4. Money and Inflation

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

Attila Gyetvai | University of Florida, Department of Economics

Inflation
Money

Money

- 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

Inflation

- 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

- Basic concept: the rate at which money circulates
- Definition: how many times currency changes hands in a given time period
- *Example 1:* 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

Velocity

- Basic concept: the rate at which money circulates
- Definition: how many times currency changes hands in a given time period
- *Example 2:* 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

- 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:

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

Recall that the growth rate of a product equals the sum of growth rates

From the quantity equation to QTM

- Assumptions:

1. Velocity is exogenous and constant over time: $V = \bar{V}$
2. Real output is determined by capital, labor, and the production function:

$$Y = F(K, L)$$

   - Why are there no bars?

3. Money supply is exogenous and can be controlled by the monetary authority

The quantity theory of money

- Under Assumption 1, the growth rate of velocity is 0
- Therefore, the quantity equation becomes

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

- Let π denote the inflation rate: $\pi = \frac{\Delta P}{P}$
- Therefore:

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

The quantity theory of money

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

- In words: economic growth requires a certain amount of money supply growth
- Why? To facilitate the growth in transactions
- Money supply growth in excess of this amount leads to inflation
- Lower money supply growth than economic growth leads to…?

The quantity theory of money

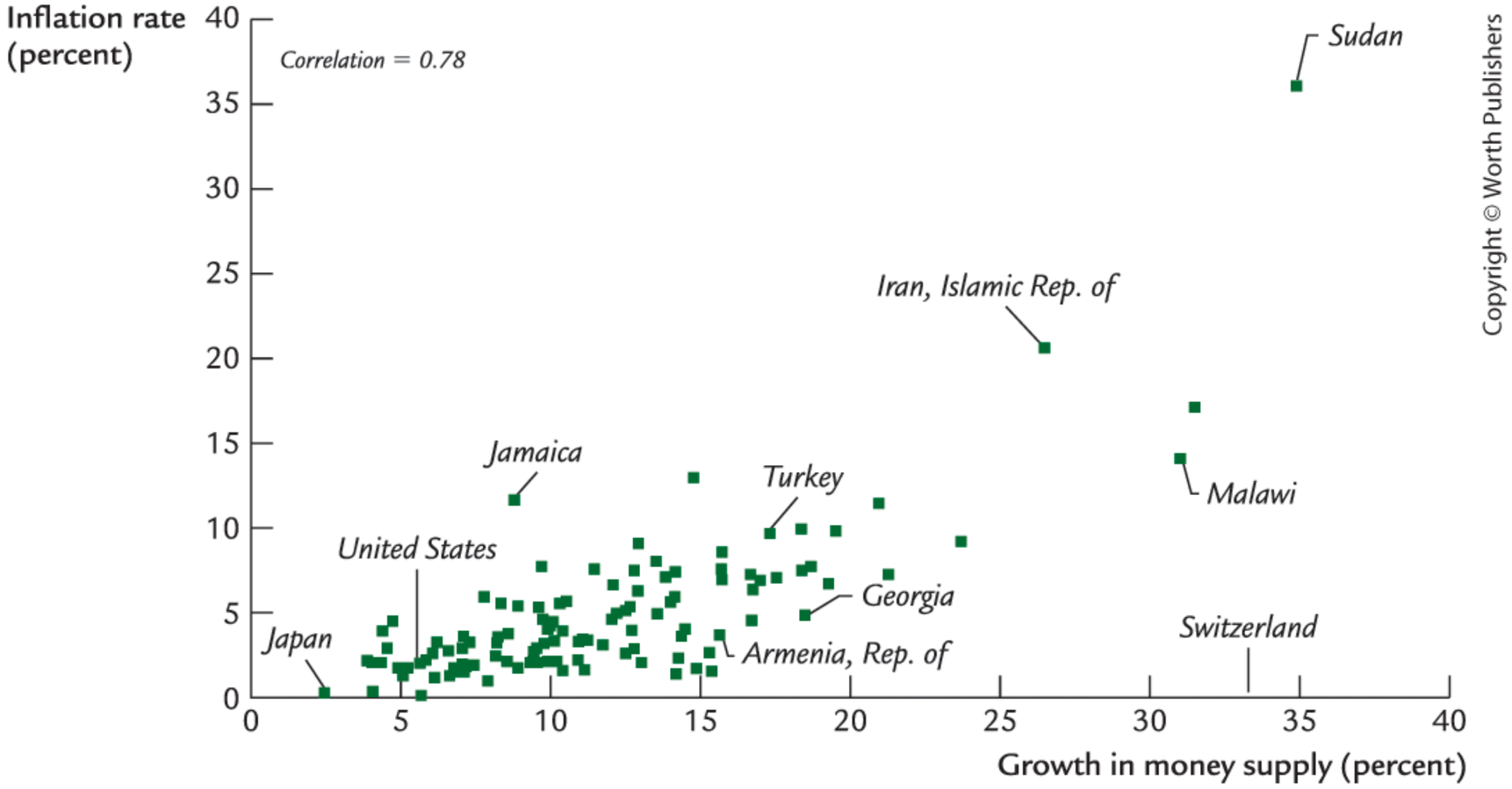
$$\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}$$

- Assumption 2: $\frac{\Delta Y}{Y}$ depends on the factors of production and technology
  - All of these are taken as given (for now)
- Assumption 3: the monetary authority can control $\frac{\Delta M}{M}$
- **QTM: the monetary authority can control inflation through money supply**

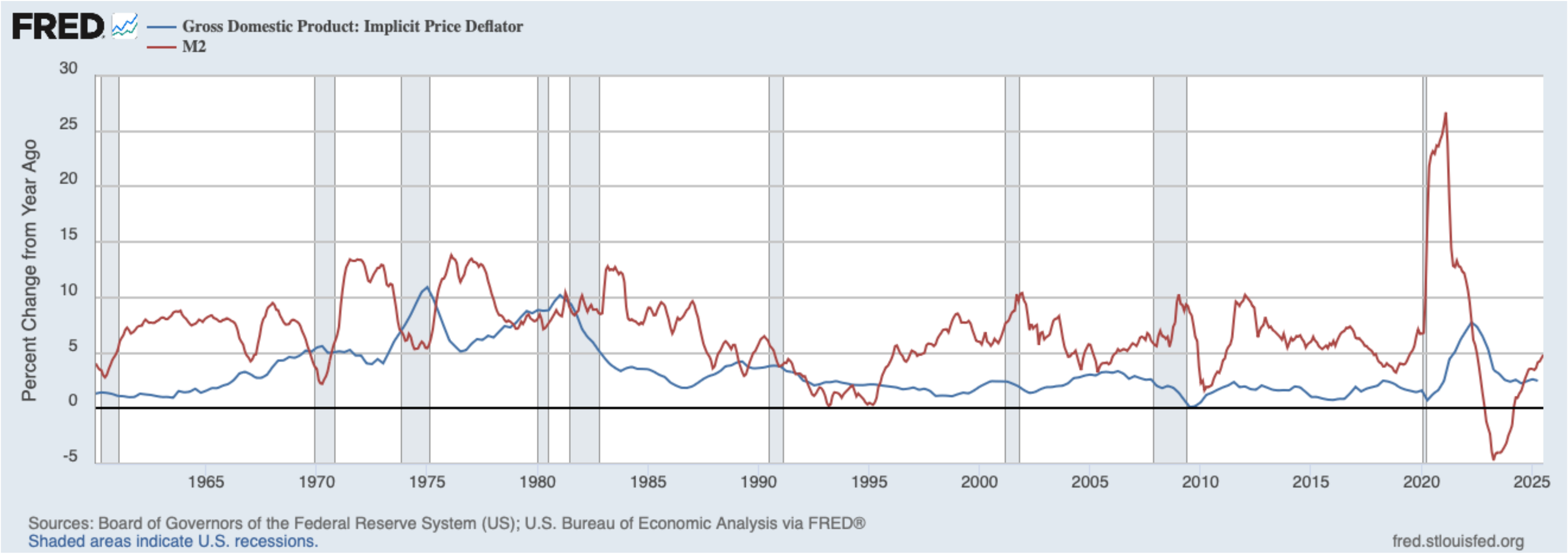
Confronting QTM with the data

- The quantity theory of money implies:
  1. Countries with higher money growth rates should have higher inflation rates
  2. The long-run trends of inflation and money supply growth should be similar
- Are the data consistent with these implications?

Inflation vs. money supply growth



US inflation vs. money supply growth



Why can’t we just print money?

- To spend more without raising taxes, the government can create money
- The “revenue” raised from money creation is called *seigniorage*
  - Pronounced SEEN-your-idge
- *Inflation tax:* money creation to raise revenue causes inflation
  - It is 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):

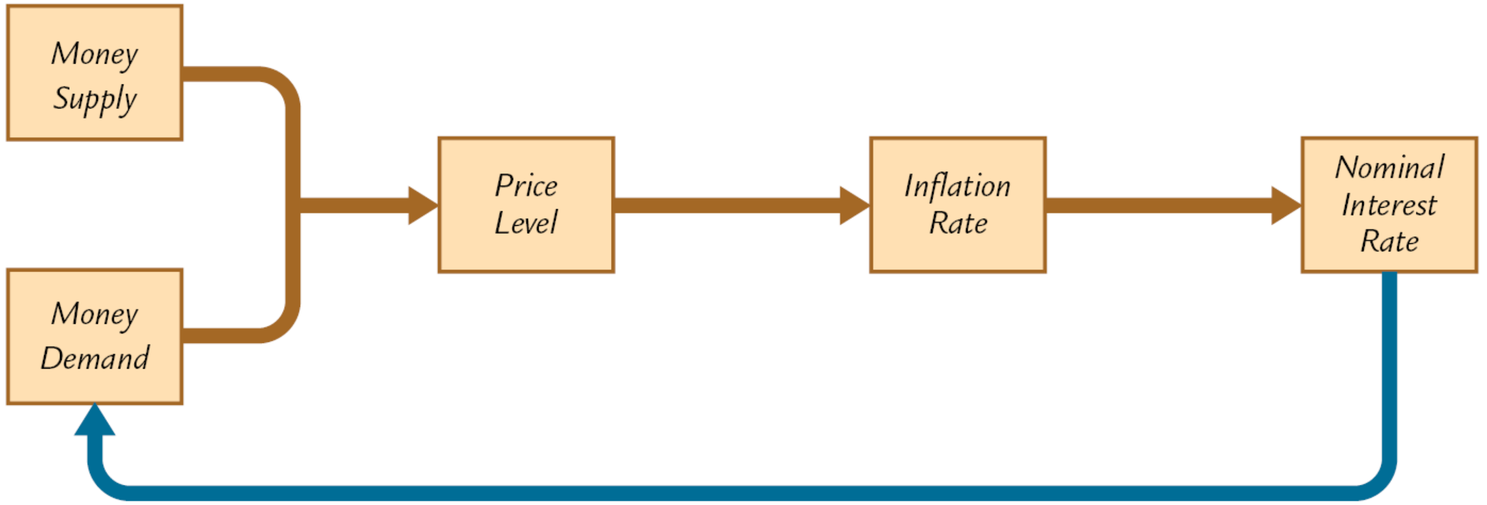
$$r = i - \pi$$

- Therefore:

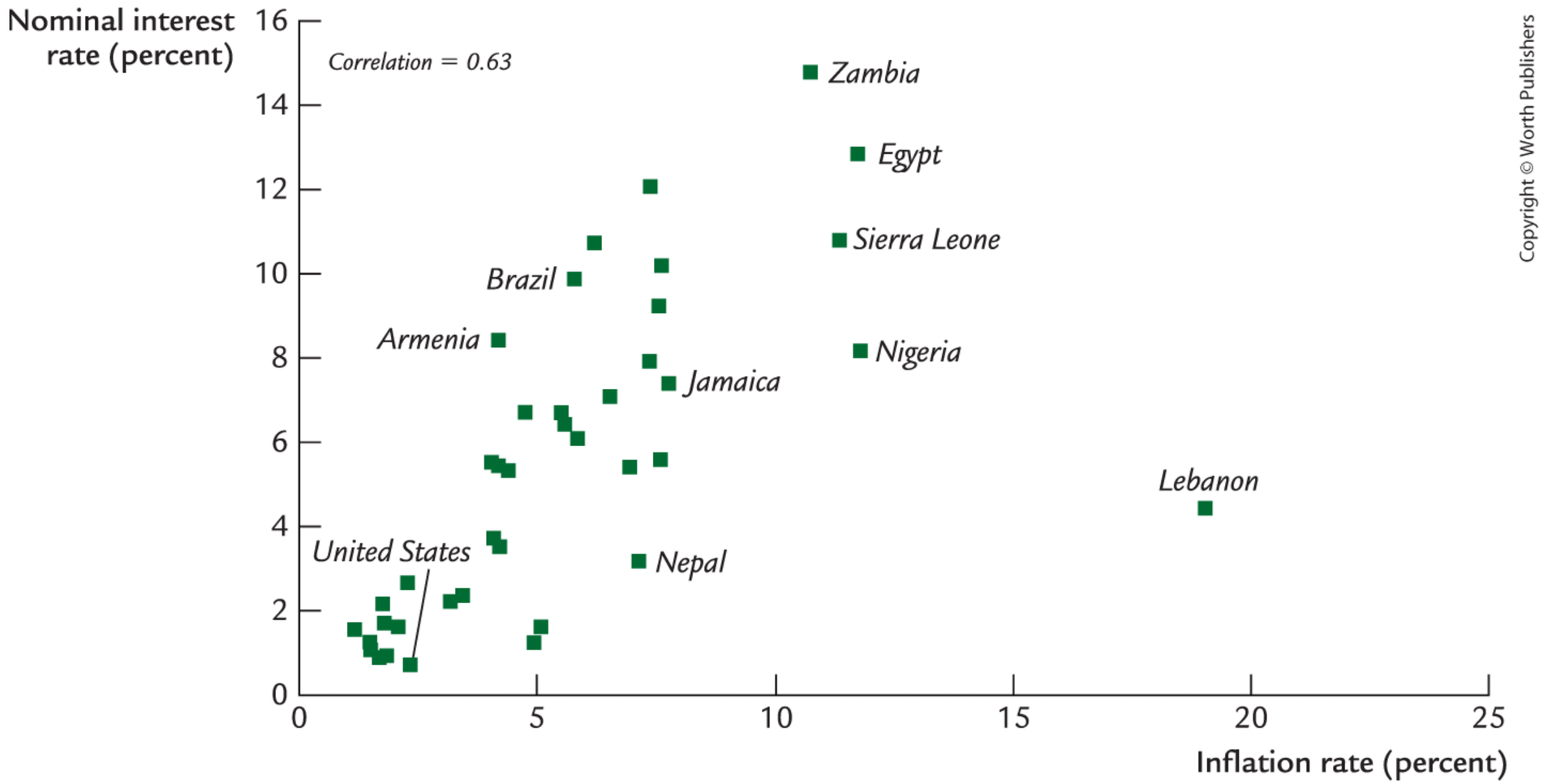
$$i = r + \pi$$

The Fisher effect

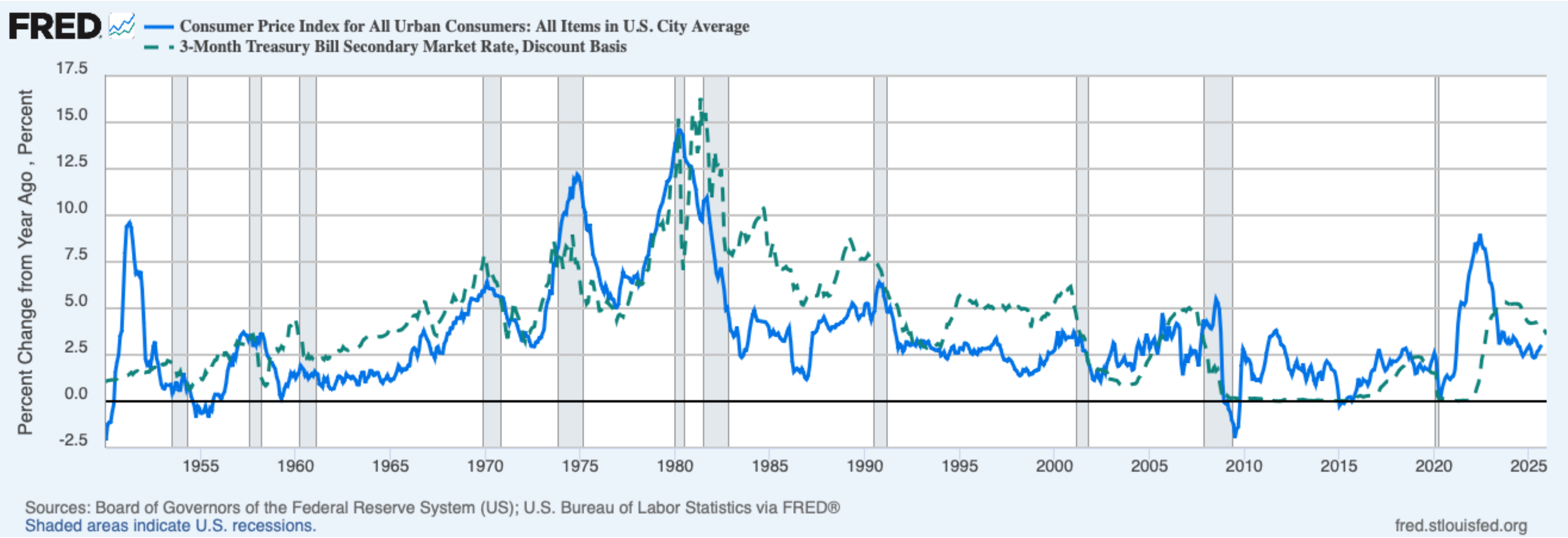
- The Fisher equation: $i = r + \pi$
- From the loanable funds model: $S = I$ determines r
- Hence, an increase in π causes an equal increase in i
- This one-for-one relationship is called the Fisher effect



Inflation vs. nominal interest rates



US inflation vs. nominal interest rates



NOW YOU TRY

- 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 monetary authority increases the money growth rate by 2 pp per year, find Δi

  c. Suppose the growth rate of Y falls to 1% per year.

     - What will happen to π?
     - What must the monetary authority do if it wishes to keep π constant?

NOW YOU TRY

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

  a. First, find π: $\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y} = 5 - 2 = 3$

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

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

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

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

Money demand and the interest rate

- In QTM, 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
  - I.e., the opportunity cost of holding money
    - … instead of holding bonds or other interest-earning assets
- So, money demand depends negatively on i

The money demand function

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

- $\left(\frac{M}{P}\right)^{D}$: real money demand
  - Depends negatively on i, the opportunity cost of holding money
  - Depends positively on Y, spending on goods & services
- L is used for the money demand function because money is the most liquid asset

The money demand function

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

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

- $E\pi$: expected inflation rate
  - Why $E\pi$? When people are deciding on money demand, they don't know what inflation will be
  - Hence, the nominal interest rate relevant for money demand is $r + E\pi$
- $i - E\pi$: ex ante real interest rate
  - The real interest rate people expect at the time they buy a bond or take out a loan
- $i - \pi$: ex post real interest rate
  - The real interest rate actually realized

Equilibrium

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

- $\frac{M}{P}$: the supply of real money balances
  - M: exogenous
  - P: endogenous
    - P adjusts to ensure $Y = F(K, L)$

How P responds to ΔM

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

- For given values of r, Y, and $E\pi$, M and P must change by the same amount
  - Just like in QTM
- Yet in real life, changes in M can change $E\pi$
- Therefore, the effect of money on prices is more complicated than in QTM

What about expected inflation?

- Over the long run, people don't consistently over- or under-forecast inflation
- Therefore, $E\pi = \pi$ 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 $\Delta E\pi$

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

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

$$\uparrow E\pi \implies \uparrow i \text{ (Fisher effect)}$$

$$\implies \downarrow \left(\frac{M}{P}\right)^{D}$$

$$\implies \uparrow P \text{ to make } \frac{M}{P} \text{ fall}$$

The classical view of inflation

- Classical view: change in prices is just 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

- *Shoe leather costs*
  - 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
  - Lower money holdings given same spending means more frequent trips to the bank
  - Why shoe-leather? More frequent trips to the bank wear out people's shoes faster

The costs of expected inflation

- *Menu costs*
  - The costs of changing prices
  - Examples:
    - Cost of printing new menus and mailing out catalogs
    - Time spent deciding what new prices should be
  - The higher inflation is, the more frequently firms must change their prices

The costs of expected inflation

- *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

- *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 stocks
    - Dec 31: you sell the stocks for $11,000, for a nominal capital gain of $1,000 (10%)
    - Suppose π is 10% during the year; then 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 by 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 lenders to borrowers

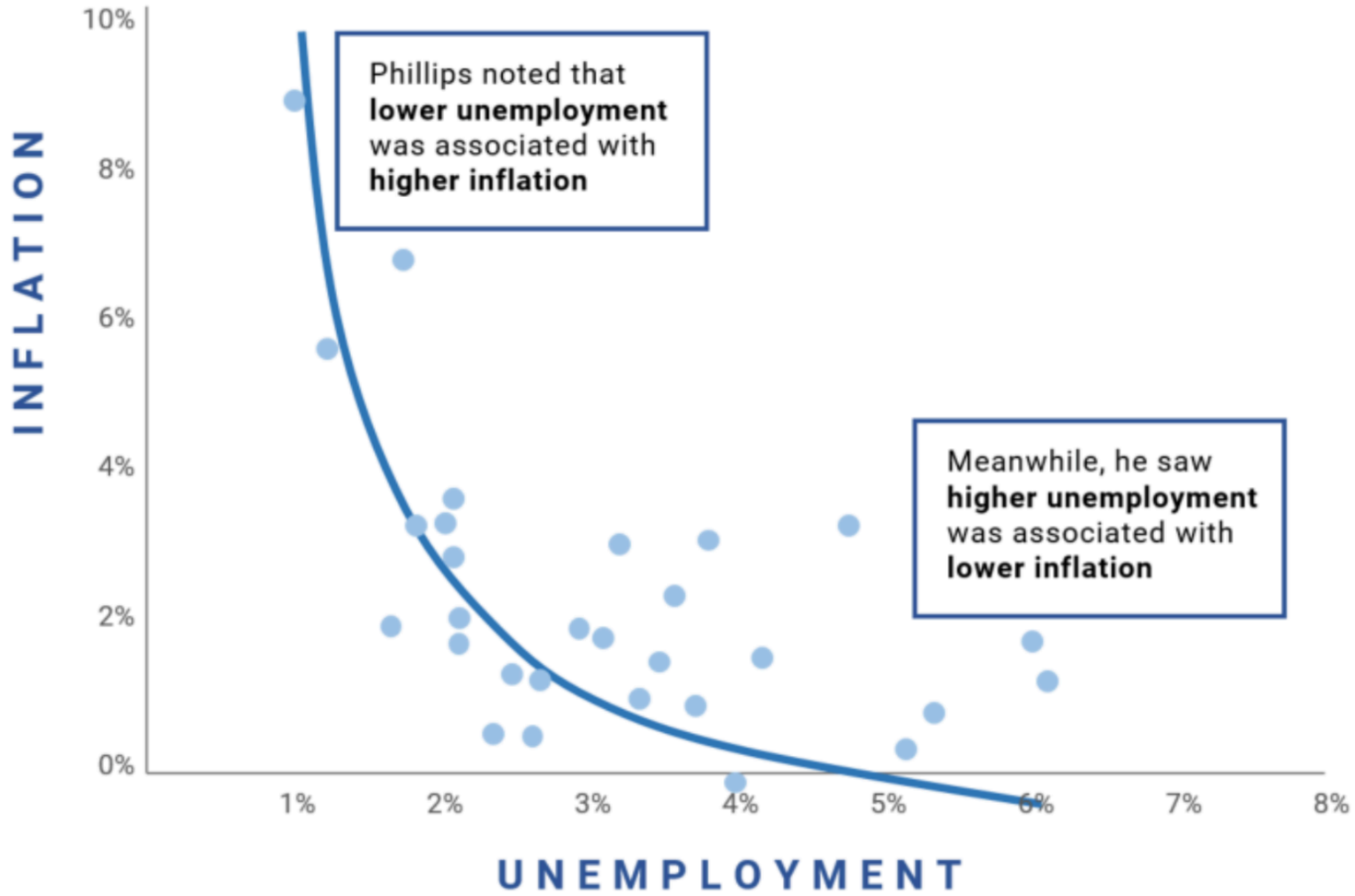
The costs of unexpected inflation

- *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 equilibrate without nominal wage cuts
- Therefore, moderate inflation improves the functioning of labor markets

The Phillips curve



Source: Federal Bank of St. Louis

Hyperinflation

- Common definition: $\pi \geq 50\%$ per month
- All the costs of inflation described earlier become *huge* under hyperinflation
- Money ceases to function as a store of value
- 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

- Suppose a government cannot raise taxes or sell bonds
- Then 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

- *Real variables:* measured in physical units—quantities and relative prices
- *Examples:*
  - 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

- *Nominal variables:* measured in money units
- *Examples:*
  - 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

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

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!
- FTPL: fiscal (not monetary) policy determines the price level, thus inflation
- Basic logic of FTPL:
  - The central bank creates money out of government debt
  - 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

Modern monetary “theory” (MMT)

- Decades of low interest rates, low inflation, and unorthodox monetary policy
- MMT: gov’t can print money indefinitely since it is the sole issuer of currency
- Hence, deficits do not matter as the gov’t can just print money to pay debt
- *Why is this wrong?*

Modern monetary “theory” (MMT)

- Decades of low interest rates, low inflation, and unorthodox monetary policy
- MMT: gov’t can print money indefinitely since it is the sole issuer of currency
- Hence, deficits do not matter as the gov’t can just print money to pay debt
- *Why is this wrong?* Inflation tax!
- Besides, MMT does not offer testable hypotheses, so it is not a theory

Inflation

Money

Money: definition and functions

- 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

- 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

- For barter to operate, the *double coincidence of wants* must be satisfied
  - Say I have a pen and I *want* an eraser
  - Then 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

- In a monetary economy, money is used as a medium of exchange and account
  - If I want an eraser, I need to find someone who has an eraser
  - I *know* this person wants my money in exchange
  - Likelihood of an exchange is higher in a monetary economy than in a barter economy

Money and barter

- Barter economy:
  - Only simple transactions are possible
  - Searching for a trade partner can be time consuming and costly
- Monetary economy:
  - More complex transactions are possible
  - The cost of transacting is likely to be low

Types of money

1. Fiat money
    - Has no intrinsic value
    - *Example:* the paper currency we use
2. Commodity money
    - Does have intrinsic value
    - *Example:* gold coins

NOW YOU TRY

- Which of these are money?

1. currency
2. checks
3. deposits in checking accounts (“demand deposits”)
4. credit cards
5. certificates of deposit (“time deposits”)
6. cryptocurrency

NOW YOU TRY

- 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

NOW YOU TRY

- 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”): maybe
  - Depends on the length of time
  - They are a store of value and are measured in money units but are not easily spent
  - As you’ll see in a few slides, there are multiple measures of the money supply

NOW YOU TRY

- Cryptocurrency: no (not in Spring 2026)
  - 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

- The *money supply* is the quantity of money available in the economy
- In simple economies, it is easy to measure the quantity of money
  - *Example:* number of pebbles in our village
- In modern economies, measuring money is not that easy

Measuring money

- 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 illiquid assets

Measuring money

- We use different measures of money, often denoted as *M0*, *M1*, and *M2*
- *M0* (monetary base) = currency in circulation + reserve balances
- *M1* = *M0* + demand deposits + traveler's checks + other checkable deposits
- *M2* = *M1* + money market mutual fund balances + saving deposits

Money supply measures

Symbol	Assets included	Amount in Nov 2025 (billions of USD)	Percent of *M2*
C	Currency	2,422.7	11
M0	*C* + reserve balances	5,301.9	24
M1	*M0* + demand deposits + traveler's checks + other checkable deposits	19,040.6	85
M2	*M1* + money market mutual fund balances + saving deposits	22,329.8	100

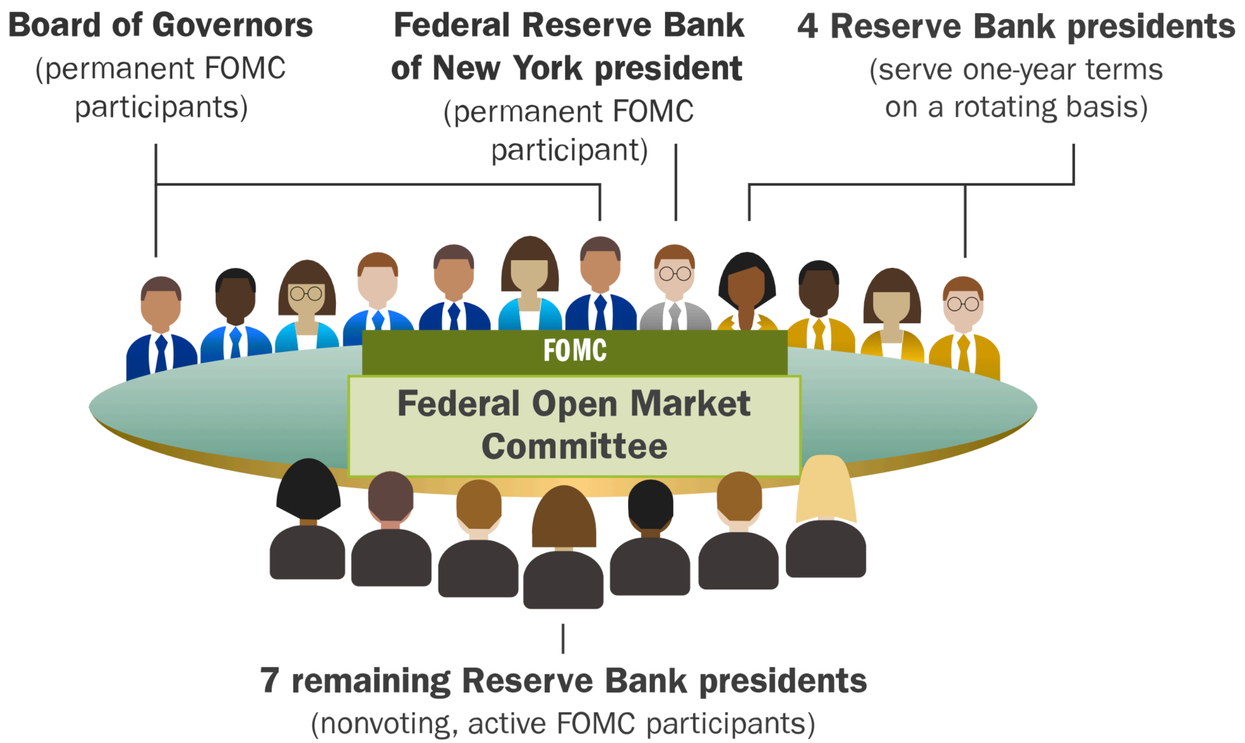
Source: Federal Reserve Board

Central banks

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

Federal Open Market Committee

- Monetary policy decisions reside with the *Federal Open Market Committee*



Source: Federal Reserve Board

The Fed Board

- Members are nominated by POTUS and confirmed by the senate
- 4-year mandate (14-year staggered)
- Current board members

12 regional Feds

- Regional Fed presidents are chosen by their individual boards of directors, subject to approval of the Fed Board

- Current NY Fed board of directors

Source: Federal Reserve Bank of New York

The dual mandate

- 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 dual mandate

- 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
  - … regulating banks (supervision)

Tools of monetary control

1. *Open-market operations* (OMOs)

   - The purchase and sale of (short-term) government bonds to control money supply
   - If the Fed wants to increase money supply, it buys gov't bonds from members of the public
   - If the Fed wants to decrease money supply, it sells gov't bonds to members of the public

2. *Quantitative easing* (QE)

   - 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

Tools of monetary control

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

- The Fed influences the monetary base and money supply by changing the interest rate

Central bank independence

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

Central bank independence

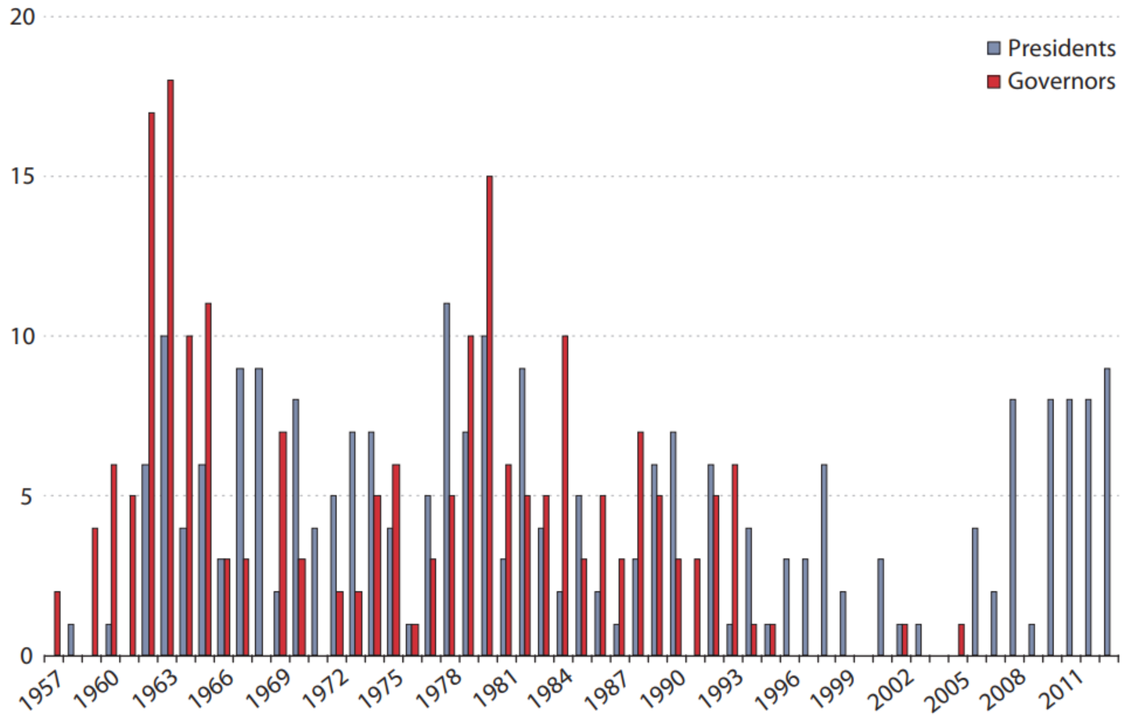
- The *independence* of the central bank is crucial for a well-functioning economy
- *Independence from what?* Fiscal policy!
- Pressure to increase money supply to finance government spending
- Why is that a bad idea? Inflation tax!
- Fiscal policy operates on a shorter term than monetary policy
  - Therefore, 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

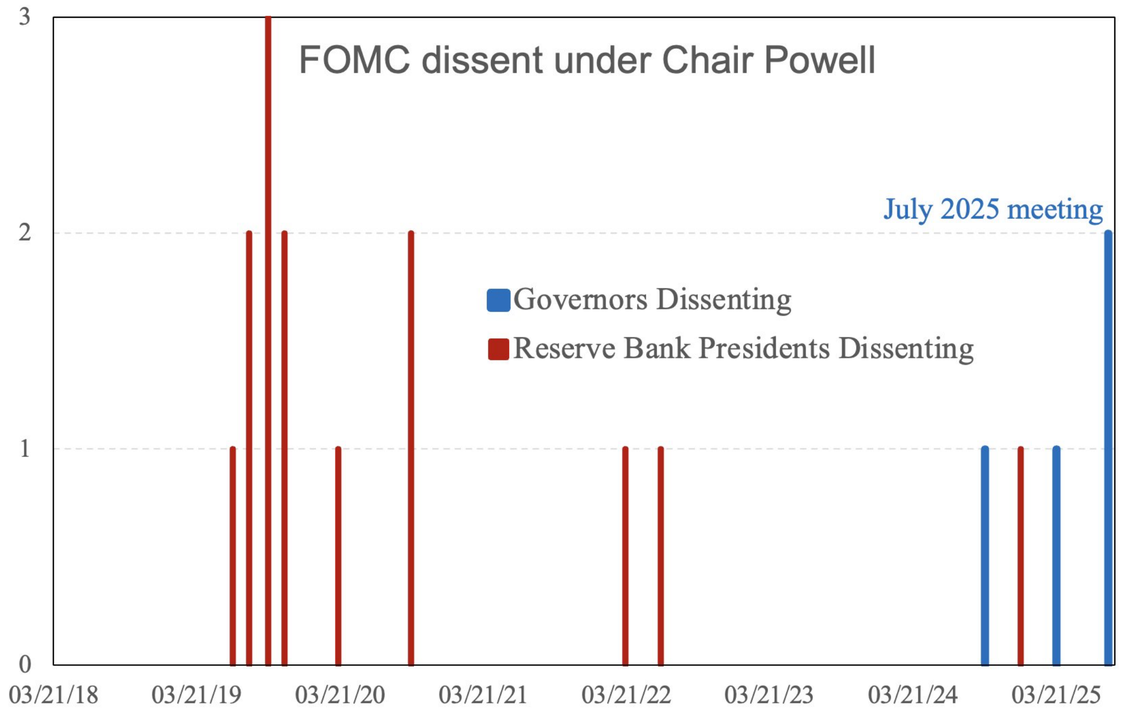
- FOMC meetings take place every 6 weeks or so
- Dissent is recorded:



Source: Federal Reserve Bank of St. Louis

FOMC meetings

- Next one is March 17–18, 2026
- Current dissents



Source: Federal Reserve Bank of St. Louis

SUMMARY

- Velocity: the ratio of nominal expenditure to money supply
  - Captures the rate at which money changes hands
- Quantity theory of money (QTM)
  - Assumes velocity is constant
  - Concludes that the money growth rate determines the inflation rate
  - Applies in the long run

SUMMARY

- Nominal interest rate
  - Equals real interest rate + inflation rate
  - The opportunity 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 of money
  - Also depends on the nominal interest rate in reality
  - If so, then changes in expected inflation affect the current price level

SUMMARY

- Costs of inflation
  - Expected inflation: shoe-leather costs, menu costs, tax and relative price distortions
  - Unexpected inflation: arbitrary redistributions of wealth between borrowers and lenders
- Benefits of inflation: allows nominal wages to adjust

SUMMARY

- 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

- 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

- 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