paper currency we use
2. Commodity money
   - has intrinsic value
   - examples:
     gold coins

NOW YOU TRY Discussion question

Which of these are money?

a. currency
b. checks
c. deposits in checking accounts (“demand deposits”)
d. credit cards
e. certificates of deposit (“time deposits”)
f. cryptocurrency

Money: Examples, part 1

- Currency: yes
  - U.S. dollar bills, Mexican pesos, and other currencies are all money.
- Checks: no
  - The check itself is not money, but the funds in the checking account are money.
- Deposits in checking accounts (“demand deposits”): yes
  - The funds in a checking account serve the three purposes.

Money: Examples, part 2

- Credit cards: no
  - They are a means of deferred payment.
  - For credit card purchases, you agree to pay back your credit card company in the future.
- Certificates of deposit ("time deposits"): depends
  - Depends on the length of time; they are a store of value and are measured in money units (dollars, for example) but are not easily spent (medium of exchange).
  - As you'll see in a few slides, there are multiple measures of the money supply.

Money: Examples, part 3

- Cryptocurrency: no (not in Sep 2025)
  - Value is very volatile, so no store of value
  - Medium of exchange for a tiny fraction of the population.
  - Prices are quoted in U.S. dollars, Yen, Euros, so no unit of account

Measuring money (1 of 3)

- The **money supply** is the quantity of money available in the economy.
- In simple economies, it is easy to measure the quantity of money (e.g., number of pebbles in our village).
- In modern economies, measuring money is not easy.

Measuring money (2 of 3)

- Individuals can transact using various assets.
  - Cash
  - Demand deposits (checking accounts using debit cards, savings accounts)

  Money used for transactions is liquid and does not include assets that are illiquid.

Measuring money (3 of 3)

- We use different measures of money, and these measures are often denoted as ***M***0, ***M***1, and ***M***2.
- ***M***0 (monetary base) = currency in circulation + reserve balances
- ***M***1 = ***M***0 + demand deposits + traveler's checks + other checkable deposits
- ***M***2 = ***M***1 + money market mutual fund balances + saving deposits (small time deposits)

Money supply measures

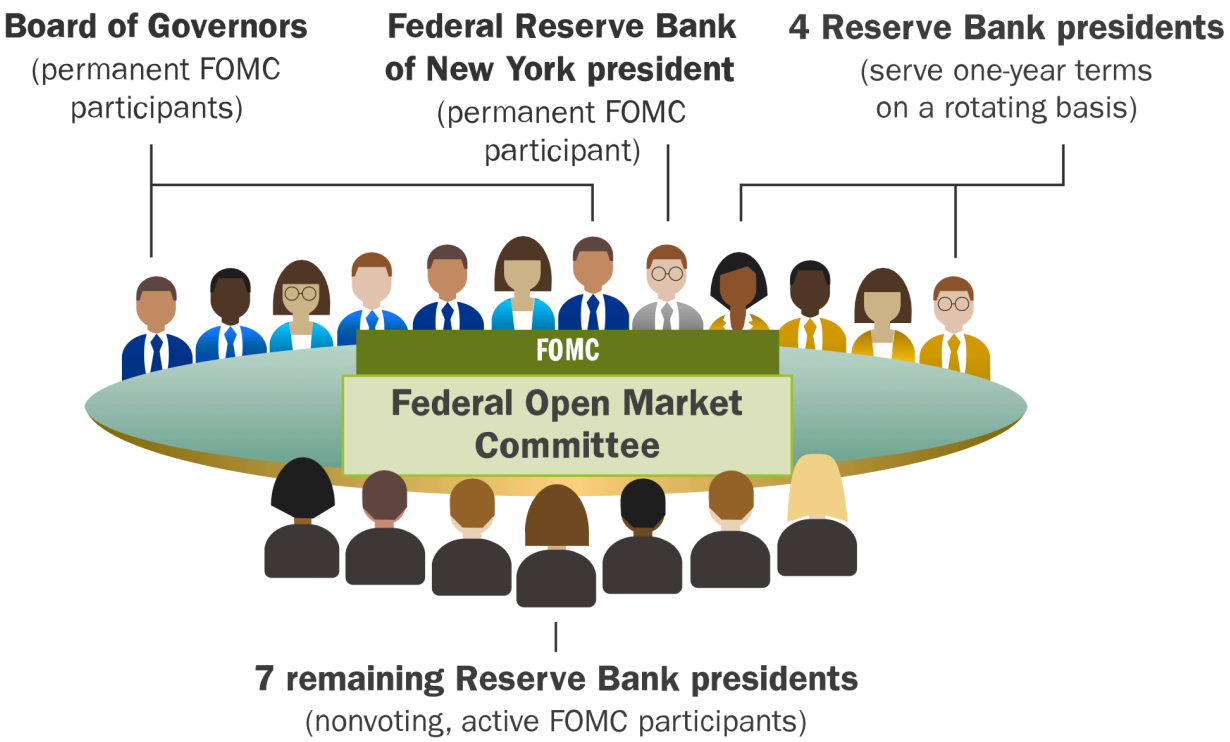
Symbol	Assets Included	Amount in Jul 2025 (billions of dollars)
C	Currency	2,399.9
***M*0**	Currency + reserve balances	5,740.3
***M*1**	*M*0 + demand deposits, traveler's checks, and other checkable deposits	18,806.8
***M*2**	*M*1 + retail money market mutual fund balances, saving deposits (including money market deposit accounts), and small time deposits	22,033.4

The central bank

- Monetary policy is conducted by a country's monetary authority, the **central bank**.
- The U.S. central bank is called the **Federal Reserve** ("the Fed").
- The Fed was created by an act of congress in 1913.
- The Fed and other central banks are often known as "lenders of last resort" and the "bank of banks"
- Federal Reserve system:
  - Board of Governors
  - 12 regional Federal Reserve Banks
- Eurosystem
  - European Central Bank
  - 20 Eurozone members' national central banks

Federal Open Market Committee (FOMC)

- Decisions about monetary policy in the United States resides with the Fed's **Federal Open Market Committee**



The Fed Board

- The 7 members of the Fed Board are nominated by POTUS and confirmed by the senate
- 4-year mandate (14-year staggered)

	Jerome Powell (Chair)
	Philip Jefferson (Vice Chair)
	Michelle Bowman (Vice Chair for Supervision)

	Christopher Waller
	Lisa Cook[a]
	Michael Barr
	Vacant

Regional Feds

- The 12 presidents of the regional Feds are chosen by their individual boards of directors (private sector), subject to approval of the Fed Board
- NY Fed board of directors:

CLASS A DIRECTORS

Douglas L. Kennedy (2025)
President and Chief Executive Officer
Peapack Private Bank & Trust

John H. Buhrmaster (2026)
President and Chief Executive Officer
1st National Bank of Scotia

René F. Jones (2027)
Chairman and Chief Executive Officer
M&T Bank Corp.

CLASS B DIRECTORS

Adena T. Friedman (2025)
Chair and Chief Executive Officer
Nasdaq, Inc.

Arvind Krishna (2026)
Chairman and Chief Executive Officer
IBM

Scott Rechler (2027)
Chairman and Chief Executive Officer
RXR

CLASS C DIRECTORS

Pat Wang, Chair (2025)
President and Chief Executive Officer
Healthfirst

Rajiv J. Shah, Deputy Chair (2026)
President
The Rockefeller Foundation

Patricia White (2027)
Director of Education and Training
International Alliance of Theatrical Stage Employees

The mandate of the central bank

- Congress gave the Federal Reserve Bank a **dual mandate**:
  1. Price stability (low inflation)
  2. Maximum sustainable employment
- *How are the two mandates related?*

The mandate of the central bank

- Congress gave the Federal Reserve Bank a **dual mandate**:
  1. Price stability (low inflation)
  2. Maximum sustainable employment
- *How are the two mandates related?* Phillips curve!
- The Fed pursues its dual mandate by exercising monetary control and regulating banks (called supervision).

Tools of monetary control (1 of 2)

1. **Open-market operations** (OMOs): the purchase and sale of government bonds to control the money supply.
   - If the Fed wants to increase the money supply, it buys government bonds from members of the public. *Why?*
   - If the Fed wants to decrease the money supply, it can sell government bonds to the members of the public. *Why?*
   - Typically involves purchasing short-term gov't bonds

2. **Quantitative easing**: the predetermined purchase of financial assets
   - Differences to OMOs: predetermined (and announced), longer term, more risky assets (not only gov't bonds), and larger scale for a pre-committed time
   - *Why does it work differently from OMOs?*

Tools of monetary control (2 of 2)

3. The Fed can also **lend directly** to banks to increase the money supply.

- By changing the discount rate, the Fed can influence the monetary base and the money supply.

Central bank independence

- The **independence** of the central bank is crucial for a well-functioning economy
- *Independence from what?*

Central bank independence

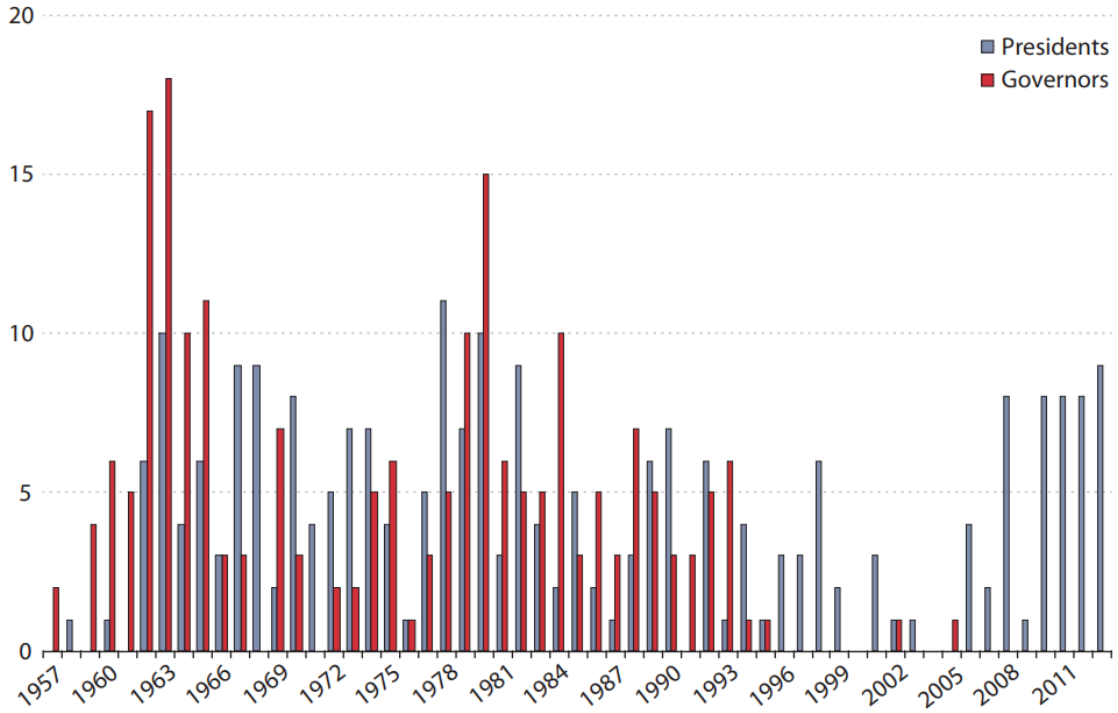
- The **independence** of the central bank is crucial for a well-functioning economy
- *Independence from what?* Fiscal policy!
- Pressure to increase money supply to finance government spending
- Why is that a bad idea? Inflation tax!
- Fiscal policy operates on a shorter term than monetary policy, so it might not care (as much) about inflation

Central bank credibility

- The **credibility** of the central bank is also crucial for a well-functioning economy
- *Why?* Expected inflation! The public has to trust the central bank's ability to maintain price stability
- One key strategy: inflation targeting
- Transparent communication is necessary to create and maintain trust. Central banks invest a lot in effective communication of their monetary policy

FOMC meetings (1 of 2)

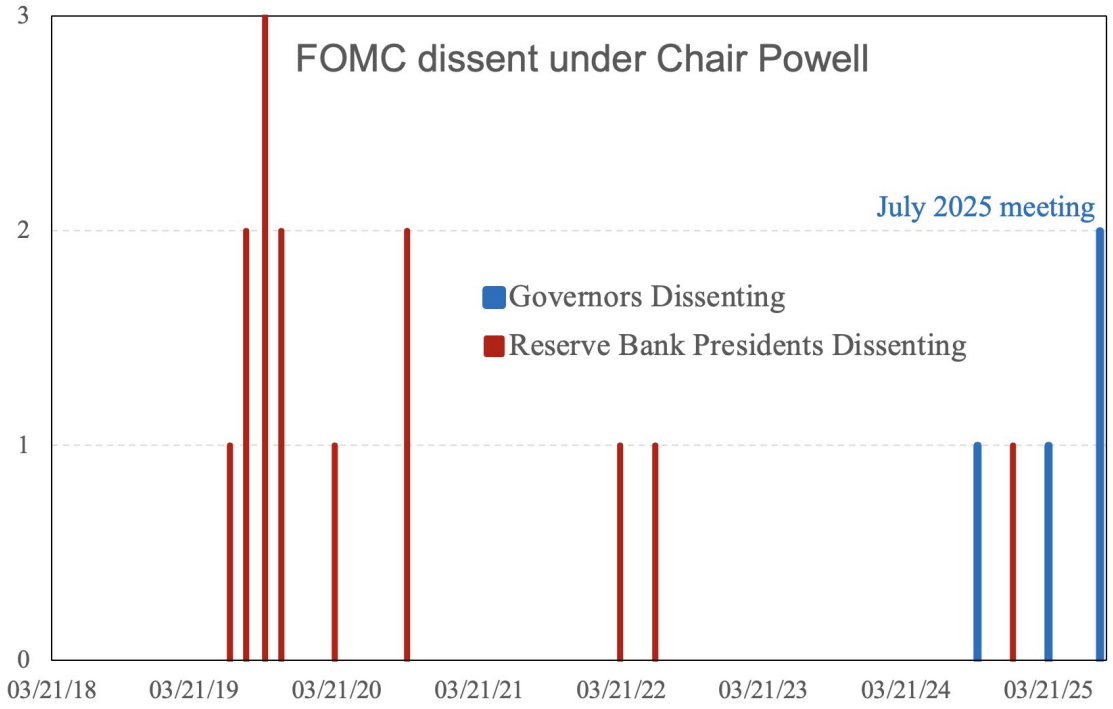
- FOMC meetings take place every 6 weeks or so
- Dissent is recorded:



Source: Federal Reserve Bank of St. Louis

FOMC meetings (2 of 2)

- Next one is **now** (Sep 16–17, 2025). Statement at 2pm ET
- Importance in context:



Source: Federal Reserve Bank of St. Louis

SUMMARY, PART 1

- Velocity: the ratio of nominal expenditure to money supply, the rate at which money changes hands
- Quantity theory of money
  - assumes velocity is constant
  - concludes that the money growth rate determines the inflation rate
  - applies in the long run

SUMMARY, PART 2

- Nominal interest rate
  - equals real interest rate + inflation rate
  - the opposite cost of holding money
- Fisher effect: Nominal interest rate moves one-for-one with expected inflation.
- Money demand
  - depends only on income in the quantity theory
  - also depends on the nominal interest rate in reality
  - if so, then changes in expected inflation affect the current price level

SUMMARY, PART 3

Benefits of inflation

- Allows nominal wages to adjust

Costs of inflation

- *Expected inflation*
  shoe-leather costs, menu costs, tax and relative price distortions, inconvenience of correcting figures for inflation
- *Unexpected inflation*
  all of the above plus arbitrary redistributions of wealth between debtors and creditors

SUMMARY, PART 4

- Classical dichotomy
  - In classical theory, money is neutral—does not affect real variables.
  - So, we can study how real variables are determined without reference to nominal ones.
  - Then, money market eq'm determines price level and all nominal variables.
  - Most economists believe the economy works this way in the long run.

SUMMARY, PART 5

Money

- Definition: the stock of assets used for transactions
- Functions: medium of exchange, store of value, unit of account
- Types: commodity money (has intrinsic value), fiat money (no intrinsic value)

SUMMARY, PART 6

Measuring the quantity of money can be complex.

The Fed can control the money supply with:

- Open-market operations
- Quantitative easing
- Lending to banks and adjusting the interest rate